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Eco-friendly management of two spotted spider mite, *Tetranychus urticae* (Koch) in Brinjal

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ABSTRACT

The effect of the application of acaropathogenic fungi viz., *Beauveria bassiana, Nomuraea anisopliae, Lecanicillium lecanii, Hirsutella thompsonii* and biopesticides viz., azadirachtin 1500 ppm, azadirachtin 3000 ppm, azadirachtin 10000 ppm and Fortified Neem oil were tested with synthetic acaricides like Propargite and Fenazaquin against two-spotted spider mite (*Tetranychus urticae*). The result of evaluation of acaropathogenic fungi revealed that low mite population of 5.68 nos/2cm^2 was observed in Fenazaquin 10 EC @ 1.5ml/l applied plot with 69.78% reduction in mite population followed by Propargite and *Nomuraea anisopliae* treated plots and the result of evaluation of botanicals revealed that the application of Azadiractin 10000 ppm @ 2 ml/l resulted in low mite population of 6.75 nos /2 cm^2 with 64.11% reduction over control. Therefore, the present investigation outlines the efficacy of plant extracts and acaropathogenic fungi as bio pesticide to display toxicity against two-spotted spider mite on brinjal increasing in yield and avoid environmental pollution and consumer health hazards.

Key words: *Botanicals, Acaropathogenic fungi, Brinjal, Two-spotted spider mite*

Introduction

Brinjal (*Solanum melongena* Linnaeus) is considered the "King of vegetables". It originated in India, where a wide range of wild types and land races occur and is now grown as a vegetable throughout the tropical, sub-tropical, and warm temperate areas of the world. Brinjal crop is subjected to attack by a number of insect-pests right from nursery stage till harvest, which affects crop cultivation and acts as a limiting factor in the profitable cultivation. Butani and Verma (1976) listed 36 insects, whereas 53 insects attack brinjal (Dhamdhree *et al*., 1995). Non-insect pests like mites, especially two-spotted spider mites, *Tetranychus urticae* Koch, are the main bottle necks in brinjal productivity (Patel *et al*., 2020). *T. urtica* has evolved into a major agricultural pest, feeding on over 900 plants including field crops, horticultural crops, green house vegetables, and ornamental plants, causing 50 to 100 percent yield loss (Kumar *et al*., 2010). Traditionally, two-spotted spider mites have been controlled using synthetic chemical acaricides with a level of residuality and permanence that constitutes a barrier to the commercialization of agricultural products and causes detrimental effects on the environment and human health. Pesticides formulated with herbal extracts are thus in practice as a safer alternative and have become part of leading research all over the world (Tehri and Gulati, 2014).

Studies have demonstrated that chemicals derived from plants are safer, specific in action, biodegradable and potentially suitable for use in integrated pest management programmes. More than 2000 plant species, including medicinal plants and spices, are known to have insecticidal and miticidal

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properties. They constitute a rich source of bioactive compounds which might act as deadly agents on the pests' physiological systems and kill them (Daoubi *et al*., 2005). Entomopathogens are promising microbial control agents against acari as these fungi invade the host by growing through the external cuticle (Chandler *et al*., 2000). They can be produced in mass using low input technology, are easily formulated as myco-pesticides suitable for spraying using conventional chemical spraying equipment, and are less harmful to non-target arthropods and mammals. Among the fungi used as biological control agents (BCAs), *Beauveria bassiana* is a classical entomopathogen and has been extensively used for the control of many important pests of various crops around the world (Varela and Morales, 1996). Therefore, the present study was carried out to obtain insight knowledge on this aspect.

Materials and Methods

Bio-efficacy of acaropathogenic fungi against brinjal red spider mite *Tetranychus urticae*

Field trial has been conducted at Thirumalayampalayam village of Madukarai Block to evaluate the effectiveness of acaropathogenic fungi against brinjal red spider mite *Tetranychus urticae* on Simran hybrid. The treatments include *viz*., *Nomuraea anisopliae* @ 3 ml/l, *Beauveria bassiana* @ 3 ml/l, *Hirsutella thompsonii* @3 ml/l, *Lecanicillium lecanii* @ 3 ml/lit., propargite 57 EC @ 2 ml/l, fenazaquin 10 EC @ 1.5 ml/l and an untreated check. Two rounds of spraying were given at fortnightly interval. The experiment was conducted in RBD with a plot size of 5 x 4 m with 3 replications. The population of biostages *viz*., adults including nymph mites was assessed before spraying and on 3, 7, 10 and 14 days after each spraying in five randomly selected plants. Top leaf was selected in each plant and the population of mites per 2 cm^2 leaf area was counted and expressed as mean population per 2 cm^2 leaf area.

