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MONITORING ADULT POPULATIONS OF TWO INSECT PESTS WITH SEX PHEROMONE TRAPS FOR EFFECTIVE TIMING OF INTERVENTIONS AGAINST THE DEFOLIATORS OF ONION (*Allium cepa* L.) GROWN AFTER RICE (*Oryza sativa* L.)

G.S. Arida[1*], B.S. Punzal[1], C.C. Ravina[1], V.P. Gapud[2], E.G. Rajotte[3] and N.S. Talekar[4]

[1] Integrated Pest Management-Collaborative Research Support Program (IPM-CRSP), Philippine Rice Research Institute, Muñoz, Nueva Ecija
[2] Entomology Department, University of the Philippines Los Banos College, Laguna
[3] Pensylvania State University, University Park, PA
[4] Asian Vegetable Research and Development Center (AVRDC), Taiwan

ABSTRACT

The lack of effective surveillance and monitoring tools to time interventions results in unnecessarily high frequency of insecticide spraying to control insect defoliators of onion grown after rice. Field studies were conducted in Bongabon, Nueva Ecija during the 2001 and 2002 dry seasons to evaluate the effectiveness of sex pheromone-baited traps as indicator for proper timing of insecticide applications against onion defoliators, *Spodoptera litura* (F.) and *S. exigua* (Hubner) (Lepidoptera: Noctuidae). In both years, critical peaks in adult trap catch were recorded between 25 and 59 days after transplanting. One to three insecticide applications at 3, 5, or 7 days after peaks in sex pheromone trap catch resulted in crop yield and leaf damage similar to those in weekly-sprayed plots. Yields from plants in all treatments were significantly higher than those in the untreated plots. The use of sex pheromone-baited traps can reduce frequency of insecticide applications substantially, from weekly spraying to only 1-3 applications in a cropping season without reducing yield. It also reduces farmers' exposure to pesticides and minimizes adverse effects on natural enemies of pests. The use of sex pheromone- baited traps can be a key decision tool in developing cost-reducing technologies to manage *S. litura* and *S. exigua* in rice-onion vegetable cropping system.

Key words: integrated pest management, sex pheromones, pest surveillance and monitoring, onion, cutworms, armyworms

Abbreviations : IPM - integrated pest management, NOGROCOMA - National Onion Growers Cooperative Marketing Association, CRSP - Collaborative Research Support Program, DAP - days after the critical peak, DAT - days after transplanting.

* corresponding author

INTRODUCTION

The use of sex pheromone traps in detection and surveillance is well recognized in pest management circles. The high specificity of sex pheromones has made them extremely valuable for insect detection, and in some instances for estimating pest densities. When used in surveillance systems, pheromone-baited traps are set out and observed regularly in areas of potential pest infestation. Capture of insects in pheromone traps signals the presence of the target species and control measures can be applied when needed and with efficient timing. Their use in insect pest management is precise and specific. In addition, it is more economical since only a small amount of chemical is needed in this system.

Several works have been done on the use of sex pheromones for surveillance of insect pests of agricultural crops. Successes in relating adult trap catch to pest density on the crop and pest damage have been reported. The codling moth, *Laspeyresia pomonella* (L.), is an example where pheromone traps were used extensively in monitoring, detecting native adult populations, and indicating the need for chemical control (Madsen and Vakenti, 1972; Rock et al, 1978). The seasonal adult catches in pheromone traps were correlated with the absolute infestation levels in the field. This was used as a reference point for insect emergence, oviposition and egg hatching on the crop (Riedl and Croft, 1974; 1976).

Pheromone traps can also be used to indicate the earliest pest arrival in crops. Working on the pea moth *Laspeyresia nigricana* (Stephens), Macaulay (1977) reported that pheromone traps predicted the arrival of pea moths in the crop considerably earlier than traditional egg counts. It is evident from results of earlier studies that sex pheromone-baited traps can be an important tool in insect pest surveillance. If a critical catch level can be used to indicate the need to apply a control measure, then the risk of insecticide misuse is reduced.

