Chemigation Application of Kerb on Lettuce

B. Tickes, University of Arizona, Cooperative Extension

Introduction

The story is that the idea to apply herbicides in irrigation water was developed by two drunken pest control advisors as they stood before the urinals in the men's room after drinking beer all night. Eptam was the first herbicide that included chemigation on the label. This occurred in the early 1960s and several chemigation applications have been registered since that time. Although there are times when it has seemed like an idea that was developed by a couple of drunks, in most cases it has offered growers a convenient and effective alternative to apply pesticides.

The recent special local need registration for the chemigation of Kerb in lettuce has created much interest and many questions about this technique. This brief article is intended to help answer some of those questions.

Rationale

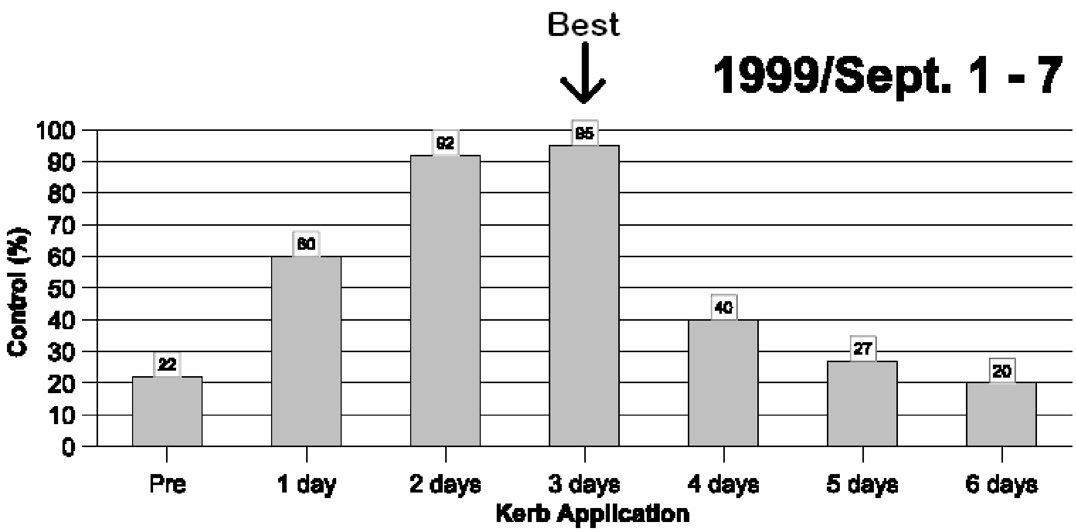
Kerb was first registered in 1969. Most of the use on lettuce, until the mid 1980s, was as a post-plant, preemergence treatment incorporated with furrow irrigation. From the mid 1980s until present, sprinkler irrigation to establish the crop has become increasingly widespread. When furrow irrigation is used, Kerb is held on the bed top where it is needed. When sprinklers are used and much water is applied prior to weed germination, the herbicide is pushed too deep and is ineffective. This problem has been overcome by delaying Kerb applications until just before weed seeds germinate. In most cases, delayed applications cannot be made by ground due to wet fields and aerial applications have been made. Aerial applications cannot be as precise as ground applications and overlaps and skips have sometimes occurred. Our tests and grower experience during the 2002-03 season indicated that making delayed application of Kerb through the sprinklers is often as effective and often more effective than aerial applications. The Western Growers Association applied for and was granted a special local need registration for the chemigation of Kerb to lettuce in July 2003. This 24C registration may be used only by members of Western Growers who have contracted with them for this use and signed a waiver of liability.

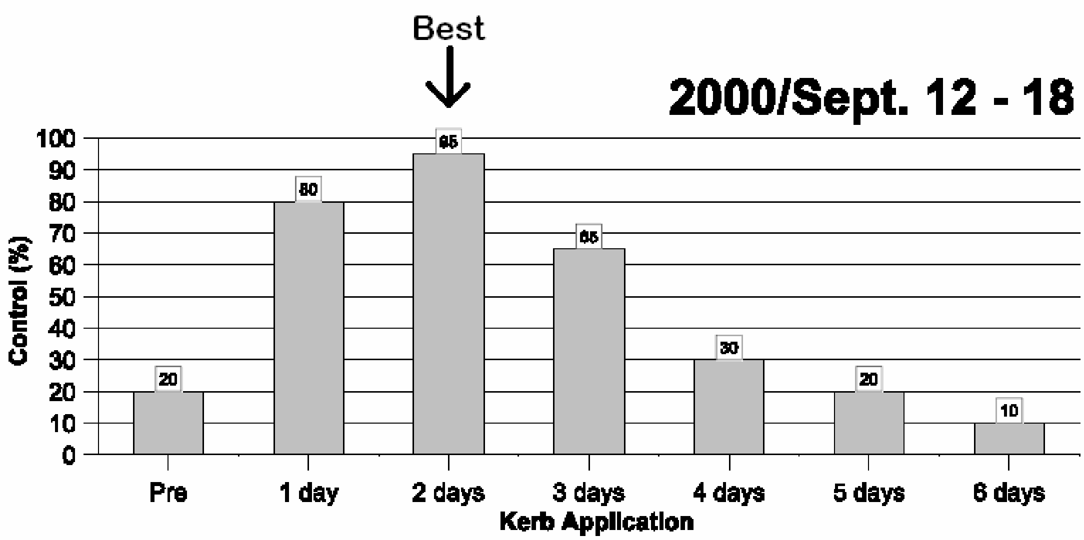
Timing and Rate

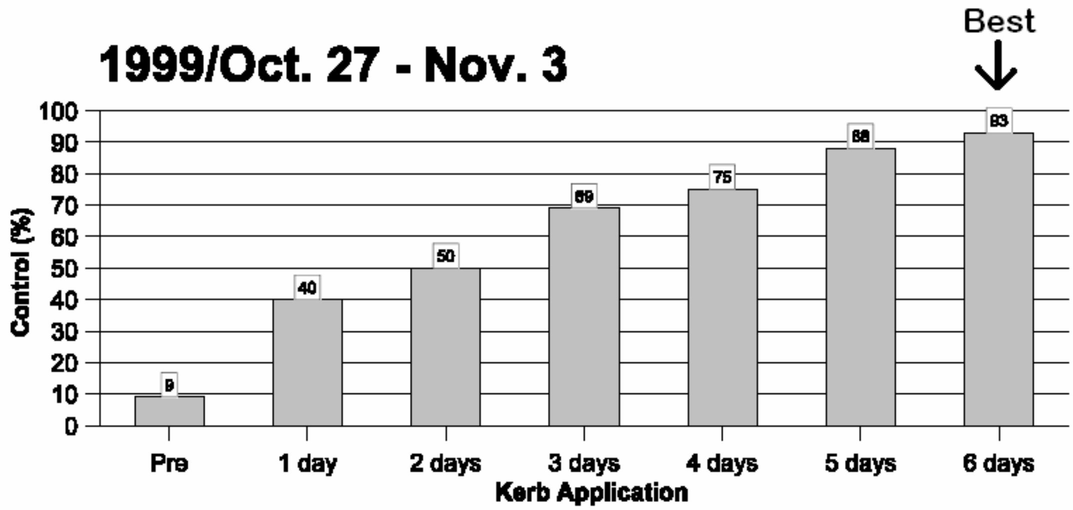
The correct timing of application is critical to the success of delayed application of Kerb and failures are more likely to occur from incorrect timing than poor applications. The correct time of application is just before weed seed germination and this will change depending upon season, weed species and environmental conditions. Typical weed germination times after moisture is present are:

