FY 2012 Specialty Crop Block Grant Program

Maine Department of Agriculture, Conservation and Forestry

Final Report

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Submitted by:

Contact: Jessica Nixon, Director
Market Development
Division of Agricultural Resource Development
Bureau of Agriculture, Food and Rural Resources
Maine Department of Agriculture, Conservation and Forestry

Address: 28 State House Station
Augusta, ME 04333

Phone: (207)287-3494

Email: jessica.l.nixon@maine.gov

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Project 1: The Spotted Wing Drosophila in Maine, Management of a Serious New Invasive Insect Pest of Small Fruit

Final Report

Project Summary

This project was a two-year research and extension/outreach project designed to enhance integrated pest management of the spotted wing drosophila a significant insect pest of wild blueberry in Maine. Research resulted in the development of an optimal baited trap to use for monitoring in Maine's small fruit production systems. The relationship between trap captures and fruit infestation only appeared to be consistent for wild blueberry, but not strawberry, highbush blueberry or raspberry. Effectiveness of insecticides for control of SWD in Maine were evaluated and recommendations to the grower community were developed. Mass trapping and netting of small plantings were evaluated, but only netting was recommended as an effective control measure for small growers. Grower outreach was developed by the creation of a spotted wing drosophila blog and the development and publication of four spotted wing drosophila factsheets and an adult and larval sampling video.
In addition, Extension /outreach presentations at grower field days were used to train growers in the application of these IPM tactics.

Project Approach:

The approach involved both field research and extension communications and presentations. The objectives that comprised the approach are as follows:

*Objective 1: Evaluate preliminary trap and bait method for early SWD detection (crop years 1**(2014)***

a) Conduct "side by side" comparisons of a range of trap designs and baits that have been developed throughout the U.S. and by Dr. Dill and Dr. Frank Drummond in Maine.

Objective 1a. Conduct "side by side" comparisons of a range of trap designs and baits that have been developed throughout the U.S. and by Dr. Dill and Dr. Frank Drummond in Maine.

Experiment #1. Attractiveness of baits to spotted-wing drosophila (Downeast, ME).

METHODS:

This trial was part of a regional/national spotted-wing drosophila (SWD) trapping experiment designed to compare available SWD baits and/or lures using unified methodology over a range of crops, regions, season, and environmental conditions. Only the results for lowbush blueberry are presented in this report. There were six replications (Blocks) of each of six baits. Traps within a block were placed 30 ft apart with 100 ft between the blocks. Each trap consisted of a 32 fl. oz clear plastic cup hung ca. 2 ft above the crop canopy from a wooden post. Traps were placed along the edge of a fruit-bearing field in Stockton Springs, ME on 3 Jul and checked and baits changed weekly. At each weekly trap check, the position of the traps within a block was rotated to the adjacent position to reduce position effects. The Trece® lures included in treatments 5 and 6 are commercial lures in development in the US and were suspended from the lid over the drowning solutions, not placed in the solutions and were changed bi-weekly. Treatment 3 (a trapping system developed in the Northeastern US) required the addition of a 4 oz specimen cup with mesh glued into the lid to exclude fly entry. Treatment 4 is a bait developed in Europe. In order to minimize potential differences in attraction due to head space, 150 ml of each liquid or drowning solution was used per trap. Data collected included – male and female SWD per trap and non-SWD drosophilids per trap.

Table 1. Composition of bait solutions.

1. Apple cider vinegar + unscented soap (4 ml/gal)
2. Yeast and sugar bait (2 tbsp yeast + 8 tbsp sugar + 24 fl oz water + 0.76 ml unscented soap)
3. Fermenting bait (69 g whole wheat flour + 100 ml water + 8 sugar + 4 ml apple cider vinegar + 1.3 g yeast); bait in specimen cup with mesh lid + drowning solution (apple cider vinegar + unscented soap)
4. DroskiDrink (450 ml Apple cider vinegar +150 ml red wine +12 g Muscovado sugar)
5. Trece lure suspended over apple cider vinegar + unscented soap
6. Trece lure suspended over drowning solution (600 ml water + 6 g Borax + 0.24 ml unscented soap)

RESULTS:

A Repeated-Measures ANOVA with "treatment" being the between subject factor, "block" the subject factor, and "date" the within-subject factor, was used to analyze the data. Analysis of the SWD data included only the last four collection dates of the trial beginning on 7 Aug. The results are given in figures 1 (SWD) and 2 (non-SWD). For SWD trapping, a tmt X date interaction was found to be significant ($F_{(15,51)} = 4.77$, $P < 0.0001$). Inspecting Figure 1 it can be seen that the interaction involves apple cider vinegar being relatively attractive early (13 Aug), but less so 20 and 27 Aug. In addition, the yeast/sugar bait becomes more and more attractive compared to the other baits over time. The fermenting bait also increases in attractiveness to SWD, but not in a comparable way to the yeast/sugar bait.

Fig. 1. Bar graph showing mean SWD adults per treatment over each sample date. Lines are standard errors of the mean.

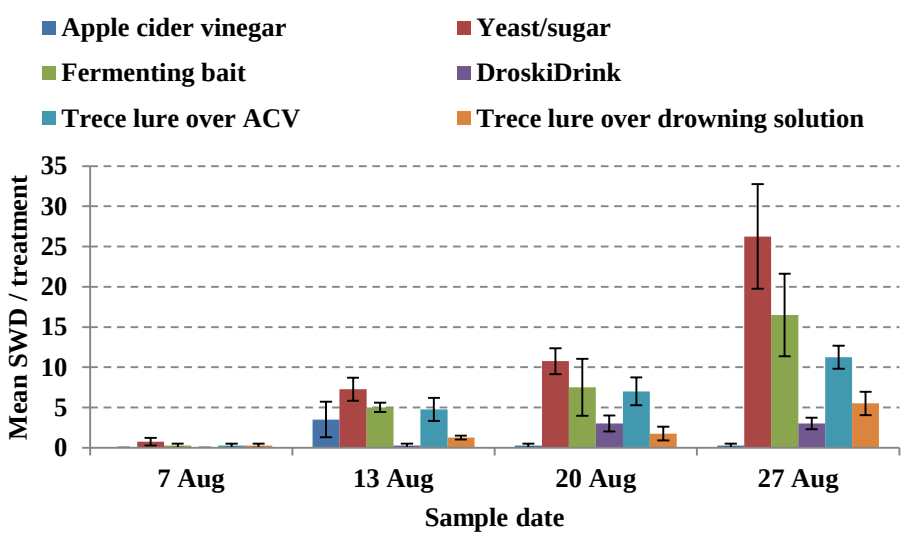
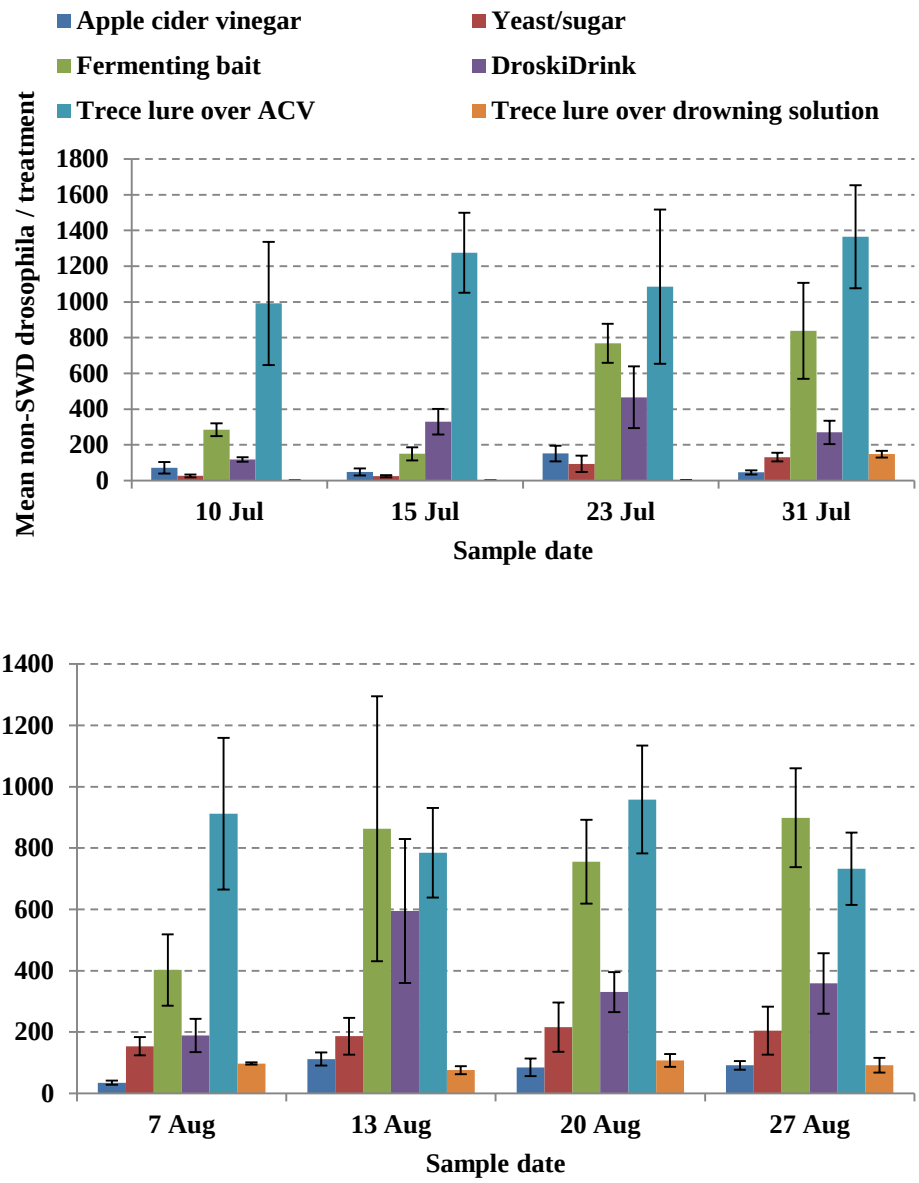


Fig. 2. Bar graph showing mean non-SWD adults per treatment over each sample date. Lines are standard errors of the mean.



The non-SWD trap captures also demonstrated a tmt X date interaction $F_{(35,112)} = 2.24$, $P = 0.0008$)(Fig. 2). This can be explained by the season long attractiveness by the Trece lure in relation to the increasing attractiveness of the fermenting bait over the season. By far the best baits for non-SWD are the Trece lure hung over apple cider vinegar and the fermenting bait.

CONCLUSIONS:

This bait trial was conducted to determine if a more efficient bait could be found for monitoring SWD and at the same time to find a bait that reduced capture of non-SWD drosophila that could be confused with SWD. The bait that has already been adopted by our research lab, the yeast/sugar bait was confirmed as being the best available bait for SWD captures AND for reducing non-SWD. Our recommendation for 2014 is for growers to use the yeast/sugar bait in the red Solo® cup.

Experiment #2. Attractiveness to baits of Spotted-wing drosophila (Downeast, ME).

This study was conducted to collect preliminary observations on SWD bait attraction and use these findings to determine the potential methods of capture that prevent fruit infestation and minimize ecologically invasive methods of control.

METHODS:

This study was conducted on Blueberry Hill Farm, Jonesboro, ME. Traps consisted of red, plastic, 16-oz. cups numbered 1-36. There were three trials with 12 traps per trial; each trap had holes punched down three equally spaced lines until about two inches from the bottom of the cup. Holes were about a half centimeter in diameter. Half of the traps had a black ring painted around the rim; baits used were either water or an apple cider vinegar/ethanol solution, alone or in combination with a yeast solution to produce three different treatments with four traps per treatment. For each treatment, one black painted and one unpainted red cup was set with a yellow sticky card hung from the lid. The apple cider vinegar solution was a combination of 90% apple cider vinegar and 10% ethanol with a drop of unscented dish detergent. The yeast mixture was 355 ml of water, 16 ml of apple cider vinegar, 4 tbsp. of whole wheat flour, 4 tbsp. of white sugar and 1 tbsp. of yeast. Traps containing the apple cider vinegar solution were filled with about an inch of the mixture. Traps containing the yeast mixture in combination with the apple cider vinegar solution had an additional, yeast-containing miniature cup within the larger red cup. These smaller cups were sealed with fine mesh tops in order to allow sufficient diffusion of the attractant while also preventing insects from crawling into the yeast mixture.

Beginning in mid-Aug the numbered traps were hung from a fence along the edge of a pruned-year field. Traps were placed in order of bait contents (i.e, all cups with water, all cups with vinegar solution only and all cups containing vinegar solution with yeast mixture). Individual cups were spaced out approximately 30 feet apart along the fence. SWD collections from cups were made at 4 to 10 day intervals for this 6 week experiment. Fresh baits were re-applied before resetting the cups on the fence in their original positions. All non-spotted wing arthropods were disregarded; SWD male, female and total abundances were determined and recorded. MANOVA was used to assess trap type, bait, and presence of sticky card and all of the interactions over time (weekly sampling). ANOVA was used to assess total trap capture over the season.

