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Tuesday, February 9

Sweet Corn – Ray Samulis, Agricultural Agent, Rutgers Cooperative Extension Burlington County

Technologies for Marketing and Promotion – Kenesha Reynolds-Allie, Agricultural Agent, Rutgers Cooperative Extension Warren County

Organic Agriculture – Joe Heckman, Specialist in Soil Fertility, Rutgers Cooperative Extension

Wine Grapes I – Gary Pavlis, Agricultural Agent, Rutgers Cooperative Extension Atlantic County

Hydroponics/Aeroponics – A.J. Both, Extension Specialist in Agricultural Engineering, Rutgers Cooperative Extension

Farm Safety – Ray Samulis, Agricultural Agent, Rutgers Cooperative Extension Burlington County

Direct Marketing/Agritourism – William Hlubik, Agricultural Agent, Rutgers Cooperative Extension Middlesex County

Alternative Production Animals – Bob Mickel, Ag and Regional Livestock Agent, Rutgers Cooperative Extension Hunterdon County

Wine Grapes II – Hemant Gohil, Agricultural Agent, Rutgers Cooperative Extension Gloucester County

Greenhouses – A.J. Both, Extension Specialist in Agricultural Engineering, Rutgers Cooperative Extension

Field & Forage Crops – Bill Bamka, Agricultural Agent, Rutgers Cooperative Extension Burlington County

Bees – Joe Ingerson-Mahar, Vegetable IPM Coordinator, Rutgers Cooperative Extension

Wednesday, February 10

Small Fruit/Strawberry – Peter Nitzsche, Agricultural Agent, Rutgers Cooperative Extension Morris County

Pesticide Efficacy – Bill Sciarappa, Agricultural Agent, Rutgers Cooperative Extension Monmouth County

Cole Crops and Lettuce – Wesley Kline, Agricultural Agent, Rutgers Cooperative Extension Cumberland County

Alternative Crops – Michelle Casella/Bill Bamka, Agricultural Agents, Rutgers Cooperative Extension Gloucester/Burlington County

Peppers/Tomatoes – Andy Wyenandt, Extension Specialist in Vegetable Plant Pathology, Rutgers Cooperative Extension

Blueberries – Gary Pavlis, Agricultural Agent, Rutgers Cooperative Extension Atlantic County

Season Extension – Richard VanVranken, Agricultural Agent, Rutgers Cooperative Extension Atlantic County

Squeezing More $ Out of Your Soil – Steve Komar, Agricultural Agent, Rutgers Cooperative Extension Sussex County

Vine crops/Pumpkins – Michelle Casella/Andy Wyenandt, Agricultural Agent Gloucester County/Specialist in Vegetable Pathology, Rutgers Cooperative Extension

Food Safety – Meredith Melendez, Agricultural Agent, Rutgers Cooperative Extension Mercer County

Thursday, February 11

Food Safety Modernization Act Training – Wesley Kline/Meredith Melendez, Agricultural Agents, Rutgers Cooperative Extension Cumberland/Mercer County

IPM: Know your Target Before you Shoot – Joe Ingerson-Mahar/Kris Holmstrom, Vegetable IPM Coordinator/IPM Research Project Coordinator, Rutgers Cooperative Extension

Basil Workshop – Andy Wyenandt, Extension Specialist in Vegetable Pathology, Rutgers Cooperative Extension

Table of Contents

Sweet Corn

SWEET CORN INSECTICIDES AND CHANGING INSECT CONDITIONS

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Synthetic pyrethroid insecticides (IRAC-3)* have been the primary class of insecticide used to manage lepidopterous (caterpillar) pests of sweet corn for 20+ years. Many of the insecticides in this class are still very effective, but some target pests have developed varying degrees of resistance to pyrethroids. Additionally, pyrethroid insecticides are devastating to many of the beneficial insects that control secondary pests of sweet corn. Repeated use of this class of insecticide can result in outbreaks of pests like aphids or mites, which then must be managed separately.

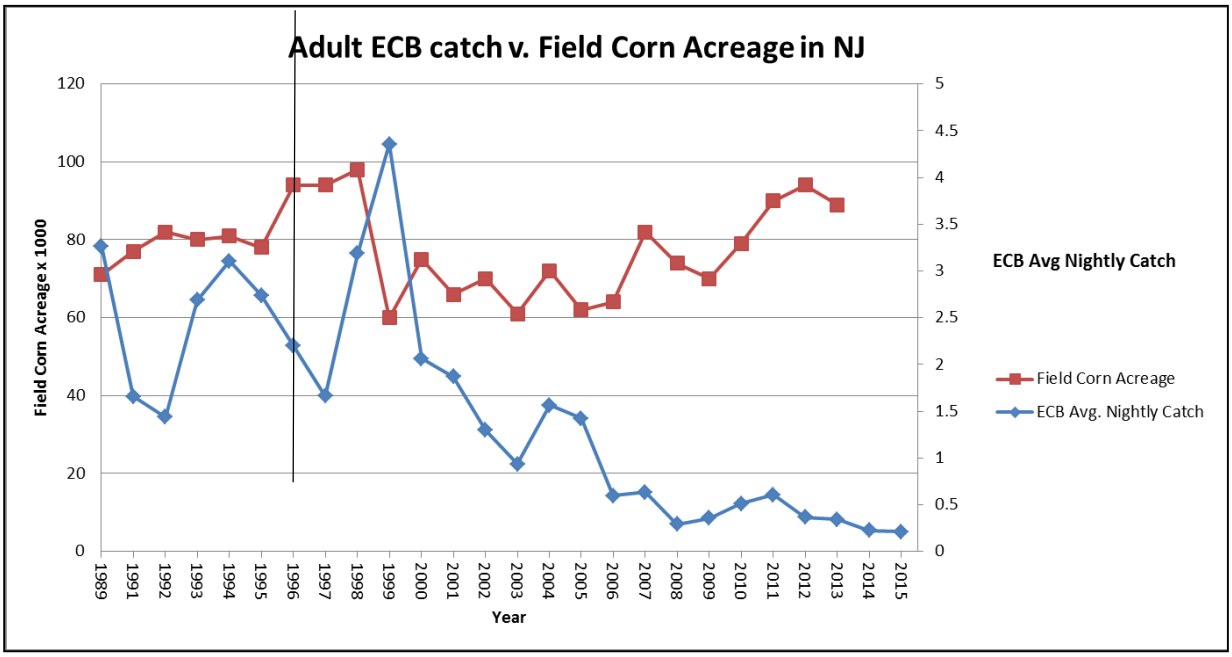
New classes of insecticides, with novel modes of action began to come on the market over 10 years ago. Among these newer materials are those based on spinosyn (IRAC-5). These include Entrust and Blackhawk (spinosad), and Radiant (spinetoram). More recently, the diamide group (IRAC-28) has entered the market. These include Belt (flubendiamide), Coragen (chlorantraniliprole) and Verimark/Exirel (cyantraniliprole). The more recent materials are, with some variability, effective against the caterpillar pests of sweet corn. Additionally, they have reduced impact (spinosyn) or almost no impact (diamides) on beneficial insects. They do not control secondary insect/mite pests of sweet corn, except that their use does not generally eliminate insects that keep secondary pests in check. An exception would be sap beetle, which is not adequately controlled by natural enemies, and must be managed with broad spectrum insecticides.

The complex nature of sweet corn insect control has been made more so, as agrichemical companies have begun offering blended products. Chief among these is one containing a pyrethroid (lambda-cyhalothrin) and a diamide (chlorantriniliprole), called Besiege. Further, transgenic sweet corn varieties, expressing genes toxic to caterpillars have become more common in fresh market production. Initial releases have been effective against some pests, while newer products have improved efficacy against a wider range of caterpillar pests. This paper incorporates insecticide efficacy trials from the mid-Atlantic states, as well as insecticide resistance data and discussion of management tactics for primary and secondary insect pests of sweet corn.

Primary caterpillar pests of sweet corn.

European corn borer (ECB):

Populations trending steeply downward with increased adoption of *B.t.* transgenic field corn in ag areas where other host crops are grown. See graph (below) of ECB adult catches in NJ blacklights relative to field corn acreage. B.t. transgenic field corn entered market in 1996, with NJ adoption increasing from an average of 42% in 2006 to 78% in 2013.



Goal – manage ECB larval population ***in plants*** prior to ear infestation.

Resistance/Other Issues: Not significant. Pyrethroid, carbamate, spinosyn and diamide insecticides all work well.

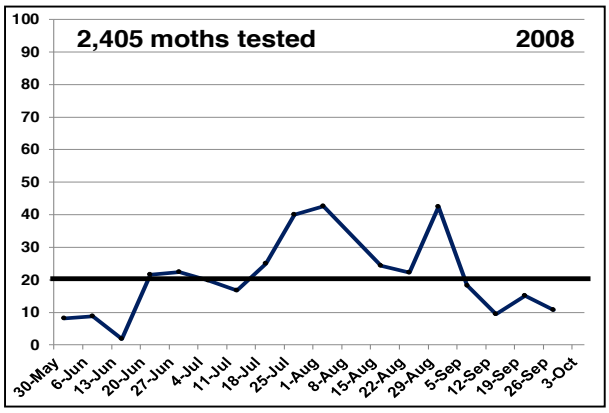
Corn earworm (CEW):

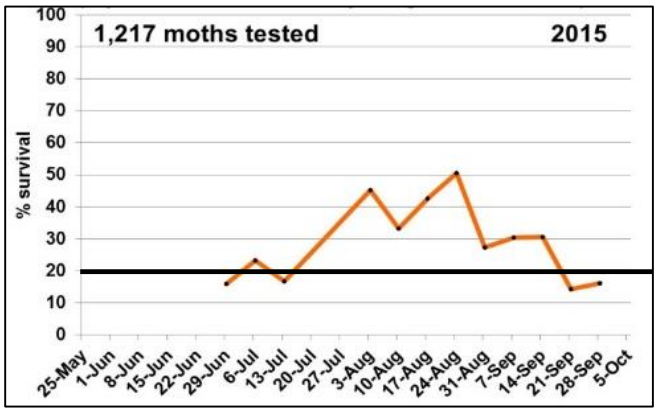
Populations also trending downward, but subject to uncertainty due to occasional overwintering success and late season migrations.

Goal – manage CEW larvae on silks between egg hatch and ear infestation.

Resistance/Other Issues: Documented but variable resistance to pyrethroids. Insecticide applications ***can*** flare aphid populations. Reduced spray schedules leave room for sap beetles.

Va. Tech entomologist **Ames Herbert** has conducted vial tests with live CEW moths captured in southeastern VA to determine the extent of their resistance to the pyrethroid cypermethrin. Vials contain 5 µg cypermethrin. % moths surviving have been plotted by week (when individuals were captured) since 2008. These graphs (below) show similar resistance trends from 2008 to 2015. Note the dramatic fluctuation in survival rate, indicating movement into southeastern VA of pyrethroid resistant adults.





The following data are summarized from an insecticide efficacy trial conducted by Univ. of Delaware entomologist, **Joanne Whalen**. The purpose of the trial was to evaluate a standard pyrethroid (Warrior) against newer diamide products combined or in rotation with pyrethroid or carbamate products. Note that Voliam Xpress (Coragen + Warrior) is now only available as Besiege. Spray regimens including Voliam Xpress provided consistently excellent control against both CEW and FAW, where Warrior II alone was substandard by comparison. It is also interesting to note the reduced control of CEW and fall armyworm (FAW) when the other diamide product (Belt) was used in this trial.

Treatment	Rate/A	App. Date	% clean ears	% CEW damaged ears	% FAW damaged ears
Belt 480 SC + LI700 Baythroid XL	3 oz + 0.25% v/v 2.8 oz	8/10,13,17,20 8/24	66.45d	29.98b	0.89b
Belt 480 SC Baythroid XL	3 oz 2.8 oz	8/10,13,17,20 8/24	78.58c	20.49bc	0.93b
Coragen 1.67 SC + MSO Lannate LV + Asana XL	3.5 oz + 0.5% v/v 24 oz + 9.6 oz	8/10,13,17 8/20, 24	91.93ab	8.07cd	0.00b
Coragen 1.67 SC + MSO Lannate LV + Asana XL	5 oz + 0.5% v/v 24 oz + 9.6 oz	8/10,13,17 8/20, 24	93.73ab	6.28d	0.00b
Coragen 1.67 SC + LI700 Lannate LV + Asana XL	3.5 oz + 0.5% v/v 24 oz + 9.6 oz	8/10,13,17 8/20, 24	90.10ab	10.86cd	0.00b
Lannate LV + Asana XL	24 oz + 9.6 oz	8/10, 13, 17, 20, 24	96.25ab	3.75d	0.00b
Warrior II	1.92 oz	8/10, 13, 17, 20, 24	87.03bc	7.20d	5.78ab
Voliam xpress Lannate LV + Warrior II	9 oz 24 oz + 1.92 oz	8/10,13,17 8/20, 24	99.11a	0.89d	0.00b
Voliam xpress Warrior II	7 oz 1.92 oz	8/10,13,17,20 8/24	98.11ab	1.89d	0.00b
Voliam xpress Warrior II	9 oz 1.92 oz	8/10, 13, 17 8/20, 24	98.28ab	1.73d	0.00b
Voliam xpress Alternate with Warrior II	7 oz 1.92 oz	8/10, 17, 24 8/13, 20	94.99ab	5.00d	0.00b
Untreated			7.35e	89.08a	11.11a

The following data are summarized from 2014 insecticide efficacy trials conducted by Virginia Tech entomologists, **Tom Kuhar** and **Helene Doughty**. In the first study, diamide products (Belt and Coragen) as well as spinosyn products (Radiant (spinetoram) and Blackhawk (spinosad)) were rotated with Hero, a combination of two pyrethroids (bifenthrin and z-cypermethrin). The two component pyrethroid performed well in this test, underscoring the unpredictability of pyrethroid resistance in CEW populations. Notably, the spinosad product Blackhawk did not perform as well as Radiant or diamide products in eliminating CEW from ears.

Treatment	Rate / acre	% marketable* ears	% unmarketable ears	Mean no. CEW larvae
1. Untreated Control		54.1	45.9	6.0 a
2. Belt rotated with Hero 1.24EC	2 fl. oz fb. 4 fl. oz	57.4	42.7	0.5 b
3. Belt rotated with Hero 1.24EC	2.5 fl. oz fb. 4 fl. oz	66.0	34.0	0.5 b
4. Belt rotated with Hero 1.24EC	3 fl. oz fb 4 fl. oz	75.4	24.6	0.3 b
5. Coragen rot.with Hero 1.24EC	3.5 fl. oz fb 4 fl. oz	65.0	35.0	0.3 b
6. Besiege rot. with Hero 1.24EC	7 fl. oz fb 4 fl. oz	70.7	29.3	1.3 b
7. Blackhawk rot. with Hero 1.24EC	2.2 oz fb 4 fl. oz	62.4	37.6	2.5 ab
8. Radiant rot. with Hero 1.24EC	3 fl. oz fb 4 fl. oz	61.9	38.1	0.0 b
9. Hero 1.24EC	4 fl. oz	75.8	24.2	0.8 b
P-Value from Anova		ns	ns	0.0001

The second study was primarily designed to look at labeled materials, and an as yet unnamed diamide insecticide (cyclaniliprole), with Warrrior II (lambda cyhalothrin), although a new pyrethroid (Fastac) and cylaniliprole were also included on their own. Here, the diamide/pyrethroid combination (Besiege) rotated with the pyrethroid (Warrior) provided the best control. A common thread among all trials is the very good control provided when diamide products are include in rotation with a pyrethroid material.

Treatment	Rate/acre	% total damaged ears	Mean # live CEW larvae/25 ears
Untreated		88 a	28 a
Blackhawk r/w Warrior II ZT	3.2 fl oz / 1.92 fl oz	42 cd	12.3 b
Besiege r/w Warrior II ZT	10 fl oz / 1.92 fl oz	4 f	0.3 d
Fastac	3.8 fl oz	45 bcd	5.3 cd
Cyclaniliprole 50 SL	22 fl oz	70 b	14.8 b
Cyclaniliprole 50 SL	16.4 fl oz	56 bc	8.5 bc
Coragen r/w Warrior II ZT	5 fl oz / 1.92 fl oz	21 de	1.8 d
Belt r/w Warrior II ZT	2 fl oz / 1.92 fl oz	55 bc	8.8 bc
Cyclaniliprole 50 SL r/w Warrior II ZT	16.4 fl oz / 1.92 fl oz	16 ef	1.5 d
P-value from ANOVA		<0.0001	<0.0001

The use of pyrethroid products or combination products that include pyrethroids can cause problems with aphids during the silk period. In New Jersey, the typical response to the presence of aphids has been to rotate with the carbamate product Lannate. This has worked well for us. However, in 2014-15, CEW pressure was so low that many growers were still on 5-6 day silk spray schedules as late as Sept. 1. Using Lannate at every other spray resulted in 10-12 days between applications, with pyrethroids in between. This was likely the cause of more frequent aphid problems in 2014. It is noteworthy that the neonicotinoid product Assail (acetamiprid) is labeled for aphid control in sweet corn. This product is also the sole neonicotinoid to not carry a bee warning on the label. While applications should be managed to avoid direct bee exposure, Assail could be an effective tool to manage aphid populations in sweet corn. Scouts should note the presence of aphids as plantings approach full tassel. An aphid population at that point warrants the use of materials targeting that pest along with materials that control the caterpillar pests.

Some growers have opted to use transgenic sweet corn varieties, especially for late season plantings when CEW pressure is highest. These hybrids express genes from the soil dwelling bacterium *Bacillus thuringiensis* (*B.t.*), which are toxic to caterpillars. Initial *B.t.* sweet corn varieties for fresh market are extremely effective against ECB larvae, but are much less effective on FAW, and have become somewhat variable in control of CEW. Newer varieties, expressing more genes, are now available for fresh market. The following data are summarized from a study conducted by Univ. of Maryland entomologist, Galen Dively in 2011. The study compares the efficacy of original *B.t.* types (cry1Ab) with newer varieties expressing Cry1Ab and Cry 2Ab genes and related non-*B.t.* varieties. Sprays were at 3-day intervals starting at fresh silk. Note that the variety expressing multiple genes for resistance provided very good, but not complete control of CEW. It is critical to know what the population pressure of CEW and FAW is at all times, as these hybrids may allow some caterpillars to survive. **The first 2-3 silk sprays are very important for clean ears.** *B.t.* hybrids do not control aphid or sap beetles.

Hybrid	Control Program	%marketable ears	%CEW damage	CEW/ear
BC 0805 *B.t.* Cry 1Ab	2 sprays	54	46	0.5
	Unsprayed	10	87	1.2
Obsession II *B.t.* Cry1Ab Cry2Ab	2 sprays	92	11	>0.1
	Unsprayed	74	37	0.4
Obsession non-*B.t.*	6 sprays	72	30	>0.1
	Unsprayed	4	96	0.9
Providence non-*B.t.*	Unsprayed	0	100	1.2

Note. Thanks to Galen Dively, Ames Hebert, Tom Kuhar, Helene Doughty and Joanne Whalen for sharing data and information contained in this article. – KH

*IRAC – Insecticide Resistance Action Committee

UPDATE ON BIRD CONTROL STRATEGIES IN SWEET CORN

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Bird damage as a concern for sweet corn growers has been with us since the development of sweet corn as a separate crop beyond just picking young field corn for human consumption. While it is true that the overall goal is to have no damage form birds in ripening sweet corn, getting to that level of control can be illusive at best in many growing operations. While processed sweet corn can tolerate small amounts of bird damage that can be removed during process, I know of no consumers who feel having even occasional damage is something desirable.

There are many different factors that come into play when we look at bird control in sweet corn over may years. Birds eat insects as an everyday part of their diet so it stands to reason if your bird insect control is less than desirable it is also likely that bird damage will be significant. Following an IPM approach to worm control will go a long way in helping limit bird damage. This can become difficult for smaller operations since you might be only picking a few rows a day to keep a constant supply of fresh corn for your roadside markets. Research has shown us that there is somewhat of a narrow window in the sweet corn season where sweet is most vulnerable to damage. In some areas, this damage can occur to seedlings as they are plucked from the ground by hungry birds. General however the most important time appears to approximately the last 3 days before harvest.

I would like to review what currently is avail be for sweet corn growers to control birds in their crops. Some of these technologies have been around for a long time and their acceptability for use will be very much tied to the size of the operation, production season, and how proactive the grower wants to be.

Shooting- What at one time was a reasonably effective method of control now seems to be of limited effectiveness in controlling birds. Bird flocks of today seem to be too massive in size to for farmers to have a chance at reducing the flock sizes significantly. Be sure to investigate the restrictions, ordinances, or other local requirements that might exist in your state or area.

Propane Cannons- Many famers have good results using propane guns to scare birds out of fields. Remember that a permit is required to use these guns. The permit is quite simple , is one page and is processed through the state fish and game office. Unfortunately, as outstate urbanizes more each year, there are more impediments to the successful use of propane guns namely houses. People like moving to what they perceive as the bucolic, quite farm areas and are upset when the sound of bird guns goes off on a continually repeating schedule. There is protection under the Right to Farm with this however making enemies with the new neighbors usually ends in losing the war when at some point in the future you may need support from the residents for something else. Many of the conflicts can be contained by being careful of the hours of operation of the cannons where people are annoyed even though you might be legally entitled to run the guns later. For maximum effectiveness be sure to move the location of the cannons frequently so that the birds do not habituate to the sounds.

Tip Cover- research of mine this past year and this year have made it evident that birds get into the ears easier if they are exposed by lack of tip cover. Varieties that I have tested range from 0” of tip cover all the way to 3” or more which is quite a difference

Severe Bird Damage 2015

Scare Eyes- Large scare eyes might be helpful but not of much use to other than small garden size plots of corn.

Audio distress Signals- Devices that have recorded birds in distress can help to effectively move birds out of the area where the sweet corn is ripening. They have some of the same problems that the cannons have in that sound can be annoying to neighbors and they will only be effective if they are moving around the field and not left in the same place all the time.

Field Crop Destruction- Farmer sin the summer are always under the gun to get practices done when the ideal timing occurs. Such is the care with old corn stalks left in the field or adjoining field. Everyone has good intentions however knocking down old stalks may not be a top priority. Sweet corn growers in Florida maintain a meticulous schedule and it is common for growers to disc up corn stubble within an hour or two to minimize spread of diseases and insects.

Bird Repellants- In the last few years there has been introduction of a series of new products that act as a repellant to bird in the field. The active ingredient is known as methyl anthralinate and is actually an extract of Concord grape juice. Since there are many new products are sure that sweet corn is one of the drops on the label and follow the phi for all products. In 2015 I decided to perform an experiment to determine the effectiveness of these products in controlling bird in a replicated, randomized block design. The treatments utilized for this study were no applications of methyl anthralinate, one application of methyl anthralinate, and two applications of methyl anthralinate.

Treatments-

1) No repellant applied
2) Applied on 10 and 4 day phi
3) Applied 10 day phi

Results:

Plot Design and % Bird Damage

35% Trt 1	49% Trt2	70% Trt1
41% Trt 2	42% Trt3	76% Trt3
26% Trt1	30% Trt2	58% Trt3

	Average % Bird Damage	
Treatment 1 Avg. no repellant	44%	
Treatment2 1 application	40%	
Treatment3 2 applications	59%	

Conclusions-

In this randomized research project, there were no significant differences in the amount of bird damage regardless of the treatment applied. This site was chosen because of it's know history of severe damage over many years. Treatments were applied by hand so that each ear was completely covered with spray. Methyl anthralinate applied closer to harvest might yield different results however the label warns against applied too late before harvest in order to avoid possible lingering grape odor.

Technologies for Marketing and Promotion

DEVELOPING WINE MARKETING STRATEGIES FOR THE MID-ATLANTIC REGION

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Mid-Atlantic consumer wine consumption and purchasing habits and appropriate wine marketing and promotion strategies were investigated though two Internet surveys that were administered (20-25 September 2013 and 22-24 October 2014) to participants residing in one of three states within the Mid-Atlantic U.S. region (New Jersey, New York, and Pennsylvania). With data indicating that U.S. wine industry sales and consumer demand continuing to increase, this research was conducted to understand the wine consumer who resides in the region, specifically their behaviors, psychographics, and demographic characteristics. Consumers who participated in the survey were age 21 and older; not a member of the wine industry; and had purchased and consumed wine at least once within the previous year. Data were collected pertaining to consumption frequency (e.g. daily, a few times a week, once a week), purchasing behavior, retail outlet preference (e.g. winery tasting room, retail store, Internet), and website and social networking outlets they felt were mandatory for a winery to implement. Additionally, consumers were asked to identify what promotion events and activities would encourage them to visit a winery tasting room and their perception of wines produced from grapes grown in the Mid-Atlantic region.

Nearly half of participants in each survey (32.1%, super core and 18.8%, core, from Survey 1 and 12.4%, super core and 36.0%, core, from Survey 2) were part of the “super core” and “core” consumption segments, with the highest frequency of respondents between 35 to 44 years of age and consuming wine “a few times a week.” Analysis indicated that 55.4% of participants responded that a Facebook Business Page was a mandatory social media tool that winery and tasting rooms should implement, while 65.2% felt a website for promoting the winery and wines produced was mandatory. As for promotion strategies that would encourage participants to a visit a winery or tasting room, 68.8% of respondents reported that a “sale section of merchandise,” followed by 67.6% wanting a “new wine featured each month at a discounted price” would appeal. Results concerning consumer perception of wines produced from grapes grown in one of the three Mid-Atlantic states found that females were more interested in purchasing wine produced with grapes grown in New York for “special occasions” (55.0%) and to “give as a gift” (54.2%) compared to males (48.1 and 47.8%, respectively). Knowing consumption and purchasing patterns and promotions that would appeal to wine consumers can assist winery and tasting rooms with enhancing their marketing strategies.

ADVERTISING IN AGRICULTURE: SOCIAL MEDIA AND ONLINE PRESENCE

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Within the past decade, many more of a person's daily interactions have started taking place online. Whether it be catching up with friends or family, finding a recipe for dinner that night, researching a hobby, communicating with business partners or discovering things to do in your area, all of us spend a great deal of time "online" on a daily basis. From Facebook, to e-mail to the myriad of messaging services and websites available on the internet there are now many ways for us to interact with the outside world from the comfort of our computer chair.

With all this activity happening online (and more and more everyday) it is extremely beneficial for a business to have a presence on the internet in our digital age. This is especially true for those of us in agriculture who thrive when we are surrounded by an active community. Whether you are a local farm market, a Christmas tree farm, a pick your own strawberry farm or one of many other agricultural businesses you rely on return customers that feel in touch with you and the products that they purchase from you. The internet is one of the best tools out there to keep in touch with your community and bring in new customers. Believe it or not, there are many potential customers out there that may never discover your business unless you have a presence online!

Imagine you were able to put up a billboard that listed all of the information you'd want your customers to know for no charge. Creating a Facebook page or a Google listing for your business isn't that different! Being able to directly interface with your customers and create an active community around your business is not only invaluable, but also easy to do. We will present to you how facebook and other social media websites can be used to your advantage, the value of a website dedicated to your business, and the effectiveness of community building and online marketing.

HUMANIZE YOUR BRAND

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Maybe you realize that, just like you, your customers have access to information at all times. You're competing with traditional media companies, advertisements, and that friend on Facebook who posts at all times of the day. Content is *everywhere*. And *Human Content* is one of the only ways you can differentiate yourself in today's online world.

Human Content:

- builds rapport with your readers
- sells your product or services without "selling"
- creates value and makes a difference
- conveys emotion
- creates repeat business
- gets referrals
- strengthens and maintains ongoing relationships with current and future clients

But many business owners who create content for the web today forget that the people who consume this content are living, breathing human beings.

In today's world, we are constantly urged to click on worthless information that sells advertising. The thing is, advertising isn't human. Advertising rarely adds value or offers unique ideas.

We need real, meaningful media that explores our universal human experiences and emotions. Because when we create Human Content, we allow our creativity to up-level business.

Join Jessica Ann, CEO + Creative Director of Jessica Ann Media, as she guides you to with how to create Human Content to bring in more sales.

Organic Agriculture

LOW SOIL INORGANIC NITROGEN: NOT SO YIELD-LIMITING IN ESTABLISHED ORGANIC SYSTEMS?

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Yield lags in organic systems are frequently attributed to low soil inorganic nitrogen (N) availability. Within a 2-year organic forage systems trial conducted on 2 sites that had been under long-term organic management, we compared two alternative N provisioning strategies, legume-based and manure based. We monitored crop yields and soil inorganic nitrogen availability throughout forage and silage phases of 3 manure-based annual systems and 4 red clover (RC, *Trifolium pratense* L.*)*-based annual systems. Annual systems consisted of annual forage followed by corn silage (CS, *Zea mays* L.), whereas a perennial forage system remained in orchardgrass (OG, *Dactylis glomerata* L.*)*-RC throughout the experiment, and served as a reference control. Annual forage yields were inversely correlated with soil inorganic N availability, and, from a groundwater quality perspective, manure-based N management resulted in concerning quantities of end-of-season soil nitrate (Figure 1). The relationship between early season nitrate availability and yields was also weaker than typically reported for conventionally managed systems and suggested lower levels might be more appropriate for both manure- and legume-based systems with a long history of organic management. Across both phases, these results imply low soil test inorganic N may not be yield-limiting, and even that higher soil inorganic N can depress yields under certain circumstances (Figure 2). Our results contradict the oft-cited notion that organic crop yields are limited by soil inorganic N and suggest that high soil inorganic N can depress crop yields as a result of indirect effects from increased weed competitive ability.

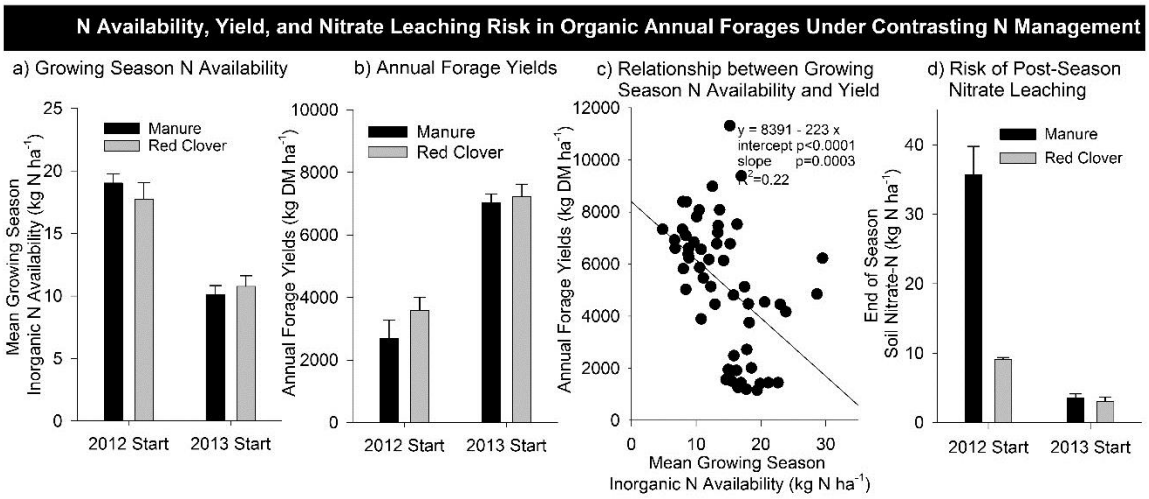

Figure 1. Forage Phase N Availability and Yields

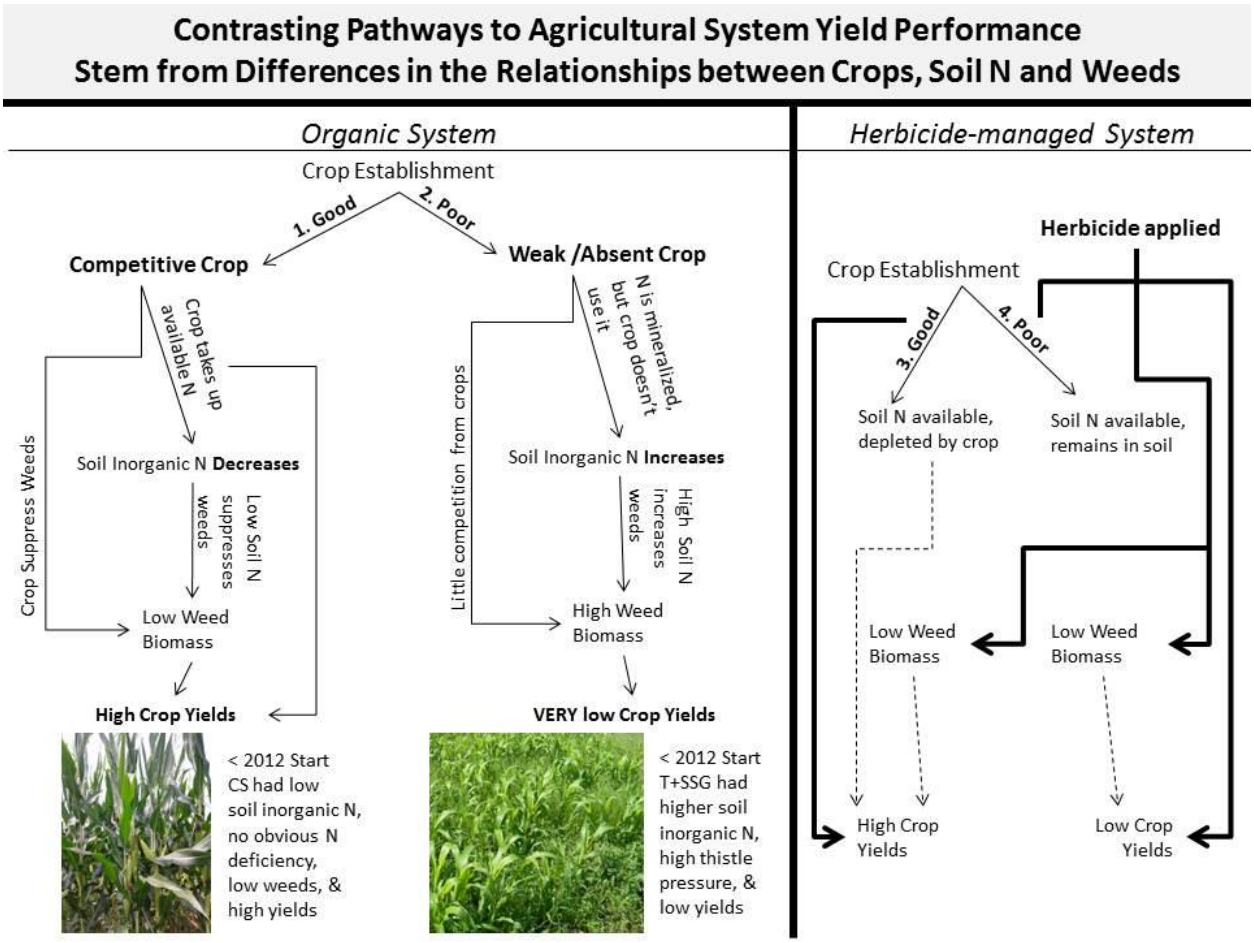

Figure 2. Nitrogen availability-yield relationships are moderated by other factors in organic systems

COMPOST AND ROW COVERS FOR NUTRIENT AND INSECT PEST MANAGEMENT IN ORGANIC CUCURBITS

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Cucumber wilt is a fatal disease which can affect almost all cucurbit crops in our area. Symptoms start as a wilting of individual leaves and branches followed by wilting of the entire plant. *Erwinia tracheiphila*, the bacterial wilt pathogen, is transmitted by striped and spotted cucumber beetles and management of this disease is focused on managing cucumber beetles. Muskmelon and cucumber losses can be greater than 80% when cucumber beetles are left unmanaged.

Squash bugs are an important insect pest of squash and pumpkin and to a lesser degree, muskmelon and cucumber. Feeding causes yellow spots on plants which turn black. Vines can turn black and dry out which is sometimes confused with bacterial wilt symptoms. Squash bugs can transmit the bacteria, *Serratia marcescens,* which causes cucurbit yellow vine disease, another fatal disease that is an emerging threat to US cucurbit production. This bacteria grows slowly in plants and symptoms are usually not seen until around two weeks before harvest. Leaves turn yellow. Older leaves have black margins and may die. Some infected plants may suddenly collapse mid-season or just after fruit set.

In addition to these pests, nutrient management can be challenging on organic farms, in part because the nitrogen availability from organic nutrient sources is difficult to predict. Through the process of mineralization organic nitrogen is converted into plant available nitrogen. Mineralization rates depend on multiple factors including soil temperature, particle size, microorganism activity and incorporation of the material. Mineralization rates and therefore plant available nitrogen in the year after applying compost can range widely from below 20% to over 40%.

In 2009-12 we conducted a study with Iowa State University and the University of Kentucky. The goal of the study was to develop an approach for managing bacterial wilt on muskmelon and squash bugs on butternut squash and integrating the use of compost with this approach.

Row covers are widely used to protect cucurbit crops from transplant until flowering. They serve as a physical barrier to prevent insect pests from accessing plants. Additionally, they increase temperatures surrounding plants which can lead to early fruit development and maturity. Preliminary findings indicate that covering plants beyond the start of flowering could suppress bacterial wilt while improving yield, but excluding cucumber beetles needs to be balanced with allowing bees access to flowers for pollination. We evaluated several timings of row cover removal for muskmelon (‘Strike’)

on the severity of bacterial wilt as well as for butternut squash ('Betternut 401') on squash bug populations.

Different amounts of compost were also evaluated for nutrient management based on the nitrogen recommendation (75 lb/acre in Pennsylvania and Kentucky and 80 lb/acre in Iowa) for muskmelon and winter squash. Amounts were based on assuming a 10% mineralization rate (high amount of compost applied) or a 30% mineralization rate (low amount of compost applied) compared to a control of an organic bagged fertilizer. This part of the study was conducted from 2009-11 in Pennsylvania and in 2010 in Iowa and Kentucky. Pennsylvania results are included in this summary.

Results and Discussion

Pest Management

In Pennsylvania and Iowa, row covers delayed the onset of bacterial wilt by 1-2 weeks, but did not provide season-long suppression. In Kentucky, using a row cover, regardless of timing of removal, suppressed bacterial compared to not using a row cover. Cucumber beetle pressure varied by state with much lower pressure in Pennsylvania and Iowa relative to Kentucky.

In all three states, squash bug was not a significant pest in any of the experimental years and cucurbit yellow vine disease was not seen.

Yield

In Pennsylvania and Iowa, removing row covers 10 days after first flowering resulted in the highest marketable muskmelon yield. In Kentucky using a row cover compared to not using one resulted in the higher marketable yields and removing row covers at first flowering generally resulted in higher yields.

For early muskmelon yield, removing row covers 10 days after first flowering resulted in the highest yield in Pennsylvania, removing at first flowering in Iowa and no difference in earliness was observed due to row cover use in Kentucky.

It's important to explain how first flowering was defined in each state and how this impacted results. In Pennsylvania, it was defined as the presence of an open flower in the plot, whereas, in Iowa and Kentucky, it was defined as when ≥50% of plants in the plot had perfect flowers. In Pennsylvania in one year of the study, high temperatures accelerated plant development and seedlings developed flowers before transplanting. In that year, it was not possible to study the timing of cover removal on bacterial wilt suppression or yield. Determining how to define first flowering for optimal row cover removal depends on several factors, including ease of implementation and yield, in addition to pest and disease management needs. For example, it was easier to see the first appearance of yellow flowers than to determine if a flower was staminate (male) or perfect through the row cover. Also, in Pennsylvania, defining first flowering as the

appearance of the first open flower, resulted in earlier yield than other treatments due to earlier pollination. In Iowa, defining first flowering as when ≥50% of plots had perfect flowers, resulted in lower yields than removing row covers at first flowering. When earliness is desired, this should be considered.

In Pennsylvania, removing row covers at first flowering resulted in the highest marketable butternut squash yield compared to all other treatments. In Kentucky, overall, using row covers resulted in higher marketable yields than not using them.

Compost
In Pennsylvania, compost treatments had no influence on bacterial wilt suppression.

In 2009, applying the high amount of compost resulted in a larger number of muskmelons compared to the low amount of compost and the control which were not different from each other. In 2010 and 2011, the number of muskmelons produced was not different with any of the compost treatments.

Compost treatments did not affect butternut squash yield differently.

Applying compost based on the crop nitrogen recommendation and assuming a 30% mineralization rate (low amount applied) supplies sufficient nutrients to plants, results in yields not different than applying the high amount of compost and decreases compost material costs.

Wine Grapes I

SHOULD YOU BE GROWING GRAPES?
PROS, CONS, AND SITE SELECTION.

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First, I've got to ask, how much money have you got? There is an old axiom in the wine business that states if you want to make a small fortune in the wine business start with a large fortune. Doesn't sound too promising does it? As a county agricultural agent with Rutgers Cooperative Extension I meet with 6-10 prospective vineyard/winery owners every month and the economics of the business is certainly one of the considerations that must be taken into account. I find that most of these people fall into two categories; farmers that are looking for something to grow that will actually make money and what I call the 9/11 people. Today's farmers must make a decision, grow a profitable crop or sell the land to the developers. The 9/11 people are from all walks of life and since that fateful day have realized that life is precious and working in a job that they hate is a waste of a life, better to grow grapes and make wine.

The first visit I have with prospective growers is usually over lunch. I figure I have to eat lunch anyway and since 2/3 of these people will never start a winery once they hear what is involved I'm not really wasting my time. I usually start the discussion on a positive note. New Jersey is 5th in wine production in the US and 5th in per capita consumption of wine in the US. So we make a lot and we drink a lot. Given this, it is interesting to note that only 1% of the wine we drink is made in New Jersey. That translates into a tremendous marketing potential for New Jersey wines if we can tap into the other 99% of sales, which we are slowly doing. In addition, even in this down economy, wine sales in the US have continued to increase and the number of wineries in New Jersey has steadily increased. Lastly, New Jersey has some of the best sites in the east for quality wine grape production. This is important because to make great wine you need great grapes. Sounds logical but you would be surprised how many people are only concerned with what the wine label will look like, or the tasting room decor. I had one guy who had already bought the cappuccino machine for the tasting room. He didn't really want to talk about the vineyard and what it takes to produce quality grapes. He's long gone now. That's because owning a vineyard and a winery is farming first. If you get all wrapped up in the romance of wine and having your name on the wine bottle, failure is just around the corner.

