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Research Article

Evaluation of Karant 5% EC Insecticide against Chickpea pod borer (*Helicoverpa armigera*), (Hubner) (Lepidoptera: Noctuidae) in Southern Ethiopia

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ABSTRACT

Helicoverpa armigera is a major pest of chickpea in Ethiopia. Field experiment was conducted to verify the effectiveness of the Karant 5% EC (Emulsifiable Concentrate) insecticide against African bollworm (*Helicoverpa armigera*), (Hubner) (Lepidoptera: Noctuidae on chickpea were tested at Zala Shasha on trial site and Bossa Qacha on farmers' field in a Randomized Complete Block Design (RCBD) with three replications during 2021. Percentage pod damage, mean larval count per plant, and grain yield were significantly affected by the treatments; two tested insecticides were significantly reduced the percentage pod damage and mean larvae per plant accordingly increased grain yield ha^{-1}. The grain yield was highly affected by pod borer damage. The results revealed that the treatments with high pod borer damage had minimum grain yield (653.05 kg/ha); whereas the treatments with maximum protection (Karant 5% EC) with active ingredient Lambda-cyhalothrin 50 g/l give higher grain yield (1825.49) followed by Megathrin 50% EC (1315.72) relative to the untreated control when its applied three times at seven days interval. Evidence obtained from the verification trial showed that Karant 5% EC at the rate of 500 ml/ha with 300 liters water acted significantly at 5% probability level in reducing number of pod borer larva and percentage of pod damage due to pod borer and consequently increased grain yield of chickpea as compared to the standard check (Megathrin 50% EC) and unsprayed checks in both locations. However, it needs further investigation for the interval and frequency.

Keywords: Chickpea; Verification; *H. armigera*; Insecticides; Efficacy

INTRODUCTION

Ethiopia is highly drought-prone and has an agricultural sector that accounts for 85% of employment. Chickpea can grow on residual moisture which allows farmers to engage in double cropping since chickpea is sown at the end of the rainy season in most of chickpea producing areas of Ethiopia [1]. Chickpea and its residues are a source of protein and can reduce malnutrition. Despite the significant economic and ecological importance, the productivity of chickpea in Ethiopia's far below its potential. In Ethiopia, its average productivity was 2.05 ton ha^{-1} in 2017/18. However, in highly suitable land could generate up to five tons per ha^{-1}. It contributes 15.18% of Ethiopia's total pulse production and is second after faba beans. However, the production of chickpea is challenging because of different insect pests and diseases such as pod borers, cut worms, aphids, jassids, thrips, whitefly and the storage pests (bruchids) which are the most devastating pests of chickpea in Asia, Africa, and Australia. Among these pod borers/ African bollworm *H. armigera* (Hubner) (Lepidoptera: Noctuidae) is a serious obstacle and a global concern for the production of chickpea. This pest is a cosmopolitan, multi-voltine and highly polyphagous, which attacks a number of crops which have agricultural importance throughout the world. Pod borer is a key pest of chickpea causing 90%-95% total damage. It can cause damage up to 100% in unprotected chickpea fields. A single *H. armigera* larva can damage up to 40 pods throughout its larval stage [2]. The chickpea economic threshold is one pod borer larva per one meter row length. Measure to reduce yield losses of chickpea is of great importance in controlling chickpea pod borers.

Wolaita areas have a high potential for chickpea cultivation but its production and productivity have been experienced drastically because of biotic and a biotic stresses. Mainly pod borer is the most important pest because of its polyphagous nature. Currently, growers manage pod borer by applying insecticides several times in the growing season. However, most insecticides become ineffective

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because the pest's larval stage attacks crops from seedling to maturity stage and its nocturnal nature. It is also extremely well adapted to different agro-ecosystems. Thus, there is a need for alternative and effective insecticide through the introduction of a new insecticide or different formulations of the existing insecticides with the same active ingredient that may continue to be introduced by the pesticide companies [3].

In Ethiopia the effective insecticides against chickpea pod borer/ African bollworm includes Highway and Parate, even if resistance is being developed on some of the insecticide used currently. To increase the availability of effective insecticide for the growers, the efficacy of the newly introduce insecticide on chickpea pod borer should be regularly tested and verified before introducing to the farming community. The efficacy of insecticide is highly influenced by environmental factors, insect population load, application time, and rates of insecticide [4]. Therefore, evaluation of the insecticide across the locations is greatly important to get an insight into the effects of the insecticide. Based on the above background, Areka Agricultural Research Center has been designated by the Ministry of Agriculture through Southern Agricultural Research Institute to test the efficacy of the new insecticide, Karant 5% EC, against chickpea pod borer during the 2021 cropping season. Therefore, the objective of the verification trial was to evaluate the efficacy of the insecticide Karant 5% EC (Emulsifiable Concentrate) relative to another promising standard insecticide, Megathrin 50% EC (Lambda-cyhalothrin), for the control of pod borer in chickpea production for registration purpose [5].

