Commercial Evaluation of Confirm for Control of Lepidopterous Pests of Lettuce using Various Applications Techniques

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Abstract

Confirm was evaluated in head lettuce for control of lepidopterous pests when applied by air, and when applied by ground at 4, 8 and 12 mph. By air Confirm may not provide commercially acceptable control when used alone. Confirm must be ingested to exhibit activity and aerial applications may not provide adequate spray coverage. When used by ground, applicators should avoid exceeding 8 mph, again because good spray coverage may be compromised.

Introduction

Beet armyworm, *Spodoptera exiqua* (Hübner) (BAW) and cabbage looper, *Trichoplusia ni* (Hübner) (CL), are two of the most serious lepidopterous pest attacking lettuce in Arizona. Presently, pest control advisors (PCAs) and growers rely primarily on Lannate or Larvin tank-mixed with a pyrethroid and/or a *B.t.* to control these pests. Lannate and Larvin target BAW while the pyrethroids target CL. Within recent years, several new insecticides have begun development for worm control in lettuce. Unlike many of the products developed in the past, these insecticides are more target specific and more mundane to the environment. One of these new products is Confirm (tebufenozide). Confirm was granted an emergency use exemption (Section 18) in Arizona in the spring of 1997, for use on lettuce, cole crops and leafy greens for control of BAW. Confirm is a "biorational" insecticide, being specific towards lepidopterous pests. Confirm in a insect growth regulator and acts by mimicking the activity of the insect hormone ecdysome. Ecdysome is used by the insect to induce the molting process. Thus Confirm induces premature molting and eventual death to poisoned insects. Because of its mode of action, it is considered a slow acting insecticide, requiring 5 to 7 days to induce mortality. However, poisoned insects stop feeding within hours of ingesting the material. Confirm must be ingested to induce mortality. Therefore, Confirm is an application sensitive material and requires thorough coverage to maximize control. In this study, we investigated the effects different application techniques have on Confirm's ability to control lepidopterous insect in lettuce within a commercial demonstration field.

Materials and Methods

Five acres of head lettuce was direct seeded into double rows on 42-in beds on 5 Mar at the Yuma Valley Agricultural Center, Yuma, AZ. This lettuce was initially intended to be treated with insecticides similarly to commercial lettuce. However, because the lettuce was having to be frequently treated for thrips, there was no opportunity to evaluate Confirm for worm control. Therefore, thrips sprays were discontinued and lepidopterous pests were allowed to develop. Confirm was evaluated following two applications using various application techniques.

The first application was made by air in 10 gal of water per acre on 1 May, when the lettuce was at the 12-15 leaf stage. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal. Because this application was made by air, there was not

The second set of applications were made using a Mel-Roe sprayer in 30 gal of water per acre on 13 May, when the lettuce was beginning head formation. The field was split into five equal strips, each constituting a different speed and/or treatment. Three of the strips were treated with Confirm at 8 oz / A + Latron CS-7 at 1 pt / 100 gal, at either 4, 8 or 12 mph. A fourth strip was treated with Success (spinosad) + Latron CS-7 at 1 pt / 100 gal, at 12 mph, and the fifth strip remained untreated.

Three techniques were used to evaluate efficacy: 1) a constant site evaluation, 2) a tagged plant evaluation, and 3) random plant sampling. Precount evaluations were made followed by evaluations at sometimes 2, and 5 and 7 days after treatment (DAT). The constant site evaluation was made by marking five locations in each treatment pseudo-replicated 4 times. Each location consisted of five consecutive plants. Each of these locations contained BAW and/or CL larvae and remained constant throughout the evaluation period. The tagged plants evaluation was made by tagging 5 individual plants pseudo-replicated 4 times, that contained BAW and/or CL larvae in each treatment area. The random plant evaluations were conducted within each treatment by inspecting 25 plants in each treatment area with 4 pseudo-replicates.

Because of the lack of naturally occurring BAW larvae, the field was artificially infested. Two days before the aerial application, each set of five consecutive plants was infested with 5 small (1st and 2nd instar) and 5 large (3rd and 4th instar) BAWs. Additionally, 20 individually tagged plants were infested, half with small BAWs and the other with large BAWs. Prior to the ground applications lettuce was artificially infested with BAWs by placing egg masses on plants 5 and 3 days prior to spraying.

In addition to collecting data on lepidopterous larvae, following the ground applications, data was collected on the number of western flower thrips, *Franklinella occidentalis* (Pergande) and beneficial insects. Ten lettuce plants were collected from four locations from each treatment and placed in insect extraction cans. Each sample was fumigated with methyl ethyl ketone to dislodge any insects into a receptacle in the bottom of the can. These samples were taken to the lab and counted using a dissecting microscope.

The percent marketable heads (based only on lepidopterous pest damage) was estimated within each ground application treatment on 22 May. Twenty-five heads from four locations within each treatment were cut and rated as marketable or non-marketable. Any plant with significant damage to the wrapper leaves, any damage to the head, or contaminated with frass of insect parts was considered unmarketable.

These tests were setup as commercial demonstrations, and because of logistical reasons were pseudo-replicated. Comparisons were made by comparing relative differences in mean standard errors and 90% confidence intervals.

Results and Discussion

Aerial Application

Evaluations from constant locations of five consecutive plants are presented in Figure 1 for BAW and Figure 2 for CL. At 2 DAT, BAW numbers dropped dramatically suggesting that the BAWs we used to infest moved from the plants they were placed (Figure 1) Therefore, BAW data generated from the artificially infested plants does not accurately represent product performance. CL number slowly declined within 7 days following the aerial application from ca. 2.7 total CLs to ca. 0.3 CLs (Figure 2).

Data taken from randomly sampled plants with naturally occurring BAW larvae suggests that, at low population densities, Confirm provided good control reducing the number of BAW detected to zero by 7 DAT (Figure 3). However, Confirm did not seem to provide as good of control of CL (Figure 4). CL densities were high prior to the aerial application totaling ca. 7 larvae per 100 plants. By 7 DAT, CL numbers had dropped to ca. 2 larvae per 100 plants, which does not represent commercially acceptable control.

