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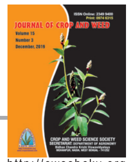

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# Efficacy of some novel insecticides against gram pod borer (*Helicoverpa armigera* Hubn.) infesting chickpea

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## ABSTRACT

*The present experiment was carried out in a farmer's field in Nadia district of West Bengal to find out the relative effectiveness of four novel insecticides viz. Alpha cypermethrin 10% EC @ 25.0 g a.i. ha$^{-1}$, Teflubenzuron 150 SC @ 15.0 g a.i. ha$^{-1}$, Lambda cyhalothrin 5% EC @ 25.0 g a.i. ha$^{-1}$and Spinosad 45 SC @ 75.0 g a.i. ha$^{-1}$ for managing gram pod borer population infesting chickpea crop during two consecutive rabi seasons of 2019-20 and 2020-21. From the results it was observed that all the treatments were superior over untreated control in managing the pest. Among the insecticides tested, Spinosad 45 SC was proved to be the most effective insecticide providing maximum reduction over untreated control during both the years (97.89% and 98.57% during 2019-20 and 2020-21, respectively) followed byLambda cyhalothrin (72.26% and 71.93%), Alpha cypermethrin (65.52% and 63.18%) and Teflubenzuron (59.76% and 55.47%). Maximum seed yield (14.83 q ha$^{-1}$ and 14.01 q ha$^{-1}$during 2019-20 and 2020-21, respectively) was also obtained from Spinosad treated plots followed by Lambda cyhalothrin (12.74 q ha$^{-1}$and 11.98 q ha$^{-1}$), Alpha cypermethrin (11.52 q ha$^{-1}$and 10.72 q ha$^{-1}$) and Teflubenzuron(10.46 q ha$^{-1}$and 9.92 q ha$^{-1}$). However, the lowest yield was recorded from control plot.*

***Keywords*:** Chickpea, *Helicoverpa armigera*, Spinosad, efficacy

Chickpea or Bengal gram or gram, a major winter season pulse crop belonging to family 'Fabaceae', is grown throughout the country and it acts as a major source of vegetable protein. Chickpea is a highly nutritious crop possessing 21, 22 and 62 per cent of protein, fat and carbohydrates, respectively as major nutrients and among the important minerals it contains 190 mg calcium, 90.5 mg iron and 280 mg phosphorus per 100 gram (Katerji *et al*., 2001). As an important source of vitamin C, germinated gram seeds are helpful for curing the chronic disorder scurvy caused due to deficiency of vitamin C. Sourness of tender chickpea leaves is due to the presence of malic and oxalic acid which have a potentiality to rectify intestinal disorder and as a blood purifier (Singh, 1996). Like other pulse crops, chickpea also enhances soil fertility through fixing atmospheric $N_2$ up to 140 kg ha$^{-1}$ year$^{-1}$ (Flowers *et al.,* 2010). Our country contributes 71 and 70 per cent of chickpea area and production in global context, for which the country ranked first (Anon., 2017). Gram production in India has been grown up from 38.55 lakh tonnes to 112.29 lakh tonnes during 2000-01 to 2017-2018 and productivity was also increased steadily from 744 kg ha$^{-1}$ to 1063 kg ha$^{-1}$ (Anon., 2018a). The 98% gram production have been realized from ten states viz. MP, Maharashtra, Rajasthan, Karnataka, AP, UP, Gujarat, Chhattisgarh, Jharkhand and Telangana (Anon., 2018b). During 2018-19, the area under chickpea in West Bengal was 35.91 thousand ha with total production 42.34 thousand tons and productivity of 1179 kg ha$^{-1}$ (Anon., 2020). However, chickpea productivity of India is quite low (1063 kg ha$^{-1}$) and it ranked 6$^{th}$ position in the world (FAO STAT, 2019). The loss due to insect pests is one out of the several reasons of low productivity of chickpea and chickpea pod borer (*Helicoverpa armigera*, Hubn.) is the most dangerous one menacing the production. Year round occurrence of the pest on several cultivated species belonging to 180 families of cereals, pulses, vegetables, fruits, spices, forages and wild plants make the insect as a nationally important pest (Jat and Ameta, 2013). A single pest during its larval period can consume 30-40 pods before reaching the maturity. Estimated annual loss due to gram pod borer was reported as approximately Rs. 150-200 millions (Anon., 2014). In different chickpea growing regions across the country, Lateef and Reed (1983) estimated the losses due to the pest as 27.9, 13.2, 24.3 and 36.4 per cent in North West Plain Zone, North East Plain Zone, Central Zone and South Zone, respectively. It was reported that if the pest infestation is not checked in proper time, extent of damage may reach upto 75-90 per cent and in some place it was reached up to 100 per cent (Lal, 1996). Broader host range, multivoltine life cycle, wider adaptability to different agro ecological

