Investigating the Use of Buckwheat Strips for the Management of Colorado Potato Beetles in Potato Production and as an Attractant of Native Pollinators for Vine Crops

1. Project Summary

This project consisted of two parts. The first was to see if buckwheat strips would attract beneficial predatory insects over to adjacent planted potato rows. My hypothesis was that Colorado potato beetle larvae would have reduced numbers due to the predation by beneficial insect predators attracted by the nearby buckwheat. Compared to the control plot where no buckwheat was planted, the treatment plots showed a significant increase in larvae reduction and predation by four species of predators.

The second part of the project was to see if strips of buckwheat planted next to rows of cucumbers would attract native pollinators over to the vine crops to help improve pollination (and increase marketable fruit). Compared to the control plot where no buckwheat was planted, the treatment plots had greater numbers of native bees and wasps. There also was a significant difference between the number of marketable cucumbers and those that were misshapen due to poor pollination.

2. Introduction to Topic

Cover crops have great benefits for vegetable production. The cover crops can suppress weeds, reduce erosion, act as a green manure providing nutrients, and adds organic matter back to the soil. Still with all of these fine properties, cover crops still are not as commonplace on an organic farm as they should be. Many small growers have land restrictions so that every piece is needed for production. Having some tied up in cover crops means reduced sales potential in the short run.

What if a cover crop could also help in reducing pests in a crop or could improve pollination of another crop? Adding more value to a cover crop by making it double duty might provide a greater incentive for farmers to begin using cover crops more extensively on their farm.

Pest management is another main concern for organic growers. Substituting one off-farm purchased pesticide for another purchased off-farm organically approved pesticide does not address enhanced sustainability. If you could use a cover crop to be a tool in pest management, this does enhance sustainability on the farm.

There have been major issues revolving around honey bees and their sudden decline due to disease and other unknown factors. Loss of habitat is a major issue when it comes to native pollinator populations. Since organic farms are supposed to be built around the premise of sound ecological principles, caring about preserving and establishing habitat for native pollinators should be of main concern.

3. Objectives Statement

The projects objectives are:

a) To determine if using buckwheat strips grown near potato beds will provide the habit for predatory insects. Once attracted to the buckwheat will these predatory insects move into potato beds and reduce the damage caused by Colorado potato beetles.
b) To determine if using buckwheat strips grown near cucumber beds will attract more native pollinators and increase marketable yields.
c) To show that using in-season cover crops can provide multipurpose benefits and could be used as part of an active rotation plan.
d) In-season cover crops could be cost effective and not tie up a lot of valuable production land.

The objectives did not change through the course of the project.

4. Materials and Methods

Part 1. Potato plots. Buckwheat seed was broadcasted into strips based on the rate for heavy seeding of 96 lbs. /acre (Managing Cover Crops Profitably) for weed suppression. This came out to be roughly 1.5-2.5lbs per 100 ft of 4-6 ft wide strip. There was one buckwheat strip seeded to 4 rows of potatoes. This is a variable that is hard to judge. Scientifically, it would be ideal to run trials with different numbers of strip to row ratios (1 strip to 1 row, 1 strip to 2 rows etc.). No one was up to having a huge trial. It was decided to run 1 strip of buckwheat to 4 rows of crops. This would make up a block.

The buckwheat strips were as wide as the seeding equipment of each farm – averaging about 48 inches wide. A block was approximately 16ft wide (depending on the size of the equipment used on each farm) and approximately 15 ft long. There was a control plot that consisted of 4 rows of cucumbers without any buckwheat strips. There were four replications of randomized blocks for each location.

Each plot planted had at least 12 plants per row so we were able to select 10 per row for sampling. Red Norland potato was used. For the cucumbers, a straight variety was picked from organic seed sources by the grower and most of the planting was in Marketmore 76.

Sampling of the potato plants took place when the plants got to be 4” high with the sampling occurring close to the same time – between 9-10am when insect activity is high and the heat of the day hasn’t built up. A sample of 10 plants per row was used. The number of adult beetles and then larvae were counted. Feeding damage was examined on the percent of leaves damaged (0 -5 with 0=no damage 1 = 20% etc.) as an observation. The number of observed larvae that were being attacked by predators was counted, the number of dead larvae found, and the number of observed predators on the potato plant was also noted. Predatory insect seen attacking larvae were identified and counted. The same methodology was used on the control plot. Comparison differences between the treatment and controls were statistically compared. Sampling with the sweep nets in the buckwheat strips and in potatoes were done in the morning.

