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Bio-efficacy of different insecticides against ear head worm *Helicoverpa armigera* (Hubner) on sorghum at flowering stage

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Abstract
The experiment was conducted during *Kharif*, 2015 at AICSIP, Sorghum Research Station, VNMKV, Parbhani (MS). And the findings was revealed that the mean population of ear head worm after spray at flowering stage was calculated the treatment with lowest population at first day after spray (0.70 ear head worm/panicle) was recorded in T_7 (Emamectin benzoate 5 SG, 0.0018%. of water) which was closely followed by T_5 (spray of Novaluron 10 EC, 0.01% @ 10ml/10 lit. of water), T_1 (spray of Spinosad 45 SC, 0.0045%) and T_3 (Quinalphos 25 EC) with 0.77, 0.93 and 0.95 mean ear head worms per panicle respectively. At third day after spray, fifth, seventh and ten DAS least ear head worm population was observed 0.75, 0.80, 0.85 and 0.95 in T_7 (Emamectin benzoate 5 SG, 0.0018%), respectively.

Keywords: ear head worm *H. armigera*, bio-efficacy, different insecticide and flowering stage

Introduction
Sorghum [*Sorghum bicolor* (L.) Moench] is an important cereal crop in India popularly known as 'Jawar', or 'Great millet'. The advantage of this cereal crop is that it can be cultivated in both *Kharif* and *Rabi* season. It having important feed and food crop in the world and used as fodder to feed millions of animals providing milk and meat for human being. Sorghum is very nutritious its fodder contains more than 50 per cent digestible nutrients with 8 per cent protein, 2.5 per cent fat and 45 per cent nitrogen free extract.

Maharashtra is foremost sorghum growing states in the country with an area, production, productivity of K*harif* jowar was 6.80 lakh ha, 5.85 lakh tonnes and 860 kg ha^{-1}, respectively (Anonymous 2014) [1]. Also, in Marathwada region area, production, productivity of *Kharif* jowar was 3.66 lakh ha, 1.97 lakh tonnes and 539 kg ha^{-1}, respectively (Anonymous, 2014) [1]. About 150 insect species have been recorded on sorghum. Out of which 31 species are economically important. In Maharashtra about 18 important insect pests have been recorded on sorghum crop. The major being sorghum *H. armigera* Hubner (Lepidoptera; Noctuidae) is one of the serious polyphagous pest attacking more than 180 plants and worldwide occurrence inflicting annual crop damage worth US $1 billion in India. The caterpillar cause major damage to the crops as it attacks reproductive parts and growing tips. The management of *H. armigera* is very difficult in many crops, including cotton, pigeonpea, sorghum and relies heavily on the use of chemical insecticides (Romeis *et al.*, 1999) [8].

The pyrethroids and organophosphorus combination insecticides were found to be effective against the resistant insect pest population of *H. armigera* (Martin *et al.*, 2003) [6]. The efficacy of fungal pathogen, *Nomuraea rileyi* (Farlow) Samson has been proven against *H. armigera* by number of workers in groundnut, soybean and cotton ecosystems (Patil, 2000; Hegde, 2001) [7, 5] Moreover application of chemical insecticides in sorghum against *H. armigera* is difficult task because of toxic nature of the chemical to the applicator and tall nature of the crop. The present recommendation depends heavily on insecticide. Hence, the insect pathogens were tried under field conditions. Considering the importance of bio-efficacy of different insecticides against sorghum ear head worm under field condition present investigation was done.

Material and Method
Experimental Details
1. Experimental Design : Randomized Block Design (RBD)
2. Replications : Three
3. Treatments : Ten
4. Spacing : 45 cm X 15 cm
5. Crop : Sorghum
6. Cultivar : SPH-1641
7. Plot size : 12 rows of 4m (5.4 m X 4 m)
8. Method of sowing : Dibbling
9. Date of sowing : 20th June, 2015.

Application of Insecticides
Insecticides (Table-1) at their prescribed doses was applied at 50% flowering stage of the sorghum crop. The volume of spray water were worked out before insecticidal spray by spraying plain water on control plot and spraying was done in early morning hours to avoid mid-day heat.

Table 1: Details of insecticides used in experiment

Tr. No.	Treatment	Conc. (%)	Formulation dose g or ml/10 lit. of water
T1	Spinosad 45 SC	0.0045	1 ml
T2	Cypermethrin 10 EC	0.005	5 ml
T3	Quinalphos 25 EC	0.05	20 ml
T4	Lamda-cyhalothrin 5 EC	0.003	6 ml
T5	Novaluron 10 EC	0.01	10 ml
T6	Azadirachtin 5 %	0.002	20 ml
T7	Emamectin benzoate 5 SG	0.0018	3.5 g
T8	Bacillus thuringiensis	-	20 g
T9	Beauveria bassiana	-	40 g
T10	Untreated control	-	-

Method was done to Record Observations

The total number of larvae were recorded from randomly selected 10 plants in each plot. The pre-treatment observation were recorded one day before one insecticidal spray at flowering stage and post treatment observation were recorded at 1st, 3rd, 5th, 7th, 10th days after spray (after 86 days).

