Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(5): 784-791

Received: 10-07-2019
Accepted: 12-08-2019

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Efficacy of different newer insecticides against pigeon pea pod borers

SM Dadas, SS Gosalwad and SK Patil

Abstract
An investigation was carried out to evaluate the efficacy of different insecticides against pod borers of pigeon pea at the Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Kharif* 2018-19. The studies was carried out under field conditions using randomized block design in three replication with seven insecticide treatments *viz*., T_1: Lambda cyhalothrin 4.9% CS @ 15 g a.i./ha, T_2: Spinosad 45% SC @ 60 g a.i./ha, T_3: Chlorantriniprole 18.5% SC @ 30 g a.i./ha, T_4: Flubendiamide 39.37% SC @ 45 g a.i./ha, T_5: Indoxacarb 14.5% SC @ 50 g a.i./ha, T_6: Emamectin benzoate 5% SG @ 11 g a.i./ha, T_7: Spinetoram 11.7% SC @ 60 g a.i./ha and T_8: Untreated control. Two sprays application was given at flowering stage of the crop and second spraying at 15 days thereafter.

The results revealed that all the insecticide treatments were significantly effective to minimize the pod borers population and found at par with each other. However, chlorantriniprole 18.5%SC was found to be most promising treatment to minimize the larval population of gram pod borer, *Helicoverpa armigera* (Hubner), spotted pod borer, *Maruca vitrata* (Geyer), plume moth, *Exelatis atomosa* (Walshingham) and pod fly, *Melanogramyza obtusa* (Malloch) to the extent of mean larval/maggot populations of 0.47, 0.48, 0.37 and 0.47 larva/plant followed by flubendiamide 39.37% SC (0.56, 0.0.62, 0.47 and 0.57 larva/plant) and indoxacarb 14.5% SC (0.66, 0.86, 0.57 and 0.69 larva/plant) after first and second spray. Chlorantraniliprole 18.5%SC was found most effective in reducing the per cent pod damage i.e. 5.59 per cent by the pod bores of pigeon pea after second spraying and it was statistically at par with flubendiamide 39.37% SC (5.00%).

The significantly maximum grain yield, gross and net profit was recorded in the plot treated with the chlorantraniliprole 18.5%SC (8.79 q /ha with Rs. 20400/- and Rs.14150/-) followed by flubendiamide 39.37% SC (7.83 q/ha. with Rs. 15650/- and Rs.14020/-). Amongst all the treatments, highest incremental cost benefit ratio (ICBR) was attained by flubendiamide 39.37% SC (1:8.60) followed by lambda cyhalothrin 4.9% CS (1:5.78).

Keywords: Pigeon pea, pod borers, insecticides

Introduction
India grows a variety of pulse crops under a wide range of agro-climatic conditions and has a pride of being world's largest producer of pulses; share of pulses to total food grain production is only 6-7 per cent. The most commonly grown pulses in India include chickpea, red gram, urd bean, field peas, horse gram, etc. These pulses play an important role in supplying proteins to large masses of the Indian people. In India per capita availability of pulses is 47.2 g per day and contributing share of pulses to total food-grain production in terms of area, production and productivity is 18.92, 6.79 and 35.91 per cent, respectively, during 2014-15 (Tiwari and Shivhare, 2016) [21].

Pigeon pea has a wide range of products, including the dried seed, pods and immature seeds used as green vegetables, leaves and stems used for fodder and the dry stems as fuel. It also improves soil fertility through nitrogen fixation as well as from the leaf fall and recycling of the nutrients (Snapp *et al.*, 2002) [16]. It is an important pulse crop that performs well in poor soils and regions where moisture availability is unreliable or inadequate. In the country, the crop is extensively grown in Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Gujarat.

Among several insect pests infesting redgram; gram pod borer, *Helicoverpa armigera* (Hubner), spotted pod borer, *Maruca vitrata* (Geyer), pod fly, *Melanagromyza obtusa* (Malloch), plume moth, *Exelastis atomosa* (Walshingham) and blue butterfly, *Lampides boeticus* (Linnaeus) are most serious. The pod sucking bugs also cause considerable damage which constitutes pod bug, *Riptortus pedestris* (Fabricius), green stink bug, *Nezara viridula* (Linnaeus), green bean bug, *Clavigralla gibbosa* (Spinola), lab lab bug, *Captosoma cribraria* (Fabricius) reported by Bijewar *et al*. (2018) [4].

The damage inflicted by *H. armigera* is confined to flowers, seeds and pods. *M. vitrata* causes substantial damage to flowers by webbing and also it bores into the pods. *M. abtusa* attack the crop from pod filling to pod maturity. *E.atomosa* attacks the crop at the stage of flowering till pod maturity. A yield loss due to pod borers in pigeon pea was estimated to a tune of 40.6 per cent (Subharani and Singh, 2007) [20]. However, it causes 60-90 per cent grain yield loss under favourable conditions while damage due to pod fly ranged from 14.3 to 46.6 per cent (Lal *et al*., 1981) [8]. Losses due to pod damage are estimated to be 11.1 to 36.4 per cent in different parts of India (Ahmad and Rai, 2005) [1].

Material and Methods

The field experiment was conducted at experimental file of Department of Agriculture Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani-431 402 (M.S.). The experiment laid out in randomized block design with three replication by using pigeon pea cv. BSMR-736. The crop was sown in first week of July, 2018 in gross plot size 4.8 m x 4.2 m in plant to plant and row to row with spacing of 120 cm and 30 cm, respectively. In the present experiment, eight treatments *viz*., T_1: Lambda cyhalothrin 4.9% CS @ 15 g a.i./ha, T_2: Spinosad 45% SC @ 60 g a.i./ha, T_3: Chlorantriniprole 18.5% SC @ 30 g a.i./ha, T_4: Flubendiamide 39.37% SC @ 45 g a.i./ha,T_5: Indoxacarb 14.5% SC @ 50 g a.i./ha, T_6: Emamectin benzoate 5% SG @ 11 g a.i./ha,T_7: Spinetoram 11.7% SC @ 60 g a.i./ha and T_8: Untreated control were tried. Application of first spraying was undertaken at flowering stage and second spraying at 15 days thereafter. The spray volume for each spray was calculated and total volume of spray fluid was taken as 500 litres per hectare. Spraying was done by using knapsack sprayer in early morning hours to avoid mid day heat.

