Management of Lepidopterous Larvae Under Experimental, Biorational and Conventional Control Programs in Lettuce

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Abstract

A large block experiment was conducted at the Yuma Ag Center to compare the field performance of three lettuce management programs for control of lepidopterous larvae. Conventional, experimental and biorational insecticides were sprayed to control beet armyworm, cabbage looper and Heliothis species throughout the growing season. Differences in populations of total larvae among the four treatments, relative to insecticide treatments and timing of application were observed throughout the season. In general, the standard and experimental treatments provided the most consistent control of lepidopterous larvae following each application. Harvest data showed that the spray regimes had a significant influence of head lettuce yield or quality. Maturity and quality were significantly reduced in the untreated control. An economic analysis shows that net returns varied widely among the management programs at different market prices. In conclusion, this study provides preliminary data to support the need for more development of experimental and biorational insecticide products as alternatives to conventional management programs in desert lettuce production.

Introduction

The beet armyworm, cabbage looper and *Heliothis* species are the major lepidopterous pests of lettuce in desert growing areas of Arizona (Kerns and Palumbo 1997) . Standard insecticides such as methomyl (Lannate) and thiodicarb (Larvin) combined with pyrethroids have been successfully used in controlling this pest complex over the past several years (Palumbo et al. 1993, Palumbo et al. 1994, Palumbo 1996). These products are used frequently during the season, and many speculate that there field effectiveness will soon be reduced under these use patterns. Unfortunately, there are no alternatives insecticides which offer comparable control of lepidopterous larvae. Furthermore, with the recent passage of the Food Quality Protection Act of 1996 (Schreiber 1996), there is speculation that some of the more broadly toxic compounds may be removed from the market in the next few years.
The organophosphate and carbamate insecticides (ie. Lannate, Orthene, Larvin, Endosulfan, Monitor, Diazinon) are being targeted as prime candidates for reduced usage.

There are several alternative products available to lettuce growers for management of the lepidopterous complex. However, these consist of biological (Bts), botanical (neem pyrethrum, rotenone) and inorganic (cryolite) insecticides that have been demonstrated to have only marginal activity on beet armyworm and cabbage looper in lettuce (Palumbo et al. 1992, Palumbo 1995). There activity against Heliothis is not known. Several new compounds are currently being developed which offer not only excellent efficacy against these pests, but are also new insecticide chemistries (Palumbo and Kerns 1996). However, we are uncertain how these alternatives will perform in the absence of the conventional insecticide products under desert growing conditions. Therefore a large- block field study was conducted to compare worm management in head lettuce using conventional, experimental and biorational compounds.

Materials and Methods

Lettuce, *Lactuca sativa* L., 'Early Queen' was direct seeded into large blocks on double-row beds on 21 Sep at the Yuma Valley Agricultural Center, Yuma, Az. Each plot consisted of eight beds, 200 ft long beds spaced 42 inches apart and bordered on each side by two untreated beds. Plots were arranged in a completely randomized block design with 3 replicates. Treatments consisted of experimental (EUP), biorational and conventional (Standard) lettuce management programs (Table 1).

Applications were made on an as needed basis (Table 1). All chemicals were applied by a tractor-mounted boom sprayer operated at 250 psi and 45 gpa. Three, disc-type cone nozzles were used per bed. All chemicals included spreader sticker (Latron CS-7) at a rate of 0.125% of the total volume. Evaluation of lepidopterous larvae control was based the number of live larvae per plant sampled from the center 4 rows of each replicate at 1-3 times per week. The number of samples per replicate varied throughout the season, decreasing as plant size increased (50 plants per replicate on 7, 12, 14 and 17 Oct; 30 plants per replicate on 21, 24 Oct and 2, 8, 12 Nov; 20 plants per replicate on 18, 26 Nov and 4, 12 Dec.).

The sample unit consisted of examination of whole plants for presence of beet armyworm (BAW), *Spodoptera exigua*, Cabbage looper (CL) , *Trichoplusia ni* , and Tobacco budworm (HEL), *Heliothis virescens* larvae. Each species was characterized a large or small. For BAW and HEL, larvae were considered small if <5 mm in length, large >5mm. For CL, larvae were considered small if <10 mm, large if > 10 mm.

Yields were taken when >75% of all heads in the experimental block were considered ready for harvest on 17 December (87 days after planting).. Yields was taken by weighing all heads within 20 ft of bed in 3 locations within each replicate. Quality was measured by estimating the % marketable heads based on shape and firmness for each head harvested. If heads maintained a reasonable shape and firmness they were considered marketable (#24s). Each head was also evaluated for the presence of worm feeding damage and contamination. A partial budget analysis was used to conduct an economic assessment of each lettuce management

Results and Discussion

Differences in populations of total larvae among the four treatments, relative to insecticide treatments and timing of application were observed throughout the season (Figure 1). In general, the standard, and EUP treatments provided the most consistent control of lepidopterous larvae following each application. The failure to make a 4th application of the EUP (20 Nov), resulted in significant increase in larvae for this treatment near harvest, particularly in the number of CL and Heliothis (Fig 3 and 4). The efficacy of each control program following the first 3 applications are shown in Figures 5-7. Both Alert and Success provided excellent control of the worm complex for 7-10 days following treatment. Similarly the conventional products in the standard control regime provided good residual control.