RESULTS:

Throughout the experiment, there was a notable preference for traps containing both the yeast and vinegar solutions as opposed to the vinegar solution alone; SWD were not attracted to traps containing only water. The results of the six week collections can be observed in Table 1. For each week of collection, the recorded number of SWD males and females found in traps with the designated mixture were summed from all three trials. The number of captured flies was almost always higher in the yeast containing cups, with exceptions in collections on 23 Aug and 4 Sep.

Multiple analysis of variance (MANOVA) provided evidence to suggest only a bait effect ($F_{(2,22)}$ = 7.758, P = 0.003), a time effect on SWD captures ($F_{(1.7,37.4)}$ = 6.154, P = 0.007), and a bait X time effect ($F_{(3.4,37.4)}$ = 4.052, P = 0.019). The interaction of bait X time suggests that as the season progressed SWD was more and more attracted to the most attractive bait, the combined ethanol, apple cider vinegar, and yeast. The analysis of variance (ANOVA) on total SWD throughout the entire season showed that bait was the only significant effect explaining trap captures ($F_{(2,28)}$ = 9.003, P = 0.001). A Tukey LS means HSD test provided evidence that the combined ethanol, apple cider vinegar, and yeast was significantly more attractive (43.2 SWD / trap) than water (0.02 SWD / trap) and the ethanol, apple cider vinegar (9.75 SWD / trap), which were not different from one another.

Table 2. SWD collection results. Males and females were counted separately. Abbreviations are as follows: VA = Cider vinegar + Ethanol solution (90%/10%); y = Yeast mixture; R = Red cup; Rb = Red cup with black painted rim; s = Yellow sticky card.

	16-Aug	23-Aug	31-Aug	4-Sep	14-Sep	21-Sep
	M/F/Total	M/F/Total	M/F/Total	M/F/Total	M/F/Total	M/F/Total
Bait: Water						
R	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
R+s	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
Rb	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
Rb+s	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
Bait: VA						
R	0/3/3	0/2/2	4/8/12	12/22/34	9/11/20	55/44/99
R+s	3/3/6	3/1/4	3/5/8	10/26/36	23/44/67	35/42/77
Rb	2/5/7	1/1/2	1/6/7	14/18/32	6/29/35	50/65/115
Rb+s	0/0/0	1/3/4	0/1/1	12/15/27	10/25/35	34/35/69
Bait:VA+y						
R	6/1/7	3/2/5	6/11/17	13/10/23	16/74/90	326/642/968
R+s	5/1/6	7/7/14	12/10/22	24/32/56	33/80/113	191/151/342
Rb	3/11/14	0/1/1	10/13/23	17/34/51	75/192/167	213/384/597
Rb+s	6/8/14	2/6/8	6/7/13	19/37/56	41/66/107	161/136/297

CONCLUSION:

This study shows that there is a preference of SWD for yeast-containing baits over those that do not have any yeast. There is no clear preference of red cups or red and black striped cups, nor do the data suggest that the yellow sticky cards have an effect on fly capture early in the season. For future evaluations of bait preference, it could be advantageous to deploy traps at different heights and to employ solid baits as well as liquid baits since several growers have complained about the use of liquid baits. The sticky card captures were consistent with timing of male SWD trap captures in the liquid bait portion of the combined traps. This suggests that sticky cards CAN BE USED to monitor FIRST trap capture of male SWD. This may offer growers an easier template for identification of SWD, although, sticky cards have their own problems for identification. The orientation of the fly on a sticky card is not always optimal for identification of females, males will be less of an issue regarding this constraint.

<u>Experiment #3. Attractiveness to baits of Spotted-wing drosophila (Central, ME).</u>

This experiment was performed to collect information on SWD trap configuration and bait attraction in order to determine potential SWD monitoring techniques for fruit growers.

METHODS:

This study was conducted on Rogers Farm in Old Town, ME and consisted of three trials with 12 experimental traps per trial. The first trial was placed in a 1-acre mixed field of raspberries and highbush blueberries (age of plants – approximately 5 years). The second trial was placed along a woods-line adjacent to hay fields and a clover field. The third trial was placed in a 1-acre field of highbush blueberries (age of plants – approximately 15 years). Traps consisted of red, plastic, 16-oz. cups with

holes punched down 6 equally spaced lines until about two inches from the bottom of the cup. Holes were about a half centimeter in diameter. Half of the traps were painted with a 1-inch, black ring around the rim. Three separate bait treatments were used, including water, an apple cider vinegar/ethanol mixture, and an apple cider vinegar/ethanol/yeast combination. The apple cider vinegar solution was a combination of 90% apple cider vinegar and 10% ethanol with a drop of unscented dish detergent. The yeast mixture consisted of 355 ml of water, 16 ml of apple cider vinegar, 4 tbsp. of whole wheat flour, 4 tbsp. of white sugar, and 1 tbsp. of yeast. For each of the three bait treatments, four distinct trap configurations were used; a red cup with bait treatment, a red/black cup with bait treatment, a red cup with a yellow sticky card and bait treatment, and a red/black cup with a yellow sticky card and bait treatment. For the water treatment, each cup was filled with approximately an inch of water. For the apple cider vinegar/ethanol treatment, each cup was filled with approximately an inch of the vinegar/ethanol solution. For the apple cider vinegar/ethanol/yeast treatment, each cup was filled with approximately an inch of vinegar/ethanol solution and a small plastic cup with the yeast mixture was floated atop the vinegar/ethanol solution. These smaller cups were sealed with fine mesh tops to prevent mixing of the vinegar/ethanol solution and the yeast bait, while also preventing insects from crawling into the yeast mixture.

The traps were deployed in late June in each of the three trial sites at Rogers Farm. Trap stations, consisting of a wooden stake 3-feet in height with a metal cup holder, were placed throughout the trial sites approximately 50 feet apart. The 12 traps were placed randomly throughout each trial site. SWD trap collections were made at 7 day intervals with fresh baits and sticky cards being reapplied before resetting the traps in their original positions. SWD males on the yellow sticky cards were tallied and recorded. Total SWD in the bait was then determined and recorded for each trap. All non-SWD arthropods were disregarded. As this study is currently ongoing (as of November 2013), statistical analysis of the data has not been conducted.

RESULTS:

Though this experiment is still in progress, some information regarding trap configuration and bait attraction can be gleaned from looking at the preliminary data. SWD began appearing in the traps in during the second week of August. SWD were not attracted to traps containing only water. Not a single SWD has been found in the water bait treatments thus far. While SWD were readily found in traps containing the vinegar/ethanol solution, it appears that the SWD preferred traps containing both the vinegar ethanol solution and the yeast combination. See Table 3 for total trap counts up to this point.

Table 3. Total SWD count (August 13 – November 5)

SPOTTED WING DROSOPHILA COUNT (TOTAL)

BAIT	TRAP	NEW BLUEBERRIES (REP 1)			WOODS (REP 2)			OLD BLUEBERRIES (REP 3)			TOTAL
		Males on Yellow Card	Total SWD in Bait	Total SWD in Trap	Males on Yellow Card	Total SWD in Bait	Total SWD in Trap	Males on Yellow Card	Total SWD in Bait	Total SWD in Trap	
WATER	RED		0	0		0	0		0	0	0
WATER	RED + YELLOW	0	0	0	0	0	0	0	0	0	0
WATER	RED/BLACK		0	0		0	0		0	0	0
WATER	RED/BLACK/YELLOW	0	0	0	0	0	0	0	0	0	0
CIDER/ALCOHOL	RED		253	253		1313	1313		79	79	1645
CIDER/ALCOHOL	RED + YELLOW	201	273	474	358	604	962	29	44	73	1509
CIDER/ALCOHOL	RED/BLACK		1113	1113		447	447		82	82	1642
CIDER/ALCOHOL	RED/BLACK/YELLOW	236	388	624	201	333	534	5	29	34	1192
CIDER/ALCOHOL/YEAST	RED		572	572		1188	1188		236	236	1996
CIDER/ALCOHOL/YEAST	RED + YELLOW	197	357	554	1461	2115	3576	46	79	125	4255
CIDER/ALCOHOL/YEAST	RED/BLACK		502	502		2091	2091		162	162	2755
CIDER/ALCOHOL/YEAST	RED/BLACK/YELLOW	990	1364	2354	623	632	1255	50	82	132	3741
	TOTAL	1624	4822	**6446**	2643	8723	**11366**	130	793	**923**	**18735**

<u>Objective 1 b</u>. Determine the relationship between first and subsequent SWD trap captures and occurrence and severity of fruit damage in raspberries, strawberries; highbush, wild blueberry.

<u>Experiment 1. Influence of production system on spotted-wing drosophila abundance.</u>

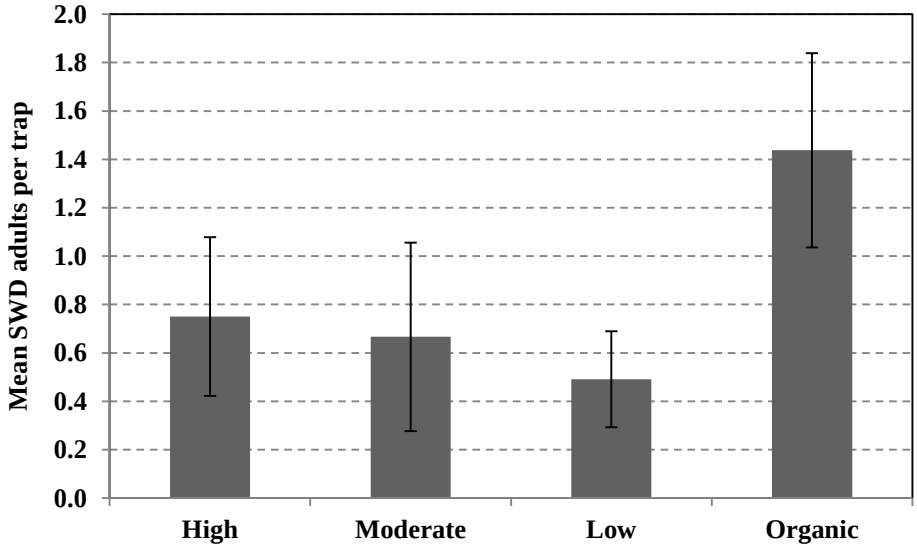
METHODS:

Beginning on 3 or 5 Jul and continuing through Aug, one trap was set in each block per 16 blueberry fields (2 traps at each farm) and monitored ca. weekly for the presence of SWD adults. Two additional traps were set on 5 Jul at Blueberry Hill Farm for a total of 17 farms sampled. Traps were constructed from Solo®, 16 fl. oz, red polystyrene cups with clear lids. Seven to 10, 3/16-inch holes were punched on the side of each container near the top, evenly spaced around the rim. Bait consisted of live yeast (1 tbsp.) + sugar (4 tbsp.) + 12 oz water (makes enough for 4 traps). The traps were hung 1-2 ft above the top of the canopy using 36' plant stands. On each sample date, traps set from the previous week were collected and returned to the laboratory where male, female, and total abundance of SWD were determined and recorded. Using this data we calculated the mean SWD per trap captured from each site between 9 or 10 Jul and 13 Aug (n = 10 or 12 sample dates).

RESULTS:

Figure 3 shows the effect of production system on adult SWD captures. Although there appears to be a trend towards more SWD in organically managed fields, the difference was not significant (ANOVA, CRD, $P = 0.2651$). This does not take into account the effect of any insecticide applications. Information on applications is still being collected.

Fig. 3. Bar graph showing SWD adult abundance from 9 or 10 Jul until 13 Aug. Lines are standard error of the mean.



