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BIOCIDAL ACTIVITY OF PLANT DERIVATIVES AND NATURAL OILS AGAINST TWO SPOTTED SPIDER MITES IN JASMINE ECOSYSTEM

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ABSTRACT

The field experiment was conducted during summer 2015 at two different locations *i.e.,* Vadipatti and Allanganallur blocks of Madurai district of Tamil Nadu to evaluate the bio-efficacy of certain promising plant derivatives and natural oils against two spotted spider mites *Tetranychus urticae* Koch in Jasmine (*Jasminum sambac* Ait.) ecosystem. The cumulative mean data from the present investigation revealed that among the different botanical extracts and natural oils evaluated, Tulsi leaf extract (*Ocimum sanctum*) @10%, Neem oil (*Azadirachta indicia*) @ 3% and Nochi leaf extract (*Vitex negundo*) @ 5% recorded the maximum per cent reduction of mites (68.98%, 67.89% and 67.06% at Vadipatti block and 69.98%, 69.10% and 68.46% at Allanganallur block), which were statistically on par with each other in their efficacy in Jasmine ecosystem. With respect to the Jasmine flower yield; amongst the different plant derivatives and natural oils evaluated, the highest per cent increase in flower yield was recorded in case of Tulsi leaf extract @ 10% (60.29% at Vadipatti block and 58.45% at Allanganallur block) and Neem oil @ 3% (60.03% at Vadipatti block and 57.82% at Allanganallur block) coupled with highest cost : benefit ratio of 1:1.90 and 1:1.80 at Vadipatti block and Allanganallur block respectively and 1:1.85 1:1.75 at Vadipatti block and Allanganallur block respectively, which were statistically at par and closely followed by Nochi leaf extract @ 5% which recorded 56.90% and 55.71% increase in flower yield at Vadipatti block and Allanganallur block respectively coupled with the Cost:Benefit ratio of 1:1.79 at Vadipatti block and 1:1.70 at Allanganallur block. Thus, in terms of per cent increase in flower yield and cost : benefit ratio also, Tulsi leaf extract @ 10%, Neem oil @ 3% and Nochi leaf extract @ 5% were superior than other plant derivatives and natural oils evaluated, which can be considered as ideal alternative option to synthetic chemical acaricides which are costlier too for the management of *T. urticae* in Jasmine ecosystem.

(Key words: Jasmine, two spotted spider mites, plant derivatives, natural oils)

INTRODUCTION

Jasmine, *Jasminum sambac* Ait.('Gundu malligai') is highly valued for their fragrant flowers, which are grown commercially in India for extraction of essential oil for preparation of perfume and loose flowers are commonly used for making garlands and adorning the hairs by women. In Tamil Nadu, it is cultivated in an area of 10,623 ha with an annual production of 92,951 tonnes. In Madurai district alone, it is cultivated in an area of 1,220 ha with an annual production of 10,675 tonnes year^{-1} (Anonymous, 2016). Hence, the city of Madurai is called "Malligai Maanagar" (City of Jasmine). The major constraint in qualitative and quantitative production of Jasmine flowers is the invasion of insect and phytophagous mite pests. Among the different pests of Jasmine, two spotted spider mites (*Tetranychus urticae* Koch) is reported to be very serious, causing economic loss to the growers (David, 1958). A heavy infestation of mites also can form webbing on the whole plant, as a result of which plants become stunted, produce inferior quality flower buds which do not open properly, and ultimately have a considerably reduced yield.

Conventional management of this pest includes use of synthetic acaricides that could lead to undesirable side effects on environment and non targeted organisms. Plant derivatives and natural oils are important alternatives to synthetic acaricides since they pose an array of beneficial properties including repellent, antifeeding, growth regulatory activity and toxicity to insect and mite pests (Khuraijam and Ray, 2016). Keeping the potentiality of plant derivatives

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and natural oils in view an attempt was made to evaluate certain plant derivatives and natural oils against *T. urticae* Koch in Jasmine ecosystem.

