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# Efficacy of Cypermethrin, Neem Extract and *Bacillus thuringiensis* for Controlling Insect Pests of Vegetable Soybean

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## ABSTRACT

Field experiments were conducted during dry and wet seasons (1999-2000) at Kamphaeng Saen Campus of Kasetsart University, Nakhon Pathom, Thailand to evaluate the efficacy of cypermethrin 10 EC, neem extract (Azadirachtin 0.1%) and *Bacillus thuringiensis* var. *kurstaki* (53,000 SU/mg) in controlling the major insect pests of vegetable soybean. *Melanagromyza sojae, Spodoptera litura, Spodoptera exigua, Helicoverpa armigera, Lamprosema indicata, Etiella zinckenella* and *Bemisia tabaci* were the most abundant species in both seasons. Insecticides were sprayed at 10 days interval until harvest. Cypermethrin showed significantly better control among the treatments. Neem extract moderately suppressed the insect pests with statistically significant efficacy over the control. *B. thuringiensis* var. *kurstaki* showed less efficacy than neem extract but exhibited statistically significant efficacy over the control in most cases. Highest yield was recorded in cypermethrin treated plot (9.83 t/ha) followed by neem extract (8.39 t/h), *B. thuringiensis* var. *kurstaki* (7.98 t/ha) and control (6.22 t/ha) in dry season whereas yields were 5.83, 4.83, 4.0 and 2.83 t/ha for cypermethrin, neem extract, *B. thuringiensis* var. *kurstaki* and control in wet season, respectively. Additionally, *Menochilus sexmaculatus* and spider were found less in cypermethrin treated plots whereas in other treatments they were significantly higher in number.

**Key words:** cypermethrin, neem extract, *Bacillus thuringiensis*, vegetable soybean, insect pests

## INTRODUCTION

Vegetable soybean, *Glycine max* (L.) Merrill, is defined as those which are harvested after the $R_6$ and before $R_7$ growth stage (Fehr *et al*., 1971) while the pods are still green and the seeds have developed to fill 80-90% of the pod width. In a review of insect pests of soybean in the tropics, Jackai *et al.* (1990) considered insect pest as a major biological constraint and of a particular problem in South East Asia where soybean has been cultivated for several hundred years. Although considered a crop of potential economic importance, investigation on soybean entomology has been negligible and vestigial in comparison with other crops of economic importance in Thailand. Insect pests attacking soybean are known as stem feeders, leaf feeders and pod feeders. Major pest species under each category are found in all locations in tropical to sub-tropical Asia, while minor ones are found in isolated areas when their damage occasionally reduce soybean yield. Certain insect pests cause serious damage in one location, but they are not considered pests of soybean at other location. Arunin (1978) gave an account of 10 species of insect pests of soybean out of 30 herbivorous species as being of economic


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importance in Thailand.

Although synthetic insecticides cause adverse effects on non-target organism and human beings, they are still considered the only effective means to control insect pest among the farmers. Increasing public concerns about environmental hazards and widespread resistance in pest populations are threatening the continued effectiveness of conventional insecticides and ones should increase the use of insecticidal products derived from *Bacillus thuringiensis* Berliner in the next decade (Tabashnik, 1994). The use of *B. thurringiensis* var. *kurstaki* to control lepidopterous species in row crops is increasing because of the development of insecticides resistance by the insects. For this reason natural pesticides are often preferred over synthetic ones. Neem, *Azadirachta indica* A. Jass., has evoked a great deal of interest because of its bio-efficacy and bio-degradability. Among the plants possessing environmental-friendly pesticides, it is proving to be a valuable asset on account of its insecticidal properties against a number of insect pests. Therefore, an attempt was made to investigate the efficacy of cypermethrin, neem extract and *B. thuringiensis* var. *kurstaki* for controlling the insect pests of vegetable soybean.

## MATERIALS AND METHODS

The experiments were carried out in fields at Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom, Thailand during dry (December, 1999) and wet (April, 2000) seasons. A randomized complete block design, replicated four times, was used. Individual plots consisted of ten rows, 5 m long and 50 cm apart. Plants within the rows were 20 cm apart maintaining 25 hills/row. Block to block and plot to plot distance were 3 m and 2 m, respectively. Vegetable soybean variety AGS292 was used as planting material. Seeds were sown at the rate of 3-4 seeds/hill. Watering was done immediately after sowing. Plots were hand-weeded at 14, 28 and 42 DAP (days after planting). Thinning to two plants per hill was done at 14 DAP. Composed was applied as basal treatment at the rate of 15.9 t/ha before land preparation. Side dressings were applied at 15, 30 and 45 DAP with NPK of 15-15-15, 12-24-12 and 13-21-13 at the rate of 312.5, 187.5 and 187.5 kg/ha, respectively.

