

Assessing CPB control options and N fertility in Organic Potato Production

Fredericton 2004

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Highlights:

The high rate of organic fertilizer was required to produce significant marketable yields.

The efficacy of the insecticide Entrust at controlling a low density population of Colorado potato beetle in an organic production setting was shown to be similar to or better than Novador.

The hypothesis that healthy, vigorous plants have a greater tolerance to insect pests such as the Colorado potato beetle was not fully assessed because of the unusually late colonization and of the very low beetle density. The preliminary data suggest that plant health may affect the timing of the different potato beetle life stages and therefore the timing for the application of the insect control measures.

It is possible to produce three levels of potato crop/plant health (vigor) by manipulating fertilization levels.

Future research:

The 2004 results demonstrated that the experimental design selected will provide the (minimum) three classes of crop health required to test the hypothesis of plant vigor as a pest defense mechanism in organic production. Need to repeat when beetle abundance is higher.

The testing of Entrust utilization for normal, early potato beetle colonization, should be pursued.

Rationale

Organic potato producers have access to a limited number of options to control the populations of Colorado potato beetles in their crop. The bacterial insecticide Novador has been a key product over recent years but was being eliminated from recommended product lists when this project was undertaken. It was necessary to assess the efficacy of a replacement insecticide, Entrust, and to determine best utilization procedure under Maritime conditions. In potato production in general but especially in organic production, it is also important to understand potential interactions between N fertility, plant development, insect population dynamics with their potential consequences for the use of insect control products.

Objectives:

The project had three objectives:

- 1) Compare the efficacy of a potential organic insecticide (Entrust) to a bacterial insecticide (Novador) and to no insecticide.
- 2) Test the hypothesis that healthy, vigorous (well fertilized) plants have a better tolerance of insect pests such as the CPB.
- 3) Compare the effect of three levels of organic fertilization on potato yield and plant biomass. The objective is not to isolate a N only effect from the Nutriwave but to compare treatments as fertilized (i.e. with NPK in poultry manure) vs. unfertilized.

Methods:

Seed potatoes, cv Shepody, were planted in the Lower Farm section of the Potato Research Centre of AAFC in Fredericton, NB on 31 May 2004. Plots, 4 rows wide and 7.62 m in length were arranged in a randomized complete block design with two factors. To apply the Nutriwave 4-1-2 organic fertilizer to the plots, a tractor mounted device was used to open two small furrows on either side of the seed furrow. Pre-measured amounts of fertilizer were then distributed by hand in the furrows of each row. Seed was placed by hand and the rows closed using the tractor. The insecticides Entrust and Novador were applied on July 21 and on August 10 using a tractor mounted sprayer. Entrust was applied at the rate of 1.5 oz/acre and Novador at the rate of 6 L/ha at a pressure of 60 psi. The fungicide Parasol was applied at a rate of 1.80 L/ha on July 21, August 12, 19 and 26. The abundance of adults, egg masses, and larvae of the Colorado potato beetle was assessed on five whole plants per plot on June 29, July 5, 12, 19, 26, August 3, 9, 16, 23 and 31st. The experimental field was cultivated on July 5th and disked on August 3rd. The field was weeded on August 6th and harvested on Oct 18th. Plant height in each plot was measured from the tallest stem in each plant monitored. The canopy was measured at one location in each plot according to an index ranging from 1 for a plant cracking the ground to 5 for plants whose leaves overlap across two rows. Defoliation in each plot was estimated according to an index of defoliation ranging from 1 to 8 where 1 represents minor defoliation along the edges of one foliole on 1 or 2 plants in a plot and 8 represents total defoliation of a plot. Total plant biomass samples of 4 plants per plot were taken before the end of the season and are being analysed. Significance of observed differences among treatments was determined using ANOVA (SAS) and t tests.

Experimental design:

The experiment had two factors:

Fertilizer – 0 kg N, 150 kg N, 300 kg N;

Insecticide – water, Novador, Entrust;

A randomized complete block design (3 blocks) was selected because of an expected gradient of beetle colonization from the previous year's potato field across from the 2004 field.