Observations recorded

The observations on larval incidence of pigeon pea pod borer complex was made on five randomly selected plants from each treatment one day before and 1, 3, 7 and 14 days after each application of insecticides. An observation on larval population of H. armigera, *M. vitrata* and *E. atomosa* was recorded on number of larvae per plant. In case of *M. abtusa* on number of maggots per 10 pods per plant was considered. At the time of harvesting, hundred pods from five randomly selected plants were collected from each plot, to study the extent of per cent pod damage by borers in different treatments. After harvesting net plot, yield was recorded and it was converted into q/ha, were subjected to statistical analysis. Incremental Benefit cost ratio was also assessed by dividing the net monetary return (B) by the total additional cost due to treatments as worked out (C).

Statistical analysis

The larval counts were transformed by using Poisson formula $\sqrt{x + 0.5}$. The per cent infestation of pods was calculated on the basis of healthy and damaged pods. The values were duly transformed in to the corresponding angular value and subjected to analysis of variance. Critical difference (CD) was applied for comparing treatment means (Gomez and Gomez, 1984) [7].

Results and Discussion

The field trial was undertaken to evaluate the efficacy of different newer insecticides against pod borers of pigeon pea during *kharif* 2018-19. The larval count of pod borers on pigeon pea was recorded on two sprays at flowering stage and 15 days thereafter. The observations recorded on one day before, 1, 3, 7 and 14 days after spraying. Data pertaining to different insecticides against population of *H. armigera*, *M. vitrata*, *E. atomosa* and *M. obtusa*, after first spray are presented in Table 1 to 4.

i. *Helicoverpa armigera*

First spray

The results revealed that the population of *Helicoverpa* before spray was uniformly distributed in all the plots varied from 2.00 to 2.87 larvae per plant and it was statistically non significant. Whereas, all the insecticides were found to be significantly superior over untreated control in reducing population of *H. armigera* at 1, 3, 7 and 14 days after spraying of insecticides.

The plot treated with chlorantriniprole 18.5% SC recorded significantly lowest population of *Helicoverpa* larvae to the tune of 0.73, 0.47 and 0.33 larva/plant followed by flubendiamide 39.37% SC (0.93, 0.53 and 0.40 larva/plant), spinosad 45% SC (1.00,0.53 and 0.40 larva) at 1, 3 and 7 days after first spray, respectively. Rest of the treatments *viz*., indoxacarb 14.5% SC (1.13, 0.67 and 0.47 larvae) and emamectin benzoate 5% SG (1.27, 0.73 and 0.53 larvae), lambda cyhalothrin 4.9% CS (1.33, 0.87 and 0.60 larvae) and spinetoram 11.7% SC (1.40, 0.93 and 0.73 larvae) were also reduced the larval population of *Helicoverpa* at 1, 3 and 7 days after first spray, respectively..

At 14 DAS, all the insecticide treatments were significantly at par with each other in reducing the larval population of *Helicoverpa* except spinetoram 11.7% SC. However, chlorantriniprole 18.5% SC recorded significantly lowest population of *Helicoverpa* larvae to the tune of 0.67 larva/plant followed by flubendiamide 39.37% SC (0.73 larva), spinosad 45%SC (0.73 larva), indoxacarb 14.5% SC (0.80 larva) and emamectin benzoate 5% SG (0.80 larva), lambda cyhalothrin 4.9% CS (0.87 larva) and spinetoram 11.7% SC (0.93 larva) and maximum larval population was observed in untreated control with 3.47 larvae per plant.

Second spray

At 1 day after second spray (DASS), chlorantriniprole 18.5% SC recorded lowest population of *Helicoverpa* larvae to the tune of 0.40 larva/plant followed by flubendiamide 39.37% SC (0.53 larva) and spinosad 45% SC (0.47 larva) and it was at par with each other. Other treatments *viz*., indoxacarb 14.5% SC (0.60 larva), emamectin benzoate 5% SG (0.73 larva), lambda cyhalothrin 4.9% CS (0.73 larva) and spinetoram 11.7% SC (0.87 larva) were significantly superior in reducing the larval population over untreated control (3.40 larvae).

Similarly, at 3 DAS, all the insecticide treatments were significantly at par with each other in reducing the larval population of *Helicoverpa* except spinetoram 11.7% SC. Minimum larval population (0.53 larva) was recorded from the plots treated with chlorantriniprole 18.5% SC and maximum in untreated control (3.60 larvae).

At 7 and 14 DAS, the least population of *Helicoverpa* (0.27 and 0.33 larva, respectively) was evidenced from the plots treated with chlorantriniprole 18.5% SC and it was at par with flubendiamide 39.37% SC (0.33 and 0.40 larva), spinosad 45% SC (0.40 and 0.53 larva) and indoxacarb 14.5% SC (0.47 and 0.53 larva). However, rests of all the insecticide treatments were also significantly superior over untreated control.

The results of the 1st and 2nd sprays, it seems that all the insecticide treatments were significantly at par with each other in reducing the mean larval population of *Helicoverpa*. However, the plots treated with chlorantriniprole 18.5% SC recorded the lowest mean population of *Helicoverpa* on pigeon pea to the extent of 0.47 larva followed by flubendiamide 39.37% SC (0.56 larva), spinosad 45% SC (0.59 larva), indoxacarb 14.5% SC (0.66 larva), lambda cyhalothrin 4.9% CS (0.80 larva), emamectin benzoate 5% SG (0.87 larva) and spinetoram 11.7% SC (0.88 larva).

The results of present investigation are agreement with the earlier researchers, Sreekanth *et al.* (2014) [18] showed that the number of *Helicoverpa* larvae per plant were lowest in chlorantraniliprole 20 SC (0.43), flubendiamide 480 SC (0.59) and spinosad 45 SC (0.85) as against untreated control plot (4.17) with 89.7, 85.9 and 79.6 per cent larval reduction over control, respectively. Patange and Chiranjeevi (2017) [11] concluded that the treatment application of rynaxypyr 18.5 SP @ 30 g a.i./ha was found effective for suppression of pod borers population. Landge and Sushil (2009) [9] reported rynaxypyr 20 SC @ 40 g a.i./ha found to be most effective reducing the larval population. Das *et al.* (2009) [6] reported that two sprayings, initiating at 50% flowering and repeated at 10 days interval of rynaxypyr (Coragen) 20 SC @ 30 - 40 g a.i./ha was quite effective in controlling pigeon pea pod borer complex. Srinivasan and Durairaj (2007) [19] recorded least (2.00/plant) *Helicoverpa* larval population in spinosad 45 SC treatment followed by indoxacarb 14.8 SC (2.40/plant) as against a maximum population of 6.70/plant in control in pigeon pea. Ambulker (2008) [2] reported that two sprays of emamectin benzoate 5% SG @ 9 g a.i./ha was found to be most effective in reducing larval population and pod and grain damage. Patel and Patel (2013) [12] reported that chlorantraniliprole 18.5% SC @ 30 g a.i./ha was the most effective insecticide against gram pod borer and blue butterfly.

ii. *Maruca vitrata*

First spray

The results revealed that the population of *M. vitrata* before spray was uniformly distributed in all the plots varied from 2.93 to 3.40 larvae per plant. Whereas, all the insecticides were found to be significantly superior over untreated control in reducing population of *M. vitrata* at 1, 3, 7 and 14 days after application of insecticides.

