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Full-Length Research Article

Efficacy of insecticides against chickpea pod borer (*Helicoverpa armigera*) at Sodo district Gurage Zone, Southern Ethiopia

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ABSTRACT

Pod borer is a major insect pest constraining chickpea production at southern Ethiopia. The experiment was conducted at Sodo district with the objective to evaluate the efficacy of different insecticides for the control of pod borer of chickpea. The experiment was conducted using one chickpea variety; Habru and five insecticides Diaznon (1.2l/ha), Diamethoate (1L/ha), Apron star (600g with 500l of water ha^{-1}), Endosulfan (250g/ha) and Karate (400ml/ha). The result revealed that all insecticides were effective against pod borer with difference on percent larval population reduction. The pod borer damage reduction by insecticides treatment ranged from 35.4% to 68.6 % and 39.5% to 76.7% compared to that in control. Diaznon and karate resulted maximum seed yield 1561.20 kg/ha and 1498.90 kg/ha, in 2017 and 1391.40kg/ha,1421.29 kg/ha in 2019 respectively. The highest larval reduction was obtained from plot treated with insecticide Diaznon followed by insecticide Karate 5% EC 68.6%, 64% during 2017 cropping season respectively and in 2019 cropping season highest larval reduction was obtained from plot treated with insecticide Karate 5% EC 76.7% followed by Diaznon treated plot 67.2%.In both 2017 and 2019 experimental years better yield increment was recorded from Diaznon and Karate 5% EC treated plot. During 2017 cropping season the maximum yield increment was obtained from Diaznon treated plot 27.3% followed by Karate 24.2% and during 2019 cropping season Karate 5% EC treated plot 32.6% followed by Diaznon treated plot 31.2%. Thus chickpea growers in the area should prefer the insecticides Karate 5% EC and Diaznon in mixed up for better pod borer management.

Keywords: Chickpea, Helicoverpa armigera, Insecticides. Pod Borer

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1. INTRODUCTION

Ethiopia is considered as secondary center of genetic diversity for chickpea and the wild relative of cultivated chickpea (*Cicer arietinum* L.). An average chickpea yield in Ethiopia on farmers field is usually below1t/ha although it's potential is more than 5t/ha (Melese, 2005). Chickpea is susceptible to a number of insect pests, which attack on roots, foliage and pods. Among insect pests, chickpea pod borer (Helicoverpa armigera. Hubner) is a major constraint for lower yield of chickpea in Ethiopia by feeding on all stages of the crop from seedling to maturity and generally cause 37- 50 % loss in grain yield (Iqbal *et al*., 2014; Ahmed and Awan, 2013). Chickpea pod borer successfully established as key insect pest of chickpea crop in spite of acid exudates on plant parts which deter insect foraging. It is highly polyphagous insect feeding on many other crops such as cotton, tobacco, safflower, tomato, maize, cabbage, peanuts and pulses (Javed, 2013) Chickpea pod borer(*Helicoverpa armigera* Hubner) (*Lepidoptera:Noctuidae*) is a major field insect pest affecting pulses in several agro-ecological zones. Single larva can damage 40pods and selectively feeds up on growing points and reproductive parts of the host plant. The 1st, 2nd, and 3rd instar larvae initially feed on the foliage (young leaves) of chickpeas and a few other legumes, but mostly on the flowers and flower buds of cotton, pigeon pea, etc. Larvae shift from foliar feeders to developing seeds and fruits as larval instar development progresses (Reed and Pawar, 1982). Larger larvae bore into pods and consume the developing seeds inside the pod. It feeds on floral buds, flowers and young pods of the growing crop (Khan, 2009). Mostly, leaving out all other approaches of insect management insecticides application appears as an easy, popular and effective technique (Akbar *et al*., 2017).

