International J. Seed Spices 9(1), January 2019:85-90

Field evaluation of IPM modules for thrips management in fennel under integrated organic farming system

N.K. Meena, G. Lal*, R.D. Meena and M.K. Choudhary

ICAR-National Research Centre on Seed Spices, Tabiji - 305 206, Ajmer, Rajasthan

Abstract

In replicated field trials, six organic based IPM modules (including control) were evaluated for the management of thrips's mixed population on fennel (*Foeniculum vulgare* Mill.) for two consecutive years. The pooled result obtained the maximum reduction (63.22%) in thrips population on the plants treated with IPM module M-3 (Garlic extract @10 ml lit.$^{-1}$ + azadirachtin 0.03% EC @ 5ml lit.$^{-1}$ + tumba fruit extract @10ml lit.$^{-1}$) followed by M-2 (sanitation + NSKE @ 5ml lit.$^{-1}$ + Ker plant extract @ 10ml lit.$^{-1}$) reduced 61.16 per cent population. IPM module M-1 consisted by sanitation + yellow sticky traps @ 25 no./Acre + *Neem* guard @ 3 ml lit.$^{-1}$, minimize the thrips population of 54.01 percent categorized as least effective module, whereas, IPM module M-4 and M-5 were observed as middle order of effectiveness for the management of thrips on fennel under field conditions.

Key words : *Foeniculum vulgare*, IPM modules, organic farming, thrips.

Introduction

Fennel (*Foeniculum vulgare* Mill.; chromosome number 2n=22) is an herbaceous biennial or perennial plant belongs to family Apiaceae. In India it is commercially cultivated as an annual herb for various uses. In India it has been considered as major and important seed spice crop, mainly growing in the states of Gujarat, Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, Tamil Nadu, Maharashtra, Bihar and few other states in small pockets under 89850 hectare area, produces 148640 tonnes of seed with an average productivity of 1433 kg hectare^{-1}. Fennel seeds are exporting for a volume of 34550 tonnes for a value of ₹ 25906 lakh during 2017-18 reflecting its potentiality. Fennel is primarily used for flavouring, seasoning and imparting aroma in variety of food items and beverages. It is a rich source of nutrients contain protein 1.24 g, carbohydrate 7.3g, minerals like calcium 49 g, iron 0.73 g, phosphorus 50g and zinc 0.2g; vitamin C 12mg, riboflavin B-2 0.032g, fatty acids 0.09g in per 100g as well as essential amino acids and nonessential amino acids (Badgujar *et al.*, 2014). Besides importance in food industry, it also has several medicinal properties used in healing of various ailments like mouth ulcer (Guarrera *et al.*, 2005), abdominal pain (Savo, 2011), swollen stomach (Guarrera *et al.*, 2005), diarrhoea (Neves *et al.*, 2009), kidney ailments (Macia *et al.*, 2005), liver pain (Albuquerque *et al.*, 2007) and arthritis (Lewu and Afolayan 2009). It is also uses in pharmaceutical preparations as well as in cosmetic industry.

A number of insect pests, *viz.*, aphids, *Myzus persicae* Sulzer, *Hyadaphis coriandri* Das and *Aphis gossypii* Glover (Hemiptera: Aphididae), thrips- *Thrips tabaci, Thrips flavus* Schrank (Thysanoptera: Thripidae); jassid, *Empoasca kerri* Pruthi (Hemiptera: Cicadellidae), leaf eating caterpillar/pod borer, *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae), cutworm, *Agrotis ipsilon* Hufnagel and *Agrotis segetum* Denis (Lepidoptera: Noctuidae), whitefly, *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae), seed wasp, *Systole albipennis* Walke (Hymenoptera: Eurytomidae), seed bugs, *Nysius* sp. (Hemiptera: Lygaeidae) and termite, *Odontotermes obesus* Ramb. (Isoptera: Termitidae) inflict damage to fennel right from germination to harvesting of the crop. Among described pests, thrips's mixed population initiated in early growth stage (25-30 days after germination) to cause damage on crop. The nymph and adults of this insect crash the epidermis layer of leaves, stem and shoots by rasping and sucking type of mouth parts and suck the out coming sap. Due to infestation, small irregular shape patches appeared on leaves, deformation of new shoots appeared on small plants as resulted plant growth (health) deteriorated and seed production affected if control measures not followed on time. Minimization of various health hazards, insecticidal pollution, pest resistance to insecticides, pests out break and resurgence are urgently necessitated. Keeping these in view, some organic based IPM modules consisted by agronomical practices, mechanical means, few botanical products and

