Performance of botanical and fungal formulation for pest management in organic okra production system

R. Harischandra Naik, N. Devakumar, Gangadhar Eshwar Rao, N. Vijaya, H.S. Imran Khan and S. Subha

ABSTRACT

In organic farming production system, biopesticides like botanicals and mycopathogenic formulation are of greater importance in managing the pest population. The evaluation of botanicals and mycopathogenic formulation were tested for their efficacy against okra leafhopper, aphids and whitefly at Organic Farming Research Centre, Navile, Shivamogga during 2009. The performance of botanicals and mycopathogenic formulation against leafhopper revealed that the Neemazol @ 3.5% recorded 2.43 and 2.60 leafhoppers/3 leaves, Neem oil @ 2% recorded 2.63 and 3.50 leafhoppers/3 leaves and NSKE @ 5% recorded 3.53 and 4.00 leafhoppers / 3 leaves. These three treatments were found superior among botanicals and *Beauveria bassiana* @ 2.5 g / l recorded 2.5 and 3.6 leafhoppers/3 leaves and was on par with other mycopathogens at 10 DAS of first and second spray, respectively. Results on aphids and whitefly were recorded as follows: Neemazol @ 3.5% recorded 1.67 and 3.17 aphids/3 leaves and 2.00 and 2.63 whitefly/3 leaves, Neem oil @ 2% recorded 1.93 and 4.33 aphids/3 leaves and 2.17and 3.40 whitefly/3 leaves and NSKE @ 5% recorded 2.00 and 6.00 aphids/3 leaves and 3.00 and 4.00 whitefly/3 leaves at 10 DAS on the first and the second spray respectively and these were found superior among botanicals. *Verticillium lecani* @ 2.5 g/l showed 2.53 and 6.67 aphids/3 leaves and 2.80 and 3.53 whitefly/3 leaves at 10 DAS on the first and the second spray respectively and was on par with other mycopathogens.

Key words: Aphids, botanicals, leafhoppers, mycopathogens, neemazol, okra, organic farming, whitefly

INTRODUCTION

Botanical and mycopathogenic pesticides are well suited for use in organic food production and may play a great role in the production and protection of food in developing countries. The current trends of modern society towards 'green consumerism' desiring fewer synthetic ingredients in food may favour plant-based products which are generally recognized as safe in ecofriendly management of plant pests as botanical pesticides (Isman *et al.*, 2006). Growing awareness of health and environmental issues associated with the intensive use of chemical inputs has led to interest in alternate forms of agriculture in the world. Demand is ever increasing for organically produced agricultural commodities all round the globe, botanical and biological agents have vital role to contain the pest damage. For organic okra production and management system needs to be solving the pest problems by application of botanicals and mycoinsecticides which would be better option. According to Agricultural and Processed Food Products Export Development Authority (APEDA) a nodal agency involved in promoting Indian organic agriculture. Growing awareness, increasing market demand, increasing inclination of farmers to go organic and growing institutional support have resulted in more than 200% growth in certified area during the last two years (Ramesh *et al.*, 2010). Okra, *Abelmoschus esculentus* (L.) Moench, one of the most important vegetable crops, has its own importance, taste, flavour and nutritional values as human food. It has good nutritional value particularly high content of calcium and vitamin C (Anitha and Nandihalli, 2008). One of the most important constraints in production of okra is insect pests. Under organic okra production, the use of botanical insecticides in pest management is considered an ecologically viable proposition which overcome pest problems. As high as 72 species of insects have been recorded on crop (Srinivasa Rao and Rajendra, 2003) among which, the sucking pest complex consisting of aphids (*Aphis gossypii* Gloner), leaf hopper (*Amrasca biguttula biguttula* Ishida), whitefly (*Bemisia tabacii* Green) are major pest and cause 17.46 per cent yield loss in okra (Sarkar *et al*., 1996). Aphids, leafhoppers and whitefly are important pests in the early stage of the crop which desap the plants, make them weak and reduce the yield

(Krishnaiah, 1980). Botanical insecticides have long been touted as attractive alternatives to synthetic chemical insecticides for pest management (Isman *et al.*, 2006; Echereobia *et al.*, 2010). Botanical pesticides are ecofriendly, economic, target-specific and biodegradable. Microbial insecticides offer effective alternatives for the control of many insect pests. Their greatest strength is their specificity as most are essentially nontoxic and non-pathogenic to animals and humans. Considering the importance of ecofriendly approaches to manage the pests, the present study was intended to evaluate botanical insecticides and mycopathogenes against three major sucking pests of okra under organic farming.