<u>Experiment 2. Relationship between adult SWD and maggot infestation of berries.</u>

METHODS:

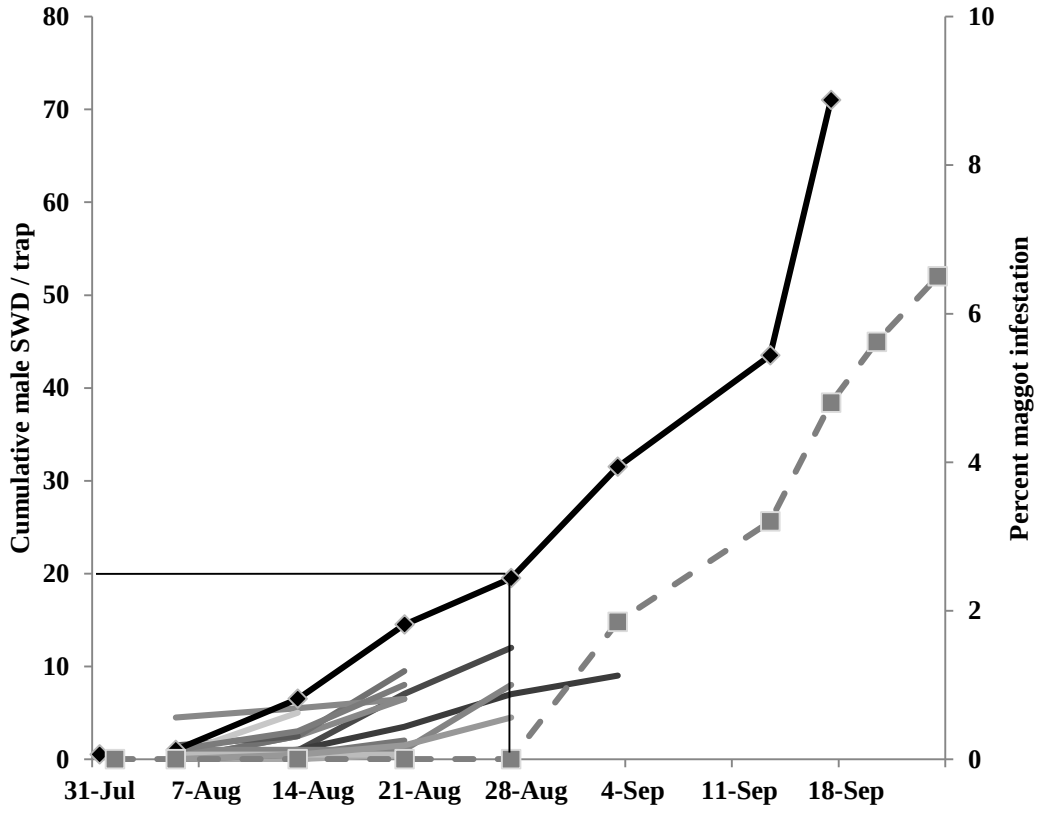
To compare adult abundance with fruit infestation, samples were taken from the on various dates from late Jul until early Sep and processed for larval infestation using the Salt Extraction Method. Each

sample consisted of 2 or 3: 2/3 cup fruit taken from each block per site as well as from an organic field in Cherryfield, and from Blueberry Hill Farm. There were ca. 359 berries per 2/3 cup sample.

RESULTS:

A comparison of SWD male abundance and percent fruit infestation is shown in Figure 4. It appears from this data that one can wait until 20 cumulative male SWD captures / trap before getting any larval infestation. This level was only reached at one of 18 sites.

Fig. 4. Comparison of SWD male abundance and percent fruit infestation (dashed line is maggot infestation and solid lines reflect SWD adult captures).



CONCLUSIONS:

In 2012, we found no significant difference in SWD populations among production systems. In 2013, the pattern appears to be the same; although, some of the higher populations were from organic fields. This may be due to the intensive insecticide control program that was implemented in many of the conventional blueberry farms.

The data assessing action thresholds is certainly preliminary, but in 2013, it appears that trap captures of up to 20 cumulative male SWD can be tolerated before maggot infestation begins to be detected. In the next several years we will continue to refine the action threshold. However, it certainly appears that a threshold of a single fly is on the conservative side. **THIS IS A MAJOR FINDING. THE RESULTS NEED TO BE VALIDATED IN 2014, HOWEVER, IF AN ACTION THRESHOLD OF THIS MAGNITUDE CAN BE SAFELY RECOMMENDED IT WILL PROVIDE GROWERS WITH AN IMPORTANT TOOL FOR MANAGING SWD.**

Experiment 3. Relationship between adult SWD and maggot infestation of berries.

We have also initiated an applied research project in a high tunnel at the Maine Agricultural Experiment Station in Monmouth. 'Autumn Britten' raspberries were planted in 3 gallon pots and grown and placed in 20 plants plots in the tunnel. Treatments were as follows:

1. Control
2. Protek 80 fabric placed over plants
3. Yeast/vinegar traps placed within plots
4. Weekly insecticide sprays.

Data is still being collected and analyzed, but fly populations in the tunnel have been very low.

Objective 2: Begin to develop the IPM program for SWD by researching and evaluating the following ***(2014);***

Objective 2a. Effective insecticides for SWD management

Experiment #4. Field Insecticide Efficacy Study.

METHODS:

In both 2013 and 2014 Each plot measured 14 x 60-ft (four replicates of each treatment). There were two applications (9 and 17 Sep). Each material was applied in 25 gallons of water-mixture per acre with a CO_2-propelled, 80-inch boom sprayer (76-inch swath) equipped with four, flat-spray 8002VS TeeJet® nozzles operating at 35 psi and at a slow walking speed. Speed was regulated using a metronome. On the dates indicated in the table three fruit samples were taken from each plot. Each sample was approximately 2/3 cup or an average of 359 berries. The average number of berries was determined by counting the number of berries in each of four samples. Sample #2 (17 Sep) was collected prior to the second application. No evidence of phytotoxicity was observed in any plot.

RESULTS:

We found in 2013 that several of the standard insecticides gave 7-day protection to the fruit. These insecticides were Delegate, Mustang Max, Malathion, and Cyazypyr. Insecticides that only gave 3 days protection were Assail, and Entrust (organically approved). The biorational mixture of Azaguard (neem) and Oxidate (hydrogen peroxide), which is also organically approved) gave 3-day control when populations were low, but failed when SWD pressure became high. The length of the protection is important, as many growers need to know when they have to reapply insecticides if harvest is postponed during the growing season. Non-insecticide controls were also evaluated.

In 2014 we observed similar results to that in 2013. The biorational mixture of Azaguard (neem) and Oxidate (hydrogen peroxide), which is also organically approved) gave 3-day control when populations were low, but failed when SWD pressure became high. We also found that the insecticides Delegate, Mustang Max, Success and Imidan all gave 7 day protection to lowbush blueberry fruit.

Also, in the 2014 season, growers using insecticides to control spotted wing drosophila in highbush blueberry and raspberry found that weekly sprays appeared to provide adequate control when populations remained relatively low (0-10 flies/per week). However, as fly populations expanded, growers found that twice-weekly sprays were needed to keep larvae out of the fruit. Growers used Entrust®, Delegate®, Brigade®, Bifenthrin®, Hero®, Mustang Max®, and/or malathion insecticides, and most found that these products usually offered adequate control if applied on a frequent basis. Growers who did not apply pesticides saw near total crop loss, following the arrival of spotted wing drosophila in their fields.

CONCLUSIONS:

Insecticides that appear to offer 7-8 day protection are Mustang Max, Malathion 8 F, cyazypyr (HGW86 10 SE), and Delegate 30 WG. Assail 30 SG and Entrust SC provided good control for 3-4 days, but increased maggot infestation resulted by 7-8 days. The combination of the fungicide OxiDate 2.0 and Azaguard did not provide effective control during either trial. As fly pressure increased during the second trial, Oxidate and Azaguard resulted in maggot infestation not different from the non-treated checks, both at 3 days and 7 days after application. This study is **COMPLETE.** We have a very good understanding of the insecticides that give long-term protection under Maine summer and early fall weather conditions and we have a tested database that can be used to provide recommendations to growers who need to protect their crop from SWD damage prior to harvest.

Objective 2b. Field edge or perimeter insecticide application strategy

1) Crop sanitation and early harvest tactics

2) Mass trapping of adult SWD

3) Netting of small plantings

Experiment #5, Sanitation or early harvest.

METHODS:

A mensurative experiment was conducted in 2014 that followed the course of 12 blueberry fields in SWD fly population buildup (assessed by yeast/sugar syrup traps), fruit infestation (assessed by the salt method), and harvest date. The purpose of this study was to determine the role that “Early Harvest” has on reducing damage to SWD in lowbush blueberry.

RESULTS:

We found that since the lowbush blueberry industry started harvesting early in 2013, most of the threat of damage can be averted by this management tactic. In fact all fields observed averted damage due to infestation by early harvest. In 2013, Early Harvest also averted significant damage, although some fields in the southern portion of the state did experience significant SWD damage.

CONCLUSION:

Early Harvest is an effective means of reducing fruit damage due to SWD infestation. However, it must be considered that this tactic does not necessarily eliminate yield loss, but just minimizes the likelihood of harvesting infested fruit that might be rejected if shipped to overseas’ markets. The yield loss resulting from Early Harvest, in in the form of a higher proportion of green berries that might have become ripe if left in the field longer. The Early Harvest portion of this Study is **COMPLETE.** However, the crop sanitation effect of subsequent infestation in raspberry will be conducted in 2015 by Dr. Handley.

Experiment #6. Mass trapping of Adult SWD.

METHODS:

Trials in both 2013 and 2014 were conducted to determine the efficacy of trapping out SWD. A single paired field plot study was setout at the University of Maine in 2013 and a replicated study was designed in 2014. In 2013 a single density of traps (12 / field) was deployed in one field plot (30 x 30 ft study plots) and a second control field had no cups deployed into it. We found that larval infestation of fruit was cut by 50% in 2013. On 27-Aug 2014, twelve 30x30 ft. study grids were set up in blueberry crops located in Jonesboro, ME. Three replicates for each treatment were assembled with three different trap densities at 3, 6 and 10 ft. of spacing between traps. All the grids of each replicate were grouped together in the same crop section and positioned at a minimum of 30 ft. from one another.

Each trap consisted of a red 16 oz. cup positioned on a 2 ½ ft. tall post. Experimental traps were filled with approximately 2 inches of liquid bait made of yeast, sugar and water with 1 tbsp. yeast: 4 tbsp. sugar: 12 oz. of water. Each trap also had a light exclusion lid in order to prevent excessive fermentation of the yeast bait. Control grids consisted of lids on red cups filled with water instead of bait, and control traps received 6 ft. of spacing. In addition, the external surface of each experimental trap was sprayed with a mixture of 10 grams boric acid per liter 25% (*w/v*) sucrose/water solution. All traps were replaced weekly and sprayed, with three traps from each grid collected to serve as sub samples. Sampled traps were taken back to the lab where male, female and total abundance of SWD adults was recorded.

Samples of blueberries were gathered weekly from random areas inside each study grid. Each blueberry sample was weighed, then crushed in a plastic bag and placed in a 10% saline solution. Crushed samples were allowed to sit in solution for roughly 30 minutes to induce disassociation of SWD larvae from the fruit pulp. SWD larvae were then filtered from the pulp and counted in a metal tray with water.

RESULTS:

In 2013, we found that by trapping intensively within a plot of lowbush blueberry we decreased the maggot infestation by 50%. In 2014 we did not find any evidence that mass trapping reduced infestation in mass trapped blueberry plots. We did find that flies responded to trap density within plots. The higher trap number within a plot resulted in higher numbers of flies in the plots and higher trap capture. However, the higher attraction of plots with more traps did not translate into a higher maggot infestation of fruit. This suggests that while mass trapping can attract in flies, the traps do kill a high proportion of flies so that infestation does not increase.

CONCLUSION:

Currently, these results do NOT suggest a mass-trapping tactic will work for lowbush blueberry growers unless additional killing of flies not captured by the traps is incorporated. **There we plan on assessing a trap AND kill strategy in 2015 by adding a low level insecticide application,** such as the biorational mixture of Azaguard (neem) and Oxidate (hydrogen peroxide).

<u>Experiment #7. Netting of small-sized plots of crop.</u>

METHODS:

Exclusion netting was evaluated during the summer of 2014 to determine its effectiveness in preventing infestation of fruit by spotted wing drosophila. Anti-Insect Netting, (25 Mesh – 13’ wide x 50’ long) was placed in two fruit-bearing wild blueberry fields at Jonesboro, ME. One replication in time was set on 9 Jul and the second on 18 July. Fruit was just beginning to ripen. Red cups with standard yeast/bait solution were placed in each trial area to monitor for the presence of SWD adults. Fruit samples were taken periodically to determine the beginning of the fruit infestation period. On 17 Sep the exclusion netting was removed and within each of five blocks within each time replication, five fruit samples were taken from areas protected by the netting and paired areas not protected by any netting. Each sample was ca. 2/3 cup of ripe fruit. The fruit was processed to determine maggot infestation using the Salt Extraction Method.

RESULTS:

We found no difference in yield between the two treatments, but a significant difference in fruit infestation, 5.7% (control) vs. 0% (netted plots).

CONCLUSION:

Of the three non-insecticide tactics evaluated, early harvest and netting appear to have promise for SWD control. Mass trapping did not. Early harvest combined with adult fly trapping and thresholds will be the preferred management tactics in lowbush blueberry for conventional growers. This can result in the near elimination of insecticide applications. Organic growers who traditionally harvest throughout the entire summer and into the fall may not be able to adopt this technique. This study is **COMPLETE** , except the economics of the netting tactic will have to be determined by obtaining estimates of the number of seasons that the netting can be used.