Part 2 – buckwheat and cucumbers. Following a similar methodology as above, sampling consisted of 10 plants per row where we looked to see any flower visiting activity by bees and other insects. Sampling was done about the same time – between 9-10am when insect activity is high and the heat of the day hadn't built up. With cucumbers, the flowers were freshly open and pollinator activity was high. Sample catches using insect nets were used to help identify types of bees. Several net sweeps of the buckwheat were done during the season to identify what insects are visiting the flowers of the buckwheat. This was done at the beginning of the season, about mid season, and towards the end of the season. We collected data on the number of cucumber fruit that were marketable and for any misshapen due to poor pollination. Cucumbers are normally straight. Two conditions exist whereby misshapen fruit could occur. The first is a deficiency in nitrogen. The second is from poor pollination. For this project, soil tests indicated that N was at moderate levels and the moisture available to the plants was not lacking at any time during the season. Therefore, we assumed that any misshapen fruit would be due to poor pollination. Cutting open of fruit to look at the seeds also help in aiding our identification. Poorly formed seeds also indicated poor pollination. Fruit that are poorly pollinated have slightly shrunken and curved ends (the tips where the flower was present). We ended up with just two locations after poor conditions forced us to drop one site. Location two only put in three rows of cucumbers with 4 replications while location 3 had the complete set of four rows and 4 replications.


examples of misshapen fruit due to poor pollination

The total number of fruit were tabulated for the sample rows both in the treatment and control crops. Counts were made of the misshapen fruit. Differences between the control and the treatment rows were statistically compared.

We collected data on the number of bees based on type with wild honey bees and a compilation of bumble bee species. We have pictures of the species of bees identified. Taking counts of the different species became difficult so we just divided them into wild honey bees and bumble bees.

5. Project Results

Due to weather conditions, timing of the planting of the potatoes and buckwheat for one of the locations did not connect so the location 3 was dropped.

Location 1	Colorado potato beetle and buckwheat trial				location 1 number of live larvae for trt vs control and number of larvae dead or missing for trt and control
		trt live	control lv	trt d/m	control d/m
	rep 1 rw1	59	48	57	4
	rw2	47	39	47	6
	rw3	52	54	50	6
	rw4	38	45	36	7
	rep2 rw1	45	66	44	2
	rw2	48	46	45	4
	rw3	25	36	25	5
	rw4	37	52	33	4
	rep3 rw1	55	51	55	4
	rw2	26	31	25	7
	rw3	38	29	36	5
	rw4	41	35	39	9
	rep4 rw1	50	48	46	3
	rw2	24	19	22	2
	rw3	47	54	44	6
	rw4	31	34	28	4

Trt live = the # of total larvae that were seen alive per treatment row
Control lv = the # of total larvae that were seen alive per control row
Trt d/m = total # of actually confirmed dead larvae plus the # of missing for treatment
Control d/m = total # of confirmed dead larvae plus # missing for the control rows

Location
2

number of live larvae for trt vs control and number of larvae dead or missing for trt and control

	Trt live	control lv	trt d/m	control d/m
rep 1 rw1	34	61	30	5
rw2	36	41	35	4
rw3	40	38	36	7
rw4	44	41	40	6
rep2 rw1	36	31	36	12
rw2	33	27	33	5
rw3	35	40	35	8
rw4	21	32	19	8
rep3 rw1	33	15	32	8
rw2	29	33	29	7
rw3	28	22	28	6
rw4	18	26	18	3
rep4 rw1	24	36	15	4
rw2	29	34	27	1
rw3	37	46	35	3
rw4	27	42	26	5

Data for predatory insects identified for the treatment and control plots.