The experiment consisted of four treatments including control (Table1). Insecticides used were Cypermethrin 10 EC, Neem extract (Azadirachtin 0.1%) and *B. thuringiensis* var. *kurstaki* (53,000 spodoptera unit per mg; Delfin, manufactured by Sandoz Crop Protection Corporation, USA). Insecticide applications were made at 10, 20, 30, 40, 50, and 60 DAP using a knapsack sprayer. The rate of applications were 1 l/ha, 1 l/ha and 400 g/ha in 400 liters of water for cypermethrin, neem extract and *B. thuringiensis*, respectively. Adjuvant (IBA spreader) was added to spray volume at the rate of 0.5 ml/liter for better adhesion of insecticides on plant surface.

Data were collected at third day after each spray application. Direct observation method was followed for data collection. For this purpose, 20 plants per plot were randomly selected for counting larvae and adults. In case of bean fly, plants were dissected for recording maggots and infestation. The efficacy of insecticides were calculated by comparing them with the untreated control plot. Yield were recorded within the center of each plot from 9 $m^2$ area at harvest.

## RESULTS

The efficacy of cypermethrin, neem extract and *B. thuringiensis* were investigated in the field for controlling insect pests of vegetable soybean for two growing seasons. It was observed that all insecticides significantly reduced larval population of *Spodoptera exigua* (Hubner) (Lepidoptera: Noctuidae) compared to control (Table 1). Cypermethrin showed the highest reduction of larvae among the treatments and differed significantly except neem extract at 53 DAP in dry season and at

43 DAP in wet season. No significant difference was observed between neem extract and *B. thuringiensis* in both seasons except at 33 DAP in wet season where neem extract significantly reduced larval population over *B. thuringiensis*.

*S. litura* (F.) (Lepidoptera: Noctuidae) was found to be most dominant among the lepidopterous species feeding on soybean leaves during both seasons. Data showed that all the treatments significantly suppressed larval population over the control in both seasons (Table 2). Among the treatments, cypermethrin showed the best result in both seasons which differed significantly except *B. thuringiensis* on 43 DAP in dry season. No significant difference was observed between neem extract and *B. thuringiensis* in dry season but differed significantly in wet season. The highest number of larvae were recorded in control plot on 43 DAP in dry season .

*Helicoverpa armigera* (Hubner) (Lepidoptera noctuidae) was found to damage soybean leaves in both seasons. It was observed (Table 3) that all the treatments significantly reduced larval population over the control in dry season. No significant difference was observed among cypermethrin, neem extract and *B. thuringiensis* on 23 and 33 DAP in dry season but on 43 DAP neem extract differed significantly over *B. thuringiensis* in the same season. Cypermethrin and neem extract did not differ significantly in wet season but differed significantly over the control. No significant difference was observed between *B. thuringiensis*

**Table 1** Effects of various insecticides on the incidence of *Spodoptera exigua* larvae.

| | Dry season | | | Wet season | | |
|---|---|---|---|---|---|---|
| | Days after planting (20 plants/plot) | | | | | |
| Treatments | 33 | 43 | 53 | 33 | 43 | 53 |
| Cypermethrin | 8.0a* | 3.75a | 0.5a | 8.75a | 8.0a | 2.75a |
| Neem extract | 13.25b | 10.5b | 1.5ab | 16.25b | 12.25ab | 6.25b |
| *B. thuringiensis* | 15.5b | 11.0b | 2.5b | 19.25c | 15.0b | 8.5b |
| Control | 25.75c | 22.5c | 5.25c | 28.25d | 28.5c | 14.5c |

* Means followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

**Table 2** Effects of various insecticides on the incidence of *Spodoptera litura* larvae.

| | Dry season | | | Wet season | | |
|---|---|---|---|---|---|---|
| | Days after planting (20 plants/plot) | | | | | |
| Treatments | 33 | 43 | 53 | 33 | 43 | 53 |
| Cypermethrin | 6.5a* | 10.75a | 9.0a | 11.0a | 15.25a | 9.5a |
| Neem extract | 14.5b | 24.75b | 30.0b | 23.0b | 27.0b | 15.25b |
| *B. thuringiensis* | 15.25b | 23.5ab | 31.25b | 33.75c | 37.0c | 26.0c |
| Control | 29.25c | 89.0c | 75.5c | 51.25d | 55.0d | 29.5d |

* Means followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

and control in the later season on 23 and 33 DAP, whereas on 43 DAP they differed significantly. Neem extract and *B. thuringiensis* did not show significant difference in wet season.