*Corresponding author email: glal67@yahoo.co.in

bio-pesticides were evaluated for the management of thrips under field conditions to make a tool of IPM as integrated organic farming system.

Materials and methods

Field experiments on evaluation of IPM modules for thrips management in fennel under integrated organic farming system was carried out at Research Farm, ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan (coordinates: 74^0 35' 39'' E and 26^0 22' 31'' N) for two consecutive years during *Rabi* 2016-17 and 2017-18 to find out the effectiveness of various IPM tools as organic based pest management approach against thrips, which considered under integrated organic farming system of seed spices. The experiments were laid out in randomized block design with four replications. The seeds of fennel variety AF-1 were sown in organic block under well prepared plots sized of 20 m^2 (5m x 4m length and width). The crop geometry of 60 cm x 30 cm (row to row and plant to plant distance) was kept and all recommended organic package of practices were adapted to the crop for luxurious growth and development. Six IPM modules (M1- Sanitation + yellow sticky traps @ 25 no. Acre.$^{-1}$ + *Neem* guard @ 3 ml lit.$^{-1}$; M2- Sanitation + NSKE @ 5ml lit.$^{-1}$ + ker plant extract @ 10ml lit.$^{-1}$; M3- Garlic extract @10 ml lit.$^{-1}$ + azadirachtin 0.03% EC @ 5ml lit.$^{-1}$ + tumba fruit extract @10ml lit.$^{-1}$; M4- Datura leaf extract @ 10ml lit.$^{-1}$ + cow urine & butter milk 50% + *Verticillium lecanii* 5g lit.$^{-1}$; M5- *Neem* oil 3 ml lit.$^{-1}$ + castor leaf extract 10ml lit.$^{-1}$ + tumba fruit extract @10ml lit.$^{-1}$, and M6- untreated control) were applied when sufficient thrips population observed on the plants. Ker (*Capparis deciduas*), tumba (*Citrullus colocynthis*), castor (*Ricinus communis*) and datura (*Datura stramonium*) are locally available in the vicinity were collected and brought into the laboratory. Plant sap of collected material was extracted with juice extracting machine by adding water as needed and then filtered through muslin cloth. The spray solutions of these botanicals were prepared by dissolving recommended doses of extracts in one litre of water and also added sticker @ 1 ml lit.$^{-1}$ of water for spraying on the crop. The data on thrips population were recorded from five randomly selected and tagged plants plot^{-1}. Initially whole plant were taken into account for observations but in later stages, three leaves plant^{-1}, one each from top, middle and bottom were taken for the observations. Pre treatment data were recorded one day before application of treatments and the post treatment data were recorded after one, three and seven days of each spray application. The reduction percentage of thrips population was calculated by using Abott (1925) formula:

$$P = \frac{T - C}{100 - C} \times 100$$

Where,

P = Corrected per cent mortality

T = Observed per cent mortality in treatment

C = Percent mortality in control.

The data on corrected mortality so obtained were converted into arc sin values and tabulated to statistically analysis to determine the various treatment effects.

