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Efficacy of insecticides against *Helicoverpa armigera* (Order, Lepidoptera: Family, Noctuidae) of Chickpea (*Cicer arietinum* L.) at Areka and Kokate, Southern Ethiopia

Andualem Alemayehu Atumo*

Southern Agricultural Research institute, Areka Agricultural Research Center, Ethiopia.

Abstract

Among insect pests that damage legumes worldwide, chickpea pod borer, *Helicoverpa armigera*, has been identified as the most harmful. Chickpea is attacked by more than 36 species of insect pests, among these pests, the pod borer, *Helicoverpa armigera* is the most serious one. The objective of this study was to evaluate and select effective insecticides against chickpea pod borer insect pest damage. In order to screen insecticides which have high efficacy to control *Helicoverpa armigera* the trial was carried out for 2020 and 2021 at Kokate and Areka main and sub research stations. The insecticides were Diazinon 60%EC, Dimeto 40%EC, Karate 5EC*, Thiodan 35%EC*, Apron star 42 WS and susceptible chickpea variety of Habru. Design was randomized complete block with three replication. The result revealed that average number of larvae outbreak on untreated plots were higher in number (12-17) than treated plot (1-6). The statistical result of grain yield implied that significant at ($p<0.5\%$ and combined data $p<0.1\%$) level. At 2020 Diazinon 60%EC, Karate 5EC* and Thiodan 35%EC gave 52.23%, 51.91% and 50.79% higher yield per ha^{-1} than untreated one . Whereas, in 2021 Thiodan 35% EC*, Karate 5EC*and Diazinon 60% EC gave 53.47%, 52.75% and 49.35% higher yield per ha^{-1} than unsprayed one. Hence, based on the relative efficiency of insecticides Karate 5EC > Thiodan 35% > Diazinon 60% > Apron star 42 WS >Dimetho 40%. As their relative efficiency variation yield was obtained from Karate 5EC (1422.905), Thiodan 35% (1420.892), Diazinon 60% (1373.4), Apron star 42 WS (1113.385) and Dimetho 40% (1030.475) kg/ha^{-1} respectively. The lowest yield was recorded from untreated (677) kg/ha^{-1} and all insecticides proved better as compared to untreated one. The cost benefit ratio revealed that among insecticide treated karate 5EC and Thiodan35% gave higher net benefit (33019 and 32891 (ETB) i.e. Ethiopia birr) respectively followed by Diazinon 60% (31871ETB).These indicate that Karate 5EC and Thiodan 35% have high efficiency to manage *Helicoverpa armigera* insect pest damage followed by Diazinon 60%. The implication for future study on time interval with spraying frequency and the biology of this insect in laboratory is important to know the accurate time of insecticide spraying.

Keywords: *Cicer arietinum; Helicoverpa armigera*; Insecticides; Pod damage; Grain yield

Introduction

Among insect pests that damage legumes worldwide, chickpea pod borer, *Helicoverpa armigera*, has been identified as the most harmful [1]. *Helicoverpa armigera* (Hubner) belongs to **family** Noctuidae of **order** Lepidoptera, is commonly known as pod borer [2]. The yield loss in chickpea due to pod borer was reported as 10-60 per cent in normal weather conditions (Srivastava SK., 2003), while it was 50-100 per cent in favorable weather conditions, particularly in the states where frequent rains and cloudy weather are prevailing during the crop season [3].

Damage potential of this pest is so great that an average of infestation of one larva per plant may destroy 30-40 pods per plant in chickpea and cause yield loss of 10-15kg ha^{-1}. *Helicoverpa armigera* is polyphagous insect pest that attacks a number of economically important crops such as cereals, sorghum, cotton, pepper, sunflower, safflower, flax and nigger seed. During the pest out breaks, the larvae damage leaves, tender, shoots, apical tips, flower buds and pods. It causes considerable yield loss both in quality and quantity, thus leading to various socio economic problems. *H. armigera* are estimated at approximately US $5billion on different crops worldwide. Yield loss by this pest varies from country to country as well a crop to crop. In Ethiopia, estimated yield loss on chickpea ranged from 21 to 36% (Tariku, 2018).