The next order of business is to talk vineyard establishment, i.e. how much, where, how, and what grapes. It will cost approximately $8,000 to $12,000 per acre to establish an acre of grapes. That includes the plants, the posts and wire, the irrigation, the land prep, etc. Then you'll need a good, narrow tractor, maybe $40,000 for a good one. You'll need

a sprayer to control diseases, say $1,000 to $10,000 depending on size and type. And no, we can't grow wine grapes in the Mid-Atlantic States organically. This region gets too much rain during the summer and the fungal disease pressure is just too intense. Rutgers is conducting research to change this but so far it just can't be done. After all this, I usually lose many of the prospective growers. In the past, I would sugar coat all this but farming grapes is expensive and better to know the facts up front then to lose your shirt later. It has been said that one of the biggest reasons that wineries fail is that they didn't know what they were getting into financially and were under funded.

Now we need to talk site. Where are the grapes and the winery to be? Do you already own the land? Farmers of course already have the land. 9/11 folks usually don't but if they do they ALWAYS tell me how great their soil is. Soil is not the top priority for site selection. First of all, I want to know how cold it gets on their land in the winter. If it gets to -10 degrees Fahrenheit routinely the grapes are going to die. It won't matter that the soil was great. In New Jersey it rarely gets below 0 in Cape May County but routinely gets there in Sussex County. If you want to grow Merlot in Sussex it is not possible. You'll have to grow Concord or the cold hardy varieties from the Minnesota grape breeding program which can withstand -35 degrees F. Matching the site with the grape variety has been the essence of fine wine for thousands of years.

From there we will cover trellis types, fertility, plant spacing, row covers, row orientation (always north/south), and site length of season. Cabernet sauvignon needs a growing season of 182 days, that's the time from the last frost in the spring to the first frost in the fall. Sussex County for example, is at least 30 days short. Only an early maturing variety will ripen here.

After all of this and a whole lot more, some people decide to start a vineyard and a winery. Of course, they will also have to learn how to make wine and build a winery. That takes more money, time, experience, a lot of reading, and maybe hiring a consultant. Many of the 54 wineries in New Jersey have started in this way. I like to think that I'm not only helping the wine business in this state to grow but also preserving farms and open space. The New Jersey Wine Industry is keeping the "Garden" in the Garden state but to be a part of it takes a lot of planning and learning.

THINGS TO REMEMBER BEFORE ORDERING YOUR GRAPE VINES

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Introduction

Wine grape is a perennial crop which can stay in a production for as long as 30-40 years, sometimes even longer. Hence your pre-plant decisions are going to have very long term effects. Knowing only about what varieties you would 'prefer', may not be sufficient. In wine grape production, the quality of the grape is what governs the quality of wine and its pricing. In addition to variety selection, it is important to know about your soil, meso-climate, clones and rootstocks which can greatly impact the fruit quality. Ideal condition for high quality wine grape production includes, a site where minimum temperature does not go below -5 °F, well drained and low fertility soil, warm days and cooler nights and dry weather during ripening. Most likely your site will not have one or more of the above conditions, however you can still grow quality wine grapes. Below mentioned points can guide you in making right choices before ordering your vines.

Some varieties are best suited to your site than others

There are three broad categories of wine grape varieties. The *vinifera*, which had their origins in Europe and later introduced to United States as a selections; *hybrids* which are cross between two different varieties, typically developed by grape breeding program; and *natives* which existed and evolved in North America. *Vinifera* varieties are relatively less cold tolerant than hybrids. Hybrids are less cold tolerant than *natives,* which can tolerate temperature dips down to -25 °F. Knowing the historic low temperature at your site and its frequency can be very useful in ruling out the varieties which are 'not suitable' for your site. Visit the older vineyard near to your site and enquire the varieties which suffered the most during moderate and harsh winters. If you site has a rolling terrain, the top of the hill will not accumulate cold while the lower areas will have cold air drainage. Advanced understanding of potential area with cold air drainage will help in estimating number of cold tolerant vines to order. Different varieties have different 'heat accumulation' requirements during berry ripening, to ripen the fruit. For example Cabernet Sauvignon and Cabernet Franc requires higher heat accumulation than Traminett and Pinot Noir. If you grow variety which requires higher heat accumulation in cooler site, your fruit may not ripen enough, leading to low sugar, very high acids and poor color and tannins developments. You cannot expect good wine from such fruits. Sometimes vineyards close to very large water bodies get its own mesoclimates (local, site specific climate) due to evaporative cooling of water bodies.

Know your soil pH

Typically, *vinifera* varieties grows well in pH range of 6.5 to 7.0, hybrids in the range of 6.0 to 6.5 and natives does well in the range of 5.5-6.0. Though there is no strict borderlines for growing particular varieties, recommended pH range is important to allow adequate nutrient uptake from soil into vine and fruit. Knowing your soil pH can help in deciding which area of vineyard best suited for particular variety with or without adjusting the soil pH.

Rootstock affects vine vigor

Rootstocks are the lower portion of a grafted vines while the top portion is what we refer to as variety. Root stocks governs the development of root system and hence indirectly responsible for vegetative growth of a vine. Rootstocks are specially developed to be cold and phylloxera resistance and adaptability to different types of soils. Unlike *natives*, the *vinifera* and *hybrid* varieties are mostly grown on the root stocks, more so in eastern US. The common root stocks used in New Jersey vineyards are 3309, 101-14, Riperia Gloire and SO4. In NJ earlier plantings were done on root stock '3309', however the growing trend is to use '101-14' rootstock which is like '3309' however less vigorous. Both 3309 and 101-14 have higher to moderate adaptation to shallow dry soil and are ideal for drought prone areas however in NJ the concern is, more often an excess rain. Growers are also beginning to explore 'Riperia Gloire' root stock, its much shallow root system could control excess vigor in heavy soils or may be necessary in a vineyard with shallow water table. Riperia Gloire is known to enhance the ripening cycle and conveys less vigor to the vine. Root stock 'SO4' has higher tolerance to acidic soils which is suitable for very low pH soil. Though it has very high nitrogen uptake rates and conveys high vigor, it does not overbear.

Remember that you want a moderately vigorous vines. Hence, root stocks which develops extensive root systems should be used in a shallow and poor soils and those which develops shallow root systems should be used for vigorous sites.

Clones affect the fruit quality

Clones are the result of years of selection for desired trait and are propagated vegetative, often by cuttings from original mother vine. That trait could be fruit compactness, cluster size, vigor, winter hardiness, fruit composition or timing of the ripening. And that trait could be very important to your site. Typically for cooler climates Dijon clones are more preferred than other clones. These clones are bred for their adaptions to terroir, naturally lower yield and smaller fruits which helps in canopy management, concentrating the flavors and early ripening.

Remember that there is no such thing as the perfect clone as the same clone responds differently based on a site's environment which includes soil, local climate, and cultural

practices. For example, two blocks of grapes from same clone and same site, however harvested 2-3 weeks apart could have very different sugar levels and resulting wine flavors.

Certified planting material is the best strategy to prevent the grape diseases

Vineyards often struggle with the problem of 'virus diseases for the simple reason that virus cannot be cured. Typically those virus are pre-existing in the sourced materials or planting materials from nursery itself. Purchasing 'certified' planting material is one of the best strategy to prevent, specifically the virus diseases in vineyard. Certified nurseries source vines from a 'Foundation Block' that has vines with complete elimination of set of pathogens. Certified nurseries then propagate the clean plant material in its 'Mother Block'. Each certification program is targeted for the set of pathogens and viruses. Knowing what certification program your ordered vines have gone through is important to know the diseases or virus your vines are free of.

Avoid sourcing planting material from untested source vineyards such as neighboring growers. Symptoms of specific diseases may be unseen in sourced vineyards however, your vineyard could provide perfect conditions to spread that disease, especially trunk diseases such as Phomopsis, Esca, or Crown gall. Presently there are no certified nurseries in New Jersey; however, there are several certified nurseries in California and few in Oregon, Washington and New York. You may also visit the nursery before you order materials for the first time. Often, to keep up with the high volume of orders, nurseries may use bench grafting which is more prone to diseases and handling damage than field grafting which is often superior. Cutting corners at this stage of viticulture can lead to enormous problems as the vineyard matures.

Remember that certified material does not guarantee disease-free grapevines after planting; it only ensures that planting material is clean for the diseases tested before it goes into the soil. You still need to follow proper cultural practices and spray programs to ensure healthy vine and quality wine grapes!

Sources

Shaffer et al. 2004. Grapevine rootstock for Oregon vineyards. OSU publication EM8882.

Gohil et al. 2015. Evaluate your wine grape planting material before planting. Rutgers publication (in press)

Hydroponics/ Aeroponics

COMMERCIAL FARMING AEROFARMS APPROACH

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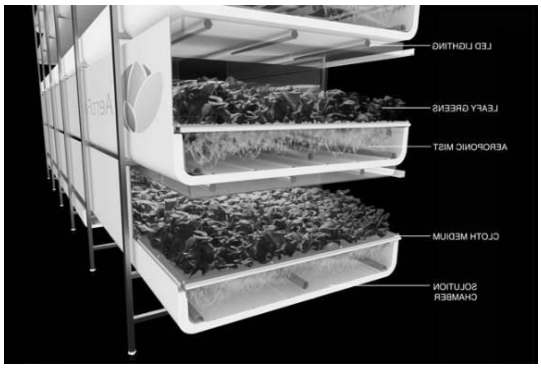
Agriculture began controlling crop production some 20,000 years ago. It has progressed by adding animals both as husbandry and as power for crop cultivation, using machinery for cultivation and harvesting, and in current times using protected methods and precision agriculture. Methods to protect and control plant growth beyond traditional agriculture include green houses and high tunnel enclosures, hydroponic methods and indoors with artificial light. AeroFarms has developed a totally controlled indoor method using aeroponics without soil, sun, or pesticides.

The technology is depicted in an illustration at the right. Machines are 5' wide, 80' long and can be as many as 12 levels high. Each level has three main segments: a top with LED lighting, a middle with plant shoot space and room for air exchange, and a bottom where nutrients are sprayed on roots and then recycled. The bottom and middle segments are separated with a proprietary cloth which is reused for years. The light appears as white but is mostly red and blue.



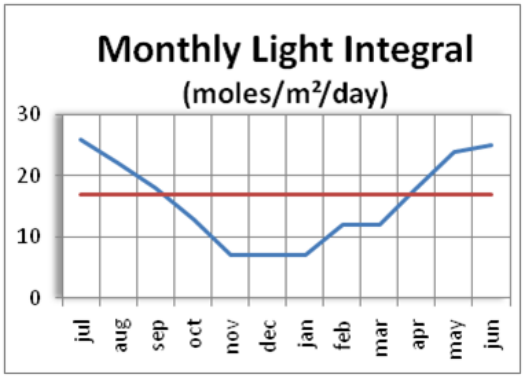
The growing process begins with seeding in a germination chamber until radicles emerge and penetrate the cloth, typically 2-3 days. Next, the germinated plants are moved to the machine for another 12-16 days of growing followed by harvest and packaging. Over 200 leafy green varieties have been grown. Baby leafy greens are the specialty of this method of growing.

AeroFarms has built a number of farms in Newark NJ including an R&D facility, pilot plant and, currently under construction, a full size commercial facility to grow more than 1.5 million pounds of baby leafy greens annually. Newark also has an AeroFarms unit in the Philips Academy Charter School (PACS) cafeteria. This installation stimulated a collaboration between PACS, AeroFarms, Rutgers University, and Temple University to research why student selection and preference for baby leafy greens was so very strong at the school.

AeroFarms growing method offers significant advantages over traditional and greenhouse based agriculture methods. The end results are consistent high quality and

predictable yields all year-round. This is accomplished with 5-10% of the water used in traditional agriculture, full use of fertilizer, close proximity to markets, and no pesticides of any kind. The product is ready to eat (RTE) and thus chemical free with a good shelf life.

Everyone learns the simple formula for photosynthesis of water plus carbon dioxide catalyzed by sunlight to produce oxygen and edible plant matter. At Aerofarms this formula is implemented using different inputs in a much more controlled manner. To understand why one would abandon the sun, it is necessary to understand the challenges the sun creates. The sun never comes when you want it or in the amount you want - see graph to the left for Ithaca, NY average amount of sunlight throughout the year compared to the red line representing what would be optimal for lettuce. Sunlight brings substantial radiant heat in the summer creating the need to ventilate and cool. The glass required for a protected facility makes heating in the winter inefficient. Further in order to grow year-round in temperate climates, one has to use supplemental light in the winter – a similar investment to that of indoor facilities.



It is key to understand the metrics of artificial light when substituting it for sunlight. Plants respond to different colors of light via their physiology with growth rate changes, anatomical differences, leaf color, and taste and crunch differences. Plants respond to different intensities (measured in moles, never lumens) of light as well. Some plants need light to germinate and certain colors attract insects or allow them to see. Electric or artificial light allows a grower to move indoors and control temperature, humidity and carbon dioxide levels with a minimum of effort. LEDs have provided an opportunity to optimize the light used to provide exactly what the plant needs when it needs it. Ten years ago utilizing LED light was an expensive proposition. Today the cost of the equipment and its energy consumption is low enough to make the cost of goods sold within reach of traditional agriculture's costs. LEDs continue to have increased efficiency, greater reliability and life, and lower initial cost.

Every farmer knows that the media used to grow their plants in is a precious resource. Soil based farmers need to fertilize, manage pH and tilth, and control for soil losses. Soilless media for hydroponic production provides similar challenges but in a more controllable way. Aeroponics avoids these by delivering nutrients at the proper pH consistently. AeroFarms reuses the media for years and recirculates the nutrient solution with strategic replenishment of nutrients. This method adds considerably to environmental sustainability.

AeroFarms manages the atmosphere for the plants. Increasing carbon dioxide to 1,000 ppm enhances growth and saves on light energy. Managing the relative humidity optimizes transpiration. Controlling the temperature ensures maximum germination and plant yields. Avoiding the open exposure to the outdoors removes most of the dangerous pests that carry human pathogens. Avoiding the significant airflows of a greenhouse optimizes carbon dioxide management and minimizes air conditioning energy requirements. AeroFarms saves energy and avoids significant pest and disease issues in the process.

Controlled growing seems like the perfect system, especially when one considers that 22 crop turns per year provides the data to optimize each variety's growing needs. Indeed, collecting thousands of data points per crop allows AeroFarms to grow using recipes where leaf dimensions are predictable and repeatable. In addition risks are lowered and we can be very responsive to customers' changing requirements.

The AeroFarms method sets the stage for much more science to better understand growing, crop quality, consumer preferences, and plant chemical make-up for commercial products. Our challenges are having the time and space to explore the scientific opportunities further, finding the trained horticulturalists to do the investigation, and creating the tests that objectively measure plant qualities.

This is an exciting time to be in the produce industry with a safe, clean, pristine, tasty, and interesting product.

VERTICAL AEROPONICS – RETHINKING GROWTH

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Over the past 5 years Aero Development Corp (ADC) has been perfecting its patent pending commercial and residential vertical aeroponic growing systems. Unlike anything else in the marketplace, these units, employed in a Controlled Environment Agricultural (CEA) setting, represent the most cost effective, clean, virtually algae free, simple to operate alternatives, or supplements, to conventional vegetable growing in these environments.

Aeroponics growing has been emerging since the 1980's. ADC has been engaged in an intensive research and development process since 2010 within its 10,000 square foot climate controlled greenhouse in the heart of the Amish community in Lancaster County, PA. The founders have extensively tested and perfected their growing systems. Virtually every kind of vegetable (except root crops like potatoes, carrots, etc.), as well as herbs and many vine type fruits. These have been successfully grown and marketed into both the wholesale and retail marketplace.

The ADC commercial and residential systems have been installed throughout the US, and the major benefits reported by users have been:

- The high volume of produce grown in very limited space (e.g. 608 planting spaces within a 6' round commercial Circular Pod unit – up to 1216 for cut and come back crops
- 90% *less* water required than produce grown in soil
- The efficiency, simplicity and cleanliness of the growing systems
- The ease of harvesting, cleaning and reseeding the systems, significantly reducing labor costs
- Growing units that provide a high degree of flexibility in terms of the portability and placement of systems within a CEA setting
- The ability to accommodate multi crop growing with variable nutrient requirements in the same commercial environment with the use of Circular Pods
- The high level of crop consistency with minimal shrinkage due to the health of the plants
- System architecture that provides the opportunity for both seasonal supplemental light in a CEA setting, as well as single source lighting in an indoor setting.

Our objective has been to make this technology readily available to both experienced as well as novice growers, whether commercial or hobbyists, with designs that are easily assembled, clean and simple to operate, as well as having unlimited, incremental scalability.

For the conventional grower with existing markets, these systems provide the opportunity to continue to serve those markets year around with *farm to table* produce with a high level of consistent quality, unlike what many end users experience with produce shipped from afar during winter months.

The marketplace for these systems has gone beyond its application to conventional growing, and in to the educational environment. Interest on the part of primary, secondary and even university level entities like Rutgers and Penn State agricultural schools has been growing at a rapid pace. The benefits have been outstanding both from the standpoint of basic education, as well as for the purposes of R&D in the university setting.

For growers situated near inner city or rural *food deserts*, the opportunities to extend their outreach for both business and charitable purposes to those communities can be significantly leveraged.

Extensive interest in both those charitable and business applications has grown significantly on the part of those serving and working with the poorest of the poor in developing countries. Well established organizations throughout Africa, Asia, Latin America and the Caribbean having been lining up to find ways to bring this technology into their respective countries and environments.

Retirement Communities represent another rapidly expanding market for the ADC systems (see www.gardenspotvillage.org/media, click on Aeroponic Greenhouse for Live Streaming of the installation there). Garden Spot Village (GSV), home to over 1,000 residents, is recognized worldwide as being in the top 1% of premier, innovative retirement communities anywhere.

In addition to supplying their formidable kitchens with exactly what the chef's require for their menus, GSV has differentiated itself both with its residents (who now know exactly where their produce is coming from) as well as with the residential community marketplace of people deciding where they will spend their retirement years.

Given the simplicity and accessibility of the ADC growing systems, of equal value to entities like GSV are the therapeutic benefits inherent in this kind of environment. Many residents will have the opportunity to participate in the growing and harvesting activities within this very pleasant greenhouse setting.

These therapeutic benefits extend as well to the special needs populations in local schools settings. ***New Jersey*** in particular faces significant challenges given the rate of children being born with ADD & ADHD in the state, one of the highest ratios in the United States.

Additionally, there are also significant therapeutic and *vocational training* benefits for those who are working with groups like *veterans* who are faced with the very formidable challenges of reentry to the culture and the workplace as a result of their wartime experiences.

SUMMARY

Given the opportunities before us at Aero Development Corp, we view *Customer Relations* as more than one of our most important *Core Values.* We understand our customers are really like partners. We greatly enjoy supporting them in every way possible for the success of their businesses. However, we also understand the importance of partnering with them to raise the awareness of this new technology that has the design and scalability potential to address the significant food and water availability challenges that exists, sadly not only here in the United States, but around the world.

CROP LIGHTING

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When sunlight is not available or its intensity insufficient, we can use supplemental lighting to increase plant growth and enhance development. We use low intensity lighting to extend the natural day length to induce the flowering response. Or we use high intensity lighting to increase the rate of photosynthesis and thus plant growth. Because photoperiod lighting is often intermittent and only needs a low intensity, the amount of electricity consumed is minimal and therefore growers are typically less concerned about operating costs. But increasing the rate of photosynthesis through high intensity lighting requires significant amounts of electricity. As large quantities of electricity are consumed, it is important to understand operating characteristics and lamp efficiency (efficacy) and how the different light sources compare.

The effectiveness of a lighting system depends on the lamp efficiency, the light distribution pattern and the light intensity at plant canopy level. Lamp efficiency is primarily determined by the type of lamp used (e.g., INC, FL, HID, LED) and how well the various components are matched to each other. The light distribution pattern is determined by the mounting height (distance between the lamp and the crop canopy) and the shape of the reflector (if applicable) used to direct the light toward the crop. The light intensity is determined by the mounting pattern (number and placement of the lamps) and mounting height (the inverse square law applies: as you increase the distance from the light source by a factor of two, the light intensity decreases by a factor of four).

The rapid developments in LED technology are also making an impact on applications in horticulture. LED lamps offer exciting opportunities to adjust the light spectrum so that the light output better matches the sensitivity of the plant's light pigments that it uses to convert light energy into chemical energy (i.e., the compounds the plant needs for growth and development). In addition, LEDs generate a different type of heat (convective instead of radiant heat) compared to the conventional HID lamps, allowing them to be placed closer to the plant canopy. While these features appear to be advantages, current LED lighting systems are not necessarily more efficient that the most efficient HID units. However, the expectation is that LED lamps will become the light source of choice in the future.

In this presentation, I will review several light sources used for horticultural applications, including commercial LED systems specifically designed for plant growth applications. I will discuss some of the ongoing research at Rutgers and elsewhere.

Farm Safety

CHANGES TO THE WORKER PROTECTION STANDARDS FOR FARM WORKERS AND HANDLERS

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The purpose of the Worker Protection Standard (WPS) is to reduce the risk of pesticide exposure to agricultural workers and pesticide handlers (persons who apply, mix or load pesticides) who work in farm, nursery, greenhouse and forest operations. This is accomplished by enforcing federal rules adopted into the state Pesticide Control Code and performing educational outreach regarding the WPS requirements for pesticide safety training, personal protective equipment, restricted entry intervals for pesticide treated fields, and other safety measures. Training workers and handlers, and the agricultural employers who hire them, is the foundation of the WPS program.

On November 2, 2015, revisions to the Worker Protection Standard were published in the Federal Register. The rule will become effective January 1, 2016.

Implementation of the revisions will be in 2 phases:

1. One year later, agricultural employers and handler employers will be required to comply with most of the new requirements on January 2, 2017.
2. Two years later, agricultural employers and handler employers will be required to comply with certain new requirements on January 1, 2018 or later (*as noted below)*:
    - Display requirements for pesticide safety information and pesticide application and hazard information.
    - Requirements for suspending applications
    - Training requirements for workers and training requirements for handlers. EPA intends to make available to the public training materials that may be used to conduct training conforming to the requirements. Employers must implement the new training curriculum by January 1, 2018 (or 180 days after EPA announces the training materials are available, whichever is later).

What are the Major Changes for Farmers and Farmworkers?

The revisions to the Worker Protection Standard cover many different areas. The major revisions include:

- Annual mandatory training to inform farmworkers on the required protections afforded to them. *Currently, training is only once every 5 years*.

- Expanded training includes instructions to reduce take-home exposure from pesticides on work clothing and other safety topics.
- First-time ever minimum age requirement: Children under 18 are prohibited from handling pesticides.
- Expanded mandatory posting of no-entry signs for the most hazardous pesticides. The signs prohibit entry into pesticide-treated fields until residues decline to a safe level.
- New no-entry application-exclusion zones up to 100 feet surrounding pesticide application equipment will protect workers and others from exposure to pesticide overspray.
- Requirement to provide more than one way for farmworkers and their representatives to gain access to pesticide application information and safety data sheets – centrally-posted, or by requesting records.
- Mandatory record-keeping to improve states' ability to follow up on pesticide violations and enforce compliance. Records of application-specific pesticide information, as well as farmworker training, must be kept for two years.
- Anti-retaliation provisions are comparable to Department of Labor's (DOL).
- Changes in personal protective equipment will be consistent with DOL's standards for ensuring respirators are effective, including fit test, medical evaluation and training.
- Specific amounts of water to be used for routine washing, emergency eye flushing and other decontamination, including eye wash systems for handlers at pesticide mixing/loading sites.
- Continue the exemption for farm owners and their immediate families with an expanded definition of immediate family.

Comparison of New Provisions and Past Provisions:

REQUIREMENT	NEW PROVISION	PAST PROVISION
TRAINING		
Frequency of full training for workers and handlers	Annual training.	Every 5 years.
Training grace period for worker training	No grace period. Workers must be trained before they work in an area where a pesticide has been used or a restricted-entry interval has been in effect in the past 30 days.	5-day grace period with abbreviated training.
Qualifications for trainers of workers	Certified applicators, State/Tribal/Federal approved trainers, and persons who have completed an EPA-approved train-the-trainer course.	Handlers, certified applicators, State/Tribal/Federal approved trainers, and persons completing an approved train-the-trainer course.

Expand training content for workers and handlers	Keep existing and expand content. Final worker training topics expanded to 23 items, and handler training expanded to 36 items. Training on new content not required until 2 years from effective date of final rule.	11 basic training items for workers and 13 items for handlers. Minimal training on reducing take-home exposure, reporting use violations, and prohibition from employer retaliation.
Recordkeeping of training	Keep records for 2 years. Give copy of record of training to workers and handlers upon their request.	No recordkeeping of training. Voluntary verification card system.
HAZARD COMMUNICATION		
Content and availability of hazard communications materials	Employer must display application information and safety data sheets (SDSs) at central location within 24 hours of end of application and before workers enter that treated area. Display both for 30 days after REI expires. Keep application information and SDS for 2 years from end of REI and make available to workers, handlers, designated representatives (identified in writing) or treating medical personnel upon request.	Employer must display application-specific information at a central location before application occurs, or, if no workers or handlers are on the establishment, before next period workers/handlers are on establishment. Keep posted for 30 days after REI expires. No recordkeeping.
Notification of treated areas under an REI	Post warning sign if REI is greater than 48 hours (outdoor applications) or 4 hours (enclosed space applications (e.g., greenhouses)), otherwise option for posting or oral notification unless label requires both.	Farms, forests and nurseries: Post warning sign or give oral notification for any REI, unless label requires both. Greenhouses: all applications require signs to be posted.
Warning sign	Same as current sign.	Red circle containing stern-faced man with upraised hand. At the top: “DANGER” and “PELIGRO”, “PESTICIDES”, “PESTICIDAS”. At the bottom: “KEEP OUT”, “NO ENTRE.”
Information exchange between handler employer and agricultural employer	Agricultural employer must provide application information on treated areas the handler may be in (or walk within ¼ mile of). Handler employer must notify	Agricultural employer must provide application information on treated areas the handler may be in (or walk within ¼ mile of). Handler employer

	before the application begins for certain changes and within 2 hours of end of application for most other changes, unless only change was less than 1 hour difference in application time.	must notify of changes to application plans before application begins.
MINIMUM AGE		
Minimum age for handlers and early-entry workers	Handlers and early-entry workers must be at least 18 years old. (Members of owner's immediate family are exempt from this and most other requirements of the WPS.)	No minimum age.
ENTRY RESTRICTIONS DURING APPLICATION FOR OUTDDOR PRODUCTION		
Ag employers must prohibit entry in areas during application for outdoor production. (Restrictions for greenhouses/enclosed space production are different.)	All outdoor production: No entry into treated area or the application exclusion zone, which is an area up to 100 feet area around the application equipment during pesticide application on farms, forests and nurseries. Size of the application exclusion zone depends on type of application. Revised descriptions of application methods.	Farms and forests: No entry into treated area. Nurseries: No entry into treated area or an area up to 100 feet around the treated area, where the size of the additional area depends on type of application.
HANDLER SUSPEND APPLICATION		
Handler (applicator) must suspend application in certain circumstances	Handler must apply pesticides so as not to contact workers or other persons. Handler must suspend application if a worker or other person is in the application exclusion zone, an area up to 100 feet around the application equipment.	Handler must apply pesticides so as not to contact workers or other persons. No specific requirement to suspend applications.
EXEMPTIONS AND EXCEPTIONS		
Exemption for certified crop advisors and their employees	Only certified crop advisors are exempt from labeling PPE and WPS requirements as specified in exemption. Certified crop advisor employees must use label-required PPE	Certified crop advisor chooses PPE for themselves and their employees working under their direct supervision in a field during an REI. Also exempted from providing

	while working in a field during an REI, and employer must provide all required WPS protections, or rely on the PPE substitutions allowed under the crop advisors.	decontamination supplies and emergency assistance for themselves and employees.
Exceptions to REIs for early entry workers – notification requirements	Notify early-entry workers of application specifics, tasks to be performed, conditions of the early-entry exception, and hazard information from the pesticide label.	Inform early-entry workers of hazard information from the pesticide label.
Display of pesticide safety information	Display pesticide safety information at a central location and at sites where decontamination supplies are located, if the decontamination supplies are at a permanent site or at a location with 11 or more workers or handlers.	Display a safety poster at central location.
Content of pesticide safety information	Information can be displayed in any format (doesn't have to be a poster); keep the 7 concepts about preventing pesticides from entering your body; delete the point that there are federal rules to protect workers and handlers; add instructions for employees to seek medical attention as soon as possible if they have been poisoned, injured or made ill by pesticides; add name, address and telephone number of state or tribal pesticide regulatory authority; revise "emergency medical facility" to "a nearby operating medical care facility." New content for safety information display not required until 2 years from effective date of final rule.	The safety poster must include 7 concepts about preventing pesticides from entering your body; the point that there are federal rules to protect workers and handlers; and the name, address and phone number of the nearest emergency medical care facility.
PERSONAL PROTECTIVE EQUIPMENT		
Respirators	Employer must provide respirator and fit testing, training, and medical evaluation that conforms to OSHA standards for any handler required to	Employer must provide respirator listed on label and ensure it fits. No recordkeeping required.

	wear any respirator by the labeling. Require recordkeeping of completion of fit test, training, and medical evaluation.	
Definition of chemical-resistant	Same as current definition.	Made of a material that allows no measurable movement of the pesticide through the material during use.
PPE exception for closed systems	Exceptions to the labeling-specified PPE allowed for handlers when using closed systems. A closed system must meet a broad performance-based standard and basic operating standards (written operating instructions and training of handlers in use of the system) must be provided.	Exceptions to the labeling-specified PPE allowed for handlers when using closed systems. No specific criteria for closed systems.
PPE exception for crop advisors and their employees	Crop advisors and their employees entering treated areas while a REI is in effect to conduct crop-advisor tasks may wear a standard set of PPE (coveralls, shoes plus socks and chemical-resistant gloves made of any waterproof material, and eye protection if the labeling of the pesticide product applied requires protective eyewear for handlers, as outlined in rule), *OR* the PPE specified on the pesticide labeling for early-entry activities instead of the PPE specified on the pesticide labeling for handling activities, provided certain conditions are met. (See exemption for certified crop advisor.)	Crop advisors and their employees entering treated areas while a REI is in effect to conduct crop-advisor tasks may wear the PPE specified on the pesticide labeling for early-entry activities instead of the PPE specified on the pesticide labeling for handling activities, provided certain conditions are met. (See exemption for certified crop advisor.)
PPE exception from eyewear for pilots in open cockpits	If product label requires eye protection, pilots in open cockpits may wear a helmet with lowered face shield instead of label-required eye protection.	If product label requires eye protection, pilots in open cockpits may wear visor instead of label-required eye protection.

DECONTAMINATION SUPPLIES		
Quantity of water	Provide 1 gallon for each worker and 3 gallons for each handler and each early entry worker as measured at beginning of workers' or handlers' work period.	Provide enough water for routine washing and emergency eye flushing for workers and handlers. For handlers, also provide enough to wash entire body in emergency.
Use of natural waters	Must provide water for decontamination. There is no reference to, or prohibition from, using natural waters in addition to decontamination water provided. Workers and handlers are trained to use any nearest clean water source in case of emergency.	Must provide water for decontamination. May use natural waters in addition to water provided for decontamination.
Eye wash for handlers	Provide a system capable of delivering 0.4 gallons/minute for 15 minutes, or 6 gallons of water able to flow gently for about 15 minutes at a mix/load site if handlers use products requiring eye protection or use a pressurized closed system. One pint of water in a portable container must be available to each handler applying pesticides if eye protection is required.	Provide enough water for emergency eye flushing. One pint of water in a portable container must be available to each handler if eye protection is required.
EMERGENCY ASSISTANCE		
Emergency Assistance	Provide prompt transportation to medical facility. Promptly provide the SDS, product information (name, EPA Reg No and active ingredient) and circumstances of exposure to treating medical personnel.	Provide prompt transportation to medical facility and provide any obtainable information about the product, antidote, first aid, and circumstances of exposure to the worker/handler or treating medical personnel.
DEFINITIONS		
Immediate Family	Expand to also include all in-laws, grandparents, grandchildren, aunts, uncles, nieces, nephews and first cousins.	Includes spouse, parents, stepparents, foster parents, children, stepchildren, foster children, brothers, and sisters.

Enclosed space production	New definition: enclosed space production that is indoors or in a structure or space that is covered in whole or in part by any nonporous covering and that is large enough to permit a person to enter.	Greenhouse means an operation inside any structure or space that is enclosed with nonporous covering and that is of sufficient size to permit worker entry.
Employ	Employ means to obtain, directly or through a labor contractor, the services of a person in exchange for a salary or wages, including piece-rate wages, without regard to who may pay or who may receive the salary or wages. It includes obtaining the services of a self-employed person, an independent contractor, or a person compensated by a third party.	No definition of "employ" in existing rule. Definitions of "agricultural employer" and "handler employer" covered aspects of what types of employment covered.

For more information see these resources researched for this article:

- NJ DEP Worker Protection Website: http://www.state.nj.us/dep/enforcement/pcp/pcp-wps.htm
- National Agriculture Center: How To Comply With the Worker Protection Standard for Agricultural Pesticides: What Employers Need To Know : http://www.epa.gov/agriculture/htc.html
- EPA Revisions to the Worker Protection Standard: www2.epa.gov/pesticide-worker-safety/revisions-worker-protection-standard.
- NJDEP Pesticide Control Program WPS Information: http://www.nj.gov/dep/enforcement/pcp/pcp-wps.htm

SELECTION OF PROTECTIVE EQUIPMENT FOR PESTICIDE SAFETY READING BETWEEN THE LINES OF THE PESTICIDE LABEL

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Pesticide applicators are subject to chemical exposures during mixing, pouring, loading, and application of pesticides. Studies have shown that wearing properly selected hand and body protective equipment can reduce exposure by as much as 99%[1].

Pesticide manufacturers provide personal protective equipment (PPE) label statements based on both the pesticide product formulation and the task. Label language requires applicators to use different types of chemical-resistant PPE when the pesticide will be a health risk by dermal or ocular exposure.

When a pesticide label lists "chemical-resistant" PPE, it means that you need a barrier to that pesticide for the duration of the task. PPE materials ("barriers") perform differently when exposed to different pesticides. It would be a misinterpretation of chemical resistance to state that there is a type PPE that is chemical-resistant to all pesticides at all times.

Three measures of PPE barrier performance are: degradation, penetration, and permeation. PPE that performs well by these measures will protect you from the pesticide being used for the duration of the task. Pesticide applicators can apply these concepts to properly select and use PPE to minimize exposure to pesticides.

1) Degradation is a reduction in one or more physical properties of PPE due to contact with a chemical; it essentially starts to break down. In some instances, it is easy to recognize as PPE may swell, discolor, have an odor, shrink, soften, become brittle, or change texture. Inspect your PPE before and during use for these signs, and replace it immediately.

2) Penetration occurs when the chemical moves through seams, pinholes, and other imperfections in the material on a *non-molecular* level. Factors that increase penetration are manufacturing defects and garment design. Inspect all PPE prior to use for flaws and defects in workmanship, even if it has never been used. Penetration can also occur by leakage through the needle holes of single stitch garment seams. When the application creates mists or fogs, penetration can be significantly minimized by selecting a garment that has bound seams, or zippers with overlapping closures.

3) Permeation is when a chemical moves through protective material on a *molecular* level without any visible evidence or change. If a PPE garment material is not very chemical resistant to a particular pesticide, passage to the inside can occur very quickly, in just minutes.

   Once "breakthrough" takes place, your bare skin is directly exposed to the pesticide without you realizing it. Breakthrough is the complete passage of pesticide to the inside of PPE. Breakthrough time, or how fast a given pesticide moves through different PPE materials (its permeation rate), can vary widely.

   The extent of permeation is affected by contact time, concentration, temperature, and physical state of the contaminant. Permeation may begin as soon as it gets on the surface, and once a pesticide is absorbed on the surface of PPE, it continues to move into and through the PPE, molecule by molecule. In these cases, the pesticide is difficult to detect or decontaminate.

   Washing gloves and other PPE does not necessarily make them safe for reuse. The effectiveness of cleaning *reusable* PPE garments once pesticide is absorbed onto its surface is controversial and unresolved[1]. Using *disposable* PPE reduces the risk of contaminating yourself, your application equipment, and vehicles. And, it lessens the probability that you will take pesticides home to your family.

There are several sources of information on PPE selection. Pesticide label 'Precautionary Statements/Hazards to Humans' typically list specific barrier materials that will provide needed chemical resistance for the duration of the task. This is most common for glove materials. Older pesticide labels may add another statement that you can consult an EPA chemical resistance category chart for more options. These labels list gloves from the chart that are rated to provide a barrier for the anticipated length of use. Select the glove from that list that best suits your needs (cost, durability, pliability, etc.).

When the pesticide label does not specify barrier material(s), there are additional options. Consult PPE garment manufacturers/vendors; their literature is often available online. Call the pesticide product manufacturer, and request to speak to the representative for that particular product.

Further, contact your Cooperative Extension Service pesticide safety program for assistance in selection, as well as use of PPE. In New Jersey, contact the Rutgers New Jersey Agricultural Experiment Station Cooperative Extension Pest Management Office by phone at 848-932-9081, or go to their website at www.pestmanagement.rutgers.edu.

[1] The Farm Family Exposure Study, *John Acquavella*

PREVENTION OF FARM INJURIES AND COMPLIANCE WITH OSHA REGULATIONS

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In the early 1980s, two pulmonologists, Drs. David Pratt and John May at the Mary Imogene Bassett Hospital in Cooperstown, New York shared an interest in researching occupational health and safety issues among New York's farming population. In 1988 their work received official designation by the New York State Legislature as the New York Center for Agricultural Medicine and Health (NYCAMH). NYCAMH's mission is: ***"Enhancing agricultural and rural health by preventing and treating occupational injury and illness".*** For more information, visit: www.nycamh.com

In recognition of the Center's excellent performance in agricultural health and safety, NYCAMH has also been designated by the National Institute for Occupational Safety and Health (NIOSH) as one of ten agricultural safety and health centers across the country -The Northeast Center for Agriculture, Forestry and Fishing Health and Safety (NEC). Serving an eleven-state region from Maine through West Virginia, (including New Jersey), the NEC promotes health and safety research, education, and prevention activities in the high-risk areas of farming, commercial fishing and logging.

An important component of NYCAMH activities is safety training. The NYCAMH outreach staff are well qualified safety educators who travel all over New York delivering outreach education. In New York, the Occupational Safety and Health Administration (OSHA) is now in its third year of a Local Emphasis Program (LEP) for dairy farms in the state. The New York LEP allows OSHA to conduct random, unannounced safety inspections of dairy farms. To help dairy farms and other commodity farms in New York with OSHA compliance, NYCAMH provides free safety audits and farm safety training in English and Spanish to farms.

Farming can be a hazardous occupation. According to the US Bureau of Labor Statistics, in 2014 farmers and ranchers had an occupational fatality rate of 26 deaths per 100,000 workers. This is a much higher rate than the average fatality rate for all workers which is 3.3 deaths per 100,000 workers. The most common cause of work place death for farmers are tractor-related incidents with tractor over turns being the number one type of incident. Incidents involving other types of farm machinery are also a major source of injury to farmers.

Due to the hazardous nature of agriculture, comprehensive safety and health planning should be a top management goal for farms. Work related injuries and illnesses cost time, money and maybe even lives and limbs. Good safety management will save your business money by preventing workplace injuries and illnesses from occurring.

Here are some steps you can follow to provide a safe workplace:

1. Engineering Controls-Best solution for safety!
    - Some examples are: ROPS, guards, shields, safety interlocks, closed systems, ventilation systems, etc.
    - Substitution-can a less toxic product to do the job or control a pest?
2. Administrative Controls
    - Safety policies & procedures that employees follow
3. Personal Protective Equipment (PPE)
    - Employees always using any required safety equipment, face shields, respirators, gloves, hearing protection, etc.
    - Employers are required to provide any required PPE
    - PPE is used as a last resort, always look for engineering or substitution changes first, that might negate the need for having to use PPE
4. Identify any potential hazards and remove them or guard them
    - Conduct annual safety audits of the entire workplace
5. Provide initial and recurring safety training
    - All new hires are given safety training before they start work
    - Annual and recurring training is delivered throughout the year
    - Tailgate training, check stuffers, safety bulletin boards, etc
6. Develop a “culture of safety in your business”
    - Practice and enforce safe work procedures
    - Have an active safety committee comprised of front line workers, middle managers and owners
    - Owners and managers model safe work behaviors and practices
    - Make safe work procedures a habit that everyone follows automatically
    - Employees exhibiting positive safety practices are recognized

OSHA requires that all employers (regardless of the number of employees) have the responsibility of protecting their employees. However, because of the small farm exemption clause (farms with 10 or less employees) OSHA regulations can only be enforced on approximately 10% of the 2.2 million farms in the U.S. The small farm exemption is a rider to the Appropriations Act that restricts the use of federal funds for enforcement of rules, regulations, standards or orders on small farms.

A farming operation is exempt from OSHA enforcement activities and fines if it:

- Has not had more than 10 total employees, (not including immediate family members), at any time in the past 12 months (including part-time workers i.e., one part-time worker equals one full-time worker).

- Has not had a temporary labor camp (providing housing for temporary employees) during the past 12 months. This applies even if the housing was only for just one person, and also even if that temporary employee is part time.

- Definition of a temporary labor camp housing for workers maintained by a farm includes housing:
  - ✓ As a required condition of employment; and
  - ✓ For a discrete, temporary period of time (i.e. for seasonal or temporary employment).