In the Philippines, work on sex pheromones started in 1975 with the identification and synthesis of the sex pheromones of the striped rice stemborer *Chilo suppressalis* (Walker) and the pink rice stemborer *Sesamia inferens* (Nesbitt et al., 1975; 1976). In a field study by Arida (1981), the main peak in adult trap catch of the striped rice stemborer preceded the peak in oviposition period. Monitoring adult densities using sex pheromones of this insect has been done in Korea and Iran (Beevor et al., 1977)

Spodoptera litura (L.) and *S. exigua* (Hubner) are important insect pests of several agricultural crops. Both insect species are polyphagous and can survive on several weed species in the absence of agricultural crops. *S. litura* was reported to feed on rice in Asia and Africa (Pathak and Khan, 1994). These species can feed on legumes, pepper, shallot, potato, crucifers and other vegetables. In most crops, the caterpillar clusters appear early in the season and reported to be the most serious problem in low-altitude onion farms in Indonesia (Shepard, et al., 1999). Both species are important defoliators of onions in Nueva Ecija, Philippines and have caused severe damage to the crop during the El Niño year of 1997. Consequently, onion farmers in Nueva Ecija spray several times against these defoliators as prophylactic treatment. It is also a common practice of farmers to spray the onion seedbed several times before transplanting the seedlings.

Studies on the use of sex pheromones of *S. litura* and *S. exigua* in pest management started after the identification and synthesis of their chemical components (Tamaki et al., 1973; Tumlinson et al., 1981). Sex pheromone was used in Japan to disrupt mating of *S. exigua* in greenhouses and fields as a pest control technique (Takai and Wakamura, 1995; Srinivas and Rao, 1999). Pheromone trap catch of male *S. litura* moths and egg population density in groundnut and other crops were reported to have significant positive correlation (Sridhar et al., 1988; Singh and Sadhan, 1993).

Our preliminary work on the use of sex pheromones of both species as surveillance and monitoring tool indicated their practical application in the control of the above insect pests in the context of IPM as defined by Kogan (1998) 'as a decision support system for the selection and use of pest control tactics, singly or harmoniously coordinated into a management strategy, based on cost/benefit analyses that take into account the interests of and impacts on producers, society and the environment'. Our earlier data showed that there were several peaks in sex pheromone trap catch during the onion crop period. Peaks in sex pheromone trap catch preceded the peaks in egg density. (Arida, et al., 2002).

The objective of the study was to determine control efficiency of timing insecticide application against *S. litura* and *S. exigua* attacking onion based on the trend in sex pheromone trap catch.

MATERIALS AND METHOD

Site of the study

This study was conducted in Kaingin, Bongabon, Nueva Ecija during 2001 and 2002 dry seasons. Nueva Ecija is the main onion-growing province in the Philippines. The experimental field was a 2-ha farm owned by NOGROCOMA (National Onion Growers Cooperative Marketing Association) that was used by the Integrated Pest Management-Collaborative Research Support Program (IPM-CRSP) project on studies related to management of weeds, diseases, and insects attacking onion. The site also served as a demonstration farm for onion farmers in the area. Several fields managed by farmers surrounded the experimental site. Most farmers in this area plant 'red onion' variety in December-January and harvesting is done in April-May. Some farmers plant yellow onion as early as October, hoping to harvest earlier for better price. However, this is risky because October is still a rainy month and diseases could be very destructive in some cases. Some of the fields in the area were planted to rice after onion season. A small percentage of farmers continue to grow several kinds of vegetables.

Sex pheromone trap

Onion cv. 'Red Creole' was grown in 4m x 5m plots following recommended cultural management practices. Modified rectangular sex pheromone traps made of metal sheet were used in the study. Adhesive material (Tanglefoot ®) was placed at the bottom of the trap to catch the moths. Three traps baited with synthetic sex pheromone of *S. litura* and another three with

S. exigua pheromone were installed in the experimental area starting from September 2000 up to May 2002. The traps were installed 20 m apart perpendicular to the prevailing wind direction. The synthetic sex pheromone materials dispensed in rubber septum were replaced every month while adhesive material was added whenever necessary. The male moths caught in the pheromone traps were monitored and recorded 3 times each week.

To evaluate the usefulness of the sex pheromone traps in providing information on adult insect abundance as an input in deciding when to apply interventions to the crop, the following treatments were included in the experiment: T1) sprayed every week starting at 1 week after transplanting; T2) sprayed 5 days after the critical peak (DAP) in trap catch; T3) sprayed 7 days after the peak in trap catch; T4) sprayed 9 days after the peak in trap catch; and T5) Untreated control. In the 2002 study, another treatment was added: sprayed 3 days after the peak in trap catch, increasing the total number of treatments to six.