location 1		Type and number of predatory insects found on trt and control		
	rep1	beneficial	trt	Control
		ASSB	28	4
		MPB	8	1
		PSB	10	1
		SB	12	0
	rep2	beneficial	trt	Control
		ASSB	38	3
		MPB	4	0
		PSB	9	1
		SB	11	1
	rep3	beneficial	trt	control
		ASSB	34	3
		MPB	6	1
		PSB	5	1
		SB	13	0
	rep4	beneficial	trt	control
		ASSB	40	2
		MPB	6	0
		PSB	4	0
		SB	12	1

ASSB = Adult Spined Soldier Bug
MPB = Minute Pirate Bug
PSB = Predatory Stink Bug
SB = Shield Bug

location 2		Type and number of predatory insects found on trt and control		
	rep1	beneficial	trt	control
		ASSB	32	1
		MPB	1	0
		PSB	7	0
		SB	11	0
	rep2	beneficial	trt	control
		ASSB	36	1
		MPB	2	0
		PSB	7	0
		SB	9	1
	rep3	beneficial	trt	control
		ASSB	40	4
		MPB	2	0
		PSB	5	1
		SB	9	0
	rep4	beneficial	trt	control
		ASSB	34	4
		MPB	4	0
		PSB	3	0
		SB	9	0

Cucumber and buckwheat trial
At Location 1, wet fields caused late planting of buckwheat and poor stand of cucumbers so this location was dropped.

location 2	# of marketable fruit	# of poorly pollinated fruit	# of marketable fruit	# of poorly pollinated fruit
	Trt		Control	
	trt mkt	poor poll	cntrl mkt	Poor poll
rep1 rw1	84	0	81	3
rep1 rw2	78	0	84	3
rep1 rw3	79	0	85	3
rep2 rw1	90	1	78	2
rep2 rw2	87	1	78	2
rep2 rw3	93	0	85	2
rep3 rw1	90	1	73	4
rep3 rw2	87	1	83	0
rep3 rw3	93	0	81	1
rep4 rw1	79	0	90	2
rep4 rw2	96	0	81	3
rep4 rw3	90	1	83	0
Totals	1046	5	982	25

The marketable number of fruit harvested between the treatment and the control was significantly different and the difference between the treatment and control poor pollinated fruit was significant both at $P < 0.05$.

location 3	# of marketable fruit	# of poorly pollinated fruit	# of marketable fruit	# of poorly pollinated fruit
	Trt		Control	
	trt mkt	poor poll	cntrl mkt	Poor poll
rep1 rw1	84	0	81	3
rep1 rw2	78	0	84	3
rep1 rw3	79	0	85	3
rep2 rw1	90	1	78	2
rep2 rw2	87	1	78	2
rep2 rw3	93	0	85	2
rep3 rw1	90	1	73	4
rep3 rw2	87	1	83	0
rep3 rw3	93	0	81	1
rep4 rw1	79	0	90	2
rep4 rw2	96	0	81	3
rep4 rw3	90	1	83	0
Totals	1323	6	1245	35

The marketable number of fruit harvested between the treatment and the control was significantly different and the difference between the treatment and control poor pollinated fruit was significant both at $P < 0.05$.

Data on bee species. Species identified including two non-bee that were seen regularly in the cucumber flowers and in the buckwheat

Apis mellifera
Agapostermon
Augochlorella
Bombus impatiens
Bombus perplexus
Bombus fervidus
Bombus ternaruis

Hylaeus annulatus
Mellisodes apicata
Non-bee species
Vestpula
Syrphisae
(see Addendum for pictures)

To make observations easier, we counted honey bees separately and combined the bumble bee species together.

Wild honey bees and a compilation of bumble bee species for both treatment plots and control plots.

location 2	Trt	Control	trt	control
	hn bee t	hn bee c	bbees	bbees
rep1 rw1	160	123	194	133
rep1 rw2	144	111	211	124
rep1 rw3	123	98	145	119
rep2 rw1	134	89	139	111
rep2 rw2	156	129	187	122
rep2 rw3	119	101	144	98
rep3 rw1	155	146	178	125
rep3 rw2	142	125	220	134
rep3 rw3	137	117	198	121
rep4 rw1	181	144	234	153
rep4 rw2	142	114	212	126
rep4 rw3	165	126	176	122
Total	1758	1423	2238	1488

For honey bees, the difference between treatment and control counts was significant at $P<0.05$.