*Lamprosema indicata* (F.) (Lepidoptera: Pyralidae) was observed to attack soybean in both seasons. Cypermethrin showed significant difference over all treatments on 23 DAP in dry season and significant difference was observed among the others (Table 4). All treatments were found on par with each other and significantly superior to the control on 33 DAP. On the other hand, all treatments significantly suppressed the larvae over the control on 43 DAP in dry season but no significant difference was observed between neem extract and *B. thuringiensis*, whereas cypermethrin differed significantly with them in the same day. It was observed that cypermethrin differed significantly in reducing larval population over all treatments in wet season. Neem extract and *B. thuringiensis* also significantly reduced the larvae over the control but on par with each other in the later season.

*Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) was found throughout the seasons. It was observed (Table 5) that neem extract was significantly superior to all treatments in both seasons except *B. thuringiensis* on 53 DAP in dry season. *B. thuringiensis* differed significantly over control in both seasons except 43 DAP in former season. No significant difference was observed between cypermethrin and control on 43 DAP in

**Table 3** Effects of various insecticides on the incidence of *Helicoverpa armigera* larvae.

| | Dry season | | | Wet season | | |
|---|---|---|---|---|---|---|
| | Days after planting (20 plants/plot) | | | | | |
| Treatments | 23 | 33 | 43 | 23 | 33 | 43 |
| Cypermethrin | 1.5a* | 3.75a | 2.0ab | 2.0a | 6.75a | 0.25a |
| Neem extract | 1.75a | 2.5a | 1.5a | 2.5ab | 7.5ab | 0.5ab |
| *B. thuringiensis* | 2.0a | 3.0a | 2.75b | 4.25bc | 10.25bc | 1.25b |
| Control | 3.75b | 9.75b | 6.0c | 5.25c | 12.0c | 2.25c |

* Means followed by the same letters are not significantly different at the 5% level by Duncan’s multiple range test.

**Table 4** Effects of various insecticides on the incidence of *Lamprosema indicata* larvae.

| | Dry season | | | Wet season | | |
|---|---|---|---|---|---|---|
| | Days after planting (20 plants/plot) | | | | | |
| Treatments | 23 | 33 | 43 | 23 | 33 | 43 |
| Cypermethrin | 1.0a* | 0.5a | 1.25a | 2.0a | 1. 75a | 1.25a |
| Neem extract | 3.0b | 1.0a | 4.5b | 4.75b | 5.0b | 4.25b |
| *B. thuringiensis* | 4.0c | 1.5a | 3.25b | 5.0b | 4.25b | 3.75b |
| Control | 5.0d | 8.0b | 10.25c | 7.0c | 8.75c | 7.75c |

* Means followed by the same letters are not significantly different at the 5% level by Duncan’s multiple range test.

dry season and 43 and 53 DAP in wet season. However, cypermethrin treated plot showed increased white fly population over control and differed significantly on 33 and 53 DAP in dry season and 33 DAP in wet season.

*Melanagromyza sojae* (Zehntner) (Diptera: Agromyzidae) was observed to infest the stem of soybean in both seasons. All treatments significantly reduced maggots over the control other than *B. thuringiensis* on 23 DAP in wet season (Table 6). No significant difference was observed between cypermethrin and neem extract in both seasons. Neem and *B. thuringiensis* significantly differed from each other in both seasons whereas on 63 DAP they were on par in dry season.

*Etiella zinckenella* (Treitschke) (Lepidoptera: Pyralidae) was observed the most destructive species in both seasons but its abundance was higher in wet season. It was observed (Table 7) that cypermethrin treated plot showed reduced pod damage and differed significantly over all treatments in both seasons. No significant difference was observed between neem extract and *B. thuringiensis* in dry season and differed significantly over the control. In wet season, neem extract significantly differed from *B. thuringiensis* but *B. thuringiensis* and the control did not differ significantly on pod damage.

