Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(4): 1224-1227
Received: 27-05-2017
Accepted: 28-06-2017

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Efficacy of newer molecules against gram pod borer, *Helicoverpa armigera* (Hub.) on chickpea (*Cicer arietinum* L.)

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Abstract

An experiment was conducted in *Rabi* season during 2014-2015 study the relative efficacy of different among all the treatments lowest number of gram pod borer was recorded in Spinosad (2.85). The next followed treatment was Chlorpyriphos (3.40), which was also statistically at par with Quinolphos (3.69), Cypermethrin (3.95). Remaining treatments are Fipronil (4.45) and Indoxcarb (4.63) were statistically at par Malathion (5.25) was recorded as least effective within the chemical insecticides. A maximum net return was recorded in T_5 Spinosad (17.45 q/ha), followed by T_3 Chlorpyriphos (16.24 q/ha), T_2 Quinolphos (15.35q/ha), T_1 Cypermethrin (13.92 q/ha), T_4 Fipronil (12.20 q/ha), T_7 Indoxcarb (11.90 q/ha), T_6 Malathion (9.26 q/ha) as compared to control T_0 plane water (7.25q/h). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was T_5 Spinosad (1:3.40), followed by T_3 Chlorpyriphos (1:3.03), T_2 Quinolphos (1:2.99), T_1 Cypermethrin (1:2.71), T_4 Fipronil (1:2.36), T_7 Indoxcarb (1:2.30), T_6 Malathion (1:1.81) as compared to control T_0 plane water Control (1:1.46).

Keywords: Chickpea, *Helicoverpa armigera,* Newer molecules, Incidence and Cost benefit ratio

Introduction

Chick pea (*Cicer arietinum* L.) is one of the most important pulse Chick pea (*Cicer arietinum* L.) is one of the most important pulse crops grown in India, with acreage of 10.91 million hectare yielding about 8.98 million tones and productivity 886 kg per hectare (Anonymous, 2013) [1]. There is steady decline in the area, production and productivity of the crop. The farmers are losing the ground due to heavy losses from pests and disease. Gram pod borer, *Helicoverpa armigera (*Hub.) is the most damaging pest in most of areas where this pulse crop is grown. *H. armigera* is a charismatic and one of the most dominant insect pests in agriculture, accounting for half of the total insecticides usage in India for protection of crops. This pest damages the chickpea plants from seedling stage to crop maturity stage and its larvae can thrive on leaves, tender twigs, flowers and pods. After pod formation, the larvae bore into the pods and feed on the seed inside and cause considerable loss to seed yield. Its caterpillars feed on young pods by making holes and eat the developing seeds by inserting the half portion of their body inside the pod. About 20-30% of the chickpea yield can be reduced due to ravages of pod borer (Sarwar, 2012) [17]. At the same time adequate ecological data is prerequisite for integrated pest management, which can therefore be enhanced after determining the seasonal abundance (Mathur *et al*, 2003) [8]. The knowledge on the seasonal incidence of pulse pod borer will certainly be helpful in formulating the insect pest management strategies for *H. armigera*. Hence, the present study was taken up to investigate the seasonal occurrence of *H. armigera* at Allahabad conditions.

Materials and methods

The present investigation was conducted at the Agricultural Research Farm Station of "Sam Higginbottom Institute of Agriculture, Technology and Sciences" Allahabad, Uttar Pradesh during *Rabi* season 2014-2015. The research farm is situated on the right side of Allahabad Rewa road at 20 degree and 150 North, 600 03 east longitude city and is about 129.2 cm abovese a level. The site selected was uniform, cultivable with typical sandy loam soil having good drainage. Chickpea variety Radhea was sown on 7th November, 2014. The observation also recorded at weekly interval from the time of sowing to harvesting. The Chickpea variety Radhea were sown @ 80 kg/ha by dibbling method with spacing of 30 cm between row to row and 10 cm between plant to plant by placing 2-3 seeds per hill at depth of 8-10 cm. The experiment was laid out in 'Randomized block design' and the plot size was 2 × 2 m^2 with recommended standard agronomical practices except plant protection.

Preparation of insecticidal spray solution:
The insecticidal spray solution of desired concentration as per treatments was freshly prepared every time at the site of experiment just before the start of spraying operations. The quantity of spray materials required for crop was gradually increased as the crop advanced in age. The spray solution of desired concentration was prepared by adoption the following formula (Singh *et al.,* 2011) [18]

$$V = \frac{C \times A}{a.i.\%}$$

where,
V = Volume of a formulated pesticide required.
C = Concentration required.
A = Volume of total solution to be prepared.
% a.i. = given Percentage strength of a formulated pesticide.

