# DEVELOPMENT OF REDUCED RISK INTEGRATED PEST MANAGEMENT STRATEGIES FOR BEET ARMYWORM, *SPODOPTERA EXIGUA*, IN CALIFORNIA SUGARBEETS

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## ABSTRACT

Beet armyworm management in sugarbeets grown in the San Joaquin Valley of California has become increasing difficult in recent years. The standard organophosphate and carbamate insecticides appear to be providing less effective control and these materials are also under scrutiny from a registration standpoint. Significant changes in sugarbeet varieties and production practices have occurred since the advent of the presently used management strategies. In addition, observations indicate that even the armyworm pest may be changing in that larvae appear to be feeding more frequently at the soil surface or within the soil compared with past years. Studies were conducted in 2001 and 2002 to re-evaluate and develop improved management strategies for beet armyworm.

## INTRODUCTION

Beet armyworm, *Spodoptera exigua* (Hübner), larvae remain a significant insect pest of sugarbeets in the San Joaquin Valley of California. This species has a wide host range and is a significant pest (in addition to sugarbeets) on tomatoes, cotton, cucurbits, alfalfa, lettuce, and other crops. Beet armyworm (BAW) eggs are deposited in clusters of ~100 on the leaf surface. Newly-emerged larvae feed in a cluster initially and than move over the plant. The larvae skeletonize plant leaves leaving the veins. The behavior of the larvae appears to have shifted in recent years; the larvae appear to feed in more protected areas of the plant as opposed to populations in the 1970's and 80's. This has resulted in the larvae often feeding on the beet roots near the soil surface or slightly below the soil surface (larvae crawl into soil cracks caused by the roots) and in the crown of the plant instead of on the exposed leaves. This root feeding provides entry ports for root rotting organisms into the beet roots which can quickly decimate a sugarbeet stand or nearly mature crop. Finally, beet armyworm larvae also inhibit sugarbeet seedling establishment by clipping emerging seedlings; this can result in inadequate stands and the need for replanting. Populations are generally relatively low in the spring and increase with each of the three generations that occur during the spring/summer growing season. The highest infestations often occur in August and September.

Control of beet armyworm infestations in the 1990's was largely accomplished with applications of organophosphate and carbamate insecticides (primarily Lorsban® [chlorpyrifos] and Lannate® [methomyl]). In recent years in the San Joaquin Valley, repeat applications of insecticides are often needed for acceptable BAW control and control has still been inadequate. These applications have eroded the profitability of sugarbeets and the lack of control has reduced the sucrose yields. In addition, the multiple applications have flared populations of secondary pests such as spider mites, leafhoppers, etc. The intense use of organophosphate and carbamate insecticides was also undesirable from a regulatory standpoint. Registrations of these materials in the U.S. are being scrutinized under the Food Quality Protection Act and due to surface water contamination concerns.

Suh (1980) evaluated the effects of defoliation on sugarbeet yield in the late 1970's. His results showed the plants were extremely resilient of damage and that acceptable yields could be produced in spite of severe (nearly 100% in some cases) defoliation. His studies, however, had many limitations and the results were never implemented or accepted by growers. It is known that parasitoids, *Hyposoter exigua*, predators, and virus diseases inflict a high degree of natural control on BAW populations (Ehler, unpl.). The development and use of adoptable thresholds would allow growers to lower insecticide use by maximizing the natural ability of sugarbeet plants to compensate for defoliation. Decreased insecticide use would in turn reduce the incidence of secondary pest outbreaks by not disrupting naturally occurring biological control organisms. Therefore, there is a need to design alternative, improved IPM programs for beet armyworms on sugarbeets in the central and southern San Joaquin Valley.

## MATERIALS AND METHODS

Five field experiments were conduced per year in 2001 and 2002 at the Univ. of California West Side Research and Extension Center in Fresno County. Plots were planted 13 March, 2001 and 26 February, 2002 and were harvested both years on 23-24 September. Plots were 6 rows by 15 m with 3-5 blocks per treatment. The center 4 rows were evaluated. All insecticide applications were made with ground equipment at 20 GPA. Arthropod populations were monitored using pheromone traps for BAW moth flights and biweekly sweep samples (20/ plot) for BAW larvae, beneficials, and leafhoppers. Biweekly defoliation ratings of each plot on a scale of 1-7 were done to estimate damage. Beets were harvested mechanically, and harvest evaluations included stand counts, percentage rotten beets, tonnage, sucrose percentage, and nutrient analysis. Studies were designed to 1.) evaluate the effects of registered insecticides on BAW and beneficial populations and 2.) examine the effects of BAW defoliation damage on yields and root rot incidence. Large-scale studies were conduced in grower fields to demonstrate the viability of using reduced risk techniques for managing BAW populations; BAW management was compared using reduced risk strategies on a12-ha portion of the field versus conventional techniques on the remainder of the field (20 to 30 ha). Pest and natural enemy populations and yields were used as the evaluation criteria.