Results

Data pertaining to effect of different insecticides on ear head worm of sorghum at flowering stage after first spray are presented in table-2.

Ear head worm population one day before insecticidal spray

The data on population of ear head worm, one day before insecticidal spray at flowering stage presented in table-2 revealed that the population of ear head worm/panicle ranged between 0.97 to 1.93, which was statistically non-significant indicating uniform distribution of these pest populations.

Table 2: Bio-efficacy of different insecticides against ear head worm of sorghum at flowering stage

Tr. No	Treatment details (per 10 lit of water)	Ear head worm population/panicle						
		1 DBS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	Mean
1	Spinosad 45 SC @ 1 ml	0.97 (1.21)*	0.93 (0.87)	0.95 (0.97)	1.00 (0.99)	1.05 (1.01)	1.15 (1.06)	1.02 (0.98)
2	Cypermethrin 10 EC @ 5 ml	1.63 (1.44)	1.20 (1.03)	1.25 (1.11)	1.30 (1.13)	1.35 (1.16)	1.45 1.20)	2.32 1.53)
3	Quinalphos 25 EC @ 20 ml	1.50 (1.40)	0.95 (0.94)	0.98 (0.99)	1.03 (1.01)	1.08 (1.03)	1.18 (1.08)	1.65 (1.27)
4	Lambda cyhalothrin 5 EC @ 6 ml	1.63 (1.45)	1.18 (1.02)	1.23 (1.10)	1.28 (1.13)	1.33 (1.15)	1.43 (1.19)	2.32 (1.52)
5	Novaluron 10 EC @ 10 ml	1.60 (1.45)	0.77 (0.82)	0.82 (0.90)	0.87 (0.93)	0.92 (0.95)	1.02 (1.00)	1.62 (1.25)
6	Azadirachtin 5% @ 20 ml	1.53 (1.41)	1.77 (1.32)	1.82 (1.34)	1.87 (1.36)	1.92 (1.38)	2.02 (1.41)	3.02 (1.73)
7	Emamectin Benzoate 5 SG @ 3.5 gm	1.83 (1.51)	0.70 (0.76)	0.75 (0.85)	0.80 (0.88)	0.85 (0.91)	0.95 (0.96)	1.78 (1.33)
8	*Bacillus thuringiensis* @ 20 gm	1.26 (1.32)	1.93 (1.39)	1.98 (1.40)	2.03 (1.42)	2.08 (1.44)	2.18 (1.47)	2.95 (1.71)
9	*Beuveria bassiana* @ 40 gm	1.46 (1.40)	2.73 (1.64)	2.78 (1.66)	2.83 (1.67)	2.88 (1.69)	2.98 (1.72)	3.08 (1.75)
10	Untreated control	1.93 (1.55)	2.87 (1.68)	2.92 (1.69)	2.97 (1.71)	3.02 (1.72)	3.12 (1.75)	4.33 (2.06)
S.E. ±		NS	0.08	0.07	0.07	0.06	0.09	0.06
C.D. at 5%		NS	0.22	0.21	0.21	0.20	0.17	0.20
CV %		NS	9.259	10.64	10.24	9.928	9.309	9.55

* Figures in parentheses denote $\sqrt{x+0.5}$ transformed values. DBS- Day before spray and DAS- Days after spray

Ear Head Worm Population One Day after Spray

The mean larval population after first insecticidal spray (at flowering stage of crop) were ranged between 0.70 to 2.87 ear head worms/panicle. All the insecticidal treatments except T_9 (spray of *Beuveria bassiana* @ 40g/10 lit. of water) found significantly superior over untreated control in reducing the larval infestation. The lowest ear head worm population (0.70 ear head worm/panicle) was recorded in T_7 (spray of Emamectin benzoate 5 SG, 0.0018% @ 3.5g/10 lit. of water) which was at par with T_5 (spray of Novaluron 10 EC, 0.01% @ 10ml/10 lit. of water), T_1 (spray of Spinosad 45 SC, 0.0045 @ 1ml/10 lit. of water) and T_3 (spray of Quinalphos 25 EC, 0.05 @ 20ml/10 lit. of water) with 0.77, 0.93 and 0.95 mean ear head worms per panicle respectively.

