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RESEARCH PAPER

Efficacy of biorationals in the management of fall armyworm *Spodoptera frugiperda* (Smith) in *rabi* sorghum

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Abstract: A field experiment was conducted at College of Agriculture, Vijayapura during the year 2019-20 to know the effect of biorationals in the management of fall armyworm *Spodoptera frugiperda* (Smith). The results revealed that, treatment with RPP (recommended package of practice) found superior over other treatments (10.18 % plant damage), Agniastra 2 per cent (13.96 %), Bramhastra 5 per cent (14.81 %), Neemastra 5 per cent and NSKE 5 per cent (15.81 %) were promising biorationals for managing invasive polyphagous pest, fall armyworm, *S. frugiperda* in sorghum.

Key words: Biorationals, Fall armyworm, Pesticide, Sorghum

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is one of the important dryland food crop. In more than 100 countries, it is growing on marginal lands. Millions of people in tropics and semi-arid tropics depend on sorghum, for food and fodder. In India, sorghum is cultivated on 5.2 million hectares to produce 3.75 million metric tonnes, with productivity of 0.72 tonnes per hectare (Anon., 2019). Sorghum is the fourth important cereal crop in the country. Karnataka is the second leading state, with an area 0.95 million hectares and production of 0.84 million tonnes of grain and productivity hovering around 0.88 tonnes per hectare (Anon., 2017).

Sorghum is vulnerable to more than 150 insect species, form sowing to harvesting. Insect pests namely, shoot fly, shoot bug, and aphids are the three major and regular pests in northern dry zone of Karnataka (Ambarish *et al.,* 2017). Fall armyworm (FAW) *Spodoptera frugiperda* (Smith) native to America, is one of the important invasive polyphagous pest (Clark *et al.,* 2007). In recent years the fall armyworm (*S. frugiperda*) has spread all over the Karnataka and it is able to cause potential damage to the cereal crop. India is a tropical country where wide varieties of crops are cultivated, due to its notorious and polyphagous behaviour may potential threat to Indian agriculture. It is primarily, a pest of maize and damages sorghum if primary host is not available. In future days, the pest may stretch to other important crops belongs to poaceae (family of grasses) like wheat, rice, ragi, sugarcane and it may also attack cotton, pigeon pea and vegetables (Mallapur *et al*., 2018).

Indiscriminate use of chemicals has led to the problems like pest outbreak, development of resistance by pests to insecticides, elimination of natural enemies and risk to human and animal health besides environmental pollution (Rosaiah *et al.,* 2001). To deal with these rising problems natural farming systems were introduced, in this technique, biopesticides (agniastra, brahmastra, neemastra *etc.*) are used instead of chemical based pesticides (Bishnoi and Bhati, 2017). Natural farming system is a sustainable agricultural practice and approachable techniques for farmers.

Biorationals are inherently potential for replacing persistent conventional pesticides. These are highly target specific and commanding no or little mammalian toxicity. The molecules used as biorational products are highly active at very low concentration and safe for natural enemies of insect pests. They have short residual activity and are degraded to simple non-toxic molecules. Nowadays, biorationals play a very important role in pest management under natural farming system. This present investigation could provide further insight in management of fall armyworm and it might benefit for the application of these efficient botanic pesticides.

Material and methods

The field experiment was conducted at College of Agriculture, Vijayapura during the year 2019-20 in a Randomized Complete Block Design (RCBD) with 18 treatments and two replications, using M 35-1 variety of sorghum in a plot size 3.6 × 3.6 m for each treatment. The crop was raised with spacing 45 × 15 cm by following zero budget natural farming (ZBNF) except plant protection methods and plot treated with RPP (recommended package of practice) to know the effect of biorationals in the management of fall armyworm *Spodoptera frugiperda* in *rabi* sorghum, the following observations were recorded**.**

Number of fall armyworm larvae/ plant

The fall armyworm larvae population was recorded from the five randomly selected plants. Then mean value was calculated.

Per cent plant damage by fall armyworm *Spodoptera frugiperda* (Smith).

Total number of plants and plants with foliage damage symptoms was recorded at vegetative stage and per cent plant was computed by the following formula.

$$\text{Per cent plant damage (\%)} = \frac{\text{Number of plants with foliage damage in a treatment}}{\text{Total number of plants in a treatment}} \times 100$$

Preparation of biorationals

Agniastra: It is composed of 10 litre cow urine and 1 kg tobacco, 500 g of green chilli, 500 g of garlic, 5 kg neem leaves pulp (crushed in cow urine).