Weed	Days to Germination
Summer annual grasses	0.5 - 1
Pigweed	2 - 4
Purslane	1 - 7
Winter Annual Grasses	3 - 7
Lambsquarter/Goosefoot	3 - 7
Shepardspurse/London Rocket	4 - 7
Nightshade	3 - 5

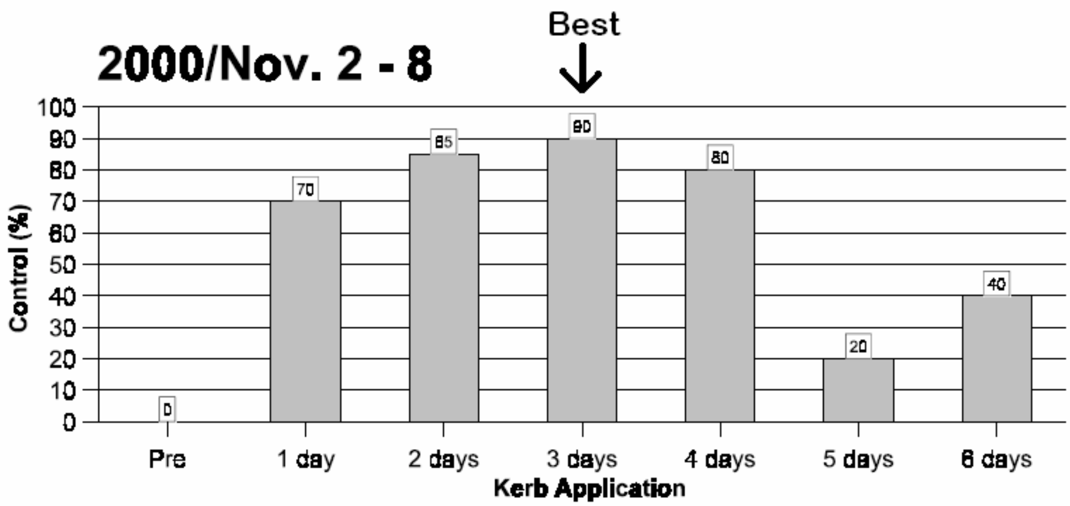
These germination times will vary however depending upon soil temperature and season. Purslane, for instance, will germinate in 24 hours in August. It will still germinate in January but it will take 5 to 7 days at that time. All of these variables make it difficult to time Kerb applications. The following graphs from our tests illustrate this difficulty.



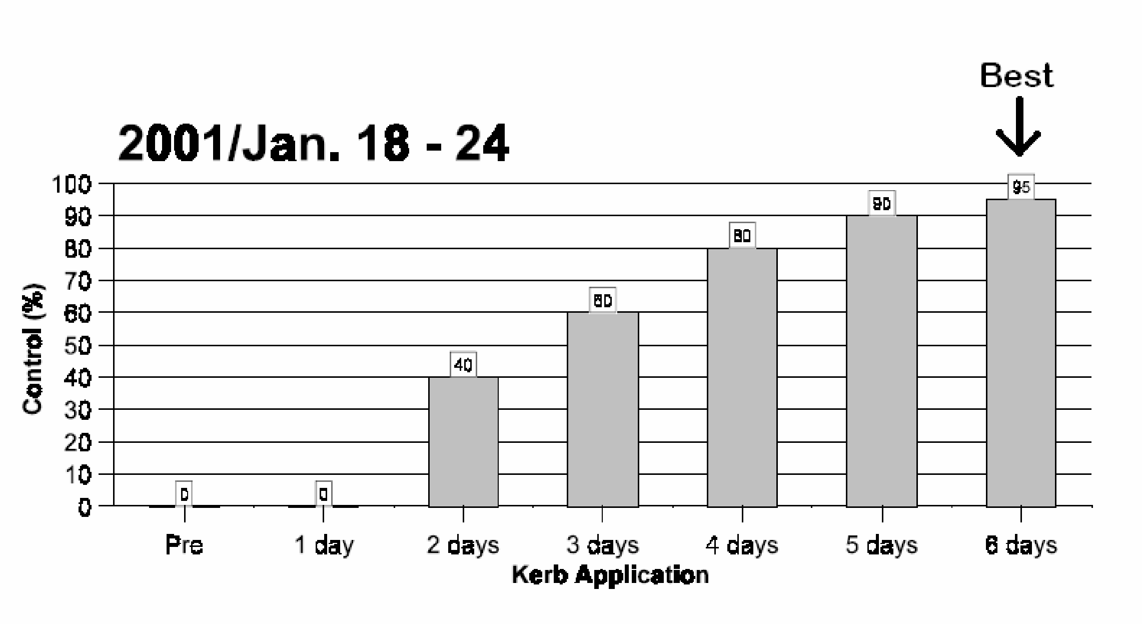




Best
1999/Oct. 27 - Nov. 3
Control (%)
9
40
50
69
75
88
93
Pre
1 day
2 days
3 days
4 days
5 days
6 days
Kerb Application



Best
2000/Nov. 2 - 8
Control (%)
0
70
85
90
80
20
40
Pre
1 day
2 days
3 days
4 days
5 days
6 days
Kerb Application



In 1999, the best early season application was 3 days after the sprinklers were started. The following year, the best time was 2 days after the sprinklers were started and dropped by 30 % if you had waited until day 3. The mid-season test results varied even more. In 1999, the best control was achieved 6 days after the sprinklers were started. In 2000, the best control was after 3 days and had dropped by 50% by day 6. In late season (January), it can take a week or more for weed seeds to germinate. Kerb applications are easily made too early at this time. Test results from only one test illustrate that control was best 6 days after the sprinklers were started. The general guidelines that appear on the supplemental label are:

Timing	Date	Application Timing (days after starting sprinklers)
Early	Sept. 1 to Oct. 15	1 - 3
Mid	Oct. 15 to Dec. 15	3 - 6
Late	Dec. 15 to Jan	5 - 6

Time of application should be adjusted when conditions, mainly soil temperatures, are favorable for weed seed germination. For instance, if temperatures have been warmer than normal in November, it would be best to aim for 3 days after starting sprinklers and if conditions have been cold, 6 days might be better.