- The small farm exemption is also voided on operations or activities on operations that are not primarily production agriculture. For example, if the principle operation of the farm is agricultural tourism or processing of agricultural products, that farm is not exempt. Also, if there is a mix of production and non-production (e.g. sales, commodity storage for product sales, agricultural tourism, etc.) agricultural activities on the farm, the non-production agricultural components of the business are not exempt.

- There are 26 states plus Puerto Rico and the Virgin Islands that have their own OSHA-approved state plans which can exceed the requirements set by the Federal OSHA. It is best to check with the laws in your own state. New Jersey has a state OSHA-approved plan but it only applies to state and local government workers, not private employers.

Legally, OSHA regulations cover all farms even though federal OSHA cannot be used to inspect or cite farms with 10 or fewer employees. However, farm employers can be sued for negligence, in a civil court of law, and OSHA rules and regulations may be cited by the plaintiff to identify unsafe conditions on the farm.

There are four conditions on which OSHA may inspect and enforce regulations on large farms. These are listed in order of priority for OSHA:

1. Imminent danger situations
2. Catastrophes and fatal accidents
3. Complaints and referrals
4. Programmed inspections (Unannounced Inspections)

OSHA has an Agriculture standard titled; 29 CFR 1928 Occupational safety and Health Standards for Agriculture. The 29 CFR stands for Title 29 Code of Federal Regulations. Under 29 CFR 1928, there are six specific Agriculture Standards:

1. 29 CFR 1928.51: Roll over protective structures (ROPS) for agricultural tractors – refers to 2 or 4 wheel drive or track vehicles of over 20 horsepower. Includes requirements for tractor safety training, ROPS use, and seatbelt use.

2. 29 CFR 1928.52: Protective frames for wheel-type agricultural tractors (this standard is for the design and structure of the frame, not to its use).
3. 29 CFR 1928.53: Protective enclosures for wheel-type agricultural tractors (this standard is for the design and structure of the frame, not to its use).
4. 29 CFR 1928.57: Guarding of farm field equipment, farmstead equipment, and cotton gins
5. 29 CFR 1928.110: Field Sanitation – refers to the provision of drinking water, hand washing and toilet facilities for hand labor workers.
6. 29 CFR 1928.1027: Cadmium – refers to exposure to toxic metal fumes; some phosphate sources in fertilizer may contain cadmium.

There are also seven General Industry (29 CFR 1910) standards that are ***directly applicable*** to agriculture:

1. 29 CFR 1910.142: Temporary Labor Camps
2. 29 CFR 1910.111: (a) and (b): Storage & Handling of Anhydrous Ammonia
3. 29 CFR 1910.266: Logging Operations
4. 29 CFR 1910.145: Slow Moving Vehicles
5. 29 CFR 1910.1201: DOT Markings
6. 29 CFR 1910.1200: Hazard Communication
7. 29 CFR 1910.1027: Cadmium (welding, grinding, painting, fertilizer)

Any safety and health hazards not covered by any of these specific regulations, could be cited under the General Duty Clause Section 5(a)(1).

> **The General Duty Clause states that the employer shall *"furnish to each employee a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious harm"***

A great source of information is the OSHA website or your regional OSHA office. The address for the website is: www.OSHA.gov. The OSHA website is a great resource to access for more information on the regulations. At the website, you can access the *Agriculture Operations Safety and Health Topics* page. From this page you can access the agriculture standards and a lot of other useful agricultural safety and health information.

The OSHA funded On-site Consultation Program offers free and confidential safety and occupational health advice to small and medium-sized businesses in all states with priority given to high-hazard worksites. The On-site Consultation services are separate from OSHA enforcement and do not result in penalties or citations. Any hazards identified through the On-site Consultation Program must be corrected. Consultants from state agencies or universities work with employers to identify workplace hazards, provide advice on compliance with OSHA standards, and assist in establishing injury and illness prevention programs. In New Jersey, this program is administered by the Department of Labor and Workforce Development. Visit their website at: http://lwd.dol.state.nj.us/labor/lsse/employer/Occupational_Safety_and_Health_Onsite_Consultation_Program.html or call them at (609) 984-0785.

WHERE ARE THE REAL FARM HAZARDS & CHILD SAFETY ON THE FARM

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Farm safety in New Jersey, as in many places, is a secondary concern of many agriculture groups. In some cases the information is somewhat sketchy while in others it is simply nonexistent. The best information we had was for other states and even other countries such as Canada, Australia and Ireland. Because of this contemporary thinking on farm safety in New Jersey consisted mostly of preconceived ideas which may or may not be true.

Farm safety here in New Jersey and other states continues to be a paradox. On one hand we were had a century of training farmers in better farm practices but at the same time the overall effect on farm injuries seems minimal and fleeting. It has been my experience that some farmers do not take farm safety seriously. It is always going to happen to the other guy, right? Farmers have often felt that farm accidents are an “Act of God” or a “freak accident” and just put it off to doing business in agriculture. The sad part about is that if the accident rate we accept in agriculture were to apply in hospitals or factories, they would all be shut down.

In an effort to help improve the dismal injury rate we have in agriculture, I decided to try and do something about it To fill in the gap of our missing farm injury data, I teamed up with Mr. Troy Joshua who was in charge of the New Jersey office of NASS, the National Agriculture Statistics Services office to do a scientific survey of farm injuries in New Jersey. The survey consisted of 1,000 farms in Southern New Jersey. The survey response rate was 437 households which is considered very good.

The results of our survey showed that 149 of New Jersey farmers had some type of disability that affected doing work on the farm. Ironically this fact is about the same as the national average for all U.S. farms.

Our survey showed that the type of problem, which occurred, age and gender For example disabilities by age was:

AGE	DISABILITY	RATIO
33-44	Arthritis	4X higher in men
45-54	Hearing Loss	2X higher in men
55-59	Diabetes	
60-64	Arthritis	

65-69	Arthritis	
70+	Arthritis and Hearing Loss	

Disability by Gender

Head Injuries	3X higher in women
Hearing Loss	3X higher in men
Orthopedic Injuries	3X higher in men
Stokes	2 ½ X higher in women
Back Injuries	2X higher in men

Children on the Farm

Farms provide a unique situation that make them significantly different than other family situations. Farming is unique in that the farm is both their work environment and home environment. The overlay creates many situations and dangers that others locations lack. The situation with children on the farm has exploded as more farm labor assignment as part of the farm operation. The charts specifically recommend the number of staff needed for various ages and size of groups when they come to your farm. The information is too extensive for this summary, but realize it does exist for your use.

So just how dangerous is it on the farm for children? The chart below gives the range of farm youth accidents for the U.S. by year.

1998	37.774
2001	29,227
2004	27,591
2006	22,894
2009	15,876
2012	13,996

The good news is that the trend is down and showing a marked improvement in lowering youth farm injuries. While the injury rate has dropped this data may also incorporate the fact that there may currently be fewer youth living on the farm compared to 1998.

Direct Marketing/Agritourism

HOW TO HANDLE LARGE CROWDS AT YOUR EVENTS

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In the Agritourism industry, everyone's goal is to grow their business. Most times, this involves increasing the number of people who visit your farm each year. This is a great thing, as long as you are prepared to handle the large crowds.

When preparing to handle large crowds, it is important to focus on two main points: safety and customer satisfaction. Safety is often easy to overlook, but needs to always be on your mind when planning and running AT events. Unfortunately, in today's world one major accident can spell the end of your on-farm business. Although some things are out of our control, everything should be scrutinized as much as possible from a safety perspective. The more people that are visiting your farm, the better chance there is for someone to get hurt. Satisfied customers are the reason we have a successful business. We must remember that as the business grows, it is important to keep our customers happy. We must make sure they feel like they are still getting their moneys worth and are having a similar to or better experience when compared to when there were smaller crowds at the farm.

A primary area of focus for us at Von Thun Farms is our parking. Parking is the first thing your customers experience when visiting the farm and if they are irritated before they even get out of their car, that's not a good thing! Since we park in fields, some of our parking lots change each year based on our crop rotations. Prior to our fall season we try to plan out which lots we park in first, how pedestrian AND car traffic should flow, and try to optimize our parking situation. There have been times that we had cars pulling into the farm that were backing up onto the street resulting in a call from the police. All of our preparation is done in attempt to avoid that, and to get cars into the parking lot quickly. We also try to limit or eliminate the number of times that pedestrians have to cross car traffic. We paint lines on the ground to help our attendants park the cars quickly and in straight lines.

Another key to handling large crowds is good signs. Some people may have been to your farm before but not all of them. It is important to have large signs in the parking lot showing the way to park and also how to exit. Good signage is also important in any area that customers are paying for things. Signs can help speed up lines as customers can be prepared if they are paying cash. As our customers enter our event area, we hand them a map of the farm with all of our activities on it so they know what activities we offer, what there is to do, and where things are located.

As we grew in size, we realized that we were becoming victim to more and more theft from our customers. This has resulted in us fencing in our entire activity area with deer fence and only allowing one entrance and one exit for our customers. We have employees stationed at the exit checking to make sure that all merchandise has been paid for. This is something that we never thought we would have to do, but it is amazing how many people try to steal pumpkins in the fall!

Some smaller things that we do to manage crowds include: making holding areas or zig zag lines for our more popular events. Zig-zagged lines give an illusion that the line is a lot shorter and prevents the line from running out into any walkways. We also have begun building our hayride wagons with two sets of steps so we can load and unload them faster, which is especially helpful during our school tours. We added a second admission booth to spread out our lines and allow us to handle more customers. To increase the flow and limit confusion, we now accept credit cards at all of our admission areas and check-out lines as well as most other areas on the farm.

Lastly, in 2012 we made the change from selling ala-carte tickets to a one price admission system. This was a great move for us and has allowed us to add some smaller activities which help spread the people out in our activity area. It also ensures that we are getting income from all your visitors and that you don't have people clogging up lines without paying for much. This also means that once people pay the admission fee they are not pulling their wallet out for each activity or continually going back to buy more tickets, which we believe has resulted in our customers having a better overall experience & increased personal spending.

As your agritourism business grows, it is very important to factor in how you will handle the larger crowds. A few bad experiences by your customers can have a large negative impact on your business, as can an accident. It is always better to be prepared for more guests than you expect rather than running around the day of the event trying to figure out how to handle the crowds that you weren't prepared for!

TIPS FOR HIRING AND MANAGING EMPLOYEES FOR DIRECT MARKETs AND AGRITOURISM EVENTS

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Human resources and employee management is critical for maintaining a positive work culture and establishing a successful farm operation. However, wages for labor can be some of the most significant costs for a farm business. The time invested in the hiring, training, and retention of productive employees can require significant time and attention, but is absolutely necessary to reduce the potential for future problems. This discussion will provide a very basic overview of some of the methods farmers can utilize to more effectively hire, train and manage employees. This discussion is intended to help those looking to hire and manage the often, short term need for a large number of employees.
This will further discuss the fluctuations in employee needs based on accommodating the size and scale of agritourism and direct marketing operations and events versus basic, on farm employment.

Designate a hiring manager
Designating a hiring manager on the farm will help keep job recruitment and hiring efforts on track. This person will be responsible for directing all job advertising, interviewing, and employee management. This key individual will communicate progress to all interested applicants, and serve as the go-to for all personnel/employment situations. This designated hiring manager will utilize consistent employee suitability standards throughout the hiring process. They will handle all levels of personnel including hiring, warning, and firing employees.

Develop job descriptions
For every job vacancy available on the farm, develop a basic description of each job to make candidates aware of what's expected of that position. Five key elements of each job description should include: Title, Summary, Qualifications, Tasks/Activities, and Time Commitment. These job descriptions will help candidates understand what is expected of them during the recruitment, hiring, and (if hired) evaluation processes.

These job descriptions can be posted on flyers around neighboring schools and sports complexes to attract younger audiences needed for weekend labor. If seeking adult employees, posting job vacancies on social media and job search engine sites are easy and effective methods for recruiting full-time employees.

How to hire?

Intensive, one-on-one interviews may be an inefficient use of your time when you need a large number of employees for select festival style farm events. It may be wise to conduct group interviews with the help of several seasoned employees helping your manager. Group settings allow hiring managers to evaluate the behaviors and skills of each candidate while working together as a team. Hiring managers can determine who follows directions, who is a leader, and who may not be fit for working on the farm. When evaluating candidates, hiring managers can measure the performance of each candidate by observing the following:

Ability to get along with others;
Ability to follow directions and pay attention to detail;
Ability to stay focused and avoid overuse of their cell phone.

The hiring staff will observe these behaviors that will help determine each applicant's organizational fit for your farm. Hiring staff can also identify strong leaders and detail oriented candidates by allowing the group to perform problem-solving activities during the group interview. These activities can allow managers to rank strengths and weaknesses of candidates working as a team. Hiring managers look closely for attention to detail, listening skills, and leadership abilities to properly coordinate candidate placement on the farm.

More intensive, highly selective candidate screening should be performed for full time, adult employees. Hiring managers typically observe the candidates' dependability and positive attitude during one-on-one interviews with adults.

Adding variety to your workforce

Finding local teens to fill vacant jobs may at first seem simple, but you must be aware of school-related activities like standardized tests that may reduce your work force during a critical weekend when you need them. Your hiring manager needs to be aware of these mandatory events that students may have to attend and plan accordingly.

Supplementing the workforce with a diverse group of employees will minimize the risk of short-handed staffing on any given day. The diversity in demographics for employees may include employees from different age groups or differing school districts. Although a nearby high school may have dozens of students interested in working on the farm, these individuals may share similar academic and extracurricular activities that will limit their work availability. (Homecoming, sports games, SAT exams etc.) Short-handed staff may result in a cancelation or poorly run farm event.

Points to consider when hiring teens to work on the farm

1. Do they have previous work experience and references?
2. Do they have a driver's license?
3. Are they involved in intensive school activities(sports, clubs) that may conflict with the critical times you need help ?
4. Are they doing well in school?
5. Are they eager to work?

6. Do they have any knowledge of farming or work experience on farms?

7. Do they have any references from previous jobs or teachers that would recommend them?

Hard working. professional employees can be your greatest asset on the farm. It will take time to determine the best strategy for employee management that works on your unique farm operation. It is well worth the time to hire an effective employee manager if you have a great number of employees to oversee. Be sure to select the right person to guide the screening and training of candidates that will become the face and voice of your farm for the many customers that attend your farm events. Utilizing effective hiring strategies will prevent unnecessary expenses, such as high employee turnover, and enhance the productivity of the farm by hiring the strongest employees. Hiring the right workforce will add value and contribute to overall farm operation success.

GROWER PANEL- YOUNG FARMERS WITH GREAT IDEAS FOR DIRECT MARKETING AND AGRITOURISM

Bill Hlubik[1], Gillian Armstrong[2,] Stephen Specca[3], Jim Johnson[4],
Wes Johnson[5] and Tim VonThun[6]
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A new era in agriculture is quickly approaching, and with this fast-paced movement enters a new generation of farmers. Young farmers are the new, leading faces of innovation and creativity that will preserve the longevity of New Jersey agriculture. Representatives from outstanding direct marketing operations in New Jersey intend to discuss their visions and suggestions for the new age of direct marketing and agritourism. This discussion will focus on topics/trends that shouldn't be overlooked, and key opportunities for farmers during this generational shift in New Jersey Agriculture.

Staying Connected

Staying connected to your customer base is critical for any farmer interested in direct marketing. With many individuals influenced by falsified agricultural media, young farmers find keeping a positive relationship with customers is more important than ever before. Some customers may be more interested in the varieties of products you have available at the time, while others might be more concerned about the products exposure to chemicals, "GMOs", sustainable practices etc. Staying connected by educating customers on farming practices, and being open to customer concerns is crucial for obtaining and maintaining customers. This will keep customers better informed on your farming practices and overall agriculture. A farmer who is out of touch with the point of sale aspect of their business will not be as adaptable as a farmer who is aware of these issues.

Another key method farmers can utilize to connect with customers is by offering a suggestions box. By offering a suggestions box, customers can extend their feedback on-site before leaving your farm. Receiving direct feedback from customers will allow your operation the ability to adapt to customer needs and market trends.

Also, staying in-sync with the demographics of your consumers is important to securing a loyal customer base. These demographics may include: religion, age, mobile ability, etc. Catering to these demographics will personify your operation by making visitors feel more welcomed.

Importance of Media Presence

Not being present on social media platforms is a missed opportunity for all direct marketers. Having a strong social media presence allows farmers to showcase their unique quality and value of their farm products. It will also enhance their loyal customer

base, cut marketing costs, and increase sales. In addition to posting general information, farmers can offer incentives to get people onto their farm by posting offers on their pages. Awarding discounts for shares or likes are easy, free methods farmers can utilize to enhance their farms exposure to expanded audiences.

Appearance and Signage

Keeping an organized, neat appearance on the farm is crucial when allowing the public to visit your farm. One of the most important tools farmers often overlook are signs on the farm. This panel will discuss the importance of having enough visible, clear signage for maintaining organization on busy days. Signs are used as directional tools that assist customers throughout their farm visit experience. Signs may include parking directions, do not pick, beware of mud, etc. The usefulness of clear legible signs cannot be overstated. Farmers should consider multiple languages, colors used, sizes/heights of signs when placing them around the farm. In addition, pictures on signs are a helpful, directional tool for customers unable to read the farm signs. Signs that highlight new products, or special varieties unique to the farm can help to enhance the farm experience.

Evolution of Direct Marketing

The panel will discuss the evolution and modernization of direct marketing on their home farms. All four young men will describe how they plan to apply their bachelor degrees in furthering the success of their farm operations, and their plans for the future. Each member of the panel will discuss the opportunities and obstacles they face as young farmers, and their challenges to starting and running a farm business.

AGRITOURISM NEED NOT BE A RISKY BUSINESS: PROTECTING PEOPLE FROM PESTICIDES

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Agritourism in New Jersey takes many forms, including U-pick, farmer's markets, Community Supported Agriculture (CSAs); outdoor recreation (birding, horseback riding); and seasonal entertainment such as Fall Harvest Festivals. Whenever your agritourism venue is located on a working farm where pesticides are used and stored, there are special precautions to protect people from pesticides.

When using pesticides to raise an agricultural commodity, restricting access and posting areas that have been treated with pesticides is required under the federal Worker Protection Standard (WPS). New Jersey more specifically defines a "restricted-entry interval" or "REI" as the period of time that must elapse after a field is treated with a pesticide, and before any person is permitted to enter to engage in an activity requiring substantial contact with treated surfaces. The REI is label-prescribed, and is legally enforceable.

The restricted entry interval begins at the time that the pesticide application is completed. U-Pick operations often opt to use pesticides with shorter restricted entry intervals, even if when there is a lower efficacy. This choice minimizes potential unsafe exposures to curious patrons (and allows for quicker field turnaround).

Product labels may give an option to either orally notify or post a pesticide-treated area for the length of the REI. It is strongly recommended that agritourism operations always post a treated area, as the public may make an "unannounced" U-Pick visit to the farm when operations are closed. Keep fields posted prior to, but no earlier than 24 hours. Products with an REI greater than 48 hours will require posting under the revised WPS. Posting should be removed or covered within three days after the REI or end of application, whichever is longer.

For the protection of others, and especially visitor patrons to the farm, pesticide storage areas should be posted at all entrances and kept securely locked. New Jersey pesticide regulations do not require specific language for signs. But, post strong warnings that pesticides are inside; such as "Warning - Pesticides", or "Danger - Pesticides - Keep

Out". Consider segregating pesticide storage, as well as application equipment in lockable barns or fenced yards for large agritourism operations. Where crowd control is difficult to monitor or manage, growers may simply opt to keep pesticides at a separate location from retail sales areas or agritourist events.

Protect your patrons from pesticide emergencies. Keep your local fire department informed of the location of all pesticide storage locations. Keep an inventory of all pesticides held in storage, update it annually, and locate the inventory list in an accessible place away from the storage site. In New Jersey, applicators are required to annually send an inventory with the exact location of pesticides in storage to their local fire department by May 1st each year. This might include written descriptions, sketches, or even GPS coordinates.

Protecting people from pesticides on your operation includes making sure pesticide containers in storage don't breach. Routinely inspect containers for tears, splits, breaks, leaks, rust, and corrosion. Rather than wood/dirt flooring or shelving, store product on epoxy-coated surfaces. All drums and bags should be stored off the floor on top of plastic pallets. Chemicals should be stored on sturdy metal shelving with the heaviest containers and liquids on the lowest shelves. Place opened bags of dry material in sealable plastic bags or other suitable containers to reduce moisture absorption and reduce the possibility of a spill.

Keep adequate and accessible cleanup supplies and equipment to handle any spill that may occur. New Jersey regulations require that your storage area have at least a shovel or dust pan & brush for dry spills and adequate sorbent to control liquids that may be spilled. New Jersey has thresholds for reporting spills to the New Jersey Department of Environmental Protection (DEP). Reportable spills should be called into the DEP immediately at 877-WARNDEP. See NJAC 7:30 for specifics; URL: www.nj.gov/dep/enforcement/pcp/pcp-regs.htm.

Finally, it is recommended that agritourism operators keep current and accurate records of pesticide applications, pesticides used, and handler supervision records. Some states are more specific. New Jersey requires all licensed pesticide applicators to maintain application records of any pesticide applied, whether it is a restricted or general use pesticide. These regulations also require that these records be kept for three years and be immediately available upon request by the DEP.

The Rutgers NJAES Cooperative Extension Pesticide Applicator Training Resources Records and Forms webpage has templates for application records, spill reporting, and storage inventory reporting that meet the minimum requirements of New Jersey regulations. See www.pestmanagement.rutgers.edu/pat/record_forms.htm. For further assistance, contact the Rutgers Cooperative Extension Pest Management Office at 848-932-9802.

Alternative Production-Animals

THE ROLE OF PASTURES IN ORGANIC LIVESTOCK FARMING

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Environmental concerns associated with annual row crop grain production and confinement animal operations – including soil erosion, soil carbon loss, intensive use of chemicals and petroleum, limited arable land, among others – could be addressed by converting conventional livestock production to an organic pasture based system. The inclusion of tree crops would further enhance the opportunity for feeding pasture- raised livestock by providing shelter and alternative feed sources. Biodiversity is an essential aspect of an organic farm plan. The idea of including tree crops and other perennials into the vision of an organic farm as a "living system" is very much compatible with the goals and philosophy of organic farming. Before modern no-till farming systems were developed, tree crops and pasture systems were found to provide similar benefits for controlling soil erosion and conserving soil carbon. For example, J. Russell Smith's *Tree Crops: A Permanent Agriculture* (Smith, 1950) pioneered tree crop agriculture as the alternative to annual row crops for protecting soils from erosion while producing livestock feed such as acorns, nuts, and fodder. A survey of Mid-Atlantic USA soils under pasture found 60% higher soil organic matter content than cultivated fields. Because United States Department of Agriculture's National Organic Program (USDA-NOP) standards require dairy cattle consume pasture forage and limited grain (7 C.F.R. pt. 206), organic milk contains higher concentrations of omega-3 and fewer omega-6 fatty acids than conventional milk. Organic standards also state "the producer must not use lumber treated with arsenate or other prohibited materials for new [fence posts] installations or replacement purposes in contact with soil or livestock." Black locust is a fast growing renewable alternative to treated lumber with many attributes compatible with organic farming. This versatile tree fixes nitrogen (N), provides flowers for honey bees and other pollinators, and produces a highly durable dense wood ideal for fence posts useable for up to 50 year. Pastures thoughtfully integrated into the farm ecosystem have much to contribute to the sustainability. Including pasture in a crop rotation is one of the most effective ways to build soil organic matter content. Herbaceous and woody perennials, even on hilly lands, protect soils from erosion. The nutritional quality of animal foods is improved when produced by livestock on pasture. People choosing to eat pasture raised foods are indirectly contributing to and helping fund soil improvement. Future research on organic food quality as it relates to pasture feeding of livestock should look beyond fatty acid composition to levels of the fat soluble vitamins A, D, E and K2 in milk, meat, and eggs. Pastures are parts of the living fabric of organic farms that create a web of connections between soils, plants, animals, and people while building healthy and sustainable ecosystems.

GRAZING AND VALUE ADDED LAMB PRODUCTION

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New and existing livestock growers are often challenged with what type of livestock production to get started with and how to proceed. The “Value Added Lamb Model”, was designed over 25 years ago by Agent Mickel to assist growers with the concept of raising terminal lambs as a livestock enterprise to utilize existing pastures and facilities. The model was designed to assist producers with limited knowledge of animal production and related production needs with the ultimate goal of marketing finished lambs directly to consumers.

The applied project design walks producers through the entire production model with specific objectives that producers need to consider to make the endeavor successful. Concepts regarding facility needs, acreage needs, animal husbandry, breed selection, management strategies, handling, marketing, harvesting (slaughter) and processing are discussed in the applied project presentation.

SELECTION AND FEEDING CONCEPTS FOR MARKET AND BREEDING BEEF CATTLE PRODUCTION

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Guidelines for prospective beef cattle producers are essential to the development and success of producing beef cattle. General considerations to get started cover production goals, breed selection (purebred or commercial), phenotypes and confirmation, general knowledge of the cattle industry, nutritional needs, animal husbandry needs, concepts of animal types for steers, heifers, cows and bulls and a host of learned production concepts.

The presentation will offer a good start to begin acquiring the knowledge to begin a beef production project. Basic concepts will assist new producers as they contemplate and eventually begin a beef production model.

Wine Grapes II

NOTES:_____

Greenhouses

VIRTUAL GROWER: A SOFTWARE TOOL TO MANAGE GREENHOUSE ENERGY COSTS

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Energy costs are the third highest production expense in protected horticulture, only surpassed by labor and plant material. According to the 2009 Census of Horticultural Specialties, over $797 million was spent by growers in the U.S. on gasoline, fuel, oil, and utilities, which was approximately 8.4% of total production costs. However, for food crops grown under protection, energy costs accounted for a greater percentage of total production expenses (14%). One way for growers to increase their profitability is to reduce energy costs while maintaining desired crop quality and timing.

Total energy costs include growing, harvesting, and shipping plant material, as well as maintaining offices and buildings. Of that, approximately 85% is spent on heating the greenhouse. Therefore, reducing heating costs without reducing plant quality or yield can greatly reduce overall production expenses. This can be accomplished by improving the efficiency of greenhouse heating systems, reducing heat loss via structural improvements, or adjusting heating schedules to optimize plant growth per unit of heat applied. In addition, adding supplemental lighting during late fall, winter, and early spring will increase plant growth and decrease production time, but is an added expense.

It can be daunting to try to determine the impact a structural modification or change in production practice may have on greenhouse energy costs. With that in mind, researchers with the Agricultural Research Service's Greenhouse Production Research Group in Toledo, Ohio, developed Virtual Grower. It is a free, decision-support software program that provides users the opportunity to build a virtual greenhouse, estimate energy costs from heating and supplemental lighting, and conduct simulations to determine where savings can be realized. Originally released in 2006, we are now on version 3.1.

Virtual Grower can, in a sense, be a safety net that allows users to look at "what if" scenarios in a risk-free setting. Examples of scenarios and simulations that Virtual Grower can assist with include the following:

- Compare energy costs of different greenhouse designs and materials before committing to a new greenhouse structure,

- Estimate energy savings that may be achieved by upgrading or retrofitting an existing structure with energy efficient components,
- Calculate an estimated payback period for an energy-efficient improvement,
- Compare energy costs across multiple locations,
- Compare energy costs for various fuel sources, heating systems, and delivery methods based on current and predicted prices,
- Make real-time predictions of energy use,
- See the impact of supplemental lighting on plant growth and development,
- Estimate total energy costs during crop production for different temperature set points, and
- Estimate a start (or finish date) for a crop based on the desired finish time (or actual plant date), heating schedule, and supplemental lighting (flowering crops).

Virtual Grower is compatible with Mac and PC computers, and is available in three languages (English, French, and Spanish). It includes crop growth modeling for more than 40 plants, although they are primarily flowering ornamentals. It is available for download from our website (www.virtualgrower.net). Questions, comments, and feedback can be e-mailed to VirtualGrower@ars.usda.gov.

MAKING WATER WETTER
USING ADJUVANTS PROFITABLY

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Due to the waxy surfaces of many insects, fungi, and plants, getting good coverage and penetration to the targeted areas can be difficult for water-based spray solutions. Overcoming this major water solubility issue was a focused area in the 1950s and 60s since most pesticides were not formulated to use water as the carrier. To overcome this barrier, adjuvants were developed to such an extent that thousands of adjuvants and new pesticide formulations flooded the market. Over 200 were labeled as additives to spray solutions and irrigation water, with nearly half of these being labeled as wetting agents, spreader/stickers and penetrants.

Even though overcoming pesticide solubility was no longer an issue, deciding which to use can be overwhelming. It is, therefore, valuable to understand the role of principle active ingredients in performing the functions expected. Defaulting to cost should not be an option!

Adjuvant is a broad term describing any additive to enhance the activity of a solution. Examples of adjuvants are surfactants, spreader/ stickers, crop oils, antifoaming materials, buffering agents, and compatibility agents. Adjuvants can determine how well a pesticide performs and improve efficiency of irrigating, so choosing the right one can reduce the pesticide or irrigating cost due to enhanced activity (Figure 1 & 2). Many pesticides recommend using an adjuvant to improve efficacy and it has been shown that when mixing a recommended adjuvant with a certain pesticides a10 to 50 percent increase in pest control can be expected.

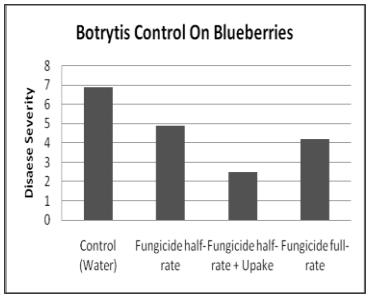


Figure 1. J. Elmhirst-Elmhirst Diagnostics and Research compared Botrytis control when adding a surfactant to the tank mix.

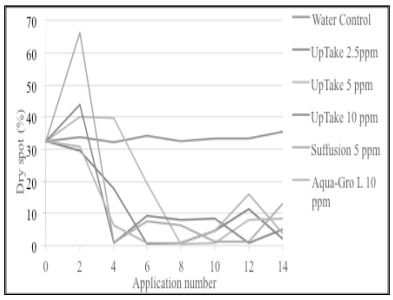


Figure 2. M. Evans-University of Arkansas compared wettability of soil wetting agents at low ppm levels.

It is critical to understand the safety parameters of various adjuvants such as incompatible chemical mixes, recommended environmental

Figure 3. Excess adjuvant on pansy foliage.

Figure 4. Figure 7. High temperature effect of adjuvant on pansy foliage.

conditions, sensitive crops and rates. Adjuvants may cause plant damage by increasing the penetration of the companion product or when applied in high temperatures or high humidity. Using the correct adjuvant on crops is a critical safety, efficacy and economics decision. Applied at too high a rate or when the temperature is too high may cause membrane permeability problems resulting in plant injury (Figure 3 & 4), which will increase production cost.

How Do Adjuvants work

To understand how adjuvants work, it helps to understand how water works. Each water molecule is bipolar, meaning it has a negative and a positive charge, very much like a magnet. When several water molecules are put together, the positive and negative forces or charges attract each other (Figure 5).

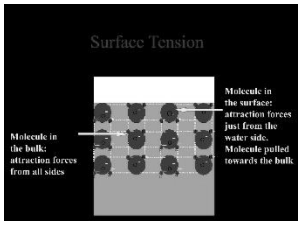
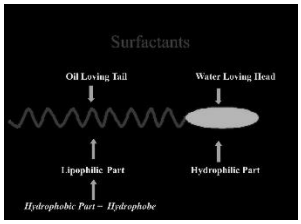


Figure 5. The interacting charges of water molecules (oxygen represented in blue - negatively charged and hydrogen represented in red

The force holding the molecules together on the surface of a water droplet is a much stronger force than that holding the interior water molecules together. This causes surface tension, which can prevent many things from going into solution and getting wet. Surfactants break the surface tension of water.



Most surfactants have a *water-loving polar head* (hydrophilic head) and *water-hating non-polar tail* (hydrophobic tail) (Figure 6). These components of a surfactant molecule help break water surface tension, thus coalescing or spreading the solution, which allows the tank mixed pesticide to be more evenly and efficiently dispersed on the plant and/or soil surface.

Figure 6. Effect of water beads by surfactants.

This principle also holds true when surfactant are used as a wetting agent in irrigation water. Since plant and soil surfaces are hydrophobic, without the addition of a wetting agent, water pressure and/or volume is needed to break surface tension. When a wetting agent is added to irrigation water the droplets on the plant and/or soil surface coalesce or spread, as the surface tension is broken without the increase of water pressure or volume, thus it will take less water to thoroughly wet. When using millions of gallons of water to irrigate, using an adjuvant can be a very economical practice.

When water molecules come into contact with unlike substances, several things may happen. If the substances have a similar or like charges they repel each other. If they have different charges the forces will attract each other and if there are no charges, there will be no reaction. When water is placed on most hydrophobic surfaces it will bead. This beading is caused by surface tension, and this surface tension can be reduced by the addition of surfactants (Figure 7).

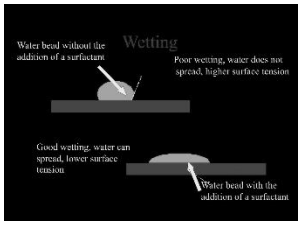


Figure 7. Components of a surfactant

The focus of this discussion is on the benefits of adding surfactants to irrigation water and tank mixes. The intent of this discussion is to explain how surfactants differ and which ones are best to use for the desired results.

Surfactants

The word *surfactant* means “surface active agent” and is the active ingredient in most adjuvants used to facilitate and increase the emulsifying, dispersing, spreading, wetting, or other surface modifying properties of the liquid it is mixed with. Surfactants fall into 3 categories - *anionic* (ionized, have a strong negative charge), *nonionic* (do not ionize, but will have a slight electrostatic charge due to the polarity of dissimilar atoms in the molecule), or *cationic* (ionized, have a strong positive charge).

Basically, *anionic* and *cationic* surfactants ionize when mixed with water, so very similar except they have opposite charges. Since water is a *dipolar* substance, having both negative and positive polar ends, *cationic* and *anionic* wetting agents are similar in their ability to make water wetter; they just bind at different points.

Anionic Surfactants are primarily used to enhance foaming and other spreading properties in products such as shampoo’s and detergents. They are not widely used in the agriculture industries due to the high foaming problems they cause with sprayers that have an agitator, or any system where the foam could disrupt water flow or pump suction. Due to their negative charge they do bind to the positive charge of water but lack the ability to bind to negatively charged particles such as soil, organic substances, pesticides or plant surfaces.

Nonionic Surfactants do not have a charge in solution and are the most commonly used surfactants in our industry, with organosilicates being the primary chemical class used. They were developed in the 1970s for use in waterproofing surfaces, but the use as agricultural spray adjuvants was not discovered until about 12 years ago. Generally several compounds such as polyoxyethylene esters, ethoxy sulfates, or derivations thereof are combined to achieve wetting, sticking and/or penetration surfactants.

Organosilicate surfactants are very good stickers which increase the rainfastness of pesticides, but they can also be formulated to reduce the surface tension and increase penetration. When mixed with fertilizers and pesticides, penetration occurs by “stomatal flooding” on the leaf surface. While stomatal flooding is a good way to move nutrients and pesticides into the plant for improved penetration, it may also provide a mechanism for foliar bacterial diseases to become systemic when using the organosilicates.

When used properly, organosilicates generally do not harm plants and remain stable without causing a problem when mixed with fertilizers or other chemicals. However, as with all surfactants, application rate and timing is critical.

Cationic Surfactants are positively charged in solution, disrupting membrane ion balance thus creating a tight bond to negatively charged particles when contacted. The most common cationic surfactant is a quaternary ammonium or quats, as they are commonly called. In the past the quats have not been widely used as agriculture

surfactants except with combined at low rates with organosilicates due to issues with crop safety if used at higher rates. The ADBAC or **a**lkyl-**d**imethyl-**b**enzyl-**a**mmonium **c**hloride quat is the most common one used in combination with organosilicates.

In the 1960s that quaternary ammonium chemistry was dramatically revised, removing the benzene ring, thus providing a more active and safe cationic surfactant for use on crops from greenhouse propagation to field, without the need to combine with organosilicates. This new category of quat is called a **d**idecyl-**d**imethyl-**a**mmonium **c**hloride or DDAC quat (Figure 8).

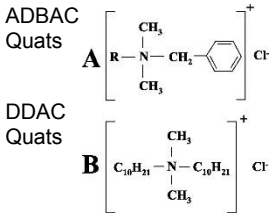


Figure 8

The new DDAC quat is a very stable molecule that has a high tolerance to alkaline solution, elevated temperatures and high organic loads. It is widely used in other industries such as oil recovery, wood preservation, disinfecting and public water treatment. Due to the ionic charged "mode of action" or MOA of membrane disruption, the DDAC quat provides a 3-in-one benefit as a wetting agent, spreader/sticker and penetrant with rainfastness, without having to combine it with other compounds as is done with the organosilicates. As with all adjuvants, rates and timing is important.

The unique tight binding to soil, plant surfaces and organic substances denatures the cellular protein molecule thus disrupting the outer cellular membrane providing many additional benefits. Since DDAC does not penetrate by way of the stomata's, there is no question of introducing bacteria into the vascular system when using DDAC, as there is with organosilicates. Also, the membrane disruption MOA is not selective to plants, soil and water, but also holds true with other negatively ionized surfaces of pest such as snails, microbials, insects and mites.

Additional Benefits

Organosilicate nonionic surfactants have been shown to control fungal contamination, especially in hydroponic systems. Studies done by Dr. M.E. Stanghellini in1969 showed that amending the nutrient solution with a nonionic surfactant resulted in the elimination of Phytophthora zoospores and 100% control of the spread of the root pathogen in hydroponic growing.

Quaternary Ammonium cationic surfactants are EPA registered hard surface, plant and water disinfectant for algae and disease control and is supported by years of research. Dr. Ann Chase and Dr. Karl Steddom as well as others have done extensive research supporting the disease and fungicide claims and show DDAC can control diseases such as Pythium, Phytophthora, Fusarium, Erwinia and Pseudomonas on hard surfaces, as well as on crops and in water for traditional and hydroponic growing.

Summary

Surfactants play a major role in improving the effectiveness of pesticide and irrigation water. The addition of the proper surfactant to nutritional, pesticide and water management programs can improve penetration, wetting and rainfastness. Therefore, understanding the mode of action and features/benefit offered by that mode of action can help you select the most effective and economical surfactant to perform the job needed.

COOL SEASON CROP PRODUCTION IN TUNNELS

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In Northern New England, expanding winter marketing opportunities have increased growers' interests in harvesting cool-season crops throughout the winter using various methods of season extension. I will share conclusions drawn from 1) our own experiments in unheated high tunnels and low tunnels, 2) our own experiments growing greens in minimally heated greenhouses, and 3) commercial growers that are successfully growing cool season crops in tunnels. This work has been done in partnership with colleagues at University of Massachusetts (Ruth Hazzard, Amanda Brown and others) and the University of New Hampshire (Brian Krug), as well as many collaborating growers.

Crop growth constraints

The two main constraints to growing crops throughout the winter in cool climates are temperature and light.

Temperature – Low temperatures affect plants in a couple of ways. Growth rate slows as temperature decreases, and when temperature reaches a certain point (the base temperature of a plant species), growth ceases completely. Plants also can experience several kinds of damage from low temperatures, including freeze damage (which can rupture cells), desiccation (because water is lost from plant tissues faster than it is taken up), and frost cracks (because plant tissues expand when they warm up and contract when they cool down).

Plant species vary in their response to low temperatures. Base temperatures vary between 40-65F, meaning that some plants continue to grow even under relatively cool temperatures. Some species are hardier than others, meaning that they are more resistant to chilling and cold injury. Hardier plants acclimate to cold temperatures, meaning that they respond to gradual exposure to low temperatures by becoming more resistant to freeze damage.

Light – Daylength fluctuates throughout the year. The amount it varies depends on latitude, but for central NH, there are fewer than 10 hours of daylength between approximately Nov 11 and Feb 3. In addition, the low angle of the sun further reduces

light incidence on growing crops. As a result, without supplemental light, photosynthesis is very limited during the late fall and early winter months.

In practice, winter growers cope with these environmental challenges using several strategies: using a range of season extension structures, choosing hardiest crops, minimal heating, and stockpiling.

Season extension structures

Season extension strategies range from applying rowcover over field crops to using fully automated greenhouses with supplemental heat and light. Three strategies that fall somewhere in-between (low tunnels, high tunnels and minimally heated greenhouses) are most commonly used among winter growers in New England (zones 4-7).

Low tunnels are small tunnel structures built over crops growing in-ground. These may be covered with rowcover and/or plastic, depending on the intended harvest time frame. Because of difficult access once ground is frozen, low tunnels are best suited for crops that are harvested in the late fall, or ones that are overwintered and harvested in early spring. For more information, see our reports *Using low tunnels for overwintering crops,* at http://extension.unh.edu/resources/files/Resource004419_Rep6301.pdf, and *Effects of low tunnels on winter temperatures, at* http://extension.unh.edu/resources/files/Resource004242_Rep6077.pdf.

High tunnels offer more temperature protection than low tunnels, and allow access and harvest throughout the winter. For winter production, it's important to use structures that are meant to withstand snow load. Without supplemental heat, the use of additional layers of rowcover supported over the crops is important for quality and survival. Growers are divided on the importance of daily removal of rowcover and ventilation.

Greenhouses (or tunnels with supplemental heat) allow more production during the coldest months; but the important question is whether increased production offsets the additional costs. We have done some work investigating the productivity of benchtop production systems in greenhouses like those used for ornamental bedding plant production during spring, and have generated an enterprise budget spreadsheet to help growers assess the potential profitability of this system. The enterprise budget is available at: http://extension.unh.edu/resources/files/Resource004050_Rep5728.xlsm.

Crop choice

For unheated high tunnels, spinach is the most common winter crop among winter growers. While spinach is relatively slow growing, it is very hardy. Individual leaves are harvested, leaving the growing point, which continues to produce new leaves that can be harvested over a long period of time. If established in early fall, spinach can be re-

harvested throughout the winter. Growers report yields in the range of 0.4-0.7 lbs per square foot over the entire winter. Varieties differ in terms of productivity, earliness, leaf shape and ease of harvest. Many growers find that prioritizing varieties with resistance to many races of downy mildew is good insurance for winter production.