Similar to the results observed from the five consecutive plant samples, few live BAWs were found on individually tagged plants even 2 DAT. Most of the larvae were categorized as missing, again suggesting that the larvae used for

artificially infested dispersed from the plants on which they were placed (Figures 5 & 6). At 2 DAT, 70% of the small CL were found alive (Figure 7). The percentage of live small CLs dropped to 25 and 15% at 5 and 7 DAT respectively. Although this represents a significant reduction in CL survival, 85% control is not commercially acceptable. When monitoring large CL larvae, by 5 DAT the percentage of live large CLs dropped form 55 to 15%, and by 7 DAT no live large CL were found (Figure 8). Since the number of missing large CLs increased significantly over the 7 day evaluation period, we were not able to effectively determine true fate of each CL. However, we were able to determine that at least 50% of the large CL monitored died by 7 DAT.

Ground Applications

Naturally occurring BAWs were too scarce following the ground applications to produce reliable data. An attempt was made to artificially infested the field using BAW egg masses, but few of the eggs hatched due to heavy predation by beneficial insect. Therefore, only CL data will be presented.

At 5 DAT, small CLs were most numerous in the untreated and Success plots, but by 7 DAT, numbers in the Success plots declined, while those in the Confirm at 8 mph increased to slightly greater than the untreated (Figure 9). Since no small CLs were detected in the Confirm at 8 mph plots at 5 DAT, the increase by 7 DAT probably represents newly hatched larvae. Because Confirm requires 5 to 7 days to kill the larvae, the presence of newly hatched larvae could make determining product performance difficult for growers and pest control advisors. The number of large CL dropped to zero by 5 and 7 DAT in all the plots except the untreated, suggesting that Confirm and Success provided good control of CL and/or induced dispersal of the larvae (Figure 10).

Data taken by counting larvae from 100 randomly selected plants produced results similar to the consecutive plant counts (Figures 11 & 12). Small CL dropped in all plots 5 DAT, except for Success and the untreated (Figure 11). At 5 DAT, all the treatments contained fewer small CL larvae than the untreated, and Confirm at 4 and 8 mph contained fewer larvae than Success or Confirm at 12 mph. This suggests that better CL control may be achieved at slower speeds where spray coverage can be maximized. There was no difference between Confirm and Success at 12 mph, 5 DAT. At 7 DAT, small CLs rose in all plots except Success which remained fairly constant, suggesting that newly hatched larvae were being sampled. Although Confirm in known to provide good residual activity, over 7 days under cool low light intensity conditions, temperatures and light intensity were high during this test. Under similar environmental conditions, Confirm has been shown to provide three days residual activity. Large CLs dropped to less than 0.5 larvae per 100 plants in all treated plots by 5 DAT (Figure 12). Numbers remained low at 7 DAT, except for Confirm at 8 mph, which unexplainably rose to equal the number found in the untreated.

The untreated plots, at 5 DAT, contained a significantly greater percentage of live larvae than any of the other treatments (Figure 13). Although, Confirm at 4 mph contained 16.6% live small CLs at 5 DAT, it did not significantly differ from the other treatments. By 7 DAT, many more larvae had become missing in the untreated plots, and there were no differences among treatments in the percentage of live small CL larvae. The only live CL larvae found following the ground application were in the Confirm at 8 and 12 mph treatments (Figure 14). Whether or not this denotes a lack of performance is not clear. Nuclear polyhedral virus had become prevalent at this time and many larvae were killed, as evident from the amount of mortality detected in the untreated.

Thrips populations were extremely high prior to applying insecticides averaging 205 thrips in the untreated plots (Table 1). However, by 5 DAT, their denisties had drop substantially across all treatments. Thus, we could not detect any significant differences among treatments. The reason for the drop in thrips numbers may have been due to the high number of predatory insects present in the field (Table 2). The high number of beneficial insects no doubt aslo contributed to our inability to produce an artificial infestation of BAW using larvae and egg masses. Neither Confirm nor Success appeared to detrimentally affect the population of beneficial insects.

Because lepidopterous pest densities were allowed to reach high numbers, the percentage of marketable heads were low in all treatments (Table 3). However, relative differences among treatments were relevant. All the treated plots contained more marketable lettuce than the untreated.

Overall, efficacy of Confirm and Success under the various application techniques used in this demonstration towards BAW was inconclusive due to the low populations. However, data concerning CL control provided some insight into the performance a commercial grower might expect to observe. Confirm appeared to be weak when applied by air. Grower may have to utilize a tank mix partner such as a pyrethroid or *B.t.* with Confirm if an aerial application is necessary. If possible Confirm should be applied by ground application equipment. Although we did not detect distinct differences among the various speeds when using a ground applicator, the 12 mph applications may be slightly inferior to slower speeds.

Table 1. Mean ± SEM of western flower thrips per 10 lettuce plants treated with Confirm and Success[a].

	Precount (12 May)			5 DAT[b](18 May)		
Treatment[c]	Nymphs	Adults	Total[d]	Nymphs	Adults	Total[d]
Untreated	129.75 ± 22.16	75.00 ± 15.72	204.75 ± 36.84	10.00 ± 7.57	13.00 ± 6.04	23.00 ± 13.58
Confirm 4 mph	194.75 ± 40.23	133.25 ± 30.27	328.00 ± 69.16	5.25 ± 1.11	10.00 ± 2.74	15.25 ± 3.22
Confirm 8 mph	29.25 ± 6.29	55.25 ± 5.20	84.50 ± 11.42	5.25 ± 1.84	6.25 ± 1.03	11.50 ± 2.72
Confirm 12 mph	87.25 ± 27.88	36.50 ± 6.13	123.75 ± 33.37	4.00 ± 2.31	8.25 ± 2.95	12.25 ± 5.04
Success 12 mph	19.00 ± 5.48	25.00 ± 9.42	44.00 ± 14.31	2.00 ± 1.35	11.50 ± 4.50	13.50 ± 5.78

[a] Whole plant counts taken using a can fumigation technique.
[b]DAT - days after treatment.
[c]Confirm - 8.0 ozs / acre + Latron CS-7 at 1.0 pt / 100 gal, applied by ground at 30 gal per acre at 4, 8, and 12 mph; Success - 4.5 ozs. / acre + Latron CS-7 at 1.0 pt / 100 gal, applied by ground at 30 gal per acre at 12 mph.
[d]Nymphs + adults.

Table 2. Mean ± SEM of predators (*Orius* spp.) and parasitic wasps *(Hyposter* sp.) per 10 lettuce plants treated with Confirm and Success[a].