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zone, higher fecundity, occurrence in all the growing season, adaptability to the adverse climatic condition made the management practices for the pest unfruitful. In this context management of the pest using chemical insecticides are still the last and quickly effective tool for reducing pest infestation and inducing yield (Sreekanth, 2014). It was observed that for managing the pest in different crops in different seasons, consumption of insecticide was almost greater than 55 per cent among overall use of insecticides in Indian agriculture (Puri *et al.,* 1995). Nowadays the indiscriminate application of different insect killing toxicants has resulted into several problems like creation of selection pressure which leads to development of resistance and resurgence, environmental pollution, toxicity to natural enemies etc. (Tabashnik *et al.*, 2014). Injudicious application of insecticide ultimately increases cost of plant protection hence reduces the profitability. In this context, the present experiment was designed to test the efficacy of some insecticides having novel mode of action against chickpea pod borer in the lower Gangetic plains of West Bengal to explore the most effective one.

## MATERIALS AND METHODS

The present experiment was carried out in a farmer's field located at Mollapara, Rautari, Chakdaha Block, Nadia, West Bengal with a latitude and longitude of 23°03'N and 88°53'E during the two consecutive *rabi* seasons of 2019-20 and 2020-21. Chick pea variety JAKI 9218 which is resistant to wilt, root rot, collar rot and a potential variety for North East Plain Zone, was selected for the experiment (Anon., 2016). The seeds of the test crop were sown during first week of December in Randomized Block Design with four replications in both the years. There were five treatments including one untreated control treatment having each plot size measuring 5 x 5 m considering row to row distance of 30 cm and plant to plant distance of 10 cm maintaining a seed rate of 60 kg $ha^{-1}$. Recommended agronomic operations were practiced for growing chickpea. Before sowing the seeds were dressed with *Rhizobium* and also treated with a premixed fungicide containing Carbendazim 12% + Mancozeb 63% WP. For efficacy evaluation study, mean larval population of *H.armigera* was counted from five sampled plants from the test plots of each treatment. All the treatments were applied for two times. The spraying operations were done for the first time when the pest was at ETL (one mature larvae of more than 1cm in length/ 10 plants) (Chandrashekar *et al.*, 2014) with a Knapsack sprayer using 500 liter spray fluid per ha and proper care was taken for avoiding the drift of spraying solution on neighboring plots and this pest population was recorded as population before spray.Four insecticides namely Alpha cypermethrin 10% EC @ 25.0 g a.i.$ha^{-1}$ ($T_1$), Teflubenzuron 150 SC @ 15.0 g a.i.$ha^{-1}$ ($T_2$), Lambda cyhalothrin 5% EC @ 25.0 g a.i.$ha^{-1}$ ($T_3$), Spinosad 45 SC @ 75.0 g a.i.$ha^{-1}$($T_4$) together with an untreated control (only water was sprayed) ($T_5$) were considered as treatments. As post treatment study observation of the pest was recorded at 1 day after first spray (DAFS), 3 DAFS, 5 DAFS, 7 DAFS and 10 DAFS. Again the mean population was taken at 15 DAFS (i.e. 1 day before second spray) and next day the treatments were applied in the field and mean population was recorded following similar schedule as followed after first spray. After harvesting the yield was recorded from each treatment plot wise. Afterwards the yield was transformed to quintal per hectare basis. During this spraying operation, $T_3$ (i.e. Lambda cyhalothrin) was applied at last after application of all other treatments as it causes dermal irritation if comes in direct contact and exposure time is more (Maiti, 2019). The mean population from each treatment of each day was analyzed by analysis of variance. Treatment significance was tested by following "F" test and after finding significant difference between treatment means it was further calculated for CD (Critical difference) at 5% level of significance (Gomez and Gomez, 1984).Percent reduction of pest over control was computed by using Henderson- Tilton's formula (1955) as stated below:

$$\text{Corrected mortality \%} = (1-)\frac{\text{n in Co before treatment X n in T after treatment}}{\text{n in Co after treatment X n in T before treatment}}$$

where, n = Insect population, T = Treated plot, Co = Control plot

## RESULTS AND DISCUSSION

Efficacy of different insecticide molecules on field population of *Helicoverpa armigera* were studied during two consecutive *rabi* seasons of 2019-20 and 2020-21 and results are furnished as follows through some tables.