Extension / Outreach

Much time and effort was spent in 2014 to help growers prepare for SWD and to manage it in their fields. The following are a list of activities conducted:

A. State-wide Trapping Network network. In 2013 and 2014, the first spotted wing drosophila were caught in southern Maine in mid to late July. With the exception of trapping sites in Warren and Bowdoinham, captures were very low, just a few flies per trap, and scattered, most sites having no flies, until the third week of August. At this point we began catching low numbers of flies at nearly all locations, including Wells, Limington, Limerick, Springvale, Cape Elizabeth, New Gloucester, Poland Spring, Mechanic Falls, Wales, Livermore, Bowdoinham, and Dresden. Traps in wild blueberry fields in Hancock and Washington counties were also catching flies at this point, but also in low numbers. By the end of August, our Monmouth, Farmington and Oxford sites had also captured flies. Trap captures generally remained low (0 to 20 flies/trap) with occasional small flare-ups (20 to 100 flies/trap) until the first week of September. At that point numbers rose fairly consistently in nearly all locations, with weekly trap counts ranging from just a few flies to nearly 1,000 (much lower catches in 2014). Raspberry and blueberry fruit infested with the small white larvae were being reported. The highest numbers of flies continued to be found in the most southern and coastal sites. By the end of October many sites were catching flies well into the thousands (many hundreds in 2014) while some caught only a few flies. At this point flies were readily visible around ripe fruit in many fields and larvae were found infesting most of the fruit in any plantings that had not been sprayed. At the end of the season we found that a trap maintained for us by a grower in Caribou had caught three flies. Therefore, SWD has now spread to almost all of the fruit growing regions in Maine.

B. Grower Presentations:

1) Drummond, F. 2013. Spotted Wing Drosophila Ecology and Management. 2013. Blueberry Summer Field Day Workshop. University of Maine Blueberry Hill Farm, Jonesboro, ME. July, 2013.
2) Collins, J. and F. Drummond. 2014. Spotted Wing Drosophila Management in Wild Blueberry. Maine Agricultural Trade Show. Augusta, Maine. January, 2014.
3) Drummond, F. 2014. Biology and Management of the Spotted Wing Drosophila. Spring Blueberry School. Ellsworth, Waldoboro, and Jonesboro, ME. March, 2014.
4) Drummond, F. 2014. Spotted Wing Drosophila Management Update and Identification Workshop. Blueberry Summer Field Day Workshop. University of Maine Blueberry Hill Farm, Jonesboro, ME. July, 2014.

C. Blogs and Newsletters:

5) Many updates through blogs and newsletters… http://umaine.edu/highmoor/blog/tag/spotted-wing-drosophila/, http://umaine.edu/blueberries/blog/ AND http://umaine.edu/highmoor/spotted-wing-drosophila/.

D. Several updated SWD Fact Sheets were produced:

6) NEW Spotted Wing Drosophila wild blueberry management insecticide options were included in the SWD Label fact Sheet (F. Drummond and D. Yarborough): http://umaine.edu/blueberries/factsheets/insects/insect-control-labels/.

7) Insects - 210-Spotted Wing Drosophila: Pest Biology and IPM Recommendations for Wild Blueberries (F. Drummond and D. Yarborough): http://umaine.edu/blueberries/factsheets/insects/210-spotted-wing-drosophila/

8) Insects - Spotted Wing Drosophila Traps (F. Drummond and D. Yarborough): http://umaine.edu/blueberries/factsheets/insects/spotted-wing-drosophila-traps/

9) Insects - Spotted Wing Drosophila Update (F. Drummond and D. Yarborough

Goals and Outcomes Achieved:

All of our objectives were met. The results of our research were integrated into an overall IPM program for spotted wing drosophila, although more field studies need to be conducted to determine the consistency of thresholds based upon cumulative male fly captures. The monitoring program for SWD program is outlined in several Maine SWD management fact sheets, currently available to wild blueberry growers both as a hard copy (available from Dr. David Yarborough, University of Maine Cooperative Extension) and an electronic download from the University of Maine Cooperative Extension Wild Blueberry Web pages http://umaine.edu/blueberries/factsheets/insects/210-spotted-wing-drosophila/ and http://umaine.edu/blueberries/factsheets/insects/spotted-wing-drosophila-traps/. Similar factsheets and information for strawberry, highbush blueberry and raspberry growers are available as a blog: http://umaine.edu/highmoor/spotted-wing-drosophila/ and a factsheet: http://umaine.edu/home-and-garden-ipm/frequent-specimens/frequent-fruit-flies/

The detailed timeline of our accomplishments are below:

1) Side by side trap design and bait evaluation, July – October 2014 – **COMPLETED and Published**
2) Determine relationship between adult SWD trap capture and fruit damage – July – October 2014 and 2015 – **COMPLETED**
3) Determined the effect of crop sanitation on SWD infestations following year – October – October 2014 & 2015 – **COMPLETED**
4) Mass trapping study October 2013 & 2014 – **COMPLETED**
5) Netting Study – July – October 2014 & 2015 – **COMPLETED**
6) Development of SWD Blog site (Dr. Handley) and factsheets and videos for grower outreach October 2013 – October 2015 (Dr. Drummond and Dr. Handley) **– COMPLETED**
   http://umaine.edu/blueberries/factsheets/insects/210-spotted-wing-drosophila/ and
   http://umaine.edu/blueberries/factsheets/insects/spotted-wing-drosophila-traps/.
   http://umaine.edu/blueberries/factsheets/production/wild-blueberry-videos/ and
   http://umaine.edu/highmoor/spotted-wing-drosophila/
7) presentation of the results for 2013-2015, to the Wild Blueberry Advisory Committee (WBAC): *November 2015* - **COMPLETED**
8) final report to Maine Department of Agriculture: November 10, 2015 **COMPLETED**

Beneficiaries:

The Maine wild blueberry, highbush blueberry, strawberry, and raspberry grower community were the identified stakeholders in this project. There are approximately 500 Maine wild blueberry growers and almost 400 other small fruit growers. These groups farm throughout the state of Maine, although the wild blueberry growers are located mostly in Washington County (ca. 70%). The median age is about 60 years old and about 30% are full-time growers. Most growers are conventionally based growers that practice IPM (80%) and almost 20% are

organic. Eighty percent of the growers are male, but 40% farm with a spouse. Most of the growers are white, although the Passamaquoddy tribe owns and farms a substantial amount of land (ca. 2,000 acres). Rose et al. (2010) describes in much more detail the Maine wild blueberry grower target audience.

Lessons Learned:

1) We learned that baited traps have many drawbacks. The most effective trap is the red solo® cup without question. However, the bait chosen for the trap matters. We found that sugar syrup and yeast was much more attractive than apple cider vinegar or other commercial baits. However, sugar syrup and yeast is very difficult to use and difficult to see flies in the liquid bait. Therefore, it is tempting for growers to use the easier to handle and inspect apple cider vinegar, but the attraction to SWD adults is an order of magnitude less at some times of the year.

2) We also learned that SWD recruitment to a crop and resulting infestation depends upon the crop. The only crop that we found a consistent relationship between trap capture of adult flies and subsequent fruit damage was in wild blueberry. We selected male flies to use as the proxy or measure of SWD population level because males are easily identified by growers, whereas, female adult SWD require a high degree of expertise. Over a three year period it was found that a level of 10 cumulative trap captures of male SWD would, on average, proceed the onset of damage (maggot infestation) in a wild blueberry field by one week. However, if a grower wanted to be sure that there was a 90% chance that the field would not have detectable damage, then the threshold would drop to 3 cumulative male trap captures. If the grower wanted to be sure that there was a 99% chance that the field would not have damage, then the threshold for harvest or insecticide treatment is 1 male fly.

3) We found that the effectiveness of insecticides results in a very limited set of options for organic growers, with only formulated spinosyns offering any control under moderate to high SWD pressure and formulated azadirachtin providing some control at low SWD pressure. Conventional growers have several spinsyns, organophosphates, pyrethroid, and neonicotinoid insecticides. However, as mentioned in our factsheet, some of these insecticides such as malathion only provide 3 days of control where as others such as Delegate or Imidan provide 7 days of control. Adding table sugar at 1 lb per acre can enhance the activity of these insecticides.

4) Lastly, we found that alternative methods of control are few and most not effective. Sanitation is much too labor intensive and requires a large proportion of infested fruit to be destroyed. However, winnow piles, commonly found in hand harvested wild blueberry fields can concentrate the SWD infestation and when in piles do not take much labor to dispose. Mass trapping is not effective even at the rate of a trap every 10 ft in a square grid throughout a field. We did see an increasing reduction in flies and maggot infested fruit with an increasing density of traps for trapping out the population, but the reduction in fruit damage was never at a level that would be acceptable to commercial fruit growers. Netting was very effective. When properly timed, just prior to fruit ripening, fruit infestation was reduced to almost zero. The question that remains is not so much if it will work, but more if netting that is economical can be obtained by the grower. We plan, in the future, to investigate the economics of netting since it is a control tactic that is suitable for many small growers that do not want to or are not able to apply insecticides.

Contact Person:

Dr. Francis A. Drummond, School of Biology and Ecology and Cooperative Extension, University of Maine, 305 Deering Hall, Orono, ME 04469, phone: (207) 581-2989, email: frank.drummond@umit.maine.edu

Additional Information:

As in the initial development and deployment of most insect IPM programs, our program for the sustainable management of the spotted wing drosophila in Maine is new. The experience of growers who adopt these tactics will be used to continually adapt and modify the tactics over the next several years where needed.

Project 2: Integrated Pest Management to Address Weed Control Resistance in the Maine Wild Blueberry Crop

Final Report - Revised

PROJECT SUMMARY

The use of a principal herbicide hexazinone to control weeds, with few effective herbicide alternatives, has resulted in less effectiveness and more shift in weed types resulting in poor weed control and loss in production. Herbicide resistance has been slow to occur because of the two year crop cycle that allows herbicide use principally in the non-crop year or prune year but after 40 years of using a single herbicide mode of action herbicide resistance is occurring. Identification and testing of new herbicides with different modes of action are needed to maintain weed control and prevent substantial, if not complete, crop loss.

Wild blueberry growers in Maine have reported weeds, particularly grasses in their fields are not responding to current IPM control practices. In recent decades growers have been relying too heavily on one previously effective control material. Because custom harvesters move between Canada and Maine, there is a high potential for introduction of weed seeds that are resistant to current control into Maine wild blueberry fields. Researchers have documented this weed control resistance in Canadian wild blueberry fields. Growers need control options to address how to control resistant weeds and education programs to learn how to use the new control options. The next crucial step is to implement resistance management practices to avoid similar and continuing problems into the future.

Implementing an effective IPM weed control program requires multiple control options in different herbicide groupings. Herbicides with similar modes of action are identified by a group number with the same mode of action. Rotating between groups will prevent weed resistance from developing from similar chemistry's that have a specific mode of action. For growers to effectively implement weed IPM they need the control options from different groups that are effective in controlling the resistant species, weed identification and mapping techniques, and an understanding of resistant management.

Wild blueberry yields have increased from an average of 20 to 90 million pounds a year over the past 40 years, largely because good weed management which has allowed the use of greater fertility, pollination and irrigation as well as maintaining good disease and insect pest controls. If the weeds are not effectively controlled then all other inputs will not maintain the increase in production. Prevention of weed resistance is essential to maintaining and improving the productivity of the wild blueberry industry in Maine.

In order to achieve this goal, experiments to evaluate herbicides with different modes of action that will effectively control the resistant weed species need to be conducted. The results of these studies will be used to educate growers on resistant weed management including rotating or combining herbicides to provide effective weed control. This practice will prevent yield reduction from competition of uncontrolled weeds.

This research has not been conducted under a previous SCGBP project.

PROJECT APPROACH

Work Plan (WP) had two objectives: First is to survey wild blueberry grower's use of herbicides and identify weeds which are developing resistance to current control strategies. A grower survey was conducted during the crop season to collect baseline data for development of an IPM program upon completion of this project. Second is to evaluate herbicides with different modes of action that will effectively control the resistant weed species.

Activities Performed (AP)

On first objective
Results from a clicker survey given at the annual wild blueberry grower's field day in July 2013 indicated that 89% of the growers had seen resistant weeds and only 8% had not known about resistant weeds. Changes in practices include 43% have scouted rotated or combined herbicides and used cultural practices; of the remainder 16% scouted and rotated herbicides, 7% just used cultural practices, 21% just rotated herbicides and 14% just scouted for weeds.