	5 DAT[b] (12 May)	
Treatment[c]	Total[d] *Orius* spp.	Adult wasps
Untreated	43.00 ± 8.80	2.75 ± 1.49
Confirm 4 mph	34.50 ± 10.09	8.00 ± 1.58
Confirm 8 mph	17.50 ± 5.24	0.75 ± 0.75
Confirm 12 mph	22.25 ± 4.31	2.00 ± 1.22
Success 12 mph	20.00 ± 4.55	0.25 ± 0.25

[a] Whole plant counts taken using a can fumigation technique.
[b]DAT - days after treatment.
[c]Confirm - 8.0 ozs / acre + Latron CS-7 at 1.0 pt / 100 gal, applied by ground at 30 gal per acre at 4, 8, and 12 mph; Success - 4.5 ozs. / acre + Latron CS-7 at 1.0 pt / 100 gal, applied by ground at 30 gal per acre at 12 mph.
[d]Nymphs + adults.

Table 3. Mean percentage ± SEM of marketable heads treated with Confirm and Success[a].

Treatment[b]	% marketable heads
Untreated	21.00 ± 6.61
Confirm 4 mph	40.00 ± 4.90
Confirm 8 mph	44.00 ± 3.27
Confirm 12 mph	61.00 ± 3.00
Success 12 mph	55.00 ± 5.00

[a] Percent marketable head considering only lepidopterous pest damage and contamination.
[b]Confirm - 8.0 ozs / acre + Latron CS-7 at 1.0 pt / 100 gal, applied by ground at 30 gal per acre at 4, 8, and 12 mph; Success - 4.5 ozs. / acre + Latron CS-7 at 1.0 pt / 100 gal, applied by ground at 30 gal per acre at 12 mph.

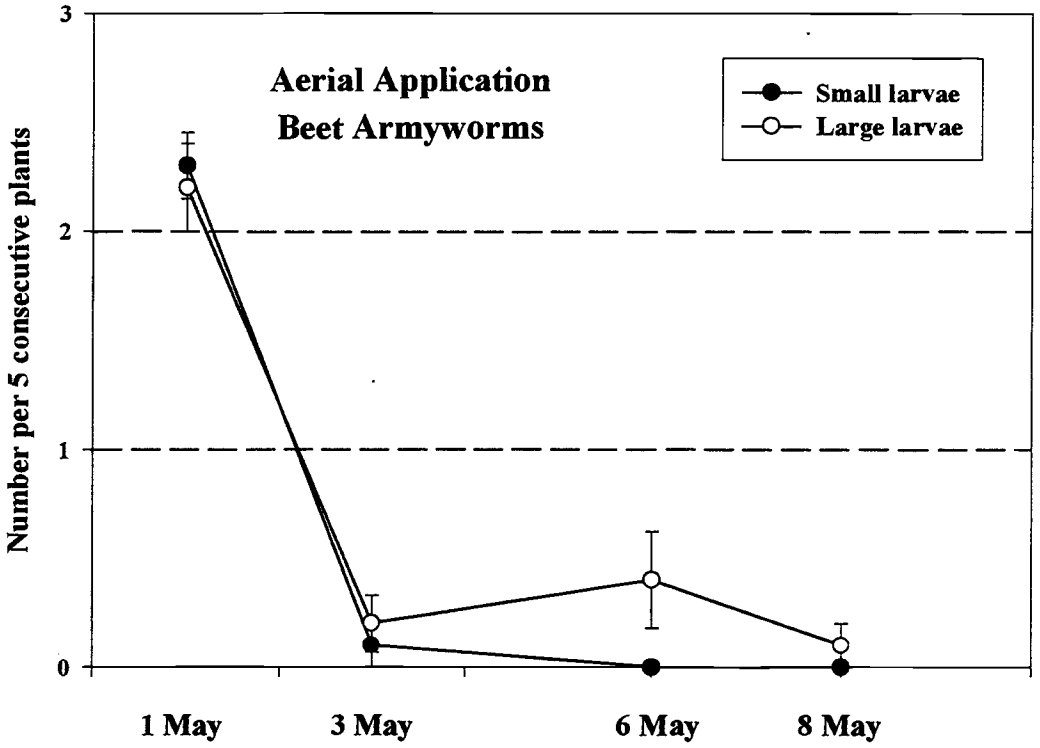

Figure 1. Number of small and large beet armyworms sampled from five consecutive plants. Application was applied on 1 May by air in 10 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal.

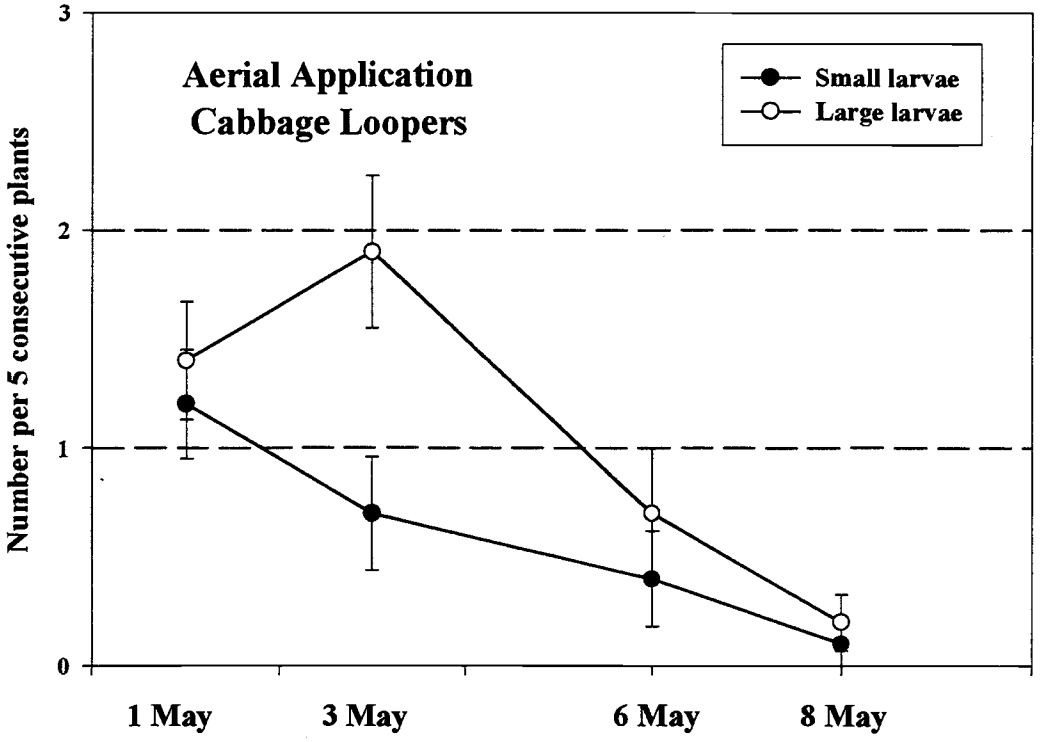

Figure 2. Number of small and large cabbage loopers sampled from five consecutive plants. Application was applied on 1 May by air in 10 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal.