The decision on the above treatments was based on the life history and behavior of the insect species. Results of our earlier study indicated that the peak in trap catch would be the peak in mating of moths in the field. This would be followed by the peak in egg deposition in 2-3 days and egg hatching in another 3-4 days. Insecticide treatment must be done when the eggs hatch, larvae are young and before they bore into the leaf tissue, otherwise they are likely to escape.

The following information were recorded: 1) sex pheromone trap catch 3x a week; 2) number of larvae of defoliators on 10 randomly selected plants per plot taken every 2 weeks; 3) number of leaves damaged by defoliators on 10 randomly selected plants per plot taken every 2 weeks; and 4) onion yield. Treatments were replicated 4 times in a randomized complete block design. Chlorpyrifos+BPMC (0.75 kg ai/ha) was applied based on the critical peak of adult male population.

At the end of the onion season, several onion farmers were interviewed in the study area to determine the most commonly used insecticides and their frequency of application.

RESULTS AND DISCUSSION

Expectedly, within a crop period, there would be several "peaks" in adult catch. We chose the peak, to be used as basis for our treatment, after considering the following : a) occurence of the peak in relation to crop age, b) sudden rise in adult male catch following much lower peaks and c) experience in our previous experiments related to sex pheromone trap catch, egg density, and damage to the plant.

2001 Dry Season

Data on sex pheromone trap catch of *S. litura* males during the onion season are shown in Fig. 1. There was no evident pattern in adult abundance in the cropping season. A high peak in trap catch was first recorded at 27 days after transplanting (DAT) and which was used as basis for spraying insecticides in T2, T3, and T4. The mean number of male moths caught during this time was higher than 20 per trap which was considered critical. This was the highest mean trap catch during the season.

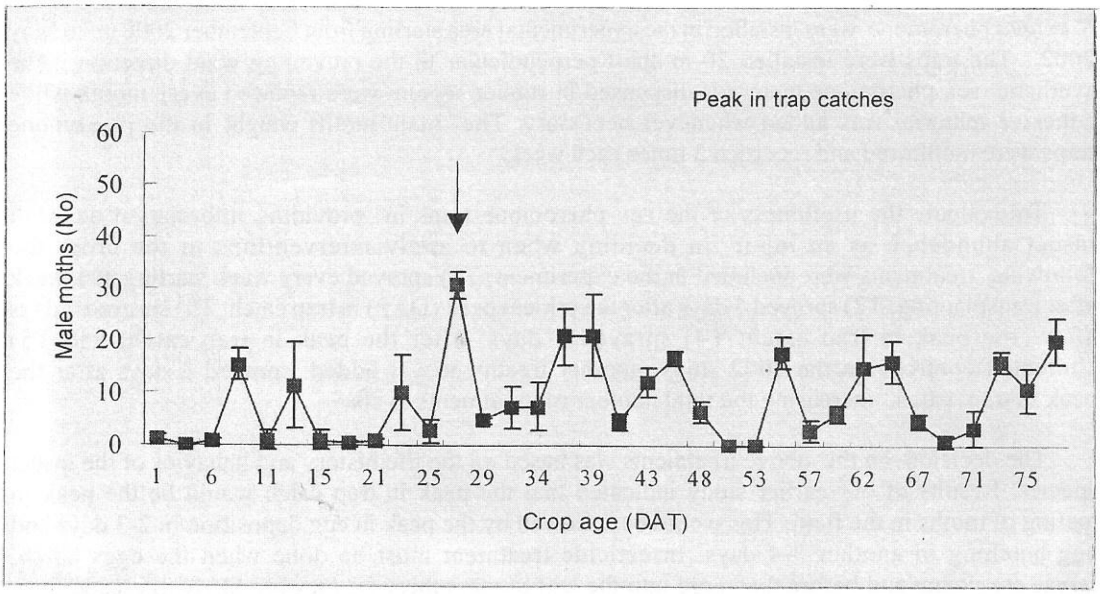

Fig. 1. Trend in catch of male S. *litura* moths in sex pheromone traps during onion season. Bongabon, Nueva Ecija. 2001 Dry Season. Arrow indicates the peak used as basis for pesticide application.

