# The Great Lakes Entomologist

Volume 17
Number 3 - Fall 1984 *Number 3 - Fall 1984*

Article 6

October 1984


# Control of the Colorado Potato Beetle (Coleoptera: Chrysomelidae) on Tomatoes with *Bacillus Thuringiensis* Var. *Thuringiensis*


G. E. Cantwell
*USDA Research Center*

W. W. Cantelo
*USDA Research Center*

# CONTROL OF THE COLORADO POTATO BEETLE (COLEOPTERA: CHRYSOMELIDAE) ON TOMATOES WITH *BACILLUS THURINGIENSIS* VAR. *THURINGIENSIS*

G. E. Cantwell and W. W. Cantelo[1]

The Colorado potato beetle, *Leptinotarsa decemlineata* (Say), is a serious pest of tomatoes grown in this country. This beetle is also developing resistance to several classes of chemical insecticides including most of the carbamates, chlorinated hydrocarbons, and organophosphates (Forgash 1981), and most recently to the pyrethroids. According to figures in a report released by Schwartz and Klassen (1981), the value of the tomato crop in the USA in 1978 was placed at $914,121,000 and crop loss due to Colorado potato beetle (CPB) damage alone would be 93% of its value if no control were undertaken. These figures along with the fact that the CPB is developing resistance dictate the need for, and development of, alternative control measures.

For over 15 years it has been known that the bacterium, *Bacillus thuringiensis* (*B.t.*) produces an exotoxin that will kill larvae of the CPB (Burgerjon, et. al. 1969). This exotoxin, the so-called beta-exotoxin or thuringiensin is produced by several varieties of *B.t.* including the variety *thuringiensis* (*B.t.t.*). Earlier laboratory work (Cantwell and Cantelo 1981) indicated that this exotoxin from several sources has, against neonate CPB larvae, a measurable $LD_{50}$ and that its quantity and quality can be determined by bioassay and high pressure liquid chromotography techniques.

The purpose of the work reported here was to test the efficacy of two experimental preparations of *B.t.t.* in field trials against the CPB in both experimental plots and under commercial growing conditions. The experimental material used in these tests has not as yet been cleared for use by the E.P.A.

## MATERIALS AND METHODS

Two experimental preparations of *Bacillus thuringiensis* var. *thuringiensis* were sprayed on tomato plants for beetle control. One, preparation produced by Sandoz, Inc. of Wasco, CA, labeled SAN 410SC72, contained 2.0 g/l of the beta-exotoxin. The other product was furnished by Biochem Products of Montchanin, DE, labeled strain #19, and contained 0.5 g/l active ingredient.

The test in which the Sandoz product was used consisted of 18 plots ca. 250 $m^2$ in size and located at the USDA Beltsville, MD, Agricultural Research Center. Nine of these plots were used as untreated controls and the remaining nine were sprayed with three levels of the *B.t.t.*, each replicated three times. *B.t.t.* applications were made at 450 psi with a tractor towed Agrotec sprayer equipped with drop nozzles at rates of either 1.17, 2.34, or 7.0 l in 935 l of water per hectare at about weekly intervals beginning 3 June 1983. Tomatoes were of the Supersonic cultivar.

Tests with the Biochem preparation were conducted on two commercial grower's farms near Cambridge, MD. On each farm three 0.3-ha plots were established (an untreated plot, a *B.t.t.* treated plot, and a plot using conventional pest controls). On one farm the *B.t.t.* was applied at 1 part:500 parts water (v/v) and the other at 1:1000. Sprays were applied to the run-off-point with a back-pack sprayer at approximately weekly intervals. Plots were planted with processing tomatoes of either the Campbell-28 or VF-134 cultivars. Transplants were set out in rows 1.2 m apart with 30 cm between plants within the row. Pre-emergent herbicides were applied and the plots were cultivated with a

[1]Vegetable Laboratory, USDA, Agricultural Research Center, Beltsville, MD 20705.

follow-up weed control of either Eptam or Tillam. The transplants received a side dressing of 10-10-10 fertilizer. All plots received fungicide applications (i.e., Dithane or Bravo) at time of crown fruit appearance. In those plots receiving conventional pest controls, Vydate was applied twice during the season. Yield data were taken at harvest.

To determine efficacy of the *B.t.t.* preparations and conventional treatment, counts were made prior to spray applications of numbers in four life stages of the beetle: adults, egg masses, 1st & 2nd instar larvae, and 3rd & 4th instar larvae. Statistical analyses were used to compare means.