MATERIALS AND METHODS

The experiment was laid out in organic farming block in ZARS, Navile, Shimoga under organic farming practices. The randomized block design (RBD) with 4 replications in plots measuring 2.5 X 2.5 m and with a spacing of 60 cm between rows and 30 cm between plants was maintained. Arka anamika okra variety was raised during kharif by following all the recommended package of practices under organic farming except the plant protection measures. Two commercial neem formulations purchased from Pest Control India Limited, four botanical formulations were prepared in the field itself by using the locally available raw materials and three entomopathogenic fungal wettable powder formulations of the conidial strength of $1X10^8$ was purchased from Pest Control India Limited and one untreated control was kept as water spray. The treatments doses were Neemazal @3.5ml / l, Neem oil @ 3.5ml /l, NSKE @ 5ml/l, *Vitex negundo* leaf @ 5ml /l, Chilly Garlic extract @ 5ml /l, NSKE @ 2.5 ml /l + chilly garlic extracts 2.5ml /l, *Baeuveria bassiana* and *Verticillium lecanii* and *Metarrhizium anisopliae* @ 2.5 g/l used for spraying. High volume knapsack sprayer was used for spraying different formulations with a spray volume of 500 liter/hectare at 35 and 55 days after sowing for the first and the second spray. Observation of the number of leaf hoppers, aphids and whiteflies per plant were made. First spray was given at 35 days after sowing and subsequent sprays at an interval of 20 days. A day before spraying the pre count of all the sucking pests were made on 10 tagged plants from each replication of treatment forming a quadrate design which were tagged. The subsequent observations were made at 3, 7 and 10 days after each spray. The observations of both pre and post count on top three, middle three and bottom three leaves of ten plants randomly selected from each replication for three sucking pests of okra were made. The data were subjected to statistical analysis and interpreted in results.

RESULTS AND DISCUSSION

Under organic farming system, the nutrient supply at recommended dose to the crop by means of organic sources only and plant protection should be through non chemical measures like botanicals, biorationals, mycopathogens and biological control. In this context, the present study showed the performance of some of the botanicals and mycopathogens against okra leafhoppers, aphids and whitefly. In case of leafhoppers, the pre observation showed the presence of the leafhoppers at a range of 8.43 to 9.70 and 10.00 to 14.00 on the first and the second sprays, respectively. Among all the treatments tested, the Neemazol@3.5% Neem oil @3.5% NSKE@5% were found superior among botanicals and on par with others and while in case of mycopathogens, the maximum control and superiority was found in *B.bassiana* @2.5 g / l was on par with other mycopathogens like *V.lecanii* @2.5g/l and *M.anisopliae* @2.5g/l at 10 DAS on the first and the second spray respectively (Table 1). The present findings are in agreement with those of Rosaiah (2001) who reported that, the higher efficacy of neem oil @ 2 per cent against the leaf hoppers found significantly superior by recording least leaf hopper population. Higher efficacy of neemazol and neem oil on leaf hopper may be due to feeding deterrence in addition to mortality. The present findings are in comparison with those of Anita (2007) who reported that the neem oil and *M. anisopliae* recorded 2.56 and 8.33 mean number of leaf hopper / 3leaves. Girish Kumar (2000) reported that the *V. lecanii* and *B. bassiana* fungi infection of leaf hopper and field collected live leaf hoppers carried infection by entomopathogens, viz., *V. lecanii* and *B. bassiana*. Present findings are in line with those of Virakthamat *et al.* (1994), who reported that *V. lecanii* on the mango leafhoppers *I. nitidulaus* and *I. nagpurensis* recorded the dead leaf hoppers 35.3 leaf hoppers/20 shoots.