### Evaluation of efficacy against *Helicoverpa armigera* on chickpea during 2019-20

Results showed that the population was not differed in different plots at first day before spraying that means the population was almost uniformly distributed among the plots and it was above ETL (Table 1). All the treatments except untreated control were noted to reduce the population significantly at all the observation

**Table 1: Efficacy of different novel insecticides against *Helicoverpa armigera* Hubn. in chickpea during *rabi*, 2019-20**

| Treatments | Mean population of *Helicoverpa armigera* Hubn.(larvae plant$^{-1}$) at different time intervals | | | | | | | | | | | Reduction over control (%) | Yield (Q ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 DBFS | 3 DAFS | 5 DAFS | 7 DAFS | 10 DAFS | 15 DAFS (= 1 DBSS) | 3 DASS | 5 DASS | 7 DASS | 10 DASS | 15 DASS | | |
| $T_1$ = Alpha cypermethrin 10% EC @ 25.0 g a.i./ha | 6.42 (2.63)* | 6.09 (2.56) | 5.58 (2.46) | 5.17 (2.38) | 4.50 (2.23) | 3.75 (2.05) | 3.42 (1.97) | 3.00 (1.86) | 2.67 (1.77) | 2.50 (1.72) | 2.33 (1.68) | 65.52 | 11.52 |
| $T_2$ = Teflubenzuron 150 SC @ 15.0 g a.i./ha | 6.50 (2.64) | 6.25 (2.59) | 5.75 (2.50) | 5.42 (2.43) | 4.84 (2.31) | 4.25 (2.18) | 4.00 (2.12) | 3.67 (2.04) | 3.42 (1.97) | 3.25 (1.93) | 3.08 (1.89) | 59.76 | 10.46 |
| $T_3$ = Lambda cyhalothrin 5% EC @ 25.0 g a.i./ha | 6.58 (2.66) | 6.08 (2.56) | 5.50 (2.45) | 4.92 (2.32) | 4.34 (2.20) | 3.50 (2.00) | 3.09 (1.88) | 2.59 (1.75) | 2.17 (1.63) | 1.92 (1.55) | 1.75 (1.49) | 72.26 | 12.74 |
| $T_4$ = Spinosad 45 SC @ 75.0 g a.i./ha | 6.58 (2.66) | 5.83 (2.51) | 4.83 (2.31) | 4.08 (2.14) | 3.09 (1.89) | 2.17 (1.63) | 1.67 (1.47) | 1.09 (1.24) | 0.58 (1.00) | 0.25 (0.84) | 0.08 (0.76) | 97.89 | 14.83 |
| $T_5$ = Control | 6.67 (2.67) | 8.00 (2.91) | 8.92 (3.07) | 9.75 (3.20) | 10.58 (3.33) | 11.42 (3.45) | 12.59 (3.61) | 14.33 (3.85) | 16.00 (4.06) | 17.83 (4.28) | 20.58 (4.59) | - | 6.14 |
| **F-Test** | NS | S | S | S | S | S | S | S | S | S | S | | S |
| **SEm(±)** | - | 0.08 | 0.07 | 0.07 | 0.06 | 0.09 | 0.09 | 0.09 | 0.10 | 0.10 | 0.08 | | 0.46 |
| **LSD(0.05)** | - | 0.24 | 0.21 | 0.20 | 0.17 | 0.29 | 0.29 | 0.29 | 0.32 | 0.30 | 0.24 | | 1.42 |

DBFS = Day Before First Spray; DAFS = Day(s) After First Spray, DBSS = Day Before Second Spray; DASS = Day(s) After Second Spray *Figures in parentheses are "(x+0.5) transformed values