There are several members of the brassica family hardy enough to survive in unheated tunnels. These can be harvested either as baby leaf/salad size or as larger braising greens, and include kales, mustards, arugula, mizuna, Tokyo bekana and tatsoi. Two unrelated greens, claytonia (miner's lettuce) and mache (Valerianella spp.), are also well suited to production in unheated tunnels, but both are very slow growing. You can read more about different varieties' in *Salad green varieties for benchtop production,* at http://extension.unh.edu/resources/files/Resource003798_Rep5413.pdf

There are many other crops that can survive and perform well in unheated tunnels, but that are less commonly grown. In comparison to spinach, they generally have lower potential yields per unit of time that they occupy valuable tunnel space. These include purple and green sprouting broccolis (cv. Santee and Happy Rich), garlic scallions (fall-planted bulbils), cilantro, summer-planted carrots and fall-planted onions. Lettuce and chard are two species that may suffer damage from freezing temperatures, and that are better suited for late fall harvest than for production through the coldest winter months.

Minimal heating

Many growers that aim to harvest greens through the entire winter in cold climates use minimal heat in their tunnels/greenhouses to prevent the air temperature inside the structure from falling below 32F. The goal is to prevent freeze damage to greens crops, increasing crop quality. Common set points are 35, 37 or 40F. Depending on the type of structure, heat source, climate and weather, the costs of heating to these temperatures can vary widely.

We conducted several experiments in side-by-side greenhouses heated to minimum temperatures of 40F and 50F to determine whether additional supplemental heating would increase rates of growth enough to be economically feasible. Our graduate student, Claire Collie, did this by seeding over a large range of dates in two years, for three species: lettuce, mizuna and spinach. She found that, as you would predict, higher temperatures made greens reach harvestable maturity faster. In our conditions, however, the cost of heating, especially during the coldest months, was high enough in the warmer house that the faster growth did not make up for the increased costs. Further, for mizuna, it appeared that the greens grown in 40F were heavier than those grown in 50F, resulting in higher yields under cooler temperatures.

Stockpiling

A common strategy for winter growers in cold climates is “stockpiling”, or establishing plantings in the early fall before growth rates slow precipitously. This is particularly important for those producing without any supplemental heat (common for in-ground spinach production), to maintain high quality harvestable greens throughout the winter. Throughout December and January, the unheated tunnel essentially acts as a large refrigerator, preserving the crops in place. Once established, plants may be harvested as needed in late fall or early winter, and some have the potential to regrow as temperature and light increases in the spring.

Field & Forage Crops

NOTES:_____

Bees

NOTES:_____

Small Fruit/Strawberry

UPDATE ON RUTGERS NJAES STRAWBERRY BREEDING PROGRAM

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Many years of traditional breeding by Dr. Gojko Jelenkovic has resulted in new selections of strawberries which exhibit unique characteristics. Over the past five years the evaluation of these strawberry selection has been expanded and expedited to determine which of them might benefit local farmers and consumers. The selections have been tested in replicated university field trials at two sites in New Jersey and also through cooperative partnerships at North Carolina State U., the U. of Maryland, Pennsylvania State U., Ohio State U, and U. of Florida. Observation trials of the selections have been conducted on thirteen local conventional and organic strawberry farms. The research and farm trials have focused on identifying selections with superior fruit flavor and adaptability to eastern U.S. environmental conditions. Fruit from the trials has been utilized in blinded taste panels to determine consumer preference of the selections compared with commercial standards.

Consumers participating in the taste panels and farmer cooperators have been pleased with the consistent flavor and fruit quality attributes of the NJAES strawberry selections. These results have led to plant patent applications for three of the selections and the release of the variety 'Rutgers Scarlet'^{TM} to two commercial nurseries. Limited trial quantities of 'Rutgers Scarlet' ^{TM} will be available to growers for the 2016 planting season from:

Kube-Pak Corp.
194 Rt. 526
Allentown, NJ 08501
Phone: (609) 259-3114
Fax: (609) 259-0487
http://www.kubepak.com/

Nourse Farms, Inc.
41 River Road
Whately, MA 01093
Phone: (413) 665-2658
Fax: (413) 665-7888
http://noursefarms.com/

The plan is to release a series of new strawberry varieties from the program and make them available to farmers over the next several years.

This research and extension project has been supported by grants from the Walmart Foundation and administered by the University of Arkansas System Division of Agriculture Center for Agricultural and Rural Sustainability, as well as by funding from the Specialty Crops initiative through NJDA and USDA. Initial funding to help launch and continue to maintain this research was provided by Rutgers NJAES and the NJ Small Fruits Council.

BRAMBLE PRODUCTION IN HIGH TUNNELS

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Brambles (red raspberries, black raspberries, and blackberries) are crops that benefit from being produced in high tunnels for a number of well-documented reasons. The most commonly-cited reason is season extension, since tunnel use adds a minimum of 3 to 4 weeks to both the beginning and end of the growing season. The longer growing season means that plants have more time to grow larger, and yields are higher – with primocane-fruiting brambles, typically at least 2 to 3 times that expected from field production.

Crop Production Methods

Tunnel Type: Either 4-season or 3-season tunnels may be used. If the tunnel is covered all winter, more cold-tender brambles such as floricane-fruiting blackberries can be grown in colder locations (USDA hardiness zones 6B and colder) where they normally otherwise would be winter-injured.

Site Selection and Infrastructure: Requirements for soil type and condition for tunnel production are similar to those for any berry planting. The soil must be well-drained and soil in the tunnel must not be lower than that outside in order to avoid problems with root rotting diseases such as *Phytophthora*, which can develop if water runs off the roof and collects in the tunnel. Brambles generally perform better in soils with high organic matter content. At least 2% organic matter is recommended, with higher amounts preferred. A relatively level site is needed.

Irrigation and Water Quality: Trickle irrigation is utilized. Especially in 4-season tunnels where the irrigation source is the sole source of water, its quality takes on added importance. Well water that is high in calcium and magnesium or other elements can result in imbalances in nutrients, cause the soil pH to change, or cause precipitation of soluble fertilizers. Excesses of calcium and magnesium can exacerbate potassium deficiencies, and can negatively affect potassium uptake even when sufficient potassium is present in the soil. Precipitation of micronutrients in soluble fertilizers has resulted in zinc and iron deficiencies. It is recommended that the water source be tested, and treatment such as acidification be used if necessary. Some soluble fertilizers are now on the market that were developed specifically for sources with very hard water.

Soil Salinity/Salt Buildup: In 4-season tunnels, the fact that the tunnel roof remains over the winter means that there is no opportunity for salts from synthetic fertilizers or composts to be leached. While not much of a problem with brambles due to their relatively deep root systems, this has been an issue with more salt sensitive crops that follow. This situation appears to be quite easily rectified by leaving the tunnel roof off for the fall and winter in years when plastic needs to be replaced anyway.

Fertility: Standard recommendations for soil preparation for the region in which you live should be followed for making initial lime, fertilizer, or compost additions. Maintenance fertilizer programs after initial adjustments are very similar to those used in the field, though nutrient additions must be made with soluble fertilizers through the trickle irrigation system. A tissue test for foliar nutrient concentrations should be performed at least yearly and a balanced soluble fertilizer, such as 20-10-20 with micronutrients, can be used to supply nitrogen for annual needs at the maintenance rates used for field production. Compost can also be used, but should be analyzed and nutrient rates calculated assuming a 20% or higher mineralization rate. If your water source is high in bicarbonates, you may want to use a fertilizer developed specifically for this type of water.

Cultivars: Primocane-fruiting raspberry varieties are generally preferred over summer-bearing varieties because they can either be fruited for just a fall crop, or some canes can be retained to also produce a summer crop. Primocane-fruiting cultivars that have performed well are 'Polka', 'Autumn Britten', 'Joan J', 'Heritage', and 'Josephine'. 'Anne', a golden raspberry, has been reported to produce high yields in tunnels also. The primocane-fruiting black raspberry ‘Niwot’ has performed well for both summer and fall production in trials in Pennsylvania. Most cultivars that perform well in a given location also perform well in tunnels, so growers are encouraged to try cultivars that performed well on their farm.

Little research has been done comparing summer-fruiting blackberry cultivars. The primocane-fruiting blackberry cultivar ‘Prime-Ark 45’ has produced well as long as the canes are allowed to bend over to some extent to encourage flowering. Otherwise, the canes continue to elongate and remain vegetative. Recently, there have been some instances of damage from broad mites on primocane-fruiting blackberries, with early symptoms being mistaken for powdery mildew and severe symptoms being mistaken for fire blight. Whether this problem is due to variety susceptibility, or problems with nursery sources is unknown as of this writing. This problem has occurred both in tunnel and field production.

Planting: Because tunnel covers either remain on over the winter, or can be put on early, and spring rains can be excluded so the soil dries earlier, plants can be established in tunnels at least a month earlier than in the field. If tissue-cultured plants are used however, growers should have row covers ready to protect the plants in the event that temperatures take a dip. If a cold spell is preceded by cloudy windy

conditions, the tunnel may not provide more than 1 or 2 degrees of frost protection at ground level. For raspberries and blackberries, row spacing can be closer than in the field, though 7-8 feet between rows appears to be the minimum. For red raspberries, 1.5 to 2 feet between plants within the row works well. Black raspberries can be spaced 2.5 to 3 feet apart, and blackberries 4 feet apart. All of the above spacings are slightly closer than what is normally used in the field in order to get into full production faster, thus making better use of the tunnel space. If any closer row spacing is used, the plants will need to be managed in a way that keeps the rows very narrow. The ground may remain either bare, or be covered with landscape fabric, as long as openings are provided through which the canes can emerge. Be aware that covering the ground may encourage the movement of small rodents into the tunnel.

Trellising raspberries and blackberries: A supported hedgerow trellis, with horizontal wires placed every 2 feet, has been sufficient to contain and support the canes. A true V-trellis may increase yields further based on field research results; however, space considerations may limit the use of this trellis type in tunnels. We used a “narrow-V” which was a basically wires 2’6” apart at a 6’6” height to which floricanes were tied.

Irrigation Frequency: In PA, typically plants are irrigated once per week starting in the spring when new canes begin to emerge (early March). Irrigation frequency is increased to 2 times per week during April. Berries require 1-2” of water per week during rapid growth and fruit production, so plants are trickle-irrigated 3 times per week during the late spring, summer, and early fall months. The length of each irrigation episode is about 2 hours using a 0.45 gal/100’/min trickle tape. Adjustments to watering time should be made if a tape with a different flow rate is used. Irrigation frequency decreases in the fall, and plants do not receive any water once the lines freeze.

Venting: Raspberries grow best when temperatures are relatively cool, so maintain the tunnel temperatures between 70 and 80 degrees F to the extent possible. Our tunnels are kept closed during rain and high wind events, and during the winter. This has not resulted in growth beginning too early in the spring.

Pollinators: For brambles, special efforts to bring in pollinators are not normally required, as pollinators are usually already present during the time that bramble plants are flowering. Brambles are quite attractive to bees. Honey bees are not recommended as they become disoriented and tend to fly upwards, becoming trapped in the upper areas of the tunnel. Bumble bees are recommended based on work at other Universities. Mason bees worked well in some early research at Penn State, as long as the cardboard tubes in which they lived were kept in a sheltered location just outside the tunnel. Growers sometimes mistake holes in the end of canes made by solitary bees for cane borer damage. If the hole only extends downward for a few inches, and is made in the pith, it was likely made by a solitary bee and is the opening to a chamber in which she laid her eggs. Canes with these holes may be collected during pruning and kept in a protected location in the tunnel so the pollinators can still hatch and emerge.

Diseases: Disease incidence in high tunnel bramble production has been negligible, even in fungicide-free production, presumably due to the fact that the foliage and fruit remains dry, though there may be other factors entering into the equation. However, good air flow through the tunnel should be maintained whenever possible. Under conditions of high humidity, powdery mildew can be problematic.

Insects: Because the environment in a high tunnel is more similar to that of a greenhouse than the field, the insect pest complex is more similar to that of a greenhouse. Significant pest problems to date have been two-spotted spider mites, whiteflies, aphids and thrips. Predatory mites have given good control of two-spotted mites and thrips if released while pest populations are still very low. Other biocontrol agents (ladybird beetles, lacewings, minute pirate bugs) have been valuable. It's best to check with a biocontrol supplier for recommendations on what to use for your situation, as factors such as temperature, humidity, tunnel area, and pest population will determine whether and/or what you need to order.

Growers should monitor for spotted wing drosophila, and check fruit for larvae during each harvest. With raspberries, this can be done simply by checking for juice inside the caps or staining the receptacle. If either are observed, pull the berry apart to check for larvae. It may take a few seconds for the larvae to begin moving, which makes them more noticeable. If larvae are found, current literature regarding spotted wing drosophila management should be consulted.

Weeds: In single-bay tunnels, because no rain reaches the ground to encourage weed seed germination, weeds typically are a problem only around the edges of the tunnel, where the soil is moist due to lateral water movement from outside, and in the rows during the year of establishment. Landscape fabric (weed barrier) may be used to discourage weeds, but be aware that small rodents are likely to move in.

Additional Information

High Tunnel Raspberries and Blackberries. 2012. Heidenreich, C., M. Pritts, K. Demchak, E. Hanson, C. Weber, and M. J. Kelly.
http://www.fruit.cornell.edu/berry/production/pdfs/hightunnelsrasp2012.pdf

GROWING AND MARKETING SMALL FRUIT AT DICKEY FARMS

David A. Dickey

1: Description of Dickey Farms:

Dickey Farms is a small-diversified fruit and vegetable farm located in Northwest Arkansas near the town of Springdale, Arkansas. The farm covers about 20 acres of which 11 acres is cultivated or in fallow. Of these 11 acres, approximately four are devoted to permanent fruit crops (apples, grapes and plums), one to strawberries, two acres to annual vegetables and the remaining acreage is fallowed. An additional 10 acres, located directly across a county road, is rented for a pick your own pumpkin patch. Also, we are have two high tunnels for off-season vegetable and strawberry production. The “owned” portion of the farm is located on a hill side with an average slope of about six percent. Soil type is predominantly Clarksville Silt Loam (very rocky) with some areas with less slope and chert rock that have higher clay content. Seasonal rain fall and temperatures are extremely erratic but generally follow conditions associated with USDA Zone 6A.

Dickey Farms is not organic or certified naturally grown, but does implement rigorous sustainability practices, especially those associated with IPM, crop rotation and cover cropping. The main crops are strawberries, grapes, pumpkins, winter squash, apples, lettuce, cantaloupes, watermelons, peppers and tomatoes. About 50% of the products raised at Dickey Farms are sold through the Rural Mountain Produce Exchange (Fayetteville Farmer's Market). An additional 25% is pick your own (strawberries and pumpkins). While the remainder is sold to public schools, high end restaurants and individuals. In my capacity as owner/operator I tend to “experiment” with different and new crops/cultivars, growing methods, production inputs and management practices. Many of these “experiments” have proven complete failures while others have exhibited positive results: Failures include: Hybrid Tea Roses, Sweet Cherries, plums, corn. Successes: Intensive cover cropping, winter production of lettuce in high tunnels. (I estimate that intensive cover cropping has reduced outside fertilizer inputs by 40 to 50 percent.)

Raising quality fruits and vegetables in Northwest Arkansas is very challenging due to erratic temperatures, rainfall and pest issues. Our region is prone to late spring frosts that limit the success of early blooming crops such as, stone fruit, strawberries and to some extent apples and grapes. In spring/early summer 2015 we experienced daily rain fall from April into early June. Thus, causing increased disease, pollination and insect issues that negatively impacted fruit and vegetable production throughout the season. Obtaining operating capital and specialized insurance is significant problem because of the small scale and diversification.

Most of the products from Dickey Farms are sold locally. However, it has become challenging to sell some products at local farmers markets and other venues due to competition. Thus, in recent years we have gravitated toward producing more fruit and off-season vegetables which have higher demand and command better prices. Selling fruits and vegetables to wholesale markets such as grocery stores and produce houses has proved prohibitive due to economies of scale and generally lower prices regardless of quality.

2: Strawberry Production and marketing:

Dickey Farms raises approximately one acre of annual plasticulture strawberries for spring harvest along with some off season production in high tunnels. For annual plasticulture production 'Chandler' is the most planted cultivar since it is relatively productive, has good flavor and seems to be more cold tolerant than other commercially applicable varieties. However, our Farm to School customer (Fayetteville Public School) has requested strawberry varieties that are less delicate that have longer shelf life than 'Chandler'. We have experimented with cultivars such as 'Camino Real', 'Benicia', 'Sweet Ann', 'San Andreas', 'Albion' and 'Festival'. For off season production, outside and under high tunnels, we are using the day neutral cultivar 'San Andreas'. Our target planting date for annual plasticulture strawberries is September 25. Other strawberry growers in our area are planting in the September10-15 window to obtain adequate plant development by the middle of December. We tend to plant later since the strawberry field is located on a south facing slope (increased growing degree days). We use plug plants, exclusively, for fall planting due to ease of establishment and the general unavailability of bare roots in September. We do not use chemical fumigation for strawberry production. However, we rely on cover cropping and rotation to maintain general soil fertility and mitigate soil borne disease issues. This entails a two year rotation/cover crop cycle between two adjacent fields. After harvest is completed in June, the plants are mowed and beds direct seeded with small winter squash for fall harvest, During the winter, the plastic mulch and drip lines are removed to prepare for an early spring cover crop of a brassica, usually mustard. The brassica cover crop is sowed in March and tilled under in late May. By June 15 a summer cover crop mix Sun Hemp, Cow Peas and Sorghum-Sudan grass is planted and allowed to grow until incorporation in mid to late August. By mid-September the cover crop organic matter has sufficiently decomposed to allow for bed formation. Prior to laying the raised beds soil samples are analyzed and nutrient amendments added if necessary. Usually, the cover crop provides the pre-plant nitrogen required to establish the strawberry crop (60-80 per acre). Approximately three weeks after planting we usually collect another soil sample from the raised beds to verify that nutrient levels are consistent with those analyzed before planting. In November we install floating row covers over the field to buffer “extremely” cold winter temperatures. Usually the plants are covered from mid-December until late February. However, if fall temperatures are unusually cool we may cover the plants earlier to facilitate adequate plant development before winter. During winter warm spells the row covers are removed to prevent early bloom and excess

branch crown numbers. Also, the row covers are used to protect blooms from frost in spring. The spring growth phase begins in early to mid-March. When the first leaves appear and unfold (most recent trifoliate) we begin collecting foliar samples for nutrient analysis. These weekly or bi-weekly foliar analysis are used for determining and adjusting nutrient allocation through the fertigation system. Bloom begins approximately March 20 with harvest commencing between April 20 and 25. Harvest continues through May until early to mid-June. During bloom fungicides are applied four times in weekly intervals to prevent Botrytis, Anthracnose and other diseases. Insects and mites are monitored from planting until end of harvest. Spotted Wing Drosophia is generally not a problem until late harvest unless the spring weather has been unusually warm.

Fresh strawberries are in high demand by local consumers. Most of the strawberries we produce are sold at local farmers markets. However, we do some limited u-pick during peak season. Our farmers market price is $4.00 per pound while u-pick strawberries are sold for $2.00-2.50 per pound. At present we cannot meet our farmers market or u-pick demand.

The greatest challenge we face in producing strawberries is wet weather during harvest. The spring of 2015 was the first year we lost money on a strawberry crop. The continuously wet conditions exacerbated problems with Anthracnose, slugs and to some extent Botrytis. Also, berry quality was poor due to high water content and external damage by heavy rain.

3: Grape production and marketing:

Grape production at Dickey Farms consists of a one acre vineyard situated high on the property. Row orientation is east and west. Most of the vines are University of Arkansas table grape cultivars that include 'Mars', 'Jupiter', 'Reliance' and 'Faith'. 'Mars' and 'Jupiter' comprise about 80% of the planting. Harvest of 'Jupiter' and 'Mars' begin in mid-July and early August, respectively. Most of the vineyard was established by planting “knock” cuttings through raised beds covered with black plastic mulch with subsurface drip irrigation. During the planting year these vines exhibited accelerated root and vine growth due to warmer soil temperatures provided by the black mulch. By the third season vine maturity and production were equivalent to plantings established from 1-year nursery plants. Spacing between rows is 10' while in-row spacing between vines is eight feet. The vines are cane pruned using the Umbrella Kniffin trellising/training system. Vineyard nutritional status is monitored by conducting soil and foliar analysis (petioles) on an annual basis. Separate petiole samples are collected for each cultivar. A grass/white clover ground cover is maintained between rows to prevent erosion. Burn down herbicides are used to control weeds under the vines. The first fungicide spray is applied when shoot length is between two and four inches. These sprays are continued through spring and early summer. The number of fungicide applications varies depending on rainfall and moisture levels.

Most of the grapes are sold at local farmers markets. Currently, Dickey Farms is the only producer at the Fayetteville Farmers Market that offers grapes. Along with other products, some grapes are sold to the public school and to higher end restaurants. The price received for grapes at the farmers market is $3.00/pound while the wholesale price is $2.00/pound.

Grape production in Northwest Arkansas can be challenging due to weather, disease and insect pests. However, susceptibility to spring frost is less since bloom occurs later than other fruit crops such as plums and apples. The most common diseases affecting the vineyard are Black Rot and Downy Mildew. Those cultivars exhibiting Vitus Lubrusca phenotype seem more susceptible to Black Rot ('Mars') while Vitus Vinifera phenotypes, such as,'Jupiter', have problems with Downy Mildew. The predominant insect pests include: Grape Berry Moth, Japanese Beetle, and Green June Beetle. Green June Beetle has become a major problem since it infests the vineyard during early harvest and tend to favor Vinifera cultivars such as 'Jupiter' over Lubruscas such as 'Mars'.

4: Panning for the future:

In coming years we plan to increase the use of high tunnels for vegetable and small fruit production. High tunnel production offers us obvious advantages such as extended seasons and off-season production. Also, high tunnels are a way to mitigate risk by protecting and enhancing production of main-season crops such as tomatoes and peppers. Furthermore, high tunnels might allow us to grow different crops and cultivars that are not economically viable, raised ambiently, due to weather and pest issues. We believe it is profitable to produce and market cut roses, cherries and certain table grape varieties raised in high tunnels. Resent research with high tunnel table grapes, at the University of Arkansas, has shown significant increases in grape yield and quality along with drastic reduction of pesticides.

Dickey Farms will continue to implement sustainability practices to increase soil health and fertility and to reduce pesticide use. We plan to remove the small plum planting since it is not economically viable.

AN UPDATE ON SPOTTED WING DROSOPHILA MANAGEMENT

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An experiment was conducted to determine the efficacy of Delegate WG, three unregistered insecticides (X, Y, and Z), and a grower standard treatment of Imidan 70WP against spotted wing drosophila (SWD) on highbush blueberry in NJ. Treatments and rates were: Delegate WG at 6 oz/ac, "X" at 5.75 floz/ac, "Y" at 16.4 floz and 22 floz/ac, "Z" at 4 oz/ac, and Imidan 70WP at 1.33 lb/ac.

The experiment was conducted in a blueberry field, cv. 'Duke,' located at the P.E. Marucci Blueberry/Cranberry Center in Chatsworth, NJ. Plots consisted of two adjacent bushes in a row and were separated by 3-4 buffer bushes or a buffer row. Treatments were repeated on five plots in a randomized complete block design. Applications were made on 29 June with an R&D CO_2 backpack sprayer, using a 2.0 liter plastic bottle. The sprayer was calibrated to deliver 50 gal of vol per acre at 35 psi, using a single ConeJet TXVS 6 nozzle, yielding 156.4 ml (5.29 fl oz) per bush.

Treated terminals with three leaves and 14-18 ripe blueberries were taken from each treated plot 0, 3, 7, and 10 days after treatment (DAT) on 29 June, 2 July, 6 July, and 9 July. These terminals and berries were placed in assay containers consisting of a 32 oz deli cup with a hole cut in the bottom in which a florist's water pick fit tightly (see picture). Terminals were supplied with water and were kept in the laboratory during the length of the experiment. Before flies were added the number of ripe/ripening berries was counted. Ten spotted wing drosophila flies (5 females and 5 males) were added to each assay container within 3 hours of terminals being clipped from bushes. Flies were from a laboratory colony and were 3-5 days old at time of use so they were considered sexually mature. Flies were anesthetized with small puffs of CO_2 injected into the rearing tubes to facilitate handling and placement in the assay containers. After flies were added to the assay containers, the containers were placed on a light bench in a horticultural planting lab under a 14L:10D photoperiod, and were kept at ambient outdoor temperature ranging from ~20-35°C during the 2 days prior to observation, and the additional 5 days allowed for continued oviposition by female flies (see picture).

Adult fly mortality data were collected 48 hours after exposure to the treated fruit and foliage. Berries were removed from assay containers on day 7 and placed in 8 oz deli containers and incubated under the same conditions for 10 more days before evaluation on day 17. Larval infestation data were collected using the salt water extraction method consisting of submerging the berries in warm salt water (~1000 ml NaCl : 5 gal H_2O), which causes larvae to leave fruit (see picture). Larvae and pupae caught by a 30 mesh sieve were counted and the number of larvae per 100 berries was calculated (no. larvae/no. ripe fruit×100, "larvae" includes all larvae + pupae). Data were analyzed using ANOVA and means separation by Fisher's LSD test at $P = 0.05$. Percent data were arcsine square-root transformed and count data were ln(x+0.1) transformed prior to analysis.

Delegate WG, "Y" (high rate), "Z", and Imidan provided good SWD control (Tables 1-4). All these insecticides had good adulticidal and larvicidal activity that lasted at least 7 days. "X" had weak SWD control.

Pesticide Efficacy

USING PESTICIDES EFFECTIVELY AND SAFELY: UPDATE ON PESTICIDE SAFETY AND REGULATIONS

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Federal and state regulations govern pesticide use in the United States. The Environmental Protection Agency revised the 1992 Agricultural Worker Protection Standard (WPS) regulation on November 2, 2015 to increase protection from pesticide exposure for the nation's two million agricultural workers and their families. These changes will afford farmworkers similar health protections that are already afforded to workers in other industries while taking into account the unique working environment of many agricultural jobs.

Revised Federal regulations will take primacy when New Jersey Worker Protection regulations are less stringent. It is likely that these New Jersey regulations will eventually be revised for parity with federal rules.

Selected changes to the regulation that will impact New Jersey growers:

- Full training will be required annually, rather than every five years, to inform farmworkers of required protections. This increases the likelihood that protections will be followed by workers and handlers.
- Training will be expanded to cover additional points that address instructions to reduce take-home exposure from pesticides on work clothing and other safety topics. (*Note: EPA has announced that it will provide employers with outreach tools such as the "How to Comply Manual", CDs, and training videos for farmworkers and handlers*).
- New no-entry "application-exclusion zones" up to 100 feet surrounding pesticide application equipment to protect workers and others from exposure to pesticide overspray.
- Requirement to provide more than one way for farmworkers and their representatives to gain access to pesticide application information and safety data sheets – centrally-posted, or by requesting records.
- Mandatory record-keeping of application-specific pesticide information, as well as farmworker training, must be kept for two years.
- Anti-retaliation provisions similar to that of the Department of Labor.
- When respiratory protection is required by the pesticide label, fit testing, medical evaluation, and training of users will be mandatory. *(Note: NJAES safety outreach*

to stakeholders on this has been ongoing for several years).

- Specific amounts of water to be used for routine washing, emergency eye flushing and other decontamination, including eye wash systems for handlers at pesticide mixing/loading sites.
- Continue the exemption for farm owners and their immediate family, with a significantly expanded definition of immediate family.

The rule became effective on January 1, 2016, and will not be fully implemented for at least two years. Agricultural employers and handler employers will be required to be in compliance with most requirements of the new rule by January 2, 2017. Certain requirements will not be in force until two years later. This includes display requirements for "pesticide safety information" and "pesticide application and hazard information". An "application suspension" requirement will not take effect until January 18, 2018. Lastly, employers must implement new training curriculum developed by EPA by January 1, 2018 (or 180 days after EPA announces the training materials are available, whichever is later).

See www.epa.gov/pesticide-worker-safety/revisions-worker-protection-standard for further information on EPA's revised Worker Protection Standard.

In August 2015, EPA proposed revisions to its' Certification and Training regulations for pesticide applicators. They posted a three-month period for submittal of comments; after overwhelming demand by stakeholders, state regulators, and Cooperative Extension the comment period was extended to January 30, 2016. If the final regulations are similar to those proposed, New Jersey Private Applicators will be significantly less impacted than those in other states.

Federal regulations for certification of applicators apply only to those products labeled as "restricted use". New Jersey certification and training regulations are significantly more restrictive than federal. Applicators must be at least 18 years old, and are required to become certified and licensed if they use any registered pesticides (both restricted and general use); with minor exemptions.

New Jersey requires that Private and Commercial Applicator candidates become both certified and licensed to use pesticides. Certification as a Private Applicator is accomplished by successfully passing a written "Private Applicator Exam", based on the corresponding training manual available through County Extension offices. The core subject matter covers pesticide safety and handling, applicable State/Federal laws and regulations, as well as understanding and correctly interpreting the label and labeling information.

In order to maintain valid Pesticide Applicator Certification in the state of New Jersey, pesticide applicators must earn a minimum of 24 recertification credits by attending continuing education courses. Private Pesticide Applicators must accumulate eight Core

credits and 16 'PP2' credits. The total 24 recertification credits must be accumulated by the applicator within a five year period subsequent to passing their certification exam. The five year period begins the November 1st following passing the exam, and ends five years later on October 30th. If the full complement of recertification credits is not earned within that five year period, certification as a pesticide applicator in New Jersey expires. Certification in these cases can only be acquired by passing the required exams again.

Unlicensed individuals, such as pesticide handlers may apply pesticides under the “direct supervision” of a responsible licensed Private Applicator. New Jersey requires that all supervising applicators maintain a list of all pesticide handlers for which they are directly responsible.

Information on current New Jersey Department of Environmental Protection Pesticide Control Program regulations and requirements are located on the web at www.state.nj.us/dep/enforcement/pcp/. They may be contacted at 609-984-6507.

The Extension Pest Management Office provides assistance to agricultural employers, pesticide applicators, handlers, and workers in understanding and complying with these regulations; contact the Office at 848-932-9802. Information on certification and licensing, and templates and tools for compliance are located at the NJAES Pesticide Applicator Training website at www.pestmanagement.rutgers.edu/pat/.

AVOIDING PESTICIDE DRIFT AND OTHER ENVIRONMENTAL CONCERNS

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Pesticide spray drift is the movement of pesticide dust or droplets through the air at the time of application or soon after, to any site other than the area intended. Pesticide droplets are produced by spray nozzles used in application equipment for spraying pesticides on crops, forests, turf and home gardens.

Pesticide labels vary with regard to information on spray drift management. Some labels provide a detailed list of required drift management techniques. Labels may specify a maximum wind speed in which to spray, or simply indicate not to apply under windy conditions. Labels may also require an “adequate” or specific size buffer zone between the target site and sensitive sites, such as areas occupied by humans, animals or susceptible vegetation.

There is no one technique that can minimize spray drift. The person applying the pesticide must consider the non-target sites downwind of the application, location of buffers, weather conditions and application equipment. Follow all regulations and label directions and carefully assess the situation. Remember, the label is the law. Therefore, follow all instructions on the product label.

Here are some items to consider:

Non-Target Sites:

Know what is downwind of your application – not only on your land, but on neighboring land as well. A small amount of spray drift to a tolerant, labeled crop on your land is very different than drift to a sensitive crop or to anything on someone else’s property. If possible, make the application when the wind is blowing away from any non-target site of concern.

Buffers:

Establishing buffers between fields that need to be sprayed and non-target areas, such as residential areas, may aid to intercept spray drift. Buffers may be border plantings or set distances. Tolerant fast-growing trees, grassed buffer strips and uncropped field borders are examples of buffers that can be positioned downwind of areas that will be treated. Know the effectiveness of the buffer as well. For example, a

tall, continuous buffer of tolerant trees will provide much better protection from drift than a narrow strip of low-growing grass. Never use someone else's land as your buffer.

When no buffer exists (or an existing buffer is insufficient under the particular application conditions), create the needed buffer by leaving a portion of the target site untreated. Using good judgement to prevent drift onto someone else's property is important and returning to complete the application when conditions are better

Weather:

Wind is the most important weather factor affecting spray drift. Apply pesticides only when winds are light and blowing away from sensitive and non-target areas. A general rule is to spray when the wind speed is 3-10 mph, but the upper limit must be modified based on all application-specific factors influencing drift. Accurately measure the wind speed and direction before and during the application, since wind can changed in short time periods. If a change in wind speed or direction results in unacceptable drift, immediately adjust the buffer size or location as necessary, or stop the application until conditions improve.

Calm conditions or variable winds can actually increase the chance of spray drift. Calm conditions might indicate the presence of a temperature inversion (a trapped layer of air). Inversions, which are most common during the early morning or evening, favor horizontal movement of pesticides.

High temperatures and low relative humidity during the application may also increase the chance of spray drift by increasing evaporation, which reduces the size of spray droplets. Keep accurate records of wind speed and direction, air temperature and relative humidity with each application. Injury from herbicides can and has occurred days after application due to temperature inversions.

Application Equipment:

Spray pressure and volume, droplet size, nozzle type, boom height and additives can all influence spray drift. Follow directions within the constraints of the label:

- Reduce spray pressure to produce larger spray droplets, which are less likely to drift.
- Increase spray volume, which allows the use of nozzles that produce larger droplets.
- Use low-drift nozzles, such as those with air-induction technology.
- Replace all worn nozzles.
- Keep the spray boom as low as possible without detrimentally affecting spray coverage.
- Consider boom shields and windscreens.
- Include a drift control agent in the spray tank.

Some of these spray drift-reducing tactics cannot be used for every pesticide application because pest control will be reduced. But, if you cannot follow the label and avoid drift, select a different product or formulation. Granules are sometimes (but rarely) available alternatives to the use of liquid sprays to eliminate drift. Applicators are legally responsible for problems that are caused by spray drift, regardless of what particular factor(s) caused the drift to occur.

Summary

Drift is undesirable for economic, environmental and safety reasons. Efficient applicators don't spend money for expensive pesticides to watch them drift away from their target fields. Unsatisfactory pest control could result if a significant portion of the chemical is lost in drift. This could require re-spraying the same field which adds to production costs. Winding up in court for spray drift damages to sensitive crops in a neighbor's field or sensitive plants in a residential landscape is not worth the aggravation. Therefore, do everything possible to avoid drift. The environmental effects of spray drift are equally costly and unacceptable. By reducing drift to a minimum, you can reduce the potential for pollution of streams, lakes and other water supplies that could endanger fish and wildlife.

Regardless of how accurately an application is made, the possibility of drift is always present. You can minimize this possibility by selecting the right equipment and using sound judgment when applying pesticides. Your judgment can mean the difference between an efficient, economical application, or one that results in drift.

Resources:

Crop Protection: Tips to Avoid Pesticide Spray Drift, June 5, 2013
http://www.striptillfarmer.com/articles/tips-to-avoid-pesticide-spray-drift#sthash.J045j4nd.dpuf

EPA Website: Introduction to Pesticide Drift.
http://www.epa.gov/reducing-pesticide-drift/introduction-pesticide-drift

READING THE LABEL - EASIER SAID THAN DONE

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If you find reading pesticide labels to be difficult than you are not alone. 91% of farmers I've asked have admitted that they had trouble interpreting at least one label. Sometimes it seems as if each label is written in a different code.

We all know that the label is the law and that we need to follow the directions precisely. But what if the directions are unclear?

Listed below are some clarifications on a few of the label items that can be challenging:

- **FRAC, HRAC or IRAC Group Codes**

What is the "Group" section?
It stands for the FRAC/IRAC/HRAC Codes -

- FRAC = Fungicide Resistance Action Committee
- IRAC = Insect Resistance Action Committee
- HRAC= Herbicide Resistance Action Committee

Pesticides are now grouped by these committees based on how the pesticides work (or mode of action).

It is important to rotate pesticides because it prevents pest resistance. Even if you rotate products rotating *within* a group is *not* rotating. FRAC groups are different from IRAC groups are different from HRAC groups. Be aware of the groups you are using and rotate between the groups by making sure the last time you used a product it was in a different group than the one you are about to use.

- **Personal Protective Equipment (PPE)**

Make sure that you and your employees who are using pesticides know how to figure out which PPE to use. Not using correct PPE is dangerous and leads to DEP violations. PPE is necessary to protect people from accidental 1) dermal absorption (by the skin), 2) Inhalation (breathing) and 3) Ingestion (eating/drinking) of pesticides. There are codes for proper PPE standards. Know them, or how to find them when purchasing and using PPE. See information on understanding the standards below.

Gloves

Once you know how to read the chart it is much easier to understand why you have to use a certain type of gloves mentioned on the pesticide label. There is an EPA Chemical-Resistance Category Selection Chart for Gloves. Here is the current one:

Table 3. EPA Chemical Resistance Category Selection Chart for Gloves

(For use when selecting glove types to be listed in the PPE section on pesticide label. Only select glove(s) that indicate a high level of chemical resistance.)

Solvent Category (see Table 4)	Barrier Laminate	Butyl Rubber ≥ 14 mils	Nitrile Rubber ≥ 14 mils	Neo-prene Rubber ≥ 14 mils	Natural Rubber* ≥ 14 mils	Poly-ethylene	Polyvinyl Chloride (PVC) ≥ 14 mils	Viton ≥ 14 mils
A (dry and water-based formulations)	high	high	high	high	high	high	high	high
B	high	high	slight	slight	none	slight	slight	slight
C	high	high	high	high	moderate	moderate	high	high
D	high	high	moderate	moderate	none	none	none	slight
E	high	slight	high	high	slight	none	moderate	high
F	high	high	high	moderate	slight	none	slight	high
G	high	slight	slight	slight	none	none	none	high
H	high	slight	slight	slight	none	none	none	High

*includes natural rubber blends and laminates
HIGH: Highly chemical-resistant. Clean or replace PPE at end of each day's work period. Rinse off pesticides at rest breaks.
MODERATE: Moderately chemical-resistant. Clean or replace within an hour or two of contact
SLIGHT: Slightly chemical-resistant. Clean or replace within 10 minutes of contact
NONE: No chemical-resistance.

When a label mentions, for example, "Category A, made of water-resistant material such as polyethylene or polyvinyl chloride (PVC) greater than or equal to 14 mils". The circle in the chart above identifies gloves in these categories that offer a high level of protection when used properly.

If you are not sure which ones to purchase call a glove manufacturer and ask them to tell you which options they have that match the specific label description. You can also go to their websites to search for gloves that match specific label requirements. Places like Gemplers, Showa Gloves and Grainger have search tools and guidance information right on the websites.

Respirators

Many times a respirator is used but not the proper kind. There are many different kinds of respirators and cartridges. It is important to know the correct one to use for each pesticide.

Here is an example of instructions on a label “A NIOSH-approved dust mist filtering respirator with NIOSH approval number prefix TC-21C or a NIOSH-approved respirator with any R, P, or HE filter.”
It may sound like a different language at first, but there are many important pieces of information in this sentence. Here are some definitions of items mentioned in this sentence that can help us understand it better:

1) Notice that the required respirator is a “dust-filtering” one.
2) It must have a NIOSH approval number. NIOSH stands for The National Institute for Occupational Safety and Health (NIOSH).
3) It will also have a NIOSH approval number that will start with “TC”. TC stands for Testing & Certification.
4) 21C= stands for the specific set of standards that a respirator must have met in order to be classified in that level of protection. 21C stands for “powered air-purifying respirator [PAPR] with particulate filter”).
5) There are some letters listed for the type of respirator filter. They are R, P and HE. Those letters stand for:
   R= Oil-resistant
   P= Oil-proof P-series
   HE= High-efficiency
   There is also the letter N used sometimes, N= Non-oil resistant, but is not included as acceptable for this particular pesticide. There will also be numbers after these letters. They are the % of particles filtered.

Want More Information?
Here is a collection of resources that has more agriculture related information:

Group Codes

- http://www.frac.info
- http://www.irac-online.org
- http://www.hracglobal.com

PPE resources:

- http://www.ppe.org
- http://www.cdc.gov/niosh/npptl/topics/respirators/CEL/ select “Searchable Certified Equipment List”
- This explains all of the codes for Worker Protection Standard (WPS) Products and I find it very helpful. http://www.epa.gov/sites/production/files/2014-07/documents/chapter10-final-fd-jr.pdf
- This is a great factsheet that explains all about NIOSH terms. http://www.cdc.gov/niosh/docs/2011-179/pdfs/2011-179.pdf

General Pesticide Safety

- National Pesticide Information Center - 1-800-858-7378 (8:00am-noon PST) npic@ace.orst.edu
- You can always call the pesticide company number on the label. They can help you understand any questions about the label which may be unclear.

FORMULATIONS AND EFFICACY

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Agricultural formulations have been around for many years and it is impossible to cover all of them here. In order to convey the most value the 8 most common will be discussed and the critical learnings are tabulated into a quick reference sheet (attached).

The physical and chemical properties of the active ingredient control the concentration in a formula, the functional additives, and the formulation types. Everything depends on the active(s). This along with the need for safe, convenient, and more efficacious products has been the primary driver of the evolution of formulations.

Physical state, properties, and formula type also relate directly to efficacy. Solid formulations and liquid suspensions of solid formulations will be less bio-available and so often are less efficacious than a liquid (dissolved) version of the same molecule. Solid formulations can be advantageous if looking for longer residual control and in the case of contact fungicides and insecticides, making it more effective. And conversely using a liquid version (if possible) could be too effective and damage non-target plants and insects. The cycle of pros and cons continues leading back to the original statement, it depends on the active.

Commercially, the next consideration is cost. Roughly 85% of a formulation is active ingredient cost, 5% is functional additives, 5% is production, and 5% is packaging and shipping. This means that the most cost effective formulation is 100% active ingredient.