The plot treated with chlorantriniprole 18.5% SC recorded significantly lowest population of *M. vitrata* larvae to the tune of 1.27, 0.53, 0.40 and 0.47 larva followed by flubendiamide 39.37% SC (1.53, 0.73, 0.60 and 0.67 larvae) and spinosad 45% SC (1.73, 0.93, 0.67 and 0.80 larvae) at 1, 3, 7 and 14 days after first application of insecticides, respectively. Rest of the treatments *viz*., emamectin benzoate 5% SG, indoxacarb 14.5% SC, lambda cyhalothrin 4.9% CS and spinetoram 11.7% SC were also significantly reduced larval population of *Maruca* in between 0.47 and 2.27 larvae) over untreated control (4.27 larvae).

Second spray

Similarly, at 1, 3, 7 and 14 days after second application of insecticides, the plot treated with chlorantriniprole 18.5% SC recorded also lowest population of *M. vitrata* larvae to the tune of 0.47, 0.33, 0.27 and 0.13 larva followed by flubendiamide 39.37% SC (0.53, 0.47, 0.33 and 0.13 larva) and spinosad 45% SC (0.67, 0.47, 0.40 and 0.20 larva), respectively. Rest of the treatments *viz*., emamectin benzoate 5% SG, indoxacarb 14.5% SC, lambda cyhalothrin 4.9% CS and spinetoram 11.7% SC were also significantly reduced larval population of *Maruca* in between 0.33 and 0.93 larvae) over untreated control (4.20 larvae).

The mean results of the treatments of 1st and 2nd sprayings were found significantly at par with each other after. However, the plots treated with chlorantriniprole 18.5% SC recorded the lowest mean population of *Helicoverpa* on pigeon pea to the extent of 0.48 larva followed by flubendiamide 39.37% SC (0.62 larva), spinosad 45% SC (0.73 larva), indoxacarb 14.5% SC (0.86 larva), emamectin benzoate 5% SG (0.92 larva), lambda cyhalothrin 4.9% CS (1.08 larvae) and spinetoram 11.7% SC (1.17 larvae).

The present findings are in conformity with results of Randhawa and Saini (2015) [13] reported spinosad 48 SC @ 150 ml/ha was found to be most effective against *M. vitrata* (Geyer) in pigeon pea and it was closely followed by indoxacarb 15 EC and cypermethrin 25 EC. Sambathkumar *et al.* (2015) [14] showed that least incidence of *M. vitrata* was recorded in indoxacarb 15.8 EC @ 75 g a.i./ha (3.1 webbings/10 plants) and chlorantraniliprole 18.5 SC 30 g a.i./ha (3.9 webbings/10 plants).

iii) *Exelatis atomosa*

First spray

The results revealed that the population of *E. atomosa* before spray was uniformly distributed in all the plots varied from 1.93 to 2.73 larvae per plant. Whereas, all the insecticides were found to be significantly superior over untreated control in reducing population of *E. atomosa* at 1, 3, 7 and 14 days after application of insecticides.

At 1, 3 and 7 days after first spray, chlorantriniprole 18.5% SC recorded lowest larval population of *E. atomosa* to the tune of 0.93, 0.27 and 0.20 larva followed by flubendiamide 39.37% SC (1.13, 0.47 and 0.27 larvae) and it was at par with each other. Rest of the treatments *viz*., spinosad 45% SC, indoxacarb 14.5% SC, emamectin benzoate 5% SG, lambda cyhalothrin 4.9% CS and spinetoram 11.7% were significantly superior by reducing the larval population in between 0.40 and 3.13 larvae over untreated control (3.13 larvae).

At 14 DAS, chlorantriniprole 18.5% SC recorded lowest population of *E. atomosa* larvae to the tune of 0.47 larva followed by flubendiamide 39.37% SC (0.53 larva) fallowed by spinosad 45% SC (0.60 larva), indoxacarb 14.5% SC (0.60 larva) and emamectin benzoate 5% SG (0.73 larva) and it was at par with each other. Lambda cyhalothrin 4.9% CS (0.80 larva) and spinetoram 11.7% SC (1.00 larva) was also effective in reducing the pest population over untreated control (3.73 larvae).

Second spray

The results revealed that all the treatments were found to be superior in reducing population of *E. atomosa* over untreated control at 1, 3, 7 and 14 days after application of insecticides.

At 1 day after second spray (DASS), chlorantriniprole 18.5% SC recorded lowest population of *E. atomosa* larvae to the tune of 0.33 larva/plant followed by flubendiamide 39.37%

SC (0.40 larva) and spinosad 45% SC (0.47 larva) and which were at par with each other. Other treatment *viz*., indoxacarb 14.5% SC (0.53 larva), emamectin benzoate 5% SG (0.67 larvae), lambda cyhalothrin 4.9% CS (0.73 larva) and spinetoram 11.7% SC (0.80 larva) were significantly superior over untreated control (3.73 larvae).

At 3, 7 and 14 DASS, all the insecticide treatments significant reduction of *E. atomosa* larval population and at par with each other except spinetoram 11.7% SC. However, plot treated with chlorantriniprole 18.5% SC was recorded minimum population (0.33, 0.13 and 0.27 larva) and maximum population was recorded in spinetoram 11.7% SC (060, 0.53 and 0.67 larva). All treatments were significantly superior over untreated control (3.80, 4.00 and 3.53 larvae) at 3rd, 7th and 14th DASS, respectively.

The mean results of all insecticide treatments of 1st and 2nd sprayings were found significantly at par with each other. However, the mean larval population of *E. atomosa* observed in the treatments with decreasing order was chlorantriniprole 18.5% SC (0.37 larva) > flubendiamide 39.37% SC (0.47 larva) > spinosad 45% SC (0.54 larva) > indoxacarb 14.5% SC (0.57 larva) > emamectin benzoate 5% SG (0.64 larva) > lambda cyhalothrin 4.9% CS (0.71 larva) > spinetoram 11.7% SC (0.84 larva)> untreated control (3.45 larvae).