For bumble bees, the difference between treatment and control counts was significant at P<0.05

location 3	Trt	Control	Trt	control
	hn bee t	hn bee c	Bees	bees
rep1 rw1	110	98	211	155
rep1 rw2	122	78	187	134
rep1 rw3	142	102	170	146
rep1 rw4	138	111	159	127
rep2 rw1	146	87	121	99
rep2 rw2	98	80	126	86
rep2 rw3	167	132	184	110
rep2 rw4	133	95	178	125
rep3 rw1	141	132	203	138
rep3 rw2	172	143	166	129
rep3 rw3	156	131	176	148
rep3 rw 4	152	114	190	169
rep4 rw1	179	140	181	142
rep4 rw2	147	119	164	121
rep4 rw3	127	89	148	119
rep4 rw4	174	131	158	139
Total	2304	1782	2722	2087

For honey bees, the difference between treatment and control counts was significant at P<0.05.

For bumble bees, the difference between treatment and control counts was significant at P<0.05

6. Conclusions and Discussion

Discuss the results of the project and what you found out. What do the results lead you to believe did, or did not, happen? In the end, how useful was this project to you and the farm operation? How useful do you feel the study and results will be to other organic farms? Did you encounter any problems during the project? What would you do differently if you did this project again? Based on what you've learned, what do you think should be studied next?

Part 1 Buckwheat and Potatoes

The data collected was very interesting and showed a huge affect on the number of larvae that survive on potatoes grown next to buckwheat as compared to the control plots of no buckwheat. Predation by at least three beneficial insects was observed on many occasions. Not all the larvae that were on potatoes grown near buckwheat were seen being eaten. The total number of larvae that were found initially minus the total number of larvae seen eaten, found dead, or were missing gives us the number of larvae left. Any of the larvae not seen being eaten or found dead on the ground or under leaves, were just considered missing.

The results indicated that there is a pronounced affect on reducing the numbers of CPB larvae substantially. The statistics back this up. There are significant differences between potato plots planted near buckwheat for controlling CPB larvae than without it. Out of the 32 rows of potatoes in the treatment trial (both locations) there were 9 rows with 100% control of the larvae; 5 rows with only 1 left alive; 9 rows with 3 alive; 5 rows with 4 alive, and 1 row with 9 alive. Compare this with the control plot where there were between 1-12 larvae dead or missing and as many as 51 left alive to feed on a row.

Across the treatment rows, there data doesn't indicate any difference with the number of CPB larvae dead and missing. This would mean that the predators are more or less evenly scattered across the plot. One reason for this could be that the buckwheat has a large influence on attracting beneficial predator insects and they move in large enough numbers across the plots. Sweep nets through the buckwheat found the same beneficial predators as on the potato plants. This occurred at the beginning (16 caught), middle (11), and the end of the season with the numbers being higher at the end of the season (22), though the range among the predators was about the same (except for Minute Pirate Bugs which there were only a couple caught in the nets).

I presented my findings at two farmer meetings. One meeting was with conventional growers while the other was directed for those using organic practices. Three farmers (2 organic and one conventional) came up to me after the meeting and stated that after hearing the talks I gave, they reflected upon their growing of potatoes in 2008. All three had buckwheat cover crops growing for weed control in a field plot next two one side of their potato planting. They were fairly sure they saw very few CPB larvae or damage in rows nearest the buckwheat. They didn't take notice how deep this control was.

Their response to this was to all ask the same questions: How far will the control of CPB larvae be across a field planted next to buckwheat? What is the best strategy for planting buckwheat and potatoes together? A next phase of research is needed to determine the answers

Part 2 Buckwheat and cucumbers

There were statistically significant differences between the numbers of marketable fruit and poorly pollinated fruit in plantings of cucumbers next to buckwheat than the control. The differences were for location 2, for the treatment plot there were 5 poorly pollinated (out of 1052) while the control plot had 25 (out of a total of 1007). For location 3, there were 6 poorly pollinated (out of 1329 total cucumbers) in the treatment plot while there were 35 poorly pollinated (out of 1280) for the control plot.

