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Research Article

Integration of Insecticides and Varieties on Management of Pod Borer (Helicoverpa Armigera) and Productivity of Chickpea (*Cicer Arietinum* L.) in Adola, Southern Oromia

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Abstract

Chickpea (Cicer Arietinum L.) is the world's second most important grain legumes after common bean (Phaseolus Vulgaris L.) among food legumes grown for production worldwide. Field experiment to evaluate and select the efficacy of insecticides for effective foliar spray against the pod borer in chickpea crop under field conditions. The experiment was conducted using two chickpea varieties; Dalota and Habru with six insecticides (Helerat 5% E.C at 400ml/ha, Profit 72% E.C at 500ml/ha, Perfecto 175 SC at 150-400 ml/ha, Con-fidence 35% at 250ml/ha, Lipron 50 SC at 600 ml/ha and Highway 50 EC at 250ml/ha). The result revealed that Helerat was the most effective against pod borer on percent larval reductions. Helerate, Profit and Highway are more effective and reduced H. armigera larvae population by 56.67%, 51% and 45.62% on Habru variety respectively. Helerat resulted maximum seed yield 2349kg/ha and 2049 kg/ha for Dalota and Habru, respectively. The plot sprayed with Helerat gave the maximum net return birr 75102/ha and 78,525/ha for Dalota and Habru, respectively. Therefore, production of chickpea with the application of Helerate was most profit for economical production compared to other insecticides and recommended for the study area.

Keywords: Chickpea; Pod Borer; *Helicoverpa armigera*; Insecticide; Net return

Introduction

Chickpea (Cicer Arietinum L.) is a legume crop of the Fabaceae family originated in present day South Eastern Turkey and adjoining Syria (Sexena and Singh, 1987). It is the second most important food legume in the world after common bean. The major chickpea-producing countries are India (67.41%), Australia (6.21%), Pakistan (5.73%), Turkey (3.86%), and Myanmar (3.74%) [6]. Ethiopia is considered as secondary center of genetic diversity for chickpea and the wild relative of cultivated chickpea (C. arietinum L.), is found in Tigray region (Yadeta and Geletu, 2002) [3]. In Ethiopia the area coverage and the volume of production of chickpea in 2018/2019 are 242703.73 ha and 4994255.5 quintal with average productivity of 2.05 ton/ha. It contributes 15.18% of Ethiopia's total pulse production and is second after faba beans (CSA, 2018/2019). It has the ability to grow on residual moisture which gives farmers the opportunity to engage in double cropping, since chickpea is sown at the end of rainy season.

Chickpea (*Cicerarietinum*L.) is the second most important cool season food legume crop after common bean (*Phaseolus vulgaris* L.) followed by field pea (*Pisumsativum*) and third in production among the food legumes grown worldwide (Diapari et al., 2014; Benzohra et al., 2014). The average chickpea yield in Ethiopia on farmers' field is usually below 20 q/ha although it's potential yield is more than 50 q/ha (Ejeta and Hussein, 2015; Melese, 2005; Zewdie, 2018b). A number of biotic and abiotic factors are responsible for high yield gaps. This resulted from susceptibility of chickpea landraces to frost, drought, water-logging, poor cultural practices and low or no protection against weeds, diseases and insect pests [7]. Although more than 70 pathogens have been reported on chickpea from different parts of world.

However, the production of chickpea is challenging because of different insect pests and diseases such as pod borers, cut

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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 gram pod borers *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 [2]. Gram Pod borer, *Helicoverpa armigera* (Hubner) is one of the major insect pests of chickpea and has resulted in substantial yield loss (37-50%) and in severe cases up to 90% pod damage [1]. Single larva can damage 40 pods and selectively feeds upon growing points and reproductive parts of the growing crop [8]. The wider host range, multiple generations, migratory behaviour, resistance against many conventional insecticides and high fecundity makes gram pod borer difficult to manage. These losses can be reduced by the application of newer insecticides with different chemistry [4,13]. Fitt (1989) recorded the crops of maize, sorghum, cotton, common bean, peas, chickpeas, tomatoes, capsicum, vicia and to a lesser extent, okras, cabbages, lettuces, strawberries, tobacco, sunflowers, and many of the other legumes as host plants of the pest. It can cause damage up to 100% in unprotected chickpea fields [1,14]. The chickpea economic threshold is one pod borer larva per one meter row length (Zahid et al., 2008).