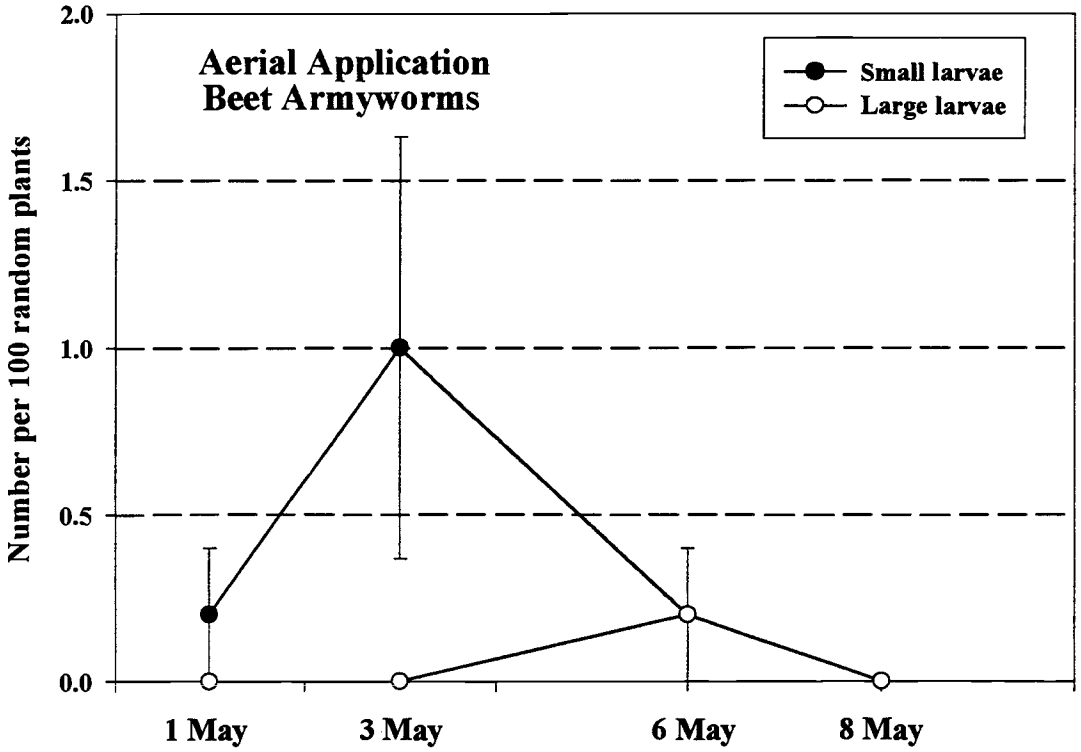

Figure 3. Number of small and large beet armyworms sampled from 100 randomly selected plants. Application was applied on 1 May by air in 10 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal.

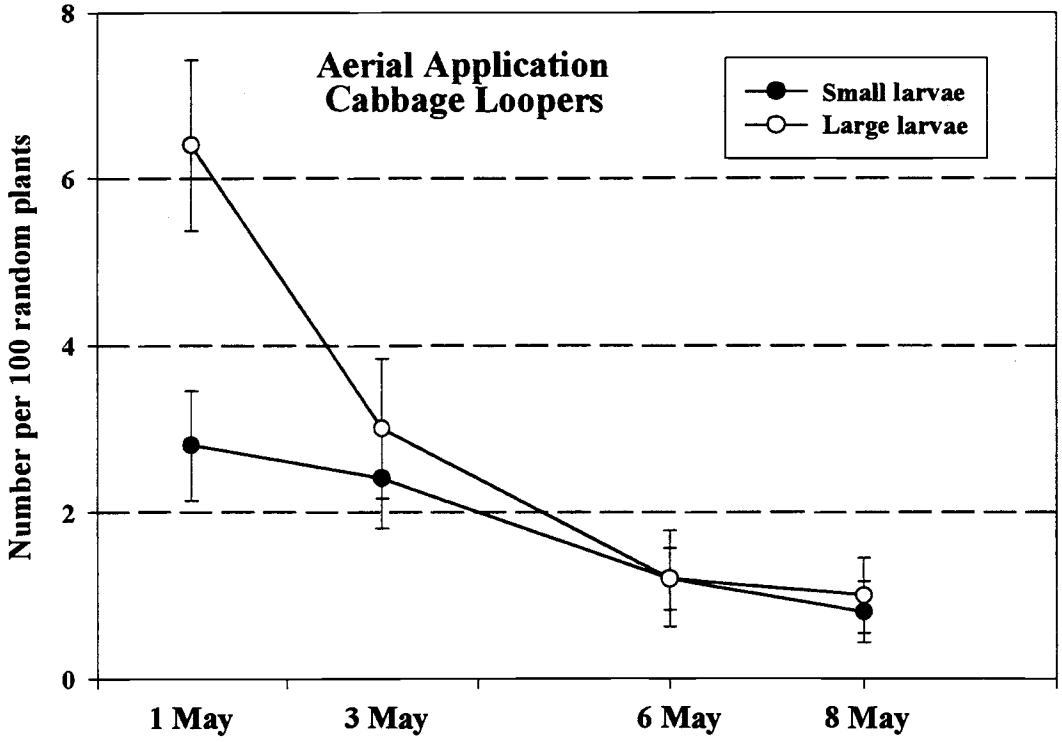

Figure 4. Number of small and large cabbage loopers sampled from 100 randomly selected plants. Application was applied on 1 May by air in 10 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal.