Population of chick pea pod borer recording
The pest population was recorded at 7 days interval, after 30 days of sowing. The population dynamics was determined by correlating weather parameter with seasonal incidence of chick pea pod borer. Efficacy of treatments: The population of chick pea pod borer was recorded before 1 day spraying and on 7th day and 14th day after insecticidal application. The population of chick pea pod borer had been recorded from one meter row at randomly from each plot at three rows each measuring one meter.

Pod damage analysis

$$\text{Per cent pod damage} = \frac{\text{No. of affected pods}}{\text{Total no. of pods}} \times 100$$

Benefit Cost Ratio
Gross return was calculated by multiplying total yield with the market price of the produce. Cost of cultivation and cost of treatment imposition was deducted from the gross returns, to find out net returns and cost benefit ratio by following formula

$$B:C = \frac{\text{Gross returns}}{\text{Total cost of cultivation}} \times 100$$

Where,
B: C = Benefit Cost Ratio

Statistical analysis
Statistical analysis was done to test the level of significance and to compare the treatments using the following formula (Kumar, *et al*. 2008) [7]

$$\tau = \frac{\sum XY - n\,\bar{x}\,\bar{y}}{\sqrt{x^2 - nx^{-2}}\,\sqrt{y^2 - ny^{-2}}}$$

Where,
$\bar{x}$ = Mean of 1st factor
$\bar{y}$ = Mean of 2nd factor
n = Total no. of observations
r = correlation coefficient ranges between -1 to +1

Results and discussion
The results showed that the larval population of *H.* Efficacy of seven newer molecules against *H. armigera* on chickpea. *The effect of treatments was assessed on the basis of number of chick H. armigera per meter row.*

First spray
The data pertaining to efficacy of certain chemical insecticides against gram pod borer on chickpea *after first spray are presented in table (1).* The data on the number of larvae per meter row, on overall mean after first spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest number of gram pod borer was recorded in Spinosad (4.29) and next followed treatment was Chlorpyriphos (4.83), which was also statistically at par with Quinolphos (5.25), Cypermethrin (5.45). Remaining treatments are Fipronil (5.71) and Indoxcarb (5.83) were statistically at par. Malathion (6.5) was recorded as least effective within the chemical insecticides. Rashid *et al.* (2003) [13] reported that Spinosad gave the highest percentage of reduction of pod borer and the same results are supported by Ahmed *et al*. (2004) [2], Venkateshalu *et al*. (2009) [22] and Tariq *et al*. (2005) [19]. *Effectiveness of Chlorpyriphos was also higher than the other insecticides* in reducing pod damage and recorded significantly higher good pods per plant and it was reported by Gowada *et al*. (2007) [5].

Second Spray
The data pertaining to efficacy of certain chemical insecticides against gram pod borer on chickpea *after second spray are presented in table (2).* The data on the number of larvae per meter row, on overall mean of second spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest number of gram pod borer was recorded in Spinosad (1.41). The next followed treatment was Chlorpyriphos (1.97), which was also statistically at par with Quinolphos (2.13), Cypermethrin (2.54). Remaining treatments are Fipronil (3.19) and Indoxcarb (3.43) were statistically at par. Malathion (4.01) was recorded as least effective within the chemical insecticides. The similar findings showing that Spinosad as effective given by Narasimhamurthy and Keval (2013) [10]. Ugale *et al.* (2010) [20] and Sreekanth and Seshamhalakshmi (2012) [16]. Spinosad is one of the best insecticides reported by many authors. The next best treatment was Chlorpyriphos, its present research finding also supported by Vojoud *et al.* (2011) [21]. Cypermethrin also given the highest percentage of reduction of pod damage and its results are supported by Parmar and Borad (2009) [11], Anandhi *et al*. (2011) [3].