Though chemical insecticides are generally preferred for its control due to their easy availability and applicability but excessive indiscriminate use has resulted in the development of environmental pollution and hazardous effect to the human and beneficial organisms. In intensive production systems pesticides are the method for pest management that represent a significant component of production costs. Over reliance on pesticides is not sustainable and brings with it considerable economic, ecological problems from pesticide resistance in key pests, and environmental concerns arising from residues in soil and water and drift of pesticides into non-crop environments. Because of continuous and indiscriminate use of insecticides to minimize the damage caused by *H. armigera,* it has developed high levels of resistance to conventional insecticides. As a result of evolution of insecticide resistant populations of *H. armigera*, farmers at times resort to frequent use of insecticide mixtures [4]. Due to *H. armigera* attack, serious and extensive yield losses has been reported in some legumes (or pulses) from 28-40%, ensuring economic loss up to 300 million dollars annually [5].

***Corresponding author:** Andualem Alemayehu Atumo, Southern Agricultural Research institute, Areka Agricultural Research Center, Ethiopia; Email: andualemet12@gmail.com

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The pod borers were considered to be the most important group causing crop loss to the tune of 60 to 80 per cent. Synthetic insecticide provide dramatic effect initially, and hence chemical control methods are still in use among farmers. Earlier, conventional insecticides like Malathion and hostathion chlorpyriphos were reported in management of pests on legumes. In recent times, new insecticide molecules offer advantages over earlier chemistry in terms of greater levels of safety, better performance and reduced environmental impact [6]. Hence, in order to manage this insect effectively to reduce yield loss with recent safe organophosphate insecticides should be necessary and contribute better for food security. Therefore, this study was undertaken with the objective of evaluation and screening of different insecticides which have high efficacy against chickpea pod borer (*Helicoverpa armigera*) damage.

Materials and Methods

The field experiment was carried out at Areka Agricultural Research Center Kokate and Areka station in Southern Nation Nationality and people region of Ethiopia. Areka is located about 300 km south west of Addis Ababa, in Ethiopia found at 7°04'N longitude and 37°41'E latitude and altitude of 1800 meters above sea level. The soils at Areka are deep, highly weathered with a pH of 4.8. The climate is tropical, with mean annual rainfall of about 1500 mm. The daily mean maximum and minimum temperature of the area is 25 ^{0}c and 13 ^{0}c, respectively. The main soil type in the area is nit soils. However, Kokate station global position system of Latitudinal and Longitudinal reading is 6°85'28" N, 37°76'10" E respectively, and altitude of 2156 meter above sea level. The soil Kokate a pH of 5.2 and type is clay loam and, mean annual rainfall of about 655 mm. The daily mean maximum and minimum temperature of the area is 24.2^{0}c and 13.6^{0}c, respectively. The experimental design used was Randomized Complete Block Design (RCBD). The experiment was laid down with five treatments and one-control plots for comparison. The plot size was 2mX2m, susceptible Habru chickpea variety was used, and it was sowed on 30cmx10cm spacing between plot and plants respectively [7].

Discussion

The outbreak of *Helicoverpa armigera* in both study years on chickpea trials had been early and larvae infestation was aggravated uniformly on the whole plots before insecticides sprayed. The damage was begin instantly on the actively growing shoot tips of leafs. The larvae of *Helicoverpa armigera* feed on the leaves, buds, flowers and rather serious on pods. Several young pods and developing seeds in pods are consumed. The different (EC) emulsifiable concentrate and (WS) Water dispersible powder formulated based on the factory recommendation with 200L/ha of water and ready to use. After insecticides sprayed the larva populations on treated plots were reduced gradually and however, leave damage level and larvae population was increased highly on untreated plots [8].

