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RESEARCH ARTICLE

Performance of different spray sequences in the management of pod borer, *Helicoverpa armigera* (Hubner) in chickpea ecosystem

■ I.U. SHIVALEELA*, B.S. NANDIHALLI AND H.T. PRAKASH

Department of Agricultural Entomology, College of Agriculture, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA

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***Corresponding author:**
Email: madhuvinoda@gmail.com

ABSTRACT

A field experiment was conducted to evaluate the performance of different spray sequences against *Helicoverpa armigera* (Hubner) infesting chickpea in the farmer's field at Kallolli village of Jamkhandi taluka, Bijapur during 2011-12. The results revealed that spray sequences, rynaxypyr 20 SC (0.2 ml/l), flubendiamide 480 SC (0.2 ml/l), emamectin benzoate 05 SG (0.25 g/l), profenophos 50 EC (2.0 ml/l), Bt (2.0 g/l) quinalphos 25 EC (2.0 ml/l) and neem oil 2 per cent (20 ml/l), flubendiamide 480 SC (0.2 ml/l), acephate 75 SP (1.0 g/l) were found most effective in reducing the *H. armigera* population and chickpea pod damage. The highest seed yield (9.33 q/ha) was also recorded in the spray sequences, rynaxypyr 20 SC (0.2 ml/l), flubendiamide 480 SC (0.2 ml/l), emamectin benzoate 05 SG (0.25 g/l) (9.33q/ha) with the highest cost benefit ratio(1:2.0) which was followed by profenophos 50 EC (2.0 ml/l, Bt (2.0 g/l), quinalphos 25 EC (2.0 ml/l) by recording seed yield of 6.67 q/ha with the cost benefit ratio of 1:1.7. The next best sequence was neem oil 2 per cent (20ml/l), flubendiamide 480 SC (0.2ml/l), acephate 75 SP (1.0 g/l) which recorded seed yield of 6.00 q/ha with the cost benefit ratio of 1:1.6.

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INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important pulse crop of India, which is grown in an area of 7.97m ha with a production of 7.05 m tonnes and a productivity of 885 kg per ha (Anonymous, 2010). The productivity of chickpea remained low due to biotic stresses of which the major limiting factor is the gram pod borer, *Helicoverpa armigera* (Hubner). They yield loss in chickpea due to pod borer was 10 to 60 per cent in normal weather conditions (Bhatt and Patel, 2001). The insecticides are most effective in reducing the pod borer of which sequential spray with different mode of action of insecticides is also one of the means to manage the pest effectively and to reduce the development of resistance to insecticides. In view of this, the present investigation was taken up to find out the effective spray sequences.

MATERIAL AND METHODS

The field experiment was laid out to evaluate different spray sequences in Randomized Block Design during 2011-2012 in farmer's field at Kallolli village of Jamakhandi taluka, Bijapur district. The experiment consisted of 9 treatments including untreated check and was replicated three times. Annigeri 1 variety of chickpea was sown in plot sizes of 4.5 m × 3 m with a spacing of 45 × 10 cm between rows and plants, respectively. The crop was raised as per the package of practices except plant protection. Each spray sequence consisted of three sprays, of which first spraying was done at 30 days after the crop stage and subsequent two sprayings were followed at 10 days intervals after first spraying. The treatment details mentioned in the foot note of Table 1.

Observations were recorded on number of pod borer larvae and cocoons of *Campoletes chlorideae* Uchida per meter row length at one day before, 2, 5 and 10 days after each spray. Ten days after each sequential sprays, total number of pods and damaged pods were counted per meter row length and per cent pod damage was worked out.

The data obtained on pod borer larval count and cocoons of *C. chlorideae* were transformed to $\sqrt{x+1}$ and data on per cent pod damage were transformed to angular values and then the data were subjected to statistical analysis.

The crop was harvested from each plot separately and yield in kg per plot was recorded. Then the yield was converted on hectare basis and subjected for statistical analysis. Increase in yield over untreated control was calculated using the following formula :

$$\text{Increase in yield over untreated control (UTC)} = \frac{\text{Grain yield in treatment} \quad \text{Grain yield in UTC}}{\text{Grain yield in treatment}} \times 100$$

The benefits of each treatment and the benefit cost ratios were worked out based on the cost of treatment and benefit.