**Table 2: Efficacy of different novel insecticides against *Helicoverpa armigera* Hubn. in chickpea during *rabi*, 2020-21**

| Treatments | Mean population of *Helicoverpa armigera* Hubn. (larvae plant$^{-1}$) at different time intervals | | | | | | | | | | | Reduction over control (%) | Yield (Q ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 DBFS | 3 DAFS | 5 DAFS | 7 DAFS | 10 DAFS | 15 DAFS (= 1 DBSS) | 3 DASS | 5 DASS | 7 DASS | 10 DASS | 15 DASS | | |
| $T_1$ = Alpha cypermethrin 10% EC @ 25.0 g a.i./ha | 8.83 (3.05)* | 8.25 (2.96) | 7.67 (2.86) | 7.08 (2.75) | 6.59 (2.66) | 6.08 (2.56) | 5.33 (2.40) | 4.42 (2.21) | 3.75 (2.06) | 3.34 (1.95) | 3.17 (1.91) | 63.18 | 10.72 |
| $T_2$ = Teflubenzuron 150 SC @ 15.0 g a.i./ha | 9.09 (3.09) | 8.58 (3.01) | 8.08 (2.93) | 7.59 (2.84) | 7.17 (2.76) | 6.75 (2.69) | 6.08 (2.56) | 5.34 (2.41) | 4.75 (2.28) | 4.42 (2.21) | 4.25 (2.17) | 55.47 | 9.92 |
| $T_3$ = Lambda cyhalothrin 5% EC @ 25.0 g a.i./ha | 9.08 (3.09) | 8.42 (2.98) | 7.58 (2.84) | 7.00 (2.73) | 6.34 (2.61) | 5.67 (2.47) | 4.84 (2.30) | 3.84 (2.08) | 3.00 (1.87) | 2.50 (1.73) | 2.25 (1.65) | 71.93 | 11.98 |
| $T_4$ = Spinosad 45 SC @ 75.0 g a.i./ha | 8.84 (3.05) | 7.83 (2.89) | 6.75 (2.69) | 5.83 (2.52) | 4.92 (2.33) | 4.08 (2.13) | 3.00 (1.86) | 1.92 (1.54) | 0.92 (1.17) | 0.33 (0.89) | 0.08 (0.76) | 98.57 | 14.01 |
| $T_5$ = Control | 9.00 (3.08) | 10.17 (3.26) | 11.75 (3.50) | 12.67 (3.63) | 14.00 (3.81) | 15.08 (3.95) | 16.25 (4.09) | 17.42 (4.23) | 18.58 (4.37) | 20.33 (4.56) | 21.33 (4.67) | - | 4.97 |
| **F-Test** | NS | S | S | S | S | S | S | S | S | S | S | | S |
| **SEm(±)** | - | 0.06 | 0.07 | 0.08 | 0.08 | 0.10 | 0.12 | 0.11 | 0.10 | 0.11 | 0.08 | | 0.55 |
| **LSD(0.05)** | - | 0.18 | 0.20 | 0.23 | 0.26 | 0.32 | 0.37 | 0.34 | 0.32 | 0.32 | 0.25 | | 1.70 |

DBFS = Day Before First Spray; DAFS = Day(s) After First Spray, DBSS = Day Before Second Spray; DASS = Day(s) After Second Spray
*Figures in parentheses are "(x+0.5) transformed values