After insecticide application different parameters, plant number per plot, number of larvae per plot, pod number per plant, damaged number of pod per plant, grain yield per plant, grain yield per plot and grain yield kilogram per ha were collected and insecticides was sprayed with in fortnight intervals. The result indicates that the pod damage of *Helicoverpa armigera* on untreated plots had been sever than that of insecticides treated plots. The above revealed that the average number of pod damaged on untreated plots were 12-17 whereas, from 1-6 on insecticides treated plots and this result confirmed with that of(Ali *et al.,* 2009). Based on their efficacy variation pod damage recorded was varied for Karate 5EC (3%), Thiodan 35% (6%), Diazinon 60% (3%), Apron Star 42 WS (19%) and Dimetho 40% (24%) respectively. Therefore, the damage percent implied that among treated insecticides the list effective was Dimethoate and Severely damage on untreated plots. The cumulative percentage pod damage of *Helicoverpa armigera* on untreated plots from 36.5-51.8% higher than on insecticides treated plots from 3.04-24%. All the treatments were found better to control *Helicoverpa armigera* relatively than untreated plots. Among the insecticides that was sprayed based on their pod damage controlled efficiency, Karate 5 EC >Diazinon 60% >Thiodan 35% > Dimetho 40% > Apron star 42 WS illustrated. Percent pod damage was calculated by using the following formula [9].

$$\text{POD DAMAGE (\%)} = \frac{\text{NUMBER OF DAMAGED POD}}{\text{TOTAL NUMBER OF POD RECORDED}}$$

The result showed that all the treatments were significantly superior to that of untreated plots. During 2020, the grain yield obtain from each insecticide treated has been varies greatly based on their insect pest controlled efficiency. Hence, from each treatment the yield obtained was Diazinon 60%, 1267.55 > Karate 5EC, 1259.15 > Thiodan 35%, 1230.38> Apron star 42WS, 1015.4>Dimetho40%, 916.52 kg/ha^{-1} respectively. The yield obtained during 2021 cropping season from each insecticide treatments was, Thiodan 35%, 1611.41> Karate 5EC, 1586.66> Diazinon 60%, 1479.25>Apron star 42 WS, 1211.37>Dimetho 40%, 1095.75 kg/ha^{-1} respectively. This result was implied that the significant variation among insecticides based on their efficiency to control *Helicoverpa armigera* insect pests. All the insecticides treated were seen good on their insect pest controlled efficiency as compared to untreated plots. This confirmed that, untreated plots gave lower yield 605 and 749 kg/ha^{-1} with in both 2020-2021 cropping seasons respectively.

Across years result showed that from treated insecticides of Karate, 1422.905 > Thiodan 35%, 1420.892 >Diazinon 60%, 1373.4 > Apron star 42 WS, 1113.385 > Dimetho 40%, 1030.475 kg/ha^{-1} of yield would obtained respectively.

As the same trend the combined data result showed that untreated plots gave lower yield, 677kg/ha^{-1}which implies that the treated insecticides were better in their controlling efficiency of insect pests. Finally, the study result showed that the yield loss due to *Helicoverpa armigera* was 47.6% this result was aligned with the finding of. The collected yield data had been subjected to analysis of variance (ANOVA) and the means were separated by Least Significance difference (LSD) at 5% probability level. The statistical result revealed that each year data analyzed were revealed significantly difference at ($p<0.5\%$) level. Whereas, the combined statistical analysis result showed that highly significant difference at ($p<0.1\%$) level. Based on the coefficient of variation (CV) result among insecticides had efficiency variation in control of *Helicoverpa armigera*.

