*The Andhra Agric. J* 55(4):484-489, 2008

# Studies on the Efficacy of Certain New Insecticides on the Major Insect Pests and their Effect on Natural Predators in Pigeon Pea Ecosystem*

**A Ramachandra, T Madhumathi, P Arjuna Rao**
Department of Entomology, Agricultural College, Bapatla - 522 101, Andhra Pradesh

**ABSTRACT**

Indoxacarb 0.0145% and thiodicarb 0.075% were highly effective against all the pod borers of pigeonpea. The chemicals spinosad 0.0225% and novaluron 0.01% though not effective by one day after treatment showed their efficacy by the fifth day and performed better. Profenofos registered a moderate efficacy against all the pests of pigeonpea while endosulfan recorded a moderate efficacy on *M. vitrata* and *M. obtusa* but failed in checking the population of *H. armigera*. HaNPV being specific registered a moderate efficacy against *H. armigera* but showed no effect on *M. vitrata* and *M. obtusa* . Azadirachtin and *B. t* were the less effective chemicals for all the pests under study. Regarding the toxicity of treatments against natural enemies, treatments HaNPV, B.t, azadirachtin, novaluron proved to be safe to coccinellids and spiders by recording less than 20 per cent reduction over untreated control. Spinosad and endosulfan were found relatively safe to natural enemies. Indoxacarb and thiodicarb were moderately toxic while profenofos was toxic to the coccinellids and spiders in pigeonpea ecosystem.

**Key words :** *H. armigera,* Pigeon Pea, *M. obtusa*, *M. vitrata*.

Among the grain legumes, pigeonpea, *Cajanus cajan* (L.) Millsp is one of the major crops in India. This legume has revolutionized in recent years and is grown in every Indian state. For years, it was looked only as a poor man's crop grown in very dry areas where farmers can scratch a living. But now many farmers of this subcontinent embrace this crop enthusiastically. In spite of the multitudinous uses of the crop, its productivity has been at low in the recent years. More than 200 species of insects live and feed on pigeon pea, though relatively few cause heavy annual yield losses. A few serious pests however, are devastating. Pod borers, which attack during the reproductive phase, are highly destructive and pigeon pea losses world wide due to *Helicoverpa armigera* (Hubner) alone are more than US $310 millions annually (Rao, 2002). The major pod borers in south India are the gram pod borer *H. armigera*, the spotted pod borer, *Maruca vitrata* (Geyer), and the pod fly *Mlanagromyza obtusa* Malloch. Of late, the spotted pod borer has attained a major pest status, in Andhra Pradesh. Insecticides are being used indiscriminately for the control of pest complex in pigeon pea, which led to pesticide residues in commodities, pesticide resistance, pest resurgence, and adverse effects on natural enemies, environmental pollution and direct and indirect hazards to human beings. However, new chemicals, which were ecofriendly, have emerged which are reported to be safe to natural enemies and effective against insect pests at far lower doses than the conventional insecticides, which were used, in higher doses. Hence the present study was taken up to study the efficacy of newer insecticides on the major pests of pigeon pea and their effect on natural predators in pigeon pea ecosystem.

## MATERIAL AND METHODS

The experiment was laid out in a randomized block design (RBD) replicated thrice with ten treatments including an untreated check. Certain new insecticides *viz.,* indoxacarb, spinosad, profenofos, thiodicarb, novaluron, endosulfan, HaNPV, *B.t.* and azadirachtin were selected to evaluate their efficacy against the pod borer complex of pigeonpea .The crop was monitored regularly for pest infestation and treatments were imposed as and when the pest load reached a moderate level, crossing ETL's. Two sprayings were given during the crop period, first at 50 per cent flowering and second at pod formation stage. Each plot ($25m^2$) received two litres of spray fluid @ 800 L $ha^{-1}$.

### Data Recording:

For recording the data, five plants were selected at random from each plot leaving border rows and tagged with wax coated labels. The observations were recorded one day before treatment as pretreatment count and at 1, 5, 10 and 15 days after spraying as posttreatment counts.

The data was recorded based on the following symptoms.

