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# COMPARATIVE EFFECTS OF CHEMICALS AND ECOFRIENDLY MANAGEMENT OF CHICKPEA POD BORER (*Helicoverpa armigera* Hubner)

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## ABSTRACT

The experiment was conducted to evaluate some botanicals and chemicals against chickpea pod borer, *Helicoverpa armigera* Hubner. The result revealed that amongst botanicals and chemical insecticides $T_5$ (Ripcord @ 2 ml/L of water) treatment was the most effective in reducing pod infestation, larvae number, (53.27% and 70.33% respectively) followed by $T_3$ (38.80% and 70.33% respectively) treated plot whereas $T_2$ treated plot showed least (8.22% and 37.00% respectively) performance over control. $T_5$ (Ripcord @ 2 ml/L of water) treatment also the most effective in increasing pod number, seed number, Grain weight (g) and yield (47.68%, 45.78%, 82.81% and 39.31% respectively) followed by $T_3$ treatment (37.29%, 35.32%, 55.20% and 37.68% respectively). $T_1$ (NSKE @ 100 g/L) treated plot was the most effective in reducing bore number (30.67%) and $T_3$ treatment increased 1000 seed weight (15.54%) followed by both $T_3$& $T_5$ (29.95%) and $T_1$ (15.04%) treated plot. Though Ripcod @ 2ml/L is best treatment for yield, % pod infestation, pod number, seed number & grain weight followed by neem oil which is comparatively safe for managing chickpea pod borer.

**Key words:** Pod borer, Eco friendly management, Pod Borer Management, Chemical control.

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## INTRODUCTION

Chickpea (*Cicer arietinum L.*) is one of the major pulses grown in Bangladesh. Chickpea ranks fifth in area and production but second in consumption priority. The area sown for chickpea in Bangladesh has reduced from >100,000 ha during 1980s to around 7,800 ha in recent years (FAOSTAT, 2013). This reduction is primarily attributed to the yield instability caused by pod borer (Rahman *et al*., 2000). Generally more than 20 insect pests attack during various growth stages of chickpea plant. The gram pod borer is one of the important among them. In server cases, it causes about 75-90 % losses in seed yield (Lal, 1996). He pointed out that gram pod borer damaged leaves, tender shoots, apical tips, floral buds and the pods. Gram pod borer (*Helicoverpa armigera* Hubner) is a key pest of chickpea (*Cicer arietinum L.*) causing 90-95% total damage (Saxena, 1996; Sachan and kathi, 1994).

Prolific use of synthetic insecticide created hazardous to environment and resulted resistance to insecticide in insects and killing natural enemies. Last few years endosulfan has been proved to be effective insecticide against gram pod borer *(H. armigera).* But studies from legume research (Suganthy *et al.*, 2002) revealed that endosulfan affected dwelling natural enemies severely, resulting 40% reduction of natural enemies. Therefore, to overcome this unfavourable situation less hazardous insecticides Deltamethrin (Decis 2.5 EC) was selected and emphasis has been given other alternative methods. Farmers are using botanical such as neem (*Azadirecta indica*) oil against gram pod borer (*H. armigera*).

Chemical insecticides are generally used in pod borer control due to their effectiveness and easy availability. Gupta *et al.* (1991), Khan *et al.* (1993), Giraddi *et al.* (1994), Noorani *et al.* (1994), Choudhary and Sachan (1995), Lal (1996) and Rakesh and Nath (1996) tested various insecticides against gram pod borer on chickpea at various stages of growth like 50% flowering, pod formation and dough stages. They reported that the application of insecticides at proper stages resulted in less pod borer population, less pod damage and increased yield as compared to the check. Recently, *H. armigera* is reported to have developed resistance to many commonly used insecticides (Lande, 1992). In past, the best insecticide was reported to be the cypermethrin (Gohokar *et al.*, 1985; Singh *et al.*, 1987; Khan *et al.*, 1993; Jadhav and Suryawanshi, 1998) and endosulfan (Chaudary *et al.*, 1980; Rizvi *et al.*, 1986). Phokela *et al*., (1990) observed a tendency of increased resistance to cypermethrin in the population of *H. armigera.* Moderate to high levels of resistance to cypermethrin and moderate resistance to endosulfan were recorded in field populations of *H. armigera* (Ahmad *et al*., 1995). Botanicals degrade rapidly from sunlight, air, and proper moisture, which generally makes them less toxic to the environment, but may also require them to be applied more often, applied correctly, and with more precise timing. It also acts

quickly to stop feeding of insect pests and often cause immediate paralysis or cessation of feeding, but they may not cause the insect's death for hours or days (Sexana *et al.,* 1980). Advantages of most botanical insecticides include almost immediate action, low toxicity to plants and to non-target organisms, selectivity, and rapid action and degradation. Disadvantages may include too rapid degradation to be effective, high cost, limited availability, lack of scientific data, and possible high levels of toxicity. Because of their rapid degradation, botanical insecticides must be applied frequently and precisely. A botanical insecticide reduces use of chemicals which is harmful to our environment. This experiment will help us to find botanicals which can be compared to chemical insecticide. The aim of the present study was to study on the infestation intensity of chick pea pod borer among different management practices and to find out the efficacy of different management practice against chick pea pod borer.