## RESULTS AND DISCUSSION

**Beltsville tests.** Surveys taken at nearly 7-day intervals throughout the test indicated no consistent significant differences among or between treated and untreated plots in numbers of egg masses or 1st or 2nd instar larvae. Two weeks after egg masses were first discovered, no significant differences were observed among numbers of 3rd and 4th instar larvae or adults, however, by the 15th of June, large numbers of older larvae were counted in the untreated plots. These numerous 3rd and 4th instar larvae and the resulting adults completely defoliated three of the untreated plots as indicated in Figure 1, and produced significant differences between numbers in these life stages in the remaining untreated and treated plots. A measure of the effectiveness of the combined *B.t.t.* treatments when compared to the combined untreated plots is evident in the tremendous reductions in the treated plots in populations of older larvae and adults which were 99.9% and 98.6% respectively (Table 1).

In most of the treated plots very few 3rd or 4th instars or adults were present and because of this there were no significant differences among the three treatment levels. From these data, we are unable to determine or predict the lowest level that would afford economic protection to different levels of beetle infestation.

**Cambridge tests.** In the test plot treated with *B.t.t.* at the 1:500 rate, significant differences from the untreated plots were noted as early as the 1st of June in both numbers of egg masses and young larvae. At this time the number of egg masses per plant in the untreated plot was nearly 1.25 which, a week later, resulted in nearly 10 1st and 2nd instar larvae per plant. By 23 July, the number of 3rd and 4th instar larvae per plant averaged 5.14. A week later there were 11.5 adults per plant which were sufficient in number to completely defoliate these immature plants in this untreated plot, resulting in no yield. At no time during the test did the average numbers of 3rd or 4th instar larvae or adults in the *B.t.t.* treated plot reach 0.1 per plant.

The effect of the *B.t.t.* on the Colorado potato beetle is in preventing 1st and 2nd instar larvae from becoming 3rd instars and hence 4th instars and adults. At a dilution of 1:500 the percent reduction of 3rd instar larvae and adults due to *B.t.t.* treatment exceeded 99% and nearly 95% respectively. The 1:1000 dilution produced similar results. These results were almost identical to those of the Vydate treatment, however, (see Table 2) the

Table 1. Percent reduction of the Colorado potato beetle by life stage on tomato plants either untreated or treated with *Bacillus thuringiensis* var. *thuringiensis*[a] at Beltsville, MD.

| Stage | Untreated[b] | Treated[b] | Reduction (%) |
|---|---|---|---|
| egg mass | 371 | 41 | 88.9 |
| 1st & 2nd instar | 1814 | 992 | 45.3 |
| 3rd & 4th instar | 1345 | 1 | 99.9 |
| adult | 1221 | 17 | 98.6 |

[a]*B.t.t.* Experimental preparation SAN 410SC72 supplied by Sandoz, Inc.
[b]Total numbers in each life stage on plants sampled.