The normal application rates for Kerb are 2 to 4 lbs. per acre. At these higher rates, if 50% of the herbicide is leached below weed seeds, it still leaves enough to control some of the most sensitive species such as grasses. It is not uncommon, however, to miss even these sensitive weeds when Kerb is applied before starting sprinklers and they are run for 6 or 7 days before seeds germinate during mid and late season applications.

Delayed applications help avoid leaching of the herbicide and the 2 to 4 lbs. Per acre rate is not needed and can cause crop injury. In practice, half of the original labeled rates have been effective and helped avoid crop injury. The supplemental label for chemigation recommends 1 to 2 lbs. per acre depending upon soil type, weed species and level of infestation.

Procedure and Equipment

In theory, irrigation management can be highly technical. In practice, it involves common sense and experience more than anything else. Chemigation involves using systems that were designed to deliver water to apply pesticides. In general, these systems lack the precise nozzles, spacing, pressure and speed that are contained in spray equipment. It is not possible to always avoid the problems inherent in using irrigation systems to apply pesticides although experience has shown that chemigation can be effective.

Mixing: Kerb is a water-soluble powder that requires continuous agitation. Even with continuous agitation it is difficult to keep all of the product in suspension when flat bottom tanks are used and there is little water left toward the end of the application. Adjuvants are available that help keep the product in suspension although the effect of these products on crop safety and weed control have not yet been established. The label suggests a minimum of 3 gallons of water per pound of Kerb.

Time to Apply: No research data is available to help establish the amount of time it should take to apply Kerb through sprinklers. It is reasonable to assume that if the application is done too quickly that the product will not be applied uniformly. On the other hand, if too much time is taken, it increases the exposure to environmental and other factors that affect uniformity. The label suggests 1 to 2 hours for injection and a rule of thumb has been that it should take 1.5 hours to treat 35 acres.

Enough water should be applied after injection to incorporate the herbicide but not too much to push the herbicide below the weed seeds. It takes approximately 1/2 inch of water to incorporate the herbicide. Most systems apply approximately 1/10 inch of water per hour. The system should be run, therefore, for at least 5 hours after the Kerb has been injected for incorporation and to flush the system. Running the system for significantly longer than this could leach the herbicide.

System requirements: The label requires the following equipment:

- Check valve
- Vacuum relief valve
- Low pressure drain
- Automatic quick closing check valve
- Solenoid-operated valve on the intake side of the injection pump
- Interlocking controls automatically shut off the injection pump when the water pump stops
- Pressure switch to stop the water pump when water pressure decreases
- Metering pump such as a positive displacement injection pump

All of this is designed to replace someone who continuously monitors the system during Kerb injection who can shut the injection down if problems occur. It is to safeguard against the possibility of Kerb going somewhere other than the field and against the wrong rate being applied. These requirements are similar to those appearing on many chemigation labels. They are a legal requirement and applicators can be cited if they are not in compliance.

Beet Armyworm and Cabbage Looper in Head Lettuce: Control with Selective and Reduced-Risk Insecticides

John Palumbo

Abstract

Studies were replicated over 2 years to further evaluate the residual efficacy of several selective, reduced-risk compounds that are now registered for use in head lettuce. In most cases, the Success, Proclaim, Avaunt and Intrepid provided excellent seasonal efficacy against beet armyworm and cabbage looper larvae. Their performance at stand establishment and harvest were also examined. Based on the results of these studies and additional trials conducted over the past several years, we now have sufficient information for optimizing their uses in our lettuce pest management program. Because they are uniquely different insecticide chemistries, they can be rotated throughout the season to prevent the rapid buildup of resistance. A table was constructed that offers suggested uses for each compound throughout the season. The results are ultimately are aimed at assisting growers and PCA's in making sound decisions on choosing compounds for use in controlling beet armyworm and cabbage looper in head lettuce.

Introduction

The beet armyworm, cabbage looper and *Heliothis* species are the major lepidopterous pests of lettuce in desert growing areas of Arizona. Conventional insecticides such as Lannate, Orthene, Larvin and pyrethroids have been used successfully in the past to control this pest complex. Unfortunately, the recent passage of the Food Quality Protection Act of 1996 threatens to remove some of these more broadly toxic compounds from the market in the next few years. In the past few years, several selective Reduced-risk insecticide products have become registered and available to lettuce growers for management of the lepidopterous complex. Our past research efforts have been focused on studies to determine ways to integrate these new chemicals into our local management programs in the most cost/effective way possible. These compounds offer excellent efficacy against lepidopterous larvae. Because they are uniquely different insecticide chemistries, they can be rotated throughout the season to prevent the rapid buildup of resistance. We have continued to tests these compounds on fall lettuce over the past two seasons to validate their efficacy under heavy worm pressure. Because growers now have a number of choices, our goal has been to compare each compound at different rates and in combinations to determine their relative performance throughout the season and at harvest. The studies reported here are aimed at assisting growers and PCA's in making sound decisions on choosing compounds for use in controlling beet armyworm and cabbage looper in fall lettuce.

Materials and Methods

2001 Lettuce Study I

Lettuce was direct seeded on 1 Sep at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were two beds wide by 50 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a randomized complete block design. Formulations and rates for each compound are provided in the Table 1. Foliar applications were made with a CO_2 operated boom sprayer operated at 50 psi and 26.5 GPA. A directed spray (~75% band, with rate adjusted for band) was delivered through 3 nozzles (TX-18) per bed. Adjuvants were applied with each treatment in the following: Kinetic at 0.065% v/v was applied with all treatments except Confirm which was mixed with Latron CS-7 at 0.125% v/v. Sprays were applied on 13 and 21 Sep. Evaluation of lepidopterous larvae control was based on the number of live larvae per plant sampled from the center 2 rows of each replicate at 3 and 6 days after each treatment was applied (DAT). Ten plants per plot were destructively sampled on each sample date. The sample unit consisted of examination of whole plants for presence of small and large BAW, CL and TBW larvae. For BAW and TBW , larvae were considered small if <5 mm in length, large >5mm. For CL, larvae were considered small if <10 mm, large if > 10 mm. Damage to plants and the plant stand were estimated on Sep 27 (see table 2). Treatment means were analyzed using a 1-way ANOVA and means separated by a protected LSD $_{(P<0.05)}$.

2001 Lettuce Study II

Lettuce was direct seeded on 5 Sep at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were four beds wide by 50 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a randomized complete block design. Formulations and rates for each compound are provided in the Table 3. Foliar applications were made with a CO_2 operated boom sprayer operated at 50 psi and 26.5 GPA. A directed spray (~75% band, with rate adjusted for band) was delivered through 3 nozzles (TX-18) per bed. Adjuvants were applied with each treatment in the following: Kinetic at 0.065% v/v was applied with Avaunt; Silwet at 0.065% v/v was applied with Proclaim and Success; and Latron CS-7 was applied with Conifrm and Intrepid at 0.125% v/v. Sprays were applied on 19 and 29 Sep, 11 and 23 Oct, and 5 Nov.