Results and discussion

The data on per cent reduction in thrips population is presented in Table 1-2 revealed that, the applied organic based IPM modules were found effective in the management of thrips on fennel crop. It brought from the study that thrips population was reduced significantly after each interval *viz.*, 1, 3 and 7 days after treatment application. Amongst three observed intervals, maximum percent reduction in thrips population was recorded on seventh day after each spray application followed by 3 and 1 days after spray in all IPM modules and was being significantly superior over untreated control. In first year during 2016-17, all the treatments (IPM modules) were found significantly superior over untreated control in management of thrips in all intervals. However, the highest reduction in thrips population (62.18, 68.14 and 71.55% in first, second and third spray, respectively) was observed under application of IPM module M-3 (Garlic extract @10 ml lit^{-1} + azadirachtin 0.03% EC @ 5ml lit^{-1} + tumba fruit extract @10ml lit^{-1}) followed by IPM module M-2 wherein, thrips populations were reduced by 58.62, 67.48 and 69.33 per cent in first, second and third spray application, respectively. Both the modules were found statistically at par to each other in their effectiveness for thrips management. IPM module M-1 consisted by sanitation + yellow sticky traps @ 25/Acre + *Neem* guard @ 3ml lit.$^{-1}$, was found least effective against thrips (Table 1). Based on average percent reduction of three spray applications, all IPM modules were found significantly superior over control, however, maximum reduction (62.37%) in thrips population was recorded under the treatment of IPM module M-3 followed by IPM module M-2 (60.83%). The minimum reduction (53.66%) in thrips population was observed under the treatment of IPM module M-1 followed by M-4 and M-5 reduced 56.10 and 55.40 percent, respectively (Table 1).

In second year, all treatments (organic based IPM modules) were found significantly superior over untreated control during entire days after application (Table 2). IPM module M-3 was noticed as most effective module amongst six evaluated modules against thrips on

Table 1. Field evaluation of IPM modules for thrips management in fennel under organic farming system during 2016-17

IPM modules	Per cent reduction in thrips population												Grand Mean
	First Spray			Mean	Second Spray			Mean	Third Spray			Mean	
	1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		
M1- Sanitation + yellow sticky traps @ 25 no. /hac. + *Neem* guard @ 3 ml/lit.	46.25# (42.85)	51.23 (45.71)	52.82 (46.62)	50.10 (45.06)	48.76 (44.29)	54.19 (47.40)	59.83 (50.67)	54.26 (47.45)	52.33 (46.35)	56.20 (48.57)	61.30 (51.54)	56.62 (48.82)	53.66 (47.11)
M2- Sanitation + NSKE @5ml/lt + ker plant extract @ 10ml/lit.	52.33 (46.34)	55.31 (48.05)	58.62 (49.97)	55.42 (48.12)	53.56 (47.04)	61.21 (51.48)	67.48 (55.32)	60.75 (51.28)	61.63 (51.73)	67.97 (55.58)	69.33 (56.39)	66.32 (54.58)	60.83 (51.33)
M3- Garlic extract @10 ml/lit + azadirachtin 0.03% EC @ 5ml/lit. + tumba fruit extract @10ml/lit.	53.27 (46.88)	59.54 (50.51)	62.18 (52.05)	58.33 (49.81)	54.66 (47.68)	61.10 (51.43)	68.14 (55.64)	61.30 (51.58)	62.35 (52.13)	68.54 (55.89)	71.55 (57.81)	67.48 (55.29)	62.37 (52.23)
M4- Datura leaf extract @ 10ml/lit. + cow urine & butter milk 50% + *Verticillium lecanii* 5g/lit.	50.25 (45.14)	52.47 (46.42)	56.76 (48.90)	53.16 (46.82)	49.23 (44.56)	58.37 (49.83)	61.75 (51.80)	56.45 (48.73)	54.00 (47.29)	57.34 (49.22)	64.73 (53.60)	58.69 (50.04)	56.10 (48.53)
M5- Neem oil 3 ml/lit. + castor leaf extract 10ml/lit.+ tumba fruit extract 10ml/lit.	45.68 (42.51)	48.64 (44.22)	54.63 (47.66)	49.65 (44.80)	49.00 (44.43)	57.88 (49.54)	60.49 (51.07)	55.79 (48.34)	56.10 (48.51)	60.23 (50.94)	65.95 (54.31)	60.76 (51.26)	55.40 (48.13)
M6- untreated control	-	-	-		-	-	-		-	-	-		
SEm±	0.68	0.71	0.87		0.70	0.80	0.90		0.79	0.93	0.81		
CD (P=0.05)	2.04	2.13	2.61		2.12	2.40	2.71		2.39	2.81	2.43		

