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Organic farming research project report submitted to the Organic Farming Research Foundation:

Project Title:

Using living straw mulch to suppress Colorado potato beetle on potatoes

FINAL PROJECT REPORT

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The use of straw mulch for the suppression of the Colorado potato beetle (CPB) on potatoes has been demonstrated (Zehnder and Hough-Goldstein, 1989). It was suggested that to eliminate the cost of purchasing and transporting commercial grain straw, growers could rotate potatoes with a cover crop suitable for mulch such as wheat, rye, vetch, etc.. The purpose of this study is to demonstrate the feasibility of using such a cover crop as a source of "living mulch."

Materials and Methods

A field of rye/vetch located on the Nesenkeag Farm in Litchfield, NH and fallow since 1992 was used for this study in 1993. The site was in an area where CPB infested eggplant and tomato plants had been grown during the 1992 season. It was also located within an agricultural production area that has a long history of commercial potato production and high CPB populations.

The experiment consisted of six treatments arranged in a latin square design with 3 replications per treatment. Each plot was 15 feet wide and 25 feet long, making them wide enough to utilize the straw from the rye growing within those plots requiring straw mulch as a treatment. The plots were established on 12 May 1993 using a 5-foot wide rototiller to turn under a 5foot swath down the middle of those plots requiring straw, leaving 5-foot swaths of standing rye on each side to be used for harvesting straw. For plots requiring no straw, the entire 15foot width of the plot was turned under. In addition to 300 lbs/acre of Sul-Po-Mag that had been broadcasted over the potato trial area on 21 April, the plots were fertilized with Plant-Rite (pelletized chicken manure) at 500 lbs./acre on 17 May. A single row of potatoes was hand-planted in each plot on 20 May using 810 inch spacings between seed pieces. Three varieties of potatoes (Kennebec, All Blue, and Yellow Finn) were used with each of the three replicates planted to a separate variety.

On 11 June, seven days after the potato plants began to emerge from the ground, the standing rye in each of the straw plots was mowed. The rye was allowed to dry in the field where it fell, which

was about two feet on either side of the row of potatoes at its closest point. On 18 June the following treatments were established in each of the three replicates:

1. Straw (cover) - The straw on each side of the potato rows was used to cover the young plants at a rate equivalent to approximately 1 bail per 75 feet of row.
2. Straw (border) - The straw on each side of the potato plants was left undisturbed.
3. Straw + B.t. (cover) - Same as No. 1 plus four applications of Novodor Biological Insecticide containing 3% coleoptera active toxin *Bacillus thuringiensis* subspecies tenebrionis (Novo Nordisk, 33 Turner Street, Danbury, CT 06813-1907) at 3 qt/A (2 applications per larval generation).
4. Straw + B.t.(border) - Same as No. 2 plus four applications of Novodor at 3 qt/A (2 applications per larval generation).
5. B.t. - No straw within 7 feet of the potato row. Four applications of Novodor at 3 qt/A (2 applications per larval generation).
6. Untreated - No straw within seven feet of the potato row.

The Novodor treatments were applied using a R & D CO_2pressurized (40psi) single nozzle hand-held sprayer that delivered 28.8 gal/acre using two passes per row. Two applications 7 days apart were made per generation with the first application made when 30% or more of the eggs of the respective generations had hatched. No herbicides or fungicides were used. Weed control was maintained by hand weeding and periodically tilling the bare ground between the potato rows and the straw. Due to hot and dry conditions, the plots were irrigated on 14 July. Once CPB adults began to appear, the treatments were evaluated weekly by counting the various life stages (adults, egg masses, small and large larvae); determining the percent defoliation that had occurred toward the end of each larval feeding period; and measuring potato yields at the termination of the study.

Results and Discussion

Influence of Straw Mulch on Colorado Potato Beetle

Populations of the First and Second Generations. An evaluation of the numbers of adults, egg masses and larval forms for the first and second generations are presented in Tables 1 and 2, respectively. The greatest effect straw mulch had on the CPB population occurred with the first generation larvae (Table 1). On 23 June there were significantly fewer adults and egg masses in the straw(cover) treatments than in the untreated treatment. On 1 July, which was before any Novodor applications had been made, there continued to be significantly fewer small larvae in the straw (cover) treatments compared with the untreated plots. On 6 July, one week after the first Novodor application, the straw (cover) treatment was equal to the Novodor treatments and significantly better than the straw (border) and untreated treatments in controlling small larvae. Similar control of large larvae occurred on 13 July. However, the straw mulch had little if any influence on the suppression of the second brood larvae (Table 2).

Influence of Straw Mulch on Plant Defoliation and Tuber Yield. The extent of defoliation caused by CPB feeding for each generation is presented in Table 3. For the first brood, the straw(cover) was equal to all treatments that included Novodor and had significantly less defoliation than either the straw (border) or the untreated treatments. However, the second brood larvae caused enough additional defoliation to the straw (cover) treatment to leave only the Novodor treatments with significantly less defoliation. In comparing the yield data (Table 4), the best yields were obtained with the Novodor treatments. However, there was a significant improvement in the yield of the straw(cover) treatment over the untreated treatment regardless of extent of defoliation that was caused by the second brood larvae. This may be explained by studies of Zehnder and Evanglo (1989) who demonstrated potato plants are most sensitive to CPB defoliation during early stages of plant growth and that yields were less affected by damage occurring during late plant growth stages.