MATERIALS AND METHODS

The field experiment was conducted during Summer 2015 (April 2015 – June 2015) at two different locations *i.e.,* Vadipatti and Allanganallur blocks of Madurai district of Tamil Nadu to evaluate the bio-efficacy of certain promising plant derivatives and natural oils such as Soapnut extract (*Sapindus marginatus* L.) @ 10% , Garlic bulb extract (*Allium sativum* L.) @ 10%, Pongamia oil (*Pungamia pinnata* (L.) Panigrahi) @ 3%, Neem oil (*Azadirachta indicia* A. Juss.,) @ 3%, Nochi leaf extract (*Vitex negundo* L.) @ 5%, Tulsi leaf extract (*Ocimum sanctum* L.) @ 10%, Fish Oil Rosin Soap (FORS) @ 20%, Cashew Nut Shell Liquid (*Anacardium occidentale* L.) (CNSL) @ 3%, Propolis @ 0.75% and Horticultural Mineral oil (HMO) @ 2% against two spotted spider mite *T. urticae* Koch in Jasmine ecosystem. The popular synthetic acaricide (Propargite 57 EC @ 0.1%) was the standard check, besides keeping an untreated check. The experiment was conducted in randomised block design with three replications. Three rounds of spray were imposed as foliar spray at fifteen days interval between each spray. Pre treatment count of mites (larvae, nymphs and adults) leaf^{-1} was recorded before imposing the treatments. The post treatment counts were recorded on 1, 3, 5, 7 and 14 days after each round of spraying. The data collected were statistically analysed using AGRES software and the yield per each treatment and Cost:Benefit economics was also calculated.

RESULTS AND DISCUSSION

The cumulative mean data from the present investigation revealed that (Tables 2 and 3) among the different botanical extracts and natural oils evaluated, Tulsi leaf extract @10%, Neem oil @ 3% and Nochi leaf extract @ 5% recorded the maximum per cent reduction of mites (68.98%, 67.89% and 67.06% at Vadipatti block and 69.98%, 69.10% and 68.46% at Allanganallur block), which were statistically on par with each other in their efficacy in Jasmine ecosystem. Nevertheless Propargite 57 EC @ 0.1% (standard check) was significantly superior to all other treatments with the highest per cent reduction of mite population (88.61% at Vadipatti block and 89.06% at Allanganallur block). Hence, among the different plant derivatives and natural oils evaluated Tulsi leaf extract @ 10%, Neem oil @ 3% and Nochi leaf extract @ 5% were significantly superior to all other treatments in their bio-efficacy in checking population of *T. urticae* in field condition on Jasmine, when applied thrice at forth nightly intervals.

With respect to the Jasmine flower yield (Table 1), amongst the different plant derivatives and natural oils evaluated, the highest per cent increase in Jasmine flower yield was recorded in case of Tulsi leaf extract @ 10% (60.29%) and Neem oil @ 3% (60.03%) coupled with highest cost :benefit ratio of 1:1.90 and1:1.85 respectively, which were statistically at par and closely followed by Nochi leaf extract @ 5% which recorded 56.90% increase in flower yield coupled with the cost : benefit ratio of 1:1.79 at Vadipatti block. So also in Allanganallur block, the highest per cent increase in flower yield was recorded in case of Tulsi leaf extract @ 10% (58.45%) and Neem oil @ 3% (57.82%) coupled with highest cost: benefit ratio of 1:1.80 and 1:1.75 respectively, which were statistically on par and closely followed by Nochi leaf extract @ 5% which recorded 55.71% increase in flower yield coupled with the cost : benefit ratio of 1:1.70. However, the standard check Propargite 57 EC @ 0.1% recorded the highest per cent increase in flower yield (64.93% at Vadipatti block and 63.91% at Allanganallur block) and cost : benefit ratio (1:2.25 at Vadipatti block and 1:2.20 at Allanganallur block) over untreated check. Thus, in terms of per cent increase in flower yield and cost : benefit ratio also, Tulsi leaf extract @ 10%, Neem oil @ 3% and Nochi leaf extract @ 5% were superior than other plant derivatives and natural oils evaluated, which can be considered as ideal alternative option to synthetic acaricides which are too costlier as well. The present findings are in line with the reports of Aslan *et al.* (2004), who reported that the tulsi leaf extract @ 10% was very effective against the nymphs and adults of *T. urticae* and adults of *Bemisia tabaci*. Kadu *et al*. (2010) based on statistical data reported that Lindane (0.14%) was the most effective in minimizing the infestation of carpenter ant but the methanol leaf extract of *Ipomoea carnea* (12%) was also found to be effective and significantly superior over all treatments of other otanical extracts followed by *Vilex negundo, Azadirachta indica, Tridax procumbeens* and *Pongamia glabra* against the carpenter ant (*Camponotus compressus)*. Kalaskar *et al*. (2012) also reported that among plant extract and bioagents, Neem seed kernel extract @ 5 % was superior to control the groundnut rust. Sireesha *et al.* (2013) observed that among aromatic plants *Ocimum sanctum* (Tulsi extract) was found most effective in restricting radial mycelial growth of *Fusarium oxysporum* f.sp.*ciceri, Rhizoctonia bataticola* and *Sclerotium rolfsii Sclerotium rolfsii* by 81.48%, 87.78% and 75.20% respectively. Kanniammal and Chinniah (2012) also affirmed that *O. Sanctum* recorded the highest mortality of *T. urticae* (75.07 per cent). The bioefficacy of neem oil is in line with works of Patil and Nandihalli (2009), Eswarareddy (2000) and All India Co-ordinated Research Project on Agricultural Acarology report (Anonymous, 2000).