The insecticides Diazinon 60% EC, Karate 5EC and Thiodan 35% sprayed could give highest yield followed by Apron star 42 WS and Dimetho 40% when 2020 cropping season. The least yield was recorded from Dimetho 40% treated plots followed by untreated plots. The yield result revealed that all treated insecticides had been varied based on their Helicoverpa armigera controlled efficiency. Based on their control efficiency sequence Diazinon 60% EC, Karate 5EC and Thiodan 35% would performed well next to Apron star 42 WS and Dimetho 40% at 2020.During 2021 cropping season result revealed that the insecticides Thiodan 35%, Karate 5EC, and Diazinon 60% sprayed could gave higher yield followed by Apron star 42 WS and Dimetho 40% sprayed. The lowest yield was recorded from Dimetho 40%

treated followed by untreated one. Based on their relative performance arrangement Thiodan 35% > Karate 5EC>Diazinon60%>Apron star 42WS>Dimetho40% in 2021 study results. As the same trend the lowest yield was recorded from Dimetho 40% sprayed followed by untreated plots.

The combined data result revealed that insecticides Karate 5EC, Thiodan 35% and Diazinon were gave higher yield followed by Apron star 42 WS and Dimetho 40%.The lowest yield has been recorded form Dimetho 40% sprayed flowed by untreated one. At 2020 Diazinon 60%EC, Karate 5EC* and Thiodan 35%EC gave 52.23%, 51.91%and 50.79% higher yield per ha^{-1} than untreated one . Whereas, in 2021 Thiodan 35%EC*, Karate 5EC*and Diazinon 60%EC gave 53.47%, 52.75% and 49.35% higher yield per ha^{-1} than unsprayed one. Based on their relative efficiency of *Helicoverpa armigera* control from high to low Karate 5EC > Thiodan 35%>Diazinon 60%>Apron star 42 WS> Dimetho 40%.

The lowest efficient insecticide from this study was Dimetho 40%. Hence, this study result revealed that based on the relative efficiency Karate 5EC and Thiodan 35% had been effectively controlled *Helicoverpa armigera* followed by Diazinon 60%EC and Apron star 42WS. Dimetho 40% had lower efficiency based on its capacity to control *Helicoverpa armigera*. The outbreak and population damage of *Helicoverpa armigera* in 2020 at Kokate was higher due to the effects of hot humid and warm temperature. However, low damage and outbreak at Areka because of low temperature and cold weather condition. In 2021 outbreak and damage of *Helicoverpa armigera* at Areka was high and however, at Kokate outbreak and damage was low due to cold weather condition and lower temperature effects.

According to insecticides purchased price and relative efficiency of *Helicoverpa armigera* control, cost benefit (CB) ratio analysis result showed that the highest net benefit was recorded from Karate 5EC and Thiodan 35% followed by Diazinon and Apron star 42 WS. Net benefit recorded from Dimetho 40% was relatively higher than that of untreated one. The lowest net benefit was obtained from untreated one. The BC ratio revealed that among treated insecticides Karate 5EC and Thiodan 35% were gave higher income and feasible to *Helicoverpa armigera* management. Diazinon 60% and Apron star 42 WS were relatively gave higher net benefits followed by Dimetho 40% and Untreated one. This cost benefit ration express that all treated insecticides had been proved to be better than that of untreated plots. Hence, among treated insecticides Karate 5EC and Thiodan 35% insecticides could have high efficiency to control *Helicoverpa armigera* and they were gave feasible net benefit results followed by Diazinon 60%. However, the lowest net benefits were obtained from Apron star 42 WS and Dimetho 40% treated followed by untreated one.

Conclusion

Present investigation confirmed that effective insecticides based on their efficiency Karate 5EC and Thiodan 35%EC revealed promising impacts in control of *Helicoverpa armigera* and gave higher yield followed by Diazinon 60%EC. Even so, this result was obtained with fortnight interval sprayed frequency of twice. Therefore, the right time of spraying is mandatory to effectively control this insect pest. So if, the condition is favorable larvae outbreak embark on first week of crop emergency. The implication for future study on different time period with spraying frequency and the biology of this insect in laboratory will be important to know about the accurate time of insecticide spraying.

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