Ear Head Worm Population Third Day after Spray

The mean of ear head worm population at 3rd day after first insecticidal spray (at flowering stage of crop) varied from 0.75 to 2.92 ear head worms per panicle. Significantly less incidence of ear head worm was observed in all the insecticidal treatments (except T_9- spray of *Beuveria bassiana* @ 40g/10 lit. of water) over untreated control. However, the lowest ear head worm population (0.75 ear head worm/panicle) was recorded in T_7 (spray of Emamectin benzoate 5 SG, 0.0018% @ 3.5g/10 lit. of water) which was closely followed by T_5 (spray of Novaluron 10 EC, 0.01% @ 10ml/10 lit. of water), T_1 (spray of Spinosad 45 SC, 0.0045 @ 1ml/10 lit. of water) and T_3 (spray of Quinalphos 25 EC, 0.05 @ 20ml/10 lit. of water) with 0.82, 0.95 and 0.98 mean ear head worms per panicle respectively.

Ear Head Worm Population Fifth Day after Spray

The mean of ear head worm population at 5th day after first insecticidal spray (at flowering stage of crop) varied from 0.80 to 2.97 ear head worms per panicle. Significantly less incidence of ear head worm were observed in all the

insecticidal treatments (except T_9- spray of *Beuveria bassiana* @ 40g/10 lit. of water) over untreated control. However, the lowest ear head worm population (0.80 ear head worm/panicle) was recorded in T_7 (spray of Emamectin benzoate 5 SG, 0.0018% @ 3.5g/10 lit. of water) which was closely followed by T_5 (spray of Novaluron 10 EC, 0.01% @ 10ml/10 lit. of water), T_1 (spray of Spinosad 45 SC, 0.0045 @ 1ml/10 lit. of water) and T_3 (spray of Quinalphos 25 EC, 0.05 @ 20ml/10 lit. of water) with 0.87, 1.00 and 1.03 mean ear head worms per panicle respectively.

Ear Head Worm Population Seventh Day after Spray

The mean of ear head worm population at 7th day after first insecticidal spray (at flowering stage of crop) varied from 0.85 to 3.02 ear head worms per panicle. All the insecticidal treatments (except T_9- spray of *Beuveria bassiana* @ 40g/10 lit. of water) recorded significantly less incidence of ear head worm over untreated control. However, the lowest ear head worm population (0.85 ear head worm/panicle) was recorded in T_7 (spray of Emamectin benzoate 5 SG, 0.0018% @ 3.5g/10 lit. of water). The next best treatments were T_5 (spray of Novaluron 10 EC, 0.01% @ 10ml/10 lit. of water), T_1 (spray of Spinosad 45 SC, 0.0045 @ 1ml/10 lit. of water) and T_3 (spray of Quinalphos 25 EC, 0.05 @ 20ml/10 lit. of water) with 0.92, 1.05 and 1.08 mean ear head worms per panicle respectively.

Ear Head Worm Population Tenth Day after Spray

Same trend as above was observed in all insecticidal treatments at 10th day after first insecticidal spray (at flowering stage of crop) in reducing ear head worm population. Highest ear head worm population (3.12 ear head worm/panicle) was noticed in untreated control whereas the lowest ear head worm population (0.95 ear head worm/panicle) was recorded in T_7 (spray of Emamectin benzoate 5 SG, 0.0018% @ 3.5g/10 lit. of water). The next best treatments were T_5 (spray of Novaluron 10 EC, 0.01% @ 10ml/10 lit. of water), T_1 (spray of Spinosad 45 SC, 0.0045 @ 1ml/10 lit. of water) and T_3 (spray of Quinalphos 25 EC, 0.05 @ 20ml/10 lit. of water) with 1.02, 1.15 and 1.18 mean ear head worms per panicle respectively. The above finding are close agreement with the Govindan *et al*. (2011) [4] reported that Emamectin benzoate 5 SG @ 11g a.i/ha was effectively reduced the larval population of *H. armigera* 7 days after application. Ghosal *et al*. (2016) [3] reported that among the three selected dose of Novaluron 5.25 per cent + Indoxacarb 4.5 per cent SC (750, 825, 875 ml ha^{-1}); the said chemical @ 875 ml ha^{-1} was recorded as best in managing *H. armigera* population up to harvesting period (mean 0.03 per cent infested pod of both years), while, @ 825 ml ha^{-1} also recorded remarkable effect on the target pest. Deshmukh *et al*. (2010) [2] revealed that Flubendiamide 0.007 per cent, Indoxacarb 0.0075 per cent, Spinosad 0.009 per cent and Emamectin benzoate 0.0015 per cent were found the most effective in reducing the *H. armigera* population and pod damage of chickpea.

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