Results

The results revealed that after É round of spraying application of fenazaquin 10 EC @ 1.5 ml/l resulted in the least mite population of 7.17nos/2cm^2 with per cent reduction in mite population of 60.03 followed by propargite 57 EC @ 2 ml/l recorded mite population of 7.69 nos/2 cm^2 with 57.09 per cent reduction in mite population. Among acaropathogenic fungi, application of *Nomuraea anisopliae* @ 3 ml/l resulted in low mite population of 11.92 nos/2cm^2 with 33.52 per cent reduction in the mite population over control (Table 1).

The results revealed that after ÉÉ rounds of spraying application of fenazaquin 10 EC @ 1.5 ml/l resulted in the least mite population of 4.20 nos/2cm^2 with 78.66 per cent reduction in mite population followed by propargite 57 EC @ 2 ml/l recorded population of 4.63 mites/2 cm^2 with 76.46 per cent reduction in mite population. Among acaropathogenic fungi, application of *Nomuraea anisopliae* @ 3ml/l resulted in low mite population of 6.72 nos/2cm^2 with 65.88 per cent reduction in the mite population over control (Table 2).

The cumulative mean population in fenazaquin 10 EC @ 1.5 ml/l applied plot has the least mite population of 5.68 nos/2 cm^2 with 69.78 per cent reduction followed by *Nomuraea anisopliae* @ 3ml/l of 9.32 nos/2 cm^2 with 50.45 per cent reduction on the mite population (Table 2).

Bio-efficacy of botanicals against brinjal red spider mite *Tetranychus urticae*

Field trial has been conducted at Thirumalayampalayam village of Madukarai Block to evaluate the efficacy of ecofriendly products against brinjal red spider mite *Tetranychus urticae* Simran hybrid. The treatments include *viz*., Azadirachtin 1500 ppm @ 5 ml/l, Azadirachtin 3000 ppm @ 3 ml/l, Azadirachtin 10000 ppm @ 2 ml/l, Neem Oil fortified @ 5 ml/l, propargite 57 EC @ 2 ml/l, fenazaquin 10 EC @ 1.5 ml/l and an untreated check. Two round of spraying were given at fortnightly interval. The experiment was conducted in RBD with a plot size of 5 x 4 m with 3 replications. Mite population was assessed before spraying and on 3, 7, 10 and 14 days after each spraying in ten randomly selected plants. Top, middle and bottom leaves were selected in each plant and the population of mites per 2 cm^2 leaf area was counted and expressed as mean population per 2 cm^2 leaf area.

Results

The results revealed that after É round of spraying application of fenazaquin 10 EC @ 1.5 ml/l resulted in the least mite population of 7.17nos/2 cm^2 with per cent reduction in mite population of 60.03 fol-

Table 1. Evaluation of acaropathogenic fungi against brinjal mite (*T. urticae*) – I spray

Location :Thirumalayampalayam

Treatments	Pre count	Active mites /2 cm² DAT					
		3	7	10	14	Mean	% redn.
Beauveria bassiana @ 3 ml/l	13.73(3.71)	11.33(3.37)	9.60(3.10)	11.87(3.44)	16.33(4.04)	12.28(3.50)	31.49
Nomuraea anisopliae @ 3 ml/l	15.20(3.90)	12.94(3.60)	7.87(2.80)	9.60(3.10)	17.27(4.16)	11.92(3.45)	33.52
Lecanicillium lecanii @ 3 ml/l	13.87(3.72)	10.66(3.26)	14.40(3.79)	15.07(3.88)	14.20(3.77)	13.58(3.69)	24.25
Hirsutella thompsonii @ 3 ml/l	15.13(3.89)	11.33(3.37)	11.00(3.32)	14.80(3.85)	15.87(3.98)	13.25(3.64)	26.10
Propargite 57 EC@ 2 ml/lit	14.20(3.77)	7.17(2.68)	7.13(2.67)	7.00(2.65)	9.47(3.08)	7.69(2.77)	57.09
Fenazaquin 10 EC @1.5 ml/l	15.27(3.91)	6.47(2.54)	7.20(2.68)	6.20(2.49)	8.80(2.97)	7.17(2.68)	60.03
Control	14.27(3.78)	17.32(4.16)	17.00(4.12)	17.20(4.15)	20.20(4.49)	17.93(4.23)	0.00
SED	0.16	0.30	0.28	0.18	0.24	0.54	
CD (0.05)	0.35	0.65	0.61	0.39	0.52	1.13	

% redn.– Per cent reduction over control, * Mean of three replications
Values in parentheses are square root transformed values.
DAT – Days after treatment

Table 2. Evaluation of acaropathogenic agents against brinjal mite (*T. urticae*) – II spray

