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ASSESSING COLORADO POTATO BEETLE CONTROL OPTIONS AND NITROGEN FERTILITY IN ORGANIC POTATO PRODUCTION

Final Research Report E2007-10

INTRODUCTION

Organic potato producers have access to a limited number of options to control the populations of Colorado potato beetles (CPB) in their crop. The bacterial insecticide Novodor has been a key product over recent years but has been eliminated from approved organic input lists. The effectiveness of a new replacement insecticide, Entrust, needed to be assessed for Maritime organic potato production.

The conventional production of high yielding commercial potatoes depends partly on the extensive use of chemical fertilizers. Unfortunately, the high levels of fertilization may also improve the nutritional quality of the plants for insects. Often, high plant nitrogen in crop tissue encourages pest outbreaks, but this effect varies between species. The influence that fertilization might have on the population dynamics of the CPB on potato is little known. The literature on the relative tolerance of conventional and organic crops to insect pests is often contradictory. In organic potato production, it is important to understand potential interactions between N fertility, plant development, and insect population dynamics with their potential consequences for the use of insect control products.

OBJECTIVES

- To compare the efficacy of a potential organic insecticide (Entrust) to a bacterial insecticide (Novodor) and to no insecticide;
- To compare the effect of three levels of organic fertilization on potato yield and plant biomass; and
- To test the hypothesis that healthy plants have a better tolerance of insect pests such as the CPB.

Adult Colorado potato beetle (G. Boiteau)

METHODS

This two year trial (2004-05) was conducted at the Lower Farm section of the Potato Research Centre of AAFC in Fredericton, NB, land which has been managed organically for at least five years. The two factors of fertilization and pest control were assessed in a small plot trial. Plots were 4 rows wide and 7.62 m in length.

Three levels of fertilizer (0, 150, and 300 kg N ha^{-1}) were applied in the form of Nutriwave™ 4-1-2 organic fertilizer. In 2005, a treatment was added with 170 kg N ha^{-1} of an inorganic fertilizer (17-17-17).

Three pest control treatments were tested:
- Entrust (spinosad 80%), applied at 0.11 L ha^{-1}
- Novodor (*bacillus thuringiensis* subspecies *tenebrionis* 10%), applied at 6.0 L ha^{-1}
- A control of water only

Entrust and Novodor were applied based on scouting need, twice in 2004 and six times in 2005 with a tractor mounted sprayer.

Novodor was applied once on the control plots to prevent excessive defoliation of the plots. The fungicide Parasol was applied for blight control, and weeds were controlled mechanically. The abundance of CPB adults and larvae at each instar (growth stage) was assessed on five whole plants per plot throughout July and August. Defoliation in each plot was estimated according to an index ranging from 0 to 8; where 0 represents no defoliation and 8 represents total defoliation. Significance of observed differences among treatments was determined using ANOVA (SAS) and Student's t-tests.

In 2005, CPB larval developmental rate was assessed on plants with different levels of organic fertilizer (0, 150, 300 kg N ha^{-1}) compared with an inorganic chemical fertilizer. These tests were replicated six times in August 2005. The time (in days) required to develop from first instar to the end of the third larval instar was calculated and data were analyzed using the General Linear Model ANOVA procedure in SAS. Repeated measures ANOVA was carried out to analyze the interaction of time with fertilizer and insecticide on CPB life stages and potato plant development.

RESULTS – CPB CONTROL

In 2004, CPB were not abundant in the trial field, and insect control was not required until July 20. Counts carried out after the first insecticide application showed significantly fewer adults in the Entrust and Novodor treated plots than in the control plots. This was also the case for third instar larvae, as assessed on three dates in July and August. Counts of larvae tended to be lower in plots treated with Entrust than in those treated with Novodor but not significantly so. Because of the late colonization and the resulting low beetle density, crop defoliation was never high.

Table 1. Efficacy of two insecticides against CPB on organically grown potatoes, 2005

Sampling date	July 18		July 25	Aug. 8	Aug. 15
Larval instar	L1	L2	L3	L4	
	----(number CPB on 5 plants^{-1})-----				
Control	17.0a[1]	22.9a	36.2a	15.3a	19.1a
Novodor	6.4b	0.1a	10.9b	2.9b	2.0b
Entrust	0.9b	0.0a	2.6b	3.9b	0.1b

[1] Numbers in a column followed by the same letter are not statistically different (P ≤ 0.05, Student's t test)

Table 2. Efficacy of two insecticides at protecting organically grown potatoes against foliar damage by CPB, 2005

Sampling date	July 25	Aug. 2	Aug. 8	Aug. 15	Aug. 22
	--------(Mean defoliation index[2])---------				
Control	1.44a[1]	1.50a	1.83a	2.17a	2.39a
Novodor	0.89b	1.11a	1.39a	1.56b	1.94a
Entrust	1.06b	1.17a	1.28a	1.44b	1.83a