100% active ingredient formulations are usually left as a powder and applied in a method called dusting. It is labor intensive, messy, and increases worker exposure while decreasing efficacy. To alleviate these issues the active loading is reduced and a wetter and dispersant are added. This allows the powder to be added to water and sprayed. Wettable Powders (WPs) are economical to produce, easy to handle, and more efficacious than dusting crops. The additives in the WP help to spread the active evenly over the target surface. But the formulation itself can sometimes run off of the plant more easily and is known to block sprayer nozzles. Another problem is that there are still dust and worker exposure issues, especially when filling large tanks.

In an effort to reduce the dust a small amount of water, clay, and silica can be added

and the product is extruded to develop a granule. The dust is lowered significantly and it's easier to handle and measure. The slides show a typical dome extruder, although there are several commercial ways to extrude, like pan and fluidized bed agglomerations. Granules are still dusty though, don't disperse well in cold temperatures, and can be consumed by wildlife. After all of this, the efficacy remains poor compared to other formulation types utilizing the same actives.

In order to improve upon these shortcomings the emulsifiable concentrate (EC) was developed. The active is dissolved in oil and combined with surfactants that allow it to be added to water. When added to water the oil forms an emulsion spontaneously. The surfactants have a hydrophilic head and a hydrophobic tail forming a micelle. Some active loading is lost because of the addition of the solvent and surfactants, but ECs are easy to produce and handle, and have high efficacy. Delivering a liquid form of the active makes it more bio-available and the solvent helps to dissolve the waxy cuticle of the leaf increasing uptake. However they are known to make actives too effective and the plant is damaged or killed. This effect can also be seen if an EC is mixed with another product. Another downside to the increased bioavailability is that it helps penetration of the skin, organs, and eyes.

They are expensive to pack and transport, susceptible to unexpected crystal growth, and can be loaded with corrosive, toxic, or volatile compounds and have low flash points. To account for these weaknesses the active loading is lowered and water is added commercially. This formula type is known as an Emulsion in Water or an EW. The flash point is lowered significantly, the skin and eye irritation are reduced, and the plant damage and corrosiveness are lessened.

Development of an EW is more time consuming and the formulations are more sensitive to water temperature and hardness. Common examples are milk and hand creams.

Solid suspensions or Suspension Concentrates (SCs) remove the solvents entirely and allow for a higher active loading. They also give more flexibility for less soluble actives and are more compatible when products are tank mixed in the field. But SCs, or Flowable Suspensions (FS) in seed treatment world, are also difficult to produce, sensitive the active purity and forms, and can be unstable over time.

Formula types kind of flow into one another. A prime example of that is the Suspo-Emulsion (SE). They are literally a combination of a suspension concentrate and an emulsion in water, "Suspension – Emulsion". It allows for the combination of previously incompatible actives and delivers them in different physical states. They are very difficult to formulate and maintain stability, but worth noting and are viable when needed.

The last two formulation types are adaptations that came later as technology progressed. The first, Capsule Suspensions (CSs) or Micro-Encapsulations (MEs)

provide a method for protecting the solid or liquid actives and add versatility to the formulation. The CS lowers the loading but allows for a reduced tox profile while increasing residual efficacy and controlling properties like volatility in clomazone. However, CSs are not without their faults. The equipment is very expensive; they thicken at high temperatures and settle easily. These, like the others, can be combined with other formula types.

The final formula type is the Oil Dispersion (OD). It is essentially a suspension of a solid active in oil. The formula promotes uptake into the plant and increases things like wetting, spreading, and rain fastness. It took a long time for formulators to find a technology that is able to properly suspend solids in oil for long periods of time. They are extremely challenging but often a necessary and beneficial risk.

Abbrev.	Formulation	Make Up	Description	Advantages	Disadvantages
WP	Wettable Powder	Active 25-80% Wetting 1-3% Dispersing 2-5% Carrier to 100%	Solid powder that disperses in water	Cheap to produce and pack; easy to handle; tolerant to low temps; no solvent	Produces dust; difficult to measure and mix; poor efficacy and rain fastness; may block lines and nozzles
WG	Water Dispersible Granules	Active 50-90% Wetting 1-5% Dispersing 5-20% Disintegration 0-15% Carrier to 100%	Solid powder combined with clay and extruded to form a granule that disperses in water	Low dusting; cheap to pack; easy to handle and measure; tolerant to freezing; no solvent; low phyto-tox	Needs expensive production equipment; dispersion is affected by low temperatures; may be consumed by wildlife (esp. birds)
EC	Emulsifiable Concentrate	Active 20-70% Emulsifier Blend 5-10% Solvent + Co-Solvent to 100%	Active dissolved in oil	Easy to produce; easy to handle and mix; useful for water-insoluble, low melting point actives; high efficacy	Expensive to pack an transport; sensitive to cold and water hardness; can cause phyto; may be corrosive; often toxic and volatile;
EW	Emulsion in Water	Active 20-45% Emulsifier Blend 2-10% Solvent 0-25% Antifreeze 5-10% Anti-settling 0.2-2% Water to 100%	Active dissolved in oil and dispersed in water	Minimal skin and eye irritation; les or no solvent; min. phyto; low or no flammability; ease of adding adjuvants	Time consuming development effort; container disposal; little or no manufacturing flexibility; sensitive to cold and water hardness
SC	Suspension Concentrate	Active 20-50% Wetting 2-5% Antifreeze 5-10% Anti-settling 0.2-2% Water to 100%	Insoluble solid active suspended in water	No solvent; high active loads; easy to mix and store; compatible with other aq. concentrates	Difficult to produce; can settle out in storage; sensitive to cold; can cause phyto; sensitive to active purity and form;

CS	Capsule Suspension	Active 10-30% Emulsifier 1-5% Polymer 5-10% Solvent 0.2-2% Anti-Settling 0.2-3% Water to 100%	Solid or liquid active coated in polymer shell and suspended in water	Low dusting; easy to handle; low solvent; low toxicity; less prone to leaching; long residual	Need expensive production equipment; sensitive to freezing; may thicken at high temp.; expensive to package
SE	Suspo-Emulsion	Any Combination of SC and EW	Solid active and liquid active droplets suspended in water	Able to combine previously incompatible actives in different physical states; See SC and EW	Very difficult to formulate; see SC and EW
OD	Oil Dispersion	Active 5-45% Emulsifier Blend 2-10% Oil Dispersant 2-10% Aq. Dispersant 5-10% Anti-settling 0.2-2% Oil(s) to 100%	Suspension of a solid technical in oil	Formulate actives that degrade in water; oil promotes plant uptake through the leaf cuticle	Difficult to formulate; requires large amounts of surfactants; settle out easily;

Citation

Knowles, D. A. Chemistry And Technology Of Agrochemical Formulations. Dordrecht: Kluwer Academic Publishers, 1998. Print.

Cole Crops and Lettuce

RESEARCH UPDATE ON RUTGERS SCARLET LETTUCE CULTIVARS

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Introduction

Rutgers University research has recently produced new and nutritionally improved lettuce cultivars – a red leaf and a red romaine type. Lettuce health benefits are due to polyphenols, vitamins, carotenoids and fiber. These cultivars were developed through somaclonal variation and tissue culture; they are not genetically modified (GMO). Field testing at extension centers, grower farms and home gardens was begun to determine commercial utility of these lettuces in terms of germination, growth, culture, color, yield, pest management and nutritional composition.

Extension Agent Bill Sciarappa, Agricultural Program Associate, Vivian Quinn, three Program Assistants and one student intern managed the research trials in central New Jersey. Agricultural Agents Wes Kline and Rick VanVranken handled south Jersey.

Material & Methods

Site description - Soil pH was generally between 6.0 and 6.5. No residual herbicide programs were used for these leafy greens. 15-15-15 fertilizer was incorporated according to Rutgers Vegetable Recommendations rate for leaf lettuce.

Production method – Pelleted lettuce seed from Shamrock Seed Company (Figure 1) was used in raised beds with double row planting with black or white plastic mulch and drip irrigation (Figure 2) for direct seeding and greenhouse transplant production. Four plasticulture beds of 24 inches width on 8 foot centers with trickle irrigation down the center compared treatments at the Cream Ridge site. Standard double row on either side of the drip tape with linear spacing 12 inches apart was used for both direct seeding and transplants. Seeds were planted approximately ¼ inch deep. Cultivation was used in the walkways for weed control and hand-weeding around the plant holes. Herbicides were not incorporated under the black or white plastic.

Treatments - The main trial treatments were two Rutgers Scarlet cultivars at two

planting times in the spring and two planting times in the fall. Both RSL cultivars were compared as direct seeded vs. transplants in both 105 or 50 cell sizes. Comparative cultivars included Red Sails, Red Romaine, Green Romaine, Boston, Ruby Red and several other red type lettuces.

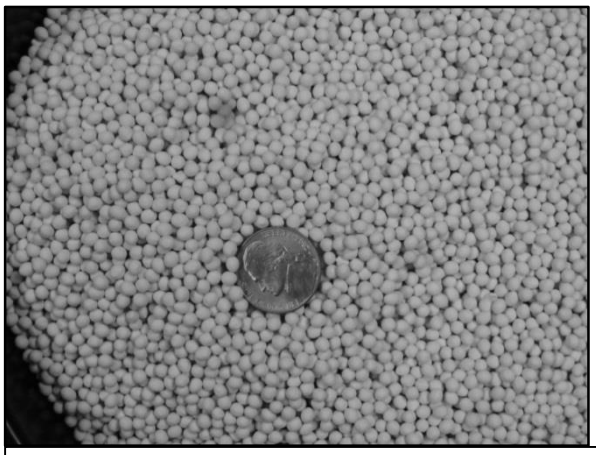

Figure 1 - Pelleted Seed – RSL Lettuce Cultivars Shamrock seed Company, LLC

Figure 2 - Spring Planting – Transplants & Seeding May, 2015 White and Black plastic

Results

Weather - Central Jersey experienced atypical weather in the spring and fall planting dates. Spring soils were termed cold to cool at normal planting times ranging from 38 degrees to 50 degrees Fahrenheit at 4" depth and were saturated from 80 to 200%. Fall planting followed a six week summer drought with extended high temperatures through October. South Jersey experienced similar or more severe conditions.

Growth – In the spring planting at Cream Ridge station, soil temperatures had risen from the high 40's to 60.5 - 63.5 degrees under either black or white plasticulture by May 21. RSL germination was fair for the seeding treatments and growth was smaller in comparison to the standard red leaf types like Red Sails and Tasty (Figure 3). The Rutgers red romaine was smaller in comparison to the standard green romaine. With the RSL transplants, growth and color were considerably better with a deep red hue but still smaller in size to the standard leaf or green romaine.

In the fall planting at Cream Ridge Research Station was harvested on October 26. Head size width for Rutgers red leaf lettuce ranged from 4 to 7 inches and height 3 to 5 inches with an average head weight of 138 grams wet weight. These sizes compared to the standard Red Sail transplants averaging 7 inches in width and 5.5 inches in height with an average wet weight of 195 grams per head; considerably larger.

The Rutgers Scarlet romaine had an average width of 5.5 inches and height of 5.5 inches with a wet weight of 110 grams per head. In comparison, the standard red romaine averaged 10.5 inches width and 11.5 inches height with an average wet weight of 204 grams per head.

At the Freehold site where Master Gardeners grew both Rutgers Scarlet leaf and romaine in the spring, average head weights were 232.6 and 246.0 grams, respectively. These plots were the best overall; perhaps because of the bare soil production method with a high quality soil (Figures 5 and 6). Reports from 10+ Master Gardener trials around Monmouth County ranged from fair to moderate to very good results in germination, growth, color, yield and taste. There was a trend for growing areas closer to the ocean to do better – possibly greater humidity/cooler nights.

Figure 5 - Master Gardener PAR Garden – Freehold

Figure 6 – Colors ranged from a chocolatey red to a deep scarlet to a purplish red to a dark burgundy

Bolting - Bolting in both RSL cultivars as well as standard lettuce cultivars was a frequent problem in both north and central NJ, especially in the fall. This growth appeared related to the weather. Associated was a bitterness taste in perhaps one-third of the fall plantings which ranged from mild to moderate to major. A severe bolting test at Rutgers RAREC site in Bridgeton showed four romaine cultivars bolting over 84% including Rutgers while two cultivars had no bolting. The RSL leaf lettuce bolting was 78.9% at the October 5 harvest with five other cultivars similarly bolting, while five others did not including the standards New Red Fire and Red Express (Figure 4).

Figure 3 - Spring Harvest – Rutgers Leaf – L. & Red Sails – R.

Figure 4 - RSL Results – Fall Planting August 25
Harvest October 5 – Wes Kline
Rutgers RAREC R & D Site
Bridgeton, New Jersey

Romaine % Bolting	
Calshot	84%
Pomegranate Crunch	0%
Rutgers Red Romaine	92%
Red Cash	26.9%
Annapolis	84.4%
Red Rosie	100%
Thurinus	2%

Leaf Lettuce % Bolting	
Red Hot	84%
Tamarindo	0%
Red Mist	88.5%
Red Magma	30.9%
Shanghai Red	9.4%
Vulcan	40.7%
Rouxai	0%
Cherokee	0%
Oscarde	56%
Rutgers Red Leaf	78.9%
New Red Fire	0% standard
Red Express	2.6% (standard)

Greenhouse Production – Initial reports from greenhouse production at three sites were much more consistent and promising. Germination at Kube-Pak (conventional) and Beyond Organics (aeroponics) were 98% or more compared to field planting which ranged from approximately 50 to 90%, depending on the site and season. Transplant growth at Edible Garden Greenhouses in North Jersey showed excellent germination, growth and color in a hydroponic system (Figures 7 & 8). Outstanding color was also reported by local chefs who were very impressed. They also reported that the slightly bitter taste blended well with Boston-Bibb-mesclun lettuce combinations; providing a sweet-sour culinary treat with high visual appeal in a red/green gourmet salad.

Figure 7 – RSL red leaf microgreen

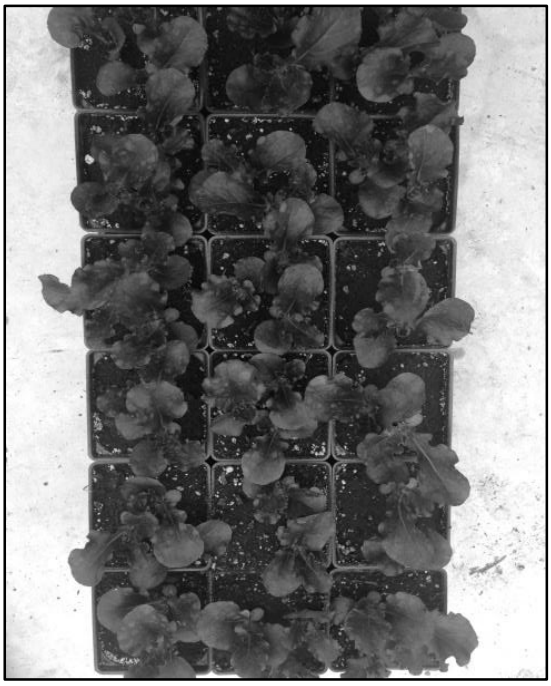

Figure 8 – RSL Transplant

Nutritional Studies - The RSL and standard romaine and red leaf types were harvested at multiple locations to determine nutritional content. These samples were frozen for polyphenol/anti-oxidant content analysis in 2016. The scientific and marketing thought is that if a consumer can obtain twice the nutrition from a cultivar at half the size/weight/volume, these factors would be a sales incentive.

Preliminary Comments

The poor growing conditions in both the spring and the fall were not favorable for agriculture in general and especially for leafy greens. Plasticulture did not appear beneficial for RSL growth compared to bare ground or container-grown, while some standard varieties did better growth-wise under similar culture and conditions. Another year of field testing is required to compare these initial findings; especially to determine how well these new releases fit with northeastern growing areas and if a spring planting is preferable to a fall planting.

Cultivation under sheltered greenhouses with either conventional, hydroponic or aeroponic systems was more promising for RSL cultivars compared to more variable field conditions. This observation may correlate with the possibility of weather being the more important factor in this 2015 season. Like our growers, we hope next year's weather is more favorable for crop production.

BROCCOLI PRODUCTION IN WARM WEATHER

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The Eastern Broccoli Project has been working to enable a year-round supply of broccoli from the East Coast. The major limitation to Eastern production has been that current broccoli varieties are not sufficiently adapted to the Eastern climate, especially the warm nights in the main growing season.

The underlying problem is that broccoli needs cool temperatures for normal flower development. Warm nights result in misshapen and unmarketable heads. For most of the East Coast, growers take too big a risk of crop loss when they grow varieties bred for other climates. In the last five years, breeding focused on the Eastern climate has produced several varieties that perform better. We expect further improvement over the next five years as new hybrids from the project are commercialized. These varieties make it possible to raise broccoli in places where it was once too high a risk, and to expand the harvest season in existing growing areas to capture more of the market.

The production areas that have been most promising on the East Coast are where the temperature range is moderated either by the ocean or by higher elevation. Finding suitable locations in New Jersey will take attention to the duration of suitable temperatures. The distance to profitable markets will also play a significant role in reducing transportation cost and being recognized as a local product.

New Jersey growers can take advantage of the moderating effect of the Atlantic Ocean to a have fall harvest when the heads develop while night temperatures are in the high 50s or low 60s. Even so, the reliable harvest window is relatively short.

Fall broccoli production in Southern New Jersey has a harvest window in October and early November. That timing allows heads to form when the risk of heat injury is mostly past and harvest to be completed before heavy frost. Sequential plantings allow a continuous harvest for about five weeks. Planting more than one variety reduces the risk of supply gaps, but varieties that look different cannot be combined in a single shipment to most buyers. New varieties from the project that fit this window include Burney and BC1691.

Crown cut has mostly displaced bunches in the market. These heads have a target diameter of 5 inches. In high-fertility production, the ideal plant population is higher than

what growers have used in the past. The yield is higher when the population matches the productivity of the field. In addition, the risk of hollow stem is reduced. In-row spacing of 8 inches, rather than 12 inches, still allows large-framed plants, whereas at 4 to 6 inches, crowding can delay harvest and crowds plants that make not marketable head. Testing different spacing to find what fits for a particular farm will improve profitability.

Spring is an especially challenging production season. Some New Jersey product reaches the market in mid-June to early July. Broccoli prefers to time vigorous vegetative growth when it is warm and is induced to produce good heads when the temperatures are cool. With spring plantings, the plants are called on to grow large when it is cold, and to head when it is warm. The risk of poor growth, and of poorly developed heads, is considerable. Fortunately there are two new varieties that are adapted to that temperature regime. DuraPak 16 and DuraPak 19 have yielded well with high-quality in late June and early July in West Virginia and Mountain North Carolina.

A common limitation for broccoli growers is infrastructure for cooling. Broccoli needs to be brought close to freezing temperatures very quickly. Broccoli's high respiration rate heats the product, and quality declines rapidly if heads are warm. There are several effective cooling technologies; the appropriate one depends on volume, use with other crops, and the cost of utilities and ice.

Identifying a particular market, and learning its requirements is essential to profitability. Producing generic broccoli and hoping to find a home for it often results in inefficient production and an inferior price. Buyers' distinctive specifications will determine the varieties, spacing, harvest technique, postharvest handling and packaging that will make broccoli a profitable product.

Raising broccoli plants is relatively straight forward, so many growers can do that well. Meeting quality requirements is far more difficult. That contrast means that those who will raise broccoli profitably are efficient in all growing and handling steps, and able to meet the exact requirements of each customer.

Local broccoli is in demand, particularly in mid-Atlantic urban areas. Our research has shown unexpected ways that demand can be used by local growers, and ways that it cannot. The largest market advantage is promoting the local identity to get the deal. There is generally no price premium, and the quality standards are rarely relaxed. If freshness results in superior quality, there are a few additional higher-price markets available.

The Eastern Broccoli Project has been funded by the USDA Specialty Crop Research Initiative. It is a transdisciplinary effort involving seven universities, four seed companies and numerous growers, distributors and sellers.

Alternative Crops

CHRISTMAS TREE PRODUCTION AND PROFITABILITY

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An opportunity waits along with some challenges in adding Christmas trees to your crop production mix. Christmas tree production is not a "new" alternative crop as production is well established on many small farms throughout most of New Jersey. Growers should carefully consider the site requirements and infrastructure necessary to produce Christmas trees commercially. Proper planning in the establishment of a Christmas tree enterprise is vital for economic success. Proper planning means knowing how Christmas trees are produced and equally important how wholesale and retail sales occur. In addition, establishment of such an enterprise is a 7 to 10 year commitment of both time and money. Yet with today' growth in agritourism and the desire by the public to visit farms, producing Christmas trees is worth a look/see.

Many established farm markets in New Jersey bring in fresh cut Christmas trees, wreaths, roping, and Christmas items for retail sale. Most large box stores carry fresh cut trees as well as what the real tree industry calls "fake" trees. Tree lots set that set up in November along busy roads mostly in urban/suburban areas feature fresh cut trees. Farm markets and other retail outlets purchase trees directly from out-of-state farms, at special auctions, or through tree brokers.

The wholesale price of a Christmas tree is dependent on the variety, size and quality. Generally prices for trees purchased in quantity range between $15 and $35 per tree wholesale, FOB for trees 5 to 9 feet. One of several advertisers in the weekly *Lancaster Farming* newspaper listed wholesale Christmas trees as follows: Wholesale Cut #1 Christmas Trees; Douglas Fir – 7 – 9 ft. $14; Fraser Fir – 61/2 – 71/2 ft. $18; Concolor Fir – 6 – 8 ft. $18. A good number of tree farms in Pennsylvania permit buyers to mark trees in the field for cutting in November. At Leola Produce Auction, Lancaster County in November 2015 trees in lots of 25 trees brought the following prices: Douglas fir 5-6 ft. $9 to $14, 7-8 ft. $15 to $17; Fraser Fir 7-8 ft. $25 to $30; Blue Spruce 7-8 ft. $17, per tree. Retailers at least double their costs including setup and transportation in pricing Christmas trees.

Michigan State University Extension published a paper on *Understanding Cost of Production Helps Christmas Tree Producers Maximize Profits and Manage Risk.* Following is an excerpt from that paper that can be found in its entirety at: http://msue.anr.msu.edu/news/understanding cost of production (_cost_of_production)

> "Because of the slim profit margins in Christmas tree production, it is important that growers understand their per tree costs and potential revenue associated with all of their enterprises – cut trees, wreaths, garland, live trees – to determine break-even prices and potential profit for each tree.
>
> The break-even price per tree is determined by calculating total production variable and fixed costs and dividing that total by the number of trees sold. For example, if total production and fixed costs per acre are $18,330 over a nine-year production cycle and 900 trees per acre will be sold, the breakeven price per tree equals $18,330 divided by 900 trees, or $20 per tree. Armed with this break-even price information, one can determine that a wholesale price of $20 per tree is just breaking even. On the other hand selling trees retail for $50 would net $30 profit per tree."

A Penn State Extension publication on *Agricultural Alternatives* developed a budget for the production of 1 acre of Douglas fir trees. Planting 1,200 per acre and harvesting 80 percent with 33 percent being second grade trees total receipts after 9 years were calculated to be $18,736. Total expenses (direct and fixed) were $7,908. Returns above total expenses equaled $10,827. Receipts for first grade trees were $20.00 per tree and $11.00 per tree for second grade. http://extension.psu.edu/business/ag-alternatives/forestry/christmas

The estimated costs and returns between the Michigan State and Penn State budgets show a wide range of production costs and returns. For New Jersey production the higher range in costs is more realistic. For receipts, selling retail is different than selling wholesale. The net retail profit of $30 per tree in the Michigan State budget did not take into consideration the extra cost of set up and handling the trees for customers.

Conducting a SWOT Analysis:

A SWOT analysis is a tool that helps you evaluate the Strengths, Weaknesses, Opportunities and Threats involved in any business enterprise – in this case Christmas trees. **Strengths** are considered mostly internal. For example, what do you and your family, employees, and management team bring to the business? If you are planning to start growing Christmas trees what experience do you have. If none, this may be viewed as a weakness. If you know where to go to find the help you need, this would be considered a strength in a SWOT analysis. If your farm is already set up to handle retail customers, this would be a strength. **Weaknesses** are generally considered internal and are the factors you will need to address to run a successful business. For Christmas trees, an example might be a lack of experience or your family members do not completely support you in this venture. You may lack qualified employees, or perhaps your business will not support full-time employees. **Opportunities** are considered mostly external. You may already selling produce retail through a farm market or conduct fall agritourism activities and there is an opportunity to extend the

season with choose and cut Christmas trees. **Threats** are considered mostly external. Competition from retail lots or other farms may limit your economic success. The production cycle for Christmas trees is 7 to 10 years. In that time consumer prefers for real Christmas trees may change.
Source: www.rma.usda.gov Risk Management Agency, USDA

If Christmas tree production seems to be a viable alternative for your operation, joining the New Jersey Christmas Tree Growers Association will vastly improve your knowledge of producing and marketing Christmas trees. It is a great organization of growers willing to share information. Every year there is a summer on-farm tour on an existing tree plantation. At the winter meeting cultural practices are presented with grower discussions.
www.njchristmastrees.org

HOW TO MAKE BIG MONEY WITH SPECIALTY PEPPERS IN NEW JERSEY

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Sometimes it pays to look beyond our own borders to see what popular food items are in the rest of the world. My wife and I have hiked in Spain over hundreds of miles throughout the countryside in order to know what it's like living with the real Spanish people. What are their food specialties, wines, and culture. In the fall of 2014 we hiked the historic Camino del Norte Trail which traversed the Pyrenees mountains in Northern Spain. If you have seen the movie "The Way" you are familiar with the pilgrimage called the Camino which we hiked. Throughout this trip we ate in small village and got to know what local foods were popular. Pulpo (octopus) was one stand out as well as Padron peppers eaten as tapas style dining. While they are classified as hot peppers, if they are picked less than 1 ½" in size they will be mild. However, in Spain they are also called Spanish Russian roulette since one out of 25-30 will be hot !It was an instant love affair that became almost an obsession where you just had to have more ! The peppers were called pardon peppers originating in the town of Padron near the larger city of Santiago de Compestella where the Camino pilgrimage ends.

Upon return to the US I realized I wanted more of these peppers so I sought them out. I could find no one who ever heard of them much to my dismay so the searched the web to see if I could find any for sale. I did find some on a famous Spanish food website where I could buy them for $17.95 lb... That's right $17.95/lb. but you had to order ahead because they were hard to get. I got excited when I found a site selling them for 1.99 euro but my hopes were quickly dashed when I found that this price was for 100 gms (less than ¼ lb.) My 38 years' experience in agriculture told me that here in New Jersey we can grow just about any kind of peppers so why don't we have these peppers here? I decided to do a research project to see how they would grow in south Jersey even thought are climate is quite different than the Mediterranean climate of north west Spain where I found them.

The research study I conducted was done at the Burlington County Agricultural Center in Moorestown, NJ in a randomized block study. I decided to add the variable of nitrogen fertility rates into the study to see what the fertility requirements of the pardon peppers are. Fertility rates included o lbs. N, 25 lbs. N, 50 lbs. N, and 100 lbs. N. The history of this site has been excellent fertility so I suspected the peppers would grow well. Plants were raised indoors with a Grow lux system that contained 12 special light bulbs. Weed control consisted of Devrinol and delayed application of Dacthal which resulted in excellent weed control.

Peppers are not know to be producers of adventitious roots however the Padron peppers produced an abundance of adventitious roots that would play an important role in being able to plant the plants deeper than normal. The plants were hardened off however, the process started later than should been that resulted in somewhat tender transplants. That could with the 16 mph winds at the field site resulted in plants with few to no leaves are 4 days. In fact, some master gardeners were betting they would not make it which was premature since by the end of the season the pepper plants were 58”.

The plants on occasion would snap off at the ground leaving a vascular discoloration but this did not cause a significant problem because the injury was only a few %. The plots did develop a significant problem with bacterial leaf spot but after evaluation the cause of the problem was the height of the sprinkler heads where the impact of the water stream hit the plants at close proximity. The sprinkler heads were 27” tall which for normal pepper plants would have been adequate to clear the tops of the plants however some plants in the trials grew to an astonishing 58” which was not anticipated.

Padron peppers are an open pollinated variety and therefore have no hybrid uniformity. A small percentage (<1%) contained black blotches which were later determined to be a genetic trait and pathological in nature.

Marketing and Economics

In order to test market selling the pardon pepper in New Jersey, I solicited 5 local growers from Burlington County. The growers practiced virtually all types of marketing including wholesale, retail, road stands, tailgates, PYO, and CSA”s. For this study, I concentrated on the retail end of the marketing systems. I decided to sell the peppers in pint boxes which are an accepted meaning of marketing crops in the area. I also developed a single page sheet that told of the history of pardon peppers and how they could be easily sautéed with olive oil and flaked sea salt. Due to the thin walls of the peppers, a pint only weighted 5 ounces which mean each pound would make 3 pint boxes. Some of the peppers went to customers of 2 local CSA’s and the vast majority (80%) went to the New Jersey Farmers Against Hunger for distribution through their channels.

Preliminary Results:

The numbers presented seem extremely high however they were based on actual prices on both the open market as well as local farm stands in the Burlington County area.

Continuous harvest from July 6, 2015 to October 18, 2015
Total actual harvest from plots 915 lbs.
Total harvest per acre 9, 150 lbs.
Fertility Yield Differences NS at 5%
Ending plant height up to 58”

Economics (actual yields and prices retail & supermarkets)

	Plot Yields	Acre basis
La Tienda site	$16,424	$161,000
Popular National Food Chain	$18,263	$182,000
Local Farm Stand Economics		
@ $3.00 per pint	$8,217	$82,120
@ $ 2.50 per pint	$6,862	$68,625
@ $2.00 per pint	$ 5,490	$ 54,900

The question that remains is how many pints can be sold? Knowing the drive that New Jersey farmers have to succeed, there is no doubt that some NJ farmers can make size profits on growing the pardon peppers that are multiples that of many other vegetable crops they grow. Of all the people I introduced these peppers to in this study; I only found one who did not strongly like them. The person who did not like them confessed that he didn’t like any peppers.

INCORPORATING SUMMER COVER CROPS FOR CROP IMPROVEMENT

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Introduction

Incorporating summer cover crops into your growing system, before, between or after producing a cash crop can greatly enhance soil health and nutrient management. There are many cover crop options for this summer practice that are gaining popularity and showing significant benefits. Most farmers realize the benefits of utilizing a winter cover crop and have become accustom to including this practice annually. One downside of adding summer cover crops is time management during the busy harvest season. However, the extra effort can be well worth it in the long run for soil health and future crop productivity. Cover crops, both summer and winter, 1-can provide a significant source of nitrogen (N) for subsequent crop, 2-reduce erosion, runoff, and potential pollution of surface waters, 3-capture soil N that might otherwise be lost to leaching, 4-add organic matter to the soil, 5-improve soil physical properties, 6-impact insect and disease life cycles, and 7-suppress nematode populations and weed growth. The benefits can far outweigh the time and cost of adding a summer cover crop to your rotations.

One reason many farmers think it isn't feasible to plant a summer cover crop is because there is a misconception that land has to be taken out of production. With some fast growing cover crops and proper management this isn't the case, since 60 days growth can be sufficient. Summer cover crops can be planted in the production window immediately following a spring harvest and before fall planting of vegetable crops.

What Can Summer Cover Crops Do for Soil Health and Future Crops?

1. **Increase Soil Organic Matter-** One of the best attributes of having organic matter in the soil is improvement in soil structure. Adding organic matter improves tilth, water infiltration, water holding capacity, nutrient holding capacity and reduction of soil crusting. Also, as important is the increase in beneficial soil microbes and earthworms. Beneficial microbes can compete with pathogens and help release nutrients. Earthworms can cycle nutrients and improve pore spaces in the soil.
2. **Reduce Soil Erosion –** Just like with winter cover crops, summer cover crops can also reduce wind and water erosion in fields, especially those with slopes. During summer rainfall events, that can be significant if resulting from tropical storms, runoff may not just include soil loss, but also fertilizer and chemical

movement. Therefore, keeping cover on a field during non-production times in any season is an excellent practice.

3. **Nitrogen Cycling in the Soil** – Nitrogen is often the most limiting nutrient for crop production, since it is so readily lost through nitrification and leaching. Storing nitrogen through plant cycling is an excellent way to improve fertility management. Whether it is a grass or non-leguminous cover crops N is still kept in the mix by the cover crop taking up residual N that would otherwise be lost. The cover crop plant takes up the nitrogen and after the crop is incorporated it decomposes, thus releasing the N for subsequent crops to use. If legume cover crops are planted, they have the ability to "fix" nitrogen from the atmosphere and through the same decomposition process will provide N for subsequent crops. Be sure to inoculate legume seed just prior to planting with *Rhizobium* bacteria in order to gain the maximum N fixation benefits.
4. **Reduce Weeds –** When fields are left fallow after crops are harvested, weed growth can occur. If left to produce seeds, these weeds will multiply in subsequent crops. Therefore, managing the field by planting cover crops between cash crops is a great weed management option. As the cover crop grows, it will suppress the germination and growth of weeds through competition and shading. Some cover crop species can also suppress weeds biochemically, either while they are growing or while they are decomposing, which may prevent the germination or growth of other plants (allelopathy). Research has shown some cover crops like wheat, barley, oats, rye, sorghum, and sudangrass may suppress weeds. In some cases it has also been reported that residues and leachates from crimson clover, hairy vetch, and other legumes have shown weed suppression.
5. **Impacts on Plant Diseases** – Cover crop residues could possibly be beneficial when it comes to plant pathogens, or can in some cases increase plant disease organisms. Some cover crop species are in the same plant families as cash crops and may be susceptible to the same disease organisms. Therefore, carrying the pathogen to the next crop. This is why paying attention to crop rotations is so important. In other cases, the cover crop residue can improve soil health in order to produce a better environment for beneficial microbes. By improving soil health, water infiltration, air pore space and other positive attributes, some soil pathogens may not survive as well, as in the case of water molds and water fungi. Some cover crops, like sorghum-sudangrass and sunnhemp, have been reported to reduce nematodes in soils. There are multiple positive factors from cover crops that can combat plant diseases.
6. **Impacts on Insects** - Like with plant diseases, cover crops can be susceptible to the same insect pests as cash crops. However, they may also attract beneficial insects into an area. Insect pests should be monitored in cover crops, just like in cash crops in order to not let populations get out of control and then move into nearby fields after the cover crop is killed.

FAST GROWING SUMMER COVER CROP CHOICES:

Determining the purpose for growing and length of growing time will aid in selecting a summer cover crop. For summer cover crops planting in between spring and fall cash crops, selecting one that is fast germinating and fast growing is important. If nitrogen cycling is the goal, since there was significant nitrogen applied to the previous crop in a short term, then using a grass crop that takes up nitrogen quickly, such as sorghum-sudangrass or millet species may be a good option. If N is depleted in the soil, using a legume for nitrogen fixation may be a good choice. If the purpose is to provide readily available, nitrogen for the subsequent crop, then choosing a legume with a low carbon/nitrogen ratio like cowpea is the best idea. If weed suppression is the goal, using a high biomass producing crop to compete or smother weed seedlings would be selected. Sorghum-sudangrass is again a good choice or using a cover crop mix may be ideal.

GRASSES AND NON-LEGUMES FOR SUMMER COVER CROPS

Buckwheat *(Fagopyrum esculentum)* - Buckwheat germinates quickly and rapidly grows. It can reach 2.5 feet in height in just 4 to 6 weeks. Unfortunately, it can also flower in that time period and should be controlled to not set seed that can become a volunteer weed in the next crop. Plant habit is a single-stemmed upright plant, with many lateral branches. It has a deep tap root and fibrous roots. From seeding to flowering can occur between spring and fall vegetable production. While growing, buckwheat can suppress weed growth and recycle nutrients during that period. Buckwheat flowers are very attractive to insects, especially bees. Therefore, if growing a crop that needs pollination, do not plant buckwheat in close proximity. When using between crops, buckwheat is so succulent that it is easy to incorporate and decomposes quickly. To get the best performance from buckwheat be sure to incorporate into soil a week after flowering, before seed is set. The seeding rate is 30 to 90 lb/acre; higher rates are used when broadcasting. Seed should be drilled ½ inch deep, or broadcast and incorporated with a light disking. Buckwheat can be planted anytime in the spring, summer or fall, but is not frost-tolerant.

Sorghum-sudangrass *(Sorghum bicolor X S. sudanense)* - The use of sudangrass and sorghum-sudangrass hybrids as a summer annual cover crop has received increased interest in vegetable rotations because they increase soil organic matter when grown and incorporated. Sudangrass and sorghum-sudangrass hybrids are annual warm season grasses that are heat and drought tolerant. Sudangrass and sorghum-sudangrass hybrids can grow from 6 to 8 feet tall and produce large amounts of dry matter. Both crops winterkill with the first hard frost. Sudangrass and sorghum-sudangrass hybrids offer several benefits as a cover crop. They can be used to store residual soil nitrogen, suppress weeds, improve soil quality, and may suppress some nematodes. For more information see the Rutgers NJAES fact sheet titled, “Sudangrass

and Sorghum-Sudangrass Hybrids as Summer Cover Crops for Rotational Plantings", by William Bamka and Michelle Infante-Casella at: http://njaes.rutgers.edu/pubs/publication.asp?pid=FS994.

German (foxtail) millet *(Setaria italica)* - German or foxtail millet is an annual warm season grass that matures quickly in the hot summer months. German millet has a fairly low water requirement, but doesn't recover well if exposed to prolonged drought because of its shallow root system. German millet forms slender, erect, and leafy stems that can vary in height from 2 to 5 ft depending on soil fertility and moisture. Grain forms in 75 to 90 days after planting. The seed can be planted from mid-May through August at a rate of 25 to 30 lb/acre. German millet is a small seeded crop and requires a relatively fine, firm seedbed for successful germination. It will not do well in coarse, sandy soils.

Pearl Millet *(Pennisetum glaucum)* - Pearl millet is a tall summer annual bunchgrass that grows 4 to 12 ft. tall depending on soil fertility and moisture. Pearl millet does best in sandy loam soils, but is well adapted to sandy and/or infertile soils, Pearl millet can be planted from late April through July at a rate of 5 to 15 lb/acre. Pearl millet matures in 60 to 70 days. Be sure to kill before hard seed is set to avoid volunteer weed issues in the next crop.

LEGUMES FOR SUMMER COVER CROPS

Cowpea *(Vigna unguiculata)* - Cowpea is fast to germinate and grow. It is adapted to a wide range of soil conditions. Since it has a deep taproot this plant can obtain moisture from deep in soil, and thus does well in hot and low moisture conditions. Cowpea compete well against weeds with its dense canopy. In some studies, cowpea yields average 3000 to 4000 lb/acre of dry biomass containing 3 to 4% nitrogen. Growth of biomass is achieved in 60 to 90 days, making this an excellent summer cover crop in between cash crops. Plant residues are succulent and decompose readily when incorporated into the soil. Cowpea is frost sensitive so it should be planted after threat of spring frost and complete growth before fall frosts occur. Cowpea seed can be drilled in rows 6 to 8 inches apart at 40 lb/acre or broadcast and lightly incorporated at 70 to 120 lb/acre. Be sure to inoculate seed before planting to maximize nitrogen fixation.

Sunnhemp *(Crotalaria juncea)* - Sunnhemp is becoming more popular, but seed may be hard to source. It is a tall, herbaceous, warm-season annual legume that has been used for soil improvement and green manuring in the tropics, but can grow in our region during summer months. Plant habit consists of erect fibrous stems that are competitive with weeds. Sunnhemp grows rapidly to reach a height of 9 ft in just 60 days, under good conditions. It can tolerate poor, sandy, droughty soils but requires good drainage. Sunnhemp should be broadcast and shallowly incorporated at 30 lb/acre or seeded in 3.5 foot rows at 5 to 7 lb/acre. Since seed costs can be high, drilling to use a lower rate

may be desirable. Sunnhemp becomes fibrous if left to grow for a long period, but the plants will remain succulent for about 8 weeks after planting.

RESEARCH CONDUCTED BY INFANTE-CASELLA IN FRANKLINVILLE, NJ. Four summer cover crops were seeded on June 7, 2011 into a fallowed field and harvested to evaluate biomass 62 days after planting.

Cover crop species and variety	Seeding rate in pounds/acre	Average lbs/acre dry biomass @ 62d
Buckwheat (*Fagopyrum esculentum*) cv. Common	70	1,289
Cowpea (*Vigna unguiculata*), cv. Iron & Clay	70	1,146
Pearl Millet (*Pennisetum glaucum*), cv. Hybrid Pearl	10	2,556
Sudangrass (*Sorghum bicolor var. sudanense*) cv. Piper	50	3,547

Before incorporating summer cover crops into a production system, farmers should account for cover crop seed and planting costs. Additionally, the savings when planting a summer cover crop can include reduced fertilizer and herbicide applications, and reduced costs of pest and disease control. Other benefits to production systems that account for less apparent long-term savings are, reduced soil erosion, increased organic matter content, improved soil physical properties, reduced nitrate leaching, and enhanced nutrient cycling. When beginning a new production system, test small areas in the first year in order to gain experience and survey benefits before implementing on a large scale.

Peppers/Tomatoes

DISEASES OF PEPPERS

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Controlling anthracnose fruit rot.

Anthracnose fruit rot has been an increasing problem in pepper production during the past few years. The pathogen, *Colletotrichum* spp., also causes a fruit rot in strawberries and tomatoes. The pathogen can infect pepper during all stages of fruit development resulting in serious losses if not controlled properly. Symptoms of anthracnose fruit rot include sunken (flat), circular lesions. In most cases, multiple lesions will develop on a single fruit. As lesions enlarge, diagnostic pinkish-orange spore masses develop in the center of lesions. During warm, wet weather spores are splashed onto healthy fruit through rainfall or overhead irrigation.