**1.The gram caterpillar, *Helicoverpa armigera* (Hubner)**: Physical presence of larvae on the pods with head inside and body outside the pod. The total numbers of larvae on five tagged plants were counted

**2. The spotted pod borer, *M. vitrata***: Recorded by the presence of irregular bored holes and fresh excreta at the entrance of the bored hole on the pod. Five branches from each tagged plant were selected at random for recording the total larval counts.

**3. Pod fly, *Malanagromyza obtusa* Malloch**: Recorded by the presence of gnawed or burrowed pod and shriveled seed in the pod. Hundred pods from each plot were collected at the time of harvest and they were split opened to count the healthy and damaged grains. The grains that were damaged by the pod fly were having a characteristic streak. Based on the symptom, the grains damaged by pod fly were separated from total grains and recorded. The percentage of infested pods by pod fly was worked out.

**4. Natural enemies**: The numbers of natural enemies like coccinellid beetles and spiders present were counted from the five selected plants in each plot during each observation. Harvesting was done treatment wise when the pods ripened. After drying for 6-7 days the pods were threshed and seeds were collected plot wise. The total yield per each treatment replication wise was recorded separately for assessing the effect of different treatments on yield.

The data of two sprays were averaged and the percent reduction in larval population over untreated control was calculated with the modified Abbott's formula as given by Fleming and Ratnakaran (1985). The percentage population values were duly transformed into the corresponding angular values and were subjected to statistical scrutiny (Snedecor and Cochran, 1967). The percent increase in yield over untreated control in various treatments was calculated by using the following formula.

The per cent increase of yield in treatment over untreated control = Yield in treatment - Yield in untreated control X 100 / Yield in untreated control

## RESULTS AND DISCUSSION

***H. armigera* (Hubner):**

The mean efficacy of different treatments against *H. armigera* revealed that all the treatments were significantly superior to untreated control (Table 1). Among the treatments, indoxacarb 0.0145% was highly effective and recorded 62.64 per cent reduction over untreated control. The higher efficacy of indoxacarb in the present studies is in agreement with the findings of Suhas *et al*. (1999) who reported only 24 per cent incidence of *H. armigera* on pigeonpea.

The next effective treatment was spinosad 0.0225% with 51.02 per cent reduction over untreated control, which was on par with thiodicarb 0.075% (47.52%). The better efficacy of spinosad obtained in the present findings is in accordance with the reports of Patil *et al*. (1999) who reported a very low incidence of 6.17 per cent of *H. armigera* on cotton. Vadodaria *et al.* (2001) also reported lower incidence of *H. armigera* on cotton treated with spinosad. The efficacy of spinosad was very low (17.38% reduction) at one day after spraying but showed a higher efficacy by fifth and tenth day after spraying (72.63% and 67.34% reduction over untreated control, respectively). Thompson and Hutchins (1999) reported that spinosad activity is characterized by cessation of feeding and the insect may remain on the plant upto two days. Hence to evaluate the efficacy of spinosad, one should wait for a minimum of three days. The effectiveness of thiodicarb against *H. armigera* is in conformity with the observations of Rao (2000) who recorded 55.17 per cent reduction of *H. armigera* larvae on pigeonpea..

Novaluron (40.69% reduction) and profenofos 0.1% (37.79% reduction) were the next best treatments and were on par with each other. However, the later was on par with *B.t* 2 g $L^{-1}$ (37.01% reduction). The efficacy of novaluron in the present studies concurs with the reports of Murthy and Ram (2003) against diamond back moth on cauliflower. Novaluron recorded only 16.65 per cent reduction of *H. armigera* over untreated control at one day after spraying but showed 65.84 per cent and 47.24 per cent reduction by the fifth day and tenth day after spraying, respectively. Novaluron being a chitin synthesis inhibitor acts only during moulting or after moulting hence its efficacy can be felt by fifth day and further to maintain its effectiveness it should be applied at short intervals of seven days (Wellinga *et al*, 1973). Since it was not applied at seventh day the efficacy was reduced by tenth day onwards.

Observations obtained with profenofos in the present study are parallel with the observations of Rao (2000) who reported 42.96 per cent reduction of *H. armigera* on pigeonpea. Similar results were also obtained by Durairaj and Ganapathy (1998) on pigeonpea with profenofos.