[1] Numbers in a column followed by the same letter are not statistically different (P ≤ 0.05, Student's t test)
[2] The defoliation index was as follows: (0) no defoliation; (1) 2-60% of plants with leaflets lightly damaged; (1.5) > 60% of plants with leaflets lightly damaged; (2) 2% of plants with one or more compound leaves at least 50% defoliated

In 2005, the experimental field was colonized by adult CPB at plant emergence. After the first insecticide application on July 18 there were significantly fewer first instar larvae in the Entrust and Novodor treated plots than in the insecticide free plots (Table 1). Counts of third instar larvae were lower in Entrust and Novodor treated plots than in the control on July 25 after the second insecticide application. In spite of an application of Novodor on the control plots on July 26, counts of fourth instar larvae were significantly lower in Entrust and Novodor treated plots than the control on August 8 and 15.

There was consistently more defoliation on the unprotected plots than on the Novodor or Entrust treated plots (Table 2), but the index was significantly lower on July 25 and August 15. The single Novodor application on the control plots on July 22 reduced the population for the remainder of the season but reduced defoliation only temporarily. Generally, yield in 2005 was higher than in 2004. In both 2004 and 2005, the plots receiving insect control treatments had consistently higher yields than plots with no insect control treatment, but this difference was not statistically significant (Table 3).

Table 3. Effect of two insecticides on total and marketable yield (t ha^{-1}) of organically grown potatoes

	2004 Yield		2005 Yield	
Treatment	Marketable	Total	Marketable	Total
Control	1.71a[1]	8.70a	4.78a	13.58a
Novodor	3.69a	13.10a	4.95a	15.26a
Entrust	3.49a	12.20a	4.85a	15.22a

[1] Numbers in a column followed by the same letter are not statistically different (P ≤ 0.05, Student's t test)

RESULTS – FERTILITY

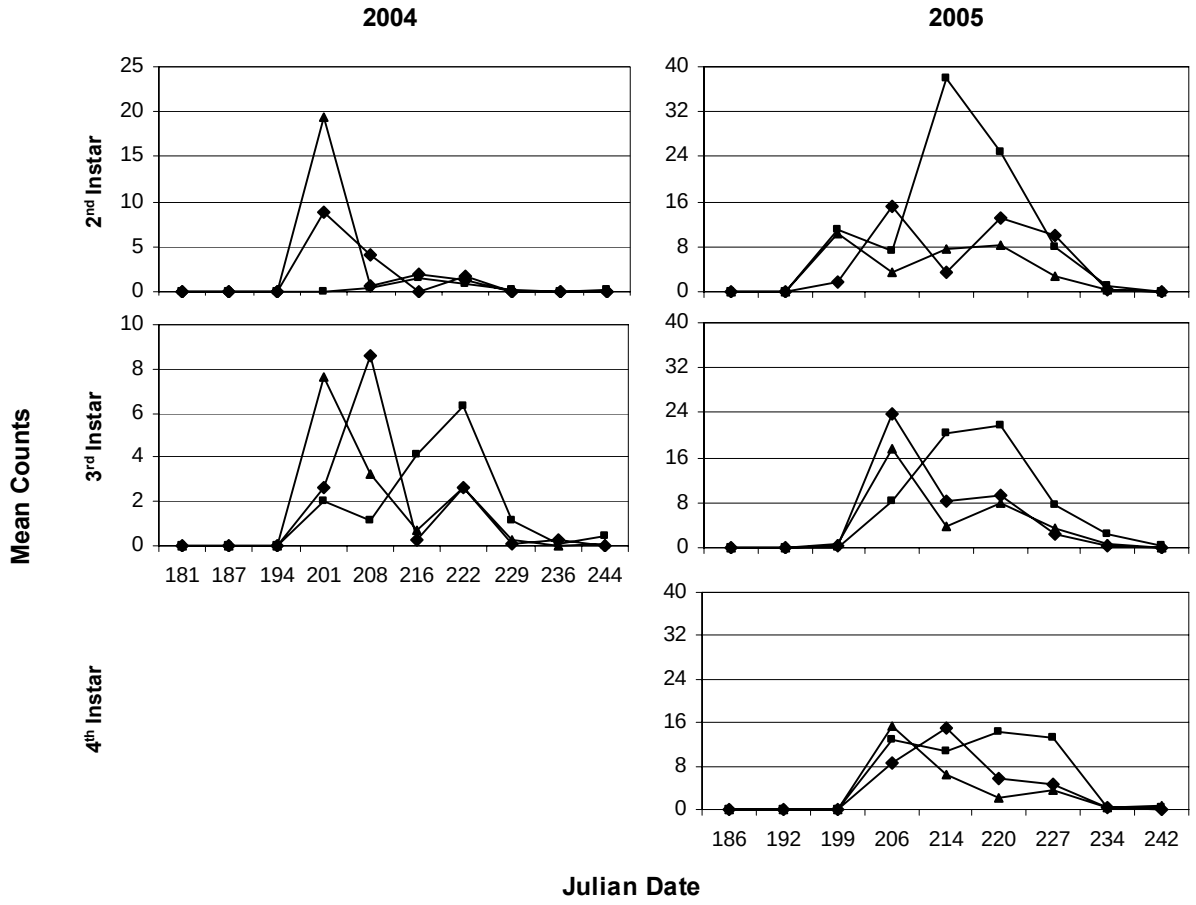

Figure 1. Seasonal changes in the mean counts of Colorado potato beetle life stages in organic potato plots unfertilized (▲) or treated with 150 (♦) or 300 kg N ha^{-1} (■) of organic fertilizer in 2004 and 2005.