Harvest data showed that the spray regimes had a significant influence of head lettuce yield or quality (Table 2). Maturity and quality were significantly reduced in the untreated control. The standard management program yielded significantly greatest number of cartons than the other management programs when based on average heads/plot, % marketable heads, % worm damage and % head contamination (Table 3). The biorational management program was by far the most expensive, relative to net carton production. Consequently , the economic analysis shows that net returns varied widely among the management programs at different market prices. At a low market price ($5.00/cart) none of the treatments were profitable. At a more common market price ($7.50/cart) the biorational treatment was not profitable, whereas at a market of $10.00 all spray treatments were profitable. As mentioned above, if a 4th application with either Alert, Success, Proclaim or Confirm had been made, yields (cart/acre) and net return in the EUP would with all probability been equal to the Standard management program. In conclusion, this study provides preliminary data to support the need for more development of experimental and biorational insecticide products as alternatives to conventional lettuce management programs under desert growing conditions.

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Table 1. Insecticide compounds, rates and dates applied for each lettuce management program, YAC, Fall 1996.

Management Program	Appl # 1 (Oct 10)	Appl # 2 (Oct 17)	Appl # 3 (Oct 29)	Appl # 4 (Nov 13)	Appl # 5 (Nov 20)
Standard	Lannate (0.8 lb) Mustang (4.0 oz)	Larvin (30 oz) Karate (3.8 oz)	Mustang (4.0 oz) Orthene (0.6 lb) Endosulfan (2pts)		Larvin (0.85 lb) Karate (4.0 oz) Dipel (1.0 lb)
EUP	Alert (9.0 oz)	Alert (9.0 oz)	Success (5.6 oz)		
Biorational	Crymax (1 lb.) Neemix (1 pt) Coax (2 pts)	Cryolite (12 lbs) Xentari (2.0 lbs) Coax (2 pts)	Dipel (1.0 lbs) Cryolite (12 lbs) Pyrellan (2 pts)	Dipel (2.0 lbs) Cryolite (12 lbs) Pyrellan (2 pts)	Dipel (2.0 lb) Neemix (1pt) Pyrellin (2 pt)

