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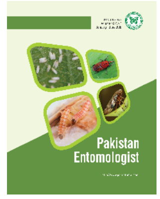

VALIDATION OF SOME NEW CHEMISTRY AND CONVENTIONAL INSECTICIDES AGAINST GRAM POD BORER (*HELICOVERPA ARMIGERA*) IN CHICKPEA

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ABSTRACT

Chickpea (*Cicer arietinum* L.) being a leguminous crop is a rich source of protein for human being and animal. Gram pod borer (*Helicoverpa armigera*) causes more than 75 % of the yield losses in case of severe attack and ranks as a major pest of the crop. Insecticidal control is the mostly adopted technique to manage this insect worldwide. Keeping in view, a comparative study was carried out using Radiant® 120 SC (spinetoram), Belt® 480 SC (flubendamide), Runner® 240 SC (methoxyfenozide), Emamectin® 1.9 EC (emamectin benzoate) and Kosher® 50 EC (lufenuron) at their recommended doses against gram pod borer in chickpea field. Two foliar sprays were made at twenty days interval. Post treatment observations were made after 1, 3 and 7 days. The results revealed that all the insecticides caused significant reduction of the larval population and ultimately increased the grain yield in comparison with control. After seven days of application, Radiant gave highest mortality of 85.71% followed by Belt (79.99%), Emamectin (74.99%) and Kosher (62.49%) whereas Runner was least effective with mortality of 50%. Maximum yield was also obtained in plots treated with Radiant with grain yield of 1533.34 kg/ha followed by Belt (1386.66 kg ha^{-1}) compared to control (593.34 kg ha^{-1}).

Keywords: Chickpea, Efficacy, Gram pod borers, Insecticides

INTRODUCTION

Chickpea (*Cicer arietinum* L.) provides highest protein (>20%) contents as an alternative to meat for poor people (Hefnawy *et al*., 2012). Along with vegetable protein, it is also a source of carbohydrate, cholesterol lowering fiber, oil, ash, calcium and phosphorus (Patil *et al.,* 2017). Chronological data regarding chickpea production shows an irregular trend due to abiotic factors like weather conditions, intensity of rains and different biotic factors such as diseases and insect pests (MINFAL, 2016). Among insect pests, chickpea pod borer (*Helicoverpa armigera.* Hubner) is a major constraint for lower yield of chickpea in Pakistan 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 and Ahmed & Awan, 2013). Along with the other factors cloudy weather multiply the yield losses up to many folds *viz.* 75-100 % (Shah *et al*., 2003; Dinesh, *et al*., 2017). Parallel generations due to high fecundity besides migratory potential along with wide host range of crop plants (Ahmad *et al*., 2004), facultative diapause and phenomenon of resistance development against insecticides empowered *H. armigera* to sustain its status of most threatening and cosmopolitan pest of agriculture (Wakil *et al.*, 2012). Chick pea pod borer successfully established as key insect pest of chickpea crop inspite of acid exudates on plant parts which deter insect foraging. Chickpea crop is the first victim of this herbivore pest if left unhampered becomes a serious threat to next agricultural crops like cotton etc. (Ahmad *et al*., 2004). According to 'nip the evil in the bud' this scenario demands an efficient approach to cope this crisis. Mostly, leaving out all other approaches of insect management insecticides application appears as an easy, popular and effective technique (Akbar *et al*., 2017). But conventional insecticides accompanied with several rounds of heavy doses enhanced the insect resistance, health and environment hazards (Kumar and Sarada, 2015). Obviously, channelizing the direction of research suggesting judicious use of latest insecticide molecules to minimize the environmental degradation and ultimately sheltering the bio control fauna (Suhail *et al.,* 2013) ensuring public health. Correspondingly, it is the need of time to explore new chemistry with novel mode of action, which is effective at lower dose consequently insignificant residues in environment ensuring human safety. Hence, the present study

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was conducted to appraise the efficacy of two bio-insecticides, Radiant 120 SC; Emamectin 1.9 EC; two insect growth regulators (IGRs): Runner 240 SC; Kosher 50 EC; and a new chemistry insecticide Belt 480 SC against pod borer's larvae in chickpea.

MATERIALS AND METHODS

Field/Plot Details: With a view to evaluate efficacy of some new insecticide against pod borer infestation on chickpea, an experiment was carried out in the experimental field of Nuclear Institute of Agriculture, Tando Jam (Sindh) Pakistanistan. The chickpea genotype D-075/09 was raised as per standard agronomic practices during Rabi 2015-16. The plot size was 4m × 1m (4m^2), keeping the spacing of 30×10 cm between rows and plants, respectively.

Experimental Design

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. There were six treatments including control (Table1). All the treatments were administered in field as foliar spray applied manually with hydraulic knapsack sprayer. Two applications of selective product were sprayed at their recommended doses. There was an interval of 20 days, during vegetative and reproductive stage of the crop correspondingly. The control plots were sprayed with plain water. A distance of 100 cm between the plots and 150 cm between the replications was maintained as buffer zone.