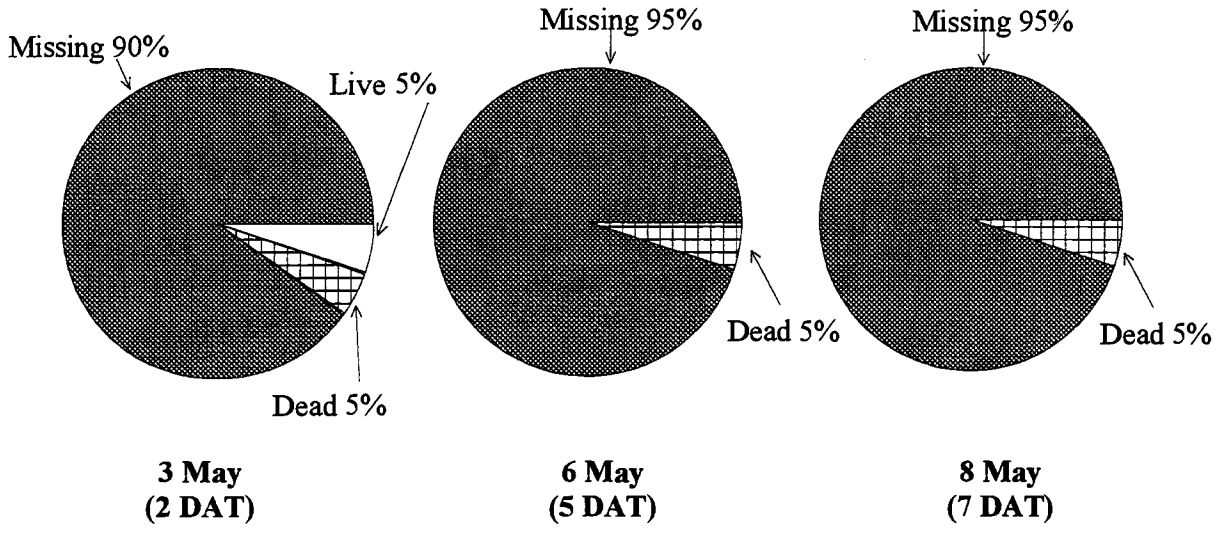

Figure 5. Percentages of live, dead and missing small beet armyworm from individually tagged worms. Application was applied on 1 May by air in 10 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal.

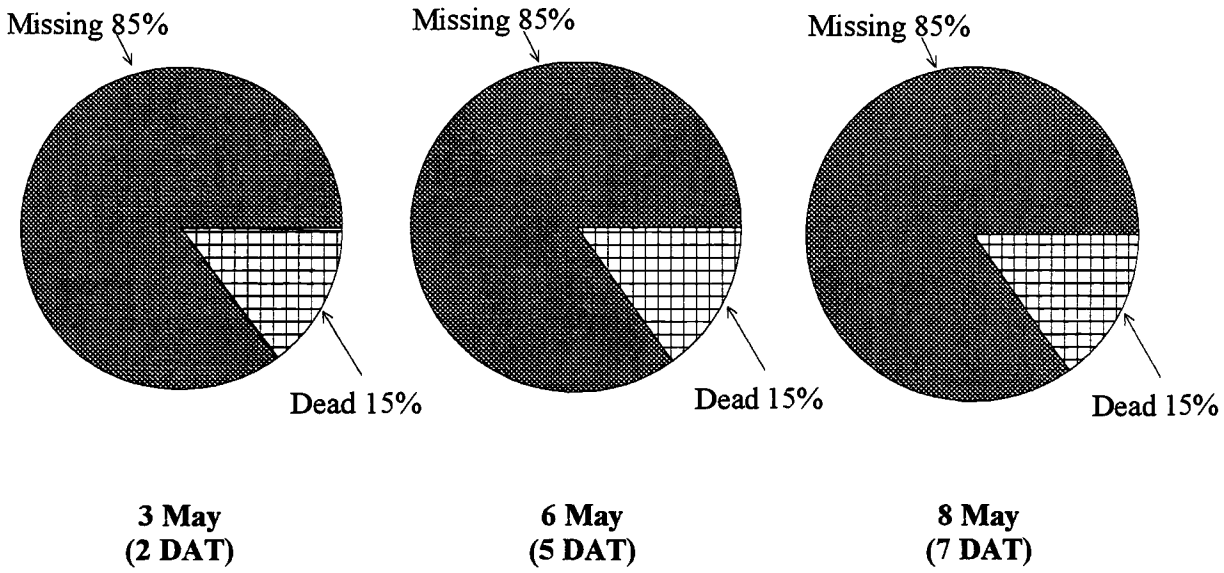

Figure 6. Percentages of live, dead and missing large beet armyworms from individually tagged worms. Application was applied on 1 May by air in 10 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal.

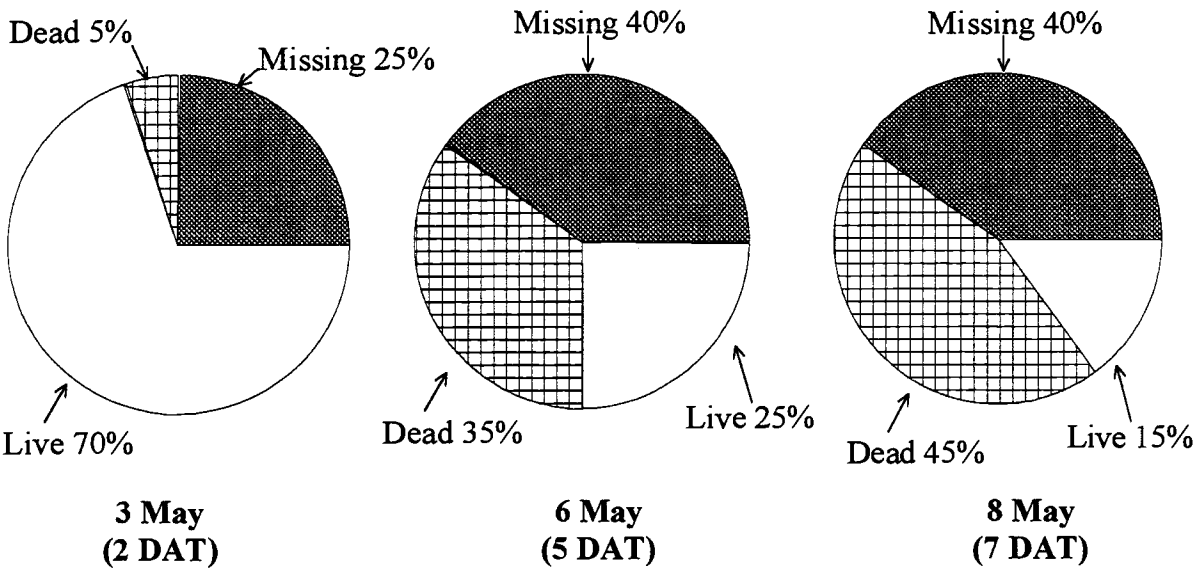

Figure 7. Percentages of live, dead and missing small cabbage loopers from individually tagged worms. Application was applied on 1 May by air in 10 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal.