There is a high infestation of pod borer on chickpea, in chickpea growing districts of Gurage Zone (Damtew and Ojiewo, 2017). *H. armigera* control with insecticide on chickpea is not common in Ethiopia; rather the majority of the farmers follow a "do nothing" strategy. Ethiopian agriculture is fast transforming from subsistence to commercial farming system and use of pesticides is expected to increase rapidly as scales of production increase. The indiscriminate use of pesticides to tackle losses caused by *H. armigera* can increase cost of production, affect human health, biodiversity and the environment. Besides, several chemical control methods have been evaluated but the pest keeps developing resistance to synthetic chemicals (Lande and Sarode, 1995). Therefore, judicious use of pesticides following established guidelines and in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment is recommended. However, wise use of effective insecticide is the need of the time to avoid their drastic side effects on environment, humans, animals and natural bio-control agents (Suhail, 2013).So for effective insecticide chemicals for the management of this insect pest(pod borer) is required. So to alleviate such limitation the activity was initiated with the following objective:

- ✓ To evaluate the efficacy of insecticides against chickpea pod borer (*Helicoverpa armigera* Hubner) under field condition.

2. MATERIALS AND METHODS

2.1 Description of Study Area

The experiment was done at Sodo district during 2017-2019 crop seasons. The location is suitable for appearance of pod borer every year under natural conditions. The experiment was conducted at Sodo located $8^0$19’N latitude and $38^0$39’E longitude and lies at altitude of 1947 meter above sea level. According to meteorological data the average annual rainfall 1050mm ranging between 800mm and 1200mm with average minimum and maximum temperature of 13^0C and 30^0C. Sodo is characterized by verity- soil type.

Field/Plot Details: With a view to evaluate the efficacy of insecticides against pod borer infestation on chickpea, an experiment was carried out at Sodo district. The chickpea variety Habru was used as per standard agronomic practices during 2017-2019. The plot size was 1.8m × 2m (3.6m^2), keeping the spacing of 30×10 cm between rows and plants, respectively.

2.2 Treatments and Experimental Design

The experiment was conducted using one chickpea varieties; Habru. Five insecticide Diaznon (1.2l/ha with 100L of water ha^{-1}), Diamethoate (1L/ha with 150L of water ha^{-1}), Apron star (600g with 500ml of water ha^{-1}), Endosulfan (250g/ha with 1000ml of water ha^{-1}) and Karate (400ml/ha with 150-200L of water) were used in the experiment. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. There were six treatments including control. All the treatments were administered in field as foliar spray applied manually with knapsack sprayer. Insect ides were sprayed at their recommended doses. A distance of 100 cm between the plots and 150 cm between the replications was maintained as buffer zone.

2.3 Data Collection

Observations were started after 30 days of sowing in one meter length from each plot during vegetative stage so to determine the economic threshold level (one larva per meter per row) of chickpea pod borers for timely application of chemicals. Five plants were selected at random from each treatment and the population of gram pod borer was observed to record number of larvae plant $^{-1}$ of chickpea. The sprays of particular treatment were applied when larval population was above the ETL to protect the crop from further heavy losses. Post treatment data on percentage mortality of caterpillars of pod borers was taken after 7 days, for a comparison with pretreatment observation (24 hours before spray). The data of five sprays were pooled and average percent mortality was calculated. The mean percent reduction of pod borer's population with respect to pre-treatment data was calculated by formula given by Abbott *et al*. (1925). The reduction percentage of larvae was recorded by counting of larval population over check.

$$\% \text{ LR} = \frac{Total\ number\ of\ larval\ population - Number\ of\ larval\ population\ after\ spray}{Total\ number\ of\ larval\ population} \times 100$$

$$\text{P YIC} = \frac{Larval\ population\ of\ sprayed - Larval\ population\ of unsprayed}{Larval\ population\ of\ sprayed} \times 100$$

Where: - % LR = Percentage of Larval Reduction

PYIC = Percentage of Yield Increase over Check

Pod Damage in percent (%)

On maturity of crop, the percent pod damage was determined by counting total number of pod and number of damaged pods from randomly selected five plants out of each treatment, using following formula: Percent pod damage was measured as:

$$\% \text{ Pod damage} = \frac{Total\ number\ of\ pods\ produced\ per\ plant - Number\ \ of\ undamaged\ pods}{Total\ number\ of\ pods\ produced} \times 100$$