Plots

Plots were 4 rows wide with 10-12 feet of fallow ground around each plot. This minimized "casual " insect movement between plots or foliar treatment drift and allowed the use of tractor mounted equipment to apply treatments or maintain the area as weed free as possible.

Blight was controlled using Parasol sprays.

Weeds were controlled mechanically as much as possible.

Plot layout: randomized complete block design for two treatment factors,

Fertilizer and Insecticide

Block	Unit	Fertilizer	Insecticide
1	1	150 kg N	Water
1	2	300 kg N	Novador
1	3	0 kg N	Water
1	4	300 kg N	Water
1	5	150 kg N	Entrust
1	6	300 kg N	Entrust
1	7	150 kg N	Novador
1	8	0 kg N	Novador
1	9	0 kg N	Entrust
2	1	150 kg N	Water
2	2	0 kg N	Entrust
2	3	300 kg N	Entrust
2	4	300 kg N	Water
2	5	0 kg N	Novador
2	6	150 kg N	Entrust
2	7	300 kg N	Novador
2	8	150 kg N	Novador
2	9	0 kg N	Water

3	1	300 kg N	Water
3	2	150 kg N	Novador
3	3	0 kg N	Novador
3	4	0 kg N	Water
3	5	150 kg N	Entrust
3	6	300 kg N	Novador
3	7	150 kg N	Water
3	8	0 kg N	Entrust
3	9	300 kg N	Entrust

Results and Discussion

The three levels of fertilization provided to the plots successfully created the range of crop “vigor” required for the field experiment. The values of the two indicators of plant development monitored, plant height and plant canopy, were significantly related to the level of fertilization in each plot. As early as July 5th, the canopy of the fertilized plots was significantly more important than that of the unfertilized plots (Figure 1). By July 19, the canopy of plots having received 300 Kg of N was significantly wider than that of plots having received 150 Kg of N. These had a canopy significantly wider than that unfertilized plots. This relation was maintained to the end of the crop season. The insect population had no effect on the canopy except at the very end of the season (Figure 2).

The colonization of the experimental field by adult Colorado potato beetles was unusually late in 2004. The field was isolated and the climate was unfavourable to beetle

dispersal. As a result, the Colorado potato beetle was never abundant in the field. Nevertheless, on July 19th, at the peak of abundance of adults, there were significantly more adults on the healthy fertilized plots (5.44 ± 0.56 and 3.44 ± 0.88) than on the, stressed, unfertilized plants (1.22 ± 0.40). There were, on the average, correspondingly more egg masses laid on the best fertilized plants (5.56 ± 0.87) than on the unfertilized plants (1.89 ± 0.54) on July 19th. There were too few adults or egg masses on the other sampling dates to establish any trends related to plot fertilization. On July 26th, there were significantly more L3 larvae on plots receiving 150 kg of N (8.56 ± 3.57) than on the ones receiving 300 kg of N (1.11 ± 0.81) suggesting that larvae may be more successful on the stressed plants than on the healthy plants. However, this could be a spurious observation.

Insect control treatment was not required until July 20th. Counts carried out on July 26th, after the first insecticide application, showed significantly fewer adults on the Entrust (0.0 ± 0.0) and Novador (0.22 ± 0.15) treated plots than in the insecticide free plots (0.44 ± 0.18). Counts of stage 3 larvae were also significantly lower in Entrust and Novador treated plots on July 26th, on August 3rd and on August 16th, after the second insecticide application (Figure 3). Counts of larvae tended to be lower in plots treated with Entrust than in those treated with Novador but not always significantly so. The preliminary data (Figure 4) suggest that plant fertilization (plant health) may affect the timing of the different potato beetle life stages and therefore the timing for the application of the insect control measures.

Because of the late colonization, the beetle population was never very abundant and plant defoliation was never high. Significant differences between treatments in defoliation were observed only on July 26th with both fertilization and insecticides having an effect. There was more defoliation on the fertilized than on the unfertilized plants and on the unprotected plots than on the Entrust treated plots.