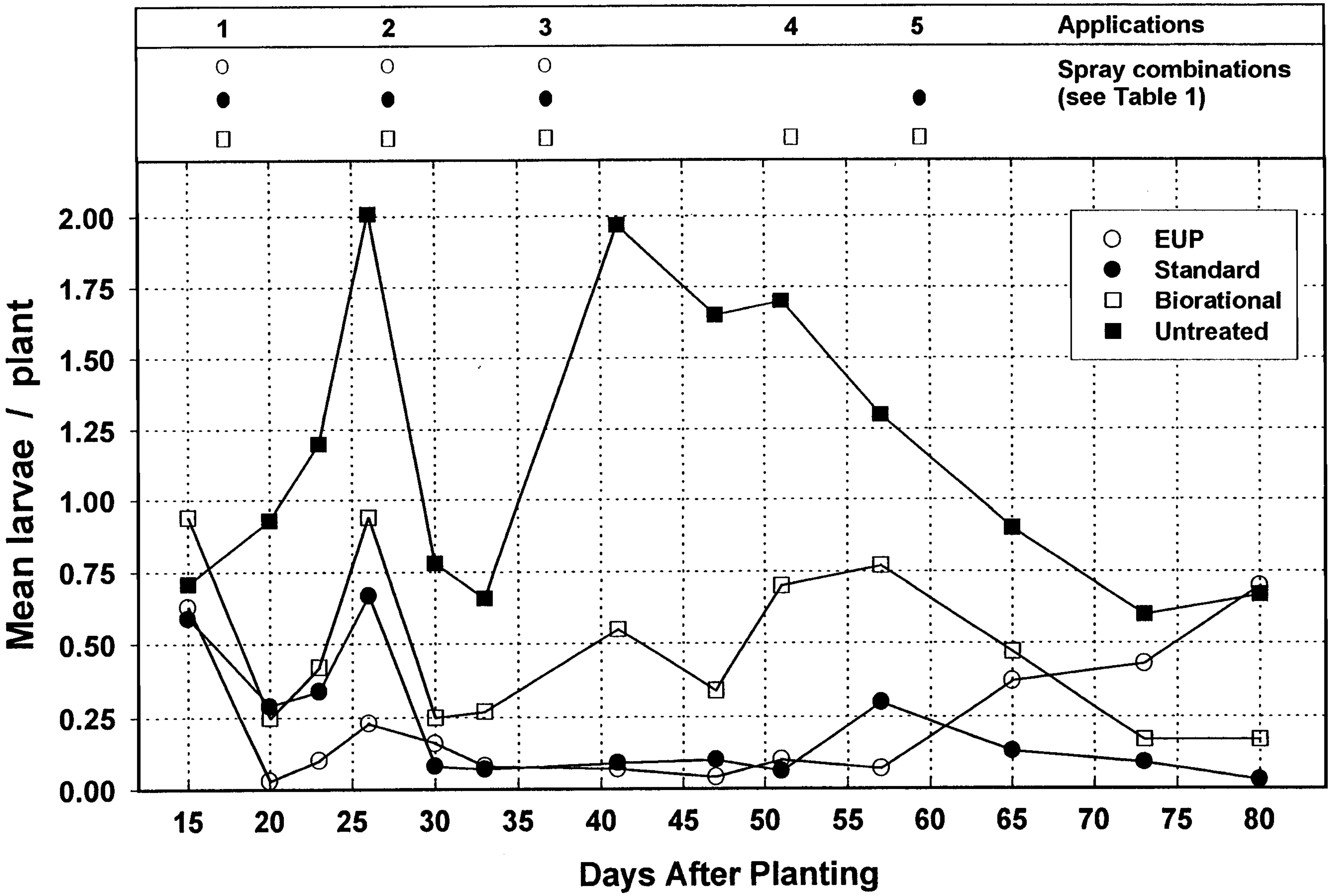


Figure 1. Seasonal Beet armyworm, Cabbage looper, and Heliothis larval populations relative to management program, and timing and frequency of applications in head lettuce, YAC, Fall 1996.