The present findings are in agreement with the results of Sonune and Bhamare (2018) [17] reported that emamectin benzoate 0.0022 per cent was the most effective treatment in minimizing larval population of *E. atomosa* (1.60 and 1.93 larvae/plant) followed by flubendiamide 0.0070 per cent (1.67 and 2.07 larvae/ plant) and chlorantraniliprole 0.0055 per cent (1.73 and 2.07 larvae/ plant) at 14 days after second and third spray, respectively.

iv) *Melanagromyza obtusa*

First spray

The results revealed that the population of *M. obtusa* before spray was uniformly distributed in all the plots varied and population was found in the range from 2.87 to 3.73 maggots /10 pods. Whereas, all the insecticides were found to be significantly superior over untreated control in reducing population of *M. obtusa* at 1, 3, 7 and 14 days after application of insecticides.

At 1 day after first spray (DAFS), chlorantriniprole 18.5% SC recorded lowest population of *M. obtusa* to the tune of 0.93 maggot followed by flubendiamide 39.37% SC (1.07 maggots), spinosad 45% SC (1.13 maggots), indoxacarb 14.5% SC (1.20 maggots), emamectin benzoate 5% SG (1.27 maggots), lambda cyhalothrin 4.9% CS (1.33 maggots) and spinetoram 11.7% SC (1.47 maggots). Flubendiamide 39.37% SC (1.13 maggots) treatment was at par with spinosad 45% SC (1.13 maggots). All treatments were significantly superior over untreated control.

Similarly, at 3 DAFS significant reduction of *M. obtusa* (0.53 maggot) was recorded from the plots treated with chlorantriniprole 18.5% SC and followed by flubendiamide 39.37% SC (0.67 maggot), spinosad 45% SC (0.80 maggot), indoxacarb 14.5% SC (0.87 maggot) and emamectin benzoate 5% SG (0.87 maggot). Rests of all the treatments were significantly superior over untreated control (3.47 maggots).

At 7 DAFS, significantly least population of *M. obtusa* (0.27 maggot) was evidenced from the plots treated with chlorantriniprole 18.5% SC and it was at par with flubendiamide 39.37% SC (0.33 maggot), spinosad 45% SC (0.40 maggot) and indoxacarb 14.5% SC (0.47 maggot). Other treatments were also significantly reducing the *M. obtusa* population over untreated control (3.73 maggots).

At 14 DAFS, all the insecticide treatments were statistically significantly reduced maggot population over untreated control except spinotoram 11.7%11.7% SC. However, chlorantriniprole 18.5% SC and spinosad 45% SC recorded significantly lowest maggot population of *M. obtusa* to the tune of 0.67 maggot followed by flubendiamide 39.37% SC indoxacarb 14.5% SC, emamectin benzoate 5% SG, lambda cyhalothrin 4.9% CS and spinetoram 11.7% SC with the reduction of *M. obtusa* population in the between from 0.73 to 1.07 maggots with untreated control (3.13 maggots).

Second spray

At 1 day after second spray (DASS), chlorantriniprole 18.5%SC recorded lowest maggot population of *M. obtusa* to the tune of 0.33 maggot followed by flubendiamide 39.37% SC (0.40 maggot), spinosad 45% SC (0.47 maggot and indoxacarb 14.5% SC (0.53 maggot) and it was significantly at par with each other. The treatment *viz*., emamectin benzoate 5% SG (0.67 maggot), lambda cyhalothrin 4.9% CS (0.73 maggot) and spinetoram 11.7% SC (0.80 maggot) were significantly superior over untreated control (3.73 maggots).

Similarly, at 3 and 7 DASS, the reduction of *M. obtusa* (0.40 and 0.33 maggot) was recorded from the plots treated with chlorantriniprole 18.5% SC followed by flubendiamide 39.37% SC (0.60 and 0.40 maggot) and spinosad 45% SC (0.60 and 0.47 maggot). Rest of the treatments *viz*.,indoxacarb 14.5% SC (0.67 and 0.53 maggot), emamectin benzoate 5% SG (0.73 and 0.60 maggot), spinetoram 11.7% SC (0.80 and 0.73 maggot) and lambda cyhalothrin 4.9% CS (0.87 and 0.67 maggot) were significantly effective to reduce *M. obtusa* population over untreated control (3.47 and 3.53 maggots).

At 14 DAS, chlorantriniprole 18.5% SC recorded significantly lowest population of *M. obtusa* maggot to the tune of 0.27 maggot and which was at par with flubendiamide 39.37% SC (0.33 maggot), spinosad 45% SC (0.40 maggot) and indoxacarb 14.5% SC (0.47 maggot). Emamectin benzoate 5% SG (0.53 maggot), lambda cyhalothrin 4.9% CS (0.60 maggot) and spinetoram 11.7% SC (0.67 maggot) were significantly superior over untreated control (3.53 maggots).

The mean results of 1st and 2nd sprayings shows that all the insecticide treatments found significantly at par with each other after in reducing *M. obtusa* population as against untreated control. The maggots population of *E. atomosa* observed in decreasing order was chlorantriniprole 18.5% SC (0.47 larva) > flubendiamide 39.37% SC (0.57 larva) > spinosad 45% SC (0.62) > indoxacarb 14.5% SC (0.69) > emamectin benzoate 5% SG (0.77) > lambda cyhalothrin 4.9% CS (0.84) > spinetoram 11.7% SC (0.93)> untreated control (3.48).

The present findings are in similar line with the results reported by earlier workers Patel and Patel (2013) [12] concluded that chlorantraniliprole @ 30 g a.i./ha was the most effective insecticide against pod borer complex of pigeon pea. Chiranjeevi and Sarnaik (2017) [5] reported chorantriniliprole 18.5 SC @ 30 g a.i. per ha was found to be most effective in reducing population of *M. obtusa* on 1, 3, 7, 10 and 14 days after first spray i.e. 46.33, 25.33, 16.67, 14.00 and 28.00 pod flies (larvae + pupae) per 100 pods respectively. Patange and Chiranjeevi (2017) [11] reported rynaxypyr 18.5 SP @ 30 g a.i./ha was most effective insecticide in minimizing the larval population of pigeon pea pod borers *viz*., gram pod borer, plume moth and pod fly.

Per cent pod damage

The novel group of seven insecticides were tested for their reaction to the infestation of pod borers on pigeon pea and it showed a significant variation in respect of per cent pod damage presented in Table 5.

Amongst the treatments, application of chlorantriniprole 18.5% SC found as the best treatment which recorded lowest pod damage (4.33%) and which was at par with flubendiamide 39.37% SC (5.00%). And this was followed by other treatments *i.e.* spinosad 45% SC (7.33%), indoxacarb 14.5% SC (8.00%), emamectin benzoate 5% SG (8.33%), lambda cyhalothrin 4.9% CS (11.00%) and spinetoram 11.7% SC (13.30%); While maximum pod damage was observed in untreated control *i.e.* 37.00 per cent.