Different management options have been practiced against pod borer in different areas and years. Cultural practices such as inter cropping, deep ploughing, trap crops and sowing date have been reported to reduce the survival and damage of *H. armigera* (Romeis et al., 2004). Extracts from different parts of neem tree (neem leaf, neem oil and neem seed kernel 5%) influenced negatively both the survival and feeding of the larva of *H. armigera* (Mesfin et al., 2012). Insecticides monocrotophos 36 WC, endosulfan 35 EC, carbaryl WP, cypermethrin 25 EC, indoxacarb 14.5 SC, Profenofos 50 EC and coragen 20 SP showed the highest mortality of *H. armigera* larvae on chickpea [7]. Mesfin et al. (2012) reported synthetic insecticides have resulted in fast and effective pest control.

Keeping in view the severe attack of gram pod borer, the objective of the present study was aimed to evaluate and select the efficacy of insecticides for effective foliar spray against the pod borer in chickpea crop under field conditions.

Materials and Methods

Description of the Study Area

The experiment was conducted at Adola sub-site of Bore Agricultural Research Center (BOARC), Guji Zone, Oromia Regional State in southern Ethiopia under rain-fed conditions during the cropping season (September-December). The site (55°36’31”N, 38°58’91”E, 1721 M) is located in Adola town in Dufa ‘Kebele’ just on the West side of the main road to Negelle town. It is located at about 463 km south from Addis Ababa, the capital city of the country.

The climatic condition of the area is a humid moisture condition, with a relatively shorter growing season. The area receives annual rainfall of 1084 mm with a bimodal pattern extending from April to November. The mean annual minimum and maximum temperature is 15.93°C and 9.89°C, respectively.

The type of the soil is red basaltic soil (*Nitisols*) and *Orthic Aerosols*. The soil is clay in texture and moderately acidic with pH of around 5.88.

Experimental Materials, Treatments and Experimental Design

Two chickpea varieties, namely: Dalota (desi type) and Habru (Kabuli type were used. 150 Blended NPS kg ha^{-1} (19% N, 38% P2O5, 7% S) was used as sources of N, P and S, respectively, for the study. The treatments were factorial combinations of six insecticide (Helerat 5% E.C at 400ml/ha, Profit 72% E.C at 500ml/ha, Perfecto 175 S.C at 150-400 ml/ha, Con-fidence 35% at 250ml/ha, Lipron 50 SC at 600 ml/ha and Highway 50 EC at 250 ml/ha) with and without spray and two Chickpea varieties (Dalota and Habru) under RCBD and replicated three times per treatment. The gross plot size was 3.0m×2.4m=7.2m^2. The spacing between blocks and plots was 1.5m and 0.1m, respectively. Each plot had 6 rows spaced 40 cm apart. The field was ploughed using oxen and harrowed manually to bring the soil to fine tilth. Normal agronomic practices were adopted for all treatments. Application of insecticide was started at the appearance of insect at their recommended doses. Two sprays of each insecticide were made during flowering and podding stage. Data were recorded four times for each treatment before and after application of insecticides.

Data Collection

Number of pod borer, damaged pods and total pods per plant were collected from eight randomly selected and tagged plants in each treatment. The yields were taken from the harvested net plot area excluding the borders. The infestation percentage and larval reduction was captured using the formula,

Infestation percentage = $\underline{Total\ number\ of damagedpods\ per\ plant}$ x100

$Total\ number\ of pods$ per $plant$

% Larval Reduction= Larval population on untreated plot-Larval population on Larval population on treated plot X100

Larval population on treated plot

% Yield increased over check = *<u>Larval population on treated plot- Larval population on Larval population on untreated plot</u> x100*

Larval population on treated plot

Results and Discussions

Larval Population and Infestation

Eight plants were randomly selected from each plots and observation were recorded at 7 days intervals. The result revealed that insecticides were effective against pod borer even if they have different percent larval reduction. The data summarized in table 1 below revealed that all the treatments were significantly superior to control. The lowest number of pod borer per plant (0.6, 1.0, and 1.03) was recorded on chickpea treated with Helerate, Profit and Perfecto at all crop growth stage. They reduced larval population by 69.74%, 49.09% and 43.5%, on Dalota variety. However, Helerate, Profit and Highway are more effective and reduced H. armigera larvae population by 56.67%, 51% and 45.62% on Habru variety respectively. In agreement with this result, Zereabruk *et al.*, (2019) reported that application of profit insecticide has reduced larval population by 54.76% in Laelay-mychew district, Tigray region. The present results revealed with findings by Dagne et al. (2018) who reported that the highest pod borer larval reduction (90.63%) was found

Table 1: Treatments Description.