RESULTS AND DISCUSSION

The data on number of pod borer larvae (Table 1) obtained at 2, 5 and 10 days after first spray of the sequences revealed that among different treatments, rynaxypyr 20 SC @ 0.2 ml/l (T_8) recorded (5, 2, 8.5 larvae/mrl). At second spray of the sequences rynaxypyr 20 SC @ 0.2 ml/l (T_1) was found significantly superior in reducing the pod borer larval population (4, 3, 6 larvae/mrl) which was followed by emamectin benzoate 05 SG @ 0.2 g/l (T_5) (5, 4, 8 larvae/mrl), fluebendiamide 480 SC (@ 0.2 ml/l (T_3 and T_8) and acephate 75 SP 1g/l (T_6) (5, 4, 8) larvae/mrl). At third spray of the sequences, emamectin benzoate 05 SG @ 0.2g/l (T_8) was significantly superior in reducing the pod borer larvae (3, 1.93, 0.67 larvae/mrl) which was followed by chlorpyriphos 20 EC @ 3ml/l (T_5) (4, 3.23, 1.47 larvae/mrl) and quinolphos 25 EC @ 2ml @ 2ml/l (T_2) (4, 3.57, 1.77 larvae/mrl). The results clearly indicated that

Table 1 : Performance of spray sequences in the management of pod borer, *H. armigera* in chickpea

Treatments	Number of pod borer larvae/ mrl										Per cent pod damage (%)			
	1 DBS	2 DAS	5 DAS	10 DAS	2 DAS	5 DAS	10 DAS	2 DAS	5 DAS	10 DAS	1st spray	2nd spray	3rd spray	Mean
T_1	10.63	9.10	8.00	10.00	4.00	3.00	6.00	4.00	3.23	1.47	42.00	37.23	35.17	38.13
	(3.41)	(3.16)^{d}	(3.00)^{d}	(3.31)^{c}	(2.24)^{a}	(2.00)^{a}	(2.63)^{a}	(2.24)^{ab}	(2.18)^{cbd}	(2.02)^{c}	(40.38)^{c}	(37.59)^{a}	(36.36)^{b}	(38.11)^{ab}
T_2	11.40	6.00	5.00	9.50	7.00	6.00	10.00	4.00	3.57	1.77	36.67	48.33	36.00	40.33
	(3.52)	(2.65)^{b}	(2.45)^{b}	(3.24)^{ab}	(2.82)^{d}	(2.65)^{d}	(3.32)^{c}	(2.24)^{ab}	(2.14)^{bc}	(1.67)^{b}	(37.24)^{ab}	(44.03)^{d}	(36.85)^{b}	(39.41)^{ab}
T_3	11.33	7.50	6.50	10.33	4.00	3.00	6.00	4.00	3.10	1.74	39.26	37.80	38.00	38.35
	(3.51)	(2.92)^{c}	(2.74)^{c}	(3.37)^{b}	(2.24)^{a}	(2.00)^{a}	(2.65)^{a}	(2.24)^{ab}	(2.02)^{b}	(1.66)^{b}	(38.78)^{bc}	(37.92)^{a}	(38.04)^{c}	(38.25)^{ab}
T_4	10.57	7.50	6.50	10.00	6.00	5.00	7.00	5.00	4.33	1.40	39.78	44.83	35.00	39.87
	(3.40)	(2.92)^{c}	(2.74)^{c}	(3.31)^{b}	(2.64)^{c}	(2.45)^{c}	(2.83)^{ab}	(2.45)^{ab}	(2.31)^{cd}	(1.55)^{ab}	(39.09)^{bc}	(42.02)^{c}	(36.26)^{b}	(39.14)^{ab}
T_5	10.67	9.90	9.50	10.50	5.00	4.00	8.00	5.00	4.17	1.38	45.17	43.23	40.00	42.80
	(3.42)	(3.30)^{e}	(3.24)^{e}	(3.39)^{b}	(2.45)^{b}	(2.24)^{b}	(3.00)^{b}	(2.45)^{ab}	(2.27)^{cd}	(1.54)^{ab}	(42.88)^{d}	(41.09)^{b}	(39.21)^{d}	(40.84)^{ab}
T_6	12.67	6.00	5.00	9.30	5.00	4.00	8.00	5.00	4.57	1.40	36.26	43.49	38.00	39.25
	(3.69)	(2.65)^{b}	(2.44)^{b}	(3.21)^{ab}	(2.45)^{b}	(2.23)^{b}	(3.00)^{b}	(2.45)^{ab}	(2.36)^{d}	(1.55)^{ab}	(36.94)^{ab}	(41.24)^{bc}	(38.24)^{c}	(38.78)^{ab}
T_7	11.37	9.00	8.00	10.23	8.00	7.00	10.00	7.00	5.53	2.40	42.45	49.20	45.00	45.55
	(3.52)	(3.16)^{d}	(3.00)^{d}	(3.35)^{b}	(3.00)^{e}	(2.83)^{e}	(3.32)^{c}	(2.82)^{b}	(2.56)^{e}	(1.84)^{bc}	(40.05)^{c}	(44.52)^{d}	(42.11)^{e}	(42.42)^{b}
T_8	11.97	5.00	2.00	8.50	4.00	3.00	6.00	3.00	1.93	0.67	35.00	37.50	33.57	35.35
	(3.60)	(2.44)^{a}	(1.73)^{a}	(3.08)^{a}	(2.24)^{a}	(1.99)^{a}	(2.65)^{a}	(2.00)^{a}	(1.71)^{a}	(1.29)^{a}	(36.05)^{a}	(37.75)^{a}	(35.39)^{a}	(36.33)^{a}
T_9	14.17	14.17	15.00	14.47	12.30	12.50	12.00	9.00	6.00	2.50	54.83	52.37	52.37	53.19
	(3.89)	(3.89)^{f}	(4.00)^{f}	(3.93)^{c}	(3.65)^{f}	(3.67)^{f}	(3.61)^{d}	(3.65)^{c}	(2.65)^{e}	(1.87)^{bc}	(47.76)^{e}	(46.34)^{e}	(46.34)^{f}	(46.81)^{c}
S.Em ±	0.16	0.03	0.05	0.05	0.05	0.06	0.07	0.06	0.05	0.09	0.72	0.28	0.25	1.39
C.D. (P=0.05)	NS	0.11	0.16	0.16	0.16	0.18	0.22	0.18	0.15	0.27	2.13	0.83	0.73	4.09
CV (%)	7.57	2.26	3.31	2.74	3.48	4.30	4.25	4.21	4.02	9.58	3.13	1.17	1.11	6.01