According to Mridul Sarmah (2016), neem based biopesticide was very effective against red spider mite exhibiting strong acaricidal, ovicidal, anti-ovipositional and growth inhibitory action which is akin with the present finding. Salman *et al*. (2014) proved that, neem oil (3%) caused 80.24% mortality of *T. urticae*. Econeem has been recently reported to reduce the fecundity and hatchability of eggs of *T. urticae* on capsicum crop (Sharma *et al.,* 2010). Chauhan *et al*. (2011) also reported that the commercial formulations of neem extracts showed significant effect in

the control of *T. urticae* on carnation and the population of *T. urticae* in the strategies in which formulations of neem extracts were used was significantly lower than in the untreated control. The findings of Ramaraju (2004) also proved that neem oil was very effective with 70.56 to 91.85% mortality against *T. urticae* on bhendi. Pasini *et al.* (2003) determined the efficacy of commercially formulated neem oil against red spider mite which efficiently controlled red spider mite by affecting the fecundity. Sudoi (1998) observed that spraying of 2.5% neem seed oil on *O. coffeae* significantly reduced the mite population; act as a contact poison indicating the potentiality of neem seed oil in controlling the red spider mite both in tea nurseries and in the field.

Sugeetha and Srinivasa (1999) reported that aqueous methanolic leaf extracts of *V. negundo* @ 6% exhibited 76.00 % adult mortality of red spider mites, which is a strong evidence for the present findings. It can be inferred that, even though the effectiveness of plant derivatives and natural oils is not superior to synthetic chemical acaricides, they are moderate in their efficacy in reducing the mite population due to multitude modes of action. Accordingly Tulsi leaf extract @10% or Neem oil @ 3% or Nochi leaf extract @ 5% may be recommended for the suppression of *T. urticae* infesting Jasmine and other ornamental crops in alternation with synthetic chemical acaricides due to their eco- friendly and target specific nature. In addition, in a broader sense there is a wide scope for integrating Tulsi leaf extract @10% or Neem oil @ 3% or Nochi leaf extract @ 5% as one of the components in Integrated Pest Management (IPM) of phytophagous mite pests infesting flowers and other ornamental crops in near future for attaining enhanced results.

Table 1. Evaluation of plant derivatives and natural oils for their efficacy against two spotted spider mite *T. urticae* Koch in Jasmine ecosystem. Season - Summer 2015, Impact on flower yield