The addition of organic fertilizer increased potato yield in both study years. In 2004, the highest level of fertilizer produced a significant benefit in marketable yield (5.87 t ha^{-1}) as compared to the two lower levels (2.37 and 0.64 t ha^{-1}). In 2005, marketable yield was significantly lower for the control (1.78 t ha^{-1}) than the two higher fertilizer levels: the 150 kg N ha^{-1} treatment (4.12 t ha^{-1}) and the 300 kg N ha^{-1} treatment (8.40 t ha^{-1}).

Fertilizer treatments did not affect CPB abundance; however, the fertilizer influenced the timing of larval abundance in 2005 (Fig. 1). In general, the peak population for the L2, L3 and L4 instar larvae occurred earlier on plants with no or low fertilizer than on plants with high fertilizer. The late colonization of plants by CPB in 2004 and the low abundance of insects made it difficult to compare the effect of fertilizer rates on CPB abundance. However, as in 2005 there was a trend for the peak CPB larvae abundance to occur later in relation to increased fertilizer level (Fig. 1). One explanation may be that the overwintered CPB moved from the plants with lower levels of fertilizer to the highly fertilized plants to lay their eggs. Plants in the fertilized plots were taller, with greater canopy cover and biomass that persisted later in the season.

In 2005, the field observations of CPB development were tested in a controlled environment. The laboratory analysis revealed that mean CPB development time (days between L1 to the end of L3) was significantly shorter on foliage from plots treated with chemical fertilizer or the high rate of organic fertilizer than on those plants that received the low rate of organic fertilizer (Fig. 2).These results indicate that using an intermediate rate of organic fertilizer may slow down the development of the CPB, but it is not known if this would result in lower pest pressure and fewer beetles under field conditions.

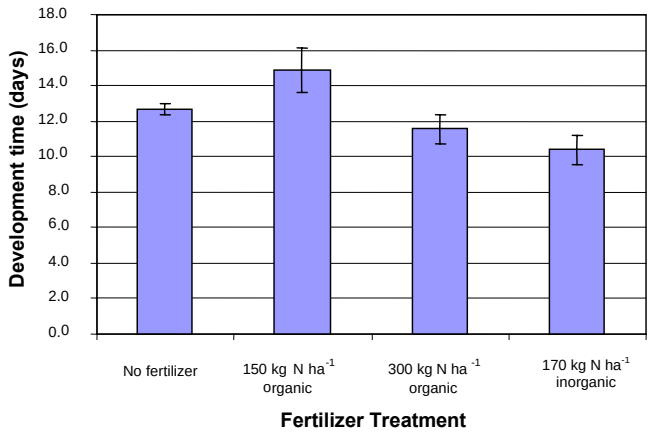

Figure 2. Mean development time of CPB larvae reared on field-collected terminal potato leaflets under different fertility treatments, 2005

THE BOTTOM LINE...

In a two-year organic potato research trial, the insecticide Entrust proved as effective as Novodor at controlling Colorado potato beetle population and leaf defoliation. Entrust should prove to be an acceptable replacement option for organic potato producers.

Faster Colorado potato beetle development was observed on potato plants receiving high levels of both organic and conventional fertilizer than on potatoes fertilised at an intermediate level. Excessive levels of fertilizer should be avoided because they may extend the amount of time that CPB larvae are present and result in more defoliation and lower yields.

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CONCLUSIONS

The bacterial insecticide Novodor has been a key product for CPB control for many years but has been eliminated from the list of products suitable for use by certified organic producers. In this trial, the application of the products at least once during peak abundance of each larval instar demonstrated that Entrust can provide a level of control similar to that provided by Novodor. In commercial potato production, fewer applications of either product would be required to protect the crop from economic yield loss. In fact, a single application of Novodor on the control plots was sufficient to reduce the development of the CPB population and the corresponding defoliation so that their yield was similar the plots receiving multiple applications of Entrust and Novodor.

Very high levels of fertilizer were observed to lengthen the time period when third and fourth CPB instar larvae are present. This can increase defoliation and the risk of yield loss, and insecticides may be needed over a longer period. Laboratory results indicate that the use of an appropriate rate of organic fertilizer may extend the number of days required for CPB maturity. The development time for CPB larvae was longest at an intermediate level of fertilization than for the highest organic or conventional fertilizer level or the unfertilised plots.

CREDITS

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