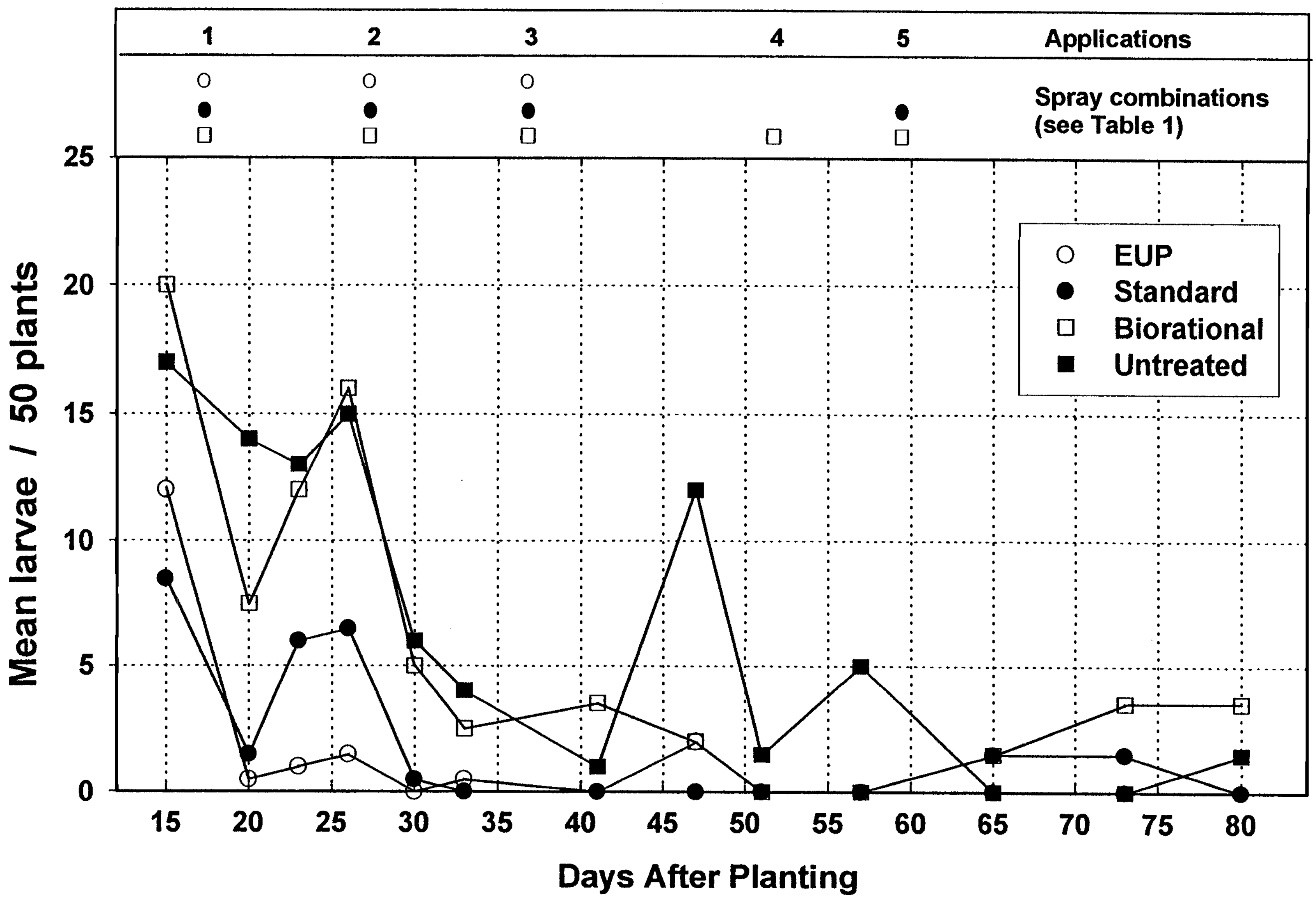


Figure 2. Seasonal beet armyworm larval populations (all instars) relative to management program, and timing and frequency of applications in head lettuce, YAC, Fall 1996.

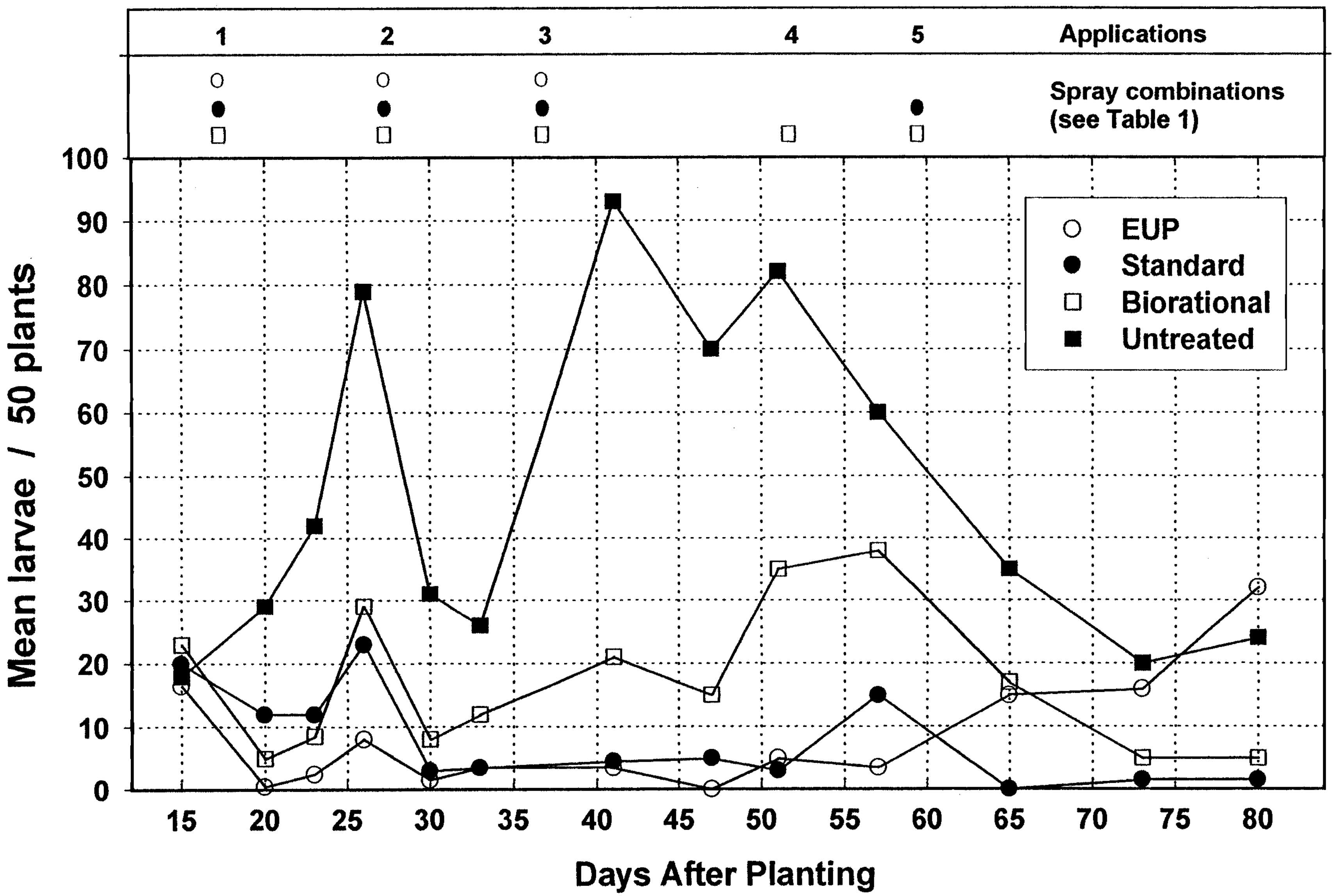


Figure 3. Seasonal cabbage looper larval populations (all instars) relative to management program, and timing and frequency of applications in head lettuce, YAC, Fall 1996.