Conclusions

It is apparent from this study that the greatest influence of straw mulch is upon the CPB population early in the season when the plants are young. It is also apparent from comparing straw (cover) vs. straw (border) treatments, that the young plants must be covered to receive the greatest benefit from straw mulching. It may be possible to prolong the benefit of straw mulch by keeping the plants covered for a longer period during the development of first generation to prevent late egg laying by late emerging adults. This may prolong the necessity for early season use of insecticides by keeping the larval population below thresholds during this period of time. Further studies are warranted to evaluate the potential of this possibility.

REFERENCES

Zehnder, G. W. and J. Hough-Goldstein. 1989. Use of Straw Mulch for Suppression of Colorado Potato Beetle Populations in Potatoes. The Vegetable Growers News 44:2.

Zehnder, G. W. and G. K. Evanylo. 1989. Influence of Extent and Timing of Colorado Potato Beetle (Coleoptera: Chrysomelidae) Defoliation on Potato Tuber Production in Eastern Virginia. J. Econ. Entomol. 82: 948-953.

Table 1. Evaluation of Spring Adult and First Generation Egg and Larval Populations of CPB on Potatoes.

	Mean Number CPB Forms per 25 Feet Row[1]										
	23 June			1 July		6 July			13 July		
Treatment	Adults	Egg Masses	Sm. Larvae	Adults	Sm. Larvae	Adults	Sm. Larvae	Lg. Larvae	Adults	Sm. Larvae	Lg. Larvae
Straw (cover)	1.0c	1.3c	0.7	0.7ab	0.3b	0.0b	14.7c	1.0a	0.0b	1.3b	41.0b
Straw (border)	7.7ab	7.7bc	0.0	0.0b	5.3ab	1.0b	114.0b	35.0a	0.0b	14.7a	142.0ab
Straw + Bt[2] (cover)	0.7c	3.0c	0.0	0.3ab	0.0b	0.3b	0.0c	0.0a	1.3b	0.0a	1.0b
Straw + Bt[2] (border)	5.7bc	18.3a	0.0	0.7ab	10.0ab	0.7b	10.0c	0.0a	0.0b	0.0a	1.0b
Bt[2]	10.7ab	12.7ab	0.0	3.0a	26.3ab	3.3a	2.3c	9.0a	5.7a	1.7a	0.0b
Untreated	12.0a	21.0a	0.0	2.0ab	91.3a	0.3b	250.0a	95.0a	1.7b	0.0a	291.0a

[1] Means followed by the same letter are not significantly different (P=0.05;DMRT)
[2] Novodor applied on 1 July and 6 July, 1993 at the rate of 3 quarts/acre. Insect counts were made prior to the application of Novodor on each date.

Table 2. Evaluation of First Generation Adults and Second Generation Egg and Larval Populations of CPB on Potatoes.

	Mean Number CPB Forms per 25 Feet Row[1]									
	28 July				3 August			10 August		
Treatment	Adults	Egg Masses	Sm. Larvae	Lg. Larvae	Adults	Sm. Larvae	Lg. Larvae	Adults	Sm. Larvae	Lg. Larvae
Straw (cover)	17.0a	0.3a	2.0a	0.0a	58.7b	17.3c	0.7a	65.3a	75.3a	12.7ab
Straw (border)	40.7a	0.3a	11.7a	1.0a	155.0ab	22.0c	7.0a	91.3a	36.3a	11.7a
Straw + Bt[2] (cover)	8.0a	0.7a	2.7a	0.0a	28.0b	18.0c	1.0a	29.3a	25.7a	1.7b
Straw + Bt[2] (border)	4.7a	0.7a	0.7a	0.0a	57.3b	57.3b	0.3a	25.0a	33.0a	4.0ab
Bt[2]	4.3a	1.0a	12.7a	0.7a	32.7b	107.0a	10.0a	24.7a	48.0a	21.0a
Untreated	39.3a	1.0a	0.0a	0.7a	238.7a	12.3c	3.3a	68.3a	43.3a	15.0ab

[1] Means followed by the same letter are not significantly different (P=0.05;DMRT)
[2] Novodor applied on 3 August and 10 August, 1993 at the rate of 3 quarts/acre. Insect counts were made prior to the application of Novodor on each date.

Table 3. Percent Defoliation by First and Second Brood Larvae.

Treatment	Percent Defoliation[1] First Brood 13 July	Second Brood 20 August
Straw(cover)	4.7c	56.7b
Straw(border)	51.7b	73.3ab
Straw + B.t. (cover)	1.3c	5.0c
Straw + B.t. (border)	0.7c	6.7c
B.t.	1.0c	5.0c
Untreated	85.0a	83.3a

[1] Means followed by the same letters are not significantly different (P = 0.05; DMRT)

Table 4. Yield Evaluation of Individual Potato Varieties and the Mean of the Three Varieties (Replications).[1]

Treatment	Varieties			Mean of all Varieties[2]
	Kennebec cwt/Acre	All Blue cwt/Acre	Yellow Finn cwt/Acre	cwt/Acre
Straw(cover)	77.0	68.2	65.3	70.2b
Straw(border)	114.7	23.2	43.6	60.5bc
Straw + B.t. (cover)	139.4	81.3	91.5	104.1ab
Straw + B.t. (border)	155.4	88.6	77.0	107.0ab
B.t.	158.3	151.0	111.8	140.4a
Untreated	5.1	3.6	47.9	18.9c

[1] Yields were obtained on 9 September 1993 by weighing all the tubers dug from 20 feet of row per treatment and converting the results to cwt/acre using 36 foot row spacings.

[2] Means followed by the same letter are not significantly different (P = 0.05; DMRT)