It was observed (Table 8) that cypermethrin treated plot showed less number of *Menochilus sexmaculatus* (F.) (Coleoptera: Coccinellidae) and spider whereas neem extract and *B. thuringiensis*

**Table 5** Effects of various insecticides on the incidence of *Bemisia tabaci.*

| | Dry season | | | Wet season | | |
|---|---|---|---|---|---|---|
| | Days after planting (20 plants/plot) | | | | | |
| Treatments | 33 | 43 | 53 | 33 | 43 | 53 |
| Cypermethrin | 96.75b* | 281.25c | 425.75c | 187.5d | 223.75c | 181.75c |
| Neem extract | 53.25a | 117.75a | 100.25a | 54.0a | 64.5a | 77.76a |
| *B. thuringiensis* | 100.25b | 207.75b | 153.25a | 83.0b | 138.75b | 110.25b |
| Control | 135.0c | 268.0bc | 243.25b | 138.75c | 220.0c | 175.75c |

* Means followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

**Table 6** Effects of insecticides on the incidence of maggots of *Melanagromyza sojae*.

| | Dry season | | Wet season | |
|---|---|---|---|---|
| | Days after planting (20 plants/plot) | | | |
| Treatments | 23 | 63 | 23 | 63 |
| Cypermethrin | 13.5a* | 20.0a | 12.25a | 10.5a |
| Neem extract | 13.0a | 22.0ab | 13.25a | 12.5a |
| *B. thuringiensis* | 16.0b | 25.25b | 15.75b | 15.5b |
| Control | 22.25c | 31.25c | 17.0b | 18.75c |

* Means followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

treated plot showed higher number in both seasons which were statistically significant. No significant differences were observed among the treatments other than cypermethrin in dry season except spider in control. In wet season, neem extract and *B. thuringiensis* also showed non-significant differences but differed over the control in few cases.

Highest yield was recorded in cypermethrin treated plot which differed significantly from all treatments in dry season (Table 9). No significant difference was observed between neem extract and *B. thuringiensis* but differ significantly over the control in dry season. In wet season, cypermethrin treated plot also showed the highest yield followed by neem extract and *B. thuringiensis*. All treatments

**Table 7** Effects of various insecticides on pod infestation by *Etiella zinckenella* at harvest (20 plants/plot).

| Treatments | Dry season | Wet season |
|---|---|---|
| Cypermethrin | 14.0a* | 30.0a |
| Neem extract | 36.0b | 90.5b |
| *B. thuringiensis* | 48.5b | 120.5c |
| Control | 68.0c | 131.5c |

* Means followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

**Table 8** Effects of various insecticides on number of *Menochilus sexmaculatus* and spider/plot.

| | Dry season | | | | Wet season | | | |
|---|---|---|---|---|---|---|---|---|
| | Days after planting | | | | | | | |
| | *Menochilus sexmaculatus* | | | Spider | *Menochilus sexmaculatus* | | | Spider |
| Treatments | 33 | 43 | 53 | 23 | 33 | 43 | 53 | 23 |
| Cypermethrin | 0.75a* | 0.25a | 0.25a | 0.50a | 1.0a | 0.25a | 0.5a | 1.5a |
| Neem extract | 3.75b | 4.0b | 3.75b | 1.75b | 5.0bc | 2.5b | 3.0b | 3.5b |
| *B. thuringiensis* | 3.25b | 3.75b | 3.5b | 2.25b | 4.0b | 2.75bc | 3.5b | 5.0bc |
| Control | 4.25b | 4.25b | 4.0b | 3.5 c | 6.0c | 3.5c | 4.0b | 5.25c |

* Means followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

**Table 9** Effects of various insecticides on the yield of vegetable soybean at harvest.

| Treatments | Dry season (t/ha) | Wet season (t/ha) |
|---|---|---|
| Cypermethrin | 9.83c* | 5.83d |
| Neem extract | 8.39b | 4.83c |
| *B. thuringiensis* | 7.98b | 4.03b |
| Control | 6.22a | 2.83a |

* Means followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

showed significant difference among each other.