Percentage yield loss were calculated with the following formula

$$\% \text{ RYL} = \frac{Yield\ of\ maximum\ protected\ - Yield\ of\ other\ treatment}{Yield\ of\ maximum\ protected} \times 100$$

Where % RYL- percentage Relative of yield loss;

$$\% \text{ YI} = \frac{Grain\ yield\ of\ treated\ plot - yield\ of\ control\ plot}{Yield\ of\ control\ plot} \times 100$$

Where % YI = percentage of yield increment

Grain Yield

The yield of grains per plot was recorded at harvesting including control and was converted into Kg/ha. Data on larval population of Helicoverpa armigera caterpillars, pod damage and yield corresponding to each treatment was subjected to statistical analysis.

2.4 Statistical Analysis

The data collected during experimentation was subjected to analyzed statistically by using analysis of variance (ANOVA) and means were separated by least significance difference (LSD) test at 5% probability level using computer software SAS version 2.0

3. RESULT AND DISCUSSION

Data collected on the comparative efficacy of five insecticides tested for the management of pod borer on Chickpea was presented in tables.

Larval Population

Five plants were randomly selected from each plot. The result revealed that insecticides were effective against pod borer even if they have different percent larval reductions at both years .In 2017 the data summarized in table1 revealed that the pest population of Helicoverpa armigera ranged from 2.83 to 3.53larvae per plant before spray and 1.10 to 3.50 after spray during the season. It indicated that the pest was active during December. This period coincided with the flowering and pod formation stage of the crop. The pod borer damage reduction by different treatments ranged from 35.4% to 68.6 % compared to that in control. The highest pod borer larval reduction 68.6 % was found in Diaznon sprayed plot followed by Karate5% EC 64 % sprayed plot. The efficacy of these insecticides were supported with the result of Suneel Kumar and Sarada (2015) who recorded the lowest number of *Helicoverpa armigera* larva in plots treated with chlorantraniliprole 20% SC against unsprayed control plot.

In 2019 the result revealed that Karate was effective against pod borer. The data summarized in Table 1 revealed that the pest population of Helicoverpa armigera ranged from 1.73 to1.90 larvae per plant before spray and 0.60 to 2.58 after spray during the season. The pod borer damage reduction by different treatments ranged from 39.5 % to 76.7 % compared to that in control. The highest pod borer larval reduction 76.7% was found on Karate5% EC sprayed plot followed by

Diaznon 67 % sprayed plot. The present study was in agreement with finding by Dagne *et al*. (2018) who reported that the highest pod borer larval reduction (90.63%) was found on Diaznon sprayed plot followed by Karate 5% EC (71.87%) treated plot.

Table 1: Average Larval Populations of Pod borer (*Helicoverpa armigera*) on Chickpea before and after spray of Insecticides at Sodo district Southern Ethiopia during 2017 Cropping Season.

Insecticides	**Mean larval population/Plant**		**Reduction % over check**
	Before spray	**After spray**	
Control	2.83	3.50	_
Apron star	2.93	2.26	35.4
Endosulfan	3.50	1.35	61.4
Karate	3.46	1.26	64.0
Diaznon	3.53	1.10	68.6
Diamethoate	3.36	1.67	52.3

Similar findings were reported by Chowdary *et al*. (2010), chlorantraniliprole was highly effective against *Helicoverpa armigera in okra.* The insecticide Apron star showed the least effective against chickpea pod borer which was in consistent with the work of Khanna *et al.* (2009) and Singh *et al.* (2014) reported that NSKE 5% was the least effective against the pod borer of chickpea among the different insecticidal treatments during both experimental both years.

Table 2 :Average Larval Populations of Pod borer (*Helicoverpa armigera*) on Chickpea before and after spray of Insecticides at Sodo district, Southern Ethiopia 2019 Cropping Season.