The efficacy of *B.t* against *H. armigera* in the present studies is in concordance with the findings of Mohammed and Rao (1999) who recorded only 8.2 per cent pod damage as against 14.7 per cent in untreated control. The present findings are also in accordance with the reports of Manjula and Padmavathamma (1996) on pod borers of pigeonpea. *B. t* showed lesser efficacy (5.49%) by the first day but improved its efficacy by fifth day and tenth day after application (51.04% and 53.54% respectively). Since *B.t* requires certain incubation period to multiply in the insect body (Maddox, 1982), its better performance could be observed from fifth to tenth day.

HaNPV 250 LE $ha^{-1}$ and endosulfan 0.07% recorded moderate efficacy of 32.90 and 30.04 per cent reduction, respectively over untreated control. The efficacy of HaNPV could not be noticed immediately after spraying because of the fact that symptoms of HaNPV infection appear only at the advanced larval instars and need an incubation period of five to six days (Srivastava, 1999). The moderate efficacy of HaNPV is in conformity with the reports of Gopali and Lingappa (2001) who concluded that sole dependence on HaNPV cannot ensure satisfactory protection against *H.armigera* in pigeonpea.

Though endosulfan was reported as an effective treatment by Mohapatra and Srivastava (2002) against *H. armigera* on pigeonpea, a moderate efficacy was observed in the present studies which may be due to the development of resistance by the pest to endosulfan in Guntur region as reported by Rajasekhar *et al*.(1996). Azadirachtin 1.0% recorded the least efficacy among all the treatments (24.47% reduction). The poor performance of azadirachtin in the present studies is in conformity with the reports of Girhepuje *et al*.(1997) who observed 21.27 per cent reduction over untreated control of *H. armigera* on pigeonpea.

***M. vitrata*:**

The mean efficacy of the treatments against *M. vitrata* revealed that indoxacarb 0.0145% was the best chemical among all and performed better throughout (55.55% reduction over untreated control). The efficacy of indoxacarb against *M. vitrata* was conformed by Babu (2002) who reported 54.69 per cent reduction. Thiodicarb 0.075% (47.85% reduction) was the next best chemical. The better efficacy of thiodicarb against *M. vitrata* in the present findings is in accordance with the reports of Rao (2000) who reported 51.13 per cent reduction over untreated control.

The next effective treatments were profenofos 0.1% (45.45% reduction) and spinosad 0.0225% (43.42% reduction). Sanap and Patil (1998) observed moderate efficacy of profenofos against pod borers of pigeonpea and recorded 35.04 per cent damage of pigeonpea pods as against 58.61 per cent in untreated control. Moderate efficacy of endosulfan @ 0.07% (39.80%) was observed in the present investigation. Which is in conformity with the reports of Girhepuje *et al*. (1997).

Novaluron 0.01% (34.38%), azadirachtin (29.21%) and *B.t* (26.82%) showed lower efficacy against *M. vitrata*. The efficacy of novaluron on *M. vitrata* was not reported earlier. The lesser efficacy of *B.t* and azadirachtin observed in the present study is in approximation with the reports of Manjula and Padmavathamma (1996). The lower efficacy of novaluron, azadirachtin and *B.t* may be due to the fact that *M. vitrata* has a peculiar habit of feeding within the webbings of flower, flower buds and pods. This typical behaviour might have protected the larvae and prevented them coming in contact with these slow acting pesticides. HaNPV 250 LE $ha^{-1}$ recorded the lowest larval reduction of only 4.17 per cent over untreated control. The reason may be due to its non-cross infectivity to other than *H. armigera*.

***M. obtusa*:**

The efficacy of treatments against *M. obtusa* (Table 3) indicated that indoxacarb 0.0145% was the most effective in reducing the grain damage (16.59%) caused by podfly. There are no reports earlier regarding the efficacy of indoxacarb against *M. obtusa* to support the present findings. The next best treatment was endosulfan 0.07% which recorded only 20.36 per cent grain damage. Endosulfan is reported to have fumigant action and this might be the reason for its better efficacy against *M. obtusa.* However, Girhepuje *et al.* (1997) recorded 61.11 per cent reduction of podfly damage over untreated control in pigeonpea.