Location :Thirumalayampalayam

Treatments	Active mites/2 cm² DAT					Cumulative	%	
	3	7	10	14	Mean	% redn.	mean	redn.
Beauveria bassiana@ 3 ml/l	12.27(3.50)	12.13(3.48)	4.27(2.07)	5.60(2.37)	8.57(2.93)	56.48	10.43	44.57
Nomuraea anisopliae @ 3 ml/l	9.47(3.08)	7.53(2.74)	4.33(2.08)	5.53(2.35)	6.72(2.59)	65.88	9.32	50.45
Lecanicillium lecanii @ 3 ml/l	13.27(3.64)	9.20(3.03)	5.27(2.29)	7.00(2.65)	8.68(2.95)	55.88	11.13	40.81
Hirsutella thompsonii@ 3 ml/l	15.20(3.90)	12.00(3.46)	8.33(2.89)	7.40(2.72)	10.73(3.28)	45.47	11.99	36.24
Propargite 57 EC @ 2 ml/l	5.60(2.37)	5.27(2.29)	3.87(1.97)	3.80(1.95)	4.63(2.15)	76.46	6.16	67.23
Fenazaquin 10 EC @1.5 ml/l	4.13(2.03)	5.47(2.34)	3.20(1.79)	4.00(2.00)	4.20(2.05)	78.66	5.68	69.78
Control	20.07(4.48)	18.67(4.32)	19.20(4.38)	20.80(4.56)	19.68(4.44)	0.00	18.81	0.00
SED	0.29	0.26	0.14	0.16	0.43			
CD (0.05)	0.64	0.57	0.31	0.35	0.90			

% redn.– Per cent reduction over control, * Mean of three replications
Values in parentheses are square root transformed values.
DAT – Days after treatment

lowed by propargite 57 EC @ 2 ml/l recorded mite population of 7.69 nos/2 cm² with 57.09 per cent reduction in mite population. Among botanicals, application of *Azadirachtin* 10000 ppm @ 2ml/l resulted in low mite population of 7.77 nos/2 cm² with 56.69 per cent reduction in the mite population over control (Table 3).

The results revealed that after ÉÉ rounds of spraying application of fenazaquin 10 EC @ 1.5 ml/l resulted in the least mite population of 4.20 nos/2 cm² with 78.66 per cent reduction in mite population followed by propargite 57 EC @ 2 ml/l recorded 4.63 mites/2 cm² with 76.46 per cent reduction in mite population. Among botanicals, application of *Azadirachtin* 10000 ppm @ 2ml/l resulted in low mite population of 5.73 nos/2 cm² with 70.87 per cent reduction in the mite population over control (Table 4).

The cumulative mean population in fenazaquin 10 EC @ 1.5 ml/l applied plot has the least mite population of 5.68 nos/2 cm² with 69.78 per cent reduction followed by *Azadirachtin* 10000 ppm @ 2 ml/l of 6.75 nos/2 cm² with 64.11 per cent reduction on the mite population (Table 4).

Discussion

Pesticidal plants as insecticides (botanical insecticides) are gaining importance since numerous plants show insecticidal properties. Currently, botanical insecticides comprise only 1% of the world insecticide trade, however, its annual sales growth in near about 15% is utterly promising (Sarmah *et al*., 2009). In the house and backyard sector, the im-

Table 3. Evaluation of botanicals against brinjal mite (*T. urticae*) – I spray

Location :Thirumalayampalayam

Treatments	Pre count	Active mites /2 cm² DAT					
		3	7	10	14	Mean	% redn.
Azadirachtin 1500 ppm @ 5 ml/l	14.40(3.79)	7.42(2.72)	8.80(2.97)	9.53(3.09)	14.67(3.83)	10.10(3.18)	43.64
Azadirachtin 3000 ppm @ 3 ml/l	12.80(3.58)	8.71(2.95)	7.80(2.79)	8.80(2.97)	9.80(3.13)	8.78(2.96)	51.04
Azadirachtin 10000 ppm @ 2 ml/l	13.80(3.71)	9.40(3.07)	4.53(2.13)	7.20(2.68)	9.93(3.15)	7.77(2.79)	56.69
Fortified Neem oil @30 ml/l	14.20(3.77)	11.89(3.45)	9.33(3.06)	10.80(3.29)	10.53(3.25)	10.64(3.26)	40.66
Propargite 57 EC @ 2 ml/l	14.20(3.77)	7.17(2.68)	7.13(2.67)	7.00(2.65)	9.47(3.08)	7.69(2.77)	57.09
Fenazaquin 10 EC @1.5 ml/l	15.27(3.91)	6.47(2.54)	7.20(2.68)	6.20(2.49)	8.80(2.97)	7.17(2.68)	60.03
Control	14.27(3.78)	17.32(4.16)	17.00(4.12)	17.20(4.15)	20.20(4.49)	17.93(4.23)	0.00
SED	0.11	0.30	0.33	0.20	0.21	0.46	
CD (0.05)	0.24	0.66	0.73	0.44	0.47	0.97	