periods. At 3 DAFS, maximum population reduction was observed in Spinosad 45 SC treated plots (5.83 larvae plant$^{-1}$) followed by Lambda cyhalothrin 5 EC (6.08 larvae plant$^{-1}$), Alpha cypermethrin 10EC (6.09 larvae plant$^{-1}$) and Teflubenzuron 150 SC (6.25 larvae plant$^{-1}$) compared to untreated check (8.00 larvae plant$^{-1}$). The similar trend was found at 5 DAFS, 7 DAFS and 10 DAFS. Spinosad was noticed to be effectual to lessen the pest density more rapidly whereas in untreated control population increased continuously. At 15 DAFS, it was found that maximum pest suppression was obtained by application of spinosad 45 SC @ 75.0 g a.i.ha$^{-1}$(2.17 larvae plant$^{-1}$) which was significantly better over rest of the treatments viz. Lambda cyhalothrin 5% EC @ 25.0 g a.i. ha$^{-1}$ (3.50 larvae plant$^{-1}$), Alpha cypermethrin 10% EC @ 25.0 g a.i. ha$^{-1}$ (3.75 larvae plant$^{-1}$), Teflubenzuron 150 SC @ 15.0 g a.i. ha$^{-1}$ (4.25 larvae plant$^{-1}$) and untreated control(11.42 larvae plant$^{-1}$). The efficacy trend was found to be similar after second spray also. At 15 DASS, Spinosad 45 SC @ 75.0 g a.i. ha$^{-1}$ was again recorded to be the most effective treatment (0.08 larvae plant$^{-1}$) which was significantly superior over other treatments viz. Lambda cyhalothrin 5% EC @ 25.0 g a.i. ha$^{-1}$(1.75larvae plant$^{-1}$), Alpha cypermethrin 10% EC @ 25.0 g a.i. ha$^{-1}$(2.33larvae plant$^{-1}$), Teflubenzuron 150 SC @ 15.0 g a.i. ha$^{-1}$ (3.08larvae plant$^{-1}$) and untreated control (20.58larvae plant$^{-1}$).Spinosad showed the highest per cent decline of pest density over control (97.89%) followed by Lambda cyhalothrin (72.26%), Alpha cypermethrin (65.52%) and Teflubenzuron (59.76%). On the other hand, the significantly highestseedyield was obtained from Spinosad 45 SC @ 0.75 g a.i. ha$^{-1}$ applied plot (14.83 q ha$^{-1}$), followed by Lambda cyhalothrin 5% EC @ 25.0 g a.i. ha$^{-1}$ (12.74 q ha$^{-1}$), Alpha cypermethrin 10% EC @ 25.0 g a.i. ha$^{-1}$ (11.52 q ha$^{-1}$) and Teflubenzuron 150 SC @ 15.0 g a.i. ha$^{-1}$ (10.46 q ha$^{-1}$). All the treatments increased the yield compared to untreated control and lowest yield was obtained from untreated control (6.14 q ha$^{-1}$). The first year study concludes that Spinosad was the most efficient insecticide in managing population of gram pod borer infesting chickpea as well as increasing the yield.

**Evaluation of efficacy against *Helicoverpa armigera* on chickpea during 2020-21**

During second year of experiment same trend of efficacy was observed. The results (Table 2) showed that the population was not differed in different plots at first day before treatment application indicating the uniform pest distribution within the plots and the pest population was above ETL. All the treatments were recorded to reduce the pest population significantly compared to untreated control at 3 DAS. The highest efficacy was observed in Spinosad 45 SC treated plot (7.83 larvae plant$^{-1}$) followed by Alpha cypermethrin 10 EC (8.25 larvae plant$^{-1}$), Lambda cyhalothrin 5 EC (8.42 larvae plant$^{-1}$) and Teflubenzuron 150 SC (8.larvae plant$^{-1}$) compared to untreated check (10.17 larvae plant$^{-1}$) unlike the previous year where, the order of efficacy were Spinosad > Lambda cyhalothrin > Alpha cypermethrin >Teflubenzuron from highest to lowest efficacy at 3 DAS. However, at other time intervals viz. 5 DAFS, 7 DAFS and 10 DAFS, the order of efficacy followed the similar trend like previous year. However, spinosad was found to be the best treatment to reduce the *Helicoverpa* population in each time intervals during second year also whereas in untreated control pest population increased continuously. At 15 DAFS, the maximum pest suppression was recorded in Spinosad 45 SC @ 75.0 g a.i. ha$^{-1}$applied plots (4.08 larvae plant$^{-1}$) which was significantly better than other treatments viz. Lambda cyhalothrin 5% EC @ 25.0 g a.i. ha$^{-1}$ (5.67 larvae plant$^{-1}$), Alpha cypermethrin 10% EC @ 25.0 g a.i. ha$^{-1}$(6.08 larvae plant$^{-1}$), Teflubenzuron 150 SC @ 15.0 g a.i. ha$^{-1}$(6.75 larvae plant$^{-1}$) and untreated control (15.08 larvae plant$^{-1}$). The efficacy trend was found to be similar after second spray also like first year. At 15 DASS, Spinosad 45 SC @ 75.0 g a.i. ha$^{-1}$ was again recorded to be the most effective treatment (0.08 larvae plant$^{-1}$) which was significantly better than other treatments viz. Lambda cyhalothrin 5% EC @ 25.0 g a.i. ha$^{-1}$(2.25 larvae plant$^{-1}$), Alpha cypermethrin 10% EC @ 25.0 g a.i. ha$^{-1}$(3.17 larvae plant$^{-1}$), Teflubenzuron 150 SC @ 15.0 g a.i. ha$^{-1}$(4.25 larvae plant$^{-1}$) and untreated control (21.33 larvae plant$^{-1}$). Again, Spinosad 45 SC @ 0.75g a.i. ha$^{-1}$ was proved to be the best treatment in suppressing the pest population during this year also. In this year also, Spinosad showed the highest per cent reduction of pest population over control (98.57%) followed by Lambda cyhalothrin (71.93%), Alpha cypermethrin (63.18%) and Teflubenzuron (55.47%). The significantly highest seed yield (14.01 q ha$^{-1}$) was acquired from spinosad 45 SC @0.75g a.i. ha$^{-1}$ treated plot followed by Lambda cyhalothrin 5% EC @ 25 g a.i. ha$^{-1}$ (11.98 q ha$^{-1}$), Alpha cypermethrin 10% EC @ 25.0 g a.i. ha$^{-1}$ (10.72 q ha$^{-1}$) and Teflubenzuron 150 SC @ 15.0 g a.i. ha$^{-1}$ (9.92 q ha$^{-1}$). All the treatments increased the seed yield compared to untreated control and lowest yield was recorded from untreated control (4.97 q ha$^{-1}$). Therefore, here also, the results revealed the superiority of Spinosad 45 SC in controlling population of *H.armigera* infesting chickpea as well as increasing the yield.