Evaluation of lepidopterous larvae control was based on the number of live larvae per plant sampled from the center 2 rows of each replicate. The plots were sampled on various days after each treatment was applied (DAT). Ten plants per plot were destructively sampled on each sample date. The sample unit consisted of examination of whole plants for presence of small and large BAW, CL and TBW larvae. For BAW and TBW , larvae were considered small if <5 mm in length, large >5mm. For CL, larvae were considered small if <10 mm, large if > 10 mm. Damage to the plant stand was estimated on Sep 29 and Oct 6 by counting the total number of live plants per 45 feet per bed. Treatment means were analyzed using a 1-way ANOVA and means separated by a protected LSD $_{(P<0.05)}$.

2002 Lettuce Study

Lettuce was direct seeded on 4 Sep at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were four beds wide by 50 ft long and bordered by two untreated beds. Four replications of each treatment were arraigned in a randomized complete block design. Formulations and rates for each compound are provided in Table 5. Sprays were applied on 25 Sep, 7, 21 and 29 Oct . Some of the spray treatments were modified by adding insecticides or increasing rates on the 21 and 29 Oct applications (see Table 5). The foliar applications were made with a CO_2 operated boom sprayer at 40 psi and 24.5 GPA. A directed spray (~75% band, with rate adjusted for band) was delivered through 3 nozzles (TX-18) per bed. Adjuvants were applied with each treatment in the following: Latron CS-7 was applied with Intrepid at 0.125% v/v and Silwet at 0.065% v/v was applied with all the other spray treatments.

Evaluation of lepidopterous larvae control was based on the number of live larvae per plant sampled from the center 2 rows of each replicate. The plots were sampled on various days after each treatment was applied (DAT). Ten plants per plot were destructively sampled on each sample date. The sample unit consisted of examination of whole plants for presence of small and large BAW, CL and TBW larvae. For BAW and TBW , larvae were considered small if <5 mm in length, large >5mm. For CL, larvae were considered small if <10 mm, large if > 10 mm. At harvest, ten plants were selected and heads and wrapper leaves were examined for presence of larvae and feeding damage/frass. Treatment means were analyzed using a 1-way ANOVA and means separated by a protected LSD $_{(P<0.05)}$.

Results and Discussion

2001 Lettuce Study I. This trial was designed to evaluate the reduced risk insecticides on small lettuce plants during stand establishment. At the time of the 1st application, plots had not been thinned yet and lettuce plants were smaller than the 3-leaf stage. BAW pressure was very high at that time with greater than 20 large larvae /plant in the untreated plot 6 DAT (Table 1). All treatments provided significant knockdown of BAW larvae. However, following the 2nd application , both Confirm and Lannate were less efficacious than the other treatments. All treatment provided significant efficacy of CL as compared with the untreated control. Based on stand counts, all treatments preformed similarly, however estimates of plant damage showed that Lannate and the reduced risk compounds Avaunt, Confirm and Intrepid resulted in significantly more plant damage than Proclaim, Success and the high rate of Avaunt (Table 2). This data is consistent with the route of activity of these compounds. Proclaim and Success are translaminar and have contact activity. Thus they usually cause quick knockdown (1-2 d) of larvae. In contrast, Lannate is a short residual compound resulting in a quick reinfestion by larvae , and Confirm Intrepid, and Avaunt are toxic through ingestion by the larvae. This resulted in significantly more larval feeding .

2001 Lettuce Study II. This trial was designed to evaluate the efficacy of the selective and reduced risk insecticides throughout the growing season. BAW and CL pressure was heavy throughout the trial. Plant stand counts showed that all the materials were effective in preventing stand losses in the presence of large BAW populations (Table 3; Fig 1). Furthermore, all of the selective compounds provided significant control of BAW and CL following 5 applications (Fig 1 and 2). The addition of pyrethroid with each compounds did not significantly improve their efficacy. In most cases, all of the treatments performed similarly. However, Intrepid and Confirm (slow-acting IGR compounds) allowed significantly more feeding damage to occur on plants near harvest and were more heavily infested with budworm/bollworm (Table 4). This is not unusual considering that Confirms is know to be weak against Budworm/bollworm. In addition, this was the first year we evaluated Intrepid and applied the product at a lower rate than is currently labeled. Overall, Proclaim, Avaunt, and Success provided good protection and resulted in a high level of marketable lettuce heads.

2002 Lettuce Study

BAW and CL pressure were heavy throughout the trial with the number of total larvae exceeding 50 per 10 plants in the untreated check just prior to harvest (Figure 3 and 4). Numbers of BAW large larvae numbers in all spray treatments were significantly lower than in the check on most sample dates (Figure 3). Similarly, numbers of CL larvae in all spray treatments were significantly lower than the untreated check (Figure 4).. All compounds provided similar efficacy, however, a few exceptions were noted. Intrepid was applied at a higher rate this year (8 oz) and appeared to be more efficacious than the 6 oz rate. This was particularly evident near harvest. The addition of Warrior to the 6 oz rate overall improved performance (Table 5). Avaunt performance varied with rate and time of season, but overall performed well at the 6 oz rate when evaluated at harvest. Proclaim provided excellent seasonal residual knockdown of BAW, but showed performed erratically against CL during the later half of the season (Fig 4). Both Success and the Lannate/Warrior provided similar efficacy, and overall resulted in significantly less damage to lettuce heads than the untreated check (Table 5). TBW populations were low during the season, but were found in high numbers in lettuce heads at harvest (Table 5). All treatments provided significant control of TBW at harvest with the exception of Intrepid applied at 6 oz and Proclaim at 3.2 oz. In general, the pre-harvest application of Lannate + Warrior appeared to provide the overall best protection of heads at harvest.

Summary

Based on the results of these studies and additional trials conducted over the past several years, we now have a great deal of information on the efficacy of the new selective and reduced risk insecticides and their fit in our lettuce pest management program. Table 6 was constructed from this large database and offers suggestion for the use of each compound for the protection for lettuce crops. This table is organized by identified stages in plant growth throughout the crop season. The fit within the table for each insecticide corresponds with its potential use. The older active ingredients are included because of their broad-spectrum activity, larval efficacy and utility in sustaining long-term efficacy of all products. Furthermore, recommended tank-mix combinations with pyrethroids (Warrior, Mustang, Asana, Pounce) are identified. A short summary of the rationale used in developing this table follows:

<u>Thinning Stage</u>: Depending on population pressure and temperature, 1-3 applications may be required for larval control during this period. It is assumed that many applications will be made by air because of sprinkler irrigation and wet fields during this period. Lannate+pyrethroid is the logical choice for initial control at stand establishment because of the excellent contact and ovicidal activity, broad-spectrum efficacy against many soil-dwelling pests, and proven efficacy by air. Success has demonstrated good activity against BAW/CL by air, but should be used after stand establishment (3-4 leaf stage) because of selective efficacy. If leafminer is also present at economic levels,

Success at higher rates (6 oz) should be used. Proclaim, is also be a good compound for this stage if applied with ground equipment, as it does not currently have an air label.