% redn.– Per cent reduction over control, * Mean of three replications
Values in parentheses are square root transformed values.
DAT – Days after treatment

Table 4. Evaluation of botanicals against brinjal mite (*T. urticae*) — II spray

Location : Thirumalayampalayam

Treatments	Active mites /2 cm² DAT						Cumula-tive mean	% redn.
	3	7	10	14	Mean	% redn.		
Azadirachtin 1500 ppm @5 ml/l	9.00(3.00)	9.33(3.06)	5.80(2.41)	7.20(2.68)	7.83(2.80)	60.20	8.97	52.31
Azadirachtin 3000 ppm @3 ml/l	10.87(3.30)	6.07(2.46)	4.53(2.13)	6.07(2.46)	6.88(2.62)	65.03	7.83	58.36
Azadirachtin 10000 ppm @2 ml/l	6.67(2.58)	5.07(2.25)	6.80(2.61)	4.40(2.10)	5.73(2.39)	70.87	6.75	64.11
Fortified Neem oil @30 ml/l	9.93(3.15)	8.53(2.92)	9.93(3.15)	9.67(3.11)	9.52(3.08)	51.65	10.08	46.41
Propargite 57 EC @ 2 ml/l	5.60(2.37)	5.27(2.29)	3.87(1.97)	3.80(1.95)	4.63(2.15)	76.46	6.16	67.23
Fenazaquin 10 EC @1.5 ml/l	4.13(2.03)	5.47(2.34)	3.20(1.79)	4.00(2.00)	4.20(2.05)	78.66	5.68	69.78
Control	20.07(4.48)	18.67(4.32)	19.20(4.38)	20.80(4.56)	19.68(4.44)	0.00	18.81	0.00
SED	0.27	0.19	0.20	0.28	0.41			
CD (0.05)	0.58	0.41	0.42	0.61	0.86			

% redn.– Per cent reduction over control, * Mean of three replications
Values in parentheses are square root transformed values.
DAT – Days after treatment

pact of botanical insecticides is most prominent. Plant products that have prospective use as insecticidal compounds have gained astonishing importance in recent years (Nattudurai *et al*., 2015). The acaricidal action of the leaf extracts of *Gliricidia maculata, Vitex negundo, Wedelia chinensis, Pongamia glabra*, and *Morinda tinctoria* on red spider mites and reported that the aqueous extracts of *P. glabra* and *M. tinctoria* showed utmost ovicidal activity, ovipositional anticipation, and 100 per cent adult mortality (Vasanthakumar *et al*., 2012). The current findings also showed similar results with reference to the ovicidal action of the selected pesticidal plant extracts against the two- spotted spider mite. In lower economic countries, the application of pesticidal plant extracts as biocontrol options has been argued for extensively as sustainable options suitable for small farmers (Isman and Machial, 2006), and our experimental findings also confirmed this and indicated that application of plant products can control pests effectively. It has also been demonstrated that pesticidal plants can minimize the population of red spider mites and can support yield increase comparable to those where synthetic pesticides were used. The relatively regular application of plant products highlights their use as synthetic pesticide substitutes; they are active compounds that break down rapidly and they show little persistence (Casida, 1980). Basal application of neem cake in combination with *B. bassiana* (1 X108 spores/ml) recorded the maximum per cent reduction of two spotted spider mite, *T. urticae* population on okra.

Higher infections of *B. bassiana* on red spider mite was recorded on beans (12.94%) in Karnataka (Kalmath *et al*., 2007). Foliar application of *B. bassiana* recorded the highest per cent mycosis on coffee berry borer *Hypothenemus hampei* (Irulandi *et al*., 2006) thus it is proved effective not only against sucking pests but also against coleopteran borers. Basal application of neem cake in combination with foliar application of *Ocimum sanctum* (20% aqueous extract) recorded the highest reduction of yellow mite and egg population on chilli (Ambika and Chinniah, 2007). Similarly (Murugesan and Murugesh, 2008) reported the insecticidial activity of the chosen plant product s on the pest, spot ted leaf beetle, *Henosepilachna vigintiooctopunctat*a in Brinjal. The pathogenicity of *B.bassiana* isolates against *T. urticae* under laboratory conditions at a temperature of 25^0 C and 70 per cent relative humidity and obtained a mortality of 50 per cent, within 6 days after application (Alves *et al*., 2005). Natural TM (Thermo Trilogy Corp.), a commercial product of *B. bassiana,* registered an excellent control of *T. urticae* on rose under glass house conditions (Chandler *et al*., 2005).

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