Average of four replications; figure in parenthesis are arc transformed values; DAS- days after spray

Table 2. Field evaluation of IPM modules for thrips management in fennel under organic farming system during 2017-18

IPM modules	Per cent reduction in thrips population												Grand Mean
	First Spray			Mean	Second Spray			Mean	Third Spray			Mean	
	1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		
M1- Sanitation + yellow sticky traps @ 25 no./hac. + *Neem* guard @ 3 ml/lit.	44.72 (41.97)	47.08 (43.33)	51.00 (45.57)	47.60 (43.62)	49.71 (44.83)	56.44 (48.70)	65.30 (53.92)	57.15 (49.15)	51.66 (45.95)	60.48 (51.05)	62.85 (52.45)	58.33 (49.82)	54.36 (47.53)
M2- Sanitation + NSKE @5ml/lit + Ker plant extract @ 10ml/lit	50.00 (45.00)	53.43 (48.70)	63.94 (53.10)	56.79 (48.93)	53.12 (46.79)	64.70 (53.56)	68.81 (56.07)	62.21 (52.14)	59.83 (50.67)	63.21 (52.67)	73.37 (58.95)	65.47 (54.10)	61.49 (51.72)
M3- Garlic extract @10 ml/lit + azadirachtin 0.03% EC @ 5ml/lit. + tumba fruit extract @10ml/lit.	53.16 (46.81)	57.11 (49.09)	68.08 (55.60)	59.45 (50.50)	55.78 (48.32)	65.13 (53.82)	70.64 (57.20)	63.85 (53.11)	60.79 (51.24)	70.14 (56.88)	75.77 (60.52)	68.90 (56.21)	64.07 (53.28)
M4- Datura leaf extract @ 10ml/lit. + cow urine & butter milk 50% + *Verticillium lecanii* 5g/lit	48.46 (44.12)	52.09 (46.20)	56.35 (48.65)	52.30 (46.32)	50.34 (45.19)	61.51 (51.67)	64.25 (53.28)	58.70 (50.05)	55.10 (47.93)	62.98 (52.53)	69.90 (56.74)	62.66 (52.40)	57.89 (49.59)
M5- *Neem* oil 3 ml/lit. + castor leaf extract 10ml/lit.+ tumba fruit extract 10ml/lit.	45.97 (42.68)	49.10 (44.48)	53.58 (47.06)	49.55 (44.74)	51.68 (45.97)	62.20 (52.07)	64.41 (53.40)	59.43 (50.48)	54.72 (47.71)	62.10 (52.01)	64.08 (53.21)	60.30 (50.98)	56.43 (48.73)
M6- untreated control	-	-	-		-	-	-		-	-	-		
SEm±	0.63	0.75	0.66		0.73	0.69	0.77		0.63	0.65	0.85		
CD (P=0.05)	1.89	2.25	1.98		2.21	2.07	2.33		1.89	1.96	2.56		

Average of four replications; figure in parenthesis are arc transformed values; DAS- days after spray

Table 3. Field evaluation of IPM modules for thrips management in fennel under organic farming system during (Pooled 2016-17 & 2017-18)