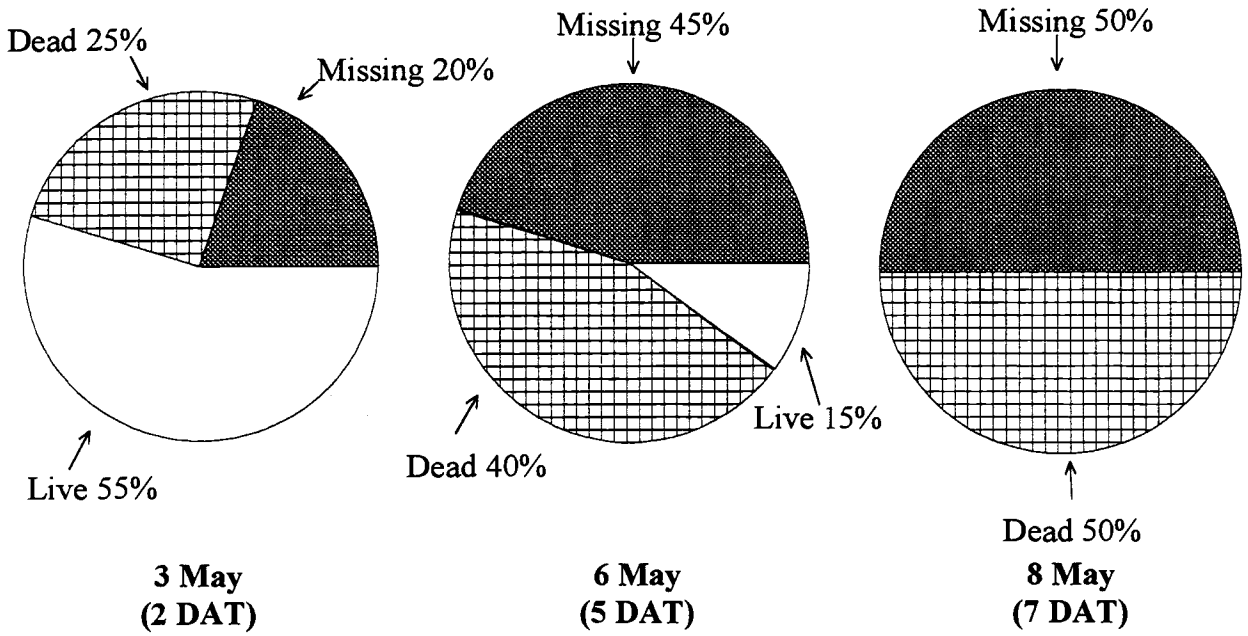

Figure 8. Percentages of live, dead and missing large cabbage loopers from individually tagged worms. Application was applied on 1 May by air in 10 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal.

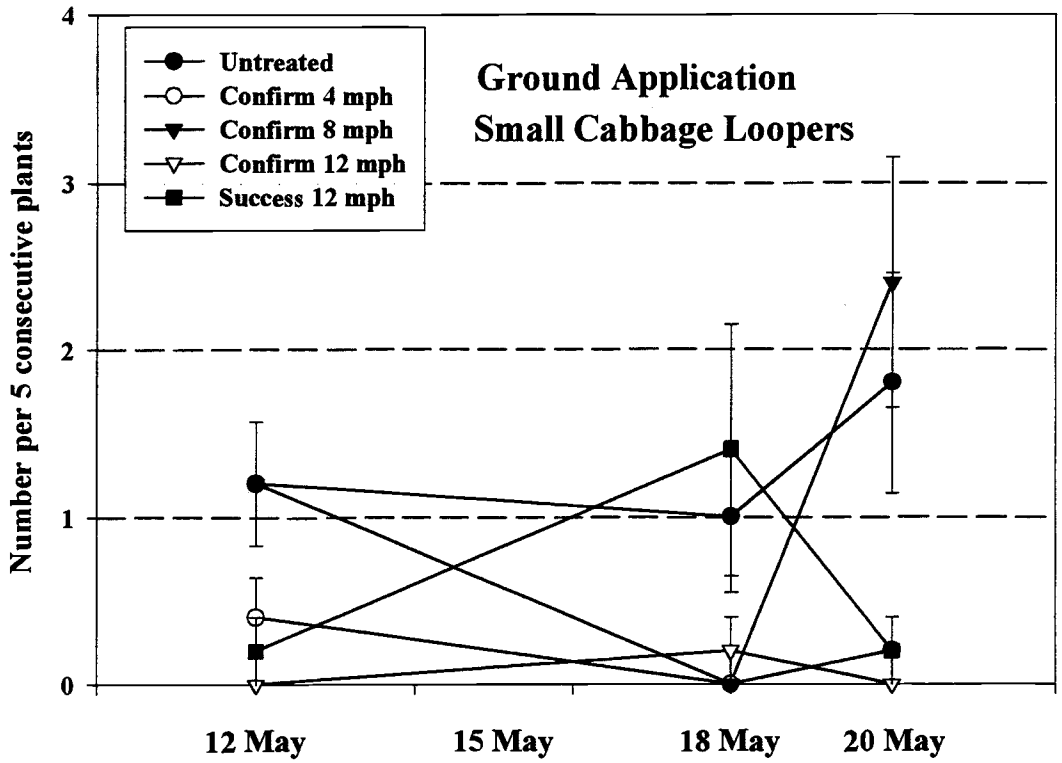

Figure 9. Number of small cabbage loopers sampled from five consecutive plants. Application was applied on 13 May by ground in 30 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal. Success was used at 4.5 oz / A + Latron CS-7 at 1 pt / 100 gal.