## MATERIALS AND METHODS

An experiment was conducted involving three insecticides and four botanicals to investigate their effects on gram pod borer (*Helicoverpa armigera* Hubner) during Rabi season, 2013-2014 at Sher-e-Bangla Agricultural University. The treatments were $T_1$: Neem Seed Kernel Extract @ 100 g/L of water; $T_2$ : Garlic extract @ 100gm/L of water; $T_3$ : Neem oil @ 3ml/L of water; $T_4$ : Chilli extract @ 10 g/L of water; $T_5$ : Ripcord 10 EC (Cypermethrin) @ 2 ml/L of water; $T_6$ : Toughgor 40 EC (Dimethoate) @ 2 ml/L of water; $T_7$ : Corollax 25EC (Quinalphos) @ 1.5 ml/L of water) and $T_8$ : untreated control. Seeds of Chickpea variety BARI Chola-5 were used as a test genotype. The experiment was conducted considering eight treatments and laid out in a Randomized Complete Block Design (RCBD). Each treatment was allocated randomly in three replications. The unit plot size was 3 m ×2.5 m having 1 m space between the blocks and 0.75 m between the plots. Each plot contains two rows having 60cm distance between the row and that between plants was 30 cm. Similar agronomic practices were applied to all treatments from sowing to harvesting. First spray was applied at pod formation stage on 90 DAS and second and third spray after 7 and 14 days of the first spray. The seeds were treated with Vitavax® 200 at the rate of 2 g per kg seed to protect seedlings against foot and root rot diseases. Harvesting was done when 90% of the seed became dark brown in color. The matured crops were harvested and tied under plot wise. The pods were then dried in bright sunshine. The pod damage was recorded by counting the total number of pods and the number of pods damaged by the pest and % increase and decrease was recorded by mean value of treated plot and mean value of untreated plot.

## RESULTS

### Effect of management practices on the pod infestation by chickpea pod borer:

The infestation starts on chickpea usually a fortnight after germination and becomes serious just after the initiation of flower bud coupled with cloudy and humid weather. So botanicals and chemicals were sprayed at 90, 97 and 104 DAS. The lowest percent pod infestation was recorded in $T_8$ (0.801) and highest percent pod infestation was recorded in $T_5$ (1.116) treatment which were statistically similar to all the treatments at 90 DAS. Again, the lowest (1.100) infestation was recorded in $T_5$treatment followed by $T_1$ (1.467), $T_3$ (1.267) and $T_6$ (1.333) treatment had no significant difference and highest (2.665) infestation was recorded in $T_8$ untreated control plot followed by $T_2$ (2.267), $T_4$ (2.067) and $T_7$ (2.133) had no significant difference at 97 DAS. Similar results found at 104 DAS and pool data (Table 1).

**Table-1: Percent pod infestation throughout the growing period of chickpea**

| Treatment | % Pod infestation | | | | |
|---|---|---|---|---|---|
| | 90 DAS* | 97 DAS | 104 DAS | Pool data | % reduction over control |
| $T_1$ | 1.026a | 1.467bcde | 1.400cde | 1.577bcd | 34.21 |
| $T_2$ | 0.880a | 2.267ab | 2.400ab | 2.200ab | 8.22 |
| $T_3$ | 1.103a | 1.267de | 1.067de | 1.467cd | 38.80 |
| $T_4$ | 0.877a | 2.067abcd | 2.533ab | 2.133abc | 11.01 |
| $T_5$ | 1.116a | 1.100e | 0.667e | 1.120d | 53.27 |
| $T_6$ | 0.964a | 1.333cde | 1.467cd | 1.513cd | 36.88 |
| $T_7$ | 1.022a | 2.133abc | 1.867bc | 2.133abc | 11.01 |
| $T_8$ | 0.801a | 2.400a | 2.667a | 2.397a | - |
| **$LSD_{(0.05)}$** | 0.80 | 0.82 | 0.80 | 0.69 | - |
| **CV (%)** | 23.64 | 26.84 | 25.96 | 21.54 | - |

* DAS= Days after sowing

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

From the above findings it was revealed that Ripcord 10 EC (Cypermethrin) @ 2 ml/L of water at 7 days intervals performed as the best treatment (53.27%) in decreasing pod infestation during the management of chickpea pod borer followed by Neem oil @ 3ml/L of water at 7 days intervals (38.80%) which is an eco-friendly approaches. As a result, the trend of results in terms of decreasing the percent pod infestation is $T_5>T_3>T_6>T_1>T_7>T_4>T_2$.

**Effect of management practices on the incidence of larvae on pods**

Pretreatment larval population of *Helicoverpa armigera* was insignificant but larval population differed among the treatments after the application of botanicals and chemicals. The lowest (0.67/10 infested pod) number of larvae was found in both $T_3$and $T_5$ treated plot at 90 DAS. Similar result was found at 97 DAS, 104 DAS pool data (Table-2). The highest incidence of larvae was found in untreated control plot.