Aphid population during the pre observation was in the range of 7.83 to 9.83 and 16.33 to 19.80 at the first and the second spray, respectively. Commercial neem formulation, Neemazol, Neem oil and NSKE recorded the least aphids population. Results on aphids revealed that Neemazol @3.5%, Neem oil @2%, NSKE@5% were found superior among other botanicals like *Vitex negundo* leaf extract @5%, chilly garlic leaf extract @5% and Neemazol+chillygarlic leaf extracts and *V. lecanii* @ 2.5 g/l was superior to the *M. anisopliae* @2.5g/l and on par with *B. bassiana* @2.5g/l (Table 2). The present findings are in agreement with those of Anita (2007) who reported that neem oil and *V. lecanii* recorded 2.56 and 3.33 mean number of aphids/3 leaves. Kabir and Mia (1987), who reported that NSKE @ 5% was found effective against mustard aphid. Bhavani Sankar Rao *et al.* (1991) reported that neem oil @1 % showed 63% reduction in aphid population over untreated check. Efficacy of mycopathogen against aphids is in

Table 1. Efficacy of botanicals and mycopathogenic formulation against leafhoppers on okra

Treatments	Number of leafhoppers/ 3 leaves									
	I Spray					II Spray				
	DBS	3 DAS	7DAS	10 DAS	Mean	DBS	3 DAS	7DAS	10 DAS	Mean
T_1 – Neemazal (3.5%)	9.30^{a}	2.27^{a}	2.00^{a}	2.43^{a}	2.2	13.00^{a}	2.83^{a}	3.47^{a}	2.60^{a}	3.0
T_2 – Neem oil (2%)	8.67^{a}	2.60^{a}	2.17^{ab}	2.63^{a}	2.5	11.67^{a}	3.53^{a}	3.17^{a}	3.50^{ab}	3.4
T_3 –NSKE (5%)	9.77^{a}	3.50^{abc}	3.53^{abc}	4.50^{ab}	3.8	12.67^{a}	4.00^{abc}	3.67^{a}	4.00^{abc}	3.9
T_4 -*Vitex negundo* leaf extract (5%)	9.53^{a}	6.50^{d}	6.00^{c}	7.20^{bc}	6.6	13.50^{a}	8.67^{bd}	7.83^{bd}	7.83^{e}	8.1
T_5 -Chilly, Garlic extracts (5%)	8.67^{a}	4.67^{dbc}	3.90^{abc}	4.80^{ab}	4.5	10.00^{a}	6.50^{bcd}	5.60^{ab}	6.17^{cd}	6.1
T_6 -Neemazal+ Chilly Garlic extracts (5%)	9.70^{a}	2.87^{abc}	2.37^{ab}	3.53^{a}	2.9	14.00^{a}	4.83^{abc}	4.00^{a}	4.67^{bcd}	4.5
T_7 - *Beauveria bassiana* (2.5g/l)	8.43^{a}	3.80^{abc}	3.43^{abc}	4.67^{ab}	4.0	12.00^{a}	4.50^{abc}	4.20^{ab}	4.87^{bcd}	4.5
T_8 - *Verticillium lecani* (2.5g/l)	9.67^{a}	2.67^{a}	2.20^{ab}	2.77^{a}	2.5	14.67^{a}	3.67^{ab}	3.33^{a}	3.83^{ab}	3.6
T_9 -*Metarhizium anisopliae* (2.5g/1)	7.47^{a}	4.97^{dc}	4.37^{bc}	5.27^{ab}	4.9	12.67^{a}	6.70^{cd}	6.10^{ab}	6.93^{d}	6.6
T_{10} -Water spray	8.50^{a}	10.00^{e}	9.50^{d}	11.17^{c}	10.2	13.17^{a}	13.33^{e}	13.00^{d}	14.33	13.6
CV (%)	9.44	14.87	19.74	19.70	-	12.19	16.62	20.65	13.22	-
SE m $\pm$	0.2300	0.2441	0.3062	0.3590	-	0.3531	0.3156	0.3772	0.2524	-
CD at 0.05	0.4832	0.5128	0.6434	0.7542	-	0.7419	0.6630	0.7924	0.5302	-