DBS: Day before spray; DAS: Days after spray

T_1 - *Ha*NPV 250LE (0.5ml) –Rynaxypyr 20 SC (0.2ml/l)-Chlorpyriphos 20 EC(3ml/l)

T_2 - Profenophos 50 EC (2ml/l) – Bt (2g/l)- Quinolphos 25 EC(2ml/l)

T_3 - Neem oil 2% (20ml/l) – Flubendiamide 480 SC(0.2ml/l)- Acephate 75 SP (1g/l)

T_4 - Nimbecidine 1500 ppm (5ml/l)- Thiamethoxam 25 WG (0.2g/l)- Chlorpyriphos 20 EC (3ml/l)

T_5 - GCK (0.5%)– Emamectin benzoate 05 SG (0.2g/l)- Carbaryl 75 WP (4g/l)

T_6 - Methomyl 40 SP (2ml/l) – Acephate75 SP (1g/l)- Methyl parathion 50 EC (1ml/l)

T_7 - *Ha* NPV 250 LE (0.5ml/l) – Neem oil 2% (20ml/l) - *Clerodendron* (5%)

T_8 - Rynaxypyr 20 SC (0.2ml/l) – Flubendiamide 480 SC (0.2ml/l)-Emamectin benzoate 05 SG (0.2g/l)

T_9 - Untreated check (UTC)

rynaxypyr 20 SC, emamectin benzoate 05 SG, profenophos 50 EC, flubendiamide 480 SC, acephate 75 SP and chlorpyriphos 20 EC used in different spray sequences were found effective in suppressing the pod borer larvae.

Satpute and Barkhade (2012) reorted that rynaxypyr 20 SC of (30 and 40 g.a.i./ha) was found effective in reducing the pod borer complex (*H. armigera, Melangromyza obtuse* and *Exelastis atmosa*) of pigeonpea. Rajesh *et al.* (2010) proved that rynaxypyr 20 SC (30 and 20 g.a.i/ha was superior in recording the less fruit borer larval population in okra. Patil *et al.* (2007) reported that application of prefenophos 50 EC @ 750 g.a.i./ha recorded lowest pest population (1.17 larve/mrl) and emamectin benzoate was very effective in reducing the larval population in chickpea. Deshmukh *et al.* (2010) opined that flubendiamide @ 0.007 per cent gave highest mortality of the pest in chickpea. Siddegowda *et al.* (2004) and Ram and Agrawal (2007) who proved that chlorpyriphos 20 EC @ 250 g.a.i./ha emerged as superior treatment in increasing the per cent pod borer larval mortality of 46.15 per cent and 41.00 per cent and 41.00 per cent in pigeonpea and chickpea, respectively. These findings are in agreement with present investigation.