**Table-2: Incidence of larvae on pods throughout the pod development stage of chickpea.**

| Treatment | Incidence of larvae (No./10 infested pod) | | | | |
|---|---|---|---|---|---|
| | 90 DAS* | 97 DAS | 104 DAS | Pool data | % reduction over control |
| $T_1$ | 1.00c | 1.00c | 1.33bc | 1.11ef | 63.00 |
| $T_2$ | 2.00b | 2.00b | 1.67b | 1.89bc | 37.00 |
| $T_3$ | 0.67c | 1.00c | 1.00c | 0.89f | 70.33 |
| $T_4$ | 2.00b | 2.00b | 2.00bc | 2.00b | 33.33 |
| $T_5$ | 0.67c | 1.00c | 1.00c | 0.89f | 70.33 |
| $T_6$ | 1.67b | 1.33bc | 1.67bc | 1.56cd | 48.00 |
| $T_7$ | 1.00c | 1.67bc | 1.33bc | 1.33de | 55.67 |
| $T_8$ | 3.00a | 3.00a | 3.00a | 3.00a | - |
| **$LSD_{(0.05)}$** | 0.62 | 0.82 | 0.73 | 0.35 | - |
| **CV (%)** | 23.57 | 28.88 | 25.57 | 12.60 | - |

* DAS= Days after sowing
In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

From the above findings it was revealed that Neem oil @ 3ml/L of water and Ripcord 10 EC (Cypermethrin) @ 2 ml/L of water at 7 days intervals performed as the best treatment (70.33%) in decreasing number of larvae during the management of chickpea pod borer followed by Neem Seed Kernel Extract @ 100 g/L of water at 7 days intervals (63.00%). As a result, the trend of results in terms of decreasing the incidence of larvae is $T_5>T_3>T_1>T_7>T_6>T_2>T_4$.

**Effect of management practices on the incidence of bore on pods**

In green pods *Helicoverpa armigera* make circular holes and feed the grains and make empty. After 90 DAS, lowest (11.00/10 infested plant) bore number was found in $T_1$ treatment followed by $T_3$ (11.67), $T_6$ (11.67) and $T_5$ (12.67) treatments but at 97 DAS lowest (10.67) infestation was found in $T_5$ treatment followed by $T_3$ (11.67) and $T_1$ (11.67). Although there is no significance difference was found at 104 DAS except control plot. Pool data shows that $T_1$ (11.55) is the best treatment followed by $T_5$ (11.67), $T_3$ (11.78) and $T_6$ (12.55) had no significance different (Table 3).

**Table -3: Incidence of bore on pods throughout the pod developing period of chickpea**

| Treatment | No. of bore per ten infested pod | | | | |
|---|---|---|---|---|---|
| | 90 DAS* | 97 DAS | 104 DAS | Pool data | % reduction over control |
| $T_1$ | 11.00d | 11.33cd | 12.33b | 11.55c | 30.67 |
| $T_2$ | 13.67bc | 14.00b | 13.00b | 13.55b | 18.66 |
| $T_3$ | 11.67cd | 11.00d | 12.67b | 11.78c | 29.29 |
| $T_4$ | 14.00b | 13.00bc | 12.33b | 13.11b | 21.30 |
| $T_5$ | 12.67bcd | 10.67d | 11.67b | 11.67c | 29.95 |
| $T_6$ | 11.67cd | 13.00bc | 13.00b | 12.55bc | 24.66 |
| $T_7$ | 13.33bc | 13.33b | 12.00b | 12.89b | 22.62 |
| $T_8$ | 16.33a | 16.33a | 17.333a | 16.66a | - |
| **$LSD_{(0.05)}$** | 2.18 | 1.99 | 1.60 | 1.01 | - |
| **CV (%)** | 9.54 | 8.86 | 7.02 | 4.48 | - |

* DAS= Days after sowing
In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

According to percent reduction over control best (30.67%) treatment was NSKE 100g/L of water at 7 days intervals followed by Ripcord 10 EC (Cypermethrin) @ 2 ml/L and Neem oil @ 3 ml/L of water at 7 days intervals. As a result, the trend of results in terms of decreasing the percent bore number is $T_1>T_5>T_3>T_6>T_7>T_4>T_2$.

**Effect of management practices on production of pod per plant**

Number of pod number was pre-requisite for yield. Highest pod number may get highest yield. The comparative effectiveness of various treatments on number of pod per plant has been shown in Table-4. The data indicated that the highest number of pod per plant (57.30/plant) was observed in $T_5$ treated plot followed by $T_3$ (53.27/plant) and $T_1$ (51.67/plant) treated plots, having no significant difference among them although they are botanicals. On the other hand lowest number of pod per plant was observed in $T_8$ (38.80/plant) untreated plot followed by $T_2$ (40.60/plant) and$T_4$ (43.00/plant) treated plots, respectively having no significant difference among them.

From the above findings it was revealed that Ripcord 10 EC (Cypermethrin) @ 2 ml/L of water at 7 days intervals performed as the best treatment (47.68%) in increasing number of pod during the management of chickpea pod borer followed by Neem oil @ 3 ml/L of water at 7 days intervals (37.29%) and NSKE @ 100 g/L of water at 7 days intervals (33.17%). As a result, the trend of results in terms of increasing the percent pod number is $T_5>T_3>T_1>T_6>T_7>T_4>T_2$.