Neemastra: It is composed of local cow urine (5 liter), cow dung (5 kg) and neem leaves (5 kg), fermented for 24 hours.

Brahmastra: It is composed of 5 kg neem leaves, 2 kg (custard apple leaves, *Lantana camara* leaves, guava leaves, papaya leaves and white datura leaves) each, crushed and boiled in 20 litres of cow urine (Bishnoi and Bhati, 2017).

NSKE 5 %: 50 g of powdered seeds of neem is soaked overnight in one litre of water, squeezed through muslin cloth and the extract collected is used for spraying.

Biodigester solution: Construct a storage tank of 20 × 10 × 6 cube foot and construct 3 foot small tank beside it. At the centre of storage tank make a canal and connected to small tank. Place the stones at the bottom of storage tank, then all the agriculture wastes are dumped in it, along with dung and water. Then these digested products will be stored in small tank through PVC pipes. Apply digested solution to crops along with irrigation (Biradar *et al.*, 2007).

Leaf extracts: Fresh leaves (*Pongamia pinnata*, *Prosopis juliflora, Vitex nigundo,* custard apple, and neem leaves) are collected and brought to the laboratory and washed thoroughly 3-4 times with tap water and finally with distilled water. The leaves are chopped into small pieces with a sharp knife. 500 g of chopped material is macerated in mortar and pestle and extracted with a small quantity of cow urine. The extract is squeezed through muslin cloth and makes up to 10 liter, with cow urine. The filtrate is stored in a clean reagent bottles for further experimental use (Anita, 2009).

RPP (Recommended package of practice) : Poison bait 20 kg/ acre for the management of fall armyworm (Poison bait : It is a mixture of 2 kg jaggery, 250 ml monocrtophos 36 SL, 2 to 3 litres of water and 20 kg rice brane, leave it for 48 hours in gunny bag),(Anon., 2016).

Results and discussions

Fall armyworm larval load/ plant

Study on bio efficacy of biorationals against fall armyworm *Spodoptera frugiperda* (Smith) incidence at 45 DAS, revealed that significant difference between treatments. Plot treated with RPP showed significantly lowest larval load/ plant (0.20/ plant), next superior treatments were agniastra 2 per cent, bramhastra 5 per cent, neemastra 5 per cent, NSKE 5 per cent and neem leaf extract 5 per cent + *Vitex nigundo* leaf extract 5 per cent (0.30/ plant). Next superior treatments were, biodigester solution 10 per cent, neem leaf extract 5 per cent, *Prosopis juliflora* leaf extract 5 per cent, custard apple leaf extract 5 per cent, *V. nigundo* leaf extract 5 per cent, pongemia leaf extract 5 per cent + *V. nigundo* 5 per cent, pongemia leaf extract 5 per cent + custard apple leaf extract 5 per cent, neem leaf extract 5 per cent + custard apple leaf extract 5 per cent (0.40/ plant). However, untreated check recorded (0.60/ plant) highest larval count/ plant (Table 2).

At 60 DAS, fall armyworm *S. frugiperda* larval load was significantly lowest in RPP (0.10/ plant), which is on par with agniastra 2 per cent and bramhastra 5 per cent (0.40/ plant). Next best treatments were, neemastra 5 per cent, NSKE 5 per cent and neem leaf extract 5 per cent (0.50/ plant) followed

Table 1. Details of experiment

Treatments	Chemical name	Concentration or dosage
T_1	Neemastra	5 %
T_2	Agniastra	2 %
T_3	Brahmastra	5 %
T_4	Biodigester solution	10 %
T_5	NSKE (Neem seed kernel extract)	5 %
T_6	Neem leaf extract	5 %
T_7	*Prosopis juliflora* leaf extract	5 %
T_8	Pongemia leaf extract	5 %
T_9	Custard apple leaf extract	5 %
T_{10}	*Vitex nigundo* leaf extract	5 %
T_{11}	Pongemia leaf extract 5 per cent + *Prosopis juliflora* leaf extract 5 per cent	1:1 (1 part Pongemia 5% leaf extract + 1 part *Prosopis juliflora* 5% leaf extract)
T_{12}	Pongemia leaf extract 5 per cent + *Vitex nigundo* 5 per cent	1:1 (1 part Pongemia 5 % leaf extract + 1 part *Vitex nigundo* 5 % leaf extract)
T_{13}	Pongemia leaf extract 5 per cent + Custard apple leaf extract 5 per cent	1:1 (1 part Pongemia 5 % leaf extract + 1 part of custard apple 5 % leaf extract)
T_{14}	Neem leaf extract 5 per cent + *Prosopis juliflora* leaf extract 5 per cent	1:1 (1 part neem 5 % leaf extract + 1 part *Prosopis juliflora* 5 % leaf extract)
T_{15}	Neem leaf extract 5 per cent + *Vitex nigundo* leaf extract 5 per cent	1:1 (1 part Neem 5 % leaf extract + 1 part of custard apple 5 % leaf extract)
T_{16}	Neem leaf extract 5 per cent + Custard apple leaf extract 5 per cent	1:1 (1 part Neem 5 % leaf extract + 1 part of custard apple 5 % leaf extract)
T_{17}	RPP (Recommended package of practice).	
T_{18}	Untreated control	only water