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. Ten 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 1, 3 and 7 days, for a comparison with pre treatment observation (24 hours before spray). The data of two 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).

Pod Damage %

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

Percent pod damage was measured as:

$$\text{Pod damage (\%)} = \frac{\text{No. of damaged pods}}{\text{No. of total pods}} \times 100$$

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 after suitable transformation.

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 STATISTIX Version 8.1**.**

RESULTS

The pre treatment observation taken 24 hours prior to spray showed that mean number of chickpea pod borer larvae were almost same among all plots (Table 2). Data regarding comparative efficacy of all chemicals against *H. armigera* were compared with control and one another. All the treatments were found superior over control by reducing the larval population significantly as presented in Table 2 and 3.

After One Day of Treatments

After one day (24 hours) of application, all spray materials gave a considerable reduction in population of chickpea pod borers larvae. Significant differences were observed among mean values for larval population in various treatments (Table 2). Among all treatments, Radiant treated plot showed maximum reduction in the larval population of pod borers followed by Belt with a mean of 1.33 and 1.00 larvae plant^{-1}whereas Runner was found least effective with a mean of 1.66 larvae per plant and found least effective among all treatments. There were significant differences in a comparison among all chemicals and control plot with a mean population of 2.33 larvae plant^{-1}. Regarding percent mortality, Radiant and Belt showed 42.85% and 39.99% maximum larval mortality percentages, respectively after one day of application. Whereas, minimum percent larval mortality of 16.66% was recorded in plots treated with Runner after one day among all the chemicals (Table 3).

After Three Days of Treatments

After three days of two spray applications, again Radiant was found highly effective as compared to other treatments and control plot with 71.42% percent mortality (Table 3) ultimately a reduced number (1.00 larvae plant^{-1}) of *H. armigera* larvae were observed as shown in Table 2. The next effective treatment was Belt with 59.99% mortality percentage whereas Emamectin and Kosher were found at par with 49.98 percent mortality in comparison to control (Table 3).

After seven days of Treatments

A rising trend of mortality of the insect pest was observed after seven days of applications (Table 2). The results after one and three days have been confirmed by the results obtained after 7th day of application. Radiant has been observed as most effective treatment by giving lowest mean value of larval population per plant (0.33). Highly significant differences were observed in mean values of larval population among all treatments as compared to control (2.66) larvae plant^{-1}(Table 2). Maximum percent mortality of 85.71 % was caused by Radiant followed by Belt (79.99%), Emamectin (74.99%) and Kosher (62.49%) as shown in Table 3.

Pod Damage % and Grain Yield (kg ha^{-1})

The Radiant and Belt maintained their superiority throughout the experiment with lowest pod borer damage (4.62 and 5.25%) and enhanced yield grain of 1533.34 and 1386 (kgha^{-1}) followed by Emamectin (6.61 % pod damage) and Kosher (9.67 % pod damage) with higher yield of 1256.66 and 1093(kgha^{-1}) as compared to control plot (593.34 kg ha^{-1}). Although Runner was found least effective with 11.60 % pod damage as compared to all other treatments but gave substantial yield of 1036 kg ha^{-1} which is significantly different from control (Table 4).

Table 1
Details of Treatments.

Tr No.	Insecticides	Formulation	Active ingredients	Group	Dose (ml acre^{-1})
T_1	Radiant	120 SC	Spinetoram	Spinosyn	80
T_2	Belt	480 SC	Flubendamide	Diamides	50
T_3	Runner	240 SC	Methoxyfenozide	Diacylhydrazines	100
T_4	Kosher	50 EC	Lufenuron	Bezoylurea(IGR)	200
T_5	Emamectin	1.9 EC	Emamectin benzoate	Avermectin	200
T_6	Control	Plain Water			

Table 2
Averaged larval population of Gram Pod Borer at different intervals after the application of insecticides.

Treatments		Pre- Treatments	After Spray		
			One Day	3 Days	07 Days
T_1	Radiant	2.33 A	1.33 B	1.00 BC	0.33 B
T_2	Belt	1.66 A	1.00 B	0.33 C	0.33 B
T_3	Runner	2.00 A	1.66 AB	1.33 B	1.00 B
T_4	Emamectin	2.66 A	1.66 AB	1.33 B	0.66 B
T_5	Kosher	2.66 A	1.33 B	1.33 B	1.00 B
T_6	Control	2.33 A	2.33 A	3.00 A	2.66 A
	LSD	1.0327	0.9197	0.8576	1.1976

Means sharing similar letters are not significantly different at $p<0.05$.

Table 3
Percentage mortality of Gram Pod Borer caused by different insecticides.

Treatments		One Day	3 Days	7 Days
T_1	Radiant	42.85	71.42	85.71
T_2	Belt	39.99	59.99	79.99
T_3	Runner	16.66	33.33	50
T_4	Emamectin	37.48	49.98	74.99
T_5	Kosher	37.34	49.98	62.49
T_6	Control	------	-------	-------

Table 4
Pod Damage % and Grain Yield (kg ha^{-1}).