**Table- 4: Number of pod per plant at harvest**

| Treatment | No of Pod/Plant | % increase over control |
|---|---|---|
| $T_1$ | 51.67ab | 33.17 |
| $T_2$ | 40.60de | 4.63 |
| $T_3$ | 53.27ab | 37.29 |
| $T_4$ | 43.00cde | 10.82 |
| $T_5$ | 57.30a | 47.68 |
| $T_6$ | 48.93bc | 26.10 |
| $T_7$ | 47.07bcd | 21.31 |
| $T_8$ | 38.80e | - |
| **$LSD_{(0.05)}$** | 7.02 | - |
| **CV (%)** | 8.42 | - |

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

**Effect of management practices on number of seeds per plant at harvest**

One or more seeds be on a pod. The highest (63.27/plant) number of seeds per plant was obtained in $T_5$ treated plot followed by $T_3$ (58.73/plant) and $T_1$ (57.53/plant) treated plots, respectively having no significant difference among them although they are botanicals.

From the above findings it was revealed that Ripcord 10 EC (Cypermethrin) @ 2 ml/L of water at 7 days intervals performed as the best treatment (45.78%) in increasing number of seeds during the management of chickpea pod borer followed by Neem oil @ 3 ml/L of water at 7 days intervals (35.32%) and NSKE @ 100 g/L of water at 7 days intervals (32.55%). As a result, the trend of results in terms of increasing the percent seed number is $T_5>T_3>T_1>T_6>T_7>T_4>T_2$.

**Table-5: Number of seeds per plant under different treatments at harvest**

| Treatment | No. of seeds/plant | % increase over control |
|---|---|---|
| $T_1$ | 57.53abc | 32.55 |
| $T_2$ | 45.73de | 5.36 |
| $T_3$ | 58.73ab | 35.32 |
| $T_4$ | 47.53de | 9.51 |
| $T_5$ | 63.27a | 45.78 |
| $T_6$ | 53.30bcd | 22.81 |
| $T_7$ | 50.80cde | 17.05 |
| $T_8$ | 43.40e | - |
| **$LSD_{(0.05)}$** | 7.83 | - |
| **CV (%)** | 8.51 | - |

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

**Effect of management practices on grain production**

Healthy seeds make a good grain weight. The highest (11.70/plant) grain weight per plant was recorded in $T_5$ treated plot followed by $T_1$ (10.47/plant) and $T_3$ (9.93/plant) treated plots, respectively having no significant difference among them.

**Table-6: Chickpea grain weight per plant under different treatments at harvest**

| Treatment | Grain weight (g/plant) | % increase over control |
|---|---|---|
| $T_1$ | 10.47ab | 63.54 |
| $T_2$ | 7.13de | 11.45 |
| $T_3$ | 9.93abc | 55.20 |
| $T_4$ | 7.07de | 10.42 |
| $T_5$ | 11.70a | 82.81 |
| $T_6$ | 9.07bcd | 41.67 |
| $T_7$ | 8.00cde | 25.00 |
| $T_8$ | 6.40e | - |
| **$LSD_{(0.05)}$** | 2.89 | - |
| **CV (%)** | 14.99 | - |

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

From the above findings it was revealed that not only Ripcord 10 EC (Cypermethrin) @ 2 ml/L of water at 7 days intervals chemicals shows best result (82.81%) but also NSKE @ 100g/L of water at 7 days intervals (63.54%) and Neem oil @ 3 ml/L of water at 7 days intervals (55.20%) shows good result in increasing grain weight during the management of chickpea pod borer although those are botanicals. As a result, the trend of results in terms of increasing the percent grain weight is $T_5>T_1>T_3>T_6>T_7>T_2>T_4$.

**Effect of management practices on thousand grain weight**

In terms of 1000 seed weight, two botanicals Neem oil (0.1383g) & NSKE (0.1377g) and two chemicals Quinalphos (Corollax 25EC) 0.1343g & Dimethoate (Toughgor 40EC) 0.1343g having no significant difference among all treatments.

**Table-7: Thousand seed weight of chickpea under different treatments at harvest**

| Treatment | 1000 seed weight (g) | % increase over control |
|---|---|---|
| $T_1$ | 0.1377 a | 15.04 |
| $T_2$ | 0.1263 b | 5.51 |
| $T_3$ | 0.1383 a | 15.54 |
| $T_4$ | 0.1273 b | 6.35 |
| $T_5$ | 0.1343 a | 12.20 |
| $T_6$ | 0.1343 a | 12.20 |
| $T_7$ | 0.1283 b | 7.18 |
| $T_8$ | 0.1197 c | - |
| **$LSD_{(0.05)}$** | 0.00529 | - |
| **CV (%)** | 2.31 | - |

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

From the above findings it was revealed that Neem oil @ 3ml/L of water at 7 days intervals performed as the best treatment (15.54%) in increasing thousand grain weight during the management of chickpea pod borer followed by Neem Seed Kernel Extract @ 100g/L of water at 7 days intervals (15.04%), Ripcord @ 2ml/L of water at 7 days intervals (12.20%) and Dimethoate (Toughgor 40EC) @ 2ml/L of water at 7 days intervals (12.20%). As a result, the trend of results in terms of increasing the percent thousand grain weight is $T_3>T_1>T_5>T_6>T_7>T_4>T_2$.