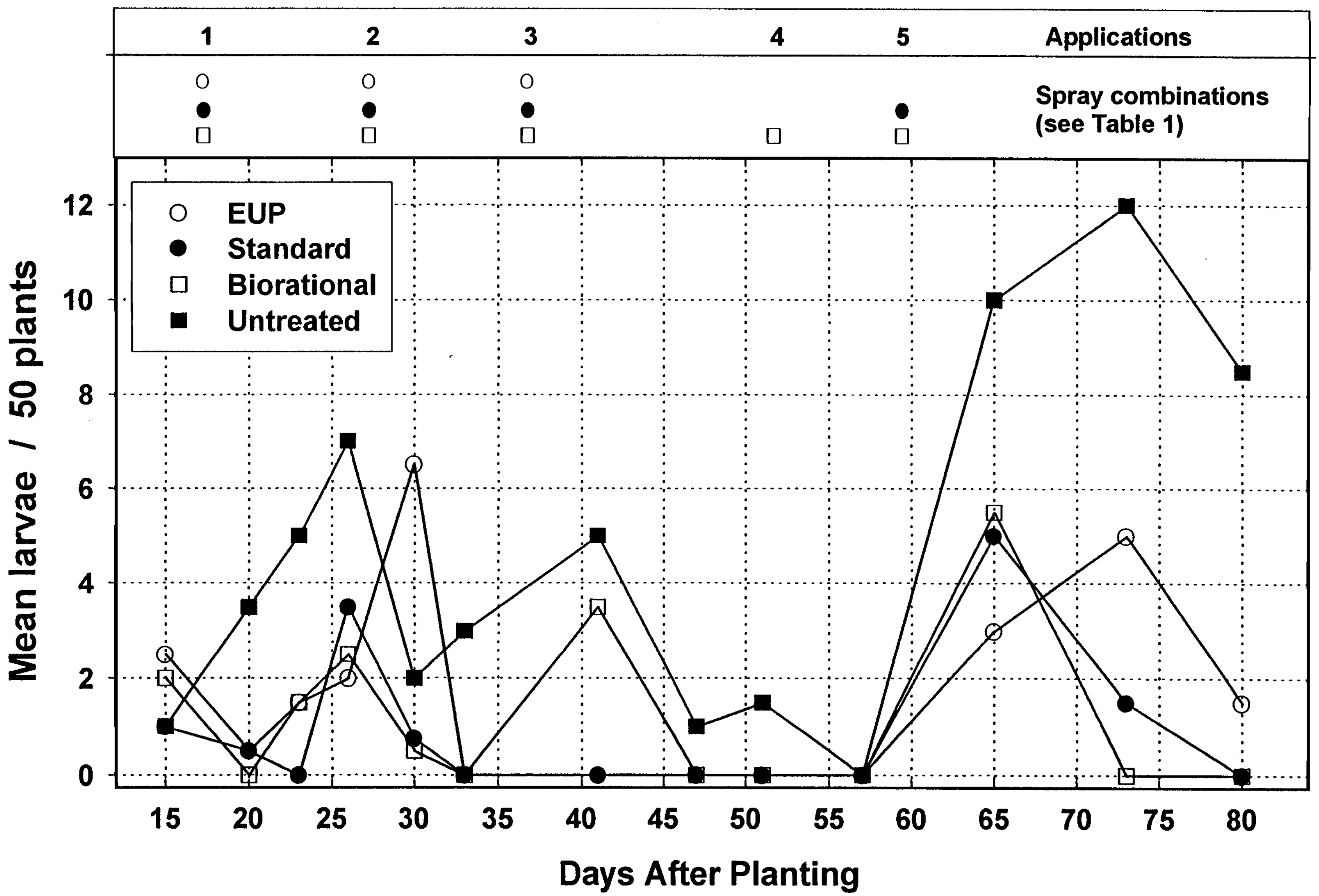


Figure 4. Seasonal Heliothis larval populations (all instars) relative to management program, and timing and frequency of applications in head lettuce, YAC, Fall 1996.

