Management of sorghum shoot fly, *Atherigona soccata* Rondani (Diptera:Muscidae) through botanicals

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ABSTRACT

Efficacy of botanicals against shoot fly showed that three sprays (7th, 14th and 21st day after germination) of neem oil (2%) depicted oviposition of 50.79, 41.61 and 38.22 per cent and in karanj oil (2%) of 54.83, 44.01 and 41.15, respectively found significantly superior to all other treatments. Nirgundi oil (2%) was found as the next effective. With respect to dead heart, neem oil (2%) showed 22.66 and 23.94 per cent while in karanj oil (2%) 23.29 and 25.13 per cent at 21st and 28th day after germination, respectively. The maximum grain yield of 32.22 q/ha and the highest Cost Benefit Ratio of 1: 1.61 was recorded from neem oil (2%) treated plots.

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INTRODUCTION

Sorghum, *Sorghum bicolor* (L.) Moench is an important cereal crop in Africa and Mediterranean Europe (Dhillon *et al*., 2005 and Subbarayudu and Indira, 2007) and its damage results in yield losses up to 90 per cent (Jotwani and Srivastava, 1970). It is grown all over the world and is a staple food and fodder crop in India. The losses due to insects have been estimated to be over US$ 1000 million annually in the semi-arid tropics. Among cereals, sorghum is the fourth most important crop after rice, wheat and maize in India. The major sorghum growing areas are in the states of Maharashtra, Andhra Pradesh, Karnataka, Gujarat, Tamil Nadu and Rajasthan. Insect pests play an important role in lowering the yield of sorghum. Severe infestation at the boot stage results in the twisting of top leaves and preventing the emergence of panicles resulting in losses up to 41 per cent in India (Subbarayudu *et al.*, 2002). The shoot fly and stem borer are the key pests in most of sorghum growing area. 150 insect species have been reported as pests on sorghum (Jotwani *et al*., 1980, Sharma, 1993), of which sorghum shoot fly (*Atherigona soccata*), stem borers (*Chilo partellus*, *Busseola fusca*, *Eldana saccharina*, and *Diatraea* spp), armyworms (*Mythimna separata*, *Spodoptera frugiperda* and *S. exempta*), shoot bug (*Peregrinus maidis*), aphids (*Schizaphis graminum* and *Melanaphis sacchari*), spider mites (*Oligonychus* spp), grasshoppers and locusts (*Hieroglyphus*, *Oedaleus*, *Aiolopus*, *Schistocerca* and *Locusta*), sorghum midge (*Stenodiplosis sorghicola*), earhead bugs (*Calocoris angustatus* and *Eurystylus oldi*), and head caterpillars (*Helicoverpa*, *Eublemma*, *Cryptoblabes*, *Pyroderces* and *Nola*) are the major pests worldwide. The shoot fly, *Atherigona soccata* Rondani is considered to be the most severe pest in India particularly in Rajasthan, causing tremendous damage at the seedling stage by killing the central shoot. Management of this pest through botanicals will play a vital role in the organic production of sorghum. There is absolutely no work on this aspect except a few reports on botanicals.

MATERIALS AND METHODS

An experiment was laid out in the Randomized Block Design in three replications at the Instructional Farm, Rajasthan College of Agriculture with a plot size of 3.75m x 2.70m. The sorghum cultivar, CSV-17 with a spacing of 45 × 15 cm was sown during 20th July 2011 by following

recommended botanical pesticides. Treatments included neem oil, *Azadirachta indica* (2 %), karanj oil, *Pongamia pinnata* (2%), mahua oil, *Madhua latifolia* (2%), castor oil, *Ricinus communis* (2%), eucalyptus oil, *Eucalyptus spp* (2%), nirgundi oil, *Vitex negundo* (2%) and untreated check. The treatments were done with hand sprayer using a spray fluid. The spray was taken at 7^{th}, 14^{th} and 21^{st} day after germination, when the shoot fly infestation was initiated. To compare the efficacy of treatments, both botanical pesticides as well as untreated control were maintained. Oviposition was recorded on 7^{th}, 14^{th} and 21^{st} day of germination, 20 tagged plants were observed and number of plants counted from each egg plot as pre treatment oviposition behaviour. At weekly interval i.e. 7^{th}, 14^{th} and 21^{st} day after germination treatment (sprays) were given in the morning hours. After 48 hours of spray 20 tagged plants from each treatment were counted for shoot fly eggs. After each post treatment spray, observations were recorded and eggs already laid were removed by brush for further fresh egg laying to be observed in the next spray.

$$\text{Oviposition (\%)} = \frac{\text{Number of plants with eggs}}{\text{Total number of plants observed}} \times 100$$

At 28^{th} day after germination, middle 4 rows plants were counted and segregated into healthy (without dead hearts) and damage (with dead hearts) expressed as percentage:

$$\text{Dead heart (\%)} = \frac{\text{Number of plants with dead heart}}{\text{Total number of plants observed}} \times 100$$

Statistical Analysis

The population data were transformed to percentage reduction in population of shoot bug and leaf folder due to the botanicals application using the Henderson and Tilton (1955) equation:

Percentage reduction =100x (1-Ta x Cb/Tb c Ca)

where,

T_a = Number of insects after treatment

T_b = Number of insets before treatment

C_a = Number of insects in untreated check after treatment

C_b = Number of insects in untreated check before treatment

Table 1. Relative efficacy of botanicals against sorghum shoot-fly oviposition during *kharif* 2011