Treatments		Pod Damage %	Yields (Kgha^{-1})
T_1	Radiant	4.62 c	1533.34 a
T_2	Belt	5.25 c	1386.66 ab
T_3	Runner	11.60 b	1036.66 b
T_4	Emamectin	6.61 c	1256.66 ab
T_5	Kosher	9.67 b	1093.34 b
T_6	Control	19.14 a	593.34 c

Means sharing similar letters are not significantly different at $p<0.05$.

DISCUSSION

In the present field study, Radiant (spinetoram) 12 SC was found the top most effective molecule against chickpea pod borers giving higher level of larval mortality with significant reduction in pod damage percentage and highest grain yield comparing to other treatments including control. Our results are in accordance to other authors. Our results are in agreement with Baber *et al*. (2017) who found that Radiant was the most potent bio-insecticide among some other new chemistry insecticides by giving maximum larval mortality of *Helicoverpa* up to seven days after treatment. Spinetoram is among the recently introduced molecule, an advance form of spinosad, more potent molecule especially against lepidopterous insect pests being a combination of spinosyns J. and L. spinosyns. After two hours of application larval movement and feeding is stopped by allosteric activation of nicotinic acetylcholine receptor. Various growth stages of insects are easily managed particularly in parallel generation by both contact and dietary toxicity. The properties like translaminar and systemic in nature give excellent and quick mortality of insect especially in short stature plants like vegetables and chickpea crops. The insect pests which exhibit resistance to conventional insecticides like *H. armigera* could be managed by such molecules like spinetoram (Shimokawatoko *et al.*, 2012). Similarly, Rizvi and Saleem (2015) mentioned spinetoram (Delegate) 25 EC among the effective treatment to control the larvae of *Helicoverpa armigera*.

The new chemistry insecticide, Belt (flubendamide) was also found effective on the basis of lower pod infestation with higher level of yield due to significant percent mortality of pest. These results verify the reports of earlier workers about toxicity of flubendamide against *Helicoverpa armigera* on different field crops (Ameta and Bunker 2007; Tatagar *et al.,* 2009 Meena *et al.*, 2013; Sreekanth *et al.,* 2014; Karar *et al.,* 2017). Flubendamide belongs to diamide group of insecticides having a mode of action by activating the ryanodine receptors (RyRs), depletion of internal Ca resulted due to uncontrolled release, general lethargy, muscle paralysis, regurgitation accompanied with rapid feeding cessation ultimately causing death within 72 hours (Carlson *et al*., 2001; Dow Agro Sciences, 2003; Teixeira and Andaloro, 2013). Emamectin and lufenuron gave considerable reduction in population of larvae with lower pod damage % and enhanced yield as compared to control plot. Iqbal, *et al.,* 2014; Patil *et al*., 2007; Hakeem *et al*. 2017; and many other researchers proved the toxicity of emamectin and lufenoron against larvae of *Helicoverpa armigera.*

Our results are corroborated by Kumar and Sarada (2015) in a study about comparative efficacy of some new chemistry molecules against Lepidopterous insects inculding *Helicoverpa armigera.* They concluded that flubendamide and emamectin treated plot proved pronounced decrease in larval population and in pod infestation resultantly enhanced yield of chickpea was recorded. Abbas *et al*. (2015) evaluated the effectiveness of nine different insecticides against *Helicoverpa armigera* in field and reported spinetoram (Delegate) 25 EC and flubendamide (Belt), emamectin benzoate 1.9EC and lufenuron 5 EC superior over control in terms of mortality of *Helicoverpa armigera* and yield of crop. In our study, Runner (methoxyfenozide) was found least effective as compared to other treatments but its results are significantly different from control plot with a measurable reduction of 50% in larval population. Our finding was in the line to the toxicological studies of methoxyfenozide against *Helicoverpa armigera* Soliman and Shalaby (2011), Alavo et al (2011) and Saber *et al.*, (2013) found this molecule effective against the said pest. The present results established that new generation insecticides like spinetoram and flubendamide were efficient against *H. armigera*. Although their recommended field doses are very low but found target specific by novel mode of action with low mammalian toxicity and least environmental impact. Such properties of these molecules provide a potential to combat the widespread insecticide resistance. Therefore, these chemicals maybe incorporated in IPM modules for the management of *H. armigera* in agricultural fields and be suggested to farmer. Integration of such molecules with other control tactics needs a sound knowledge about local ecological conditions.

AUTHORS' CONTRIBUTION

Waseem Akbar and Muhammad Usman Asif conceived the basic idea of research and wrote the manuscript and made statistical analysis. Moula Bux and Raza Muhammad Memon provided their technical guidance and supervision throughout the experiments and during write up made this study successful. Mubasshir Sohail helped in write up and statistical analysis.

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