These results are in accordance with the findings reported by Nishantha *et al.* (2009) [10] reported that rynaxypyr 20 SC @ 30 g a.i. /ha as superior molecule in recording lower pod damage. Ambulker (2008) [2] reported that two sprays of emamectin benzoate 5% SG @ 9 g a.i./ha was found to be most effective in reducing larval population and pod and grain damage followed by lambda-cyhalothrin 5% EC @ 37.5 g a.i./ha and spinosad 45% SC @ 56 g a.i./ha, respectively. Patel and Patel (2013) [12] reported chlorantraniliprole 18.5% SC@ 30 g a.i./ha registered the lowest pod damage due to borer and pod fly. Sreekanth *et al.* (2014) [18] showed that lowest pod damage due to *Helicoverpa* was recorded in plots treated with flubendiamide (1.16%), chlorantraniliprole (1.26%) and spinosad (1.92%) with 88.7, 87.7 and 81.2 per cent reduction over control, respectively. Sonune and Bhamare (2018) [17] reported that maximum reduction in pod and grain damage due to *E. atomosa* was registered in the plots treated with emamectin benzoate 0.0022 per cent to the tune of 2.33 and 1.67 per cent, respectively followed by chlorantraniliprole 0.0055 per cent (3.00 and 2.33%) and flubendiamide 0.0070 per cent (3.67 and 3.00%). Highest reduction in pod and grain damage due to *M. obtusa* was exhibited in the plots treated with emamectin benzoate 0.0022 per cent to the extent of 9.00 and 6.33 per cent, respectively followed by chlorantraniliprole 0.0055 per cent (9.67 and 7.00%) and spinosad 0.0070 per cent (10.33 and 7.67%).

Grain yield

The data regarding grain yield of pigeon pea revealed that all the treatments were statistically significant in increasing grain yield over untreated control. The grain yield of pigeon pea in different treatments varied from 4.71 to 8.79 q/ha. The significantly highest grain yield (8.79 q/ha) of pigeon pea was recorded in chlorantriniprole 18.5% SC. This was followed by flubendiamide 39.37% SC (7.83 q/ha), spinosad 45% SC (7.15 q/ha), indoxacarb 14.5% SC (7.00 q/ha), emamectin benzoate 5% SG (6.82 q/ha), lambda cyhalothrin 4.9% CS (6.56 q/ha) and spinetoram 11.7% SC (6.34 q/ha) and found statistically superior over control (4.71 q/ha).

Similar findings have been reported by Patel and Patel (2013) [12] they concluded that chlorantraniliprole 18.5% SC @ 30 g a.i./ha was the most effective insecticide against pod borer complex and recorded highest grain yield of pigeon pea. Sreekanth *et al.* (2014) [18] showed that highest grain yield was recorded in chlorantraniliprole (686.1 kg/ha) with 127.5 per cent increase over control followed by flubendiamide (595.8 kg/ha) and spinosad (589.0 kg/ha) with 97.6 and 95.3 per cent increase over control (301.6 kg/ha). Patange and Chiranjeevi (2017) [11] concluded that the treatment application of rynaxypyr 18.5 SP @ 30 g a.i./ha was found effective for suppression of pod borers population and extenuate yield. Ambulker (2008) [2] reported that two sprays of emamectin benzoate 5% SG @ 9 g a.i./ha registered highest grain yield followed by lambda-cyhalothrin 5% EC @ 37.5 g a.i./ha and spinosad 45% SC @ 56 g a.i./ha, respectively. Landge and Sushil (2009) [9] reported rynaxypyr 20 SC @ 40 g a.i./ha also registered highest grain yield. Babariya *et al.* (2010) indicated that the indoxacarb 0.0075% recorded significantly highest grain yield (1486 kg/ha).

Therefore, the present findings are in conformity with their previous studies.

Incremental cost benefit ratio

The data generated on incremental cost benefit ratio (ICBR) of different insecticides applied against pod borers of pigeon pea are tabulated in Table 6. The cost benefit ratio was worked out based on the obtained yield and pigeon pea support price gave realization over untreated.

Amongst the treatments, highest incremental cost benefit ratio (1:8.60) was attained by flubendiamide 39.37% SC which was followed by lambda cyhalothrin 4.9% CS (1:5.78), emamectin benzoate 5% SG (1:2.28), chlorantriniprole 18.5% SC (1:2.26), indoxacarb 14.5% SC (1:1.38), spinosad 45% SC (1:1.10) and the treatment of spinetoram 11.7% SC was proved to be uneconomical i.e. (1:0.41) as the insecticide cost was expensive.

The results obtained in the present investigation in relation to cost benefit ratio are in accordance with the earlier workers; Wadaskar *et al.* (2013) [22] reported that the treatments with economic feasibility were indoxacarb 14.5 SC @0.55 ml/1 (ICBR 1:5.1), emamectin benzoate 5 SQ @ 0.3 g/1 (1:5.0) and spinosad 45 SC @ 0.3 ml/1 (1:4.6) and may also be recommended as potent alternatives in management of pod borer complex of pigeon pea. Sreekanth *et al.* (2014) [18] showed that the cost effectiveness of chlorantraniliprole and flubendiamide was also high and very favorable with incremental cost-benefit ratios of 1: 4.64 and 1: 4.50, respectively followed by indoxacarb (1: 3.67), emamectin benzoate (1: 3.13) and spinosad (1: 2.97). Ambulker (2008) [2] reported highest cost benefit ratio was obtained from lambda cyhalothrin which was closely followed by emamectin benzoate, chlorpyriphos and spinosad, respectively. Landge and Sushil (2009) [9] reported that maximum cost benefit ratio 1:5.61 was obtained from fenpropathrin 30 EC @ 100 g a.i./ha, followed by flubendamide 20 WDG @ 50 g a.i./ha (1:2.35). Singh (2014) reported that highest cost benefit ratio was obtained from chlorantraniliprole (1: 4.24).