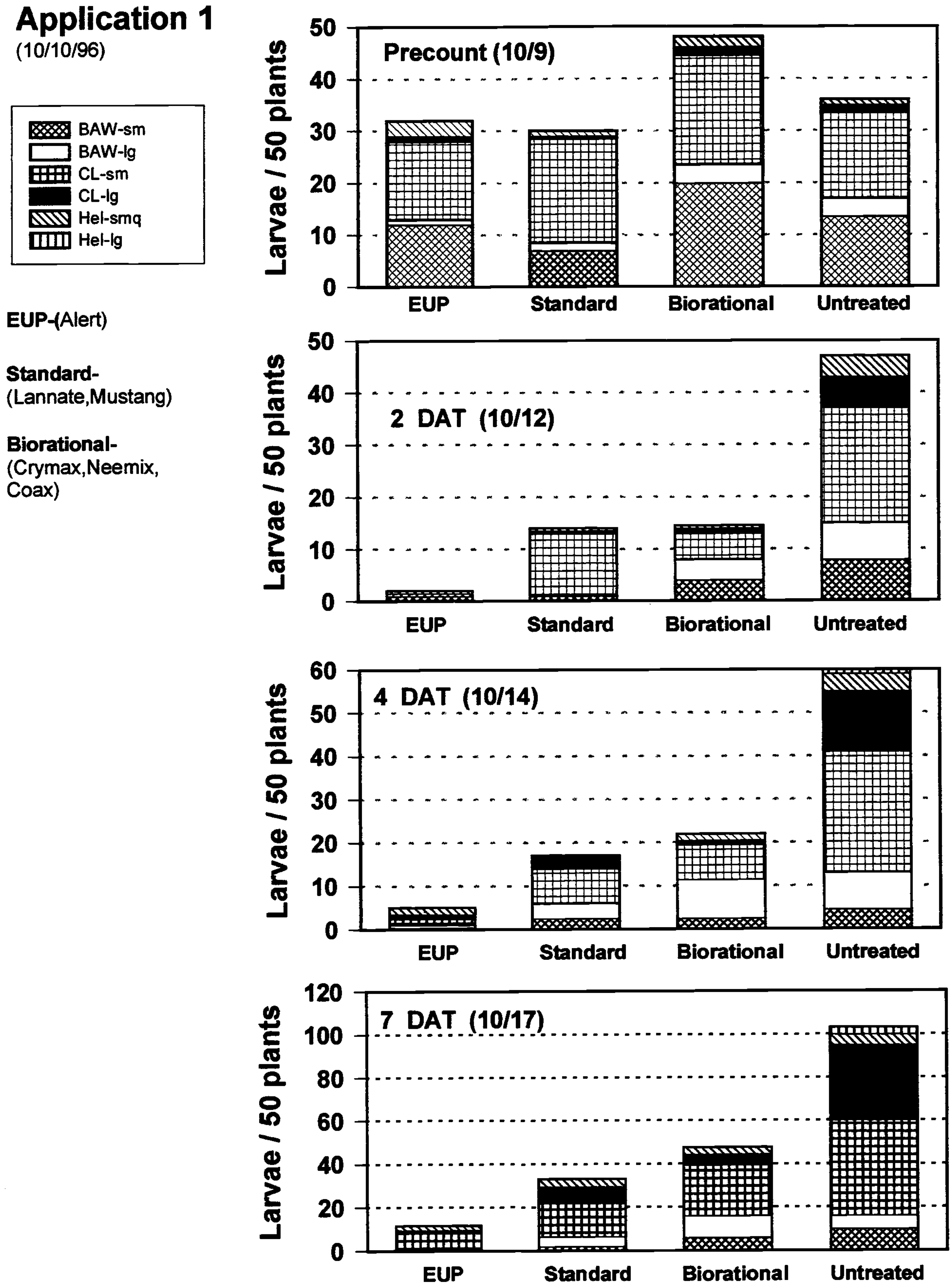
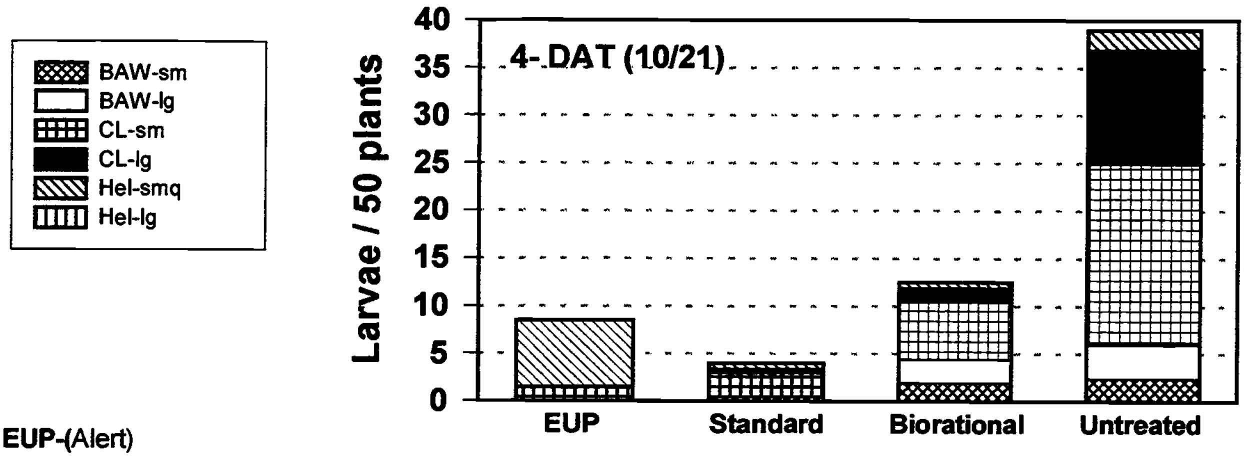


Figure 5. Efficacy of insecticdes against small and large Beet armyworm, Cabbage looper and Heliothis used in each management program at several days after treatment (DAT).