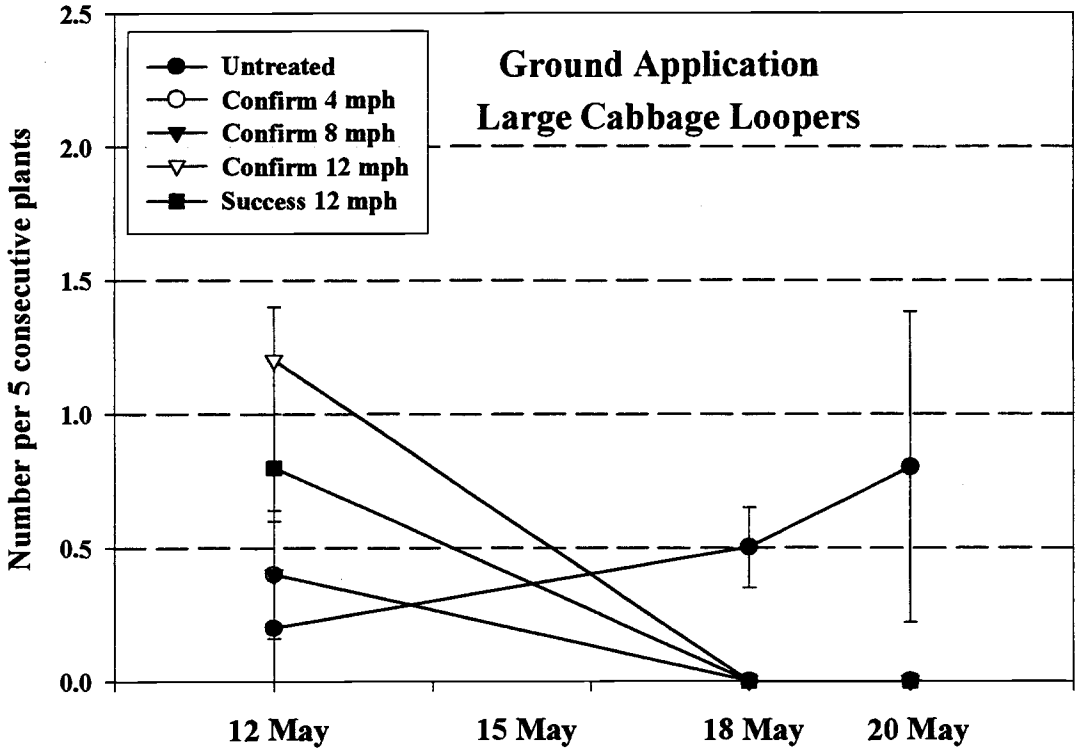

Figure 10. Number of large cabbage loopers sampled from five consecutive plants. Application was applied on 13 May by ground in 30 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal. Success was used at 4.5 oz / A + Latron CS-7 at 1 pt / 100 gal.

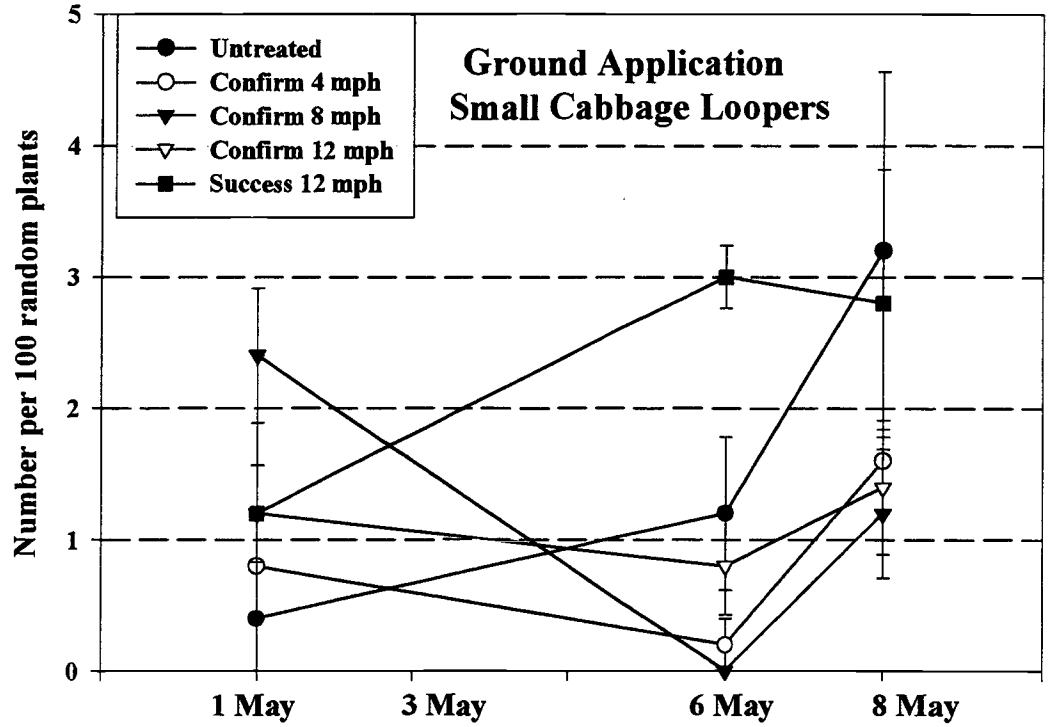

Figure 11. Number of small cabbage loopers sampled from 100 randomly selected plants. Application was applied on 13 May by ground in 30 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal. Success was applied at 4.5 oz /A + Latron CS-7 at 1 pt / 100 gal.