Thiodicarb 0.075% (24.89% grain damage) and profenofos (28.67% grain damage) were the next best treatments. However, Rao (2000) also reported (8.02 per cent grain damage) similar results. The efficacy of profenofos against *M. obtusa*, was supported by Rao (2000) who reported 31.62% grain damage. Novaluron 0.01% (32.52% grain damage), spinosad 0.0225% (33.54%), *B.t* 2 g $L^{-1}$ (40.22%) and azadirachtin 1.0% (41.14%) showed lower efficacy against *M. obtusa* and this may be due to the reason that the pest might not have directly come in contact with these chemicals as it is an internal feeder. Reports are not available to support the present findings, however lower efficacy of these treatments were reported earlier by several workers against lepidopteron pests as discussed under *H. armigera* and *M. vitrata*. The treatment HaNPV was the least effective (53.11%) in reducing grain damage against *M. obtusa.* This may be due to its specificity to *H. armigera* only.

**Natural Enemies:**

Based on the data obtained on the toxicity of insecticides to natural enemies, the insecticides are classified as safe (< 20 per cent reduction over control), relatively safe (20-40%), moderately toxic (40-50%), toxic (50-70%) and highly toxic (>70%).

**Coccinellids**:

The data on mean toxicity of insecticides to coccinellid predators (Table 4) revealed that HaNPV, azadirachtin, B.t and novaluron were safe to coccinellids as they recorded less than 20 per cent reduction over untreated control. These reports are in conformity with the findings of Rao (2000) who reported higher populations of 29.00 and 23.00 coccinellids per ten plants of pigeonpea treated with azadirachtin and B.t, respectively. The chemicals spinosad and endosulfan recorded 22.12 and 28.91 per cent reduction, respectively and are graded as relatively safe to coccinellids. These findings are in accordance with the reports of Dhawan (2000) who observed lesser toxicity of endosulfan and spinosad to coccinellids in cotton ecosystem.. Indoxacarb and thiodicarb were classified as moderately toxic to coccinellids (40.01 and 44.03 per cent). The present findings on indoxacarb and thiodicarb are also in agreement with the observations of Rao (2000). Profenofos proved to be toxic chemical among all the treatments and recorded 53.35 percent reductions of coccinellids. These findings are in conformity with the reports of Patil *et al*. (2001) who reported 0.75 coccinellids per plant.

**Spiders:**

The overall results pertaining to the toxicity of insecticides to spiders indicated that HaNPV, azadirachtin, B.t and novaluron were safe to spiders as they recorded less than 20 per cent reduction of spiders over untreated control. These results are in accordance with the findings of Rao (2000) who reported 9.04 and 7.60 spiders per ten plants as against 18.29 in control. Babu (2002) also observed similar results. The treatments spinosad and endosulfan recorded 22.20 and 25.11 per cent reduction respectively over untreated control and are graded as relatively safe to spiders. However Dhawan (2000) recorded slightly higher mortality of 59.2 and 33.5 per cent reduction of spiders in cotton ecosystem with endosulfan and spinosad respectively. Indoxacarb and thiodicarb recorded 35.53 and 44.35 per cent reduction over untreated control and are treated as moderately toxic to spiders. However Dhawan (2000) recorded higher per cent of 58.5 and 66.6% reduction of spiders in cotton ecosystem with indoxacarb and thiodicarb respectively. The present findings are also in agreement with the reports of Babu (2002) who reported moderate toxicity of these chemicals on spiders. Profenofos was toxic as it recorded 50.63 per cent reduction of spiders over untreated control. Similar observations were made by Patil et al. (2001) who recorded only 0.58 spiders per plant when compared to 6.5 in untreated control.