**Effectiveness on yield of chickpea under different treatments**

Chickpea yield also refer to the actual seed generation from the plant. The highest (1.12 ton/ha) yield was obtained in $T_5$ treatment plot followed by $T_3$ (1.10 ton/ha) treated plot, which is botanical having no significance difference.

**Table-8: Yield of chickpea under different treatments during Rabi season**

| Treatment | Yield (ton/ha) | % increase over control |
|---|---|---|
| $T_1$ | 1.03ab | 28.04 |
| $T_2$ | 0.88cd | 9.85 |
| $T_3$ | 1.10a | 37.68 |
| $T_4$ | 0.88cd | 9.48 |
| $T_5$ | 1.12a | 39.31 |
| $T_6$ | 0.96bc | 20.30 |
| $T_7$ | 1.02ab | 27.54 |
| $T_8$ | 0.80d | - |
| **$LSD_{(0.05)}$** | 0.11 | - |
| **CV (%)** | 6.20 | - |

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

From the above findings it was revealed that Ripcord 10 EC (Cypermethrin) @ 2 ml/L of water at 7 days intervals performed as the best treatment (39.31%) with Neem oil @ 3 ml/L of water at 7 days intervals (37.68%) in increasing yield during the management of chickpea pod borer. As a result, the trend of results in terms of increasing the percent yield is $T_5>T_3>T_1>T_7>T_6>T_2>T_4$.

## DISCUSSIONS

From the above data we can say that in case of % pod infestation, number of larvae on pods, number of pod per plant, number of seeds per plant and yield, the highest efficacy (53.27%, 70.33%, 47.68%, 45.78% and 39.31%) was found in $T_5$ treatment, Ripcord (Cypermethrin) @ 2 ml/L of water at 7 days intervals which is synthetic chemical followed by $T_3$ treatment, Neem oil @ 3ml/L of water at 7 days interval (38.80%, 70.33%, 37.29%, 35.32% and 37.68%) has no significant difference between them which is a botanical pesticide. Some studies pertaining to the chemical control of *H. armigera* have also been conducted by Singh *et al.*, (1976), Barum (1981), Yadav and Yadav (1983), Koul (1985), Naik *et al.* (1987) and Lohar and Junejo (1995), where the successful results for pest control were achieved. Similar to present study, superiority of chemicals in controlling the gram pod borers on chickpea crop has been reported by several researchers in different parts of the world such as Sinha *et al.* (1977), Mishra and Saxena (1981), and Sachan and Lal (1993). Likewise, Srivastava and Sehgal (2002) found that chemical pesticide (endosulfan) significantly provided protection against pod borer but plant product was not found so effective. Bhatt and Patel (2002) reported that endosulfan significantly proved superior in increasing grain yield over control. While, its superiority was negated by the observations of Rawat *et al.* (1979), Shetgar and Puri (1979), Sinha *et al.* (1983), Dhurve and Borle (1985), Gohokar *et al.* (1985), and Panchabhavi and Kadam (1990), where endosulfan was noted at medium level in controlling insect population.

On the other hand, this study revealed that 2$^{nd}$ most effective treatment was Neem oil, although, was inferior to synthetic insecticides, but was fairly effective than control plots which is in agreement with the findings from those of Sinha and Mehrotra (1988) who reported that neem oil did not have a significant effect on pest than synthetic insecticides. Similarly, Rajput *et al.* (2003) evidenced that synthetic insecticide gave the best results than all sets of natural products. On the other hand, it is not in conformity with the findings of Gohokar *et al.* (1985) where neem extract gave better control than insecticide. Sachan and Lal (1993) reported that neem seed kernel extract and neem leaf extract were more effective for controlling the pest on chickpea, but synthetic chemical was not most effective. Naqvi (1987), Butani and Mittal (1993), and Talpur *et al.* (1997) concluded that neem seed solution was equally effective in

reducing pest population, as compared with conventional insecticides, but grain yield was the least. Gilani (2001) reported that neem extract have anti-feeding, repellent and insecticidal influences.

Hence, the superiority of endosulfan as an insecticide especially for the control of pod borer is a well-established fact. But the performance of Cypermethrin was also effective against pod borer management. Results showed that 3 spray applications of cypermethrin at 7 days interval after flower formation initiation but this negated by Saxena et al. (1971). His recommended foliar spray to protect the crop against this pest was 2 sprays.

The interesting results of the present findings were that, all the tested insecticides and botanicals have beneficial effects on the plant population. Likewise Neem oil Neem seed kernel extract also effective for the management of chickpea pod borer. But other botanicals and chemicals were not effective against this pest.

**Correlations:** Correlation study was done to establish a relationship between % pod infestation and grain weight (Figure-1). The regression equation y= -2.208x + 12.56 gave a good fit to the data and value of the co-efficient of determination ($R^2$ = 0.730). From this it can be concluded that the grain weight per plant was decreased with the increase of number of infestation.