Table 1: Efficacy of different newer insecticides against *H. armigera* on pigeon pea

Tr. No.	Treatments	Dose (g a.i. /ha)	No. of *H.armigera* larvae/plant									
			First spraying					Second spraying				Mean
			Precount	1DAS	3DAS	7DAS	14DAS	1DAS	3DAS	7DAS	14DAS	
T_1	Lambda cyhalothrin 4.9% CS	15	2.47 (3.18)*	1.33 (2.40)	0.87 (1.58)	0.60 (1.31)	0.87 (1.58)	0.73 (1.44)	0.73 (1.44)	0.60 (1.31)	0.67 (1.38)	0.80 (1.14)
T_2	Spinosad 45% SC	60	2.00 (2.71)	1.00 (1.71)	0.53 (1.24)	0.40 (1.11)	0.73 (1.44)	0.47 (1.18)	0.67 (1.38)	0.40 (1.11)	0.53 (1.24)	0.59 (1.04)
T_3	Chlorantriniprole 18.5% SC	30	2.00 (2.71)	0.73 (1.44)	0.47 (1.18)	0.33 (1.04)	0.67 (1.38)	0.40 (1.11)	0.53 (1.24	0.27 (0.98)	0.33 (1.04)	0.47 (0.98)
T_4	Flubendiamide 39.37% SC	45	2.13 (2.84)	0.93 (1.64)	0.53 (1.24)	0.40 (1.11)	0.73 (1.44)	0.53 (1.24)	0.60 (1.31)	0.33 (1.04)	0.40 (1.11)	0.56 (1.03)
T_5	Indoxacarb 14.5% SC	50	2.47 (3.18)	1.13 (1.84)	0.67 (1.38)	0.47 (1.18)	0.80 (1.51)	0.60 (1.31)	0.60 (1.31)	0.47 (1.18)	0.53 (1.24)	0.66 (1.08)
T_6	Emamectin benzoate 5% SG	11	2.73 (3.44)	1.27 (2.98)	0.73 (1.44)	0.53 (1.24)	0.80 (1.51)	0.73 (1.44)	0.67 (1.38)	0.53 (1.24)	0.67 (1.38)	0.87 (1.17)
T_7	Spinetoram 11.7%SC	60	2.87 (3.58)	1.40 (2.11)	0.93 (1.64)	0.73 (1.44)	0.93 (1.64)	0.87 (1.58)	0.80 (1.51)	0.67 (1.38)	0.73 (1.44)	0.88 (1.17)
T_8	Untreated control	--	2.60 (3.31)	2.67 (3.38)	3.07 (3.78)	3.27 (3.98)	3.47 (4.18)	3.40 (4.11)	3.60 (4.31)	3.73 (4.44)	3.80 (4.51)	3.38 (1.97)
S.E. ±			0.21	0.10	0.07	0.06	0.08	0.06	0.07	0.07	0.07	0.09
C.D. at 5%			NS	0.31	0.22	0.19	0.25	0.19	0.22	0.21	0.22	0.28
C.V. (%)			15.26	13.8	12.95	12.96	12.79	11.40	12.41	13.66	12.98	15.75

*Figures in parentheses are $\sqrt{x + 0.5}$ transformed values NS=Non significant DAS =Days after spraying

Table 2: Efficacy of different newer insecticides against *M. vitrata* on pigeon pea

Tr. No.	Treatments	Dose (g a.i./ha)	No. of *M. vitrata* larvae/plant									
			First spraying					Second spraying				Mean
			Precount	1DAS	3DAS	7DAS	14DAS	1DAS	3DAS	7DAS	14DAS	
T_1	Lambda cyhalothrin 4.9%CS	15	3.07 (3.78)*	2.13 (2.84)	1.53 (2.24)	1.07 (1.78)	1.27 (1.98)	0.87 (1.58)	0.73 (1.44)	0.53 (1.24)	0.47 (1.18)	1.08 (1.26)
T_2	Spinosad 45%SC	60	3.13 (3.84)	1.73 (2.44)	0.93 (1.64)	0.67 (1.38)	0.80 (1.51)	0.67 (1.38)	0.47 (1.18)	0.40 (1.11)	0.20 (0.91)	0.73 (1.11)
T_3	Chlorantriniprole 18.5%SC	30	3.20 (3.91)	1.27 (1.98)	0.53 (1.24)	0.40 (1.11)	0.47 (1.18)	0.47 (1.18)	0.33 (1.04)	0.27 (0.98)	0.13 (0.84)	0.48 (0.99)
T_4	Flubendiamide 39.37% SC	45	3.33 (4.04)	1.53 (2.24)	0.73 (1.44)	0.60 (1.31)	0.67 (1.38)	0.53 (1.24)	0.47 (1.18)	0.33 (1.04)	0.13 (0.84)	0.62 (1.06)
T_5	Indoxacarb 14.5% SC	50	3.00 (3.71)	1.93 (2.64)	1.07 (1.78)	0.87 (1.58)	0.93 (1.64)	0.73 (1.44)	0.53 (1.24)	0.47 (1.18)	0.33 (1.04)	0.86 (1.17)
T_6	Emamectin benzoate 5% SG	11	3.40 (4.11)	1.87 (2.58)	1.13 (1.84)	0.93 (1.64)	1.20 (1.91)	0.80 (1.51)	0.60 (1.31)	0.53 (1.24)	0.33 (1.04)	0.92 (1.19)
T_7	Spinetoram 11.7%SC	60	3.13 (3.84)	2.27 (2.98)	1.60 (2.31)	1.13 (1.84)	1.33 (2.04)	0.93 (1.64)	0.80 (1.51)	0.73 (1.44)	0.53 (1.24)	1.17 (1.29)
T_8	Untreated control	---	2.93 (3.64)	3.09 (3.80)	3.47 (4.18)	3.93 (4.64)	4.27 (4.99)	4.00 (4.70)	3.93 (4.64)	4.07 (4.78)	4.20 (4.91)	3.87 (2.09)
S.E. ±			0.20	0.13	0.11	0.09	0.10	0.09	0.08	0.08	0.07	0.11
C.D. at 5%			NS	0.40	0.33	0.27	0.30	0.27	0.25	0.23	0.20	0.35
C.V. (%)			11.07	11.67	13.7	12.79	12.32	13.65	14.3	14.38	14.19	16.11

*Figures in parentheses are $\sqrt{x + 0.5}$ transformed value, NS=Non significant DAS =Days after spraying

Table 3: Efficacy of different newer insecticides against *E. atomosa* on pigeon pea