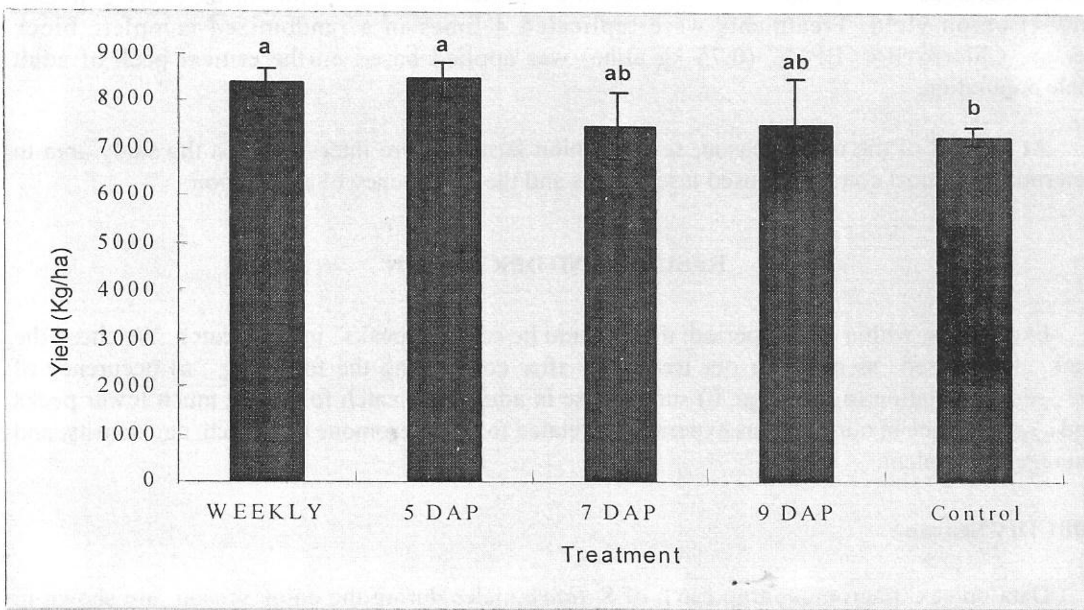

Fig. 2. Yield (mean of 4 replications ± se) of onion with different timing of insecticide application. Bongabon, Nueva Ecija. 2001 Dry season. DAP = days after critical peak in trap catch. Yield means with the same letter are not significantly different at 5% level by DMRT.

Table 1. Percent damaged leaves at different crop growth stages. Bongabon, Nueva Ecija. 2001 Dry season.

Treatment	Days after Transplanting[1] 42	56	70
T1 - Weekly spray	0.6 c	21.7 c	31.6 a
T2 - Spray 5DAP	1.0 c	33.5 b	33.1 a
T3 - Spray 7DAP	3.3 bc	42.4 a	31.5 a
T4 - Spray 9DAP	5.1 b	41.3 a	33.7 a
T5- Control	9.2 a	45.8 a	36.3 a

[1] Ave. of 4 replications. In a column, means with the same letter are not significantly different at 5% level by DMRT.DAP= days after critical peak in trap catch.

Table 2. Density (no/plant) of larvae of insect defoliators at different growth stages of onion crop. Bongabon, Nueva Ecija. 2001 Dry season.

Treatment	Days after Transplanting[1] 42	56	70
T1 - Weekly spray	0.00 c	0.10 b	0.03 b
T2 - Spray 5DAP	0.00 c	0.13 b	0.00 b
T3 - Spray 7DAP	0.00 c	0.23 b	0.15 ab
T4 - Spray 9DAP	0.25 b	0.30 b	0.13 ab
T5- Control	0.48 a	0.65 a	0.28 a

[1] Ave. of 4 replications. In a column, means with the same letter are not significantly different at 5% level by DMRT.DAP= days after critical peak in trap catch.