IPM modules	Per cent reduction in thrips population												Grand Mean
	First treatment			Mean	Second treatment			Mean	Third treatment			Mean	
	1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		
M1- Sanitation + yellow sticky traps @ 25 no./hac. + *Neem* guard @ 3 ml/lit.	45.49 (42.41)	49.16 (44.52)	51.91 (46.10)	48.85 (44.34)	49.24 (44.56)	55.32 (48.05)	62.57 (52.29)	55.71 (48.30)	52.01 (46.15)	58.34 (49.81)	62.08 (52.00)	57.48 (49.32)	54.01 (47.32)
M2- Sanitation + NSKE @5ml/lit + Ker plant extract @ 10ml/lit	51.17 (45.67)	55.87 (48.37)	61.23 (51.53)	56.11 (48.52)	53.34 (46.92)	62.96 (52.52)	68.15 (55.69)	61.48 (51.71)	60.75 (51.22)	65.50 (54.12)	71.35 (57.67)	65.90 (54.34)	61.16 (51.52)
M3- Garlic extract @10 ml/lit + azadirachtin 0.03% EC @ 5ml/lit. + tumba fruit extract @10ml/lit.	53.22 (46.84)	58.33 (49.80)	65.13 (53.83)	58.89 (50.16)	55.22 (48.00)	63.12 (52.63)	69.39 (56.42)	62.58 (52.35)	61.57 (51.70)	69.34 (56.33)	73.66 (59.16)	68.19 (55.75)	63.22 (52.75)
M4- Datura leaf extract @ 10ml/lit. + cow urine & butter milk 50% + *Verticillium lecanii* 5g/lit	49.36 (44.63)	52.28 (46.31)	56.53 (48.77)	52.73 (46.57)	49.79 (44.88)	59.94 (50.75)	63.00 (52.54)	57.58 (49.39)	54.55 (47.61)	60.13 (50.87)	67.32 (55.17)	60.68 (51.22)	56.99 (49.06)
M5- *Neem* oil 3 ml/lit. + castor leaf extract 10ml/lit.+ tumba fruit extract 10ml/lit.	45.83 (42.60)	48.87 (44.35)	54.11 (47.33)	49.60 (44.77)	50.34 (45.20)	60.04 (50.80)	62.45 (52.23)	57.61 (49.41)	55.41 (48.11)	61.17 (51.43)	65.02 (53.76)	60.53 (51.12)	55.91 (48.43)
M6- untreated control	-	-	-		-	-	-		-	-	-		
SEm±	0.65	0.73	0.76		0.72	0.74	0.84		0.71	0.79	0.83		
CD (P=0.05)	1.96	2.19	2.30		2.16	2.23	2.52		2.14	2.39	2.49		

Average of four replications; figure in parenthesis are arc transformed values; DAS- days after spray

F. vulgare which reduced 68.08, 70.64 and 75.77 per cent population in first, second and thirds spray treatments, respectively followed by IPM module M-2 reduced 63.94, 68.81 and 73.37 per cent population and these treatments were statistically at par with each other at seventh days of second and third spray applications. The next effective IPM modules were M-4 and M-5 reduced 56.35, 64.25, 69.90 and 53.58, 64.41 and 64.08 per cent population, respectively, whereas minimum reduction (51.00, 65.30 and 62.85%) in thrips population was recorded on the plants treated with IPM module M-1. No work was done on effectiveness of such organic based IPM modules against thrips especially on fennel (*F. vulgare*) so far, hence the results couldn't compare and discussed. However, the similar results obtained by Torkey *et al.*, (2009) on other crop, i.e. *Citrullus colocynthis* has good insecticidal property against *Aphis craccivora*, get support the present findings. Meena *et al.*, (2016) also reported the insecticidal evidence in the extract obtained from *Capparis deciduas* (ker extract), *Allium sativum* (garlic extract), *Datura stramonium* (datura leaf extract) and *Ricinus communis* (castor leaf extract) against aphid on coriander are accordance with present finding. In an another study was carried out by Mamun and Ahmed (2011) in Bangladesh, showed that some plant extract i.e. lantana extract, custard apple leaf extract, datura extract were found effective in management of sucking pests and mites in tea gardens, also support the present findings.