## RESULTS

Results will be briefly summarized herein.

Effects of commercial insecticides on BAW and beneficial organisms. Success® (spinosad) and Confirm® (tebufenozide) (this material is not registered on sugarbeet) provided the best overall BAW suppression and did not disrupt populations of natural enemies. Larval control with Lepinox® (Bacillus thuringiensis subsp. kurstaki) was inconclusive. In 2001, Lorsban® (chlorpyrifos) and Lannate® (methomyl) provided larval suppression through the second BAW flight, but flared populations (resulting in higher BAW densities than the control) after the third BAW flight. Applications of Asana® (esfenvalerate) resulted in BAW densities consistently higher than the control. In 2001 and 2002, the peak BAW populations in plots treated 3X (in June, July, and August) with Lorsban and Lannate were later and higher than in untreated plots. Removal of populations of beneficial organisms may have influenced these changes. Numbers of natural enemies were significantly lower (by 40-60%) in the plots treated with Lorsban, Lannate, and Asana compared with untreated plots.

Effects of BAW on root rot incidence. Data from the 2001 and 2002 insecticide studies were evaluated across all treatments to determine if BAW density had an effect on root rot incidence. Cumulative armyworms collected per plot were examined against the percentage root rot. For 2001, there was a positive relationship showing that increased BAW densities resulted in increased root rot incidence with % rotten beets peaking at 38% (Fig. 1). Root rot incidence in 2002 was very low and no relationship was seen.

Effects of defoliation of sugarbeet productivity. The effects on tonnage and sucrose percentage of single and repeated defoliation of sugarbeet plants during the four months preceding harvest were evaluated. A worst-case, artificial defoliation was used where leaves were completely removed by cutting midway up the petiole with a knife. Seven treatments plus a control were used and represented complete plant defoliation one, two, three, and four months before fall harvest as well as three treatments representing multiple defoliations. Defoliated treatments had lower tonnage and sucrose percentage than the control which yielded 84.9 MT/ha in 2002 (Fig. 2). Multiple defoliations led to greater reduced yields compared to plots receiving single defoliations. The later the defoliation, the less effect it had on yield (defoliations in September, August, July, and June reduced the yields by 9.5, 15.6, 25.3, and 39.1%, respectively). Sucrose percentage was lower in plots defoliated 2 or 3 months before harvest (averaging 13.7%) than in plots treated 1 or 4 months before harvest (averaging 14.6%).

Development of economic injury levels for BAW. Economic injury levels are critical for IPM programs. These values form the decision criteria for evaluating the economics of applying an insecticide application. Field trials were established to determine the effects of natural defoliation of sugarbeet on tonnage and sucrose percentage. Harvest data on tonnage and sucrose percentage were collected from 7 different field trials over 2 years. Each trial had plots with BAW levels suppressed, untreated plots, and some had plots with insecticide-induced BAW outbreaks. Insecticides for BAW suppression did not cause a statistical increase in tonnage or sucrose percentage when compared to the untreated control in any of the seven tests. BAW in the untreated plots of most trials averaged 3.9/20 sweeps in July, 6.1/ 20 sweeps in August, and 7.0/20 sweeps in September. Apparently, management of BAW under the conditions at this research site in 2001 and 2002 was unnecessary. When adopting thresholds, commercial growers should consider that fall-planted beets are probably even more tolerant of defoliation than were these February/March-planted beets, but that BAW densities in commercial sugarbeet fields in 2001 and 2002 were generally higher than those in these research plots.