Post-thinning / Pre-heading stage: All of the compounds are options for control during this period. The opportunity to use ground application equipment is also greater. Now that Intrepid has been registered, it should be used instead of Confirm. Both Intrepid and Avaunt and should be used at higher rates when CL and BAW pressure is high, and addition of pyrethroid should be used when budworm/bollworm are detected. All compounds should be applied with ground equipment whenever possible. Orthene and endosulfan (high rates) may be a good alternatives soon after thinning when BAW pressure is low, and thrips and/or aphids are present.

Heading-Harvest stage: perhaps the most important period in which plant protection is required. Fewer options, but several effective compounds are available. Addition of pyrethroid with all active ingredients is recommended for treatments 7-14 days before harvest to enhance control of small larvae, budworm/bollworm, and miscellaneous pests such as beetles, plant bugs and thrips.

Product Sustainability Table 6. provides insecticide options available for management of lepidopterous larvae during the growing season. It should primarily serve as a guide for identifying windows of use for individual products/combinations. It can also serve as a reference choosing compounds to rotate with throughout the season for the purpose of maximizing and sustaining product efficacy. Additional tactics should be practiced to avoid the development of resistance by lepidopterous larvae to any of these new active ingredients:

- Avoid making more than 2 consecutive applications of the same active ingredient to the same field.
- This also includes pyrethroids whenever possible.
- An alternative active ingredient should be applied before reapplying the first active ingredient.
- Do not apply active ingredient below labeled rates.
- Avoid tank-mixtures containing 2 or more of the new, selective chemistries when controlling lepidopterous larvae. Not only is this expensive, but generally not necessary based on past performance.

Ideally, these strategies will optimize control of the Lepidopterous larval complex and maximize the longevity of all these compounds. We recognize that in certain situations, these management practices may be difficult to implement, but emphasize that they may be necessary for the long-term sustainability of these valuable chemistries on desert lettuce crops.

Table 1. Abundance of large larvae in head lettuce at 3 and 6 DAT with selective insecticides, 2001 Lettuce Study I

		Mean large larvae (3rd instar or older) / 10 plants							
		Beet Armyworm				Cabbage Looper			
Treatment	**Rate/ac**	**16-Sep**	**19-Sep**	**24-Sep**	**27-Sep**	**16-Sep**	**19-Sep**	**24-Sep**	**27-Sep**
Avaunt	6.0 oz	0 b	0.4 b	0 b	0 c	0 b	0 b	0 c	0 b
Avaunt	3.5 oz	0 b	0.8 b	0 b	1.1 c	0 b	0 b	0 c	0 b
Proclaim	3.2 oz	0 b	0.8 b	0 b	0 c	0 b	0 b	1.1 b	1.1 b
Proclaim	2.4 oz	0 b	0.4 b	1.1 b	0 c	0 b	0 b	0 c	0 b
Intrepid	2.0 oz	0 b	0.8 b	0.6 b	1.1 c	0 b	0 b	0 c	0.6 b
Confirm	8.0 oz	0 b	0.8 b	1.1 b	2.0 bc	0 b	0 b	0.6 bc	0.6 b
Success	4 oz	0 b	2.1 b	0.5 b	1.1 c	0 b	0 b	0 c	1.1 b
Lannate+Warrior	0.75 +3.7 oz	0.7 b	2.9 b	1.1 b	5.0 b	0 b	0 b	0 c	0 b
Check		7.3 a	20.8 a	7.2 a	8.3 a	0.3 a	0.8 a	6.1 a	3.9 a

Means followed the same letter are not significantly different; ANOVA, protected LSD ($p < 0.05$)

Table 2. Differences among treatments in damage to head lettuce plants on Sep 27, 2001 (6 DAT #2) , 2001 Lettuce Study I

Treatment	Rate	Plants / 40 row ft	Damage [a] rating
Avaunt	6.0 oz	80.6 a	2.3 ab
Avaunt	3.5 oz	88.3 a	2.0 c
Proclaim	3.2 oz	82.0 a	2.3 ab
Proclaim	2.4 oz	79.7 a	2.1 bc
Intrepid	2.0 oz	86.7 a	2.0 c
Confirm	8.0 oz	81.7 a	1.9 c
Success	4 oz	87.3 a	2.4 a
Lannate+Warrior	0.9 lb+3.8 oz	74.3 a	1.5 d
Check		9.7 b	0.3 e

Means followed the same letter are not significantly different; ANOVA, protected LSD ($p < 0.05$)

[a] Damage rating= 3, no damage; 2= little damage on newer foliage; 1=moderate amounts of old and new damage 0=plants with extreme feeding damage on old and terminal growth

Table 3. Differences among treatments in plants stands in head lettuce plots, 2001 Lettuce Study II

		Mean no. plants / 45' of bed	
Treatment / formulation	Rate (oz/acre)	Sep 29	Oct 6
Avaunt 30DG	6.0	107.8 a	102.5 a
Avaunt +Warrior T	3.5+3.8	110.2 a	102.0 a
Proclaim WDG	3.2	112.0 a	104.0 a
Proclaim +Warrior	2.4+3.8	108.5 a	100.3 a
Intrepid 80WSP	2.0	110.0 a	101.5 a
Intrepid +Warrior	2.0+3.8	112.0 a	101.0 a
Confirm 2F	8.0	104.5 a	98.3 a
Confirm 2F +Warrior	8.0+3.8	105.3 a	101.5 a
Success 2SC	5.5	113.0 a	105.0 a
Success +Warrior	4.0+3.8	111.5 a	104.0 a
Untreated	--	54.7 b	28.0 b

Means followed the same letter are not significantly different; ANOVA, protected LSD ($p < 0.05$)

Figure 1. Seasonal trends of large beet armyworm larvae on head lettuce following applications with (A) Avaunt, (B) Proclaim, (C) Intrepid and (d) Success, YAC fall 2001