Trade name	Common name	Chemical name	Dose (ml ha^{-1})
Con-fidence 350 EC	Imedachloprid	1-(6chloro-3-pyridylmethyl)-N-nitroimidazolidin-2-ylideamine	400
Helerat 5% EC			400
Highway 50 EC	Lamda-cyhalothrin	Alpha-cyno-3-phenox ybenzyl	100
Lipron 50 SC			350-600
Per-fecto	imedachloprid+lambda-cyhalothrin		150-400
Profit	Profenofos	0-4 bromo-2-chlorophenyl 0-ethyl 5-propyl phosphorothioate	500

Table 2: Field efficacy of different insecticides on chickpea pod borer larva after spray.

Treatments (Var + Insecticide)	Pre-treatment population of pod borer per plant	Percent reduction in larval population over check			
		Mean No pod borer 4DAS	Reduction (%)	No of pod borer 9DAS	Reduction (%)
Dalota unsprayed	4.33^{b}	4.92	-	5.50^{a}	-
Dalota X Con-fidence	2.6^{c}	2.04	21.54	1.50^{b}	42.31
Dalota X Helerate	0.77^{ef}	0.46	40.26	0.23^{d}	69.74
Dalota X Highway	1.77^{de}	1.08	38.98	1.00^{bc}	43.50
Dalota X Lipron	1.27^{ef}	1.00	21.26	1.10^{d}	13.39
Dalota X Per-fecto	1.03^{f}	0.85	17.48	0.903^{d}	12.33
Dalota X Profit	1.10^{ef}	0.71	35.45	0.67^{cd}	49.09
Habru unsprayed	5.03^{a}	5.60	-	5.50^{a}	-
Habru X Con-fidence	2.00^{cd}	1.85	7.50	1.40^{b}	30.00
Habru X Helerate	0.60^{def}	0.34	43.33	0.26^{bcd}	56.67
Habru X Highway	2.33^{def}	2.10	9.87	1.26^{cd}	45.62
Habru X Lipron	2.80^{de}	2.56	8.57	1.77^{bcd}	36.89
Habru X Per-fecto	2.33^{def}	1.97	15.45	1.43^{cd}	38.63
Habru X Profit	1.00^{f}	0.84	36.00	0.49^{d}	51.00
LSD (0.05)	24.3				
CV (%)	1.64				

Table 3: Field efficacy of insecticides on chickpea yield and yield components.

Treatments (Var + Insecticide)	Total no pod per plant	pod Infestation (%)	Shriveled and discolored seed (g)	Grain Yield (kg ha^{-1})	Yield increased over check
Dalota unsprayed	20.46^{e}	57	43.53^{ab}	1027^{c}	
Dalota X Con-fidence	47.37^{a-d}	36	27.33^{abc}	2081^{ab}	50.65
Dalota X Helerate	61.58^{cde}	11.3	26.23^{abc}	2349^{a}	56.28
Dalota X Highway	39.89^{a-e}	12.7	47.7^{ab}	1835^{abc}	44.03
Dalota X Lipron	39.89^{b-e}	12.7	47.97^{a}	1704^{abc}	39.73
Dalota X Per-fecto	37.83^{a-e}	12.7	39.23^{abc}	1820^{abc}	43.57
Dalota X Profit	35.97^{b-e}	13.3	26.50^{abc}	2028^{ab}	49.36
Habru unsprayed	29.79^{de}	57.0	57.33^{abc}	997^{c}	-
Habru X Con-fidence	41.57^{a-d}	23.3	30.93^{abc}	1667^{abc}	40.19
Habru X Helerate	58.00^{a}	14.0^{cd}	27.23^{abc}	2049^{a}	51.34
Habru X Highway	30.58^{cde}	11.3	20.03^{abc}	1639^{abc}	39.17
Habru X Lipron	40.63^{a-e}	16.7	32.47^{abc}	1509^{bc}	33.93
Habru X Per-fecto	51.40^{abc}	14.2	28.43^{abc}	2026^{ab}	50.69
Habru X Profit	55.40^{ab}	14.3	33.17^{abc}	1577^{bc}	36.77
LSD (0.05)	26.3		25.6	750.26	
CV (%)	21.03		27.81	27.1	

in Diazenon sprayed plot followed by Karate 5% EC (71.87%) sprayed plot. Similarly, Khan et al. (2009) conducted a trial against gram pod borer and to assess comparative efficacy of insecticides (thiodan 40EC, lorsban 40EC, ripcord 10EC, nurell-D (chlorpyrifos + cypermethrin 50+500g/L EC) and methomyl 45 WP). Methomyl was found most effective against the tested pest under field conditions.