Managing anthracnose fruit rot begins with good cultural practices. The pathogen overwinters on infected plant debris and other susceptible hosts. The fungus does not survive for long periods without the presence of plant debris. Pepper fields should be thoroughly worked (i.e., disced, plowed under) after the season to help break down and bury old debris. Heavily infested fields should be rotated out of peppers for at least three years. Do not plant or rotate with strawberries, tomatoes, eggplant or other *solanaceous* crops. Once areas in fields become infested, management of the disease can be difficult. Prevention is critical to controlling anthracnose fruit rot.

Beginning at flowering, especially if fields have had a past history of anthracnose.

Alternate:

chlorothalonil (FRAC group M5) at 1.5 pt/A or OLF, or
Manzate Pro-Stik (M3) at 1.6 to 3.2 lb 75DF/A

with a tank mix of chlorothalonil at 1.5 pt/A plus one of the following FRAC code 11 fungicides:

Quadris (azoxystrobin, 11) at 6.2-15.0 fl oz 2.08SC/A, or
Cabrio (pyraclostrobin, 11) at 8.0-12.0 oz 20EG/A, or
Priaxor (boscalid + pyraclostrobin, 7 + 11) at 4.0 to 8.0 fl oz 4.17SC/A.

With a tank mix containing chorothalonil at 1.5 pt/A or Manzate Pro-Stik at 1.6 lb/A and one of the following FRAC code 11 fungicides:

Quadris Top (azoxystrobin + difenconazole, 11 + 3) at 8.0 to 14.o fl oz 1.67SC/A
Aprovia Top (difenconazole + benzovindiflupyr, 3 + 7) at 10.5 to 13.5 fl oz

Prevention is critical to controlling anthracnose fruit rot. Infected fruit left in the field during the production season will act as sources of inoculum for the remainder of the season, and therefore, should be removed accordingly. Thorough coverage (especially on fruit) is extremely important and high fertility programs may lead to thick, dense canopies reducing control. Growers have had success in reducing the spread of anthracnose by finding 'hot spots' early in the infection cycle and removing infected fruit and/or entire plants within and immediately around the hot spot.

Controlling Phytophthora crown and fruit rot.

Phytophthora blight (*Phytophthora capsici*) is one of the most destructive soil-borne diseases of pepper in the US. Without proper control measures, losses to Phytophthora blight can be extremely high. Heavy rains often lead to conditions which favor Phytophthora blight development in low, poorly drained areas of fields leading to the crown and stem rot phase of the disease. Infections often occur where water is slow to drain from the soil surface and/or where rainwater remains pooled for short periods of time after heavy rainfall. Always plant phytophthora-resistant/tolerant cultivars, such as Paladin, Aristotle, Turnpike, or Archimedes to help minimize losses to the crown rot phase of the disease. For an updated cultivar list please see the 2016 Commercial Vegetable Recommendations Guide.

For control of the crown rot phase of Phytophthora blight, apply:

Ridomil Gold (mefenoxam, 4) at 1.0 pt 4SL/A or 1 Ultra Flourish (mefenoxam, 4) at 1.0 qt 2E/A, or MetaStar (metalaxyl, 4) at 4.0 to 8.0 pt/A. Apply broadcast prior to planting or in a 12- to 16-inch band over the row before or after transplanting. Make two additional post-planting directed applications at 30-day intervals. Mefenoxam is still effective against sensitive populations of the pathogen. However, DO NOT USE mefenoxam, if mefenoxam-insensitive strains are present on your farm.

Ranman (cyazofamid, 21) at 2.75 fl. oz 400SC/A may be applied via transplant water (see label for restrictions)

Presidio (fluopicolide, 43) at 3.0 to 4.0 fl oz/4SC/A can be applied via drip irrigation (see supplemental label); PHI: 2 days

For prevention of the fruit rot phase of Phytophthora blight, alternate the following on a 7 day schedule:

Ridomil Gold Copper (mefenoxam + copper, 4 + M1) at 2.0 lb 65WP/A.

with one of the following materials.

Presidio (fluopicolide, 43) at 3.0 to 4.0 fl oz 4SC/A plus fixed copper at labeled rates

Revus (mandipropamid, 40) at 8.0 fl oz 2.08SC/A plus fixed copper at labeled rate

Ranman (cyazofamid, 21) at 2.75 fl oz 400SC/A *plus* a non-ionic surfactant

Forum (dimethomorph, 40) at 6.0 oz 4.18SC/A plus fixed copper at labeled rate.

Zampro at 14.0 fl oz 535SC/A plus fixed copper at labeled rate.

Tank mixing one of the above materials with a phosphite fungicide (FRAC code 33), such as K-Phite, Rampart, or Prophyt will also help control the fruit rot phase of Phytophthora blight.

Managing bacterial leaf spot in pepper

Bacterial leaf spot (BLS) in pepper has increased in some areas of the mid-Atlantic region over the past few years. There are ~10 races of the pathogen and in the past few years races 1,2,3,4,5 and 6 have been detected in New Jersey. The pathogen can be seed-borne and can cause significant problems in the field if transplants are exposed to the pathogen during transplant production. Hot water seed treatment can be done to help mitigate potential problems due to BLS. Any seed suspected of carrying BLS should be hot water treated, this is especially important in heirloom varieties or organic seed where BLS problems have been suspected or an issue in the past. Some of the most commonly-grown commercial bell and non-bell pepper cultivars in the region carry resistance packages to different races of the pathogen (see Table below). Many of the bell peppers grown in the region also have resistance/tolerance to phytophthora blight. Growers with past histories of BLS and/or phytophthora on their farm should only grow those cultivars that carry resistance/tolerance to both pathogens.

BELL PEPPER

Cultivar	BLS race resistance	Phytophthora Resistance/Tolerance
Paladin	none	R/T
Aristotle	1,2,3	T
Archimedes	1,2,3	T
Turnpike	1-5,7,9	T
Declaration	1,2,3,5	T
Revolution	1,2,3,5	T
Archimedes	1,2,3	T
1819	1,2,3,4,5	T
Intruder	1,2,3	T
Tomcat	1,2,3,4,5	none

EXOTIC PEPPER BREEDING AND DEVELOPMENT PROJECT: 2015 UPDATE

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In 2015 we conducted three studies on exotic peppers: i) Pepper breeding; ii) Advanced comparison of habanero selections; and iii) Field and greenhouse comparison of eight culinary pepper selections.

1. **Pepper Breeding:** Ten inbred parental lines with variable fruit qualities (shape, wall thickness, pungency, color) were used to generate 49 new hybrid combinations during winter 2014-2015. Along with inbreds and controls, these new hybrid combinations were tested for field performance and fruit quality at three locations: Horticultural Farm III (HF3) on Cook Campus in New Brunswick (conventional, 95 selections & organic, 48 selections) and Rutgers Ag Research & Ext. Center (conventional, 64 selections). Control entries included two Bell pepper cultivars ('Aristotle' and 'Paladin') and a Cubanelle ('Sweet Cubanelle'). The objective was to identify the top 20 hybrids to be taken to the next level of evaluation for final determination of the pepper types to release to NJ growers. Field selection criteria were based on growth habit, maturity cycle, phenotypic stability, fruit yield and marketability. The results showed that seven *jalapenos*, two *mini-bells*, three *habaneros*, one *cayenne* and seven other unique selections, which appeared as crosses among the foundation germ plasm in our collection (*Capsicum annuum, C. chinense and C. frutescens*), met the selection criteria for the top 20. These selections are under further greenhouse evaluation and chemical analysis for further determination for release to NJ growers.

2. **Advanced comparison of habanero selections:** Fourteen habanero peppers selected from previous field evaluations since 2012 were compared. The objective was to identify the top selections for the NJ market based on the criteria listed above. From a replicated trial under conventional production and a single plot demonstration trial under organic production at HF3, Cook Campus, New Brunswick, six outstanding cultivars were selected and named as: a) Naveled Habanero (Atarodo onidodo), b) Pumpkin Habanero, c) Red Habanero (or Softskin Red), d) Rosebell Red Habanero, e) Rosebell Yellow Habanero, and f) Yellow Habanero. The nutritional and phytochemical profiles and the attributes of the fruit of these cultivars are being processed and will be factored into which cultivars to release to the market.

3. **Field and greenhouse comparison of eight culinary pepper selections:** In this study, eight pepper selections which emerged from previous field

experiments over the past three years, as promising new exotic peppers that fit into the emerging exotic culinary pepper market niches in New Jersey were again grown and evaluated. The selections comprised one yellow habanero/African Birdseye type, three Jalapenos (thick/smooth skin, medium fruit size, heat levels: mild, medium, hot), one African Poblano, and three mini-bells (yellow, orange, and red fruit). The peppers were evaluated in replicated trials in the field at HF3 (conventional and organic) and in the greenhouse (hoophouse at HF3 and controlled environment at NJAES greenhouses on Cook Campus). In the field, all selections exhibited good to excellent fruit yield except the orange and yellow mini-bell peppers that performed erratically. In the greenhouse, the African Poblano performed poorly in the hoophouse but outstanding in controlled environment greenhouse. The yellow habanero/African Birdseye selection yielded poorly in both the hoophouse and the controlled environment greenhouse. The *Jalapenos* were the most stable of the eight selections compared.

Summary: Several new promising advanced exotic pepper breeding/selection lines have been identified that are ready to release; others that are near ready to release; and many which will require further crossing and examining the genetic stability. The additional focus as to the phytochemical and nutritional composition of the exotic peppers coupled with their unique phenotype (visual appearance) will assist growers in generating market and consumer interest.

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UPDATE ON TOMATO DISEASE MANAGEMENT

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Effectively managing the many diseases that plaque tomatoes is essential to obtain a good crop. Achieving this necessitates knowing about new management tools and changes in disease occurrence.

New Disease Resistant Varieties. An important component of a successful, integrated management program is resistant varieties. There are new varieties with resistance to late blight and TSWV. Developing additional varieties with resistance to these diseases is a focus for plant breeders, along with resistance or tolerance to early blight, Septoria leaf spot, and bacterial speck. Resistance to bacterial spot has been genetically engineered into tomato by moving resistance genes from pepper; this is not commercially available.

New Fungicides.
Aprovia Top (FRAC Groups 3 + 7). Active ingredients are difenoconazole and benzovindiflupyr. This fungicide is labeled for anthracnose, early blight, leaf mold, Septoria leaf spot, and powdery mildew. It cannot be used in greenhouses. Make no more than 4 or 5 applications per season (depending on rate used) and no more than 2 sequential applications before alternating to a fungicide with a different FRAC Code. Apply with a spreading/ penetrating type adjuvant. REI is 12 hr and PHI is 0 day.

Orondis (FRAC Group U15). Active ingredient is oxathiapiprolin. This fungicide was approved by EPA for use in the U.S. in September 2016. It will be labeled for late blight in tomato and marketed as premixes with Bravo and Revus.

Priaxor (FRAC Groups 7 + 11). Active ingredients are fluxapyroxad + propiconazole. This fungicide is labeled for anthracnose, early blight, Septoria leaf spot, and powdery mildew, and for suppressing Botrytis gray mold and white mold. Apply no more than thrice per season with no more than 2 sequential applications before alternating to a fungicide that is in neither Group 7 or 11. Do not mix Priaxor with crop oil concentrate or with another pesticide that is an emulsifiable concentrate. REI is 12 hr and PHI is 0 day.

Quintec (FRAC Group 13). Active ingredient is quinoxyfen. There is a Section 2(ee) recommendation for use of Quintec to suppress bacterial spot in tomato. This is the only labeled use on tomato. REI is 12 hr and PHI is 3 days.

Vivando (FRAC U8). The active ingredient, metrafenone, has targeted activity for powdery mildew diseases. Use on tomato is on a supplemental label. Make no more than 3 applications per season and no more than 2 sequential applications before alternating to a fungicide with a different FRAC Code. Do not mix with horticultural oil. REI is 12 hr and PHI is 0 day.

Zing! (FRAC Groups 22 + M3). It has the same targeted active ingredient as Gavel (zoxamide) plus chlorothalonil. Gavel contains mancozeb, and thus has a longer REI (48 hrs versus 12 for Zing!). PHI is 5 days for both fungicides. Make no more than 8 applications with no more than 2 in succession. Limit total use with all products used to 0.2 lb zoxamide and 1.18 lb chlorothalonil per acre per season. Do not tank-mix with another product if the target disease is only late blight.

New and Emerging Diseases.

Tomato chlorotic spot virus (TCSV) is a new disease that has been causing substantial losses in southern Florida. It was first detected in 2012. In just two years it was causing significant yield losses with more than 30% plants infected in some fields. TCSV causes chlorotic leaf spots, necrosis, and death of leaves. It also stunts plant growth, reduced fruit production, and renders fruit unmarketable due to necrotic rings. There is concern it could get moved to the Northeast in tomato seedlings or infected ornamental plants. There already has been a detection in another state: Ohio in 2013. TCSV is a tospovirus. Similar to other viruses in this group, it is transmitted by thrips and it appears to have a wide host range. TCSV has been detected in tomato, pepper, tomatillo, tobacco, petunia, jimsonweed, lettuce, impatiens, and annual vinca. Growers who think they might have TCSV should promptly report it to an extension specialist.

Tomato spotted wilt virus (TSWV) has been reported more commonly in the Northeast in recent years. It is a tospovirus, transmitted by thrips, with a wide host range that includes potato, pepper and many ornamentals. This virus causes a range of symptoms, partly depending on when infection occurred. A characteristic symptom is leaf spots with a target appearance similar to early blight, but the spots are smaller and tend to be clustered; this is most evident on potato. Clustering of spots can result in affected leaves having large areas that are completely dark brown to black, more often at the leaf base. There can be few leaf spots among general browning of leaf tissue. Stems and petioles often have dark brown areas. Growing points can be killed. Tomato fruit usually develop brown discoloration and may drop when green. Affected plants may be yellow, stunted and can be killed. As is common with virus diseases, there will be completely unaffected plants next to diseased plants.

The first step in managing TSWV is growing tomato transplants separate from ornamentals. There are varieties with resistance to TSWV. Monitor for thrips as well as TSWV symptoms. Removing affected plants is recommended to reduce the amount of inoculum in a planting. Target the larval stage when applying insecticides to manage thrips to control TSWV. Only larvae can acquire this virus while feeding on an infected plant and only adults transmit it. It takes about 2 weeks for larvae to become adults. Adults transmit TSWV too quickly for insecticides applied to adults to suppress TSWV. Insecticides include Admire Pro (Group 4A) applied to growing media or soil before or after transplanting, Assail (4A), Radiant (5), Entrust (5), and Movento (23). Development of resistance in thrips is a concern with these insecticides.

Powdery mildew has been occurring sporadically but more frequently. It is common in high tunnels and greenhouses, but also occurs outdoors. Recent increase in high tunnel production at least partly accounts for increased importance of powdery mildew in the Northeast. Symptoms are the typical powdery white spots characteristic of this type of disease. They usually appear first on lower leaves inside the plant canopy. Early to mid-August is when this disease typically is first found on Long Island in field-grown tomatoes. Left unmanaged, powdery mildew can quickly kill affected leaves. See images at: http://livegpath.cals.cornell.edu/gallery/tomato/powdery-mildew-on-tomatoes/. Fungicides with targeted activity that move through leaves are needed to effectively manage powdery mildew because of the challenge of getting spray material to the leaf underside. It is important to examine the underside of leaves when inspecting a crop that has been treated with a broad-spectrum fungicide to determine if powdery mildew is present. Choose a fungicide with a FRAC Code U8, 3, 7, and/or 11 active ingredient(s). Vivando (FRAC U8) and FRAC 3 products like Rally are only effective for powdery mildew. FRAC 11 products like Cabrio also have activity for anthracnose, early blight, and Septoria leaf spot. Priaxor has FRAC Code 7 and 11 ingredients. Quadris Top has FRAC Code 3 and 11 ingredients. Inspire Super has FRAC Code 3 and 9 ingredients. Revus Top (FRAC 3 and 40) is a good choice when late blight is also present. Alternate among products in different FRAC Groups to manage resistance and to ensure effective control.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Before purchase, make sure product is registered in your state. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

LAUNCHING THE 'RUTGERS 250' TOMATO IN NEW JERSEY

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Long-time residents of New Jersey lament the disappearance of the exceptional flavor of what came to be known during the 19th and 20th centuries as the "Jersey Tomato". Due to higher production costs and a short season, it is also crucial for farmers in the northeastern U.S. to produce and market value-added crops to ensure continued profitability. A distinct trend has emerged in the direction of healthier, more local foods in the diet.

In this vein, the Rutgers New Jersey Agricultural Experiment Station (NJAES) project "Rediscovering the New Jersey Tomato" was launched in 2007 and has successfully released several old flavorful tomato varieties to home gardeners and commercial farmers. Positive publicity has been generated for NJ tomato farmers as a consequence of the program, along with increased sales of local fruit to consumers and transplants to gardeners.

To further capitalize on this momentum, the cross used to create the once popular and widely planted 'Rutgers' tomato was redone in 2011 in an effort to breed an updated and more flavorful tomato variety. The original 'Rutgers' was released by NJAES in 1934, and once dominated commercial and home gardener tomato acreage worldwide. The variety was so iconic that it was chosen above all others to be sent into space by NASA in the 1970s to ascertain long-term effects of interspace exposure to seeds. Derivatives of the original 'Rutgers' are still used extensively by home gardeners. Unfortunately, Rutgers University/NJAES lost control over the original seed stock. Our research has shown that the variety was extensively altered by seed companies over the ensuing decades.

The original 'Rutgers' was replaced in the 1960s by higher-yielding hybrids adapted to the southern and western U.S. and that can be shipped long distances. It was discovered that researchers at Campbell Soup Co. in Camden, NJ had retained seeds that descended from the original parents of 'Rutgers' ('JTD' and 'Marglobe'). It was decided that Campbell and Rutgers would jointly undertake a breeding program to

recreate ‘Rutgers’ from these original parents, and use more modern selection techniques and criteria to develop a replacement that was even better.

The original cross of ‘JTD’ and ‘Marglobe’ was redone in spring 2011. The F_2 population (225) was evaluated at Snyder Farm during summer 2012, and 14 single plant selections were made. After two more years of selection for high flavor and field performance, the Rutgers NJAES research team narrowed the field of contenders down to three advanced breeding lines.

During 2015, these three lines were subjected to a rigorous program of field, laboratory, and consumer testing. A Northeast SARE/Partnership Grant was secured to conduct two replicated yield trials (Snyder Research and Extension Farm, Pittstown, NJ and Rutgers Research and Extension Farm, Bridgeton, NJ) and observational trials with Rutgers Master Gardeners and commercial growers in different regions of NJ. The three selections were compared to ‘Celebrity’ a flavorful home garden standard and ‘BHN589’ a flavorful commercial fresh direct market standard. Marketable yield, fruit size and quality data were collected from the replicated trials and observational on performance collected from Master Gardeners and farmers. Consumer preference data was collected through six blinded tomato taste panels throughout New Jersey during the harvest season.

The results of the trials along with input from Rutgers Cooperative Extension faculty and staff, Master Gardeners, and farmers was used to select top entry to be named ‘Rutgers 250’ and released to clientele in 2016. The top selection was TRW3002, a mid-season, semi-determinate variety that bears smooth, globular fruits that are relatively firm and uniformly red when ripe. Replicated performance trials showed that overall yield of TRW3002 to be equivalent to ‘Celebrity’ and greater than ‘BHN589’. Consumer preference scores of TRW3002 were the highest of six entries in the tasting events, but the results were not statistically significant.

Approximately 1.10 lbs. of ‘Rutgers 250’ seed was produced during summer 2015, and is being packaged for distribution to home gardeners (http://www.njfarmfresh.rutgers.edu/) address) and a limited number of New Jersey wholesale transplant producers.

Efforts are now being made to develop a flavorful F_1 hybrid tomato variety with some of the original ‘Rutgers’ tomato genetics in its background for commercial production. Initial tests of these tomato breeding lines were conducted in summer 2015 at the Snyder Farm. Several test hybrids performed extremely well. Additional seeds of these selections are being produced during winter 2015-2016 for replicated tests in 2016 and 2017, with an anticipated release of a commercial F_1 tomato hybrid soon thereafter. The hope is that this variety will be suitable for production by commercial wholesale and retail tomato growers in New Jersey.

TRAP CROPS TO PROTECT YOUR PEPPERS FROM STINK BUGS

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Piercing-sucking herbivores, such as the brown marmorated stink bug (BMSB) and other stink bugs (Figure 1), make growing bell peppers organically and/or with reduced insecticide input nearly impossible. Stink bug nymphs and adults pierce plants with their needlelike mouthparts and will feed on the pepper buds, blossoms, and fruit. Immature fruits fed upon by the bugs become deformed as they develop. On a maturing pepper, feeding causes a condition that is known as 'cloudy spot' (Figure 2). Under the surface, these white areas are soft and spongy, and if spots are large or numerous, the peppers become unmarketable and may rot quicker than undamaged fruit.

BMSB and native stink bugs follow host plant phenology, and will more commonly attack plants when fruiting begins. Additionally, as they colonize a new host/crop, they generally attack from the crop edge before moving into the crop interior. One management method that takes advantage of this stink bug behavior is known as 'trap cropping'. A trap crop is the planting of an attractive host plant that creates a barrier surrounding a cash crop with the goal of preventing or slowing injury to the cash crop (Figure 3). Through a multi-state project funded by USDA-NIFA Organic Research and Extension Initiative (Grant # 2012-51300-20097) and lead by Dr. Anne Nielsen at Rutgers University, we tested trap crops as a method to manage stink bugs.

In 2013 field trials indicated that sunflower and sorghum were the most attractive plants evaluated to BMSB and native stink bugs. In 2014, we conducted a field-scale experiment across 11 farms in 7 states on the efficacy of sunflower and sorghum as a combined trap crop to protect bell peppers from stink bug pests. We assessed pepper damage due to stink bugs throughout the season (0=no damage, 1=minor damage, 2=major damage) and monitored the abundance of stink bugs and natural enemies (beneficial insects). The trap crops were attractive to BMSB and native stink bugs and delayed colonization of the pepper crop. In NJ, we had low stink bug pressure, which resulted in similar damage between our control (the standard plot) and our trap crop plot (marginally lower in the trap crop pepper plots) (Figure 4). Assessing the results from all the states suggest that under low-to-medium pressure, stink bugs are retained longer

and move less in the trap crop compared to the cash crop resulting in lower pepper damage (Figure 5). However, under high stink bug pressure, the trap crop does not work as well and may have inadvertently increased damage in the trap crop peppers.

In 2015, in NJ we continued to evaluate the sunflower and sorghum trap cropping tactic for stink bug management and added a third treatment where we included a pyramid trap baited with BMSB aggregation pheromone to further 'trap' stink bugs in the trap crops. With low numbers of BMSB and high numbers native stink bugs, results in 2015 were similar to the 2014 results, where the trap crops protected the pepper cash crop from major stink bug damage compared to unprotected peppers (Figure 6). The pyramid traps baited with the aggregation pheromone did not appear to benefit the removal of stink bugs and thus there was not a reduction of pepper damage compared to trap crop plots without the traps. Additionally, in both 2014 and 2015, there were more beneficial natural enemies observed in pepper planting surrounded by the trap crops compared to the control plots (Figure 7). This may potentially lead to an increase in predation of stink bugs within the plots, which could subsequently lead to a further reduction in damage.

More work is needed to refine the trap crop tactic for stink bug management, but our current results reveal that under low-to-medium stink bug pressure, the use of sunflower and sorghum can reduce the amount of damage done to the peppers they surround compared to a peppers with no trap crops. Additionally, the use of another management tool, such as a pyramid trap, flaming, or insecticides, may be needed to manage stink bugs in the trap crop if the pressure is high.

Project collaborators: Clarissa Mathews (Shepherd University, Redbud Farm), Galen Dively (University of Maryland), Gladis Zinati (Rodale Institute), Jennifer Moore (University of Tennessee), James Walgenbach (North Carolina University), Celeste Welty (Ohio State University), Doug Pfeiffer (Virginia Tech), and James Kotcon (West Virginia University)

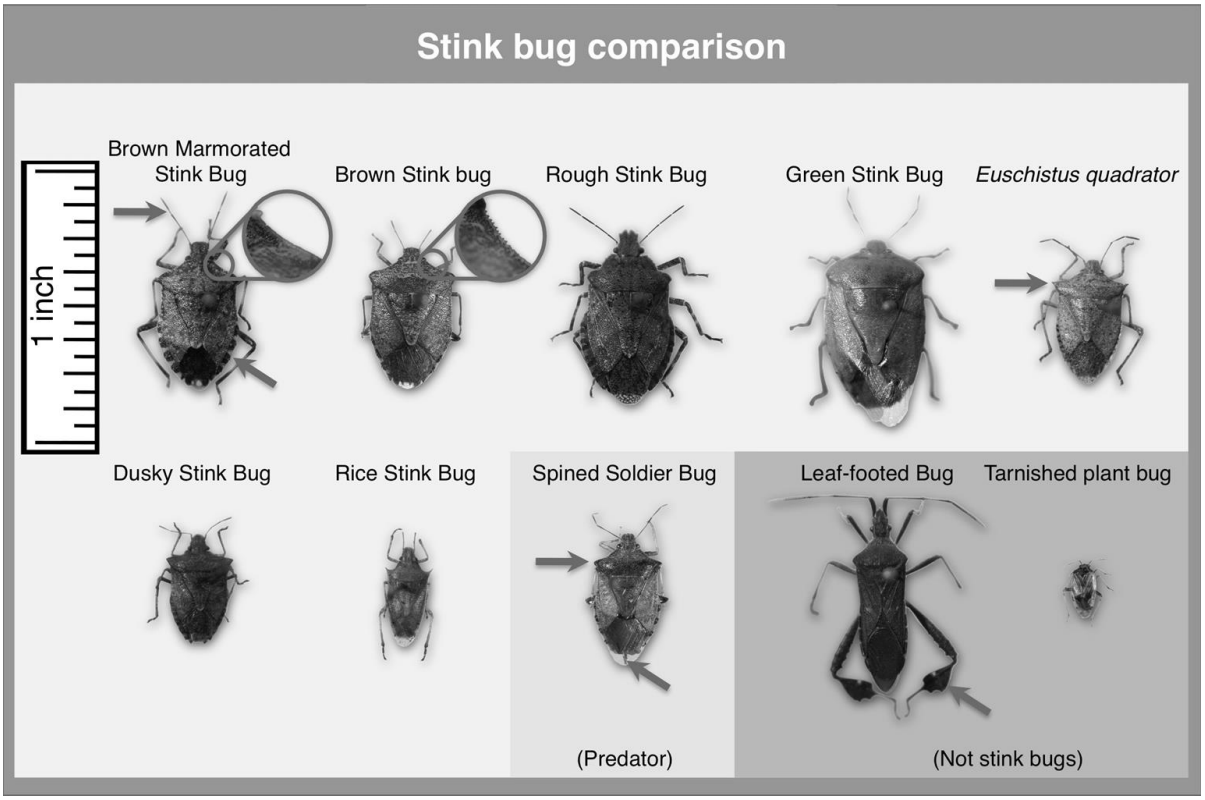

Figure 1. Brown marmorated stink bug versus other piercing-sucking herbivores.

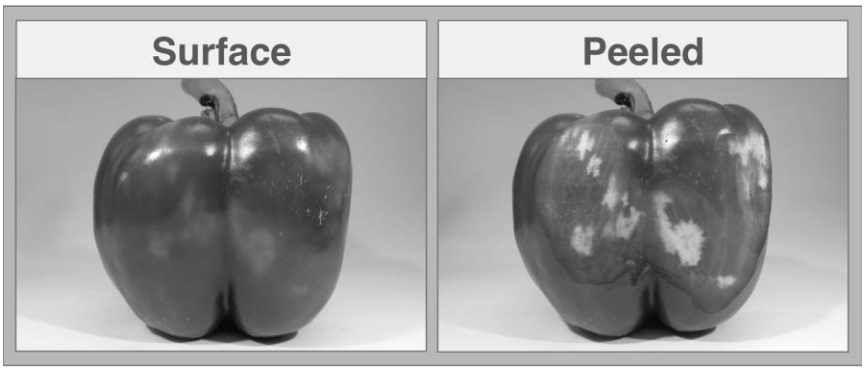

Figure 2. Stink bug damage to the surface (‘cloudy spot’) and under the skin (spongy white) of a bell pepper.

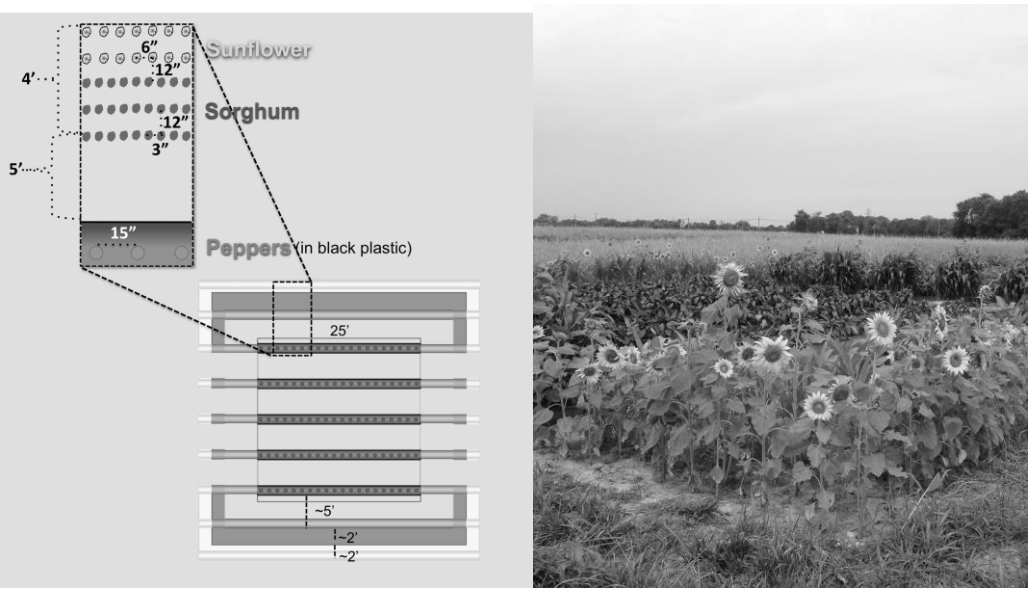

Figure 3. Trap crop design and layout, illustrating a pepper plot (cash crop) surrounded by a combination of sunflower and sorghum (trap crop).

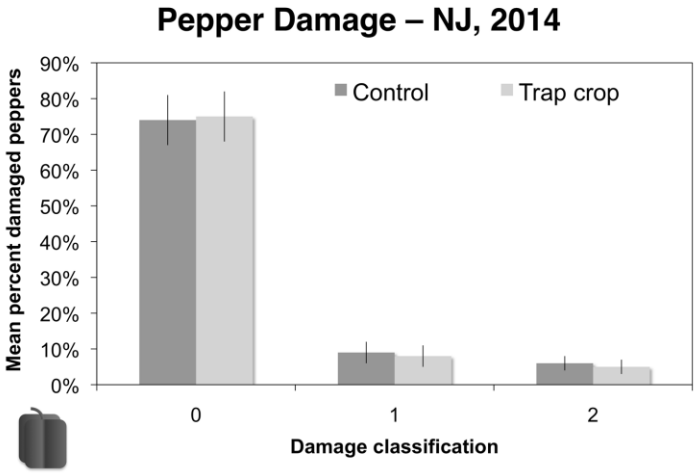

Figure 4. Pepper damage in NJ in 2014 (0=no damage, 1=minor, 2=major).

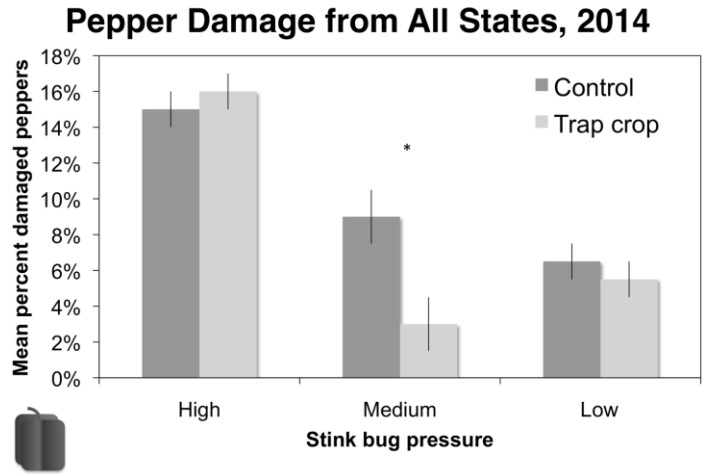

Figure 5. Pepper damage from all states in 2014, showing the difference stink bug pressure has on pepper damage.

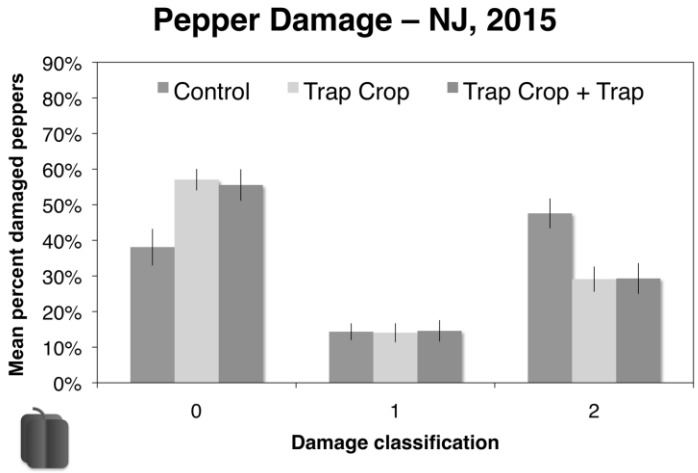

Figure 6. Pepper damage in NJ in 2015 (0=no damage, 1=minor, 2=major).

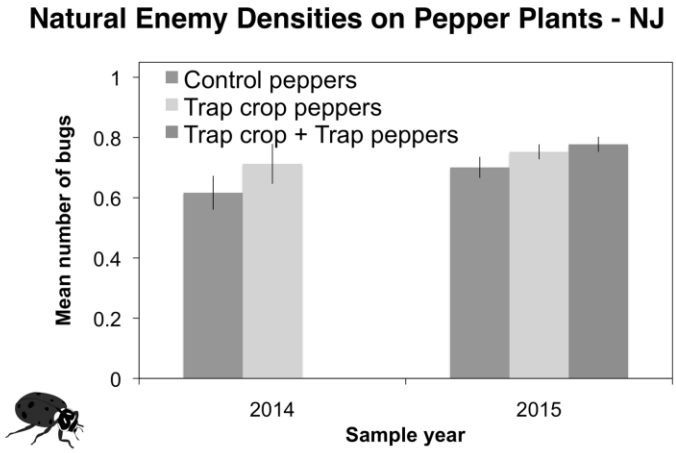

Figure 7. The abundance of natural enemies observed in the peppers in NJ in 2014 & 2015.

POST HARVEST SANITATION FOR FRESH MAREKET TOMATOES

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Tomatoes are one commodity where there is concern for water infiltration if fruits are dumped in water when packing. At the present time, only tomatoes are required to have the water temperature monitored in dump tanks. If the operation is using spray bars then temperature monitoring is not required. According to the USDA Tomato Food Safety Protocol - "In systems where tomatoes are submerged or dwell in water, water temperature is monitored and controlled. Water temperature should be at least 10ºF above highest measured pulp temperature of tomatoes when entering the water. If operation can demonstrate retention times are never more than two minutes and water submersion does not exceed 1 ft., water temperature shall be controlled to be not less than highest measured pulp temperature." If fruit temperatures are too high in the summer tomatoes can be put in the shade or better yet in a cold room before packing.

We have been carrying out a study to determine if microbial load is reduced on tomatoes that go through a sanitation step. Five farms across New Jersey were sampled over three years. All the tomatoes were grown on stakes and plastic. In 2013, tomatoes were sample one time and the other two years twice, early and late. Five samples were taken from different parts of the baskets or bins just prior to dumping then a second sample was taken just before packing. Three farms used dump tanks and then ran the tomatoes under spray bars. Two farms just ran the tomatoes under spray bars. All farms used a sanitizer, either chlorine or hydrogen peroxide/peroxyacetic acid.

No farms in this study maintained their water temperature 10◦F above the fruit pulp temperature. Pulp temperature at most sampling dates was warmer than the water.

Packinghouse one (used dump tank and spray bars) had a higher E. coli count at each sampling time after washing. This was especially true at the second sampling date in 2014. When 4 out of 20 fruit tested positive for E. coli prior to washing and17 out of 20 after. This indicates that cross contamination occurred between tomatoes or further contamination was introduced at the packinghouse. When the equipment was examined there was a track that could have been resulting in contamination of the fruit post washing. In 2015 the E. coli levels dropped to 2 out of 20 prewash versus 3 out of 20 post wash. These levels still need to be lower post wash.

Packinghouse two (used dump tank and spray bars) was able to eliminate E. coli from all samples with their sanitation process going from 6 prior to 0 post wash at one sampling date.
Packinghouse three (used dump tank and spray bars) only had E. coli in the 2013 and first sampling date of 2015. The E. coli count was reduced from 4 pre wash to 1 post wash in 2013, but increased from 0 to 7 in 2015. The second sampling in 2015 returned to 0 for pre and post wash. There is no explanation for this change.

Packinghouse four (spray bars) had an increase in E. coli counts two out of five sampling and a decrease in the other three. Contact time is very short which may be a factor in with this system since it is very short from dumping tomatoes on the line and running under the spray bars.

Packinghouse five (spray bars) had no detectable E. coli for four of five sampling times. One sample tested positive for E. coli prewash for the first date in 2015, but none tested positive post wash.

All packinghouses had no increase in total plate or coliform counts after going through there sanitation step, but the amount of reduction vary widely. Each had different sanitary procedures that did result in a wide range of potential bacterial reductions.

Growers should be using a sanitation step if using water when packing tomatoes. This means that that the level of sanitizer must be monitored and depending on the sanitizer used the pH may need to be monitored. How often you monitor should be based on run time. If using a dump tank, check the pH just before putting the sanitizer in the tank and if needed adjust the pH. Put in the properly calculated amount of sanitizer then check the concentration. Continue to check the concentration at least hourly. Drain the tank at the end of the day and refill with clean water. Remember the more organic matter that goes into the tank the more often a sanitizer needs to be monitored and added.

Along with cleaning the dump tank, all the equipment than comes in contact with the tomatoes should be cleaned and sanitized after each use. This does not mean just cleaning off, but vigorously scrubbing and rinsing then applying a sanitizer. Make sure the person doing the cleaning and sanitizing understands the procedure. The standard sanitization operating procedure should be written down and readily available for review. Any cleaning supplies, brooms, mops, etc. should only be used for cleaning and sanitizing the equipment. Store these items separate from other items. The best way to ensure there is no confusion is to color code everything. This can be done with paint or colored tape.

Blueberries

Season Extension

GETTING THAT EARLY SEASON JUMP START IN THE FIELD WITH VINE CROPS AND OTHER VEGETABLES

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Vegetable growers continue to look at lengthening the growing season to achieve maximum production and to schedule harvest dates during times of short supply to attain increased prices. The use of season extension methods can be as simple as selecting an early maturing variety, planting a wind break or irrigating a crop to reduce frost damage. More complex season extension techniques, such as high tunnels, low tunnels, row covers, individual plant caps/covers, plastic mulches, and transplanting rather than seeding in spring, have all contributed to earlier production. Vegetable crops grown that are being produced utilizing season extension techniques include strawberry, sweet corn, tomato, cantaloupe, watermelon, pickles, cucumbers, zucchini squash, yellow summer squash, and specialty melons.

The most popular and most adopted cultural practice for earlier production has been the use of plastic mulch to cover the soil surface on raised beds. Different mulches have been investigated to find multiple benefits of using this techniques. Often, multiple strategies of using plastic mulch and row covers are paired for early season production. Growers report the ability to harvest these crops 5 to 7 days earlier when using fiber row covers, 7 to 10 days earlier with low tunnels and 12 to 18 days sooner with high tunnels than without covers. The highest acreage of season extension methods for vegetables in Southern New Jersey is the use of low tunnels with clear polyethylene covering or fiber row covering. Row cover removal is critical during flowering to allow for adequate pollination. Material cost is one issue, but labor costs can also be high. Reaching the market place a week or more before other area producers can result in higher prices that make using season extension methods worth the investment, in most years.

Plastic Mulch

Most mulches are made of polyethylene. See Table 1, Plastic Mulch Types, to see descriptions of the different types. They are available in widths of 1.2-1.5 m (4-5 ft.) with a thickness of 1-1.5 mil (thousandths of an inch).

Several commercial plastic mulch layers are available. Proper set-up of the mulch layer is essential. The edges of the mulch should be well covered, and the plastic should be tight on the soil surface to permit heat transfer to the soil. Angle the discs and press wheels of the mulch layer to ensure a tight and uniform fit.

Do not lay mulch on dry soil. If the soil is very dry, irrigate or wait for rainfall before laying. Soil moisture is important for heat retention. Lay mulch 2-3 weeks prior to planting for maximum soil heating.

Table 1. Plastic Mulch Types and soil warming, advantages and disadvantages.

Plastic Mulch Types			
Type	**Average Soil Warming at 2 in. depth**	**Advantages**	**Disadvantages**
Black	2°C-4°C	Prevents weed seed germination	Good soil-to-plastic contact is necessary to ensure maximum heat transfer.
Clear	4°C-8°C	Can be used with direct-seeded crops such as sweet corn.	Weed germination under the mulch requires good preplant (residual) weed control.
White	-1°C (cools the soil)	. Keeps the soil temperature lower to minimize bolting in cool season crops.	Weed germination may occur under the mulch. Requires good preplant weed control.
Infra-red transmitting (IRT)	6°C	Absorbs certain wavelengths of light, preventing weed seed germination and growth.	Expensive. Tomato and pepper yields may be lower on IRT mulches than on black.
Photo-degradable	Same as non-degradable mulch	Breaks down with exposure to sunlight, eliminating the need for retrieval and disposal at the end of the season.	Rate of breakdown can be inconsistent. Buried edges frequently do not break down, leaving plastic residue in the field. These plastic residues are often difficult to retrieve.
Biodegradable	Same as non-degradable mulch	Usually a starch-based plastic. Broken down by soil micro-organisms.	Most of these mulches are relatively new in the marketplace, and only limited quantities are available. There is a big range in the quality and degradability of products. Always field-test new products on a limited scale first.