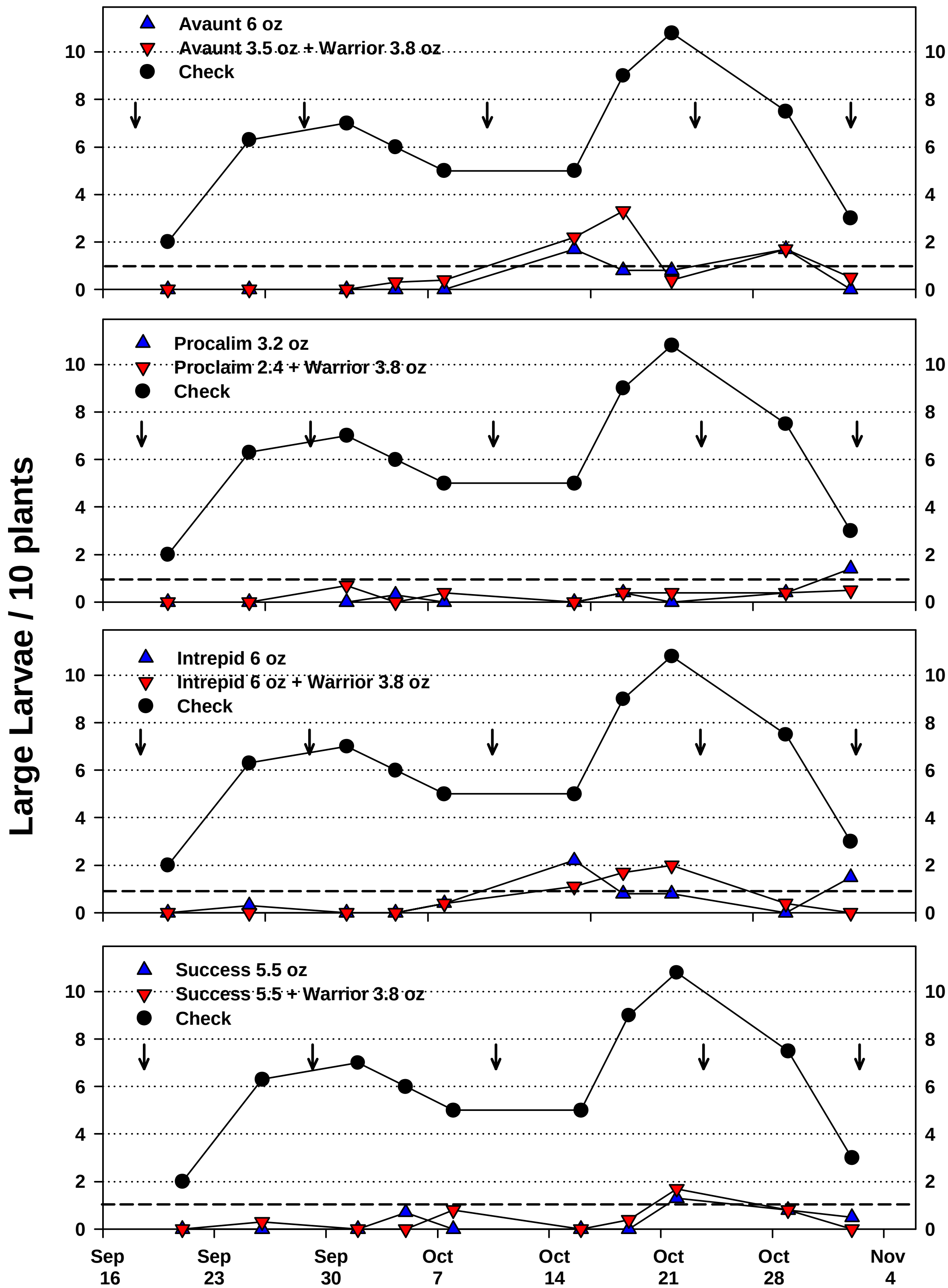


Figure2. Seasonal trends of large cabbage looper larvae on head lettuce following applications with (A) Avaunt, (B) Proclaim, (C) Intrepid and (d) Success, YAC fall 2001

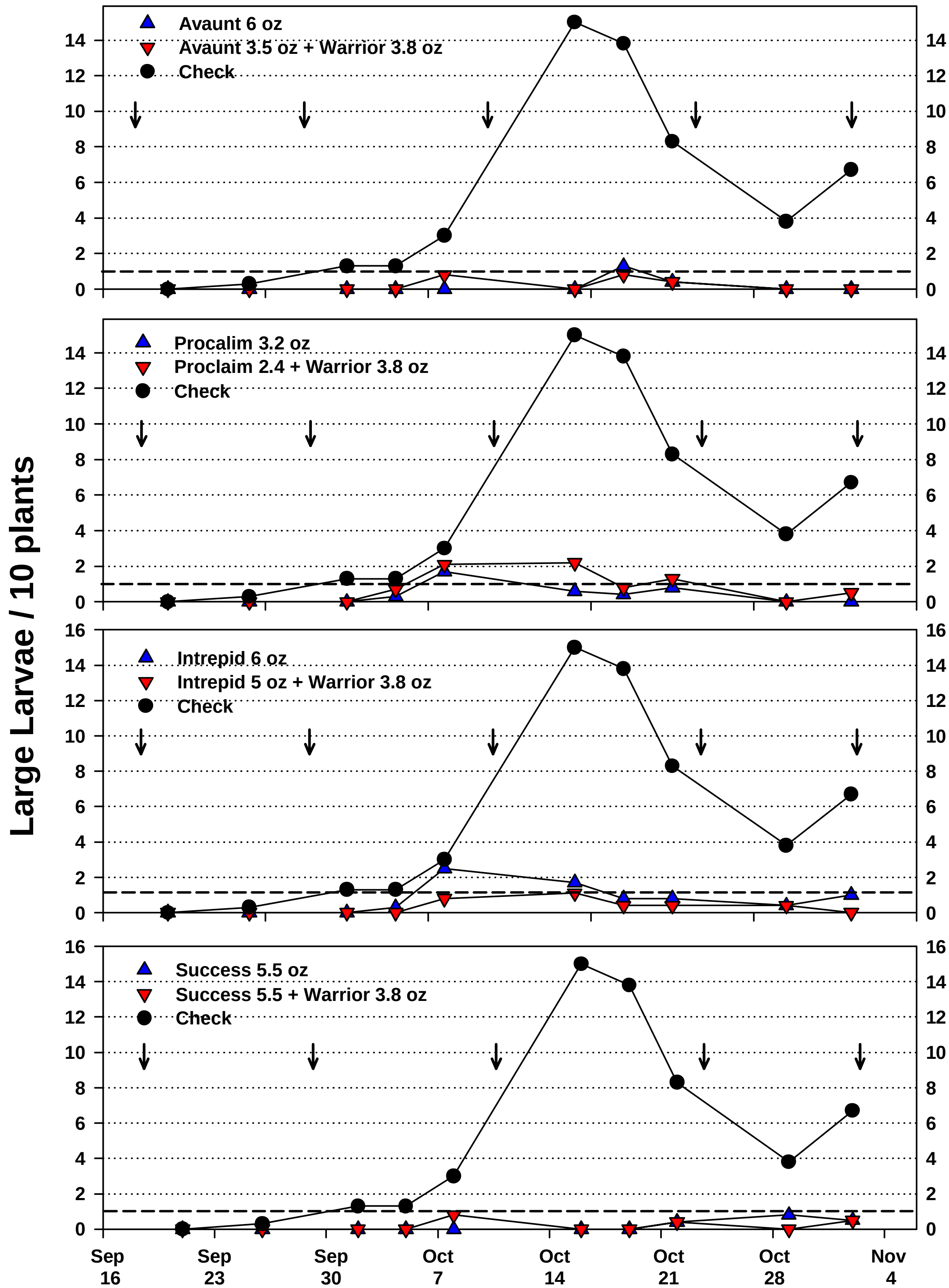


Table 4. Damage and contamination of marketable lettuce heads at harvest, Nov 11, 2001, Lettuce Study II.