The total yield was significantly higher in the fertilized plots than in the unfertilized control plots and only the high rate of fertilizer produced a marketable yield significantly higher than that in the unfertilized control (Table 1). The plots receiving insect control treatments had consistently higher yields than plots with no insect control treatment but not significantly so. The overall low value of the yield, regardless of treatment, is difficult to explain. Potential contributing factors include a high water table in the last third of the growing season. Hopefully, the final analysis of plant biomass samples will help find the cause of the low values.

Table 1. Effect of three levels of organic fertilizer and of three types of Colorado potato beetle controls on the average marketable and total yield (t/ha) of organically grown potatoes in 2004.

Fertilizer	Marketable Yield Mean \pm S.E	Total Yield Mean \pm S.E
0 kg N	0.64 \pm 0.15 b	6.57 \pm 0.60 b
150 kg N	2.37 \pm 0.54 b	12.15 \pm 1.60 a
300 kg N	5.87 \pm 1.27 a	15.27 \pm 1.94 a
Insecticide		
Water	1.71 \pm 0.63 a	8.70 \pm 1.74 a
Novador	3.69 \pm 1.30 a	13.10 \pm 2.04 a
Entrust	3.49 \pm 1.15 a	12.20 \pm 1.74 a

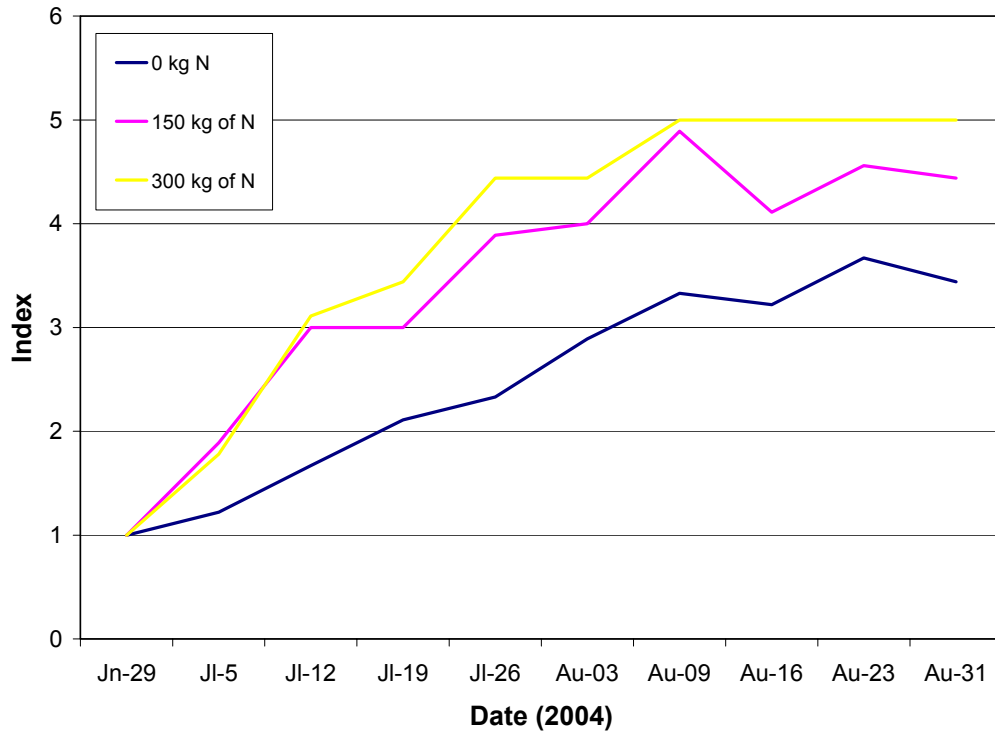


Figure 1. Seasonal changes of the canopy index in organically grown potato plots treated with 150 and 300 kg of N (Nutriwave) at planting or left unfertilized.