On the second objective
Experiments that were conducted to evaluate timing and combinations of herbicides with new modes of action (details of these experiments were provided in the 2013 and 2014 annual reports) include;

- Evaluation of herbicides for control of fine leaf sheep fescue for grass control in wild blueberries
- Velpar by Matrix pre and post-emergence applications - demonstration plots
- Evaluation of three pre-emergence herbicides alone and in combination with Velpar or Sinbar for effects on wild blueberry productivity and weed control
- Post-harvest control of red sorrel in a non-crop blueberry field

GOALS AND OUTCOMES ACHIEVED

For the first objective, growers were informed of how to identify weed resistance and how to identify and use herbicides with different modes of action. Growers were also informed about the use of cultural management, including the use of sulfur and cutting woody weeds over time to reduce weed competition and thereby increase yields. Presentations on weed resistance identification and measures to determine and reduce weed completion to improve yields were made at the Agricultural Trade Show in Augusta in January, at a winter meeting at Blueberry Hill Farm in Jonesboro and at the Wild Blueberry Spring meetings in Waldoboro, Ellsworth and Machias in March, at ICM scouting sessions in Warren, Orland and Jonesboro in May and June and at the annual wild blueberry growers field day in July. The 2014 Wild Blueberry Pesticide Charts were updated with new herbicides including the AI/Group numbers needed to manage for weed resistance.

The experiments listed in the Activities Performed for the second objective yielded some significant results. We determined from the study of the herbicides registered for use on wild blueberry as well as currently unregistered herbicides evaluated for control of fine leaf sheep fescue and other weeds, as well as injury to blueberry that of the following:

1. Kerb (pronamide applied post-pruning in fall and pre-emergence in spring.
2. Sinbar (terbacil) + Direx (diuron) + Velpar (hexazinone) ="Trimix",
3. Matrix (rimsulfuron) and Lorox (linuron) were also applied pre-emergence, and
4. Arrow (clethodim) and Option (foramsulfuron) were applied twice post-emergence.

Fall pronamide application resulted in the highest blueberry cover. Linuron and foramsulfuron had significantly higher initial phytotoxicity but overall levels were not unacceptably high, and the plants grew out of it with the exception of minor phytotoxicity in August in the linuron treatment. The Trimix was most effective on broadleaf weeds, while foramsulfuron was the least effective. Fall pronamide was also significantly and consistently most effective in controlling fine leaf sheep fescue over time while rimsulfuron closely followed. Clethodim and linuron were consistently ineffective.

In conclusion, fall application of pronamide and pre-emergence application of rimsulfuron controlled fine leaf sheep fescue, and Trimix could be effective with low fine leaf sheep fescue pressure. Clethodim, linuron, foramsulfuron and spring application of pronamide were not effective control options under sheep fescue and/or broadleaf weed pressure. Since hexazinone and terbacil are Group 5 herbicides, pronamide is in Group 3 and rimsulfuron is in Group 2, the use of these herbicides will prevent the development of resistant grasses. The results from the rimsulfuron were significant in that the pronamide must be applied in the fall when temperatures are below 50F and rain or irrigation is needed shortly after application to be effective. This treatment also costs more than $200/a, whereas the rimsulfuron may be applied in the spring as a tank mix and costs $40/a for the application. So a more effective, less costly material was found to control fine leaf sheep fescue.

Rimsulfuron was labeled for use on wild blueberries in 2012 but there was little information on what weeds were controlled and how it would perform in combination with existing herbicides, so three demonstration plots were established to evaluate the effect of rimsulfuron with or without hexazinone on wild blueberry cover, phytotoxicity and on broadleaf and grass weed cover. Broadleaf cover was reduced most by the 4 oz/a rimsulfuron treatments with or without hexazinone. Grass cover was reduced with the 4 oz/a of rimsulfuron and was lower with 2 oz/a rimsulfuron with 1 lb/a of hexazinone than it was with 2 lb/a of hexazinone. Because rimsulfuron is a Group 2 herbicide, the use of this herbicide pre or early postemegence will prevent the development of resistant grasses and broadleaf weeds in wild blueberry fields.

We continued to assess three new herbicides for efficacy in weed control and effects on blueberry growth and yield. A trial was set up on nine sites with different soil conditions and weeds to determine the effects of pre-emergence applications of indaziflam, halosulfuron methyl or rimsulfuron on wild blueberry cover/injury and weed cover, alone and combined with hexazinone or terbacil, in a split block experimental design with location serving as replication. The growers' spray regimens with and without halosulfuron methyl was also included. Including the untreated check provided for a total of 14 treatments. An additional location was treated with indaziflam, halosulfuron methyl and rimsulfuron in the fall and hexazinone and terbacil were applied at right angles in the spring to compare the effects of these three new herbicides when applied in the fall after pruning.

Indaziflam or rimsulfuron, alone or in combination with hexazinone or terbacil, did not reduce wild blueberry cover or result in appreciable phytotoxicity. Halosulfuron methyl, alone or in combination, did show an initial stunting and delay in growth, but the plants recovered fully over the growing season.

The growers' spray regimen alone, halosulfuron methyl alone, and the combination had an effect in suppressing broadleaf weeds over the long-term, as did hexazinone, indaziflam+hexazinone, halosulfuron methyl+hexazinone, indaziflam+terbacil and rimsulfuron+terbacil.

Grasses were initially controlled by halosulfuron methyl+hexazinone, terbacil, indaziflam+terbacil and rimsulfuron+terbacil but only rimsulfuron+terbacil continued to control grasses later in the season and all of the terbacil combinations continued to maintain grass cover about 5% or below.

Applying indaziflam, rimsulfuron and halosulfuron methyl in the fall improved long term blueberry cover overall, as well as reduced early halosulfuron methyl phytotoxicity. Fall application improved broadleaf weed control in general compared to spring application when combined with spring hexazinone. Grass control was improved by fall application of indaziflam with spring hexazinone, and to a lesser extent halosulfuron methyl+hexazinone and halosulfuron methyl+terbacil grass control improved as well when compared to halosulfuron methyl applied in spring.

Nine new locations have been established to evaluate more sites for the fall application of indaziflam, halosulfuron methyl or rimsulfuron, alone and combined with spring application of hexazinone or terbacil in in order to reduce any phytotoxicity from the indaziflam, halosulfuron methyl or rimsulfuron, and improve the efficacy of hexazinone or terbacil

by allowing for a later spring application of these two herbicides. In addition, we will also evaluate isoxaben which was recently registered for blueberries and has a group number 21, which is different than all the others but we have no data on phytotoxicity or efficacy on weeds found in wild blueberry fields.

Results from these studies will be used to develop the labels for halosulfuron-methyl and indaziflam so that wild blueberry growers will have herbicides with different modes of action to prevent weed resistance.

BENEFICARIES

Maine's 510 wild blueberry growers and six grower/processors will receive tremendous benefits from the results of the research efforts to study to develop appropriate lower risk control measures for resistant grasses and broadleaf weeds for Maine's 60,000 acres of wild blueberries. Without effective management, the five year average annual yield loss due to herbicide resistance would be a 50% crop loss. The wild blueberry industry loss is estimated at 42.1 million pounds annually or a potential loss of about $29.6 million in farm gate revenue a year to Maine's wild blueberry growers (5 yr. USDA-NASS average production and price per #).

The public will benefit from production practices that allow growers to produce wild blueberries at an affordable price and volume so that consumers will be able to afford to eat more healthy wild blueberries. The benefits of a healthier society are incalculable.

LESSONS LEARNED

Matrix (rimsulfuron) herbicide was identified in being effective to control the resistant grass fine leaf sheep fescue with better reliability and less cost than the alternatives. However, there is a potential for herbicide injury with late applications of some of the new herbicides we evaluated and others as they are identified, so more testing with fall or earlier spring applications of these herbicides and others as they are identified need to be conducted to determine the best fit for these weed control materials.

CONTACT PERSON

Dr. David Yarborough, Telephone: 207-581-2923 Email: Davidy@Maine.edu

ADDITIONAL INFORMATION

Identification of modes of action of registered herbicides may be found at:

http://umaine.edu/blueberries/files/2010/05/2014-ME-Wild-Blueberry-Pesticide-Chart-Herbicides.pdf

Weed identification information available for growers on the wild blueberry web site at:

http://umaine.edu/blueberries/factsheets/weeds/blueberry-weed-images/

Project 3: Maine Potato Integrated Pest Management Proposal FY 2013

Final Report – Previously Accepted

PROJECT SUMMARY

The $500 million potato industry is the largest agricultural sector in Maine. The management of insects, diseases, weeds, and other pests is integral in sustaining a healthy Maine potato crop. Without reliable and sustainable pest management strategies, Maine's potato industry faces the potential of severe crop losses resulting in significant reductions in profits and threats to long-term viability. The current market demand for perfect, pest and damage-free produce and crops, combined with the public's desire to decrease pesticide use for human health and environmental reasons, comes at a time when Maine potato growers face ever increasing production costs and pest pressure. Potato growers are increasingly relying on a multidisciplinary Integrated Pest Management (IPM) approach to ensure that Maine's potato crop is pest and damage free while attempting to minimize the amount of pesticides that are applied.

The increasing number of emerging pests and diseases in Maine, including potato mop-top virus, potato wart (a quarantinable pest), necrotic strains of potato virus Y (PVY), white mold, nematodes, and new strains of potato late blight, indicate a significant need for research and educational outreach. In order to mitigate the risks associated with existing and emerging potato pests, a close and direct connection between growers and the University of Maine Cooperative Extension Potato Integrated Pest Management (IPM) Program is vital. Through this project, information gathered through multiple sources, including direct observation, trapping, weather data, and predictive modeling, was delivered to stakeholders in Maine and throughout the region via electronic and standard newsletters, websites, and telephone message centers. The data produced continues to help IPM scientists track potential pest outbreaks and provides growers with current information on specific and timely treatments in order to minimize the number of pesticide applications and maximize potato yield. This project builds upon previous project funding from the Specialty Crop Block Grant Program (SCBGP) that have allowed for continuation of University of Maine Cooperative Extension's potato pest monitoring and research efforts.

PROJECT APPROACH

Staff involved:
James Dwyer, Crops Specialist, University of Maine Cooperative Extension
James Dill, Pest Management Specialist, University of Maine Cooperative Extension
Griffin Dill, IPM Professional, University of Maine Cooperative Extension
Steve Johnson, Crops Specialist/Plant Pathologist, University of Maine Cooperative Extension
Bruce Watt, Disease Diagnostician, University of Maine Cooperative Extension Sean McAuley, Scientific Technician, University of Maine Cooperative Extension Meghan Dill, Administrative Assistant, University of Maine Cooperative Extension Donald Flannery, Maine Potato Board
Tim Hobbs, Maine Potato Board
Fourteen seasonal program aides

Activities Performed:
In cooperation with the Maine Potato Board, University of Maine Cooperative Extension implemented a comprehensive integrated pest management program for potato growers. Fourteen seasonal program aides surveyed 70 potato fields on a weekly basis during the growing season. These fields were located in the potato producing areas of northern and central Maine. Information from the surveying effort was communicated to

the Potato Industry via a weekly newsletter, a website and a telephone hotline. During the growing season, monthly meetings were held with the field and technical staff of local companies, which provide service to potato growers.

A special program was held for field workers to identify Potato Virus Y and Potato leaf Roll Virus symptoms. This "Roguing School" was targeted towards field workers who surveyed fields for diseased plants. A Potato Pest Management Conference was held in December to update technical field staff and growers on the latest potato pest management research from the University of Maine.

Project Results

For the 2013 crop season the University of Maine Cooperative Extension's Potato IPM program:

- Monitored: 70 potato fields on a regular basis.
- Operated: 50 Heliothis style pheromone traps for European corn
- Operated: 60 sticky type pheromone traps for European corn borer.
- Operated: 70 yellow pan water traps for aphid collection.
- Operated: 8 pheromone traps for Black cutworm detection.
- Operated: 5 Black light traps for European corn borer

Client contacts made:

- 2500 individual personal grower contacts, May through September.
- A weekly newsletter with current regional pest updates was emailed to approximately 375 industry staff in Maine, New Brunswick and Eastern United States. 9 issues were written.
- Three issues of Spudlines, a periodic newsletter regarding pertinent potato pest/crop management matters, was distributed to a mailing list of approximately 780 individuals.
- Pest information was posted on www.mainepotatoipm.com
- Pest information was posted on a telephone hotline which received 1920 calls June through September.

Cooperation:

- Maine Potato Board hosted six monthly meetings for the field and technical staff of companies and agency staff that work with potato growers to get the latest information on pest issues.
- Seventy grower cooperators directly participated in the program by having field scouts survey their farms.
- Consultants brought disease and insect samples to the Presque Isle Cooperative Extension office and the Pest Management Office in Orono for identification.