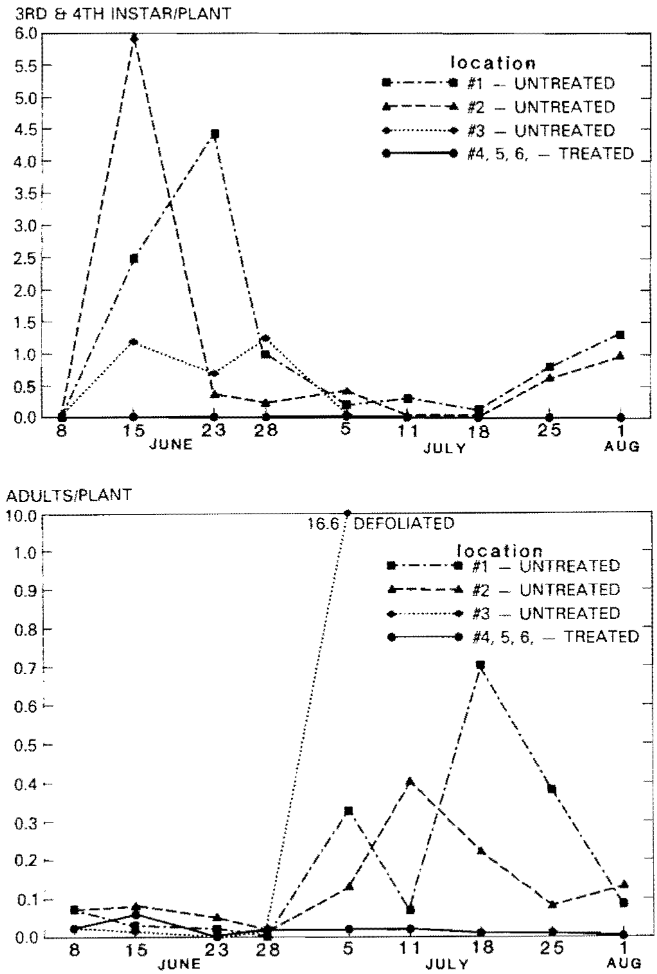


Fig. 1. Effect on numbers of Colorado potato beetle 3rd and 4th instar larva of adults on tomato plants due to weekly applications of spray containing *Bacillus thuringiensis* var. *thuringiensis*. Location #1 (plots 1, 2, and 3 untreated); location #2 (plots 4, 5, and 6 untreated); location #3 (plots 7, 8, and 9 untreated); locations #4, 5, and 6 (plots 10–18 treated) at Beltsville, MD.

chemical was much more effective in reducing the number of egg masses and 1st and 2nd instar larvae.

No significant differences were noted in number of beetles between *B.t.t.* and conventional treatments, nor was there a difference in tomato yield. The conventional and *B.t.t.* treated plants yielded 28.5 and 30.5 lbs. of ripe tomatoes per 150 row ft. This low tomato production was partly due to severe drought which also deactivated herbicides and allowed annual weeds to effectively compete with the crop.

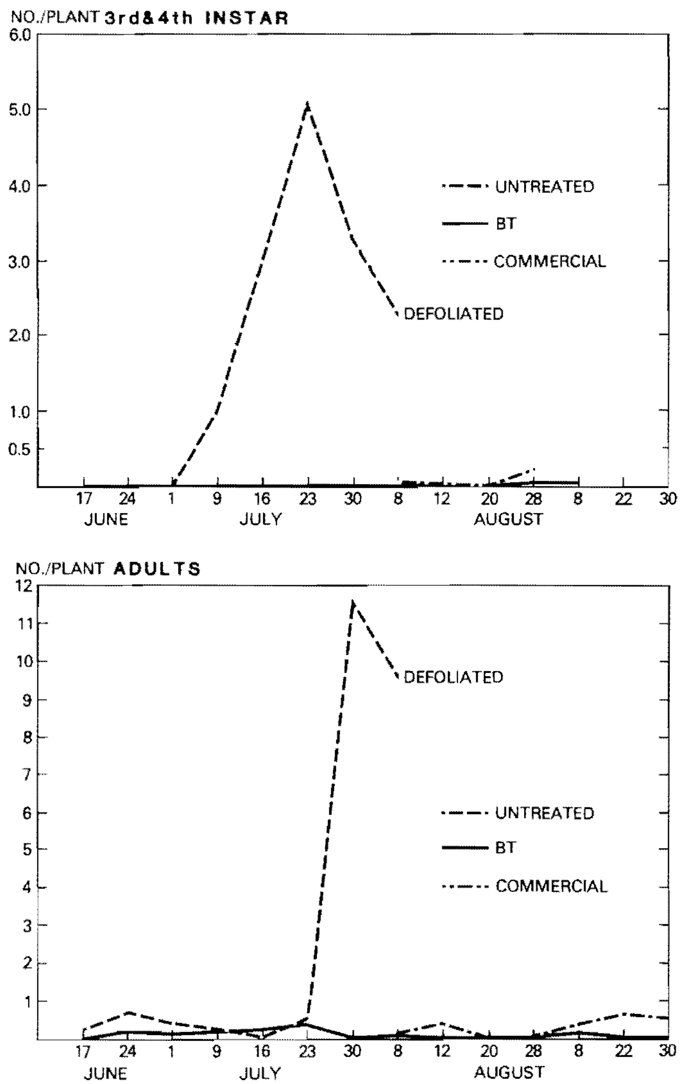


Fig. 2. Effects on numbers of Colorado potato beetle 3rd and 4th instar larvae or adults on tomato plants due to weekly applications of *Bacillus thuringiensis* var. *thuringiensis* at a dilution of 1:500 at Cambridge, MD.