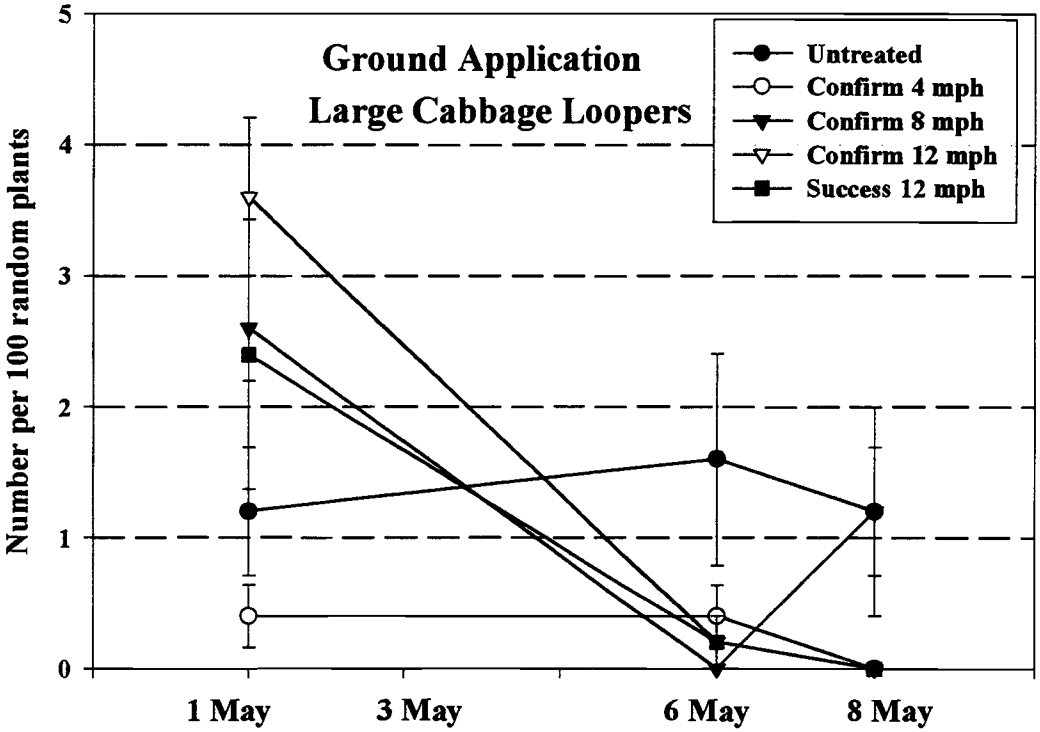

Figure 12. Number of large cabbage loopers sampled from 100 randomly selected plants. Application was applied on 13 May by ground in 30 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal. Success was applied at 4.5 oz /A + Latron CS-7 at 1 pt / 100 gal.

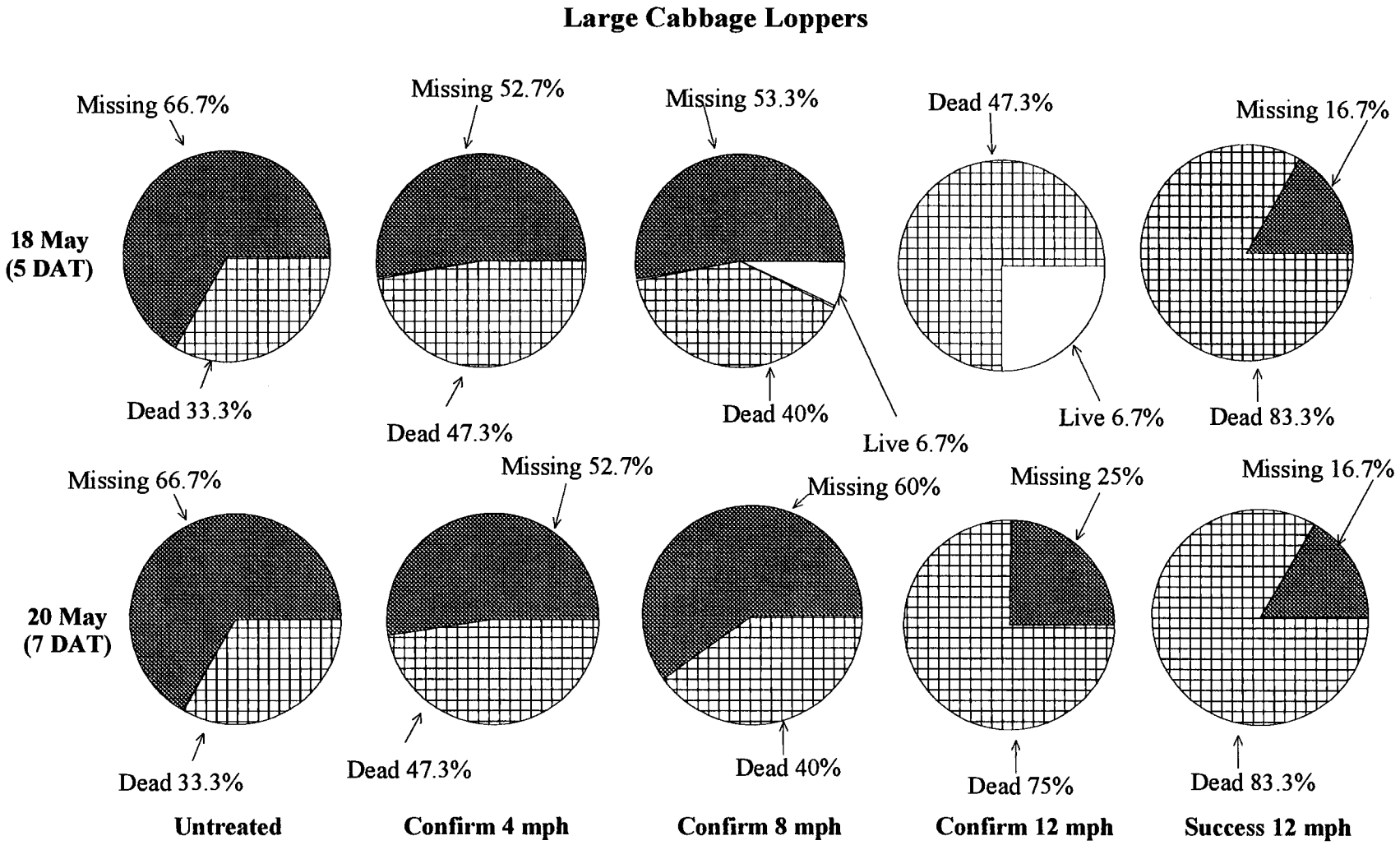

Figure 14. Percentages of live, dead and missing large cabbage loopers from individually tagged worms. Application was applied on 13 May by ground in 30 gallons of water per acre. Confirm was used at 8 oz / A + Latron CS-7 at 1 pt / 100 gal. Success was used at 4.5 oz / A + Latron CS-7 at 1 pt / 100 gal.