**Effect of Treatments on Yield**:

The treatments which recorded higher mean reduction of larval populations of *H. armigera, M. vitrata* and *M. obtusa viz.*, indoxacarb, spinosad and thiodicarb also recorded higher yields (Table 3). The higher yields obtained with indoxacarb (910.37 Kg $ha^{-1}$) is in agreement with the reports of Babu (2002) who reported highest yield in groundnut. The next best treatment was spinosad (804.39 Kg $ha^{-1}$) and thiodicarb (783.70 Kg $ha^{-1}$). The better yields obtained by spinosad is in agreement with the reports of Babu (2002) in groundnut. higher yields recorded in thiodicarb treated plot is in accordance with Giraddi et al. (2002) who recorded higher seed yield in pigeonpea. Rao (2000) also observed similar results with thiodicarb in pigeonpea. The treatments that followed were profenofos (664.58 Kg $ha^{-1}$), novaluron (639.50 Kg $ha^{-1}$) and endosulfan (564.26 Kg $ha^{-1}$). The lowest yields obtained in B.t (445.14 Kg $ha^{-1}$), azadirachtin (432.6 Kg $ha^{-1}$) and HaNPV (313.48 Kg $ha^{-1}$), treated plots over other treatments may be attributed to lesser efficacy of these insecticides against the larvae of pod borers as discussed their efficacy earlier under different insect pests.

Table1. Effect of insecticides against the major pest complex and natural predators in pigeonpea

| Treatments | Dose | Mean per cent reduction over untreated control | | | | Mean Yield (Kg plot$^{-1}$) | Yield (Kg ha$^{-1}$) | % increase over control |
|---|---|---|---|---|---|---|---|---|
| | | *H. armige zra* | *M. vitrata* | M. obtusa | Spiders | | | |
| $T_1$ - Indoxacarb | 0.0145% | 62.64 (52.88) | 55.55 (48.37) | 16.59 | 35.53 (36.44) | 1.453 | 910.97 | 263.25 |
| $T_2$ – Spinosad | 0.0225% | 51.02 (45.36) | 43.42 (41.01) | 33.54 | 22.20 (27.95) | 1.283 | 804.39 | 220.78 |
| $T_3$ – Novaluron | 0.01% | 40.69 (39.19) | 34.38 (35.29) | 32.52 | 17.87 (24.85) | 1.020 | 639.50 | 125.00 |
| $T_4$ – Thiodicarb | 0.075% | 47.52 (43.52) | 47.85 (43.85) | 24.89 | 44.35 (41.76) | 1.250 | 783.70 | 212.50 |
| $T_5$ – Profenofos | 0.1% | 37.79 (37.67) | 45.54 (42.35) | 28.67 | 50.63 (45.39) | 1.060 | 664.58 | 164.97 |
| $T_6$ – Azadirachtin | 1.0% | 24.47 (27.28) | 29.21 (31.85) | 41.14 | 11.20 (19.34) | 0.690 | 432.60 | 72.50 |
| $T_7$ – HaNPV | 250 LE ha$^{-1}$ | 32.90 (33.23) | 4.17 (11.55) | 53.11 | 6.11 (14.31) | 0.50 | 313.48 | 25.00 |
| $T_8$ – *B. t* | 2 g L$^{-1}$ | 37.01 (36.04) | 26.82 (30.43) | 40.22 | 15.54 (23.10) | 0.710 | 445.14 | 77.50 |
| $T_9$ – Endosulfan | | 30.04 (32.89) | 39.80 (38.68) | 20.36 | 25.11 (30.01) | 0.900 | 564.26 | 125.00 |
| $T_{10}$ – Untreated control | | 0.00 (0.00) | 0.00 (0.00) | 54.44 | 0.00 (0.00) | 0.400 | 250.78 | 0.00 |
| SEM (±) | | 0.94 | 0.84 | 0.34 | 1.09 | 5.50 | - | - |
| LSD ( p= 0.05) | | 3.03 | 2.50 | 1.03 | 3.05 | | - | - |

Values in the parenthesis are angular transformed values

## LITERATURE CITED

**Babu B R 2002.** Ecology and management of insect pests of groundnut. M.Sc(Ag) Thesis submitted to Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad.

**Fleming R and Ratnakaran A 1985.** Evaluation of single treatment data using Abbot's formula with reference to insects. Indian Journal of Economic Entomology 78 : 1179-1181.

**Durairaj C and Ganapathy N 1998.** Bioefficacy of some new insecticides and botanicals against pod infesting insects in pigeonpea. Pestology 22 : 12-14.