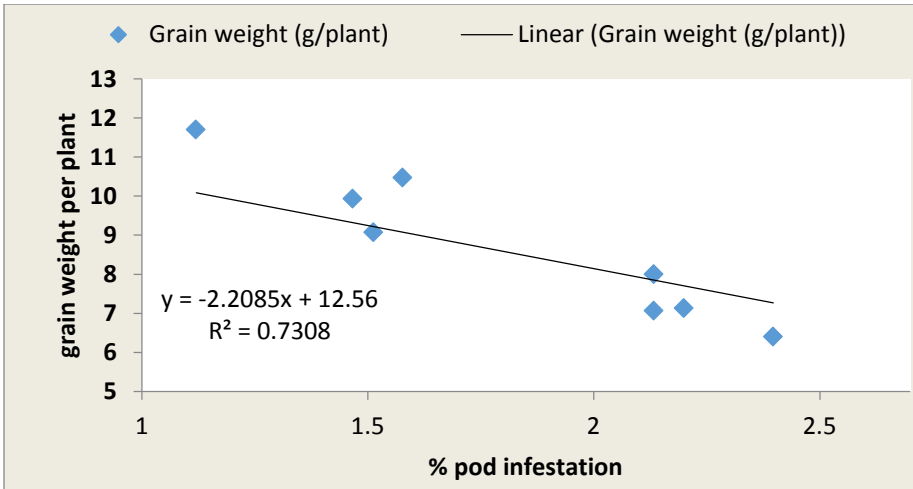


**Figure-1: Relationship between percent pod infestation and grain weight per plant**

**Figure-2** shows that a relationship between % pod infestation and thousand grain weight. From the study it was revealed that significant correlation existed between the characters. The regression equation y= -0.010x +0.15 gave a good fit to the data and value of the co-efficient of determination ($R^{2 =}$ 0.745). From

this it can be concluded that the thousand grain weight per plant was decreased with the increase of number of infestation.

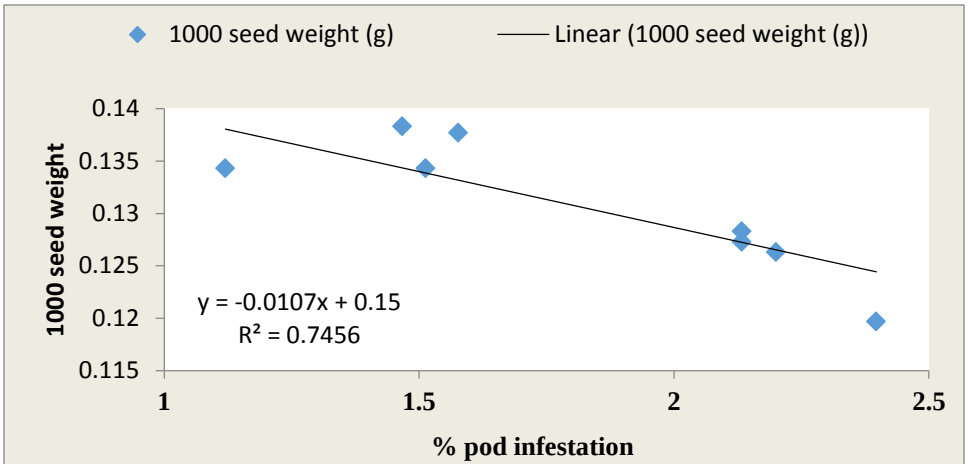


**Figure-2: Relationship between percent pod infestation and thousand seed weight**

**Figure 3** shows a relationship between % pod infestation and yield (ton/ha). The regression equation y= 0.134x + 1.21 gave a good fit to the data and value of the co-efficient of determination ($R^2$ = 0.618). From thisrelations it can be concluded that the yield was decreased with the increase of number of infestation.

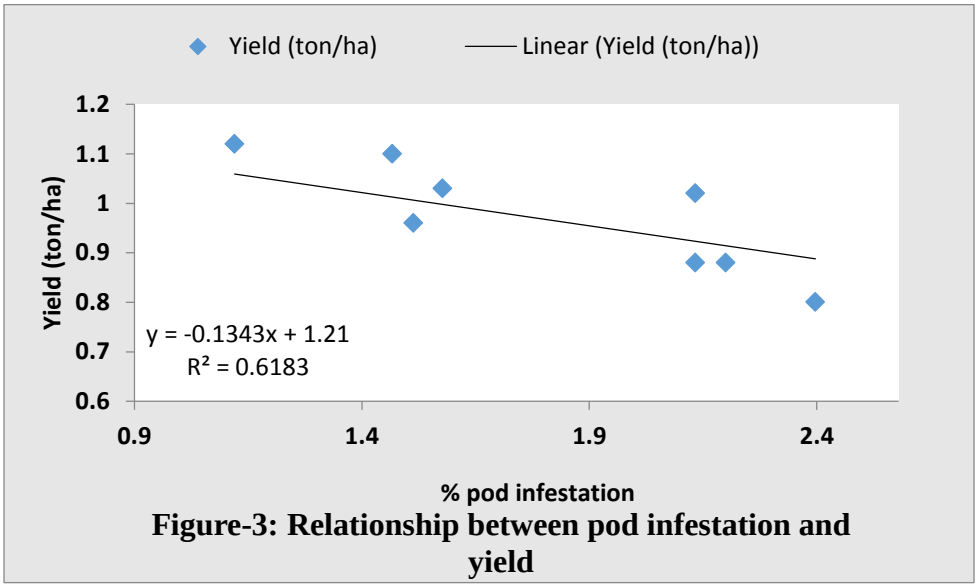


**Figure-3: Relationship between pod infestation and yield**

## CONCLUSION

Although natural and synthetic insecticides contributed in reducing the pest population over the untreated plots, yet the synthetic chemicals are still better solution against the ravages of insects, but, these should be used only as a last resort. Further, need based use of safer pest control chemicals is advocated as an effective and dependable component of integrated pest management strategy. It is suggested that Neem oil could be used as anti-feedant in an integrated pest management programme because it is harmless to beneficial arthropods and cheaper than commercial insecticides. Besides being an organic insecticide, using this product would allow hitting target pest only and if it is properly applied, can kill pest only when it ingests the sprayed foliage.