Application 2
(10/17/96)



EUP-(Alert)

Standard-
(Larvin, Karate)

Biorational-
(Cryolite,Xentari, Coax)

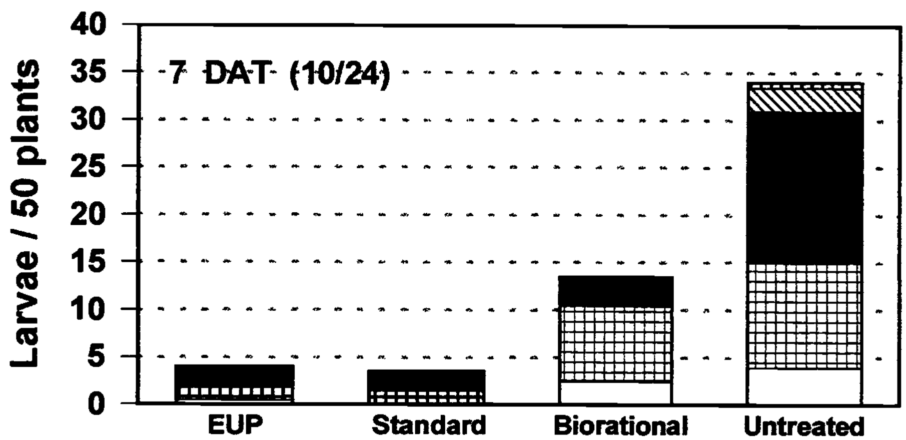
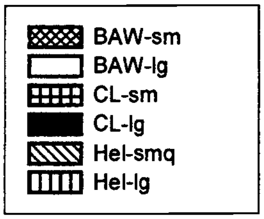


Figure 6. Efficacy of insecticdes against small and large Beet armyworm, Cabbage looper and Heliothis used in each management program at several days after treatment (DAT).

Application 3

(10/29/96)



EUP-(Success)

Standard-
(Orthene, Mustang, Endosulfan)

Biorational-
(Dipel, Cryolite, Pyrellin)