DBS-Day before spraying; DAS-Day after spray; Figures in the same column with similar alphabets do not differ significantly at P=0.05 by DMRT

Table 2. Efficacy botanicals and mycopathogenic formulations against aphids on okra

Treatments	Number of aphids/ 3 leaves									
	I Spray					II Spray				
	DBS	3 DAS	7DAS	10 DAS	Mean	DBS	3 DAS	7DAS	10 DAS	Mean
T_1 – Neemazal (3.5%)	8.67^{a}	1.93^{a}	1.50^{a}	1.67^{a}	1.7	18.67^{a}	4.50^{a}	3.33^{a}	3.17^{a}	3.7
T_2 – Neem oil (2%)	7.83^{a}	2.17^{a}	1.83^{ab}	1.93^{ab}	2.0	19.50^{a}	6.67^{ab}	5.00^{ab}	4.33^{ab}	5.3
T_3 –NSKE (5%)	9.17^{a}	2.50^{ab}	2.00^{ab}	2.00^{ab}	2.2	17.00^{a}	9.33^{bc}	5.67^{abc}	6.00^{abc}	7.0
T_4 -*Vitex negundo* leaf extract (5%)	8.67^{a}	4.83b^{cd}	3.67^{bc}	4.67^{bcd}	4.4	18.00^{a}	11.67^{c}	9.00^{d}	9.67^{c}	10.1
T_5 -Chilly, Garlic extracts (5%)	9.50^{a}	3.67^{abc}	2.67^{ab}	3.67^{abc}	3.3	18.00^{a}	9.20^{bc}	6.33b^{cd}	6.87^{bc}	7.5
T_6 -Neemazal + Chilly Garlic extracts (5%)	8.93^{a}	3.33^{abc}	2.33^{ab}	3.33^{abc}	3.0	17.33^{a}	10.67^{c}	7.33b^{cd}	8.53^{c}	8.8
T_7 - *Beauveria bassiana (2.5%)*	8.33^{a}	3.87^{abc}	3.33^{abc}	3.50^{abc}	3.6	16.33^{a}	12.20^{c}	7.33b^{cd}	7.67^{bc}	9.1
T_8 - *Verticillium lecani (2.5g/l)*	9.50^{a}	2.50^{a}	2.33^{ab}	2.53^{ab}	2.5	19.80^{a}	10.67^{c}	6.00b^{cd}	7.00^{bc}	7.9
T_9 -*Metarhizium anisopliae (2.5g/l)*	9.83^{a}	5.67^{cd}	5.67^{cd}	6.67^{cd}	6.0	17.00^{a}	12.33^{c}	8.67^{cd}	9.00^{c}	10.0
T_{10} -Water spray	8.83^{a}	8.00^{d}	8.33^{d}	8.67^{d}	8.3	19.33^{a}	19.00^{d}	20.00^{e}	21.00^{d}	20.0
CV (%)	9.26	19.56	22.34	24.62		4.16	10.31	12.60	17.23	
SE m$\pm$	0.3163	0.3011	0.3161	0.3742		0.1443	0.2693	0.2782	0.8192	
CD at 0.05	0.6646	0.6327	0.6641	0.7863		0.3032	0.5658	0.5845	0.3899	

DBS-Day before spraying; DAS-Day after spray; Figures in the same column with similar alphabets do not differ significantly at P=0.05 by DMRT

Table 3. Efficacy of botanicals and mycopathogenic formulation against whiteflies on okra