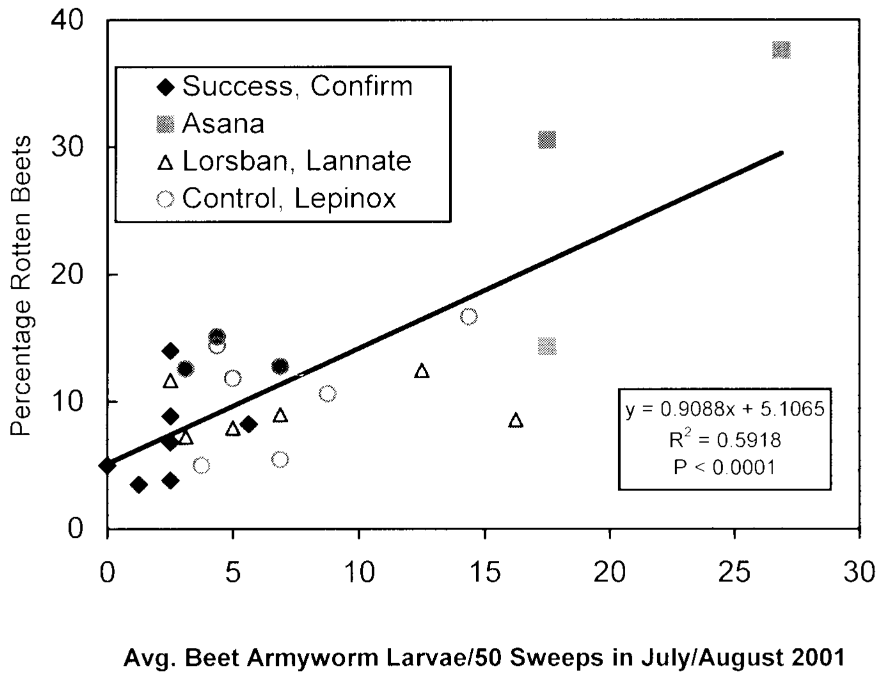
Demonstration tests in grower fields. Studies were done from 2000 to 2002 to demonstrate the use of reduced risk techniques to manage BAW. The overall summary of the work was that BAW management was comparable using a biorational approach (primarily *Bacillus thuringiensis* subsp. *kurstaki* sprays) compared with a standard approach. The standard approach at the beginning of the study relied on applications of carbamate and organophosphate insecticides; the availability of Success®, a reduced risk product, beginning in 2001, altered the philosophy slightly. Pheromone traps and degree day accumulations were used to predict moth flights and the occurrence of BAW eggs and small larvae. All insecticides, especially reduced risk materials, such as *Bacillus thuringiensis* provide better control if used on small larvae. In 2001 and 2002, BAW larval levels were comparable using these two approaches; studies were conducted in fields at least 32 ha in size with the reduced risk approach used on 12 ha (Tab. 1). Numbers of beneficials were generally greater in the field section with the biorational method of BAW control. Leafhopper and spider mite levels did not differ under the two management approaches. Sucrose yields showed no consistent trends with management method - sometimes higher under the standard control methods and in other cases higher under the biorational approach. BAW populations in 2001 and 2002 were overall moderate and two applications, at most, were used.

*Tab. 1. Yield and arthropod population levels from demonstration test utilizing two approaches for managing Beet Armyworms, 2001, Fresno County, CA.*

| | Approach | Avg. Beneficials per 50 Sweeps (June – Sept.) | Avg. BAW Larvae per 50 Sweeps (June – Sept.) | Number of Applications for BAW | Beet Yield (MT/ha) | % Sucrose | Sucrose (MT/ha) |
|---|---|---|---|---|---|---|---|
| Field 1 | Biorational | 4.8 | 6.6 | 0 | 74.4 | 14.2 | 10.5 |
| Field 1 | Conventional | 4.1 | 6.3 | 1 | 84.9 | 13.7 | 11.6 |
| Field 2 | Biorational | 8.8 | 5.0 | 1 | 79.1 | 13.7 | 10.8 |
| Field 2 | Conventional | 5.2 | 11.2 | 2 | 74.6 | 13.4 | 10.0 |

Conventional approach utilized applications of carbamate and organophosphate insecticides, biorational approach utilized application of *Bacillus thuringiensis* subsp. *Kurstaki*

*Figure 1. Relationship between BAW populations and root rot incidence in 2001.*




## CONCLUSIONS

This study has shown ability of a healthy sugarbeet plant to tolerate significant levels of defoliation without losses in tonnage or sucrose percentage. This ability increased with increased sugarbeet plant age, and reached a maximum approximately one month before harvest.

No significant losses in yield were detected in 2001 or 2002 for defoliation from BAW populations that reached an average over two evaluation dates (two weeks apart) of 3.9 per 20 sweeps in July, 6.1 in August, and 7.0 in September. Thresholds for BAW need to take into account the potential effects of BAW on root rot in a year of high root rot incidence. In years with low root rot incidence, this type of damage need not be considered when developing thresholds.

In the case of BAW densities beyond the scope of these experiments, Success should be the primary insecticide for BAW. It is reduced risk, provided the most BAW suppression and did not disrupt biological control. Lorsban and Lannate should be used sparingly, and should not be considered after the second summer BAW flight. Biological control has considerable influence on BAW suppression. Highest BAW densities repeatedly came from plots treated with insecticides known to disrupt biological control.

Utilizing an increased level of in-field scouting and monitoring BAW moth flights with pheromone traps facilitated effective BAW management with reduced risk Bt insecticides. Yields under this scenario were equivalent to that with a conventional insecticide approach.

## REFERENCES

Suh, J. B. 1980. Effects of simulated and natural defoliation on yield and sugar content of sugarbeets in California. Ph. D. diss., Univ. of California, Davis.

*Figure 2. Influence of artificial defoliation on sugarbeet productivity, 2002.*