Row Covers

Row covers can be used to promote earlier production by increasing the canopy air temperature and protecting young transplants from wind damage. There are two basic types: floating row covers and low tunnels.

Both types of row cover used, can protect plants, but heat can also build up inside the covers and damage crops on sunny days. Temperatures should be monitored to protect young plants. It is important to remove or ventilate the covers when the temperature exceeds 32°C-35°C (90°F-95°F). For crops that require bee/insect pollination and wind pollination, row covers must be removed or opened up at flowering time. High temperatures under the row cover during flowering may cause flower abortion, fruit deformities or a decrease in pollen viability and transfer.

Floating Covers:

These are made of polypropylene or various polyester-type fabrics and are laid directly over the crop. They are available in sheets up to 15 m (50 ft.) wide and other dimensions to cover multiple rows. Floating covers are well suited for large acreages and low-growing plants. They are not recommended for use on upright-growing crops such as tomatoes and peppers. When windy or as plants grow upwards, floating row covers may cause abrasions on the plant's shoot tips or twisted growth. They also must be properly secured along edges, as to not blow away during high winds.

Low Tunnels

These are made of white or clear polyethylene or polypropylene fabric and are supported over the crop on wire hoops. The plastic usually has slits or perforations for ventilation. Spun fabrics allow for air movement, however may not provide as much warmth. Commercially available layers install hoops, lay the plastic covers over the hoops and bury the edges of the row cover in one operation.

Research has demonstrated that use of low tunnels can result in earlier production of lettuce, peppers, cucumbers and melons. Tunnels used on fresh-market tomatoes should be removed well before flowering. If row covers are left on the plants for too long of a period, it may result in reduced fruit set. This has been seen on tomato and pepper.

Conclusion

In conclusion, the use of techniques to accelerate maturity or extend a season with cultural methods like those listed above can increase production, earliness and hitting the market during low supply which can mean higher prices. Additionally, the use of multiple techniques used in combination can also improve crop maturity and performance.

MAINTAINING MARKETABILITY POSTHARVEST

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Season extension can be interpreted in a number of ways. Most recently much of the discussion on this topic has centered on Controlled Environment production, either in high tunnels, greenhouses, or even in fully enclosed buildings using artificial light to either extend production earlier or later than the normal season, or to produce crops year round.

Production technologies that coax earlier yields to try to capture higher market prices before the bulk of the season's crop floods the market include early season transplanting with protective materials such as plastic mulches, row covers and floating covers that help warm the soil and hold heat around the plants. Some of the same tools can be used to hold crops longer into the fall to again capture some higher prices when the bulk of the crop starts to get scarce.

Other practices that effectively extend the marketing season include post-harvest technologies that cool, clean and treat fresh produce.

Reasons for proper Post Harvest Handling of fresh produce include:

- Food Safety
- Maintaining Quality
- Maximizing Shelf-Life
- Long term storage

Quality of fresh produce is often cited as the number one reason consumers select and continue shopping at a particular retail grocery store. Employing techniques to maintain quality, enhance food safety and maximize shelf-life are keys to keeping up demand for your fresh produce as long as possible after harvest.

This presentation will illustrate current post-harvest handling tools and technologies employed in the fresh produce industry.

Resources:
postharvest.ucdavis.edu/
www.vegetables.cornell.edu/postharvest/
www.gaps.cornell.edu/documents/edumat/FApdfs/AssessmentSections/14-Postharvest-Handling.pdf

Squeezing More $ Out of Your Soil

SOIL PH, SOIL STRUCTURE AND SOIL WATER INFLUENCES ON PLANT GROWTH

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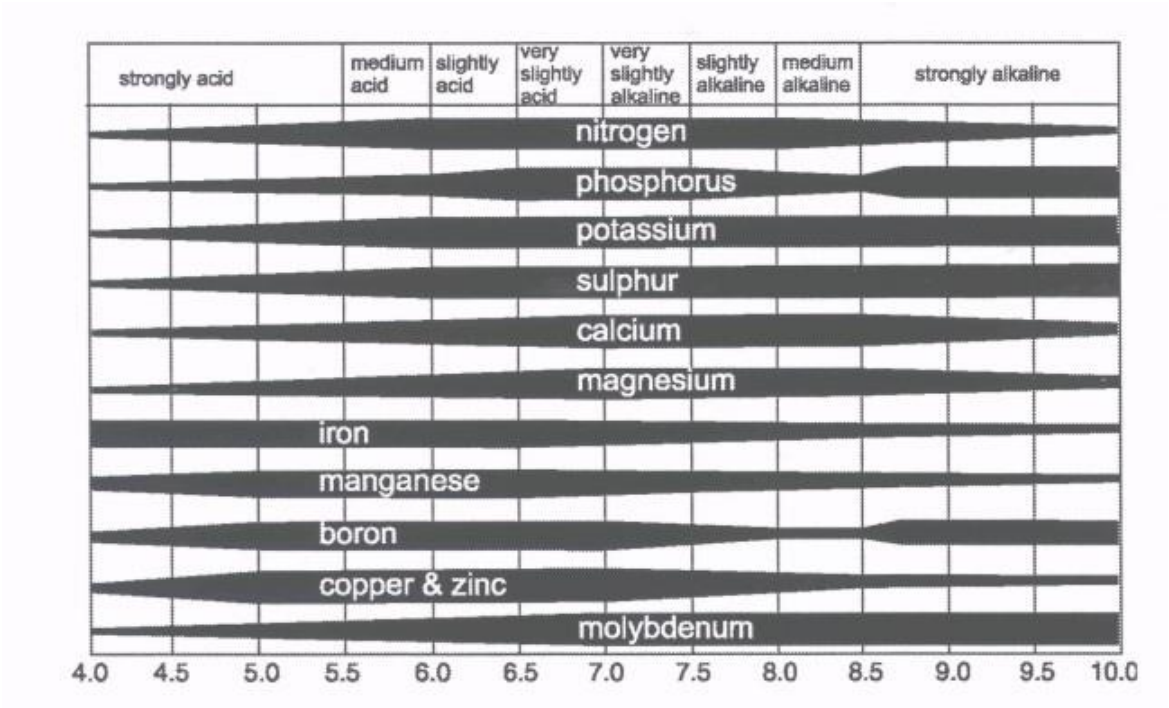
There are many reasons that plants can or cannot absorb nutrients contained in the soil they are growing in and the process can be complicated. Creating a healthy soil environment is the most effective way to maximize nutrient availability, water uptake and ultimately, healthy, productive plants.

SOIL PH

Soil pH measures the acidity or alkalinity of a soil. At a pH of 7 (neutral), acidity and alkalinity are balanced. Technically, pH is a gauge of the hydrogen-ion concentration in the soil. Soils become acid when basic elements, such as calcium, magnesium, sodium, and potassium held by soil colloids are replaced by hydrogen ions.

Most plants prefer a somewhat neutral pH, anything from 6.2 to 7.0. However there are many plants that are more specific in their pH needs, such as blueberries which like a very acidic soil and lilacs that prefer a more alkaline soil.

Soil pH can hinder or assist in the release of some soil nutrients. A chart below shows the availability of essential plant nutrients under certain pH levels. The wider the bar the more available that nutrient is to plants. The thinner the bar, the less available that nutrient is for plant uptake.



SOIL STRUCTURE AND SOIL WATER

Soil water plays a major role in plant health and plant growth. It is the carrier of many nutrients in the soil into the roots. Water transports nutrients within the plant, cools the plant, provides turgidity (stiffness) in the plant and is the key source of hydrogen the plant used for metabolic processes. Water plays a role in plants, much like it does in our own bodies.

If your soil stays wet in the spring, you will have to delay tilling and planting. Working wet soil can damage its structure. Seeds are less likely to germinate and often rot in cold, wet soil. Many plants don't grow well in wet soil. Raspberries, for example, often become infected by root diseases in wet soil and lose vigor and productivity.

Soil Pore Space:

A productive soil is both permeable to water and able to supply water to plants. A soil's permeability and water-holding capacity depend on its network of pores:

- Large pores (*macropores*) control a soil's permeability and aeration. Macropores include insect, earthworm and root channels. Because they are large, water moves through them rapidly by gravity. Rainfall and irrigation infiltrate into the soil and excess water drains through it.
- Small pores *(micropores)* are fine soil pores, typically a fraction of a millimeter in diameter. They are responsible for a soil's water-holding capacity. Like the fine pores in a sponge or towel, micropores hold water against the force of gravity. Much of the water held in micropores is available to plants, while some is held so tightly that plant roots cannot use it.

Soil that has a balance of macropores and micropores provides adequate permeability and water-holding capacity for good plant growth. Soils that contain mostly macropores drain readily but are droughty and need more frequent irrigation. Soils that contain mostly micropores have good water-holding capacity but take longer to dry out and warm up in the spring. Runoff of rainfall and irrigation water also is more likely on these soils. The total amount of pore spaces in the soil is its *porosity*.

Particle size also affects the surface area in a volume of soil. Surface area is important because surfaces are the most chemically and biologically active part of the soil. They hold plant nutrients, provide a home for microorganisms and bind contaminants. Clay particles have a very large surface area relative to their volume, so a small amount of clay makes a large contribution to a soil's total surface area.

Drought:

When drought conditions occur in soils, plants can wilt. Wilt can cause significant problems with plant growth and future yields. When a plant is stressed from lack of water, plant functions may slow or cease. One of the first plant responses to lack of water is closing of the stomates (openings on the undersides of leaves that regulate respiration and water loss through leaves). When stomates close this disrupts the movement of water and nutrients through plants, since transpiration (movement of water

and nutrients) is regulated by root uptake and stomatal removal. Think of it as a pump. The roots are the intake and the stomates are the hydrant or output. If the stomates close, like a closed valve on a pipe, then no water movement can go through that pipe. Hence, nutrients and energy are not transported throughout the plant. When severe lack of water occurs in plants, wilt can be seen. Additionally, with prolonged drought stress plants will abort certain parts to try to lessen the burden of having too many leaves or other plant parts, especially fruit and flowers. This is why we often see dropping of leaves or abortion of flowers in fruiting crops.

Excessive Soil Water:

When soils have too much water, they may drain or may stay water logged for periods of time, depending on soil type, structure and slope. Excessive rainfall or irrigation leaches certain nutrients in soil and therefore they are not there for plant needs. Optimum soil moisture levels will assist with availability of nutrients that are taken up in the soil solution by roots. Roots also need air space in the soil pores to survive. Just like other parts of the plant, roots respire. If kept in water logged soils they will suffocate and in instances where soil-borne diseases are present weakened roots are susceptible to disease infection.

MEASURING SOIL HEALTH AND ESTIMATING BIOLOGICAL NITROGEN RETURN

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Introduction

Our study in the central New Jersey area surveyed local soils from 2013 to 2015 that are nearly level and well drained. Their surface layer is classified as loamy sands, sandy loams or loams, while the sub-soil is sandy loams and sandy clay loams. Fertilizer recommendations are typically based upon a chemical laboratory analysis and estimated crop needs over the growing season. What is not typically measured is the ability of farmland soils to biologically produce their own nutrients such as carbon and nitrogen through mineralization by soil microbes. Maintenance of the chemical and biological "health" of the soil is a goal of high yielding, sustainable land management.

Measurement of soil respiration CO_2 derived from micro and macro organisms is a potentially important tool to predict availability of nitrogen, the essential element not measured in routine soil tests. To be able to accurately credit nitrogen and other nutrients from dynamic natural organic matter mineralization against the suggested static total fertilizer recommendation would be a valuable contribution to economical and sustainable farming.

Training & Equipment

The Extension Agent, Agricultural Program Associate, three Program Assistants and one student intern were trained by the Rutgers University Soil Lab Director Dr. Stephanie Murphy. Four hundred soil test kits and supplies were purchased included a digital color reader, beakers, filters and gel paddles from the Solvita® company – a Division of Woods End Laboratories, Inc.

Training and Laboratory Processes - Transition of this laboratory setup to our county agricultural building was found feasible and practical. Solvita® equipment was set-up within a small space in an extra room in the extension office. Training staff was straightforward and easily implemented. A Powerpoint presentation was made of the process steps to insure standard methods. The 0 to 5 color value index for soil CO_2 rate was simple to use and understand (Figure 1). The digital color reader was more accurate and not subject to normal human error. Extension offices may opt to save this expense and just use the visual estimate from the color code scale.
Extension staff was able to incorporate this biological sampling method within a

standard chemical soil test program to survey a diversity of county cropping systems and soils. Notes were taken of production systems, horticultural practices and soil amendments as reported by the growers.

Solvita® is a patented environmental measurement system with applications for soil, compost, manure and grain. One type measures carbon dioxide (CO_2) in a low and high range, and the other type is for ammonia (NH_3) – (Haney and Brinton 2008). Thin-gel technology assesses a component of soil health by measuring CO_2 emissions from soil which are primarily due to microbial respiration. The level of microbial activity is indicative of the amount of active organic matter that is being broken down and nutrients being released. The CO_2-Burst Lab Method (Haney-Brinton Protocol) uses a drying-rewetting method to associate soil health with a soil's mineralization capacity to release nutrients (Solvita® Guidelines, 2013). (Figure 2). Soils with more biological activity may be considered healthier in terms of providing additional nutrients for plant growth.

Sampling Process

From 2013 – 2015, 18 representative soil sites were selected in Monmouth County, NJ; primarily farms having sandy loam soils with pH values ranging from approximately 5.1 to 6.3 and typical organic matter from 1.0 to 2.0%. Seventy-four crop fields were GPS/GIS mapped and sampled at the same location in spring, summer and fall. Six study groups of local horticulture were constructed with three replications each. These categories were artificial golf greens, annual crops, perennial fairways, residential lawns, perennial grass crops and organic blueberry. Representative types of plant production in the county included sweet corn, pepper, tomato, field corn, blueberry, equine pasture, bio-energy grass, residential lawns and golf courses.

Results

Baseline Measures – In this temperate growing zone 7A, soil temperatures for the spring at 4 inches depth ranged from 55° to 64°F., 65° to lower 80's in the summer and fall with 20 – 40° F. in the winter. There was no significant difference in comparing the yearly cumulative CO_2 results of 2013 to 2014. The first year average for all color values was 2.41 with a standard deviation of 0.69 while the second year average was 2.50 with a standard deviation of 0.51. Similarly, the CO_2 respiration values of years 1 and 2 using the digital colorimeter showed no statistical difference between their respective values of 22.02 and 20.45 CO2-C with a standard deviation of 13.85.
As seen in Figure 3, the six categories of crops showed significant differences in increased respiration in both color value and carbon dioxide output. Slight differences were noted between the visual reader scale of 0-5 for gel color versus using the expensive yet more accurate colorimeter measuring parts per million. There was a trend in most annual crop sites where early spring color values averaged approximately 2.0 with a small increase to 2.4 in the summer and to 2.7 in the fall. These initial values translate to low-moderate activity rising to moderate-medium activity by the seasons

end. On the other hand, perennial crops with no tillage and more compost applications were significantly higher earlier and later in the season; ranging from an average of 2.61 to 3.10 (moderate to optimum activity). In comparing all 287 sample values in 18 separate farming systems, six replications had peak color ratings which indicated ideal microbial activity and soil health. These highest peak results were achieved in two organic blueberry farms, an equine pasture, a bio-energy demonstration and one residential lawn – 4.53 and 4.06, 4.37, 4.27, and 3.55 on the color scale, respectively. Correspondingly, six of these replications had the highest CO_2 – C production, ranging from 45.54 to 108.02 ppm. The main distinction of these six site categories was perennial cropping where no tillage was used leaving soil undisturbed along with standard practices of "feeding the soil" with composted amendments or mowing mulch on a regular basis.

These measures of CO_2 serve as a potential indicator of an unmeasured nutrient contribution in these sandy loam soils. With the estimated correlation of CO_2 carbon flux to potential nitrogen contribution, additional N production predicted for the annual crops category ranged from about 10 to 15 lbs. per acre for annual crops and 20 to 35 lbs. per acre for perennial crops (Figure 1).

Comments & Conclusion

Our pilot soil survey with the Solvita® soil respiration test in sandy loam soils has accurately measured active carbon and microbial biomass that have been correlated with potential nutrient release over the growing season. This low-cost, high-tech soil test provided a simple and quantitative means of evaluating an important component of soil health that can be used in conjunction with standard soil lab testing. Seasonal sampling may be utilized to measure any changes in management practices over time; such as cover cropping, tillage systems, municipal leaves, compost applications, chemical fertilizers and organic soil amendments.

These consistent results in central New Jersey over three years show promising implications for agronomy and horticulture. Farmers, advisors, extension agents and agricultural specialists may be able to add a new assessment method into their technical toolbox at their home base. Further research and demonstration work will use this regional baseline information to compare nutrient recycling from microbial metabolism of organic matter application and predict subsequent nitrogen release that contributes to crop nutrition and yield on a site by site basis. This "new" source of nutrient availability has the potential for growers with biologically healthier soils to reduce the amount of fertilizer application and advisors to reduce N rates; yet expect the same yield, reduce expenses and avoid excessive nutrient runoff.

Blue-Gray Color 0-1	1 – 2.5 Gray-Green	2.5 – 3.5 Green	3.5 – 4 Green-Yellow	4 – 5 Yellow
VERY LOW SOIL ACTIVITY Association with dry sandy soils, and little or no organic matter	MODERATELY LOW SOIL ACTIVITY Soil is marginal in terms of biological activity and organic matter	MEDIUM SOIL ACTIVITY Soil is in a moderately balanced condition and has been receiving organic matter additions	IDEAL SOIL ACTIVITY Soil is well supplied with organic matter and has an active population of microorganisms	UNUSUALLY HIGH SOIL ACTIVITY High/excessive organic matter additions
Carbon dioxide levels – PPM range				
0 – 5	6 – 12	13 – 30	31 – 70	71 – 160
Approximate quantity of nitrogen (N) release per year (average climate)				
<15 lbs/acre	15 – 25 lbs/acre	25 – 45 lbs/acre	45 – 75 lbs/acre	75 – 105 lbs/acre

Figure 1 – Solvita Index Color Scale, correlated CO_2 levels and predicted N contribution

Figure 2 – Color Reference Chart, Digital Color Reader, Beakers, Jars and Gel Paddles

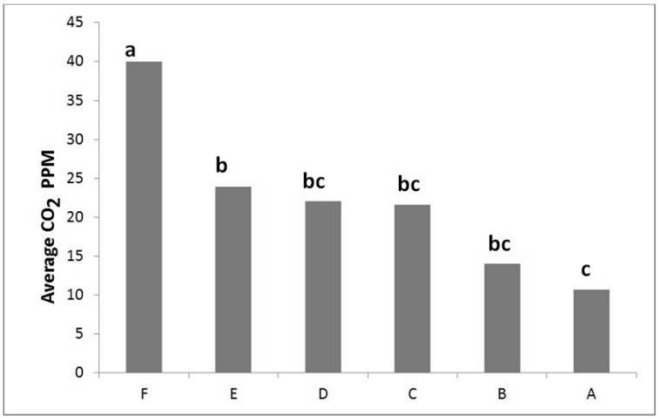

Figure 3 - Solvita® CO_2 analysis of six crop categories

Means with no letters in common are significantly different at 0.05 according to Fisher's Protected LSD

A= Golf Greens, B = Annual Crops, C = Golf Fairways,
D= Home Lawns, E = Bioenergy Crop, F = Blueberry

Vine Crops/Pumpkins

MANAGING CUCURBIT DOWNY MILDEW WITH DISEASE MONITORING, CULTIVAR RESISTANCE AND EFFECTIVE FUNGICIDE PROGRAMS

Sponsored by the 2014 and 2015 Charles and Lena Maier Vegetable Research Award presented by the NJ-VGA

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In 2014 and 2105, five different fungicide programs with varying fungicide inputs were evaluated at the Rutgers Agricultural Research and Extension Center (RAREC) in Bridgeton, NJ on three different cucurbit crops. The five fungicide programs with either no fungicide input (untreated control), a low fungicide (protectant fungicides only) input, medium input (protectant + moderately effective downy mildew fungicides), or high fungicide input (protectant + highly effective downy mildew specific fungicides) are listed in Table 1. The three cucurbit crops evaluated were cucumber cv. 'Marketmore 76', zucchini cv. 'Reward' (summer squash), and acorn squash cv. 'Taybelle' (winter squash). In each year, raised beds were laid with white plastic on 5 ft center with one drip off set to one side. Plots were one row 15-ft-long and 5-ft between beds and arranged in a randomized complete block design with four replications. Plots were hand seeded (2 seed/hole) at 12 inch spacing on 22 July 2014 and 17 July 2015 and reseeded as needed one week later. The field was fertilized pre-plant incorporated with 50 lb/A nitrogen (calcium nitrate). The remainder of the fertilizer was applied through the drip system at the rate of 30 lb/A as 20-20-20 equivalent as needed during the study. Prowl at 2 qt/A + Dual Magnum at 1 qt/A + Sandea 0.75 oz/A were applied then followed with an application of Dual Magnum at 1 pt/A + Command at 4 oz/A for weed control.

The five fungicide programs were initiated on 7 Aug 2014 and 29 July 2015 and applied every 7 to 10 days for a total of 10 (in 2014) and 9 (in 2015) fungicide applications (Table 2). All fungicide treatments were applied with a pressurized tractor-mounted sprayer with 3 hollow-cone D4-25, disc core drop nozzles (one over the top, one on each side of the row at a 45 degree angle) at ~43 gal/A and 58 psi. Plots were evaluated for downy mildew development from August until October. Foliage was rated weekly on a scale of 0 to 100 (0.0 = no downy mildew; 100 = 100% of leaves infected) for downy mildew development. The Arcsine-transformed area under disease progress curve (AUDPC) values for downy mildew development were calculated for each fungicide program in each year. A total cost per season for each program was also calculated and presented in 2014. No harvests were done.

In 2014, cucurbit downy mildew appeared late in the production season about 1 month after seeding and approximately 2 weeks after the first fungicide application. Importantly, during the course of study only cucumber 'Marketmore 76' became infected by the pathogen. This suggests, along with other reports in the region, that the primary host for cucurbit downy mildew in 2014 was cucumber. This also suggests that cucurbit downy mildew may have different race(s) and host specificity, and predominant race(s) may emerge in any specific growing season. Area under disease progress curve (AUDPC) values varied significantly based on fungicide program (Table 2). AUDPC values were significantly highly in the UTC and low input programs compared to the medium and high input fungicide programs for cucurbit downy mildew control (Table 2). Control was similar between the medium and 2 high fungicide input (new and old standard) programs (Table 2). Although not significantly different, both high input fungicide programs resulted in numerically lower AUDPC values (Table 2) suggesting slight better downy mildew control compared to the medium input program (Table 2). Fungicide costs were obtained from a local supplier and season-long program costs (fungicide material only) were calculated. Although not significantly different in AUDPC value, the new cucurbit downy mildew fungicide program cost was approximately $150 more than the old standard program (Table 2).

In 2015, cucurbit downy mildew appeared late in the production season about 1 month after seeding and approximately 2 weeks after the first fungicide application on cucumber. Unlike 2014, cucurbit downy mildew appeared in summer squash (zucchini) and winter squash (acorn) as well as cucumber in 2015 at RAREC. There was a significant interaction between fungicide program and crop in 2015 and AUDPC values are presented by crop (Tables 3 and 4). On cucumber, the medium, high-input (old standard), and high-input (new standard) fungicide programs all significantly reduced cucurbit downy mildew compared to the low input and UTC (Table 3). On summer squash, the high-put programs (old and new standards) significantly reduced cucurbit downy mildew compared to the low input and medium input fungicide programs, as well as the UTC suggesting that fungicide programs with rotations of cucurbit downy mildew-specific fungicides used on a weekly basis provided better effective control of cucurbit downy mildew (Table 3). On winter squash, the low, medium, high-input (old standard), and high-input (new standard) all significantly reduced cucurbit downy mildew compared to the UTC (Table 4).However, only the high-input (new standard) was significantly lower than the low input an UTC (Table 4). The low, medium, and high-input (old standard) were all similar in control and significantly lower than the UTC (Table 4). Figure 1 graphically depicts the AUDPC values across the five fungicide programs and three crops. Remember, a high AUDPC value represents less cucurbit downy mildew control, hence for fungicide program 1 (untreated controls) we would expect the most disease since no fungicide were applied season-long (Figure 1). For the low-input fungicide program #2 where only chlorothalonil was applied weekly season-long, control of cucurbit downy mildew was better on winter squash compared to cucumber and least effective on summer squash (Figure 1). Control of cucurbit downy mildew was similar in winter squash and cucumber for fungicide program #3 (medium input) and better when

compared to summer squash when chlorothalonil was tank mixed and rotated with Curzate or Tanos on a weekly basis (Figure 1). Overall, control of cucurbit downy mildew was best across all three crops using fungicide program #4 - the high-input (new standard) where multiple downy mildew specific fungicides (Ranman, Previcur Flex, and Zampro) were tank mixed and rotated with chlorothalonil and/or each other season-long (Figure 1). Control was also good using the high-input (old standard) where Ranman was tank mixed with chlorothalonil and rotated with Presidio (Figure 1). Control of downy mildew was better in cucumber and winter squash compared to summer squash using the old-standard fungicide program #5 (Figure 1).

Results of this study suggest that race(s) of cucurbit downy mildew may be appearing in the region and that cucurbit host susceptibility and fungicide control may vary greatly from year to year. In 2014, only cucumber became infected at RAREC. In 2015, all three crops were infected, but summer squash appeared to be more susceptible than cucumber and winter squash. All cucurbit growers in New Jersey and the mid-Atlantic region need to follow reports of cucurbit downy mildew during the production season through the CDM forecasting hosted by NCSU at http://cdm.ipmpipe.org/. By following up-to-date reports though the CDM forecasting website and via timely reports via the Plant and Pest Alert System through NJAES during the production season growers will be able to determine which cucurbit where the pathogen is located in the US and which cucurbit crops are most at risk. Control of cucurbit downy mildew begins with regular scouting, keeping up with reporting, recognizing the symptoms, and preventative fungicide programs. In this study, the best control of cucurbit downy mildew was in the fungicide programs that contained downy mildew-specific fungicides such as Ranman, Presidio, Zampro, and Previcur Flex used in rotations and/or tank mixes on a weekly basis. These fungicides in combination (and rotation) with protectants such as chlorothalonil, Gavel, or mancozeb should be used according to their respected labels. Results also demonstrate that in some instances more broad-spectrum fungicides such as chlorothalonil or mancozeb or fungicides with moderate or lower specificity to downy mildew [(and lower chances for resistance development (i.e., Tanos, Curzate, Phosphites)] may provide adequate control of downy mildew on certain cucurbit crops. These fungicides should also remain for use cucurbit downy mildew control programs. Possible resistance to Presidio has been detected in the southern US and in our region its efficacy in the state and region should be closely monitored.

COMPARING PLASTICULTURE TO STRIP TILLAGE FOR MUSKMELON AND SUMMER SQUASH

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Plasticulture systems consisting of raised beds, drip irrigation and polyethylene (plastic) mulch are commonly used to grow muskmelon (*Cucumis melo*) and summer squash (*Cucurbita pepo*). Black plastic mulch is commonly used in the Northeast, for in-row weed suppression and increasing soil temperatures which often result in increased yields. In addition to the cost of the plastic and its disposal, there are environmental consequences of plastic mulches including intensive tillage required for installation and increased potential or soil erosion. Strip tillage systems may be an alternative to plasticulture systems to minimize these concerns.

Cucumber wilt is a fatal disease that can affect almost all cucurbit crops in our area. Symptoms start as a wilting of individual leaves and quickly spreads throughout the entire plant. *Erwinia tracheiphila*, the bacterial wilt pathogen, is transmitted by striped and spotted cucumber beetles (*Acalymma vittatum* and *Diabrotica undecimpunctata howardi*, respectively). The only commercially viable management of this disease is the management of cucumber beetles. Muskmelon and cucumber losses can be greater than 80% when cucumber beetles are left unmanaged. A previous study (Sanchez et al., 2015) investigated the timing of row cover removal as an approach to managing cucumber beetles.

Research at The Pennsylvania State University's Russell E. Larson Research and Education Center in Rock Springs, PA was conducted in 2013-14 to compare plasticulture to strip tillage with and without the use of row cover for muskmelon and summer squash in organic and conventional systems.

The research was designed as four separate experiments focusing on a different crop and production system:

1. Organic muskmelon
2. Organic summer squash
3. Conventional muskmelon
4. Conventional summer squash

The muskmelon cultivar used was Athena and the summer squash cultivar was Lioness. Additionally, each experiment was conducted over a 2-year period.

For all experiments, a cover crop seeding mix of 75% winter rye and 25% hairy vetch at a rate of 90 lb/A was planted in the fall before each growing season. In the two organic

experiments, a roller crimper was used to terminate the cover crop and applications of glyphosate were used in the two conventional experiments.

In all experiments, strip tillage consisted of tilling a 12 inch wide row through the rye/hairy vetch residue with a single line of drip irrigation tape per row. The plasticulture systems consisted of 2.5 ft wide raised beds with a single row of drip tape and black plastic mulch over the beds.

In all experiments, row covers (Agribond AG-30 for the two summer squash experiments and conventional muskmelon experiment, AG-19 for the organic muskmelon experiment) were deployed at transplanting over half of the plants, while the other half were left uncovered. Row covers were removed when 50% of the strip tillage plots had at least one open flower for the two summer squash experiments and 10 days after first flowering for the two muskmelon experiments.

Data collected include pest pressure (all experiments), air and soil temperatures (organic experiments only), soil moisture level (conventional experiments only), soil nitrate levels (all experiments), plant growth characteristics (all experiments) and yields (all experiments). Yields and soil and air temperatures are presented here.

A randomized complete block with split-plot design replicated four times was used with whole plot treatments consisting of production system (plasticulture or strip tillage) and the split plot factor was row cover use (row cover or no row cover). The same experimental design was used in both years of all four experiments. Data were analyzed using the PROC MIXED application with the Statistical Analysis Software version 9.4 (SAS Institute, Inc., Cary, NC, 2006).

Results and Discussion

Air and soil temperatures

Air and soil temperatures were measured in the organic muskmelon and summer squash experiments only. In both experiments, average air temperatures were not different between plasticulture and strip tillage treatments during the period of row cover deployment. However, air temperatures were about 5.3°F higher when using row covers compared to not using them. Average soil temperatures were about 3.5°F higher in plasticulture treatments compared to strip tillage treatments during the period of row cover deployment. The use of row cover did not impact soil temperatures.

Bacterial wilt incidence and cucumber beetle populations

The incidence of bacterial wilt was low in all experiments and both study years. Additionally, cucumber beetles were sprayed with insecticides when numbers exceeded thresholds. We were unable to test the effects of the treatments on these factors. However, the number of insecticide applications for each treatment in each experiment will be presented.

Yield

Organic muskmelon experiment

Using a plasticulture system resulted in higher marketable yields than the strip tillage system in both years. In 2014, cool weather delayed the maturity of the cover crop, therefore pushing back the optimal timing for terminating the cover crop with the roller crimper. As a result, the muskmelon crop did not have sufficient time for the entire crop to mature. The use of row covers did not impact yield in 2013 and resulted in higher yields in 2014.

Organic summer squash experiment

In 2013, the highest marketable yields were from plants grown in the plasticulture system with no row covers, followed by the plasticulture system with row covers and strip tillage with row covers. The lowest yields were from plants grown in strip tillage without row covers. In 2014, the highest marketable yields were from plants grown in the plasticulture system with or without row covers and the strip tillage system with row covers. The lowest yields were from plants in the strip tillage system without row covers.

Conventional muskmelon experiment

In 2013 and 2014, the highest marketable yields were from the plasticulture system compared to the strip tillage system. In 2013, the use of row covers did not impact yields in either system. However, in 2014, using row covers increased yields in the strip tillage system compared to not using them. As in 2013, their use in 2014 did not impact yield in the plasticulture system.

Conventional summer squash experiment

In 2013, marketable yields were higher from the plasticulture system compared to the strip tillage system and row cover did not impact yield. In 2014, yields were not different between plasticulture and strip tillage systems. Row cover use did not impact yield.

Overall, for all four experiments, using a plasticulture system generally resulted in higher yields than the strip tillage system, possibly related to soil temperature as well as other factors, including soil nitrate levels and weed pressure. While some yield loss may be acceptable in strip tillage systems due to decreased field preparation time and decreased input costs, the reduction in productivity seen in the two muskmelon experiments was beyond an acceptable level. In the organic summer squash experiment yield was also unacceptably lower than observed in the plasticulture system. In 2014, conventional summer squash grown in the strip tillage system matched the productivity of the plasticulture system; however, significantly lower yields were observed in 2013.

Row cover use produced unexpected results. It was thought that the increased temperatures from their use would translate into increased yields. However, our protocol for determining row cover removal may have been at fault. Previous research demonstrated that removing row covers 10 days after first flowering for muskmelon and

at first flowering for summer squash optimized yield. In this study, row cover removal was based on reaching these thresholds for the strip tillage plots with row cover – the latest to reach this physiological stage. This means that plants receiving the plasticulture with row cover treatments had significantly passed the threshold. For the summer squash experiments, this resulted in plants exceeding the area available for growth underneath the row cover and plants were damaged as a result, possibly reducing yields.

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POST HARVEST CONSDIERATIONS WITH CUCURBIT CROPS

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Post-harvest considerations for cucurbit crops are the same as most other fruited vegetables. Even before the crop is harvested decisions must be made to determine yield and quality. Selecting the proper varieties, applying pest control measures to avoid injury from insects and disease organisms, and determining proper maturity are all steps to bring a top quality product to market. The information provided below will be divided into crop groups within the cucurbit family, since there are differences in post-harvest handling.

SUMMER SQUASH AND ZUCCHINI:

The quality of summer squash and zucchini is based on uniform shape, tenderness of rind, skin free of cuts, abrasion or defects, overall firmness, a glossy skin color, and an intact well-trimmed stem portion. Shape and color are important quality factors and generally based on type or variety.

When fruit reach desired size, harvests can begin. With summer squash and zucchini, multiple harvests will take place generally for a 4-5 week period and multiple times per week. During high temperatures, daily harvest may occur to prevent fruit from becoming too large. Fruit are harvested by hand, cutting the stem of the fruit where it attaches to the plant with care being taken to not cut into any immature fruit left on the vine. It is also important to avoid abrasions to the harvested fruit when pulling it away from the plant. This is why certain varieties are advertised in seed catalogs as, “open plant habit”, which indicates ease of harvest. Since the petioles of squash plants have spines, they can injure tender fruit being harvested if scraped against the petiole. Fruit should be place in clean harvest containers, free of sand and other debris. Also, older, worn harvest containers that are abrasive can cause injury on tender fruit. Take care to use proper containers and techniques to avoid damage when harvesting.

Once harvested, fruit are still alive and will respire. This means, the fruit will exchange gasses, lose moisture and begin decaying. Therefore, handling the squash to reduce respiration, moisture loss and decay must be done quickly to ensure shelf-life and quality. Optimum storage temperature for summer squash is 41-50°F (5-10°C). Ways to reduce field heat may include room cooling and forced air cooling. Hot fruit coming from the field should not be submerged into cooled water, as the cut stem will take in water that may contain pathogens. These pathogens may later cause decay in storage or transit. It is best to first cool in cold rooms or with forced air before washing to pack into boxes. Summer squash and zucchini shelf life is generally 10 days to 2 weeks if properly stored. Storage at below 41°F (5°C) for more than 3-4 days will generally

result in chilling injury. Quality will deteriorate, surface pitting will occur, and discoloration or browning progress rapidly following chilling injury. Shriveling, yellowing, and degradation will increase if fruit are stored beyond two weeks; especially once placed on retail sales shelves. For fall crops, chilling injury (even if frost does not occur) can take place over time and may begin in the field before harvest.

Summer squash varieties are low to moderately sensitive to ethylene gas injury. However, yellowing of green types and green zucchinis will result from low levels of ethylene during transportation and short-term storage. Avoid long term storage and transport with ethylene producing fresh produce like apples.

Diseases are also an important factor in postharvest loss, and are usually found in combination with physical injury or chilling stress. A large list of bacterial and fungal pathogens cause postharvest losses in transit, storage, and to the consumer. *Alternaria alternata, Colletotrichum* spp. (Anthracnose), Bacterial Rots, Cladosporium Scab, Pythium Cottony Leak, Didymella Black Rot, Phytophthora fruit rot, Rhizopus Soft Rot and others, are common disorders on summer squash that can cause decay after harvest.

PUMPKIN AND WINTER SQUASH:

During production, the use of a regular fungicide program to prevent fruit from becoming diseased in the field is important. Harvest of pumpkin and winter squash should be done when fruit are mature and before frost. It is important to handle fruit with care to not cause injury such as cuts, wounds or bruises. All of these injuries will be entry points for disease organisms to infect fruit and cause rots. The ability to store the fruit for a long period and still maintain quality is highly dependent on how it is grown, harvested and handled before storage. If storing winter squash, it is important to cure fruit at temperatures between 80-85ºF (26.7-29.4ºC), with a relative humidity of 75 to 80 percent for approximately 10 days. An exception is with acorn squash, since curing is detrimental to fruit quality for this type. Therefore, do not store acorn squash in a facility where other squashes are being cured for storage. For most types of winter squash, temperatures below 50ºF (10ºC) can cause chilling injury. With hard-shelled squashes, such as butternut, delicata, spaghetti, and Hubbard, they should be stored at 55ºF (12.8ºC) with a relative humidity of 50-70 percent. Acorn squash can be stored for 5-8 weeks under these same conditions, but remember not to cure. Pumpkin can be stored for 2-3 months using the above temperatures and humidity, but are rarely stored since often sold out of the field or shortly after maturity for Halloween sales. Butternut, delicata, kabocha, Calabaza and other hard shelled squashes can be stored for approximately 3 months. Hubbard squash may store for up to 5-6 months. Storage life depends on the condition of the crop when it comes in and your ability to provide careful handling and a proper storage environment. For recommended storage conditions for different pumpkin and squash types and their storage life expectancy see Table 1.

Table 1. Recommended Storage Conditions for Different Pumpkin and Squash Types and Their Storage Life Expectancy.

Culinary Type	Temperature (ºF)	Percent relative humidity	Storage life expectancy
Pumpkins, general	50-55	50-70	8-12 weeks
Squash, general	50	50-70	Varies with variety
Acorn	60-70	60	4 weeks
Acorn	50-60	60	4-7 weeks
Buttercup	50	50-70	13 weeks
Butternut	50-60	60	7 weeks
Butternut	50	60	8-11 weeks*
Hubbard	50-60	60-70	27 weeks
Turban	50	50-70	13 weeks

* Storage for 4 months or more is possible if all production, curing, and storage recommendations are followed. (Source of Table: Zitter, 1992)

Common storage pathogens that cause diseases of pumpkin and winter squash in storage are *Alternaria cucumerina* (Alternaria fruit rot); *Botrytis cinerea (*gray mold*)*); *Choanephora cucurbitarum* (Choanephora fruit rot); *Colletotrichum orbiculare* (anthracnose); *Didymella bryoniae* (black rot); (*Erwinia carotovora* (bacterial soft rot); *Fusarium* spp. (Fusarium rots); *Phytophthora capsici* (Phytophthora fruit rot); *Plectosporium tabacinum* (Plectosporium blight); *Pythium* spp. (Pythium fruit rot); *Sclerotium rolfsii* (southern blight); and *Sclerotinia sclerotiorum (*Sclerotinia rot). These pathogens are present in the field and come into storage with the fruit or from unsanitary harvest containers or bins. The best way to control these storage diseases is to first control them in the field so that healthy fruit are harvested.

MELONS

Just as in squash, melons should be produced in the field to result in the best quality fruit possible, before harvest, to aid in high quality post-harvest. Care should be taken to reduce insect damage and diseases in the field with cultural and pesticide controls. Fruit should be harvested at the best possible maturity and handled in a way that prevents injury.

MUSKMELON, CANARY, GALIA, HONEYDEW

Shortly after harvest, these melons should be cooled to remove field heat to reduce respiration rates. Precooling is generally done with room cooling and forced air cooling. The use of cold water may introduce pathogens into injured areas or stem ends of fruit. After precooling, these melons should be stored at 36-41ºF (2.2-5 ºC) and 95 percent relative humidity. Storage under these conditions can last for about 15 days if fruit are in good condition. For honeydew and other non-slip melons, do not store below 40ºF (4.4 C) to avoid chilling injury. Non-slip type melons can be stored for 2-3 weeks at 45-50ºF (7.2-10ºC) and retain adequate quality.

WATERMELON

Once harvested, watermelons should be stored at 50-60ºF (10-15.5ºC) and a relative humidity of 90 percent. Watermelon are not well adapted to long term storage and can quickly lose quality. They can be injured by chilling at low temperatures and at high temperatures can decay rapidly. It is important to consume melons within 2-3 weeks of harvest since the flesh will lose crispness and take on undesirable textures. Quality of a watermelon is often judged by high sugar content, deep colored flesh, crisp texture and edible flesh that is of proper maturity. All of these factors are dependent on maturity, variety and handling methods after harvest.

Watermelon are sensitive to ethylene gas injury and should not be stored or shipped with other produce that emits ethylene gas. Storing large sized watermelon in sturdy bins on pallets for transport is the preferred method. Smaller sized or personal watermelons are generally boxed in cardboard boxes and stacked on pallets for shipping.