Efficacy of Insecticides on Chickpea Yield and Yield Components

The data presented in Table-3 reveals that all the treatments yielded significantly higher over control. Helerate 5% E.C at 400 ml/ha recorded significantly highest seed yield of 2349 kg/ha and 2049 kg/ha on Dalota and Habru respectively and was found statistically at par with Con-fidence; Highway, and Per-fecto (1667, 2026 and 1639 kg/ha yield, respectively). The minimum seed yield 997kg/ha on unsprayed plot of Dalota. Maximum percent of seed yield (56.28%) was increased over check by Helerate on Dalota. The second maximum percent of seed yield (51.34%) was increased over check by Helerate on Habru. In agreement with this result, Dagne et al. (2018) who reported that the highest seed yield 2610 kg/ha, and Maximum percent of seed yield (68.58%) over check were found in Diazenon sprayed plot at ginnir.

The current study also showed that all insecticides were effective to reduce the number of damaged pods per plant com-

Table 4: Return and Benefit Cost Ratio of Treatment for the Control of Pod borer in Chickpea.

Treatments (Var + Insecticide)	Yield obtained kg/ha)	Total variable cost	Sale price (ETB/qt	Gross Return (price x kg)	Net Return (GR-TVC)	Cost Benefit Ration (NR/TC)
Dalota unsprayed	1027	12460	3800	39026	26566	2.13
Dalota X Con-fidence	2081	14225	3800	79078	64853	4.56
Dalota X Helerate	2349	14160	3800	89262	75102	5.30
Dalota X Highway	1835	14330	3800	69730	55400	3.87
Dalota X Lipron	1704	14070	3800	64752	50682	3.60
Dalota X Per-fecto	1820	14240	3800	69160	54920	3.86
Dalota X Profit	2028	13960	3800	77064	63104	4.52
Habru unsprayed	997	12460	4500	44865	32405	2. 60
Habru X Con-fidence	1667	13745	4500	75015	61270	4.46
Habru X Helerate	2049	13680	4500	92205	78525	5.74
Habru X Highway	1639	13850	4500	73755	59905	4.33
Habru X Lipron	1509	13590	4500	67905	54315	4.00
Habru X Per-fecto	2026	13760	4500	91170	77410	5.63
Habru X Profit	1577	13480	4500	70965	57485	4.26

pared to the untreated check. The highest number of effective pods per plant, lower damaged pods and infestation percentage were recorded on insecticide applied with Helerate. Thus, application of Heleate gives the highest effective pods per plant (61.58), lower infestation percentage (11.3%) and minimum amount of Shriveled and discolored seed (26.23g) with the highest seed yield (2349 kg/ha). Savita and Pandurang (2014) reported that the lowest number of surviving population of larvae 0.70 larvae/plant, highest yield recorded 15.00 q/ha, lower pod damage 8.10% were recorded on chickpea treated with rynaxypyr 20 SC at 40 g/ha.

Return and Benefit Cost Ratio

For dalota variety the result showed that Helerate sprayed plot provided the highest gross returns (ETB89262/ha) and the lowest gross return TB39026/ha was computed from untreated check. The plot sprayed with Helerate gave the maximum net return ETB 75102/ha and gave the highest benefit cost ratio of (5.3). The unsprayed plot gave the minimum net returns birr 26566/ha and gave the lowest benefit cost ratio (2.31).

In other way, Helerate sprayed plot with Habru variety provided the highest gross returns (92205/ha) and the lowest gross return ETB 44865/ha was computed from untreated check. The plots prayed with Helerate gave the maximum net return ETB 78525/ha and also gave the highest benefit cost ratio (5.74). The unsprayed plot gave the minimum net returns ETB 324055/ha and gave the lowest benefit cost ratio (2.60).

Therefore, production of chickpea with the application of Helerate was most profit for economical production compared to other insecticides.

Conclusions and Recommendation

The result revealed that Helerat was the most effective insecticide to give high mortality of pod borer on chickpea under field conditions. The most economic benefit for pod borer management was also obtained from Helerat sprayed plot and followed by Per-fecto sprayed plots. It has been indicated from the present studies revealed that insecticide Helerate was most effective and economic for controlling gram pod borer on chickpea and resulted in the maximum reduction percentage of larval population of pod borer.

Therefore, it is recommended that this effective insecticide were suggested to the growers/farmers or other stake holders for management of the pod borer population below economic threshold level under field conditions.

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