Tr. No.	Treatments	Dose (g a.i./ha)	No. of *E. atomosa* larvae/plant									
			First spraying					Second spraying				Mean
			Pre-count	1DAS	3DAS	7DAS	14DAS	1DAS	3DAS	7DAS	14DAS	
T_1	Lambda cyhalothrin 4.9%CS	15	2.27 (2.98)*	1.40 (2.11)	0.73 (1.44)	0.53 (1.24)	0.80 (1.51)	0.73 (1.44)	0.53 (1.24)	0.47 (1.18)	0.47 (1.18)	0.71 (1.10)
T_2	Spinosad 45%SC	60	2.60 (3.31)	1.27 (1.98)	0.53 (1.24)	0.33 (1.04)	0.60 (1.31)	0.47 (1.18)	0.40 (1.11)	0.33 (1.04)	0.40 (1.11)	0.54 (1.02)
T_3	Chlorantriniprole 18.5%SC	30	2.47 (3.18)	0.93 (1.64)	0.27 (0.98)	0.20 (0.91)	0.47 (1.18)	0.33 (1.04)	0.33 (1.04)	0.13 (0.84)	0.27 (0.98)	0.37 (0.93)
T_4	Flubendiamide 39.37% SC	45	2.47 (3.18)	1.13 (1.84)	0.47 (1.18)	0.27 (0.98)	0.53 (1.24)	0.40 (1.11)	0.33 (1.04)	0.27 (0.98)	0.33 (1.04)	0.47 ((0.98)
T_5	Indoxacarb 14.5% SC	50	1.93 (2.64)	1.20 (1.91)	0.53 (1.24)	0.40 (1.11)	0.60 (1.31)	0.53 (1.24)	0.47 (1.18)	0.40 (1.11)	0.40 (1.11)	0.57 (1.03)
T_6	Emamectin benzoate 5% SG	11	2.33 (3.04)	1.33 (2.04)	0.67 (1.38)	0.47 (1.18)	0.73 (1.44)	0.67 (1.38)	0.47 (1.18)	0.40 (1.11)	0.40 (1.11)	0.64 (1.07)
T_7	Spinetoram 11.7%SC	60	2.60 (3.31)	1.67 (2.38)	0.87 (1.58)	0.60 (1.31)	1.00 (1.71)	0.80 (1.51)	0.60 (1.31)	0.53 (1.24)	0.67 (1.38)	0.84 (1.16)

T_8	Untreated control	---	2.73 (3.44)	2.73 (3.44)	2.93 (3.64)	3.13 (3.84)	3.73 (4.44)	3.73 (4.44)	3.80 (4.51)	4.00 (4.71)	3.53 (4.24)	3.45 (1.99)
S.E. ±			0.21	0.10	0.07	0.06	0.09	0.08	0.07	0.06	0.07	0.07
C.D. at 5%			NS	0.30	0.21	0.18	0.26	0.24	0.21	0.19	0.21	0.20
C.V. (%)			14.91	11.54	13.77	13.96	13.91	14.04	13.79	13.49	14.79	12.04

*Figures in parentheses are $\sqrt{x + 0.5}$ transformed values NS=Non significant DAS =Days after spraying

Table 4: Efficacy of different newer insecticides against *M. obtuse* on pigeon pea

Tr. No.	Treatments	Dose (g a.i./ha)	No. of *M. obtusa* maggots/10 pods									
			First spraying					Second spraying				Mean
			Pre-count	1DAS	3DAS	7DAS	14DAS	1DAS	3DAS	7DAS	14DAS	
T_1	Lambda cyhalothrin 4.9%CS	15	3.13 (3.84)*	1.33 (2.04)	0.93 (1.64)	0.67 (1.38)	0.93 (1.64)	0.73 (1.44)	0.87 (1.58)	0.67 (1.38)	0.60 (1.31)	0.84 (1.16)
T_2	Spinosad 45%SC	60	2.87 (3.58)	1.13 (1.84)	0.80 (1.51)	0.40 (1.11)	0.67 (1.38)	0.47 (1.18)	0.60 (1.31)	0.47 (1.18)	0.40 (1.11)	0.62 (1.06)
T_3	Chlorantriniprole 18.5%SC	30	3.33 (4.04)	0.93 (1.64)	0.53 (1.24)	0.27 (0.98)	0.67 (1.38)	0.33 (1.04)	0.40 (1.11)	0.33 (1.04)	0.27 (0.98)	0.47 (0.98)
T_4	Flubendiamide 39.37% SC	45	2.93 (3.64)	1.07 (1.78)	0.67 (1.38)	0.33 (1.04)	0.73 (1.44)	0.40 (1.11)	0.60 (1.31)	0.40 (1.11)	0.33 (1.04)	0.57 (1.03)
T_5	Indoxacarb 14.5% SC	50	3.73 (4.44)	1.20 (1.91)	0.87 (1.58)	0.47 (1.18)	0.80 (1.51)	0.53 (1.24)	0.67 (1.38)	0.53 (1.24)	0.47 (1.18)	0.69 (1.09)
T_6	Emamectin benzoate 5% SG	11	3.47 (4.18)	1.27 (1.98)	0.87 (1.58)	0.53 (1.24)	0.93 (1.64)	0.67 (1.38)	0.73 (1.44)	0.60 (1.31)	0.53 (1.24)	0.77 (1.13)
T_7	Spinetoram 11.7%SC	60	2.93 (3.64)	1.47 (2.18)	1.07 (1.78)	0.80 (1.51)	1.07 (1.78)	0.80 (1.51)	0.80 (1.51)	0.73 (1.44)	0.67 (1.38)	0.93 (1.20)
T_8	Untreated control	---	3.20 (3.91)	3.27 (3.98)	3.47 (4.18)	3.73 (4.44)	3.13 (3.84)	3.73 (4.44)	3.47 (4.18)	3.53 (4.24)	3.53 (4.24)	3.48 (1.99)
S.E. ±			0.15	0.12	0.09	0.07	0.08	0.08	0.07	0.06	0.07	0.09
C.D. at 5%			NS	0.35	0.28	0.22	0.25	0.24	0.21	0.189	0.22	0.26
C.V. (%)			8.33	13.76	13.88	13.61	12.74	13.55	11.85	11.65	14.41	14.19

*Figures in parentheses are $\sqrt{x + 0.5}$ transformed values, NS=Non significant DAS =Days after spraying

Table 5: Effect of different newer insecticides on pod damage caused by pod borers and grain yield of pigeon pea

Tr. No.	Treatments	Dose (g a.i/ha)	Pod damage (%)	Grain yield (q/ha)
T_1	Lambda cyhalothrin 4.9% CS	15	11.00	6.56
T_2	Spinosad 45% SC	60	7.33	7.15
T_3	Chlorantriniprole 18.5% SC	30	4.33	8.79
T_4	Flubendiamide 39.37% SC	45	5.00	7.83
T_5	Indoxacarb 14.5% SC	50	8.00	7.00
T_6	Emamectin benzoate 5% SG	11	8.33	6.82
T_7	Spinetoram 11.7% SC	60	13.30	6.34
T_8	Untreated control	---	37.00	4.71
S.E. ±			0.94	0.12
C.D. at 5%			2.85	0.36
C.V. (%)			13.8	14.78

Table 6: Incremental cost benefit ratio (ICBR) of different insecticides used against pod borer complex of pigeon pea