		Feeding damage/frass (%)		Heads infested with larvae (%)			
Treatment / formulation	**Rate (oz/ac)**	**Wrapper leaves**	**Heads**	**BAW**	**CL**	**TBW**	**Total**
Avaunt	6.0	8 d	13 cd	0 b	4 b	4 de	8 bc
Avaunt +Warrior	3.5+3.8	8 d	8 d	0 b	0 b	4 de	4 c
Proclaim	3.2	0 d	0 d	0 b	0 b	0 e	0 c
Proclaim +Warrior	2.4+3.8	13 cd	4 d	0 b	4 b	0 e	4 c
Intrepid	6.0	8 d	8 d	0 b	0 b	8 cd	8 b
Intrepid +Warrior	5.0+3.8	17 dc	17 cd	0 b	8 b	8c d	16 bc
Confirm	8.0	33 bc	42 b	0 b	13 b	17 b	30 b
Confirm +Warrior	8.0+3.8	55 b	33 bc	4 ab	13 b	13 bc	30 b
Success	5.5	8 d	8 d	0 b	4 b	0 e	4 c
Success +Warrior	4.0+3.8	4 d	4 d	0 b	0 b	0 e	0 c
Untreated	--	95 a	92 a	8 a	38 a	25 a	71 a

Means followed the same letter are not significantly different; ANOVA, protected LSD ($p < 0.05$)

Figure 3. Seasonal trends of large beet armyworm larvae on head lettuce following applications with (A) Avaunt, (B) Proclaim, (C) Intrepid and (d) Success and Lannate/Warrior, YAC fall 2002

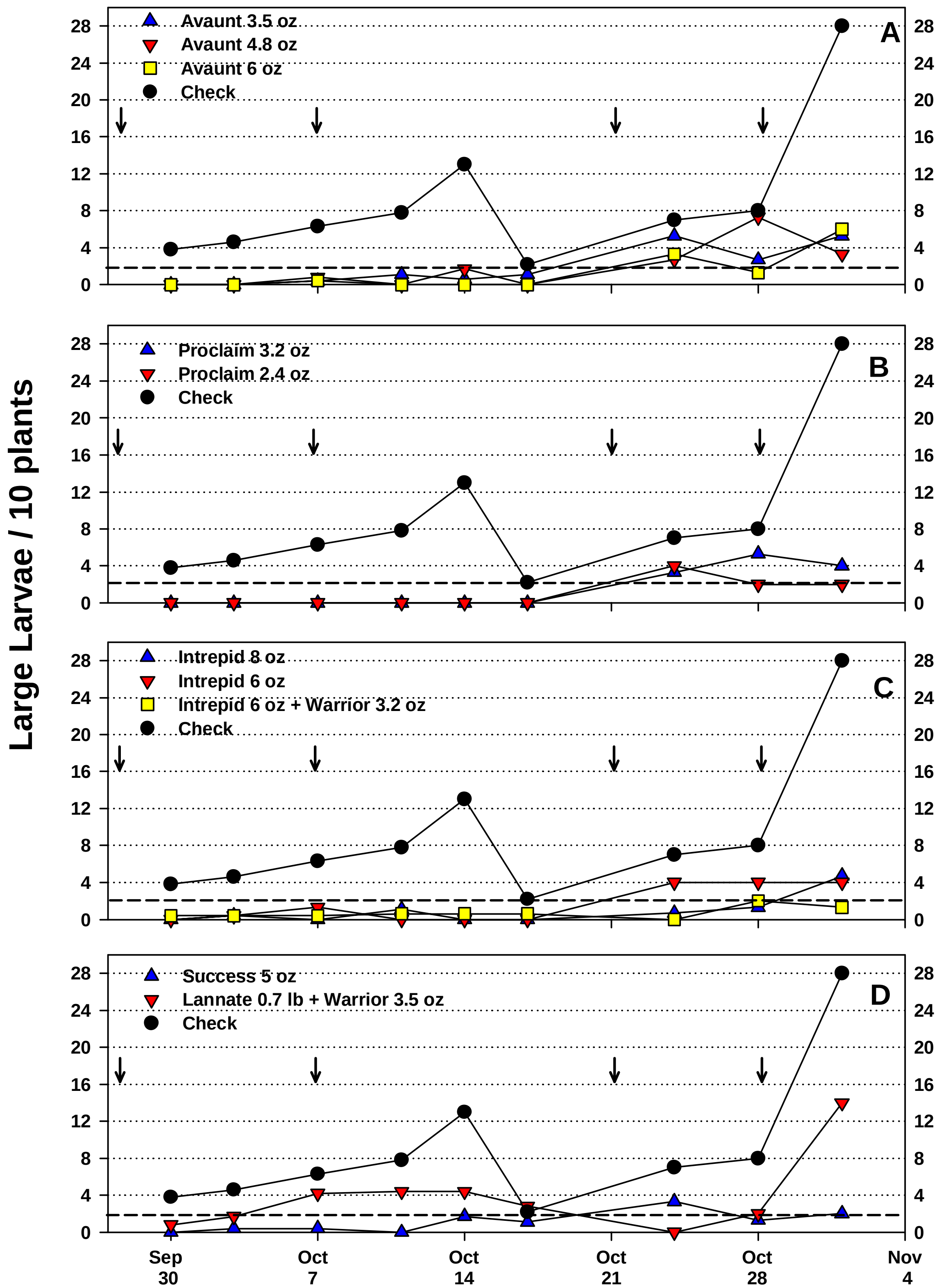


Figure 4. Seasonal trends of large cabbage looper larvae on head lettuce following applications with (A) Avaunt, (B) Proclaim, (C) Intrepid and (d) Success and Lannate/Warrior, YAC fall 2002