by pongemia leaf extract 5 per cent, custard apple leaf extract 5 per cent, pongemia leaf extract 5 per cent + *V. nigundo* 5 per cent, pongemia leaf extract 5 per cent + custard apple leaf extract 5 per cent, neem leaf extract 5 per cent + *V. nigundo* leaf extract 5 per cent, neem leaf extract 5 per cent + custard apple leaf extract 5 per cent (0.70/ plant). Among biorationals, *P. juliflora* leaf extract 5 per cent (4.50/ plant) recorded significantly highest untreated check. These results of present investigation was in closely associated with results of Santhosh (2008) who revealed the efficacy of different herbal asthras and extracts against *Spodoptera litura* on soybean, among indigenous products NSKE (5 %) was the most effective (73.33 % larval mortality) followed by agniasthra (63.33 %) after 72 hours of application (Table 2).

Patil (2000) revealed that, among plants aqueous extracts of along with recommended insecticide (monocrotophos), chemical insecticide found more toxicity to larvae of *Spodoptera litura* and among different botanicals, NSKE (5%) caused highest mortality of 72.94 per cent followed by *V. negundo* leaf extract (42.57%) and *Annona squamosa* L. (40.73 %). Kavitha (2009) revealed among ecofriendly practices, treatment NSKE (5 %) + *Nomeria rileyi,* NSKE (5 %) alone, quinalphos, agniastra (5 %), brahmastra (5 %) spray and neemastra (5 %) recorded significantly less number of defoliators in groundnut ecosystem. Among biorationals agniastra found superior, this may be due to presence of mixture of phenols with known pesticidal properties, working synergistically against fall armyworm.

Table 2. Effect of different biorationals on fall armyworm, *Spodoptera frugiperda* (Smith) in *rabi* sorghum

Treatments	Dose g/ml/l	Number of fall armyworm larvae/ plant	
		45 DAS	60 DAS
Neemastra	5%	0.30 (0.89)^{b}	0.50 (1.00)^{b}
Agniastra 2%	0.30	0.40 (0.89)^{b}	(0.95)^{ab}
Brahmastra	5%	0.30 (0.89)^{b}	0.40 (0.95)^{ab}
Biodigester solution	10%	0.40 (0.95)^{bc}	0.80 (1.14)^{cd}
NSKE (Neem Seed Kernel Extract)	5%	0.30 (0.89)^{b}	0.50 (1.00)^{b}
Neem leaf extract	5%	0.30 (0.89)^{bc}	0.50 (1.00)^{b}
Prosopis juliflora leaf extract	5%	0.40 (0.95)^{bc}	0.90 (1.18)^{d}
Pongemia leaf extract	5%	0.50 (1.00)^{cd}	0.70 (1.10)^{c}
Custard apple leaf extract	5%	0.40 (0.95)^{bc}	0.70 (1.10)^{c}
Vitex nigundo leaf extract	5%	0.40 (0.95)^{bc}	0.80 (1.14)^{cd}
Pongemia leaf extract 5 %+ *Prosopis juliflora* leaf extract 5 %	1:1	0.50 (1.00)^{cd}	0.80 (1.14)^{cd}
Pongemia leaf extract 5 % + *Vitex nigundo* 5 %	1:1	0.40 (0.95)^{bc}	0.70 (1.10)^{c}
Pongemia leaf extract 5 %+ Custard apple leaf extract 5 %	1:1	0.40 (0.95)^{bc}	0.70 (1.10)^{c}
Neem leaf extract 5 %+ *Prosopis juliflora* leaf extract 5 %	1:1	0.50 (1.00)^{cd}	0.80 (1.14)^{cd}
Neem leaf extract 5 %+ *Vitex nigundo* leaf extract 5 %	1:1	0.30 (0.89)^{b}	0.70 (1.10)^{c}
Neem leaf extract 5 %+ Custard apple leaf extract5 %	1:1	0.40 (0.95)^{bc}	0.70 (1.10)^{c}
RPP (Recommended package of practice).	(0.84)^{a}	0.20 (0.77)^{a}	0.10
Untreated control		0.60 (1.05)^{d}	1.00 (1.22)^{e}

*Figures in the parenthesis are square root transformed values. Figures with common alphabet along the column do not differ by DMRT at 0.05%.