Tr. No.	Treatments	Yield (q/ha)	Increase in yield over untreated control (q/ha)	Cost of insecticides per lit. or kg (Rs.)	Quantity required for two sprays (g or ml)	Cost of insecticide required for two sprays (Rs/ha)	Spraying charges for two sprays (Rs/ha)	Total cost (Rs/ha) (7+8)	Value of additional yield over untreated control (Rs/ha)*	Net profit (Rs/ha)	ICBR	Rank
1	2	3	4	5	6	7	8	9	10	11	12	13
T1	Lambda cyhalothrin 4.9% CS	6.56	1.85	1000	600	600	1000	1600	9250	7700	1:4.81	2
T2	Spinosad 45% SC	7.15	2.44	16000	300	4800	1000	5800	12200	6400	1:1.10	6
T3	Chlorantraniliprole 18.5% SC	8.79	4.08	17500	300	5250	1000	6250	20400	14150	1:2.26	4
T4	Flubendiamide 39.37% SC	7.83	3.12	14000	200	2800	1000	2530	15650	14020	1:4.83	1
T5	Indoxacarb 14.5% SC	7.00	2.29	4000	1000	4000	1000	5000	11450	6650	1:1.33	5
T6	Emamectin benzoate 5% SG	6.82	2.11	2500	440	1100	1000	2100	10550	7790	1:3.71	3
T7	Spinetoram 11.7% SC	6.34	1.63	11000	800	9900	1000	10900	8150	2200	1:0.20	7
T8	Untreated control	4.71	_	_	_	_	_	_	_	_	_	_

*Cost of pigeon pea seeds : Rs.5000/q

References

1. Ahmad R, Rai AB. 25 years of research on *Helicoverpa* at IIPR. In: Indian Institute of Pulses Research, Kanpur. 2005, 54.
2. Ambulker VK. Studies on efficacy of newer insecticides on gram pod borer, *Helicoverpa armigera* (Hub.) infesting pigeonpea and their impact on potent parasites. M.Sc. (Ag.) thesis submitted to JNKVV, Jabalpur, 2008
3. Babariya PM, Kabaria BB, Patel VN, Joshi MD. Chemical control of gram pod borer, *Helicoverpa armigera* Hubner infesting pigeon pea. *Legume* Research. 2010; 33(3):224-226.
4. Bijewar, Ajay Kumar, Das SB, Saxena AK. Population dynamics of major insects of pigeon pea (*Cajanus cajan* (L.) Millsp.). International Journal of Chemical Studies. 2018; 6(5):912-920.
5. Chiranjeevi B, Sarnaik SV. Efficacy of different insecticidal treatments on population of pod fly, *Melanagromyza obtusa* (Malloch). Journal of Entomology and Zoology Studies. 2017; 5(4):1812-1815.
6. Das SB, Veda OP, Mazumder ND. Efficacy of rynaxypyr 20 SC (Coragen) against pod borer complex infesting pigeonpea. In: National Symposium on IPM strategies to combat emerging pests in the current scenario of climate change held at Central Agricultural University, Pasighat, Arunachal Pradesh from Jan., 28th - 30th, 2009, 59-60.
7. Gomez KA, Gomez AA. Statistical procedures for Agricultural Research, Second edition. John willey and Sons, New York. 1984, 582.
8. Lal SS, Yadav CP, Dias CR. Insect pests of pulse crops and their management. Annual Report. 1981, 66-67.
9. Landge SA, Sushil KS. Studies on pest complex of pigeon pea, C*ajanus cajan* (L.) and their management under late sown condition. M.Sc. (Ag.) thesis submitted to JNKVV Jabalpur, 2009.
10. Nishantha KM, Bhosle BB, Patange NR, Bhute NK. Rynaxypyr, a new insecticide for managing pod borer complex in pigeon pea. Indian Journal of Entomology. 2009; 71(2):179-183.
11. Patange NR, Chiranjeevi B. Bioefficacy of newer insecticides against pigeon pea (*Cajanus cajan* L. Millsp.) pod borers. Journal of Entomology and Zoology Studies, 2017; 5(3):28-31.
12. Patel SA, Patel RK. Bio-efficacy of newer insecticides against pod borer complex of pigeon pea [*Cajanus cajan* (L.) Millspaugh]. An International e-Journal. 2013; 2(3):398-404.
13. Randhawa HS, Saini MK. Efficacy of different insecticides against pod borer, (*Maruca vitrata* Geyer) in pigeonpea. Legume Research. 2015; 38(5): 687-690.
14. Sambathkumar S, Durairaj C, Ganapathy N, Mohankumar S. Field evaluation of newer insecticide molecules and botanicals against pod borers of red gram. Indian Journal of Agriculture Research. 2015; 38(2):260-267.
15. Singh AK. Evaluation of new molecule of insecticides against pod fly (*Melanagromyza obtusa*) of pigeon pea. SAARC Journal of Agriculture. 2014; 12(1):89-95.
16. Snapp SS, Rohrbach DD, Simtowe F, Freeman HA. Sustainable soil management options for Malawi: Can small holder farmers grow more legumes? Agriculture Ecosystems and Environment. 2002; 91:159-174.
17. Sonune KR, Bhamare VK. Bio-efficacy of different insecticides against pod fly, *M. obtusa* (Malloch) and plume moth, *E. atomosa* (Walsingham) infesting pigeon pea. International Journal of Current Microbiology and Applied Sciences. 2018; 6:2027-2035.
18. Sreekanth MS, Lakshmi M, Koteswar R. Bio-efficacy and economics of certain new insecticides against gram pod borer, *Helicoverpa armigera* (Hubner) infesting pigeonpea (*Cajanus cajan* L.). International Journal of Plant, Animal and Environmental Sciences, 2014, 4(1).
19. Srinivasan T, Durairaj C. Newer insecticides against pod borer complex of pigeonpea with special reference to *Helicoverpa armigera* and *Melanagromyza obtusa*. Indian Journal of Plant Protection. 2007; 35(1):47-49.
20. Subharani S, Singh TK. Influence of meteorological factors on population dynamics of pod fly, *Melanagromyza obtusa* Malloch (Diptera: Agromyzidae) in pigeonpea under agro-climatic conditions of Manipur. Indian Journal of Entomology. 2007; 69(1):78-80.
21. Tiwari K, Shivhare AK. Pulse in India Retrospect and prospects, 2016. http://dpd.dacnet.nic.in.
22. Wadaskar RM, Bhalkare SK, Patil AN. Field efficacy of newer insecticides against pod borer complex of pigeon pea. Indian Journal of Food Legumes. 2013; 26(1-2):62-66.