**Girhepuje P D, Wanjari R R, Kahare N P and Supare N R 1997.** Efficacy of synthetic insecticides in comparison with neem seed extract for the management of pod borer complex in pigeonpea . Pestology 21(12) : 45-48.

**Giraddi R S, Dasareddy S V and Lingappa S L 2002.** Bioefficacy of new molecules of insecticides against gram pod borer *Helicoverpa armigera* in pigeonpea. Indian Journal of Agricultural Sciences 72 : 311-312.

**Gopali J B and Lingappa S 2001.** Integrated management of pigeonpea pod borer, involving HaNPV and insectivorous birds. Karnataka Journal of Agricultural Sciences 14 : 58-61.

**Dhawan A K 2000.** Impact of some new insecticides on natural enemy complex of cotton ecosystem. Pestology 24(5) : 8-14.

**Maddox J V 1982.** Use of insect pathogens in pest management. In (eds. R L Metcalf and WH Luckmann) Introduction to Insect Pest Management pp. 189-234.

**Manjula K and Padmavathamma K 1996.** Effect of microbial insecticides on the control of *M. testulalis* (Geyer) and on the predators of redgram pest complex. Entomon 21 : 269-271

**Mohammed G and Rao S A 1999.** Evaluation of some new insecticides on *Helicoverpa armigera* in pigeonpea. International Chickpea and Pigeonpea Newsletter 6 : 46-47.

**Mohapatra S D and Srivastava C P 2002.** Bioefficacy of chemical and biorational insecticides against incidence of legume pod borer, *Maruca vitrata* in short duration pigeonpea. Indian Journal of Plant Protection 30 : 22-25.

**Murthy K S R K and Ram G M 2003.** Studies on the effect of new chitin synthesis inhibitor Rimon (Novaluron 10 EC) on American Bollworm *Helicoverpa armigera* (Hub.) Pestology 27(1) : 6-7.

**Patil B V, Bheemanna M, Prasad A R B and Goudar S B 2001.** Integration of Insect growth regulators in the management of cotton bollworm *Helicoverpa armigera*. Pestology 25(9) : 10-12.

**Patil B V, Rahman S M, Sreenivasa A G and Bheemanna S 1999.** Spinosad 48 SC.: An ideal insecticide in cotton IPM. Pestology 23(4) : 3-6.

**Rajasekhar P, Venkataiah M, Venugopalrao N, Rao B R and Rao V S P 1996**. Monitoring of insecticide resistance in *Helicoverpa armigera* (Hubner) from areas receiving heavy insecticidal applications in Andhra Pradesh, India. Journal of Entomological Research 20(2) : 93-102.

**Rao G R 2002.** Agricultural technologies for rural poverty alleviation. Report from International Crop Research Institute for Semiarid Tropics, Patancheru, Hyderabad.

**Rao C H S 2000.** Management of pod borers of pigeonpea. M.Sc(Ag) Thesis, Acharya N.G.Ranga Agricultural University, Hyderabad.

**Sanap M M and Patil J V 1998.** Comparative efficacy of newer insecticide against pigeonpea pod borers. Pestology 22(7): 5-7.

**Snedecor W G and Cochran W G 1967.** Statistical methods. Oxford and IBH Publishing Co., New Delhi pp. 593.

**Srivastava 1999.** Elements of economic entomology. Kalyani Publishers pp.16.

**Suhas Y, Siddegowda D K and Patil B V 1999.** Efficacy of indoxacarb (Avaunt 15% SC) against pigeonpea pod borer *Helicoverpa armigera* (Hubner). Pestology 23 : 60 – 64.

**Thompson G and Hutchins S 1999.** Bioinsecticide – Spinosad. Pesticide Outlook pp. 78-81.

**Vadodaria M P, Patel U G, Maisuria I M, Patel C J and Patel R B 2001.** Bioefficacy of a new insecticide spinosad against bollworms of cotton. Pestology 25 (9) : 24-28.

**Wellinga K, Mulder R and Daalen J V 1973.** A synthesis and laboratory evaluation of 1-(2,6-disubstituted benzyol) 3- phenyl ureas, a new class of insecticides. Journal of Agricultural Food chemistry 21 : 348 - 354.

(Received on 02.04.2008 and revised on 09.06.2008)