From the two years of experiment it was found that all the treatments were effective in controlling the pest problem, as all the treatments were recorded with significantly higher mortality of the concerned pest than that of control treatment. Randhawa *et al*. (2009) as well as Kumar and Sarada (2015) also reported that the most effective insecticide was Spinosad for controlling *Helicoverpa armigera*, though the pesticide formulations they had tested were different (45 SC and 48 SC).Patel and Chavadhari (2016) also reported Spinosad @ 0.0135% as an effective treatment against larvae of *H. armigera* in Gujarat condition. Another experiment by Vikrant *et al.* (2020) revealed the least population of *Helicoverpa* as well as highest yield from Spinosad 45 SC treated chickpea plots which supports the present findings. Present findings were also in partial agreement with the findings of Kumar *et al.* (2014) who found that Indoxacarb 14.5 SC was superior in controlling gram pod borer in chickpea, followed by Spinosad 45 SC, Lambda cyhalothrin 5 EC, Quinalphos 25 EC, Fenvalerate 10 EC, Neemarin 1500 ppm and *Ha* NPV, respectively. The relatively better efficacy of Spinosad than Lambda cyhalothrin was earlier reported by Deshmukh *et al.* (2010). The present findings partially support the findings of Sood and Mondal (2005) who reported that highest seed yield (14.58 q $ha^{-1}$) as well as gross return and cost benefit ratio were obtained from application of Lambda cyhalothrin along with lowest pod infestation (9.26%) by *H. armigera* infesting chickpea, though they conducted the experiment in dry temperate conditions of western Himalayas. The present experimental result is also in close approximation with Balikai and Yelshetty (2012) who reported that application of Teflubenzuron 15 SC @ 0.66 ml/ l provided more than 50% protection against gram pod borer compared to untreated control. The findings of the present experiment are also closely held up by the findings of Khan *et al.* (2006) who revealed that toxicity of Karate (Lambda cyhalothrin) was found to be higher than Alpha cypermethrin against *Helicoverpa armigera*. The present finding partially supports the report of Shah *et al.* (2003) who observed significant reduction of larval density of gram pod borer after application of different chemical insecticides including Lambda cyhalothrin in Pakistan.Therefore, from the two years of experiment it can be concluded that though all the treatments were effective comparing to the untreated check, the most effective one among the tested insecticides was Spinosad 45 SC @0.75g a.i. $ha^{-1}$ succeeded by Lambda cyhalothrin 5% EC, Alpha cypermethrin 10% EC and Teflubenzuron 150 SC both in reducing pest population as well as increasing seed yield.

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