Percentage of damaged leaves (Table 1) and number of larvae per plant (Table 2) were low up to 42 DAT. The highest percentage of damaged leaves and number of larvae were recorded at 56 DAT in all the treatments. Plants sprayed weekly (T1) had the lowest percentage of damaged leaves and number of larvae per 10 plants; highest was recorded in the unsprayed control (T5). Field samples at 56 DAT showed that larval populations consisted of *S. litura (69%), Helicoverpa armigera* (30%) and *S. exigua* (1%). This was the only year when we observed high larval population of *H. armigera.* No sex pheromone trap for this insect was installed.

Yields in T1 and T2 were significantly higher than that in the control plot (T5) (Fig. 2). It is evident that efficient timing of a single application of insecticide gave the same result as weekly spraying. A single application of insecticide at 5 days after the critical peak in trap catch (T2) resulted in yield level similar to that of the treatment sprayed weekly (T1). Spraying once at 7 or 9 days after peak in trap catch (T3 and T4) resulted in a slightly higher yield than the untreated control (T5); however, the difference was not significant. Our data showed that the population of defoliators was not as high as farmers perceived to adversely affect onion yield. It is also likely that the onion crop can tolerate certain levels of damage at certain stage of crop growth as reported earlier in shallot (Djoni et al., 1996) and in onion (Arida et al., 2004).

According to the 23 farmers interviewed at the end of onion season, frequency (mean ± std) of insecticide spraying was 12±5 and 22±8 in Talavera and Bongabon, respectively. Farmers in Talavera sprayed more in the seedbed (3.8 ± 1.4) but much less after transplanting the crop than those in Bongabon (2.2 ±1.2), but the Bongabon farmers sprayed much more after transplanting. The high frequency of insecticide spraying in the seedbed was directed to leaf feeding insects specially *Spodoptera* spp., according to farmers. However it was doubtful if indeed insecticide application was needed at that time.

2002 Dry Season

Based on the number of male moths caught in sex pheromone traps (Fig. 3), there were more *S. litura* than *S. exigua* early in the season, reaching a critical peak at 25 DAT. Population of *S. exigua* males caught in the traps began to increase starting at 36 DAT, reaching critical peak at 39 DAT. Two critical peaks in trap catch of male moths of both species (25 and 59 DAT for *S. litura* and 39 and 59 DAT for *S. exigua*) were recorded during the season (Fig. 3). These peaks were used as basis for application of insecticide. Since the peak of 59 DAT occurred for both species, only a total of 3 sprayings (using peaks at 25, 39 and 59 DAT) were done in Treatments 2,3,4 and 5. In both years, insecticide was applied when the mean was about 20 or more male moths per trap. Since this peak was much higher than the earlier ones observed, it was taken as indicator of the upcoming population increase. A follow-up study on this aspect should be done to determine if a catch higher than 20 adults per trap would be a better indicator for effective timing of interventions.