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## REFERENCES

Ahmad, M., Arif, M. I. and Ahmad, Z. (1995). Monitoring insecticide resistance of *Helicoverpa armigera* (Lepidoptera: Noctuidae) in Pakistan. *J. Econ. Entomol.* 88:771–776.

Barum, L. O. (1981). Tests with nine insecticides intended to protect tomato crops in New Caledonia. Rep. *Appl. Entomol.*, 70: 28-57.

Bhatt, N. J. and Patel, R. K. (2002). Bio-efficacy of various insecticides against *Helicoverpa armigera* on chickpea. *I. J. Entomol*., 64 (1): 27-34.

Butani, P. G. and Mittal, V. P. (1993). Comparative efficacy of botanical insecticide (neem seed kernel suspension) and other insecticides against *Heliothis armigera* (Hubner). *I. Soci. Tobacco Sci*., 276-281.

Chaudhary, J. P., Yadav, L. S. and Rustogi, K. B. (1980). Chemical control of gram pod borer, *Heliothisarmigera*Hubner and semi-loopers, *Plusia*spp. on gram, *Cicerarietinum*L. *Haryana Agri. Univ. J. Res.* 10: 324–328

Dhurve, S. B. and Borle, M. N. (1985). Chemical control of gram pod borer (*Heliothis armigera*) (Hubner). *PKV Res. J*., 9 (2): 83-85.

FAOSTAT. (2013). FAO Statistical Yearbook. Retrieved from http://faostat.fao.org/site/340/DesktopDefault.aspx?PageID=340.FAO Statistics Division 2013, 18 April 2013.

Gilani, G. (2001). Neem the wonder tree. In farming, Oct- Nov. Ed: Saleem, M. T. SAFE Foundation, pp. 27-30.

Giraddi, R. S., Goudreddy, B. S. and Patil, B.V. (1994). Critical time of spray in chickpea for the control of gram pod borer *Helicoverpa armigera* (Hubner). Karnataka J. Agric. Sci., 7: 79-81.

Gohokar, R. T., Thakre, S. M. and Borle, M. M. (1985). Chemical control of gram pod borer (*Heliothis armigera* Hubner) by different synthetic pyrethroids and insecticides. *Pesticides*, 19: 39–40 and 55-56.

Gupta, M. P., Thakur, B. S. and Shrivastava, S. K. (1991). Spray schedule of endosulfan for gram pod-borer (*Helicoverpa armigera*) in chickpea (*Cicer arietinum*). Indian J. Agric. Sci., 61: 860-861.

Jadhav, R. S. and Suryawanshi, D. S. (1998). Chemical control of *Helicoverpa armigera* (Hubner) on chickpea. *J. Maharashtra Agric. Univ.* 23: 83–84.

Khan, M. M., Rustamani, M. A., Talpur, M. A., Balouch, H. B. and Chhutto, A. B. (1993). Efficacy of different insecticides against *Heliothis armigera* (Hub.) on gram. *Pakistan J. Zool.* 25: 117–119

Koul, O. (1985). Azadirachtin interaction with development of *spodoptera litura*. *I. J. Exp. Bio.*, 23: 160-163.

Lal, O. P. (1996). Insect pests of vegetables and their control in East Pakistan. Directorate of Agriculture, Dacca, pp. 12-13.

Lal, O.P. (1996). An outbreak of pod borer, *Heliothis armigera* (Hubner) on chickpea in Eastern Uttar Pradesh, *India. J. Entmol. Res.* 20: 179–181

Lande, S. S. (1992). Susceptibility of *Helicoverpa armigera* (Hb.) to conventional insecticides. Unpublished M Sc Thesis submitted to P.K.V., Akola.

Lohar, M. K and Junejo, G. M. (1995). Susceptibility of last instar larvae of *Spodoptera litura* F. against different insecticides. *Proc. Pakistan Conger. Zool.*, 15: 183-187.

Mishra, P. N and Saxena, H. P. (1981). Search for safer insecticides while controlling pod borer in chickpea, *Cicer arietinum* L. Int. Chickpea Newlet. 5: 12-13.

Naik, R. L., Pokharakar, D. S., Ambekar, J. S. and Pohkarakar, R. N. (1987). A study on control of chickpea pod borer by some insecticides. *J. Maharashtra Agric. Univ.*, 12: 176-177.

Naqvi, S. N. H. (1987). Biological evaluation of fresh neem extracts and their components with reference to abnormalities and esterase activity in insects. *Proc. Pakistan Conger. Zool.*, 17: 315-330.

Noorani, A. M., Shah, A. D., Jugtani, T. K. and Lohar, M. K. (1994). Efficacy of different insecticides against gram pod borer *Heliothis armigera* Hub. on gram crop under field conditions. Sarhad J. Agric., 10: 183-186.