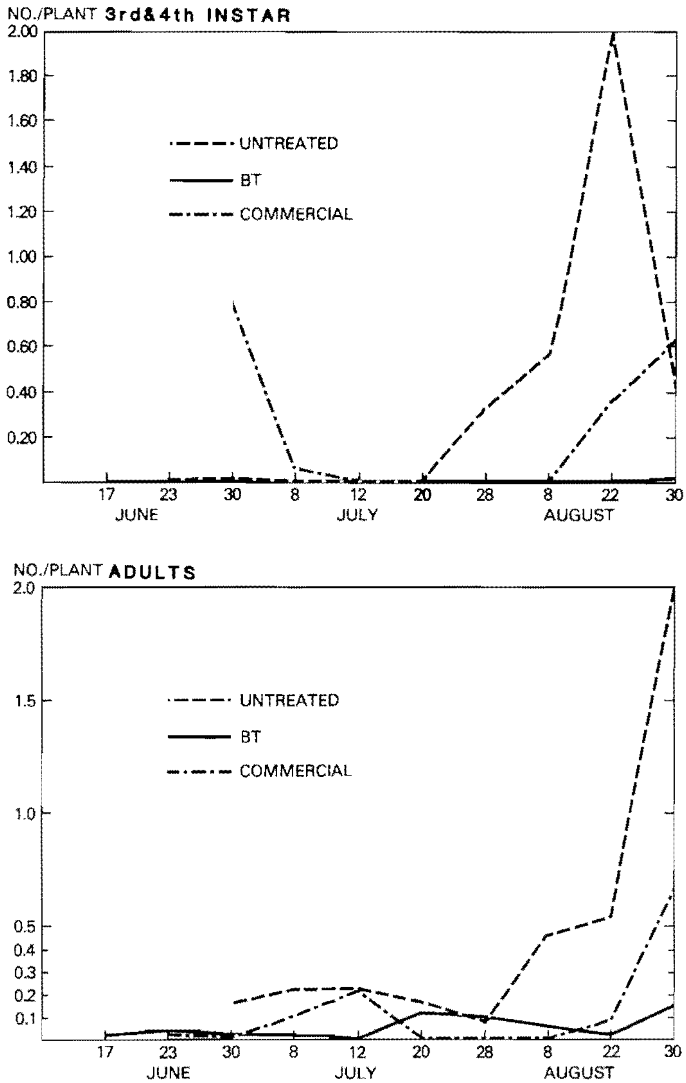


Fig. 3. Effects on numbers of Colorado potato beetle 3rd and 4th instar larvae or adults on tomato plants due to weekly applications of *Bacillus thuringiensis* var. *thuringiensis* at a dilution of 1:1000 at Cambridge, MD.

Table 2. Percent reduction of the Colorado potato beetle on tomato plants treated with either *Bacillus thuringiensis* var. *thuringiensis* (*B.t.t.*)[a] or Vydate compared to untreated plants at Cambridge, MD.

| Stage | *B.t.t.* (1:500) | *B.t.t.* (1:1000) | Vydate |
|---|---|---|---|
| egg | 57.6 | 0.0 | 100.0 |
| 1st & 2nd instar | 34.3 | 0.0 | 99.2 |
| 3rd & 4th instar | 99.1 | 99.5 | 98.5 |
| adult | 94.8 | 88.9 | 94.2 |

[a]*B.t.t.* Experimental preparation of crude supernatant, strain #19 supplied by Biochem Products.

## LITERATURE CITED

Burgerjon, A., G. Biache, and P. Cals. 1969. Teratology of the Colorado potato beetle. *Leptinotarsa decemlineata,* as provoked by larval administration of the thermostable toxin *Bacillus thuringiensis.* J. Invertebr. Pathol. 14:274–278.

Cantwell, G. E. and W. W. Cantelo. 1981. *Bacillus thuringiensis,* a potential control agent for the Colorado potato beetle. Amer. Potato J. 58:457–468.

Forgash, A. J. 1981. Insecticide resistance of the Colorado potato beetle, *Leptinotarsa decemlineata* (Say). p. 34–46 *in* J. H. Lashomb and R. C. Casagrande (eds.). Advances in potato pest management. Hutchinson Ross Pub. Co., Stroudsburg, PA.

Schwartz, P. H. and W. Klassen. 1981. Estimate of losses caused by insects and mites to agricultural crops. CRC Handbook of Pest Management in Agriculture. 1:15–77.