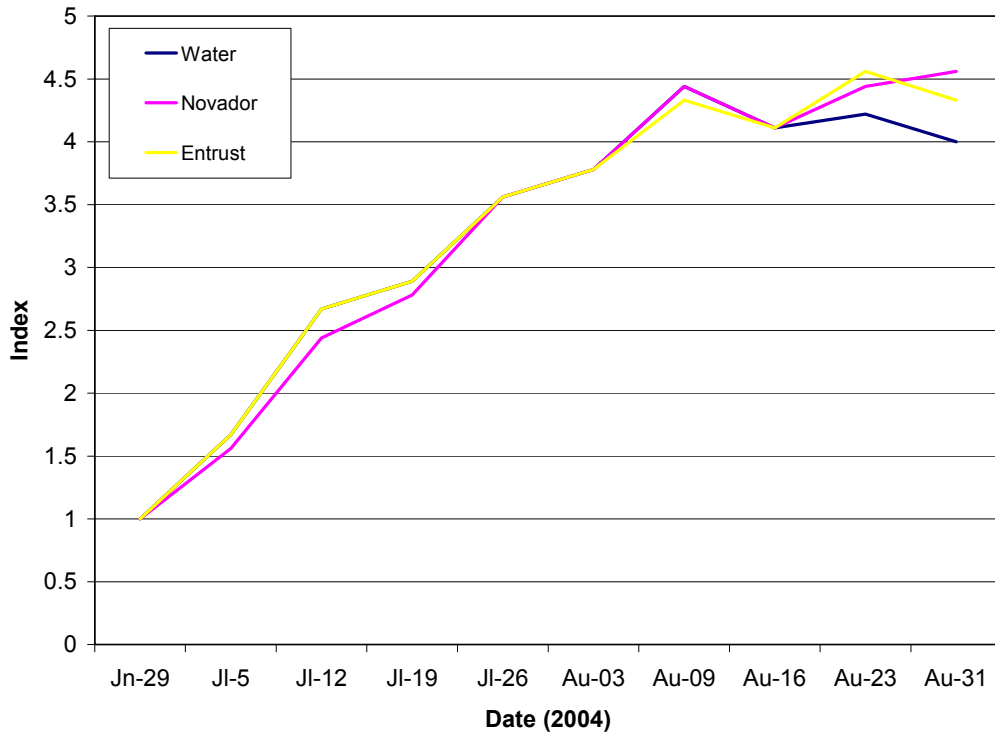


Figure 2. Seasonal changes of the canopy index in organically grown potato plots treated with Entrust, Novador on July 20th and August 10th or left untreated.