CUCUMBERS

Cucumbers and pickles should be harvested at a desired size, and before seeds harden inside the fruit. The more immature the fruit, the less time they will retain quality post-harvest. During harvest, fruit should be handled carefully, placed into clean, non-abrasive harvest containers and transferred gently into bins. Removing field heat soon after harvest with cool rooms or forced air is recommended. Cucumbers are sometimes waxed to reduce respiration rates and prolong storage. Cucumbers can be held for 10-14 days at 50-55ºF (10-12.7ºC) with a relative humidity of 90-95 percent. If temperature in storage goes below 50ºF (10ºC) for more than 2 days, chilling injury may occur and fruit may show pitting of the skins. If temperatures in storage are above 50ºF (10ºC) fruit will respire at a rapid rate and lose moisture and green skin color can begin to turn yellow. The yellowing can be accentuated if ethylene producing crops are comingled with cucumbers, especially after 10 days at above sub-optimum storage temperatures.

Diseases than can affect cucumbers in storage are often accentuated when fruit are exposed to chilling stress in storage. Some of the most typical pathogens that cause post-harvest rots in cucumber are: *Alternaria* spp., *Didymella* (black rot), *Pythium* (cottony leak), and *Rhizopus* (soft rot). During harvest, reducing injury to fruit will aid in reducing incidents of storage disease infection on fruit.

Resources:

Alabama A&M and Auburn Universities, Horticulture Notes
http://www.aces.edu/pubs/docs/A/ANR-1110/ANR-1110.pdf

PNW Plant Disease Management Handbook
http://pnwhandbooks.org/plantdisease/node/3955/print

Rutgers NJAES, 2015 Commercial Vegetable Production Recommendations http://njaes.rutgers.edu/pubs/publication.asp?pid=E001

Suslow, T.V. and M. Cantwell, Department of Plant Sciences, Cucumber: Recommendations for Maintaining Postharvest Quality, University of California, Davis http://postharvest.ucdavis.edu/pfvegetable/Cucumber/

Suslow T.V. and M. Cantwell, Department of Plant Sciences, University of California, Davis http://postharvest.ucdavis.edu/pfvegetable/Squash/

Virginia Cooperative Extension, Pumpkin and Winter Squash Harvest and Storage http://pubs.ext.vt.edu/2906/2906-1344/2906-1344.html

Zitter, T.A. 1992. Fruit Rots of Squash and Pumpkins. Fact Sheet 102VCFS732.10. Cornell Cooperative Extension.

Food Safety

ON-FARM FOOD SAFETY DECISION TREES: HELPING FARMERS ASSESS RISKS, PRIORITIZE RESOURCES, AND IMPLEMENT PRACTICES EFFECTIVELY

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Food safety is every growers' responsibility; however, identifying and prioritizing food safety risks on the farm is often difficult. Small and medium scale growers often have limited time, money, and resources to implement food safety practices on the farm. While there are many food safety resources and templates offering guidance on practices to reduce risks, most do not explain how to assess risks or how to prioritize which food safety practices should be put in place first. Not all risks are the same and farm resources are limited. Understanding how to prioritize the implementation of food safety practices that reduce the biggest risks is important to farm viability and safety.

This project developed Decision Tree Portfolios to help fruit and vegetable growers assess on-farm risks and develop farm food safety plans that guide and prioritize the implementation of Good Agricultural Practices (GAPs). A documented food safety plan is required by some produce buyers (i.e. for a third party food safety audit) so this resource will aid growers in maintaining and growing their markets. Microbial contamination of fruits and vegetables in the field and packinghouse can come from many sources, such as wild and domestic animals, water, soil amendments, workers, and adjacent land. To address the diversity of risks, nine Decision Tree Portfolios were developed including: Worker Health, Hygiene, and Training, Wildlife and Animal Management, Land Use, Agricultural Water for Production, Postharvest Water, Soil Amendments, Sanitation and Postharvest Handling, Transportation, and Traceability. Each Decision Tree Portfolio contains an overview of the topic, a decision tree for assessing risks, food safety template language, sample standard operating procedures, sample log sheets for recording food safety practices, and references for additional resources. Initial development and review of the Decision Trees was guided by an advisory group of growers, extension educators, topic-specific experts, and government personnel. Focus groups were conducted with growers in Minnesota, New York, and Tennessee to evaluate the final Decision Tree Portfolios for usability and functionality.

Join this session to learn how to use this resource and get started on writing your food safety plan today! This session applies to all fruit and vegetable growers, with particular emphasis on small and medium scale farms, including the Plain community, organic, and direct-to-market growers. The Decision Trees are available online for download at http://www.gaps.cornell.edu/tree.html or can be purchased in print form from the Cornell GAPs Bookstore: http://www.gaps.cornell.edu/educationalmaterials.html#decisiontree.

WHAT AUDITORS ARE FINDING – 3RD PARTY AUDITS?

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Auditors each year seem to find similar issues when carrying out a Good Agricultural Practices/Good Handling Practices Audit or the Harmonized Audits. Following are reoccurring issues in the harmonized audits which growers should review for their audits.

Food Safety Training (1.4.1 field and 1.5.1 post-harvest) – All personnel shall receive food safety training. This means everyone from the field to office workers and all owners. Did all employees at least receive basic food safety training as it pertains to their jobs? Did the owners receive food safety training? Everyone does not need to receive the same training. It depends on their job responsibilities. Remember to record the training sessions!

Water/Microbial Sampling/Testing (1.5.1 field and 1.25.1 post-harvest) – There are two types of sampling in these audits. One is water sampling which is required for third party audits. The other is produce sampling. Most growers are not required to do product sampling. This will depend on your buyer whether this is required. If the operation is required to do produce testing be sure to follow the sampling instructions from the laboratory exactly. You can have a false if samples are not handled properly. In both cases, the laboratory must follows recognized laboratory practices and have at a minimum passed a Good Laboratory Practices (GLP) audit or participates in a proficiency testing program. The operation needs to obtain a copy of the laboratory procedure for their records.

If the water source is being used for potable (drinking) water, make sure the testing company isn't doing an irrigation water test that has less restrictive allowances. Water used in the packinghouse must be potable (below detectable levels for total coliform). When testing for irrigation water, an acceptable level is 126 cfu/100ml of generic E. coli. Surface water must be tested three times during the growing season (when irrigation starts, mid-season and close to harvest). Well water must be tested once during the season.

Who is a subcontractor (1.4.3 field) – This is an individual or company that does work on your operation such as the pest control company, electrician, carpenter, etc. The operation needs a record to demonstrate that the subcontractor whose activities can affect food safety have been informed of and, to the extent that can been verified, are in compliance with your food safety plan. This could be a written form that you require them to sign before starting work.

What commodities require water temperature to be monitored (1.11.8 post-harvest)? – At the present time, only tomatoes are required to have the water temperature monitored in dump tanks. If the operation is using spray bars then temperature monitoring is not required. According to the USDA Tomato Food Safety Protocol - "In systems where tomatoes are submerged or dwell in water, water temperature is monitored and controlled. Water temperature should be at least 10ºF above highest measured pulp temperature of tomatoes when entering the water. If operation can demonstrate retention times are never more than two minutes and water submersion does not exceed 1 ft., water temperature shall be controlled to be not less than highest measured pulp temperature." If fruit temperatures are too high in the summer tomatoes can be put in the shade or better yet in a cold room before packing.

All cleaning agents shall be approved for their intended use on food contact surfaces. What is acceptable? (1.13.3 post-harvest) – All cleaning agents must have a label that specifies it can be used on food contact surfaces. Some can only be used on contact surfaces others can be on the produce and/or contact surfaces. Whatever is used there must be a label and remember the label is the law!

Equipment, vehicles, tools, utensils and other items or materials used in farming operations that may contact produce are identified. What is an acceptable list? (2.7.1 field) – The list should be of things that may pose a risk of produce contamination during normal use. The list can be handwritten on your phone or in a computer. It should not be a generic list of all equipment on the farm. What items do you use on leafy greens for example? Crops can be grouped together if the same equipment is used, but there are items which would be used on eggplant, but not peppers as an example.

Foreign material control devices are inspected a maintained. What is a foreign material control device? (2.6 post-harvest) – This only applies to certain operations where they may be used in the packinghouse. Some blueberry operations use magnets to check for metal in the picked blueberries. If a device is used it must be calibrated according to a written procedure or manufacturer/s recommendations.

Protective clothing, when required, shall be maintained, stored, laundered and worn so as to protect from risk of contamination. What is protective clothing? (2.2.10 field and 1.21.6 post-harvest) – If an operation requires aprons for example

then there needs to be procedures for how they are used, cleaned and stored. This applies to any protective clothing that is used close to the product.

Glove use policy (2.2.9 field and 1.21.13 post-harvest) – This is one question that is confusing for growers. If gloves are optional or required than you must have a policy on the type of gloves, how they are use, cleaned, sanitized and stored. If the policy is optional you still need to address the type of gloves especially if they are reusable.

Pre-harvest assessments (3.1.1 field) – These can be done the day before harvest or the morning of harvest. Auditors will want to see the assessment then go into the field and see if the assessment agrees with what is in the field. Big issues in an assessment include: Are there signs of wildlife especially fecal material; are the portable toilets too close to the field, etc.

These are some of the concern areas observed in 2015. Look these over and see if you have addressed these issues in your food safety plan. Remember not all questions may apply to your farm operation. Do not put anything in your plan that does not apply to your operation. It is better to have less and make corrections than put something in the plan that cannot be verified.

FARM FOOD SAFETY LIABILITY CONSIDERATIONS

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When it comes to a food safety incident, a single mistake can have steep consequences. Farmers suffer the emotional devastation of having caused someone harm. Food poisoning can cause permanent disability or even death. It goes without saying that every farm should prioritize producing the safest food, first and foremost. But even still, we need to pay attention to the legal aspects of a food safety incident. Accidents can happen to anyone.

This summery is not an exhaustive discussion of the legal ramifications of a food safety incident, by any means. It is a selection of relevant legal issues that may accompany a food safety incident extending from a farm operation. Farmers should take steps to learn more by discussing their situation with an attorney and an insurance agent, for example. This information is not a substitute for the counsel of a qualified attorney. Rather, it is an introduction that serves as a launching pad for a more detailed exploration of individual risks and management options.

In addition to the information here, in my presentation I will be talking briefly about the Food Safety Modernization Act (FSMA) and the final rules that were just released. At the time of this document, we are just beginning to delve into that information, so it will be not reflected in this summary. Please visit farmcommons.org for many resources and webinars on food safety and other legal issues that apply to farmers.

Liability and Negligence

"I might be sued if someone gets sick." This is the first thing that comes to mind when farmers think about the legal implications of a food safety incident. In the legal lingo, this type of case is often called a "personal injury" case. Personal injury lawsuits (also called "tort claims") don't have the finest reputation. That may not be entirely deserved. The premise behind a personal injury lawsuit is this: if one person does something wrong and hurts a second person, the first person should compensate the injured person for their damages. The premise seems fair. The same applies to property damage.

Of course, not every person who suffers an injury gets money for it. Although the line between eating contaminated food and becoming sick may be straightforward, the line between getting sick and winning a lawsuit against the source is not. In the case of food poisoning, the source may have to be at fault before the court will order them to pay up.

Fault is determined in many different ways. For our purposes, we'll be focusing on just one way that farmers might find themselves at fault: negligence. Negligence is a legal concept that basically says this: If you act with less care than the average person in your circumstances would act, then you are negligent. Of course, that begs the question, "How does an average person act in these circumstances?" Untold time and money is spent sorting out the answer and in determining whether the individual in question met that standard. When a negligence lawsuit ends in favor of the plaintiff, the injured person may receive money for their medical bills, lost wages, future loss of earning potential, among other losses. There is much more that we could say about negligence and liability, but for the sake of this summary the point is this: A personal injury lawsuit is a risk that all farmers face, and it's a complex, unpredictable risk.

Role of Insurance in managing the risk of personal injury suits

When it comes to personal liability suits, the best risk management option is insurance (assuming farmers are following the best food safety practices already). Insurance is important for two reasons: First, the insurance company will provide an attorney to defend the insured person or business against the claim. Second, if the farmer is at fault, the insurance company should pay the resulting liability up to the coverage limit.

With the knowledge that insurance companies defend lawsuits and pay on successful covered claims, the whole ordeal of buying insurance makes a little more sense. Insurance agents make inspections to verify that unreasonable risks don't exist on the property. The policy may also impose requirements on insured businesses to protect the company's ability to win cases. On the other hand, this is also why some farmers have trouble getting insurance at all. If a company thinks a certain type of operation is more risky (as happens with some value-added and agritourism operations), the company may refuse coverage and the farmer may be stuck without any insurance to buy.

Buying the right policy to protect from personal injury lawsuits

Each farmer needs to make certain that their specific policy covers the contamination risks experienced by that farm. This isn't as easy as it sounds, and here's why. Most farmers carry liability insurance for the farm- it goes by the name "property and casualty insurance," "farm liability insurance," and a host of other names. Farm Commons tends to use the phrase "farm liability insurance." Basically, these policies cover damage to farm property from covered risks (fire, tornado, etc.) and injury to farm guests. However, most farm liability policies will cover a food poisoning injury under select circumstances. Some policies only cover injuries that occur on the farm. This means if the contaminated product was purchased from a wholesaler, the farmer is not insured. Some policies cover food poisoning injury only if the contamination was the result of a fire, tornado, or other natural risk, but not farmer negligence. Farmers never intend to be negligent, but as we discuss above, accidents happen. An insurance policy that doesn't cover negligence has a significant gap. Generally speaking, farm liability coverage will not extend to contamination of value-added products or those occurring at an agritourism event.

Instead, many farms will need to modify the standard farm liability policy to address food safety incidences. A “business endorsement” may do the trick if the farm wants coverage for a small value-added operation or a few agritourism events. If the farm wants broader coverage, a commercial liability policy may be the best choice. Commercial policies provide coverage across many marketing channels- wholesale, value-added, processing, and direct-to-consumer- the latter three of which are not covered by farm policies. These are general guidelines only. In Farm Commons’ experience, many policies are different. (And, some even contradict themselves as to whether food safety outbreaks are covered.)

The hard reality is that it can be difficult to determine if a specific insurance policy will cover a specific risk. Farms have a few options for finding out what exactly their policy covers: Go straight to the source and read the policy language itself, or simply asking the insurance agent whether specific risks are covered. Admittedly, this is not a bullet-proof strategy, but as a secondary strategy it’s always a best practice to get things in writing. When talking with an insurance agent about whether a risk is covered, create a paper trail. Communicating via email is one way to establish a written record. Where that isn’t possible, an office log containing the time of the call, identity of the person called, and the content of the discussion can go a long way towards establishing potential recourse if you are misinformed.

Food Safety and Contract Law

Contract laws also play an important role in the legal effect of a food safety incident. I will be discussing just two of the potential ways contracts can come into play: indemnification clauses and agreements to maintain specific standards.

Indemnification

Indemnification is a legal concept that basically means if Person A does something that harms Person B, Person A will pay Person B back for their damages. It is similar to negligence, but one big difference centers on how a person becomes liable. Negligence relies on an implicit societal responsibility to meet unspoken but commonly accepted standards. For example, I can sue someone for negligence even though they never agreed to be responsible for their negligence.

Indemnification can quickly come into play during a food safety incident involving a grocery store or other retailer. A grocery store may suffer loss of sales from all products of the type (all spinach, or all apples) regardless of the source. The grocery store’s reputation may be damaged. The store itself may be sued for negligence- perhaps for negligently working with a farmer who did not meet standard safety protocols. If the farmer agreed to indemnify for these damages, the farmer would then have to pay the grocery store back for all these things. Indemnification can pile up fast and put a farmer out of business in a hurry.

Fortunately, many insurance policies will cover liability incurred by indemnification of others. Commercial policies often provide this coverage. As always, though, the devil is in the details. The precise language of the insurance policy may limit the types of indemnification. Folks need to read both the insurance policy and the sales agreement closely to make sure the indemnification offered to the buyer is the type covered through the insurance policy.

Contract breach risks

When one party violates a term of a contract to which they have agreed, they have "breached" the contract. The other party can then bring a lawsuit to force the breaching party to pay for damages the non-breaching party suffered. Contract breach is another way farmers may end up with legal consequences from a food safety incident.

In terms of food safety, many sales agreements obligate farmers to adhere to specific food safety practices or standards. Buyers might want farmers to maintain GAP (Good Agricultural Practices) certification, buy specific levels of liability insurance, follow specific sanitation practices, offer broad indemnification, or even do vague things like follow the "highest" food safety practices. These provisions seem innocuous enough. Small breaches fly under the radar and on one cares. But, when bad things happen and bills start to pile up, everyone starts looking around for ways to reduce the damage. Even small breaches can end up leading to large damages. When things are already going wrong, farmers don't need yet another penalty because they didn't follow the terms of a contract. The main point here is that farmers should take care to understand exactly what the contract or agreement requires so that they can follow it properly.

Product is Recalled

When a food safety incident does occur, one of the primary ways to control the outbreak is to recall all the potentially affected products. Recalls are generally very expensive to perform. In addition to the costs of carrying out the recall itself, the farm suffers a loss of reputation, lost revenue from not being able to sell, and if the indemnification dominoes fall, the damage quickly escalates. Farmers should take care that their tracking is narrow enough to order as narrow a recall as necessary. If a farmer is required to perform a recall and cannot, several things may happen. The law may impose a fine. Or, the producer may be forced to destroy all products to be on the safe side.

Insurance is available to protect against the expense of a recall. Generally, farm liability policies do not often cover the losses from performing a recall or losing revenue. Commercial policies are much more likely to cover the broad risks of a recall. However, even commercial policies may only address voluntary recalls and not government ordered ones. A full product liability policy covers the widest breadth of risk from a food safety incident. Many cover product recall expenses, lost revenue, and more. These policies can be quite expensive, though.

Conclusion

As mentioned earlier, we will also be discussing FSMA and other state and federal regulations that can influence food safety considerations. This is brief overview of some of the legal points farmers should keep in mind regarding food safety – please visit farmcommons.org for more information, and always consult an attorney about your unique situation before taking action.

Food Safety Modernization Act Training

FOOD SAFETY MODERNIZATION ACT PRODUCE SAFETY RULE TRAINING

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Introduction

Fruit and vegetables growers and others interested in learning about produce safety, Good Agricultural Practices (GAPs), co-management, and the Food Safety Modernization Act (FSMA) Produce Safety Rule should be interested in this training. The Produce Safety Alliance Grower Training Course is one way to satisfy the FSMA Produce Safety Rule requirement outlined in § 112.22(c) that requires '*At least one supervisor from the farm must complete food safety training at least equivalent to the standardized curriculum recognized by the FDA'.*

What to Expect at the PSA Grower Training Course

This is approximately a seven hour course to cover these seven modules:

- Introduction to Produce Safety
- Worker Health, Hygiene, and Training;
- Soil Amendments
- Wildlife, Domesticated Animals, and Land Use
- Agricultural Water (Part I: Production Water; Part II: Postharvest Water)
- Postharvest Handling and Sanitation
- How to Develop a Farm Food Safety Plan

In addition to learning about produce safety best practices, parts of the FSMA Produce Safety Rule requirements are outlined within each module. There are time for questions and discussion, so participants should come prepared to share their experiences and produce safety questions.

Benefits of Attending the Course

The course provides a foundation of Good Agricultural Practices (GAPs) and co-management information, FSMA Produce Safety Rule requirements, and details on how to develop a farm food safety plan. Individuals who participate in this course are expected to gain a basic understanding of:

- Microorganisms relevant to produce safety and where they may be found on the farm

- How to identify microbial risks, practices that reduce risks, and how to begin implementing produce safety practices on the farm
- Parts of a farm food safety plan and how to begin writing one
- Requirements in the FSMA Produce Safety Rule and how to meet them.

After attending the entire course, participants will be eligible to receive a certificate from the Association of Food and Drug Officials (AFDO) that verifies they have completed the training course. To receive an AFDO certificate, a participant must be present for the entire training and submit the appropriate paperwork and an additional fee of $35.00 to the trainer at the end of the course.

FSMA training vs 3rd party audits

This FSMA training does not take the place of a 3rd party audit. The Food and Drug administration considers this training to be the baseline for food safety. Whether an operation needs a third party audit will be up to your buyer in the wholesale trade.

Training Compliance Dates

Farms that have an annual value of produce sold during the previous three-years of $25,000 or less are exempt from the produce rule and do not need to be trained.

If the farm just grows for commercial processing that adequately reduces the presence of microorganisms the operation may be exempt.

There is a qualified exemption for eligible farms, but the following criteria must be met.

1. The farm must have **food sales** averaging less than $500,000 per year during the previous three years and
2. The farm's sales to qualified end-users must exceed sales to all others combined during the previous three years. In other words at least 51% of your product must be for retail. A qualified end–user is either
    a. (a) the consumer of the food or
    b. (b) a restaurant or retail food establishment that is located in the same state or the same Indian reservation as the farm or not more than 275 miles away.

When the training needs to be completed depends on the size of your operation.

Very small farm – Those with more than $25,000, but no more than $250,000 in average annual produce sales during the previous three year period have four years.

Small farm – Those with more than $250,000, but no more than $500,000 in average annual produce sales during the previous three years period have three years.

All other farms – Two years.

It is hoped that the farms that are exempt will still take advance of the training to be up to date on food safety concerns and how to improve their operations.

Note: The operation must have three years of records to show they meet the criteria for very small farm, small farm or for the qualified exemption. You must start collecting sales records at the latest in January 2016 for small farms and January 2017 for very small farms.

IPM: Know Your Target Before you Shoot

NOTES:

Basil Workshop

BREEDING BASIL FOR RESISTANCE TO DOWNY MILDEW AND FUSARIUM: WHERE ARE WE NOW?

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Recognizing the need for disease resistance, the basil-breeding program at Rutgers evaluated the response of commercial varieties, USDA-NPGS accessions and Rutgers own germplasm to downy mildew and Fusarium in field and greenhouse screening. A range of tolerant and resistant responses to basil downy mildew and Fusarium were identified. Commercial sweet basil cultivars remain susceptible to BDM. Furthermore, sweet basil cultivars and breeding lines previously exhibiting Fusarium resistance were found to be susceptible to several Fusarium isolates. New sources of resistance to Fusarium have been discovered in several RU experimental sweet basil lines and these are being further developed. In an effort to introduce downy mildew resistance to sweet basil, F1 hybrids were generated from cross-pollinations of resistant and tolerant genotypes with marketable sweet basil breeding lines. Although a number of interspecific hybrids demonstrated downy mildew resistance, some crosses between different species results in sterility due to extensive genetic dissimilarity. And, in other cases, resistance was introduced into sweet basil types, yet the resulting progeny lacked the 'look and aroma' of sweet basil. However, a single F1 progeny derived from a cross between downy mildew resistant RU329 and susceptible RU328 parents was identified as fertile. From this, we created the RU329 x RU328 F1 hybrid was used to produce source populations (F2 and backcross), facilitating breeding and genetic studies. Analysis of downy mildew response frequency distributions among generations indicated the utility of this population for resistance breeding. In short, we have shown breeding for BDM resistance is an inheritable trait one can breed for and since then we have created many advanced lines with resistance and which have the sweet basil phenotype (look) and aroma and taste. Our current work seeks to ensure these new advanced lines are genetically stable and this presentation will illustrate some of the latest lines we've been developing.

OCCURRENCE AND IMPACT OF DOWNY MILDEW ON SWEET BASIL IN 2015

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Symptoms of downy mildew in basil.
Affected leaf tissue turns yellow and then brown. A characteristic symptom is the yellow tissue being in bands across the leaf blade delimitated by the leaf veins. This occurs because the pathogen cannot grow through or around large veins. Other affected leaves are more generally yellow because there were multiple infection sites. Affected leaves die after they turn brown and drop off the plant. Key to confirming the yellowing is due to downy mildew is to look for signs of the pathogen (brown sporulation) on the underside of leaves. The best time to look is in the morning because spores are produced during night and will be dispersed during the day. The structures that hold the spores are white and thus not as readily visible as the brown spores. The pathogen begins producing spores before leaves turn yellow, so sometimes spores can be seen on a green leaf. Very rarely spores develop on the top side of leaves and on leaf petioles. Spores also develop on the leafy parts of flowers.

Biology of the pathogen causing downy mildew in basil.
It is important to understand the biology of a pathogen as this knowledge enables selecting cultural practices to manage the disease. The pathogen that causes downy mildew in basil (*Peronospora belbahrii*) has no other known host plants; thus there is no need to be selective about other crops grown nearby.

Peronospora belbahrii can be seed-borne, which is the main source of the pathogen for greenhouse crops grown between outdoor growing seasons (late fall through spring in the northeastern USA). Unfortunately gelatinous exudate from seed when soaking in water precludes treating seed in hot water. Steam is being used instead to manage seed-borne inoculum.

Peronospora belbahrii is an obligate pathogen, which means it cannot survive long in the absence of living plant tissue (leaves or seed), unless it produces oospores, which are its resting, survival spore. Most Oomycete pathogens produce oospores through sexual reproduction that occurs when pathogen strains of opposite mating type grow together. Oospores have only been observed recently in Israel. There have been no indications from patterns of downy mildew occurrence to suggest that the pathogen could be surviving over winter in the USA as oospores; therefore crop rotation is not considered a necessary management practice.

The pathogen makes an abundance of asexually-produced spores (sporangia, the brown spores on the underside of leaves) that can be dispersed long distances by wind. These spores are considered to be the main initial inoculum for field-grown crops and for basil grown in greenhouses during the outdoor growing season. The spores can be moved easily between rooms in a greenhouse complex and can survive at least a few days after their production; therefore good sanitation is needed to prevent spread between greenhouse rooms and before starting another crop following a greenhouse outbreak.

The pathogen does not need leaves to be wet in order to infect; relative humidity above about 85% is adequately favorable. Therefore in a greenhouse it is not sufficient for managing this disease to avoid wetting the leaves when watering plants. Humidity needs to be managed by using fans, lights, and/or bottom heat.

The pathogen needs a period of darkness to produce spores. When plants were grown with lights on during at least the first six hours of night, spores did not form on leaves directly exposed to the light.

Occurrence of basil downy mildew in USA.
Basil downy mildew has been reported in 42 states plus the District of Columbia (see table) since it was first observed in Florida in fall 2007. States where this disease has not yet been reported and/or confirmed are Alaska, Idaho, Nevada, New Mexico, Oklahoma, South Dakota, Utah, and Wyoming. Unknowingly distributing contaminated seed is a plausible way that the pathogen was first introduced into the USA and how it has been spread long distances between geographically-separated areas.

These reports were almost all made to a web-based monitoring page in a Google spreadsheet. It was started in 2009. Links to the pages are at:
http://vegetablemdonline.ppath.cornell.edu/NewsArticles/BasilDowny.html
A total of 49 reports of basil downy mildew were logged in 2009, 63 reports in 2010, 63 reports in 2011, 75 reports in 2012, 64 reports in 2013, 284 reports in 2014, and 281 in 2015. These came from 20, 26, 22, 26, 20, 36, and 34 states, respectively, plus the District of Columbus. Some reports were from outside the USA: Argentina, Australia, Mexico, Baja California, Grand Cayman, Costa Rico, Puerto Rico, Jamaica, Quebec, Ontario, British Columbia, South Africa, and South Korea. Most reports were made by home gardeners, growers and extension specialists of sightings on outdoor plants. Affected plants were also seen in greenhouses. Some reports were not confirmed; most were confirmed through photographs. Several reports received in 2015 were from gardeners who had not seen downy mildew in previous years.

Some growers reported challenges managing downy mildew in 2015. There were crop losses. Gardeners also reported loosing basil to downy mildew.

For more information about downy mildew of basil plus photographs, go to:
http://vegetablemdonline.ppath.cornell.edu/NewsArticles/BasilDowny.html

Years that reports of downy mildew in basil were made from each state and the District of Columbia to the monitoring page.

State	2008	2009	2010	2011	2012	2013	2014	2015
Alaska			? *					
Alabama			X		X		X	X
Arkansas	X		X		X			
Arizona				?				
California		X	X	X	X	X	X	X
Colorado			X	X	X			
Connecticut				X	X	X	X	X
Washington D.C.						X	X	X
Delaware		X	X	X	X		X	X
Florida	X	X	X	X	X	X	X	X
Georgia		X			X		X	X
Hawaii				X	X		X	X
Iowa							X	X
Idaho								
Illinois		X	X	X		X	X	X
Indiana		X		X	X		X	X
Kansas	X			X			X	X
Kentucky			X				X	X
Louisiana			X	X		X	X	X
Massachusetts	X	X	X	X	X	X	X	X
Maryland		X	X	X	X	X	X	X
Maine				X	X	X	X	X
Michigan			?		X		X	X
Minnesota				X	X		X	X
Missouri					X		X	X
Mississippi		X						
Montana			?				X	
North Carolina	X	X	X		X		X	X
North Dakota	?	X	X					
Nebraska							X	
New Hampshire			X		X	X	X	X
New Jersey	X	X	X	X	X	X	X	X
New Mexico								
Nevada								?
New York	X	X	X	X	X	X	X	X
Ohio		X	X			X	X	X
Oklahoma								
Oregon					X			
Pennsylvania		X	X	X	X	X	X	X
Rhode Island				X		X		X
South Carolina		X	X		X	X	X	X
South Dakota								
Tennessee		X				X	X	X
Texas			X	X	X		X	X
Utah								
Virginia		X	X			X	X	X
Vermont		X	X	X	X	X	X	X
Washington				X	X		X	X
Wisconsin		X	X			X	X	X
West Virginia					X	X	X	X
Wyoming								

* Question mark indicates the only report(s) from the state did not have sufficient information to confirm the report. Other reporters either were known to be capable of identifying the disease or provided pictures and/or adequate description to confirm that it was basil downy mildew.

FUNGICIDES FOR MANAGING BASIL DOWNY MILDEW – NEW JERSEY

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Sweet basil (*Ocimum basilicum*) is an economically important fresh culinary herb grown in the United States. In fall of October 2007, a new disease of basil, downy mildew (*Peronospora belbahrii*) was first reported in FL. Since then, basil downy mildew has resulted in significant losses throughout the United States. The epidemiology of the pathogen is still unknown. However, it is believed that the pathogen has spread globally via the shipment of infested seed and through natural weather cycles. Unfortunately, there are currently no effective seed treatments for basil downy mildew.
During the summers of 2010-2014 at the Rutgers Agricultural Research and Extension Center (RAREC) in Bridgeton, NJ, a number of conventional and biological fungicides were evaluated for efficacy in field trials. Our studies over the past 4 years have shown that foliar applications of phosphite products (FRAC code 33) such as K-Phite, Rampart, or Pro-Phyt provide the best season-long control if initiated before the pathogen appears in the region and/or prior to the onset of symptoms. In each year of the study none of the organic fungicides evaluated provided an adequate level of season-long control of basil downy mildew. Results of all trials at RAREC will be discussed in detail. Growers should know the symptoms of basil downy mildew and monitor the field daily. If the pathogen is detected in the region, growers should make frequent protectant fungicide applications before the pathogen enters the field and before symptoms appear.

MANAGING BASIL DOWNY MILDEW - NEW YORK PERSPECTIVE

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Downy mildew can be effectively managed in basil with conventional fungicides applied weekly starting before symptoms are detected. This disease has proven difficult to manage, especially in crops grown organically. A high level of control is needed for fresh-market herb crops to be salable. Inadequate control obtained with organic fungicides is at least partly due to the challenge of obtaining thorough spray deposition on the underside of basil leaves. Resistant varieties providing a high level of suppression are in development. They will be an important management tool, especially for organic producers. The first commercial resistant variety (Eleonora) has not provided sufficient suppression to be used as the sole management tool or in an integrated program with organic fungicides. Basil downy mildew has been occurring regularly in New York, albeit sporadically in some areas, since 2008. Both greenhouse and field-grown crops have been affected. Managing this disease has become a routine part of successful basil production. These statements are based on results from research and observations from commercial plantings.

Results from research conducted in 2015 confirmed previous results. Research on Long Island is being conducted with field-grown plants exposed to naturally-occurring downy mildew. In one experiment, downy mildew was very effectively controlled with programs with conventional fungicides applied weekly (98-100% control). The fungicides in the two programs were Quadris, Revus, Ranman, and Zorvec (only product included not yet registered for this use) or Ridomil and K-Phite. In contrast, the organic fungicide program evaluated was ineffective tested on a susceptible variety, Italian Large Leaf, and a moderately resistant variety, Eleonora. The program was MilStop and Double Nickel applied in alternation with Regalia mixed with Double Nickel and Cueva followed by Trilogy. Applications for the organic program were made twice weekly on a preventive schedule. In another experiment, two new fungicides were evaluated used alone or in programs with Revus and Quadris. They were compared to Quadris alternated with Revus, the copper fungicide Cueva, and Ranman plus K-Phite alternated with Revus plus K-Phite. Only one of the programs was effective. Poor control in this experiment is at least partly due to the spray interval being extended to 13 days due to rain after downy mildew had started to develop. This documents the importance of maintaining a regular application schedule to manage this disease. In a fourth experiment, several biopesticides were evaluated in combination with Cueva applied every third application. The biopesticides were Double Nickel, Oso, Procidic,

Sil-Matrix, Regalia, and an experimental. Applications were made weekly on a preventive schedule until downy mildew was found, then twice weekly. None of the treatments were effective. Two experiments were conducted in 2015 to evaluate basil being developed with resistance to downy mildew. Experimental lines from Rutgers University exhibited excellent resistance and good horticultural characteristics (leaf size, shape and flavor). An experimental hybrid from Enza Zaden USA, Inc. also exhibited excellent resistance. Downy mildew was also suppressed, albeit numerically not as well, in two other experimentals from Enza, Eleonora, and two experimentals from PanAmerican Seed.

A seedling assay was conducted in 2015 to assess whether inadequate spray coverage was a potential explanation for poor control with biopesticides and organic fungicides. Most of these products lack the ability that many conventional fungicides have to move through leaf tissue to the underside where downy mildew develops. Seedlings in pots were dipped in fungicide solutions of the same concentration as was used to spray on plants in field experiments. The seedlings were allowed to dry in the greenhouse overnight, then put in the field next to the experiment plants for three days beginning on 23 Sep before returning to the greenhouse. When the assay seedlings were examined 8 days after they were put in the field, no symptoms were found on any plants treated with Sil-Matrix, Trilogy, Cueva, or the conventional standard fungicide, Revus. There were symptoms on only 1-3 out of 10 plants treated with MBI-110, Regalia, Procidic, and MilStop, 4 plants treated with Oso, while there were 6-8 affected plants for the nontreated control, Actinovate, and Double Nickel treatments. Among these treatments, severity on affected plants was lowest for MBI-110 and Regalia. No symptoms were found on plants treated with Sil-Matrix or Cueva at the second assessment 5 days later. In conclusion, inadequate spray coverage appears to be an explanation for poor control with some products.

Research results and reports are being posted at:
http://livegpath.cals.cornell.edu/research/basil-downy-mildew/

For more information about downy mildew of basil plus photographs, go to:
http://vegetablemdonline.ppath.cornell.edu/NewsArticles/BasilDowny.html

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Before purchase, make sure product is registered in your state. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

NEW PESTICIDE REGISTRATIONS AND UPDATES FOR BASIL DOWNY MILDEW CONTROL FROM RUTGERS IR-4 PROJECT HEADQUARTERS

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Since 1963, the IR-4 Project has been a major resource for supplying pest management tools for specialty crop growers by developing research data to facilitate the registration of pesticides for specialty crops and minor uses in an effort to aid growers.

Recently, the IR-4 Project has been working to facilitate the registration for a number of fungicide products to control basil downy mildew (BDM), caused by *Peronspora belbahrii*. There are currently no commercially available sweet basil cultivars resistant to BDM. Therefore, all sweet basil varieties in the U.S. are at risk from this devastating disease. BDM resistant sweet basil is currently being developed at Rutgers University and their new advanced lines look most promising relative to resistance. Presently, there are only a few conventional fungicides that are registered for control of BDM including cyazofamid (Ranman, FMC Agricultural Products) and mandipropamid (Revus, Syngenta Crop Protection). Other conventional fungicide products including azoxystrobin (Heritage, Syngenta Professional Products;
24c registration for transplants), mefenoxam (Subdue Maxx, Syngenta Professional Products; 24c registration for transplants), and mandipropamid (Micora, Syngenta Crop Protection; 24c registration for transplants) had (have) temporary or state registrations.

Conventional fungicide products currently in the IR-4 registration process include fenamidone (Reason 500 SC, Bayer CropScience), fluopicolide (Presidio, Valent U.S.A. Corporation Agricultural Products), and oxathiapiprolin (Syngenta Crop Protection). All conventional fungicide products mentioned above are proposed for both field and greenhouse use. Estimated date of submission to EPA for all pending projects is January 2016. Registration is expected 15 months after submission to EPA.

Organic Materials Review Institute (OMRI Listed) federally registered fungicide products include *Streptomyces lydicus* (Actinovate AG, Novozymes BioAg Inc.), *Bacillus amyloliquefaciens* strain D747 (Double Nickel 55 and LC, Certis U.S.A.), extract of *Reynoutria sachalinensis* (Regalia, Marrone Bio Innovations), neem oil (Trilogy, Certis U.S.A.), potassium bicarbonate (Milstop, BioWorks Inc.), hydrogen dioxide (Oxidate, BioSafe Systems LLC), and hydrogen dioxide; peroxyacetic acid (Oxidate 2.0, BioSafe Systems LLC).

Biological fungicide products that are not OMRI Listed include mono- and di-potassium salts of phosphorous acid (K-Phite, Plant Food Systems), phosphorous acid, mono- and dipotassium salts (Confine Extra, Winfield Solutions LLC), phosphorous acid, mono- and dibasic sodium, potassium, and ammonium salts (Alude and Phostrol, Nufarm Agricultural Products), potassium bicarbonate (Armicarb 100, Helena Chemical Company), potassium phosphite (Fosphite, JH Biotech, Inc.; Fungi-Phite, Plant Protectants, LLC; Prophyt, Helena Chemical Company; Rampart, Loveland Products, Inc.), a combination of potassium phosphate and potassium phosphite (Phorcephite, Loveland Products, Inc.), sodium tetraborohydrate decahydrate (Prev-Am Ultra ORO Agri, Inc.), hydrogen peroxide, peroxyacetic acid (Rendition, Certis USA LLC), hydrogen peroxide; phosphorous acid; mono- and dipotassium salts (Oxiphos, BioSafe Systems LLC), citric acid (Procidic, Greenspire Global Inc.) and hydrogen peroxide; peroxyacetic acid (Sanidate 12.0, BioSafe Systems, LLC).

Many of these conventional and organic products have been evaluated in efficacy studies in basil production areas of the United States, with varying results.

Some recommendations for management of BDM include initiating a regular fungicide maintenance program prior to arrival of BDM, rotating fungicides with different modes of action (FRAC group), being very careful to ensure that all applications reach the entire undersides of the leaf canopy, purchasing pathogen-free seed (at least requesting this from seed companies), planting less susceptible species or varieties of basil, minimizing leaf wetness and humidity in the plant canopy, harvesting plants before risk of disease is present and reducing or eliminating overhead irrigation.

BREEDING BASIL FOR RESISTANCE TO FUSARIUM: WHERE ARE WE NOW?

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Sweet basil (*Ocimum basilicum*) is one of the most economically important herbs in the world that is favored for its flavor, fragrance, and culinary uses. Since the 2007 introduction of the basil downy mildew (BDM) pathogen, *Peronospora belbahrii*, 100% of the sweet basil acreage in the U.S. has been at risk. In addition, Fusarium wilt caused by *Fusarium oxysporum* f. sp. *basilicum* (FOB), which was first identified in the U.S. in 1990 and had been problematic for growers for many years until seed companies began screening certifying fusarium free basil seed and the industry released a few fusarium resistant/tolerant varieties. However, fusarium is now resurging. Causing wilt, crown and root rot in sweet basil, once a plant becomes infected with FOB, death and crop loss follows. In response to the outbreak of this pathogen during the 1990s, several basil varieties 'tolerant' to FOB were introduced including 'Nufar' and 'Poppy Joe's'. To counter BDM and FOB, one of the most economically feasible strategies is to incorporate resistance to both pathogens into a single sweet basil variety. Inheritance of resistance to BDM was recently characterized in a full sibling family developed from a BDM resistant parent 'MRI' and BDM susceptible parent 'SB22' and shown to be an inheritable. In 2014, FOB screenings revealed that MRI was highly susceptible to the virulent isolate FOB 33 (*Fusarium oxysporum* f. sp. *basilicum*), while SB22 was substantially less susceptible, indicating that the MRI x SB22 family was also appropriate for studying genetic action for tolerance to FOB. In 2015, vegetative cuttings of the MRI x SB22 F2 generation were screened for tolerance to FOB 33. Individuals were rated for disease severity using a disease rating scale. The frequency distribution among individuals of the F2 generation demonstrated a skew toward resistance suggesting dominant gene action conferred by SB22 for FOB tolerance. Chi-square tests were performed to determine goodness-of-fit to expected segregation ratios of multiple hypothesized major gene models. Evidence for goodness-of-fit was identified for the 3:1 and 13:3 gene models, suggesting tolerance from SB22 is controlled by one or two genes. To better elucidate gene action, additional generations of the MRI x SB22 family will need to be screened against FOB 33. This past year we have been culturing virulent lines of fusarium (FOB), have worked out techniques to screen basil and have begun to refocus our efforts in breeding sweet basil for fusarium resistance.

Screenings for genetic resistance to Fusarium wilt for introgression into sweet basil (*Ocimum basilicum*) were conducted during the 2015 season. In one screening, a number of Rutgers chilling tolerant lines and Fusarium resistant lines were inoculated with virulent isolate Rutgers 318 (*Fusarium oxysporum* f. sp. *basilici*). Results were

encouraging for a number of sweet basil chilling tolerant lines and Fusarium resistant lines. In another study, we crossed a fusarium resistant sweet basil with one of our Rutgers sweet basil breeding lines. The F2 population was then inoculated with virulent isolates Rutgers 318 (*Fusarium oxysporum* f. sp. *basilici*) and NJSN1 (*Fusarium oxysporum* f. sp. *basilici*). Of the population screened, only a few plants were susceptible, showing that resistance can be developed from this cross. These preliminary results can aid in the design of appropriate breeding and selection strategies for the development of new FOB resistance in sweet basil and incorporation of FOB resistance into the BDM resistant sweet basil both which are currently being developed at Rutgers University.

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