Treatments	Number of whiteflies / 3 leaves									
	I Spray					II Spray				
	DBS	3 DAS	7DAS	10 DAS	Mean	DBS	3 DAS	7DAS	10 DAS	Mean
T_1 - Neemazal (3.5%)	5.83 [a]	2.17 [a]	1.60 [a]	2.00[a]	1.9	7.23 [a]	2.83 [a]	2.33[a]	2.63[a]	2.6
T_2 – Neem oil (2%)	6.00 [a]	2.50 [ab]	2.00 [ab]	2.17[a]	2.2	9.00 [a]	3.17 [a]	2.90[ab]	3.40[a]	3.2
T_3 –NSKE (5%)	5.67 [a]	3.00 [abc]	3.17 [bcd]	3.00[ab]	3.1	8.33 [a]	3.77 [b]	3.87[b]	4.00[a]	3.9
T_4 -*Vitex negundo* leaf extract (5%)	5.00 [a]	4.77 [cd]	3.17 [bcd]	3.73[bc]	3.9	8.00 [a]	6.33 [e]	6.00[c]	6.93[cd]	6.4
T_5 -Chilly, Garlic extracts (5%)	6.00 [a]	4.00 [bcd]	3.53 [cd]	2.67[ab]	3.4	8.33 [a]	4.00 [b]	4.00[b]	4.50[abc]	4.2
T_6 -Neemazal+ Chilly Garlic extracts (5%)	5.67 [a]	3.33 [abc]	3.00 [abcd]	3.27[ab]	3.2	9.00 [a]	3.77 [b]	4.00[b]	4.33[ab]	4.0
T_7 - *Beauveria bassiana* (2.5g/l)	5.70 [a]	3.67 [bcd]	3.40 [c]	3.67[bc]	3.6	8.00 [a]	5.70 [d]	5.90[c]	6.67[cd]	6.1
T_8 - *Verticillium lecani* (2.5g/l)	6.33 [a]	3.00 [abc]	2.53 [abc]	2.87[abc]	2.8	8.50 [a]	4.63 [c]	3.10[ab]	3.53[a]	3.8
T_9 -*Metarhizium anisopliae*(2.5g/l)	5.67 [a]	4.83 [d]	4.57 [de]	5.17[d]	4.9	8.67 [a]	7.67 [f]	6.50[cd]	6.47[bcd]	6.9
T_{10} -Water spray	6.50[a]	5.50 [d]	5.67 [e]	5.93[d]	5.7	8.00 [a]	7.50 [f]	8.00[d]	8.50[d]	8.0
CV (%)	11.64	18.86	14.84	13.02		5.00	2.93	9.69	14.24	
SE m±	0.2298	.2865	0.2141	0.1934		0.1175	0.0523	0.1672	0.2567	
CD at 0.05	0.4827	0.6019	0.4499	0.4064		0.2469	0.1099	0.3513	0.5394	

DBS-Day before spraying; DAS-Day after spray; Figures in the same column with similar alphabets do not differ significantly at P=0.05 by DMRT

accordance with Nirmala *et al*. (2006), *V. lecanii* recorded maximum mortality of *A. craccivora* and *A. gossypii*.

The observation on whitefly were recorded that the Neemazol @ 3.5% (2.00 and 2.63 whitefly/3leaves), Neem oil @ 2%, NSKE @ 5% were found superior among botanicals and *V. lecanii* @ 2.5 g/ l was on par with *B. Bassiana* @ 2.5 g / l and significantly superior to the *M.anisopliae* @ 2.5g /l in reducing the whitefly population at 10 DAS on first and second spray respectively (Table 3). In both the sprays, the water spray proved poorer. The present findings are in agreement with those of Mallappanavar (2000) who observed that the reduction of different stages of whiteflies was distinctly evident at 15 DAS results indicated that *V. lecanii* @ 1.33 × 10^8 spores per ml and Vertilec 7.5 g per litre were found to be most effective. Andrew *et al.* (2004) reported *Lecanicillium muscarium* oil formulation to be reducing *B.tabaci* on tomato and verbena foliage at high humidity. Anitha (2007) reported that *V. lecanii* was significantly superior in controlling the whiteflies and was on par with NSKE. The effectiveness of *V. lecanii* is in agreement with Quinden (1994), Meade and Bruce (1991) and Nier *et al.* (1993), according to whom *V. lecanii* formulation was found effective against whitefly, *B. tabaci*.

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R. Harischandra Naik*, N.Devakumar, Gangadhar Eshwar Rao, N. Vijaya, H.S. Imran Khan and S. Subha

Organic Farming Research Centre, Navile, Shivamogga, India, *Communication author E-mail: harientomology@gmail.com

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