Treatment Plant oils [@2%]	***Mean Oviposition (%)**					
	First Spray at 7^{th} day after germination		**Second Spray at 14^{th} day after germination**		**Third Spray at 21^{st} day after germination**	
	Before	**After (48 hrs)**	**Before**	**After (48 hrs)**	**Before**	**After (48 hrs)**
Azadirachta indica	63.55	50.79	45.00	41.16	42.12	38.22
Pongamia pinnata	62.40	54.83	52.74	44.01	46.91	41.15
Madhua latifolia	69.55	60.31	56.84	52.74	50.79	46.91
Ricinus communis	61.22	57.86	54.75	52.74	45.96	44.01
Eucalyptus sp.	62.40	56.84	50.97	50.79	45.00	43.09
Vitex negundo	68.66	54.78	57.86	48.85	51.76	42.13
Untreated check	64.69	65.95	61.22	62.48	59.00	59.05
S. Em. ±	2.724	2.356	2.084	1.888	1.442	1.686
CD (5%)	NS	7.261	6.421	5.820	4.443	5.196
CV (%)	7.300	7.118	6.660	6.491	5.119	6.420

RESULTS AND DISCUSSIONS

It is evident from Table 1 that the maximum per cent oviposition was observed in the untreated check; whereas the minimum was recorded in the neem oil (2%). Among the tested botanicals, neem oil (2%) was better than the rest of the treatments followed by karanj oil (2%). The untreated check had shown the maximum oviposition followed by mahua oil. Neem oil and karanj oil and nirgundi oil were significantly at par though neem oil significantly reduced oviposition

compared to the rest of the treatments except with karanj oil and nirgundi oil. The data recorded on 14th day after germination revealed that the maximum oviposition was recorded in the untreated check, while the minimum was recorded in neem oil 2% and karanj oil 2%. Untreated check possessed maximum eggs followed by mahua oil, eucalyptus oil and castor oil which had significant oviposition when compared to neem oil and karanj oil. Likewise, the data recorded on 21st day after germination revealed that the maximum per cent oviposition was increased in the untreated check (59.05%), while the minimum was recorded in the neem oil 2 per cent (38.22%). In other treated plot maximum eggs were possessed in mahua oil (46.91%) followed by eucalyptus oil (44.01%) and castor oil (46.91%). Again, neem oil, karanj oil and nirgundi oil significantly proved better than the rest of the treatments. The lowest per cent dead heart formed at 21st day after germination varied from 22.66 (neem oil 2%) to 29.73 (mahua oil 2%). Treatments mahua oil, eucalyptus oil, castor oil and nirgundi oil, significantly produced more dead hearts over neem oil and karanj oil. Data recorded on dead heart at 28th day after germination revealed that the maximum was reported in the untreated check, whereas the minimum was recorded in neem oil. The dead heart formation in all tested botanical-pesticides was significantly lower than in the untreated check. The per cent dead heart ranged from 23.94 (neem oil 2%) to 34.63 (mahua oil 2%). Among the treatments minimum dead heart percentage observed in neem oil, was found significantly better than rest of the treatments (Table 2). Neem oil 2% (32.76 q/ha) treatment has given significantly more yield over rest of the treatments with the highest Cost Benefit Ratio of 1: 1.61 followed by karanj oil 2% (1: 1.52). Though, karanj oil (29.35 q/ha) and nirgundi oil (29.68 q/ha) proved significantly at par in terms of grain yield, mahua oil (21.85 q/ha) and eucalyptus oil (2%) (18.06 q/ha) provided minimum grain yield (Table 3).

Table 2. Comparative efficacy of botanicals on dead heart formation by shoot fly, *kharif* 2011

Treatment Plant oils [@2%]	Mean dead hearts (%)	
	21st day after germination	28th day after germination
Azadirachta indica	22.66 *	23.94
Pongamia pinnata	23.29	25.13
Madhua latifolia	29.73	34.63
Ricinus communis	26.16	29.08
Eucalyptus sp.	27.83	31.97
Vitex negundo	25.32	27.90
Untreated check	36.73	45.12
S. Em.±	0.404	0.475
CD (5%)	1.247	1.463
CV (%)	2.559	2.645

These findings are in accordance with Bai and Kundaswamy (1985); Anonymous 2001; reported that *V. negundo* (nirgundi oil) and neem oil (2%) reduced egg laying. Shrinivas and Shekharappa (2009) also reported NSKE (5%) spray at 21st day after germination reduced dead heart formation. Sable (2009) recorded the highest yield in neem oil (2%) treated plots (14.56 q/ha) which was at par with plant mixture (13.89 q/ha) and NSKE (5%) (13.65 q/ha). Similarly, maximum grain yield of 32.22q/ha and the highest Cost Benefit ratio of 1: 1.48 was recorded from meen oil (l3%) according to Gautam *et al*., (2014).

Table 3. Effect of botanicals on grain yield grain yield of sorghum, *kharif* 2011

Treatment Plant oils [@2%]	Grain yield (q/ha)	C: B Ratio
Azadirachta indica	32.76	1: 1.61
Pongamia pinnata	29.35	1: 1.52
Madhua latifolia	21.85	1: 1.11
Ricinus communis	23.57	1: 1.19
Eucalyptus sp.	18.06	1: 1.10
Vitex negundo	29.68	1: 1.40
Untreated check	16.07	-
S. Em. ±	0.463	-
CD (5%)	1.429	-
CV (%)	3.529	-

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