Based on pooled data for the years of 2016-17 and 2017-18 are presented in Table 3, revealed that, the average per cent mortality in thrips population was ranged from 54.01 to 63.22 per cent under field conditions. All the treatments were recorded significantly superior over untreated control in reduction of thrips population over the season in both the years. The maximum average reduction (63.22%) in thrips population was recorded in IPM module M-3 followed by IPM module M-2 (61.16%), whereas, minimum mean per cent reduction in thrips population was recorded in IPM module M-1 (54.01%) over the season in both years.

Conclusion

It is concluded from the present study that thrips causes damage to fennel crop in early growth stage and its management in needed for quality growth and yield. In organic production system of seed spices, IPM module consisted by garlic extract @10 ml lit^{-1} + azadirachtin 0.03% EC @ 5ml lit^{-1} + tumba fruit extract @10ml lit^{-1}, given best management of thrips under field conditions.

References

Albuquerque, U. P. de., Medeiros, P. M. de., Almeida, A. L. S. de. 2007. Medicinal plants of the caatinga (semi-arid) vegetation of NE Brazil: a quantitative approach. *J. Ethnopharmacology*, 114 (3): 325–354.

Badgujar, S. B., Patel, V. V. and Bandivdekar, A. H. 2014. *Foeniculum vulgare* Mill: A review of its botany, phytochemistry, pharmacology, contemporary application and toxicology. *Bio Med Res Int.,* 1-32.

Lewu, F. B. and Afolayan, A. J. 2009. Ethnomedicine in South Africa: the role of weedy species. *African Journal of Biotechnology*, 8 (6): 929–934.

Guarrera, P. M., Forti, G. and Marignoli, S. 2005. Ethnobotanical and ethnomedicinal uses of plants in the district of Acquapendente (Latium, Central Italy). *J. Ethnopharmacology*, 96 (3): 429–444.

Guarrera, P. M., Salerno, G. and Caneva, G. 2005. Folk phytotherapeutical plants from Maratea area (Basilicata, Italy). *J. Ethnopharmacology*, 99 (3): 367–378.

Macia, M. J., Garcia, E. and Vidaurre, P. J. 2005. An ethnobotanical survey of medicinal plants commercialized in the markets of la Paz and El Alto, Bolivia. *J. Ethnopharmacology*, 97 (2): 337–350.

Mamun, M. S. A. and Ahmed, M. 2011. Prospect of indigenous plant extract in tea pest management. *International J. Agril. Res. Innov. & Tech.*, 1:16-23.

Meena, N. K., Singh, B., Lal, G., Kant, K. and Meena, R.D. 2016. Sustainable management of aphid in coriander (*Coriandrum sativum* L.) through botanicals and bio-pesticides. *International J. Seed Spices*, 6 (1): 25-31.

Neves, J. M., Matos, C. M. C., Queiroz, G. and Gomes, L. R. 2009. Ethno pharmacological notes about ancient uses of medicinal plants in Tras-os-Montes (northern of Portugal). *J. Ethnopharmacology*, 124 (2): 270–283.

Savo, V., Giulia, C. Maria, G. P. and David, R. 2011. Folk phytotherapy of the Amalfi Coast (Campania, Southern Italy). *J. Ethnopharmacology*, 135 (2): 376–392.

Torkey, H. M., Abou-Yousef, H. M., Abdel Azeiz, A. Z. and Hoda, E. A. F. 2009. Insecticidal effect of Cucurbitacin E glycoside isolated from *Citrullus colocynthis* against *Aphis craccivora*. *Australian J. Basic and Applied Science*, 3: 4060-4066.

Received : November 2018; Revised : December 2018; Accepted : December 2018.