Insecticides	**Mean larval population/Plant**		**Reduction % over check**
	Before spray	**After spray**	
Control	1.81	2.58	-
Apron star	1.90	1.56	39.5
Endosulfan	1.73	0.98	62.0
Karate	1.90	0.60	76.7
Diaznon	1.82	0.85	67.0
Diamethoate	1.73	0.90	65.2

Yield of chickpea

The data of seed yields (kg/ha) and increased percent over check is presented in Table 2. From the result obtained at Sodo, Diaznon resulted maximum seed yield 1561.20 kg/ha, followed by

Karate 5% EC1498.90 kg/ha, and where as the minimum seed yield 1135.58 kg/ha on unsprayed plot. Maximum percent of seed yield 27.3 % was increased over check by Diaznon. The second maximum percent of seed yield 24.2% was increased over check by Katare5% EC. The present finding is in agreement with work of Sreekanth *et al*. (2014) who reported the lowest pod damage and highest seed yield was obtained from plots treated with chlorantraniliprole.

Table 3: The grain yield of chickpea at Sodo 2017/18 cropping season.

Treatment	**GY(kg/ha)**	**Percent yield increase over check**
Control	1135.58	-
Karate	1498.90	+24.2
Apron Star	1137.90	+0.2
Endosulfan	1466.70	+22.6
Diaznon	1561.20	+27.3
Diamethoate	1459.00	+22.2

GY, Grain Yield; kg, kilogram; ha, hectare; +, increment

In 2019 Karate 5%EC resulted maximum seed yield 1421kg/ha, followed by Diaznon 1391.40 kg/ha, and where as the minimum seed yield 957 67 kg/ha on unsprayed plot. Maximum percent of seed yield 32.6% was increased over check by Karate 5%EC. The second maximum percent of seed yield 31.2% was increased over check by Diaznon. Similarly Adsure and Mohite (2015) reported that Rynaxypyr treated plots had maximum yield and minimum pod damage by pod borer in comparison to indoxacarb and spinosad.

Table 4. The grain yield of chickpea at Sodo 2019/20 cropping season.

Treatment	GY (kg/ha)	Percent yield increased over check
Control	957.67	-
Karate	1421.29	+32.6
Apron Star	1134.60	+15.6
Endosulfan	1333.40	+28.2
Diaznon	1391.40	+31.2
Diamethoate	1389.00	+31.0

GY, Grain Yield; kg, kilogram; ha, hectare; +, increment

Economic analysis of insecticidal treatment

In 2017 the result showed that Diaznon sprayed plot provided the highest gross returns (ETB 62,440/ha) and the low gross return (ETB 45,400/ha) was computed from untreated plot (Table

5). The plot sprayed with Diaznon gave the maximum net return ETB 61,890 /ha and the unsprayed plot gave the low net returns birr 45,400/ha (Table 5).

Table 5:- Return and economic analysis of Treatment for the Control of Pod borer in Chickpea during 2017/18 Cropping Season at Sodo districts

Treatment	Yield obtained (kg/ha)	Sale price (ETB/kg)	Fc & Ac (ETB/ha)	Gross Return (Price x kg)	Net Return ((GR-(Fc + Ac))
Control	1135.58	40	-	45,400	45,400
Karate	1498.90	40	840	59,920	59,080
Apron star	1137.90	40	300	45,480	45,180
Endosulfan	1466.70	40	600	58, 640	58,040
Diaznon	1561.20	40	550	62, 440	61,890
Diamethoate	1459.00	40	600	58, 360	57,760

Fc, Fungicide Cost; Ac, Application Cost; GR, Gross Return; kg, kilogram ETB, Ethiopian Birr

In 2019 Karate 5EC sprayed plot provided the highest gross returns (ETB 63,958/ha) and the lowest gross return ETB 43,095/ha was computed from untreated. The plots sprayed with karate 5EC gave the maximum net return ETB 63,005/ha. The unsprayed plot gave comparably low net returns ETB 43,095/ha (Table 6)

Table 6: Return and of economic analysis Treatment for the Control of Pod borer in Chickpea during 2019/20 Cropping Season at Sodo districts.