Monitored Chain Retailer Stores:

- Plant material capable of hosting potato late blight was monitored at chain retailer stores in northern and central Maine. Stores were monitored on a weekly basis. In 2009 potato late blight was detected at multiple big box stores throughout the state of Maine. The infected plant material was being sold and distributed throughout the state. No potato late blight was detected at these stores in 2013, however, green peach aphid were found on green pepper seedlings. The Maine Dept. of Agriculture interceded to rectify the problem.

Trained at Potato IPM Scout School:

- Trained Twenty individuals who included chemical sales staff, on farm employees, consultants and others. Training included information on:

1. Potato Late Blight identification
2. aphid identification

3. European corn borer identification
4. Colorado potato beetle identification
5. secondary pest identification
6. economic thresholds
7. scouting techniques
8. insect models for Maine producers
9. disease models for Maine producers

Trained at Potato Pest Management Conference:

- 125 individuals attended the 2013 Maine Potato Pest Management Conference, which updated growers and technical staff on the latest pest management research information, which included:

1. Aphid collection results and management strategies
2. PVY survey and results
3. Update on insecticide control studies
4. Update on potato storage diseases
5. Update from the Maine Board of Pesticides Control
6. Slug Issues and Management
7. Late blight update

Trained at Maine Potato Conference:

- 250 individuals attended the January 2013 Maine Potato Conference, which provided growers, technical staff, and potato industry personnel with information regarding:

1. PVY management
2. Potato late blight management
3. Detection and management of wireworms
4. Detection and management of aphids

GOALS AND OUTCOMES ACHIEVED

A primary goal of this project was to effectively identify and respond to the insect, weed, and plant disease issues facing Maine's potato growers. Through the intensive monitoring program and subsequent educational outreach (via informational websites, hotlines, newsletters, conferences, and grower meetings) associated with this project, potato pest issues were effectively managed, ultimately resulting in a multimillion dollar economic impact on Maine's potato industry (as described in the BENEFICIARIES section).

Another primary goal of the project was to increase implementation of IPM among potato growers. Each year the University of Maine Cooperative Extension brings together Potato IPM program participants, technical service representatives and early adopter growers for the annual Potato Pest Management Conference. The goal of the conference is review pest issues of the previous growing season as addressed by the Industry and the Potato IPM program as well as to bring the latest research information on potato pest management strategies to the Industry.

A written evaluation was completed by the participants. Eight percent of the participants felt the because of the program they were better able to make better pest management decisions that created an impact of between $500 and $1000. Two percent of the participants felt the information would create and influence of between $1000 and $2000; Eight percent between $2000 and $5000. Twenty-four percent of the participants felt that the information gained from the program would create greater than a $5000 impact within their farming operation. This equates to program participants indicating that increasing their knowledge base could have a potential

$668,000 positive impact on the Maine Potato Industry from better decision making as a result of this program. A review of the Potato IPM program was also provided to the Aroostook County Extension Association.

Through the educational outreach associated with this project, additional objectives including an increase in grower awareness of potato pest issues, increased grower knowledge of pesticide risks, and minimization of pesticide use through the implementation of IPM practices, were achieved.

BENEFICIARIES

The beneficiaries of this project include all of Maine's 400 commercial potato growers and their approximately 59,000 acres of potatoes, national and international growers who rely on Maine's seed potato crop, hobby farmers and backyard gardeners, as well as a multitude of researchers and industry personnel who utilize the information generated from this project.

Economic Impact:

- 14 seasonal program aides were provided with summer employment.

- During the 2013 growing season in Maine potatoes colonizing aphid populations were very low for most of the season, but in August colonizing aphid populations rose significantly. Non-colonizing aphid populations were very active during the entire growing season. The Potato Industry was alerted to this activity. Some seed growers utilized stylet oil, a non-traditional insecticide because non-colonizing aphids are capable of transmitting Potato Virus Y and traditional insecticides do not prevent these aphids from transmitting virus. It is too early to determine economic impact for the aphid work this year.

- In 2013 European corn borer populations were lower than in past years and 11% of the farms monitored exceeded economic threshold levels for European corn borer.

- 57,000 acres X 11% (number of farms exceeding threshold levels) = the number of acres potentially impacted. 6,160 acres

- 6,160 acres X 275 cwt/a X $8/cwt X 10 % potential yield loss = **$1,355,200 loss avoided.**

- Colorado potato beetles: Thirteen farms exceeded economic threshold levels for Colorado Potato beetles:
  57,000 acres X 18% of farms exceeding threshold = 10,260 acres potentially impacted

- 10,260 acres X 275 cwt X $8/cwt X 10% potential yield loss = **$2,257,200 losses avoided**

Economic impact from the insect monitoring aspect of the program for the 2013 season is currently being estimated at $3,612,400, an approximately 27 to 1 return on investment.

LESSONS LEARNED

As a result of this project, the changing nature of potato pest dynamics has become more evident to the project staff. The emergence of new pest threats as well as the ever changing weather variables forces project staff,

growers, and potato industry personnel to adapt pest management techniques to a rapidly evolving system. Weather and changes in pest profiles present a challenge when implementing a crop pest management system. New strains of potato late blight have been introduced into the state of Maine. These new strains have differences in how they react to the weather and their sensitivity to some fungicides. Late season rains were conducive to increased slug populations and some growers realized 5% or greater damage to their tubers.

The issue of non-persistent virus transmission and non-colonizing aphids is a topic on which more research is needed. New strains of potato virus Y have been introduced into North America, which can cause an internal necrosis in potato tubers. These new virus strains have the potential to cause a significant negative impact for seed, table and processing producers.

The European corn borer population in the northern part of the state of Maine appears to be different from the population in central and southern Maine. In the northern area, there appears to be a strain difference, therefore a combination of pheromone traps and black light traps are utilized. Black light trapping is highly effective, but very costly and very time consuming.

Rain events make keeping regular field monitoring schedules impossible at times. Adapting to weather events is one of the challenges which any field based program encounters.

There is an anticipation that IPM programs will always reduce pesticide usage, due to changing weather and pest pressures, sometimes pesticide usage is reduced and sometimes the usage is increased in order to maintain produce quality. The utilization of an IPM approach in potato cultivation remains popular and continues to increase in use.

CONTACT PERSON

Don Flannery, Executive Director
Maine Potato Board
744 Main Street, Suite 1 (207) 769-5061 flannery@mainepotatoes.com

Project 4: Using an Orchard Platform to Increase Pruning and Harvest Labor Effectiveness and Efficiency

Final Report – Previously Accepted

PROJECT SUMMARY

Orchard platforms eliminate the need for ladders and are expected to increase the efficiency of orchard tasks such as harvesting, fruit thinning and pruning. However, the high cost of platforms prevents growers from evaluating them under conditions that exist in Maine apple orchards. We tested an ORSI platform designed for use on hilly terrain and in snow. The ORSI platform increased labor efficiency for orchard tasks of hand thinning fruit, installing a trellis and training trees to a trellis. It did not increase harvest labor efficiency in traditional training systems. It was designed for "fruiting wall" systems which have not reached bearing age in Maine. It was also not effective for dormant pruning since the snow depth in Maine frequently exceeded the tire capability for most of the pruning season.

Labor remains a limitation for orchard profitability due to its high cost and scarcity. Apple growers in Maine are increasingly planting dwarf trees which are adaptable to the use of orchard platforms. This project provided much needed information on the best use of new labor-saving platforms and where they are not expected to be cost effective.

PROJECT APPROACH

Apple trees were pruned using a mechanical hedger to adapt tree shape to better accommodate the platform. The tree training system normally used with platforms relies on annual mechanical pruning with follow-up hand pruning every three years. The ORSI orchard platform arrived in Maine and was used for tree training. A safety plan was devised for its use in orchards. Based on this, the weight limit created inefficiencies for harvesting since only one full bin of apples could be on the platform at one time. A harvest trailer designed to hold three apple bins was designed and built to have an adjustable height for uneven terrain and to adjust to the height of the platform.

Harvest measurements were conducted at Ricker Hill Orchards and Highmoor Farm using a standard harvest crew in both locations. Comparisons were made between a ladder-equipped ground crew and the platform. A ground crew without ladders picked the lower limbs of trees. This was followed by the platform crew on the ORSI to harvest the upper limbs of trees. The traditional crew with ladders picked both upper and lower limbs. The time required to pick one 21-bushel bin of apples, the time needed to unload full bins and replace with empties, as well as, the time to change trailers were measured in both systems. As a result of these harvest measurement, some inefficiencies were identified when the orchard platform was used in these orchards.

In 2014, the orchard was tested for pruning, but was ineffective because the snow depth exceeded the tire capacity. During summer, the platform was used for tree training and fruit thinning. The time required to perform these tasks was compared with labor requirements of a traditional crew from the previous seasons as measured by the manager of Ricker Hill Orchards. The platform was used for harvesting apples in 2014, but modifications were not made to reduce time needed for apple bin transfer, so no increase in labor efficiency occurred. In addition, gaps in the bearing surface had not yet filled in and continued to reduce efficiency.

The number of bushels picked by one man in one hour was 14.6 for the traditional crew with ladders and one tractor driver. This time includes the need for one tractor driver per six-man crew. Using the ORSI, one man harvested 10.9 bushels per hour, with a three-man crew and one driver. When harvesting the lower limbs, the fastest picking times were achieved, and this was 16.8 bushels per hour. Since the ORSI and other platforms were intended for harvesting trees without using ladders, lower limbs are harvested first without ladders or the use of the platform. Moreover, the height of the platforms is too high for harvesting lower limbs. The combined average of the ORSI platform and harvesting the lower limbs was 13.8 bushels per hour.

The slower picking time with the ORSI platform was due in part to extra time needed to load and unload bins. The time needed to unload a full bin from the platform to a trailer was on the average 2.9 minutes compared to less than 30 seconds with a traditional ground crew. For the ORSI, this bin switching time ranged from 1.5 to 4 minutes, so improvements can be achieved. The average time per bushel was 8 seconds. The ORSI was connected to a trailer that held bins full of apples. After three bins were loaded, a time of 6 minutes was needed to unload these full bins onto another trailer. No apple picking could be done while this occurred, and this added to the inefficiency at a rate of about 6 seconds per bushel. The combined bin unloading and replacing time was on the average 14 seconds per bushel for the platform crew compared to 1 second per bushel for the traditional ground crew. We conclude that this aspect of using the ORSI contributes to harvest inefficiency.

Additional inefficiency resulted from time wasted when the platform passed spaces where trees had died or when the ORSI was used to harvest semidwarf trees which have a wider tree spacing. This resulted in one or two members of the crew not picking apples while they waited for the third to finish. This aspect of the harvest contributed the greatest inefficiency. The number of bushels picked per hour for one person of the ORSI platform ranged from 9 to 13.5. By increasing the platform speed and reducing the time needed to switch bins, the rate could be increased to 15 bushels per hour in these orchards.

The ORSI platforms did not achieve expected harvest labor efficiency in the apple orchards used in this project. In this study, the platforms were used in orchards with the vertical axe training system which has trees spaced farther than six feet within the row. Use of the ORSI in vertical axe systems should be altered to adjust for the larger number of gaps compared to the tall spindle system. A

simple adjustment in the speed of the platform as it moves down the row may increase labor efficiency. The ORSI platform can be more efficient than the standard ground crew if the harvest time per bin is reduced to less than 28 minutes and the time to switch bins is reduced to less than 1.5 minutes.

The platform was tested for pruning in snow, but failed to work when snow depth exceeded 6 inches. For much of the winter, the ORSI platform was not useful in Maine. The deep snow of northern New England reduces the usefulness of platforms for labor efficiency.

The platform increased labor efficiency of hand thinning fruit, tree training and trellis installation. The use of the platform for fruit thinning allowed workers to remove fruit from tree tops where too many fruit occurred. This increased fruit size and grower returns. The platform was used to train trees from a traditional vertical axe to a fruiting wall. Measurements of the time required to perform these tasks were not done since a traditional crew was not available for comparison. However, labor efficiency was estimated to be increased by 20%.

GOALS AND OUTCOMES ACHIEVED

We measured harvest and pruning times of the orchard platform and found it to be inefficient at these two tasks which are the most labor intensive in an apple orchard. The grower-cooperator also used the platform for other orchard tasks of tree training and fruit thinning for which it was found to be more efficient than a non-platform labor force. A goal was to determine the cost effectiveness of the platform. It was found to be inefficient at the two tasks that require the most labor, and that pruning and training modifications could not be accomplished during the two-year period of the project.

BENEFICIARES

The beneficiaries of this project are 40 growers in Maine and other producers in New England that rely on hired labor to harvest apples. This information is useful to growers who are considering the purchase of a platform, and who are installing orchards that are designed for their use.