METHODOLOGY

Descriptions of the study site

The verification trial was conducted during the 2021 main cropping season in an open environment to convince the objectives of the current verification around wolaita in two locations (Zala Shasha and Bossa Qacha farm) in Southern Ethiopia. The two experimental sites are geographically located at 06°52'55''N and 037°49'15''E (at Zala Shasha) and 06°51'25''N and 037°47'30''E (at Bossa Qacha). The sites are found at an elevation of 2105.94 (at Zalas hasha) and 1944.73 (at Bossa Qacha) meters above sea level. Bimodal rainfall pattern is the major characteristics of the study area, short rainy season (April and May), and the main rainy season (early June to mid-November). Thus, the areas receive average annual rainfall is 1200 mm-1300 mm and mean monthly temperatures varies from 11°C-26°C. The soils are dominantly Vertisols and Netosols with PH values of 5-6 [6].

Treatments, design of experiment and trial management

The trial was conducted in an open environment to assure the insect pest destiny and increase the natural prevalence at the starting of the experiment. The areas are the hot spots for the intended pest. The total width and length of the layout were designed at 33 m × 34 m with a unit plot size of 10 m ×10 m, respectively. Plots were spaced at each other by 1.5 m and blocks separated by a safeguard path of 2.0 m to prevent the drifts or cross-contamination. The experiment was layout in a randomized complete block design with three replications. A total of three treatments, including control, were comprised during the study. The variety Akuri (Kabuli type) recommended to the area was planted. All agronomic and trial management practices (like fertilizer, weeding) were implemented as per the recommendation [7].

Insecticides such as Karant 5% EC (Lambda-cyhalothrin) at the rate of 500 ml/ha with 300 L water (Candidate insecticide), Megathrin 50% EC at the rate of 500 ml/ha with 300 L water (Standard check), and unsprayed check were used. For the candidate insecticide, the use of the rate of insecticide per hectare and amount of water for mixing of insecticide was performed as suggested by the manufacturer. The control plots were sprayed with water only. Each plot was received three sprays of each insecticide treatment to get the maximum protection potential of insecticides [8].

The application was done with the help of Knapsack hand sprayer" with 1-liter capacity bottles. Periodic inspection of the chickpea field was made to notice target insect population. The first application was made when the larval population crossed the economic threshold level (one larva per meter row) at the pod setting stage of the crop. The second and third sprays were applied at a week interval to get maximum protection of the pest [9].

Data collection

Data were collected on the number of larvae of *H. armigera* a day before starting of spray and 3rd and 5th day of a week after each spray for three consecutive weeks at both locations. Larvae were counted from the whole above-ground parts of 10 randomly selected plants in each plot a week after each spray. Thus, mean larvae count per plant presented by the extrapolation of three consecutive weeks. The efficacy of each insecticide was determined by counting the larvae on 10 plants randomly taken from each replication. The pod damage was noted during the harvesting of matured crop [10,11]. Healthy and damaged pods were counted on randomly selected five plants per plot and then percent pod damage was evaluated. Grain yield was collected from whole harvestable plot area (excluding border rows) then extrapolated for 1 ha. The infestation percentage was captured using the formula,

$$\text{Infestation}(\%) = \frac{\text{Total number of damaged pods per plant}}{\text{Total number of pods per plant}} \times 100$$

$$\text{Pod borer larva reduction}(\%) = \frac{\text{Mean of untreated plot-Mean of treated plot}}{\text{Mean of untreated plot}} \times 100$$

Data analysis

The aforementioned parameters for larvae assessment were computed from randomly selected plants within the central rows and the mean values were used for data analysis. Before analysis, the insect data were transformed using square root transformation before analysis [12-15]. All the collected data were subjected to analysis of variance to determine the treatment effects. The treatment means were separated using the Fishers protected Least Significance Difference (LSD) test at 5% probability level. The data analyses were conducted using the general linear model procedure of the SAS software version 9.2.

RESULTS AND DISCUSSION

The data collected on the comparative efficacy of insecticides used against chickpea pod borer larva tested are presented in Tables 1 and 2. The result showed that there was a significant difference among treatments ($P<0.05$) for mean larval count per plant, percentage pod damage and grain yield.

Efficacy of insecticides on *H. armigera* larvae count per plant

No statistically significant ($P>0.05$) difference was observed on the pre-spray count of pod borer larva populations on the three treatments including untreated control in both locations. However, after spray all treatments were significantly different (P<0.05) from each other at both trial sites. That means insecticide treated plots were significantly different from the untreated control even though there was significant difference in effectiveness between candidate and standard check insecticides. After treatment the lowest pod borer larva populations were recorded on Karant 5% EC (Emulsifiable Concentrate) and Megathrin 50% EC (Emulsifiable Concentrate) as compared to the unsprayed after 3 days and 5 days of the application in both locations. However, application of Karant 5% EC (Emulsifiable Concentrate) and Megathrin 50% EC on pod borer larva showed no statistically significant difference in the mean pod borer larva populations at 3 days of the treatment application on both sites even though Karant 5% EC (Emulsifiable Concentrate) has highest larval reduction percentage (76.8, 70.72) when compared with Megathrin 50% EC (42.5, 45.5) but it showed statistically significant difference after 5 days of treatment application in both locations. This indicates that effectiveness of these insecticides varied with time intervals (Table 1) [16].