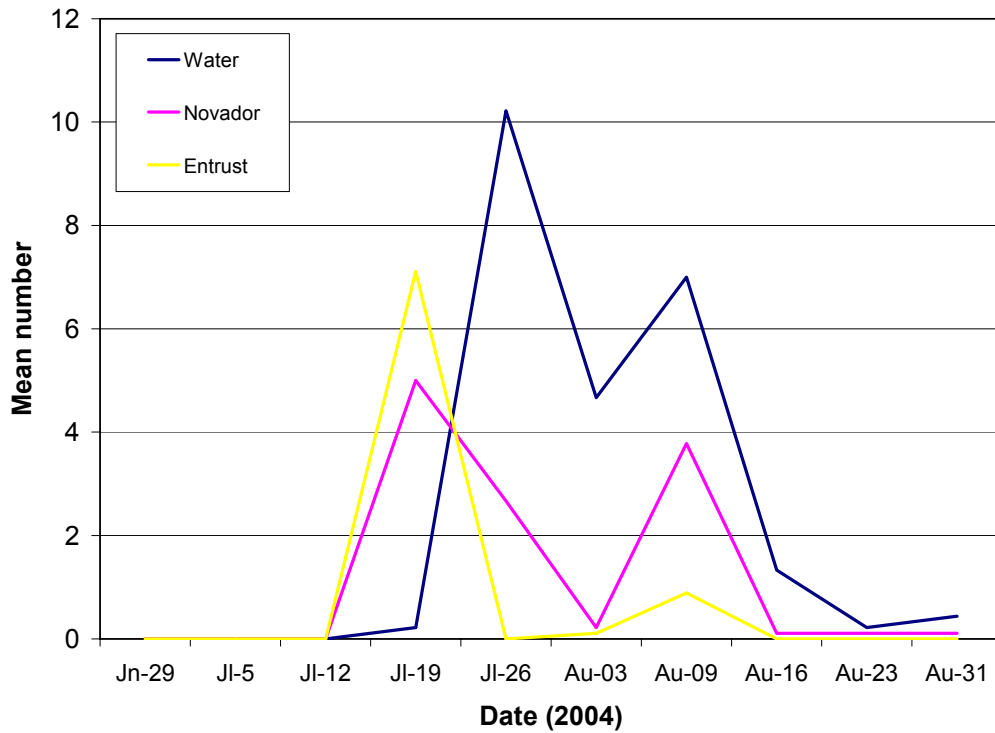


Figure 3. Seasonal changes (2004) in the mean number of stage 3 Colorado potato beetle larvae per 5 plants in 2004 in organically grown potato plots treated with Entrust, Novador on July 20th and August 10th or left untreated.

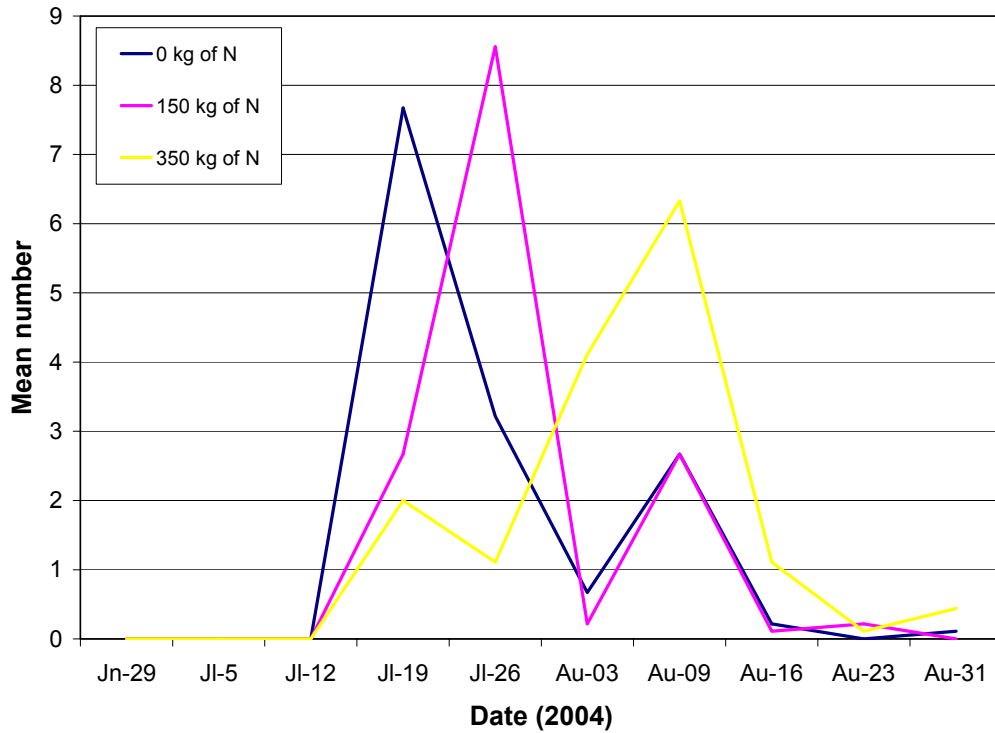


Figure 4. Seasonal changes (2004) in the mean number of stage 3 Colorado potato beetle larvae per 5 plants in organically grown potato plots treated with 150 and 300 kg of N (Nutriwave) at planting or left unfertilized.

Acknowledgements

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