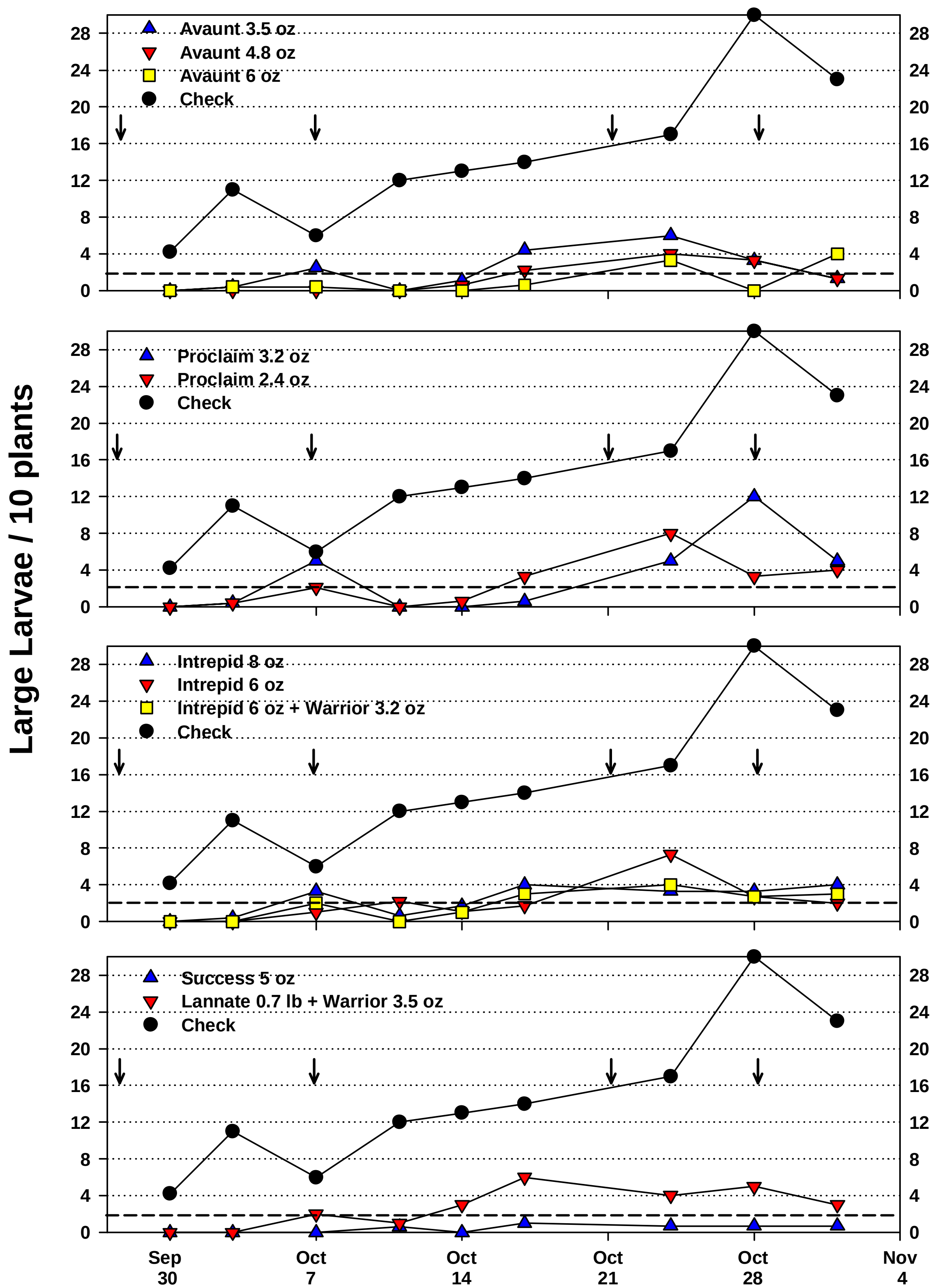


Table 5. Damage and contamination of marketable lettuce heads at harvest, Nov 7, 2002, 2002 Lettuce Study.

		Wrapper Leaves					Head and Cap leaf				
		Damage	Mean / 10 plants				Damage	Mean / 10 plants			
Treatment	Rate/acre	(%)	BAW	CL	TBW	Total	(%)	BAW	CL	TBW	Total
Intrepid 2F [a]	8 oz	20 cd	0 b	0 b	0 a	0 b	46 a	2.7 a	0 c	2.7 bcd	5.2 bcd
Intrepid 2F [a]	6 oz	38 bc	0 b	0.7 b	0 a	0.7 b	66 a	0.7 b	0.7 bc	6.7 abc	8.0 bc
Intrepid+Warrior [a]	6 oz+3.2 oz	18 cd	0 b	0 b	0 a	0 b	32 a	0 b	1.2 bc	1.2 d	2.4 de
Success 2F [b]	5 oz	6 d	0.7 b	0 b	0 a	0.7 b	26 b	0 b	0 c	2.6 bcd	2.6 de
Avaunt 30WG [c]	3.5 oz	26 bcd	0 b	0.7 b	0 a	0.7 b	52 a	0 b	0 c	2.6 bcd	2.6 de
Avaunt 30WG [c]	4.8 oz	26 bcd	0.7 b	0.7 b	0 a	1.4 b	40 a	0 b	2.7 ab	3.2 bcd	6.0 bcd
Avaunt 30WG [c]	6.0 oz	6 d	0.7 b	0 b	0 a	0.7 b	24 b	1.2 ab	0 c	2.0 cd	3.2 de
Proclaim 5SG [d]	3.2 oz	6 d	0 b	0.7 b	0 a	0.7 b	68 a	0.7 b	0.7 bc	7.2 ab	8.6 b
Proclaim 5SG [d]	2.4 oz	6 d	0 b	0 b	0 a	0 b	40 a	0 b	0 c	4.0 bcd	4.0 cde
Lannate +Warrior	0.7 lb+ 4 oz	26 bcd	0.7 b	0.7 b	0.7 a	2.0 b	12 b	0 b	0 c	0.7 d	0.7 e
Untreated	--	83 a	2.0 a	8.7 a	0 a	10.7 b	72 a	2.7 a	4.0 a	10.0 a	16.7 a

Means followed by the same letter are not significantly different, ANOVA; LSD *(p<0.05).*

[a] For the Oct 21 and 29 spray applications the rates of Intrepid were increased from 8 to 10 oz and from 6to 8 oz.

[b] For the Oct 21 and 29 spray applications the rate of Success were increased from 5 to 5.5 oz.

[c] For the Oct 21 and 29 spray applications Mustang 1.5EC at a rate of 4.0 oz was combined with Avaunt at 3.5 oz.

[d] For the Oct 21 and 29 spray applications Mustang 1.5EC at a rate of 4.0 oz was combined with Proclaim at 2.4 oz.

Table 6. Suggested Insecticide Use Patterns for Control of Lepidopterous Larvae Complex on Desert Lettuce, 2003

	Stand Establishment		Post-thinning to Pre-heading			Heading to Harvest		
	Coty -1 lf	*2-4 lf*	*4-8 lf*	*9-14 lf*	*Pre-heading*	*Early Head <2"*	*Head 2-4"*	*Head >4"*
Success	■	■	■	■	■	■	■	▒
Proclaim	■	■	■	■	■	■	■	▒
Avaunt			■	■	▒	▒		
Intrepid			■	■	▒	▒		
Confirm			▒	▒				
Lannate	▒	▒	▒	▒	▒	▒	▒	▒
Larvin			▒	▒				
Orthene or Endosulfan			▒	▒				

■ Insecticide has demonstrated good efficacy as stand-alone application

▒ Pyrethroid should be combined for additive Lep control and/or broad spectrum activity.