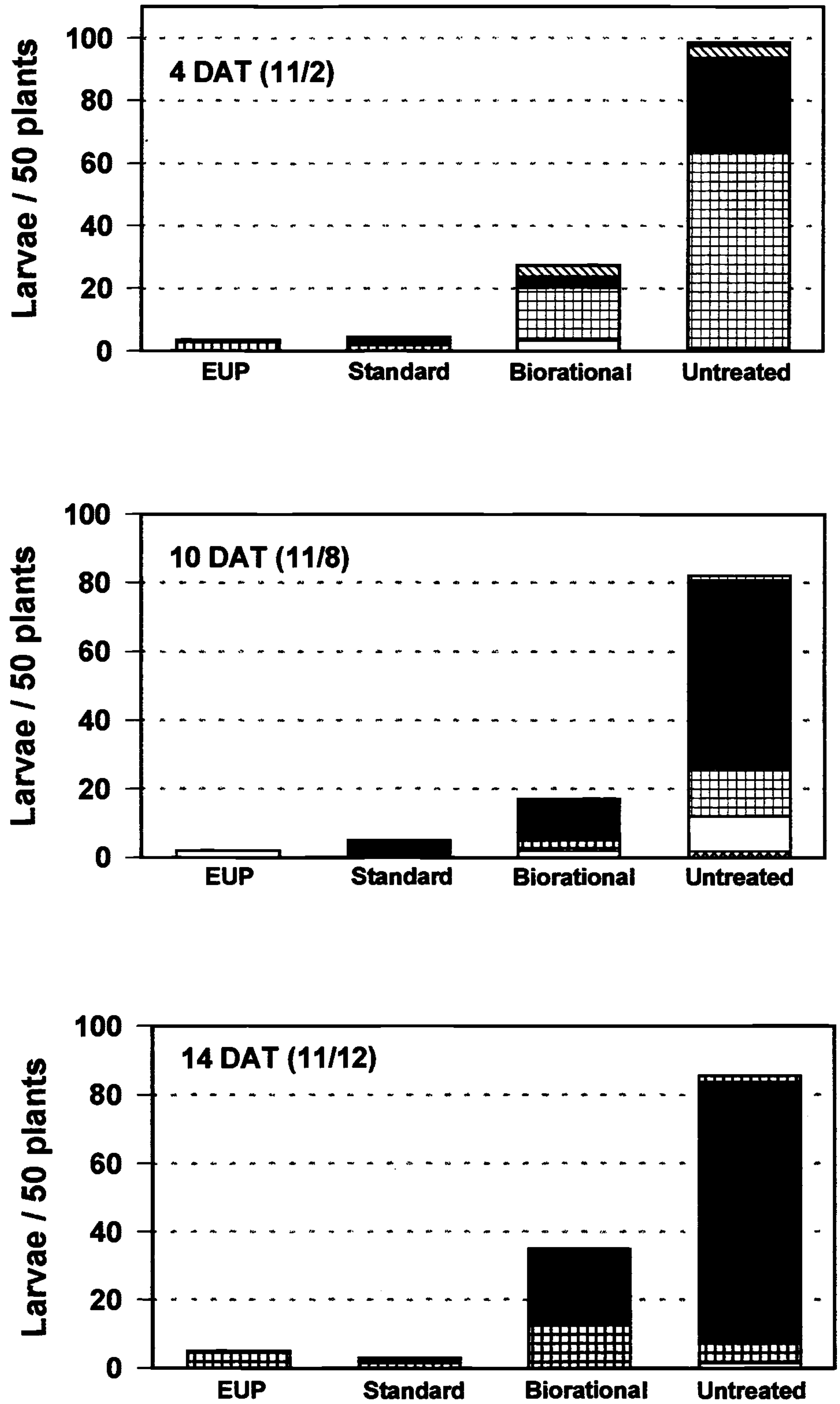


Figure 7. Efficacy of insecticdes against small and large Beet armyworm, Cabbage looper and Heliothis used in each management program at several days after treatment (DAT).

Table 2. Yields and quality for head lettuce grown under various spray regimes, YAC, December 17, 1996.

Treatment	Avg. no. heads/20 ft	Avg. wt /head (lb)	% marketable heads		% worm damage		% head contamination	
			shape	maturity	wrapper leaves	head, cap leaf	frass	live worms
Standard	45.0 a	1.85 a	96 a	95 a	10 b	3 b	1 b	1 b
EUP	48.5 a	1.94 a	96 a	96 a	24 b	7 b	16 b	1 b
Biorational	46.8 a	1.93 a	97 a	97 a	18 b	12 b	8 b	1 b
Untreated	46.7 a	1.85 a	97 a	85 b	63 a	40 a	53 b	10 a

Mean followed by the same letter are not significantly different (ANOVA, $LSD_{0.05}$).

Table 3. Yields and costs associated with various spray regimes for management of lepidopterous pests on lettuce, YAC, Fall 1996.

Treatment	Cartons(24) per acre: Gross[a]	Net[b]	Total no. sprays[c]	Insecticide cost ($)/acre[d]	Application cost ($) /acre[e]	Total cost/acre[f]
Standard	1125	728 a	4	127	45	$254
EUP	1212	540 b	3	94	34	$210
Biorational	1170	555 b	5	288	56	$509
Untreated	1168	126 c	--	0	0	$82

[a] total number of cartons (24s) that could have been potentially packed from field based on ave no. heads per 20 ft (see Table 3).
[b] average number of cartons (24s) that were harvested from plots after individual heads were culled out due to shape, maturity, worm damage and contamination in heads (see Table 3).
[b] see Table 1.
[d] based on average retail value from 3 local distributors of foliar chemicals applied in each program (see Table 1 for products applied.).
[e] based on cost to apply insecticides by ground ($12.00 for banded application; $11.00 for broadcast application). The first application (10 Oct) was applied as a band, all subsequent sprays were broadcast.
[f] Total cost of all chemicals applied during season; includes Insecticide and application cost above cost, and $62.50 for Admire at planting applications (16 oz/acre) and application of Karate (3.8 oz) and Diazinon (1pt) during stand establishment applied to all treatments.

Table 4. Economic assessment of three lettuce management programs, YAC, Fall 1996.

Treatment	Expenditures ($ / acre)[a]: Harvest cost	Total cost	Net Return ($/acre)[b]: $5.00/cart	$7.50/cart	$10.00/cart
Standard	2714	4227	-587	1233	3053
EUP	2517	3986	-1286	64	1414
Biorational	2532	4300	-1528	-138	1250
Untreated	2082	3423	-2793	-2478	-2163

[a] Marketing/harvest cost calculated from Yuma Co. Farm Budgets for Fall Lettuce, 1995, Univ of Arizona, Department of Ag and Res. Econ., F14/49. Total costs include marketing/harvest cost, growing costs estimated at $1227/acre based on Yuma Co. Farm Budgets.
[b] Net return calculated from Market price($/cart) for net cartons (Table 3) after accounting for total production costs.