Table 3. Effect of different biorationals on fall armyworm (FAW) *Spodoptera frugiperda* (Smith) in *rabi* sorghum

Treatments	Dose g/ml/l	Per cent plant damage by fall armyworm	
		45 DAS	60 DAS
Neemastra	5%	15.81 (23.43)^{bc}	19.44 26.16)^{cd}
Agniastra	2%	13.96 (21.94)^{b}	16.66 24.09)^{b}
Brahmastra	5%	14.81 (22.63)^{b}	18.51 25.48)^{bc}
Biodigester solution	10%	23.15 (28.76)^{gh}	26.85 (31.21)^{i}
NSKE (Neem Seed Kernel Extract)	5%	15.81 (23.43)^{bc}	21.29 27.48)^{de}
Neem leaf extract	5%	17.59 (24.79)^{cd}	22.22 28.12)^{ef}
Prosopis juliflora leaf extract	5%	25.00 (30.00)^{hi}	26.85 (31.21)^{i}
Pongemia leaf extract	5%	17.59 (24.79)^{cd}	23.15 (28.76)^{efg}
Custard apple leaf extract	5%	20.37 (26.83)^{efg}	25.00 (30.00)^{ghi}
Vitex nigundo leaf extract	5%	20.37 (26.83)^{efg}	25.00 (30.00)^{ghi}
Pongemia leaf extract 5 %+ *Prosopis juliflora* leaf extract 5 %	1:1	24.07 (29.38)^{h}	25.92 (30.61)^{hi}
Pongemia leaf extract 5 % + *Vitex nigundo* 5 %	1:1	23.15 (28.76)^{gh}	26.85 (31.21)^{i}
Pongemia leaf extract 5 %+ Custard apple leaf extract 5 %	1:1	22.22 (28.12)^{fgh}	25.92 (30.61)^{hi}
Neem leaf extract 5 %+ *Prosopis juliflora* leaf extract 5 %	1:1	22.22 (28.12)^{fgh}	26.85 (31.21)^{i}
Neem leaf extract 5 %+ *Vitex nigundo* leaf extract 5 %	1:1	19.44 (26.16)^{def}	25.00 (30.00)^{efgh}
Neem leaf extract 5 %+ Custard apple leaf extract5 %	1:1	18.51 (25.48)^{de}	23.15 (28.76)^{fghi}
RPP (Recommended package of practice).		10.18 (18.61)^{a}	13.96 (21.94)^{a}
Untreated control		27.77 (31.80)^{i}	34.26 (35.82)^{j}

*Figures in the parenthesis are arc sin transformed values. Figures with common alphabet along the column do not differ by DMRT at 0.05%.

Per cent plant damage

The plant damage due to fall armyworm at 45 DAS was significantly lowest in RPP (10.18 %). Among biorationals, agniastra 2 per cent (13.96 %) and bramhastra 5 per cent (14.81%) found superior over all other treatments and on par with neemastra 5 per cent and NSKE 5 per cent (15.81 %). Next superior treatments were neem leaf extract 5 per cent and pongemia leaf extract 5 per cent (17.59 %), followed by neem leaf extract 5 per cent + custard apple leaf extract 5 per cent (18.51 %) which is on par with neem leaf extract 5 per cent + *V. nigundo* leaf extract 5 per cent (19.44 %). However, untreated check recorded highest per cent plant damage (27.77 %) by fall armyworm (Table 3).