Pooled data first and second spray
Two sprays data on the number of larvae per meter row, on overall mean after first and second spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest number of gram pod borer was recorded in Spinosad (2.85). The next followed treatment was Chlorpyriphos (3.40), which was also statistically at par with Quinolphos (3.69), Cypermethrin (3.95). Remaining treatments are Fipronil (4.45) and Indoxcarb (4.63) were statistically at par. Malathion (5.25) was recorded as least effective within the chemical insecticides. Rashid *et al.* (2003) [13] reported that Spinosad gave the highest percentage of reduction of pod borer and the same results are supported by

Ahmed *et al*. (2004) [2], Venkateshalu *et al*. (2009) [22] and Tariq *et al*. (2005) [19]. *Effectiveness of Chlorpyriphos was also higher than the other insecticides* in reducing pod damage and recorded significantly higher good pods per plant and it was reported by *Gowada et al. (2007)* [5] and also the similar findings showing that Spinosad as effective given by Narasimhamurthy and Keval (2013) [10]; Ugale *et al.* (2010) [20] and Sreekanth and Seshamahalakshmi (2012) [16]. Spinosad is one of the best insecticides reported by many authors. The next best treatment was Chlorpyriphos, its present research finding also supported by Vojoud *et al.* (2011) [21]. Cypermethrin also given the highest percentage of reduction of pod damage and its results are supported by Parmar and Borad (2009) [11] and Anandhi *et al.* (2011) [3].

Cost benefit ratio of treatments

The yields among the treatment were significant. The highest yield was recorded in T_5 Spinosad (17.45q/ha), followed by T_3 Chlorpyriphos (16.24q/ha), T_2 Quinolphos (15.35q/ha), T_1 Cypermethrin (13.92q/ha), T_4 Fipronil (12,20q/ha), T_7 Indoxcarb (11.90q/ha), T_6 Malathion (9.26q/ha) as compared to control T_0 plane water Control (7.25q/h). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was T_5 Spinosad (1:3.40), followed by T_3 Chlorpyriphos (1:3.03), T_2 Quinolphos (1:2.99), T_1 Cypermethrin (1:2.71), T_4 Fipronil (1:2.36), T_7 Indoxcarb (1:2.30), T_6 Malathion (1:1.81) as compared to control T_0 plane water Control (1:1.46). Gowda *et al* (2007) [5] who reported that, the Spinosad 45 SC recorded the highest yield and maximum cost benefit ratio. Mandal *et al.,* (2006) reported cost benefit ratio was obtained in the treatment of Chlorpyriphos in combination with *Bacillus thiurengenesis* was at par with this data. Parmar *et al.,* (2009) recorded the highest cost benefit ratio was obtained in the treatment of cypermethrin 0.006%. Singh *et al.,* (2005) [15] obtained lower yield with the treatment of Malathion which corroborates the present findings. The minimum benefit cost ratio was obtained in Malathion (1.2) due to its less effectiveness compared to other insecticides.

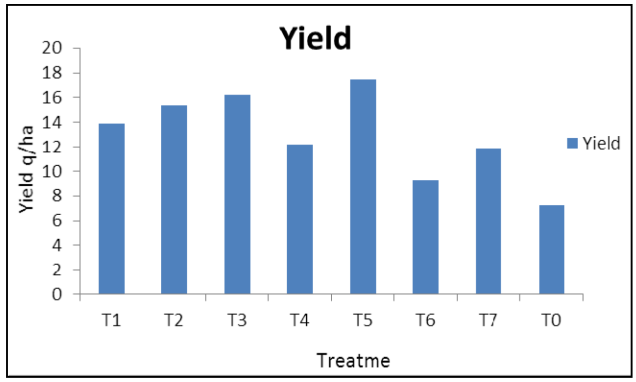

Fig 1: cost benefit ratio of treatments

Table 1: Efficacy of newer molecules against chickpea pod borer, *Helicoverpa armigera* (Hubner) during *Rabi* season, 2014-2015 (Ist and IInd Spary))