LESSONS LEARNED

The orchard platform was not cost effective in dwarf orchards as they exist today. However, it was able to maneuver through orchards with uneven terrain unlike older models that the grower had been using. During the project, new lower-cost platforms became available that may be as effective as the ORSI in Maine's orchards. Information was gathered on how to prune and train new orchards in a way that will increase the effectiveness of the platform.

CONTACT PERSON

Renae Moran, (207) 933-2100; rmoran@maine.edu
Additional Information: A similar study was performed in Ontario with similar conclusions as the Maine study. http://www.omafra.gov.on.ca/english/crops/hort/news/orchnews/2014/on-1214a2.htm

Project 5: Supporting Maine Specialty Crop Producers with Good Agricultural Practice and Good Handling Practice (GAP/GHP) Audit Preparation; Produce GAP's Harmonized Audit Preparation, and Assistance with Other Third Party Food Safety Audits

Final Report – Previously Accepted

Project Summary

Maine has 1572 Specialty Crop farms (NASS 2012) and averages approximately 106 Food Safety GAP audits per year. AgMatters LLC worked with 35 of them. This year there were 4 Produce GAPs Harmonized Audits performed. AgMatters worked with three of them.

Supporting Maine Specialty Crop Producers with Audit Preparation Year 2 focused on assisting Specialty Crop growers with preparation for GAP/GHP and Produce GAPs Harmonized audits.

It built on and was a result of needs we noted for a grant we wrote and were funded for the year before.

It is especially timely because Food Safety is always in the news, especially with FSMA and the Produce Safety Rules. We note that the science behind the audits has not changed over the last few years; however we are sure that when FSMA is done, scientific based expectations will affect current audits.

AgMatters LLC would like to acknowledge and thank our project partners, the Maine Vegetable and Small Fruit Growers Association and the Maine Pomological Society. Both groups have gone out of their way to offer opportunities for us to share at their meetings. Many of their memberships have utilized the services of this grant and shared their knowledge with others. Both groups have been there whenever they were asked for assistance.

Project Approach

AgMatters LLC began the work of this grant on October 1, 2013 and concluded it on September 30, 2014. We prepared and revised GAP and GAP Harmonized materials for distribution to growers. Copies were sent via email, regular mail, and brought to every audit training session held. We have distributed approximately 45 pages of materials to each person we have trained. We have worked with over 115 people with this grant. We talked with and worked with Hannaford Markets to clarify their expectations for growers. Other markets (Shaw's, Whole Foods, distribution centers like SYSCO; Crown of Maine; & Martha Putnam) also became accepting and trusting of GAP audits for their growers. We have worked with and presented to Maine Farmland Trust's Food Hub, The New American Sustainable Agriculture Project (NASAP) Cultivating Community, University of Maine's Extension Food Safety Programs, the Certified Crop Advisors of New England training, The New England Food Policy Building A Sustainable Food System's Webinar #9 "Food Safety: The Elephant on the Farm", as well as with Kennebec Valley Community College's Agricultural Program and leadership.

AgMatters LLC has spent time educating themselves about the future direction of food safety, FSMA, and lessons learned from other's food recall experiences. We have helped to disseminate information about the Produce Safety Rule to Maine growers.

Maine auditors have been very helpful in making us aware of issues that arise with GAP/GHP and Produce GAPs Harmonized audits, so that we can take steps to train growers more appropriately.

Evaluations have been given out when appropriate and their content was studied and applied to future presentations.

AgMatters LLC presented to over 600 Maine growers during this grant year. One on one Food Safety Audit Training was given to 115 individuals. Four growers were assisted as they prepared for Produce GAPs Harmonized Audits. This preparation is more time consuming, simply because of the detail required in the audits.

Each meeting was unique. Each farm is different and needs to understand how they fit into the GAP picture. Growing and harvesting tomatoes is very different than beets. Each crop has its own special requirements. Growers need an idea of what is expected by an auditor, so that they can meet those requirements. AgMatters LLC's template for Food Safety Plans is a beginning point in each training. As we proceed through the process, it becomes easier to tailor the plan to the individual farm and process.

AgMatters LLC would like to acknowledge and thank our project partners, the Maine Vegetable and Small Fruit Growers Association and the Maine Pomological Society. Both groups have gone out of their way to offer opportunities for us to share at their meetings. Many of their memberships have utilized the services of this grant and shared their knowledge with others. Both groups have been there whenever they were asked for assistance.

AgMatters LLC feels that we have been very successful in our task of assisting growers with Food Safety Audit preparation. All allocated monies have been spent.

Goals and Outcomes Achieved

Measureable Outcomes

Supporting Maine Specialty Crop Producers with Good Agricultural Practice and Good Handling Practice (GAP/GHP) Audit Preparation; Produce GAP's Harmonized Audit Preparation, and Assistance With Other Third Party Food Safety Audits. Year 2

A minimum of 40 growers who participate with this grant will receive assistance preparing for Food Safety audits such as GAP/GHP , Produce GAP's Harmonized Audits, Global GAP, and GSFI recognized programs such as SQF 1000 or other third party audits. This will include recertification, new certification, or increased certification levels for these farms.

Outcome: A list of participants for the grant and a list of certifications earned during the year will be maintained by AgMatters LLC.

Reality: AgMatters LLC did outreach and training and reached over 700 individuals. 115 people were trained through one-on-one meetings.

35 of those trained chose to pursue follow up certification and received it.

It is safe to say that all improved their knowledge of food safety, whether they pursued certification or not.

The one on one grower work will continue to evolve and improve, based on grower feedback.

Outcome: Evaluations will be given to each grower. Resulting feedback will be studied and incorporated into the program. Results will be saved and summarized so they can be reported in the grant's final report.

Reality: Evaluations were very positive. Of 102 returned evaluations, 96 rated the quality of our work as good to excellent. 85 rated the importance of food safety as high. As a result of our work, 97 felt more confident about their knowledge of food safety.

There was one suggestion for improvement that was to schedule more than three hours for a session and there was another that stated it was just the right amount of time. Many comments echoed the relief in finally knowing what was real and what was rumor in food safety. All were appreciative of our materials and their easy access on our web site.

AgMatters LLC will hold a large group meeting at the Maine Agricultural Show held in January, 2014.

Outcome: Agendas for the programs will be kept and attendance numbers will be saved.

Reality: AgMatters LLC spoke to the Maine Small Fruit and Vegetable Growers (60) and the Maine Pomological Society (30) Annual meetings held at the show.

The agenda included reminders that AgMatters LLC was available to help growers learn more about and or prepare for GAP or Harmonize GAP audits at their convenience. It included a comparison between GAP and GAP Harmonized audits. It included an update on what was new with the audits. It also alerted growers about a proposal to increase the cost of the audits by several hundred dollars and organized an effort for growers to respond to that. As a result, the move to increase the costs was defeated.

AgMatters LLC will speak to at least three other grower meetings during the year, sharing information about the grant and encouraging others to undertake a Food Safety Audit.

Outcome: Records will be kept of speaking engagements, as well as numbers in the audience.

Reality: AgMatters LLC presented food safety information at many meetings throughout the year.

Presented at a Crop Advisor's Training in Portsmouth, NH. (25 attendees)

Met with Under Secretary Edward Avalos who acknowledged and appreciated AgMatters LLC's efforts and commitment to helping growers obtain GAP certification through Specialty Crop Grants.

Presented at Extension Vegetable School in Portland-GAP basics (93 attendees)

Presented at Extension Vegetable School in Bangor-GAP basics (77 attendees)

Presented at Oxford County Extension Office a complete GAP training (20 attendees)

Trained Somalian ESL class on the Basics of Food Safety and GAP audits (30 attendees)

Trained area farmers in Sweden area on GAP audit expectations/walkabout (8 attendees)

Spoke at MVSFGA Twilight Meeting in Richmond (30 attendees)

Trained KVCC class on basics of GAP Audits (10 attendees)

Participated as a presenter in New England Food Policy Webinar #9, Food Safety: The Elephant on the Farm (70 enrolled)

Materials put together by AgMatters LLC to assist growers with this process will be shared on their website (www.agmattersllc.com) and updates will be sent out in regular email notifications to growers on a regular basis.

Outcome: A summary of these materials will be made in the final report.

Reality: All materials related to Food Safety and audits on our website (AgMattersLLC.com) have been updated this grant year.

An email distribution list has allowed us to share important information with those we have worked with. We have sent out five email updates this year. We try not to overuse the tool. We have gotten good feedback to date, thanking us for sending out that information.

In January, the hot topic was a proposal to have a blanket price increase for the cost of an audit by several hundred dollars. Email helped raise awareness of the situation and eventually helped to squelch the effort by USDA to increase the cost of audits.

Bleach and its use on food contact surfaces and on food have been the hot topic most of the summer because it has become a directive to auditors to make sure growers are following the label restrictions of the chemical and that they have the label in hand. AgMatters LLC has researched the issue and shared their findings with growers so they are prepared for this portion of the audit.

Materials on our website:

Food Safety Plan Templates for GAP 1, 2 & 3

USDA GAP Audit Verification Checklist

Food Safety Plan Template for Harmonize GAP Harvest and Post-harvest

GAP Harmonized Standards and Audit forms for Harvest and Post-harvest

We have other materials that we have put together that we distribute to growers as needed. These include alternative mock recall forms for specific retailers; advisories on cleaning and sanitizing; links to other resources, hints on where to locate specific supplies, how to organize the growing year in relation to audit recommendations…

Beneficiaries:

This project directly benefitted all Maine Specialty crop growers. Although only 35 growers chose to be certified. AgMatters LLC worked with 75 others who wanted to know more about food safety but who chose not to certify.

Most who do not certify verbally cite the cost of the certification as the cause. It is our experience that growers want to do the best job they can to grow the best produce they can. They learn and use what they feel will make the biggest impact on the quality of their product.

In summary,

Over 700 producers were exposed to some knowledge of Food Safety by AgMatters LLC through talks at different venues.

115 growers met with AgMatters LLC one -on -one to be trained to be prepared for an audit.

35 of those trained actually went on to achieve their certification.

We feel that this grant was hugely successful and more than met all of its goals.

The potential impact of the grant is the knowledge of food safety imparted in the training, and the ability of growers who do become certified to grow their markets.

When there have been funds to reimburse growers for part of the cost of the audits, there were more audits done for small growers. That reimbursement funding disappeared two years ago, and that loss also caused many small growers to stop getting audited, simply because of the cost.

Lessons learned:

Offering food safety training assistance is only part of what is needed to encourage small growers to be audited. Somewhere, there has to be the ability to recoup some of the costs of the audit.

AgMatters LLC received 8 calls and emails asking for assistance from NH and MA growers. We have never refused. Most of these trainings occurred over the phone, each taking several hours and we did not count these encounters in our totals for this grant because they were not Maine growers.

However, because we believe there is an understanding that we are part of New England and we were prepared, we just did it.

This project began on October 1, 2013 and ended on September 30, 2014.We have received a Specialty Crop Grant for 2014-15. We have been funded at a half-time level for one more year.

Contact Information

AgMatters LLC
Lauchlin, Linda, Jeremiah Titus
1063 Main St.
Vassalboro, ME 04989
Ltitus21@myfairpoint.net
207-631-3303

Project 6: Increasing Specialty Crop Knowledge and Consumption in Maine Children and Adults through School Gardens

Final Report – Previously Accepted

Project Summary

The Center for Disease Control reports that more than 90% of Americans are not eating enough fruits and vegetables. They recommend incorporating fruit and vegetable activities such as gardening into schools as a strategy to increase consumption. The current focus in Maine on local and regional food systems fosters student, teacher, administrator and parent attention and commitment to school garden programs. The Maine School Garden Network has offered programs and a website designed to assist the state's educational gardens since 2009. The response has been very favorable, expanding to 63 schools across the state by 2012 and indicates enormous potential to increase our support for school gardens with the addition of a state coordinator.

The Specialty Crop Block Grant enabled the Maine School Garden Network to support an increase in gardening activities, nutrition education, awareness and access to healthy Specialty Crops by providing resources and information for existing and developing Maine school gardens. The coordinator provided necessary support for school gardens to advance awareness and the consumption of healthy foods by students, educators, volunteers and extended family members. In addition to encouraging students and their families to learn gardening skills and gain knowledge about healthy foods and eating habits, the coordinator focused on increasing connections between school gardens and local farms. This created an invaluable opportunity for our audience to not only learn about fruits and vegetables, but become familiar with the logistics of how to locate and purchase these Specialty Crops, connect with farmers outside of the classroom and experience additional real world lessons.

Project Approach

A coordinator was hired in January 2013. An overhaul of the Maine School Garden Network website was completed with updated software and a more effective design to provide a user friendly directory, a more complex newsletter template, and remove unused features. Every registered garden was contacted to update their registry information. Two $2,000 School Garden Grants were awarded in June. One grant will support the citizen-science curriculum component of Mount Desert Elementary Schools "Growing Gardens, Growing Minds" program. The other grant supports Rippling Waters Farm's efforts to supply MSAD6 schools with garden infrastructure and relevant training.