## DISCUSSION

It was obvious from the experiment that cypermethrin provided better control by reducing insect pests in both seasons. Reduced larval population of *S. exigua*, *S. litura*, *H. armigera*, *L. indicata*, *M. sojae* were observed at all sampling days in cypermethrin treated plots. Field and green house studies were conducted by Jiang *et al*. (1999) and they reported that alpha-cypermethrin 5% EC was effective in controlling *S. exigua* and aphids. A field evaluation of some insecticides was made by Uddin *et al*. (1993) for the control of spotted pod borer in the field of cowpea in Bangladesh. They reported that the best control of this pest was achieved by three sprays of cypermethrin (0.007%). Our investigation also showed less number of infested pods caused by *E. zinckenella* in cypermethrin treated plots in both seasons. The effect of contact as well as systemic insecticides on larval population of *Ophiomyia phaseoli* (Tryon) (Diptera: Agromyzidae) in soybean was investigated by Sharma *et al.* (1997) where fenvalerate (0.012%) was found effective in reducing larval population of the agromyzid. The effectiveness of some insecticides against the noctuid *H. armigera* on gram (*Cicer arietinum*) was evaluated in the field studies in Maharastra, India by Gohokar *et al.* (1985). They observed that the application of 0.009% cypermethrin and 5% neem seed extract were made at 50% flowering and 15 days later reduced the incidence of *H. armigera*, followed by 0.006% cypermethrin and the highest yield was obtained by from plots treated with 0.006% cypermethin, followed by neem seed extract. In our experiments, cypermethrin failed to control *B. tabaci* which might be due to resistance development (Table 8).

Azadirachtin, the main active ingredient in neem insecticides, has been demonstrated to have antifeedant effects on insects and varies depending on the concentration and species of the target insects (Xie *et al*., 1995; Zehnder and Warthen, 1988). Neem derivatives have been reported to provide broad spectrum control of over 200 species of phytophagous insects (Ascher, 1993). A field study conducted by Hazara *et al.* (1999) in Pakistan showed significant efficacy of Neembokil 60 EC extracted from neem seed in reducing the population of *Thrips tabaci* Lind.(Thysanoptera: Thripidae) in onion field. Coudriet *et al*. (1985) observed ovipositional deterrence and mortality of *B. tabaci* after treated with neem seed extract under greenhouse conditions. Our results also showed less number of *B. tabaci* in neem treated plots among the treatments. Over all, neem showed a moderate control of major soybean insect pests in both seasons. Better control might be achieved by increasing its concentration.

Salama *et al.* (1990) reported that one spray application with Dipel (a formulation of *B. thuringiensis* var. *kurstaki*) or fenvalerate reduced infestation of soybean in Egypt with larvae of *S. exigua* and increased crop yields significantly, depending on dosages. *B. thuringiensis* successfully controlled a variety of lepidopteran larvae in field crops, vegetables, and ornamental plants (Broza and Sneh, 1994). Ignoffo *et al*. (1974) reported that the effectiveness of microbial insecticides is influenced by coverage and field stability. They also reported a half-life of over 1 day on soybean foliage. Ali and Young (1993) found half-lives for *B. thuringiensis* applied at a range of 1.12 kg/ha in cotton terminal were 3-3.1 days for 46.7, 93.4 and 140 l/ha. Results of our experiments showed that application of *B. thurigiensis* var. *kurstaki* controlled low to moderate levels of soybean insect pests might be due to short persistence on soybean foliage. *B. thuringiensis* activity also might be reduced by wash-off by rainfall or degradation by sunlight. In addition, most commercial formulations of *B. thuringiensis* are not palatable to insect, thus limiting their effectiveness (Gillespie *et al*., 1994).

Effects of different insecticides on parasitization of *Corcyra cephalonica* Stainton

(Lepidoptera: Pyralidae) by *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) was investigated by Sarode and Sonalkar (1999). They reported that insecticides belonging to pyrethroid and organophosphorus groups showed toxic effects on parasitoids whereas neem seed extract were moderately safe. Hoelmer *et al*. (1990) reported that neem products were less toxic to natural enemies of pests than synthetic insecticides. Boyd and Boethel (1998) observed that foliage treated with *B. thurigiensis* var. *kurstaki* had the lowest contact toxicity to hemipteran predators among the insecticides tested. Our results reflected these evidences.

The yield of vegetable soybean grown in the dry season was much higher than in wet season. Because in wet season, the crop suffered from heavy rainfall at early stage which resulted in stunted growth. From this study it was revealed that cypermethrin had better efficacy in controlling major insect pests of vegetable soybean resulting the highest yield. Neem extract also showed moderate efficacy followed by *B. thuringiensis* in both the seasons.

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