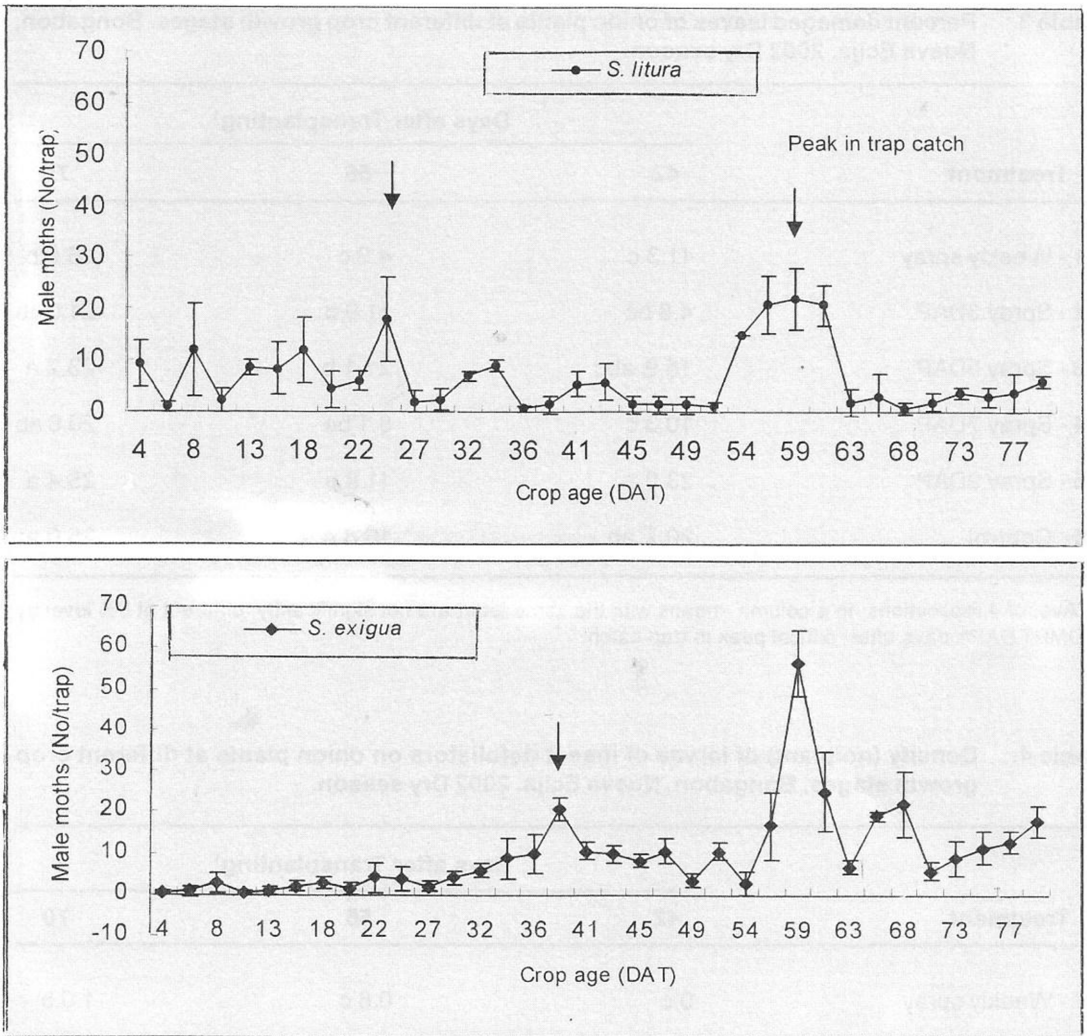

Fig. 3. Trend in catch of male *S. litura* and *S. exigua* moths in sex pheromone-baited traps during onion season. Bongabon, Nueva Ecija. 2002 Dry season. Arrow (⟶) indicates the peaks used as basis for insecticide application. DAT = days after transplanting.

Majority of the defoliators recorded were *S. litura* and *S. exigua*. Larva of *Helicoverpa armigera* was not recorded during this year. Damage assessment and counting of larvae were done at 42 (vegetative), 56 (bulb formation) and 70 (bulb maturity) DAT to represent the three distinct stages of onion crop growth. Ideally, each assessment of damage and larval density should be done also at same number of days after treatment application for a better comparison of the treatment effects. This is to give each treatment the same length of time for insecticide action after each application. For example, when % damaged leaves and larval density were taken at 42 DAT (Tables 3 & 4), the plants in T2,T3,T4, and T5 had the first insecticide treatment 14, 12, 10 and 8 days earlier, respectively. This may partly explain the significantly higher number of larvae in T5.

Table 3. Percent damaged leaves of onion plants at different crop growth stages. Bongabon, Nueva Ecija. 2002 Dry season.

Treatment	Days after Transplanting[1] 42	56	70
T1 - Weekly spray	11.3 c	4.9 c	16.5 b
T2 - Spray 3DAP	4.8 bc	11.9 b	21.0 ab
T3 - Spray 5DAP	15.9 abc	21.1 b	23.2 a
T4 - Spray 7DAP	10.3 c	8.1 bc	20.6 ab
T5 - Spray 9DAP	23.0 a	11.8 b	25.4 a
T6- Control	20.7 ab	16.6 a	25.0 a

[1] Ave. of 4 replications. In a column, means with the same letter are not significantly different at 5% level by DMRT.DAP= days after critical peak in trap catch.

Table 4. Density (no/plant) of larvae of insect defoliators on onion plants at different crop growth stages. Bongabon, Nueva Ecija. 2002 Dry season.