Treatment No.	Treatment	Percentage reduction in larval population of chickpea *H. armigera* after 1st and 2nd spray									
		First Spray					Second Spray				
		1DBS*	3DAS**	7DAS	14DAS	Mean	3DAS	7DAS	14DAS	Mean	Overall mean
T_1	Cypermethrin	6.33 (2.66)^{a***}	5.00 (2.33)^{bc}	5.25 (2.42)^{bc}	6.10 (2.57)^{bc}	5.45	3.0 (1.87)^{bc}	2.75 (1.79)^{cd}	1.88 (1.54)^{c}	2.54	3.99
T_2	Quinolphos	7.33 (2.75)^{a}	4.75 (2.28)^{bc}	5.13 (2.36)^{bc}	5.88 (2.51)^{bc}	5.25	2.88 (1.82)^{bc}	2.38 (1.69)^{bc}	1.15 (1.27)^{c}	2.13	3.69
T_3	Chlorpyriphos	6.50 (2.63)^{a}	4.25 (2.17)^{b}	4.88 (2.31)^{b}	5.38 (2.39)^{b}	4.83	2.75 (1.80)^{b}	2.28 (1.66)^{b}	0.88 (1.18)^{b}	1.97	3.40
T_4	Fipronil	7.25 (2.77)^{a}	5.25 (2.39)^{bcd}	5.75 (2.49)^{cd}	6.13 (2.58)^{cd}	5.71	3.75 (2.05)^{cd}	3.15 (1.90)^{de}	2.69 (1.78)^{d}	3.19	4.45
T_5	Spinosad	7.00 (2.73)^{a}	3.50 (1.99)^{a}	4.25 (2.17)^{a}	5.13 (2.34)^{a}	4.29	2.28 (1.66)^{a}	1.15 (1.27)^{a}	0.81 (1.14)^{a}	1.41	2.85
T_6	Malathion	7.68 (2.85)^{a}	6.00 (2.54)^{de}	6.50 (2.64)^{de}	7.00 (2.73)^{de}	6.5	4.15 (2.14)^{de}	4.00 (2.11)^{e}	3.88 (2.09)^{ef}	4.01	5.25
T_7	Indoxcarb	6.88 (2.71)^{a}	5.50 (2.44)^{cd}	5.88 (2.52)^{cd}	6.13 (2.57)^{cd}	5.83	3.80 (2.06)^{de}	3.50 (1.99)^{e}	2.99 (1.86)^{e}	3.43	4.63
T_0	Control	6.38 (2.61)^{a}	7.38 (2.80)^{e}	8.80 (3.04)^{e}	9.00 (3.07)^{e}	8.39	9.25 (3.11)^{e}	8.75 (3.07)^{f}	8.38 (2.96)^{f}	8.79	8.59
F-Test		NS	S	S	S	__	S	S	S	------	S
S.Ed($\pm$)		0.09	0.09	0.07	0.07	__	0.09	0.08	0.06	------	0.80
C.D.(P= 0.05)		0.20	0.21	0.16	0.17	__	0.19	0.19	0.14	------	1.90

*DBS=Days before spray, **DAS=Day after spray, ***Figures in parentheses are arc sin transformed values

Table 2: Economics of chickpea pod borer, *Helicoverpa armigera* (Hub.) management using certain chemical insecticides:

Tr. No:	Treatment	Yield q/ha	Cost of yield Rs/q	Total cost of yield Rs.	Common cost Rs.	Treatment cost Rs.	Total cost Rs.	C:B ratio
T_1	Cypermethrin	13.92	4200	58464	20720	840	21560	1:2.71
T_2	Quinolphos	15.35	4200	64470	20720	840	21560	1:2.99
T_3	Chlorpyriphos	16.24	4200	68208	20720	1775	22495	1:3.03
T_4	Fipronil	12.20	4200	51240	20720	906	21626	1:2.36
T_5	Spinosad	17.45	4200	73290	20720	800	21520	1:3.40
T_6	Malathion	9.26	4200	38892	20720	660	21380	1:1.81
T_7	Indoxcarb	11.90	4200	49980	20720	992	21712	1:2.30
T_0	Control	7.25	4200	30450	20720	------	20720	1:1.46

Conclusion

Two sprays data on the number of larvae per meter row, on overall mean after first and second spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest number of gram pod borer was in Spinosad (2.85) and followed by Chlorpyriphos (3.40), which was also statistically at par with Quinolphos (3.69), Cypermethrin (3.95). Remaining treatments are Fipronil (4.45) and Indoxcarb (4.63) were statistically at par. Malathion (5.25) recorded least effective the chemical insecticides. A maximum net return was recorded in T5 Spinosad (17.45q/ha), followed by T3 Chlorpyriphos (16.24q/ha), T_2 Quinolphos (15.35q/ha), T1 Cypermethrin (13.92q/ha), T4 Fipronil (12.20q/ha), T7 Indoxcarb (11.90q/ha), T6 Malathion (9.26q/ha) as compared to control T0 plane water Control (7.25q/h). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was T5 Spinosad (1:3.40), followed by T3 Chlorpyriphos (1:3.03), T2 Quinolphos (1:2.99), T1 Cypermethrin (1:2.71), T4 Fipronil (1:2.36), T7 Indoxcarb (1:2.30), T6 Malathion (1:1.81) as compared to control T0 plane water Control (1:1.46).

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