On 60 DAS, the plant damage due to fall armyworm was significantly lowest in treatment with RPP (13.96 %) followed by agniastra 2 per cent (16.66 %) and on par with bramhastra 5 per cent (18.51%), next best treatments were neemastra 5 per cent (19.44) followed by NSKE 5 per cent (21.29 %), next superior treatments was neem leaf extract (22.22 %) and on par with pongemia leaf extract 5 per cent (23.15 %), followed by custard apple leaf extract 5 per cent and *V. nigundo* leaf extract 5 per cent (25.00 %), next superior treatments were pongemia leaf extract 5 per cent+ *P. juliflora* leaf extract 5 per cent and pongemia leaf extract 5 per cent + custard apple leaf extract 5 per cent (25.92 %) and among biorationals, biodigester solution 10 per cent, *P. juliflora* leaf extract 5 per cent and neem leaf extract 5 per cent + *P. juliflora* leaf extract 5 per cent (26.85 %) were found inferior in managing FAW. However, untreated check recorded highest per cent plant damage (34.26 %) by fall armyworm. These results of present investigation was in agreement with reports of Santhosh (2008) who revealed the efficacy of different herbal asthras and extracts against *Spodoptera litura* on soybean, among indigenous products NSKE (5%) was the most effective (73.33 % larval mortality) followed by agniasthra (63.33 %) after 72 hrs of application (Table 3).

Patil (2000) revealed that, among plants aqueous extracts of along with recommended insecticide (monocrotophos), chemical insecticide found more toxicity to larvae of *Spodoptera litura* and among different botanicals, NSKE (5%) caused highest mortality of 72.94 per cent followed by *V. negundo* leaf extract (42.57%) and *Annona squamosa* L. (40.73 %), whereas others registered mortality in between 21.11per cent to 26.64 per cent as compared to control (13%). Kavitha (2009) revealed among ecofriendly practices, treatment NSKE (5 %) + *Nomeria rileyi,* NSKE (5 %) alone, quinalphos, agniastra (5 %), brahmastra (5 %) spray and neemastra (5 %) recorded significantly less number of defoliators in groundnut ecosystem. Among biorationals agniastra found superior, this may be due to presence of mixture of phenols with known pesticidal properties working synergistically against fall armyworm.

Conclusion

Although RPP recorded lowest pest damage, biorationals like Neemastra and Agniastra also recorded lower pest damage indicating their value in pest control.

References

Ambarish S, Biradar A P, Jagginavar S B, Karbhanatanal S S and Sajjanar G M, 2017, Management of insect pests in *rabi* sorghum, *Sorghum bicolor* (L.) Moench. *International Journal of Chemical Studies*, 5(6): 642-646.

Anita V S, 2009, Non-chemical approaches for the management of shoot fly, *Atherigona soccata* Rondani in *kharif* sorghum. *M. Sc. (Agri.) Thesis,* University of Agricultural Sciences, Dharwad, Karnataka, India.

Anonymous, 2016, Package of practices for agriculture crops. University of Agricultural Sciences, Dharwad, Karnataka, India, pp. 41-52.

Anonymous, 2017, Agriculture statistics at a glance, Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare. pp. 99. agricoop.nic.in and http://eands.dacnet.nic.in

Anonymous, 2019, Office of Global Analysis, United States Department of Agriculture/ Foreign Agricultural Service. pp. 18. https://apps.fas.usda.gov/psdonline/ circulars/ production.pdf.

Biradar A P, Biradar D P, Guggari A K, Hiremath J R, Guled M B, Babalad H B, and Patil M B, 2007, biodigester solution preparation. Savayava krishiya saptapadigalu. University of Agricultural Sciences, Dharwad, pp. 104.

Bishnoi R and Bhati A, 2017, An overview: zero budget natural farming. *Trends in Biosciences*, 10 (46): 9314-9316.

Clark P L, Molina O J, Martinelli S, Skoda S R, Isenhour D J, Lee D J, Krumn J T and Foster J E, 2007, Population variation of *Spodoptera frugiperda* (Smith) in Western Hemisphere. *Journal of Insect Sciences*, 7(5): 1-10.

Kavitha A S, 2009, Eco friendly practices against major pests in different cropping systems with special reference to groundnut. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad (India).

Mallapur C P, Anjan K N, Sireesh H, Prabhu S T and Patil R K, 2018, Status of alien pest fall armyworm, *Spodoptera frugiperda* (J E Smith) on maize in northern Karnataka. *Journal of Entomology and Zoology Studies*, 6(6): 432-436.

Patil R K, 2000, Eco-friendly approaches for the management of *Spodoptera litura* (F.) in groundnut. *Ph. D. Thesis*, University of Agricultural Sciences, Dharwad, Karnataka, India.

Rosaiah R, 2001, Evaluation of different botanicals against the pest complex in bhendi (okra). *Pestology*, 25(4): 17-19.

Santhosh M N, 2008, Evaluation of ITK components against major insect pests of soybean. *Ph. D. Thesis*, University of Agricultural Sciences, Dharwad, Karnataka, India.