Treatment	Days after Transplanting[1] 42	56	70
T1 - Weekly spray	0 c	0.8 c	1.0 b
T2 - Spray 3DAP	0 c	1.8 bc	1.8 b
T3 - Spray 5DAP	0 c	2.5 bc	1.5 b
T4 - Spray 7DAP	0 c	2.5 bc	2.5 ab
T 5- Spray 9 DAP	2.5 a	4.8 b	2.5 ab
T6- Control	5.5 b	8.9 a	6.0 a

[1] Ave. of 4 replications. In a column, means with the same letter are not significantly different at 5% level by DMRT. DAP= days after critical peak in trap catch.

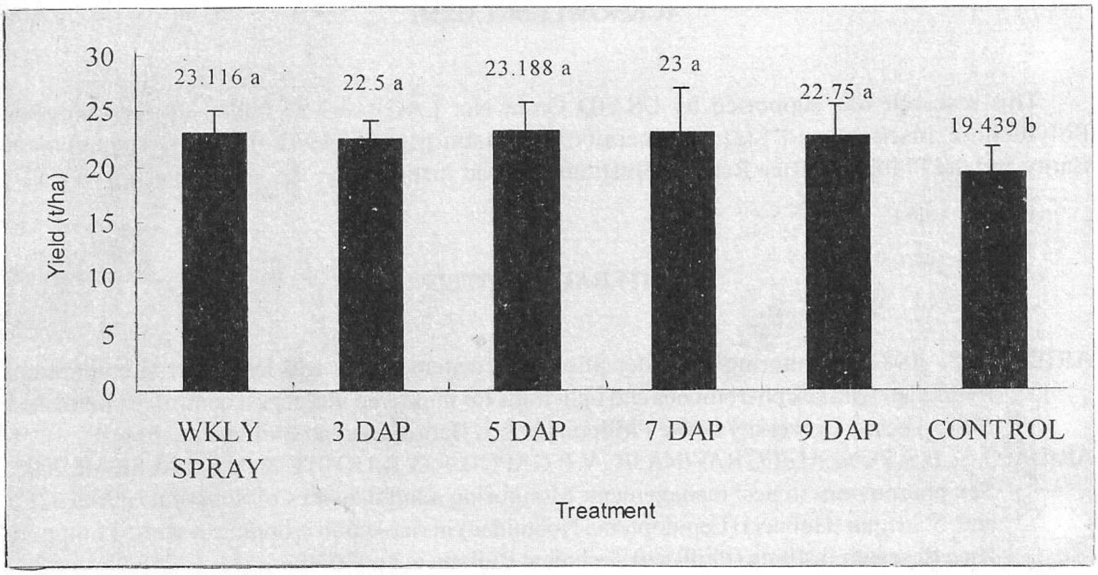

Fig. 4. Yield (mean of 4 replications ± std) of onion with different timing of insecticide application. Bongabon, Nueva Ecija. 2002 Dry season. DAP = days after the critical peak in trap catch. Means with the same letter are not significantly different at 5% level by DMRT.

Significantly higher yields were recorded for all the treated plots compared to the untreated control (Fig. 4). Data for both years showed that spraying at 5,7, or 9 DAP resulted in yields comparable to that of weekly-sprayed plot. Furthermore, with monitoring, spraying was reduced to 70% and 90% in 2002 and 2001, respectively, thereby reducing production cost and farmers' exposure to insecticide. In our earlier studies as already mentioned, the peak in sex phermone trap catch was estimated to coincide with the peak in mating of adults and this was followed in a few days by the peak in egg density in the field. Since egg incubation is about 3 days, it is assumed that 5 to 9 DAP is the time when the young larvae are vulnerable to insecticide treatment. At this time, young larvae are still exposed, feeding on the leaf surface of the onion plant.

CONCLUSION AND RECOMMENDATION

It is evident from the results of the study undertaken that monitoring the densities of adult lepidopterous pests using sex pheromone traps could lead to significant reduction in the amount of insecticides applied on onion without reducing crop yield. In addition, this will result in reduction in production costs, less hazards to farmers and to the environment. It is highly recommended therefore that a surveillance and monitoring tool like sex pheromone-baited traps be incorporated in the strategies for management of *S. litura* and *S. exigua* in a rice-onion cropping system to help farmers determine the most appropriate time for applying control interventions. Sex pheromones are generally cheap as a monitoring tool, safe to farmers, and environment-friendly.

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