The long-lasting and durable effect was observed on Karant 5% EC (Emulsifiable Concentrate) as compared to Megathrin 50% EC especially after 5 days of application. Comparatively, Karant 5% EC was found to be effective and showed a long-lasting effect by controlling and minimizing the population of pod borer with larval reduction percentage (90.05, 87.3) when compared with Megathrin 50% EC (Emulsifiable Concentrate) with larval reduction percentage (50.8,49) on both locations. On unsprayed plots, the pod larva populations were progressively increased and consequently resulted in the highest pod larva population during the growing period in both locations (Table 1).

Effect of insecticides on percentage of pod damage

No statistically significant (P>0.05) difference was observed on the percentage of pod damaged on the three treatments including untreated control before spray in both locations. Pod damage percentage by the larvae of H.armigera was significantly decreased in treated plots compared to control even if there is statistically significant (P<0.05) difference among treatments. At both locations (Zala Shasha and Bosa Qacha) the insecticides significantly reduced the percentage pod damage; the minimum percentage pod damage was recorded at Karant 5% EC (9.34%, 8.73%) when compared with Megathrin 50% EC (17.63, 16.43) while the control untreated resulted (42.14%, 40.64 %) pod damage respectively (Table 2).

Effect of insecticides on grain yield

The result showed that all treatments were significantly different (P<0.05) from each other in two locations. At Zala Shasha and Bossa Qacha sites highest grain yields were recorded on plots sprayed with Karant 5% EC with (1825.49 kg/ha, 1365.64 kg/ha)while the lowest grain yields were recorded from the unsprayed control plot (812.84 kg/ha, 653.05 kg/ha) respectively [17].

The grain yield was highly affected by pod borer damage. The results revealed that the treatments with high pod borer damage had minimum grain yield (653.05 kg/ha); whereas the treatments with maximum protection (Karant 5% EC) give higher grain yield (1825.49) followed by Megathrin 50% EC (1315.72) relative to the untreated control (Table 2).

Table 1: Chickpea pod borer population counted at different intervals (before and after spray) of two insecticides at Areka ARC in two locations during 2021 main cropping season.

Treatments	Zala Shasha					Bossa Qacha				
	No. of larva before spray	No. of larva 3 days after spray	Reduction (%)	No. of larva 5 days after spray	Reduction (%)	No. of larva before spray	No. of larva 3 days after spray	Reduction (%)	No. of larva 5 days after spray	Reduction %
Karant 5% EC	18.1	4.2	76.8	1.8	90.05	14.3	5.3	70.72	2.3	87.3
Megathrin 50% EC	16.87	9.7	42.5	8.3	50.8	18.7	9.2	45.5	8.6	49
Unsprayed	17.7	17.3	-	16.4	-	17.4	16.8	-	17.7	-
Mean	17.56	10.07	-	8.4	-	16.8	10.4	-	8.9	-
LSD (5%)	13.43	6.2		5.8		6.7	8.4		5.35	
CV (%)	22.9	17.53		14.3		19.43	25.4		18.62	

Note: CV: Coefficients of Variation (%); LSD: Least Significant Difference at P<0.05 probability level.

Table 2: Percentage of pod damage and yield responses at different intervals (before and after spray) of two insecticides at Areka ARC in two locations during 2021 main cropping season.

Treatments	Zala Shasha			Bossa Qacha		
	% of PD before spray	% of PD after spray	Yield kg/ha	% of PD before spray	% of PD after spray	Yield kg/ha
Karant 5% EC	38.45	9.34	1825.49	29.17	8.73	1365.64
Megathrin 50% EC	35.85	17.63	1315.72	33.18	16.43	1012.7
Unsprayed	36.92	42.14	812.84	30.15	40.64	653.05
Mean	37.07	23.04	1318.02	30.83	21.9	1010.46
LSD (5%)	8.62	6.45	15.32	9.42	6.5	18.67
CV (%)	17.83	13.96	19.2	22.4	15.54	28.63

Note: PD: Pod Damage; CV: Coefficients of Variation (%); LSD: Least Significant Difference at P<0.05 probability level.

CONCLUSION AND RECOMMENDATION

Chickpea production was seriously constrained by chickpea pod borer (*Helicoverpa armigera*) during the growing periods. Evidence obtained from the verification trial showed that Karant 5% EC (Emulsifiable Concentrate) at the rate of 500 ml/ha with 300 liters water acted significantly at 5% probability level in reducing number of pod borer larva and percentage of pod damage due to pod borer and consequently increased grain yield of chickpea as compared to the standard check (Megathrin 50% EC) and unsprayed checks in both locations.

During the growing periods, no foliar toxic effect was observed from the effect of any tested insecticides. Generally, results showed that Karant 5% EC (Emulsifiable Concentrate) at the rate of 500 ml per hectare with 300 L water was highly effective in controlling chickpea pod borer. Hence, Karant 5% EC was found highly effective for the control of chickpea pod borer and therefore it is recommended for registration for the management of chickpea pod borer.

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