The sites chosen for this trial were secluded in order to help rule out any domesticated honey bee hives being nearby. One field was surrounded by large wooded areas on four sides. The other site was surrounded by pasture on two sides, and corn and soybeans (dairy farms) on the other two sides. Therefore, we considered any honey bees found to be wild and classified them as “native”.

Wild honey bees were easy to see. Because of the difficulty in identifying other bee species while they visited cucumber flowers, these species were counted together. Using sweep nets across the buckwheat and in the cucumbers, the bee species were figured out. There were 9 species of bees identified plus *Vespula* (wasp – Yellow Jacket) and *Syrphisae* flies which were very plentiful both in the buckwheat and on the cucumber flowers. *Apis mellifera* (wild honey bee) was plentiful. Bombus species were numerous and threw were also some Agapostemon and *Augochlorella* species caught and seen in the cucumbers.

In the treatment plots, there were significantly more wild honey bees as well as significantly more other bee species than in the control plots. For location 2, there were 1758 honey bees vs. 1423 and for other bees, there were 2238 vs. 1488. For location 3, there were 2304 honey bees vs 1782 for the control and 2722 other bees vs. 2087 for the control. There were also significantly more other bee species than wild honey bees for both the treatment plots and the control plots. The data would indicate then that buckwheat had an influence in attracting native bees including wild honey bees to nearby cucumber plants. This increased attraction might explain why there were less poorly pollinated fruit when there were a large number of bees present.

In location 2, there were significantly more other bees than wild honey bees in the treatment plots than the control. This was not the case for location 3. This could mean that for some farms, the true native bee populations are smaller than the wild honey bees present. Maybe more needs to be done to attract native bees to nest in preserved areas set aside by the farmers. Understanding the biology of the native bees is important.

Attracting native bees including wild honey bees would provide greater advantages for the farmer. Improved pollination of fruiting crops like cucumbers and maybe others like squash, melons, small fruit, and tree fruit could increase profitability. Establishing habitat is critical and preserving areas for nesting is essential to maintain and increase native pollinator populations.

Buckwheat strips had measureable positive impacts on the two crops we studied. CPB larvae were reduced to a level where minimal damage occurred. This saved the farmer time and money in having to go out and manage the pest themselves using whatever off-farm inputs they could purchase.

Pollination improved in cucumbers. The more marketable fruit that comes out of a harvest means greater sales. Not having to rent hives of domesticated bees saves money. Relying on native bees helps balance the ecology of the farm and surrounding area.

7. Outreach

So far, I have presented this data at a conventional grower meeting (2009 Niagara County Fresh Market Meeting) held in Lockport, NY 1/20/09. There were 37 farmers present. The second presentation was at the NOFA-NY 2009 conference held 1/23-25 in Rochester, NY. There were 42 farmers present. I also plan to present the findings at a gathering of the Great Lakes Vegetable Specialists to be held in Geneva< NY 2/25-26 and at a workshop for new and novice farmers sometime this spring.

A finished version of this report will be posted on the new and improved Cornell Vegetable Program's Team website when it goes live sometime in mid-February (http//cvp.cornell.edu). There will be pictures of the beneficial predators and native bees along with it. Announcements of the new website will be sent out to the agricultural papers and newsletters that go out. A notice will also go out on the NOFA NY list serve.

8. References

Provide a list of references you used to help develop your project and/or that you referred to in the body of your report.

9. Addenda

Field strip of buckwheat

Rows of potatoes in plot

Potatoes with Colorado Potato Beetles Feeding

Beneficial Predatory Insects found in the buckwheat strips and potatoes.

 Predatory Stink Bug (*Perillus*)

 Shield Bug (*Elasmostethus)*

 Adult Spined Soldier Bug (*Podisus maculiventris)*

 Minute Pirate Bug (*Anthrocoris nemaoralis)*

 Assassin Bug (*Reduviidae*).

Pictures of the types of bees and pollinators found with sweep net collections.

Apis mellifera

Agapostermon

Augochlorella

Bombus impatiens

Bombus perplexus

Bombus fervidus

Bombus ternaruis

Non-bee species

Vestpula

Syrphisae