Among the different spray sequences, rynaxypyr 20 SC (0.2 ml/l), flubendiamide 480 SC (0.2 ml/l), emamectin benzoate 05 SG (0.2 ml/l) was significantly superior in reducing the pod damage in chickpea (35.35%). Satpute and Barkhade (2012) reported that rynaxypyr 20 SC not only reduced the pest population, it also registered the lowest pod damage in pigeonpea against pod borer complex. Rajesh *et al.* (2010) also proved the lower fruit damage in rynaxypyr sprayed okra crop by fruit borer. Deshmukh *et al.* (2010) reported that application of flubendiamide and emamectin benzoate recorded 5.67 and 8 per cent reduced pod damage in chickpea, respectively. Patil *et al.* (2007) also recorded minimum pod damage of 3.5 to 2.6 per cent by pod borer in chickpea. The spray sequences containing chloryriphos 20 EC was superior in reducing the pod borer damage. Siddegowda *et al.* (2007) reported that higher number of healthy pods were found in the plot sprayed with chlorpyriphos 20 EC @ 250 g.a.i./ha. Ram and Agrawal (2007) also reported less chickpea pod damage (5.7%) in chlorpyriphos treated plots. These findings are in agreement with the present study.

The data on yield and cost economics of treatments (Table 2) revealed that among various treatments in spray sequences, ryanxypyr, flubendiamide, emamectin benzoate recorded the highest seed yield (9.33 q/ha) with the highest cost benefit ratio of (1:2). The next best treatments were profenophos, Bt quinalphos, yield 6.67 q/ha (1:1.7) and neem oil, flubenidamide, acephate yield 6.00 q/ha (1:1.6).

Deshmukh *et al.* (2010) reported the highest grain yield of 1850 kg/ha in flubendiamide 0.007 per cent and 1665 kg/ha in ememectin benzoate @ 0.00015 per cent treated chickpea plots and recorded highest benefit cost ratio of 6.10 and 4.24, respectively. According to Satpute and Barkhade (2012), rynaxypyr 20 SC registered highest at yield of pigeonpea. Patil *et al.* (2007) reported that the application of emamectin benzoate recorded highest cost benefit cost ratio of 2.27 in chickpea.

To conclude that the spray sequence of rynaxypyr 20 SC (0.2 ml/l), flubendiamide 480 SC (0.2 ml/l), emamectin benzoate 05 SG (0.25 g/l) was found significantly superior in the management of chickpea pod borer which was followed by profenophos 50 EC (2.0 ml/l), Bt (2.0 g/l), quinalphos 25 EC (2.0 ml/l) and Neem oil 2 per cent (20ml/l), flubendiamide 480 SC (0.2 ml/l), acephate 75 SP (1.0 g/l).

Table 2 : Effect of spray sequence on seed yield and economics of chickpea

Treatments (sequential spray)	Yield (q/ha)	Increased yield over UTC	Cost of treatment (Rs./ha)	Benefit (Rs./ha)	B:C ratio
T_1 - *Ha*NPV 250LE (0.5ml)–Rynaxypyr 20 SC (0.2ml/l)-Chlorpyriphos 20 EC(3ml/l)	6.33[b]	0.49	2032	1960	1.0
T_2 - Profenophos 50 EC (2ml/l) – Bt (2g/l)- Quinolphos 25 EC (2ml/l)	6.67[b]	0.52	1228	2080	1.7
T_3 - Neem oil 2% (20ml/l) – Flubendiamide 480 SC(0.2ml/l)- Acephate 75 SP (1g/l)	6.00[bc]	0.47	1194.6	1880	1.6
T_4 - Nimbecidine 1500 ppm (5ml/l)- Thiamethoxam 25 WG (0.2g/l)- Chlorpyriphos 20 EC (3ml/l)	6.33[b]	0.49	1693	1960	1.1
T_5 - GCK (0.5%)– Emamectin benzoate 05 SG (0.2g/l)- Carbaryl 75 WP (4g/l)	6.00[bc]	0.47	1090	1880	1.5
T_6 - Methomyl 40 SP (2ml/l) – Acephate75 SP (1g/l)- Methyl parathion 50 EC (1ml/l)	6.33[b]	0.49	2510	1960	1.0
T_7 - *Ha* NPV 250 LE (0.5ml/l) – Neem oil 2% (20ml/l) - *Clerodendron* (5%)	5.33[c]	0.68	2800	2725	0.9
T_8 - Rynaxypyr 20 SC (0.2ml/l) – Flubendiamide 480 SC (0.2ml/l)-Emamectin benzoate 05 SG (0.2g/l)	9.33[a]	1.00	2097	4000	2.0
T_9- Untreated check (UTC)	3.17[d]	–	–	–	–
S.Em ±	0.26	–	–	–	–
C.D. (P=0.05)	0.78	–	–	–	–
CV (%)	7.40	–	–	–	–

In a column, means followed by same letters are not significantly different at P=0.05 as per DMTR

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