Panchabhavi, K. S. and Kadam, M. L. (1990). A note on the control of *Heliothis armgiera* Hubn. in bengal gram. *Karnataka J. Agric. Sci.*, 3 (3-4): 271-272.

Phokela, A., Dhingra, S., Sinha, S. N. and Mehrotra, K. N. (1990). Pyrethroid resistance in *Heliothis armigera* Hubner: Development of resistance in field. *Pestic. Res. J.* 2: 28–30.

Rahman, M. M. (2000). Infestation and yield loss in chickpea due to pod borer in Bangladesh. Bangladesh J. Agril. Res. 15(2): 16-23.

Rajput, A. A., Sarwar, M., Bux, M. and Toufiq, M. (2003). Evaluation of synthetic and some plant origin insecticides against *Helicoverpa armigera* (Hubner) on chickpea. *Pak. J. Biol. Sci.*, 6 (5): 496-499.

Rakesh, R. and Nath, P. (1996). Evaluation of some insecticides for the management of the pod-borer *Helicoverpa armigera* infesting gram *Cicer arietinum*. Ann. Plant Prot. Sci., 4: 154-159.

Rawat, R. R., Patel, R. K., Veda, O. P and Patitunda, A. (1979). Control of gram pod borer, *Heliothis armigera* (Hub.). *I. J. Entomol.*, 41(1): 33-35.

Rizvi, S. M. A., Chandhary, M. B., Pandey, V. and Upadhyay, V. K. (1986). Efficacy and economics of some insecticides in the management of *Heliothis armigera* Hubner. *Indian J. Plant Prot.* 14: 47–50.

Sachan, J. N. and Katti, G. (1994). Integrated Pest Management. Proceeding of International Symposium on Pulses Research, April 2-6, IARI, New Delhi, India. 23-30.

Sachan, J. N. and Lal, S. S. (1993). Role of botanical insecticides in *Helicoverpa armigera* management in pulses. In botanical pesticides in integrated pest management. *I. Soci. Tobacco Sci.,* 261-269.

Sahan, and Katti, (1994). Analysis of joint action of insecticides *J. Econ. Ent.*53:887-892.

Saxena, H. P., Phokhela, A. and Singh, Y. (1971). Effectiveness of insecticides against gram pod borer. Entomologist's News, 2: 17-18.

Saxena, R. C. (1980). IRRI-ICIPE research project on rice brown plant hopper, *Nilaparvata lugens* (Stal.) International Rice Research Institute, Los Banos, Philippines. 88.

Sehgal, V. K. (1990). Damage yield relationship due to *H. armigera* (Hubner) larvae in chickpea in India. Proc 2nd. Int. Work. On chickpea improvement. Chickpea in Nineties. ICARDA/ICRISTI, 4-8 Dec., 1989.

Shetgar, S. S. and Puri, S. N. (1979). Efficacy of Quinalphos and other insecticides against pod borer, *Heliothis armigera* Hubner infesting chickpea. *Ind. J. Enotomol.*, 41 (4): 403-405.

Singh, D., Ramzan, M. and Bindra, O. S. (1976). Field evaluation of some new insecticides against the tomato fruit borer, *Heliothis armigera* Hub, *I. J. Plant Prot*., 4: 112-113.

Singh, H. M., Singh, R. and Rizvi, S. M. A. (1987). Screening of synthetic pyrethroids against *Heliothis armigera* attacking chickpea. *Narendra Deva J. Agric. Res.* 2:140–143

Sinha, M. M., Yazdani, S. S., Kumar, A. and Lal, K. (1983). Relative efficacy of different spray formulations against gram pod borer. Pesticides, 17 (12): 33-44.

Sinha, N. M., Yadav, R. P. and Kumar, A. (1977). Evaluation of some insecticides for the control of plume moth (*Exelastis atomosa* Walsche) and pod fly (*Melanagromyza obtuse* M.) on red gram (*Cajanus cajan* L.). Pesticides, 11: 29-30.

Sinha, S. N. and Mehrotra, K. N. (1988). Diflubenzuron and neem (*Azadirachta indica*) oil in control of *Heliothis armigera* infesting chickpea (*Cicer arietimum*). *I. J. Agric. Sci.*, 58 (3): 238-239.

Srivastava RM, Sehgal VK (2002). Bioefficacy of various insecticides against Helicoverpa armigera in chickpea. I. J. Entomol., 64 (1): 17-20.

Suganthy, M., Rao, G. V. R. and Kumar, S. T. (2002). Relative efficiency of IPM strategies of chickpea on soil inhibiting and aerial natural enemies. *Legume Res*. 25(1): 66-68.

Talpur, M. A., Rustamani, M. A., Khan, M. M., Baloch, H. B., Hussain, T. and Shar, M. U. (1997). Plants extracts and insecticidal value of conventional pesticide (Thiodan) against *Helicoverpa armigera* Hbn. on chickpea. Proc. *Pakistan Conger. Zool.*, 17: 179-185.

Yadav, L. S. and Yadav, P. R. (1983). Insecticidal control of pod bore, *Heliothis armigera* Hbn. on Kabuli gram. Pesticides, 17: 25-26.