The coordinator sought out interest in school garden collaborations from farmers in the Journey Person mentorship program sponsored by the Maine Organic Farmers' and Gardeners' Association. The group was targeted as a small population of Specialty Crop growers, providing a starting point to evaluate how farmers can successfully interact with school garden programs to the benefit of both parties. Four farms indicated that they would like to work with a local school garden. Three farms were introduced to existing school garden programs. The process of linking farms to local resources revealed interest from three schools in starting garden programs with the support of a local Specialty

Crop farmer, which the coordinator is working to facilitate. Collaboration with school garden programs enables Specialty Crop growers to build strong relationships with the local community.

The coordinator is learning how farmers and school gardens are currently involved or interested in working with each other. School gardens and local farmers were contacted to establish connections from 61 responses. The coordinator will continue to establish connections and begin to observe what types of collaborations are most successful for a farm-school mentor program.

The coordinator has worked to promote the Maine School Garden Network by attending 8 exhibition events. The coordinator's participation served to disseminate resource materials and educate students about Specialty Crops, observe the impact of school garden programs, and support school garden facilitators and partner organizations. Taste tests were administered using Specialty Crops, and also solicited from school garden programs. The coordinator met many garden facilitators during these events and visited 16 school gardens to learn about their programs and how they work with local Specialty Crop farms. This information was shared through newsletters, website article highlights, and anecdotal conversations with garden facilitators across the state. The coordinator is collaborating with the Maine Federation of Farmers' Markets to explore how farmers' markets can serve as a resource for students and increase their fruit and vegetable consumption.

The coordinator organized two educational events with partner organizations. Maine School Days was two days of training workshops for school garden facilitators, hosted with Maine Agriculture in the Classroom. The Maine Farm to School Conference was a collaborative effort involving the MSGN, the University of Maine Cooperative Extension, and the Maine Farm to School Network. This conference offered workshops for educators and food service staff in 3 categories, Food Service, School Gardens, and Agriculture & Food Education.

Goals and Outcomes Achieved

The coordinator was hired in January 2013 through a USDA Specialty Crop Block Grant. Monthly newsletters profiled Specialty Crops, provided networking opportunities and resources for garden facilitators, and highlighted school garden programs. The MSGN website was updated to include an interactive map of school gardens across the state, a user-friendly school garden directory, and improved article content which includes food safety, IPM, and farm to school resources. To date, the directory of school gardens has grown by 40% from 63 to 105 registered school gardens, surpassing the 20% annual goal.

Taste tests administered to 2,604 students revealed that only 14.44% of participants has previously eaten the seasonal foods offered, including beets, broccoli, turnips, cucumbers, peppers and other vegetables. Samples were tasted by 86.44% of participants and enjoyed by 75.52% of these students. Students reported willingness in 61.48% of taste tests to try these fruits and vegetables again. More than 42% of students who participated in tasting food sample desired to incorporate these healthy foods into their regular diet, with 42.51% of students requesting that these Specialty Crops be served in the school cafeteria, and 42.11% requesting that their families serve these foods at home.

The coordinator worked to facilitate collaborations between school garden programs and local farms, for children to learn where to find healthy foods in their community and how to purchase them with their families. The coordinator established 61 connections between school garden programs and local

farms. The coordinator has gained the support of the Maine Federation of Farmers Markets to increase collaboration between school garden programs and these venues.

Beneficiaries

The primary audience served by the MSGN is the Maine school population: children, administrators, staff, volunteers and their families. Healthy behaviors and access to fresh fruits and vegetables encouraged by school garden programs also benefit Specialty Crop farmers. The project has broad reach into the community as the MSGN works to establish collaborative connections and encourage volunteer involvement.

The gardens currently registered in our directory reach from 50 to 1000 students each, for an extrapolated number of over 45,000 students. Each garden has a minimum of two educators directly involved, or at least 210 adults. If we include three adults who are volunteers, administrators, school food service, farmers or other community members, our numbers reach more than 45,500 people that have already expressed interest or are currently working with school gardens.

Lessons Learned

The MSGN learned that the demand for a school garden resource hub is greater than anticipated, given that new school garden directory registrations were double the network's annual goal of 20%. Anecdotal conversations indicated that many garden facilitators were unfamiliar with food safety and IPM guidelines related to school garden programs. These conversations also revealed that a major stumbling block for garden programs is the maintenance of school gardens over summer break. This presents an opportunity to engage the community in helping with maintenance and educating garden facilitators that with season extension the focus of the garden can be on the shoulders of the growing season, rather than when students are not in school.

Students were eager and willing to try Specialty Crops, and in many cases would like to incorporate these foods into their diet. The MSGN has learned that this favorable response indicates that the network should explore the effectiveness of providing preparation tips and recipes along with taste tests to encourage the students' consumption of these healthy foods. Additionally, the MSGN should provide garden programs with a taste test template, to simply and align solicited data. Further collaboration with local farms can reinforce students connection to these Specialty Crops and influence families purchasing habits.

Contact Person

Ryan Fahey
Coordinator
Maine School Garden Network
207-659-2554

Project 7: Roberts Farm Community Supported Agriculture and Education Project

Final Report – Previously Accepted

Project Summary

The overall goal of the Roberts Farm CSA & Education program was to engage students in nutrition and science programs through the growing of specialty crops at Roberts Farm, the 2 acre farm of the Oxford Hills School District. Specialty crops grown, were distributed through a CSA for low-income residents, donation to the University of Maine Cooperative Extension – Maine Harvest for Hunger Program and USDA Summer Feeding Program.

Project Approach:

In 2013/14, the Oxford Hills School District continued this expansion of programming opportunities at Roberts Farm for students and community members. These integrated curriculums were delivered at the 2nd grade and 5th grade (ecosystems, biomes, nutrition education, 6th grade (living things and nutrition education) and middle school levels (chemistry, biology, living things, ecosystems, nutrition education, fitness plans) provided interwoven curriculum opportunities that paralleled the Next Generation Science Standards, Common Core and Maine Learning Results. This integrated learning continued to occur both in the school classroom and at Roberts Farm Preserve, which hosts the schools districts 2 acre farm, 6 greenhouses and 28 raised beds. We also partnered with 2 local farmers (Bisbee Orchard and Whitman Farms) to deliver the goals and objectives.

Goals and Outcomes Achieved:

Objective 1: Childhood obesity prevention through Specialty Crop Consumption and Education

Measurable Goal – 400 students will participate in Roberts Farm Educational programs including 100 that will participate in 6 hours of Farm-to-School nutrition education.

Achieved Outcome –

- Year 1: 468 students participated in Roberts Farm Education programs and 138 participated in 135 hours or more of programs. Thirty four of the 135 hours were Farm-to-School Nutrition Education.
- Year 2: 498 students participated in Roberts Farm Educational programs and 189 participated in 135 hours or more of these programs. Twenty eight hours were spent in Farm to School Nutrition Education

Over the course of the USDA Specialty Crop Grant, the following student data has been collected regarding educational programs for students:

- Year 1 - Seventy-seven 5th grade students from Oxford Elementary participated in 38 days of educational programming at Roberts Farm for a total of 228 hours per student.
- Year 2- 156 5th & 6th grade students from Oxford Elementary participated in 35 days of educational programming at Roberts Farm for a total of 208 hours per student.
- Year 1: Thirty-three 2nd grade students from Waterford/Harrison Elementary participated in 30 days of educational programming at Roberts Farm for a total of 180 hours per student.
- Year 2: Twenty-four 2nd grade students from Waterford/Harrison Elementary participated in 20 days of educational programming at Roberts Farm for a total of 120 hours per student

- Year 1 - Twenty-eight 7th and 8th grade students from Oxford Hills Middle School participated in 35 days of educational programming at Roberts Farm for a total of 165 hours per student.
- Year 2 – 22 7th and 8th grade students from Oxford Hills Middle School participated in 35 days of educational programming at Roberts Farm for a total of 165 hours per student.
- Year 1- Forty 5th and 6th grade students from Paris Elementary participated in 10 days of programming for a total of 80 hours per student.
- Year 2 – 121 5th and 6th grade students from Paris Elementary participated in 10 days of programming for a total of 80 hours per student.
- Year 1 - Forty five 8th grade students from Oxford Hills Middle School participated in 13 days of programming at Roberts Farm for a total of 98 hours per student.
- Year 2 – 42 8th grade students from Oxford Hills Middle School participated in 14 days of programming at Roberts Farm for a total of 101 hours per student.
- Year 1- One hundred and forty-five students, grades K-6 from Paris Elementary participated in 12 days of educational programs at Roberts Farm for a total of 48 hours per student.
- Year 2 – 133 students, grades K-6 from Paris Elementary participated in 12 days of educational programs at Roberts Farm for a total of 48 hours per student.
- Year 1 - Ninety-two students, graded K-6 participated in 8 hours of programming at Roberts Farm.
- Year 2 – Zero K-2 students participated in programming, as after Year 1, this age group participated in district programming related to the Oxford County Fair.

Objective 2: Nutrition and Nutrition Education through specialty crop production at Roberts Farm, partnerships with 2 local farmers and an adult education agriculture course.

In total, Roberts Farm partnered with 4 area farms over the project, 2 of which were contracted in Year 1 to help with the with the deliverable outcomes of the grant. Roberts Farm administer an Adult Education Course in both Year 1 and Year 2 of the project.

The first local farmer Roberts Farm partner was Scott Vlaun of Moose Pond Farm and Ecology in Otisfield, Maine. Moose Pond Farm provided both student agricultural programs and facilitated the Adult Education Course. Scott worked with three 5th grade classes over the course of Year 1 of the grant year providing 9 days of educational programming at Roberts Farm and three days at Moose Pond Farm. In addition he provided in-kind in year 2 by working with 16 Middle School students on a hydroponics project at Roberts Farm. The majority of his programming offered to students included specialty crop production of lettuce, spinach, squash and apples. Scott also facilitated all 8 Adult Education classes in Year 1 (16 hours total), which had a total of 22 adult students. In Year 2, Scott was a guest presenter at 2 of the adult education courses. Moose Pond Farm continued as a partner in year two.

The second local farmer was Thaine Eastman of Bisbee Apple Orchard & Farm in Sumner, Maine who donated his time and orchard for the project. In total, 12 middle school science classes made day-long visits to Bisbee Apple Orchard where the participated in an in-depth analysis of the orchard, its economic value and the nutritional value of apples. Bisbee Apple Orchard & Farm will continue as a partner in year two.

The third farmer was Dottie Bell, of Flying Hill Farms in Waterford, Maine. Dottie donated her time with 2nd grade classrooms at Harrison and Waterford Elementary schools as part of a 4 series curriculum unit. This program integrated nutrition, agriculture and visits to Flying Hill Farm. Flying Hill Farm did not continue as an in-kind contributor in year two.

The fourth farmer was Toby Whitman of Whitman Farms in West Paris, Maine. Toby both worked with students growing squash and working with students to make organic soil amendments. Whitman Farms will continued as an in-kind donor in Year 2.

Objective 3: Food Security through a C.S.A. for low income community members and donated produce for the Maine Harvest for Hunger program. (Goal – 10,000 pounds of donated produce. Actual 7,900 pounds of donated produce)

Roberts Farm CSA:

- Roberts Farm provided 10 CSA shares for low-income community members. The CSA distributed between 12 and 40 pounds of produce per week for a 12 week period of time. 3,900 total pounds of specialty crops were part of this effort.

Roberts Farm Harvest for Hunger

- In Year 1, Students at Roberts Farm grew and donated 4,000 pounds of produce to the University of Maine Cooperative Extension Harvest-for-Hunger program and 1,500 pounds of produce to the Oxford Food Bank. These donations were made each Thursday and became part of the network of Harvest for Hunger distributions in both South Paris and Oxford, Maine.
- In Year 2, students at Roberts Farm donated 4,400 pounds of produce to Harvest for Hunger and 1800 pounds to the Summer Feeding Program in Oxford Hills.

Potential Impact

Total Student Participation at Roberts Farm

Programming Option	Total student participants in Roberts Farm programs	48 hour plus student participation at Roberts Farm	165 hour plus student participation at Roberts Farm
Year 1 # of students	468	368	138
Year 2 # of students	498	498	178

Lessons Learned

MSAD 17 entered into this project under the impression that this was a 2 year project with 2 separate budget years. Going into Year 2, the Director of the USDA John Harker asked for the submission of the 2nd year budget. As it turns out, there was not a 2nd year awarded, in which MSAD 17 has absorbed $18,000 in deficit funds to cover the goals and objectives of year 2.

Contact Information

Patrick Carson
Oxford Hills School District
207-592-9247
p.carson@msad17.org