Treatment	Yield obtained (kg/ha)	Sale price (ETB/kg)	Fc & Ac (ETB/ha)	Gross Return (Price x kg)	Net Return ((GR-(Fc +Ac))
Control	957.67	45	-	43,095	43,095
Karate	1421.29	45	940	63,958	63,005
Apron star	1134.60	45	700	51,056	50,330
Endosulfan	1333.40	45	750	60,003	59,253
Diaznon	1391.40	45	650	62613	61,963
Diamethoate	1389.00	45	700	62505	61,805

Fc = Fungicide Cost Ac = Application Cost GR= Gross Return kg= kilogram ETB = Ethiopian Birr

4. CONCLUSIONS AND RECOMMENDATIONS

The result revealed that Diaznon and Karate5% EC were the most effective insecticides to give high mortality of pod borer on chickpea under field conditions. The most economical benefit for pod borer management was obtained from Diaznon sprayed plot and followed by karate sprayed plots. It has been indicated from the present studies that insecticide Diaznon and karate were remained the most effective against pod borer on chickpea and resulted in the maximum reduction percentage of larval population of pod borer on chickpea even if they have slight difference on efficacy at both years. Farmers should have used both insecticides for the management of pod borer in chickpea. They can be used one insecticide in the absence of the other as an option/alternatives to increase their productivity and also quality. Therefore, we suggested/recommended that these effective insecticides (Karate %EC and Diaznon) in mixed up at recommended rate were suggested to the growers for management of the pod borer population below economic threshold level under field conditions and to inhibit the resistance development of the pest.

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Conflict of the interest

The authors declare that there is no conflict of interest

ANOVA Table

Table 1: The effect of insecticides on yield, yield Components and larval population of chick pea during 2017 main cropping season at Sodo district, Southern Ethiopia

Treatment	PH	NPP	HSW	Y/ha(kg)	LBA	LAA
Control	44.96bc	39.93c	29.98	1135.6b	2.13b	3.50a
Karate	49.53ab	45.80ab	29.55	1498.9a	3.46a	1.35b
Apron star	46.87abc	42.46bc	28.19	1137.9b	2.93ab	1.66b
Endosulfan	48.26ab	43.93bc	28.15	1466.7a	3.50a	1.26b
Diazinon	49.93a	50.46a	30.06	1561.2a	2.73ab	0.80b
Diamethoate	43.20c	43.13bc	29.04	1459.0a	3.36ab	1.66b
Mean	47.12	44.28	29.16	1376.5	3.02	1.70
CV (%)	5.48	6.45	3.44	6.46	24.04	34.30
LSD %	4.6949*	5.20*	Ns	161.67*	Ns	1.06*

*PH= Plant Height PPP= Pod per plant SPP= Seed per plant HSW= Hundred seed weight Y/kg= Yield per hectare LBA= Larva before application LAA= Larva after application CV= Coefficient of Variation LSD = Least Significance Difference Ns = Non significant * = shows significant*

Table 2: The effect of insecticides on yield, yield Components and larval population of chick pea during 2019 main cropping season at Sodo district, Southern Ethiopia

Treatment	PH	NPP	SPP	HSW	Y/ha(kg)	LBA	LAA	DPs
Control	43.20	31.400c	34.00d	29.46	957.80c	1.26	3.75a	4.08a
Karate	44.80	49.200a	52.80a	30.96	1421.29a	2.10	0.86b	0.74c
Apron star	44.93	36.267c	39.75bc	29.13	1134.60b	1.66	1.66b	1.99b
Endosulfan	44.40	37.533bc	38.83cd	30.24	1333.40a	1.73	1.45b	1.66bc
Diaznon	40.80	43.667ab	45.26b	29.87	1391.40a	2.20	1.60b	1.46bc
Diamethoate	40.20	35.867c	41.00bc	29.31	1389.00a	1.73	1.40b	1.60bc
Mean	43.05	38.98	41.9	29.83	1256.80	1.77	1.78	2.05
CV (%)	6.35	10.41	7.41	2.56	6.51	31.75	43.99	33.19
LSD %	ns	7.38*	5.65*	Ns	149.55*	Ns	1.43*	1.24*

*PH= Plant Height PPP= Pod per plant SPP= Seed per plant HSW= Hundred seed weight Y/kg= Yield per hectare LBA= Larva before application LAA= Larva after application DPs= Damaged pods CV= Coefficient of Variation LSD = Least Significance Difference Ns = Non significant * = shows significant*

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