Treatments	Vadipatti Block			Allanganallur Block		
	Flower Yield (t ha^{-1})	% increase over untreated check	C:B ratio	Flower Yield (t ha^{-1})	% increase over untreated check	C:B ratio
T_1 - Soapnut extract (*Sapindus marginatus*) @ 10%	6.00 (0.78)^{d}	49.50	1:1.40	5.93(0.77)^{de}	47.72	1:1.39
T_2 - Garlic bulb extract (*Allium sativum*) @ 10%	5.91 (0.77)^{d}	48.73	1:1.37	5.71 (0.76)^{e}	45.71	1:1.28
T_3 - Pongamia oil (*Pungamia pinnata*) @ 3%	6.12 (0.79)^{d}	50.49	1:1.45	6.08 (0.78)^{d}	49.01	1:1.43
T_4 - Neem oil (*Azadirachta indicia*) @ 3%	7.58 (0.88)^{b}	60.03	1:1.85	7.35 (0.87)^{b}	57.82	1:1.75
T_5 - Nochi leaf extract (*Vitex negundo*) @ 5%	7.03 (0.85)^{c}	56.90	1:1.79	7.00 (0.85)^{c}	55.71	1:1.70
T_6 - Tulsi leaf extract (*Ocimum sanctum*) @ 10%	7.63 (0.88)^{b}	60.29	1:1.90	7.46 (0.87)^{b}	58.45	1:1.80
T_7 - Fish Oil Rosin Soap (FORS) @ 20%	5.13 (0.71)^{e}	40.94	1:1.18	5.00 (0.70)^{f}	38.00	1:1.12
T_8 - Cashew Nut Shell Liquid (*Anacardium occidentale*) (CNSL) @ 3%	4.38 (0.64)^{g}	30.82	1:1.02	4.03 (0.61)^{h}	23.08	1:1.01
T_9 - Propolis @ 0.75%	4.86 (0.69)^{f}	37.65	1:1.09	4.61 (0.66)^{g}	32.75	1:1.06
T_{10} - Horticultural Mineral oil (HMO) @ 2%	5.03 (0.70)^{ef}	39.76	1:1.13	4.86 (0.69)f	36.21	1:1.09
T_{11} - Propargite 57 EC @ 0.1%	8.64 (0.94)^{a}	64.93	1:2.25	8.59 (0.93)^{a}	63.91	1:2.20
T_{12} - Untreated check	3.03(0.48)^{h}	-	-	3.10(0.49)^{i}	-	-
SEd	0.0093			0.0098		
CD (p=0.05)	0.0192	-	-	0.0203	-	-
CV%	1.49			1.60		

Each value is the mean of three replications

Figures in parentheses are log transformed values

In a column, means followed by common letter(s) is /are not significantly different by LSD at P=0.05%

Table 2. Evaluation of plant derivatives and natural oils for their efficacy against two spotted spider mite *T. urticae* Koch in Jasmine ecosystem. Season - Summer 2015 (Location - Vadipatti Block, Madurai District)

Treatments	treatment count	Mean population leaf $^{-1}$ after				% reduction over untreated check
		I st Spray	II nd Spray	III rd Spray	Cumulative Mean	
T_1 - Soapnut extract (*Sapindus marginatus*) @ 10%	21.36	13.88 (3.73)^{d}	11.64 (3.41)^{de}	15.38 (3.92)^{c}	13.63 (3.69)^{c}	52.93
T_2 - Garlic bulb extract (*Allium sativum*) @ 10%	21.22	14.14 (3.76)^{d}	11.87 (3.45)^{de}	15.55 (3.94)^{c}	13.85 (3.72)^{c}	52.17
T_3 - Pongamia oil (*Pungamia pinnata*) @ 3%	20.93	13.64 (3.69)^{d}	11.31 (3.36)^{d}	15.03 (3.88)^{c}	13.33 (3.65)^{c}	53.99
T_4 - Neem oil (*Azadirachta indicia*) @ 3%	21.49	9.63 (3.10)^{bc}	7.41 (2.72)^{bc}	10.86 (3.30)^{b}	9.30 (3.05)^{b}	67.89
T_5 - Nochi leaf extract (*Vitex negundo*) @ 5%	21.36	9.89 (3.14)^{c}	7.66 (2.77)^{c}	11.07 (3.33)^{b}	9.54 (3.09)^{b}	67.06
T_6 - Tulsi leaf extract (*Ocimum sanctum*) @ 10%	21.53	9.24 (3.04)^{b}	7.14 (2.67)^{b}	10.57 (3.25)^{b}	8.98 (3.00)^{b}	68.98
T_7 - Fish Oil Rosin Soap (FORS) @ 20%	21.51	15.01 (3.87)^{e}	12.86 (3.59)^{f}	17.27 (4.16)^{d}	15.05 (3.88)^{d}	48.05
T_8 - Cashew Nut Shell Liquid (*Anacardium occidentale*) (CNSL) @ 3%	21.43	16.71 (4.09)^{g}	15.28 (3.91)^{i}	22.6 (4.75)^{f}	18.20 (4.27)^{f}	37.17
T_9 - Propolis @ 0.75%	20.91	15.97 (4.00)^{f}	14.43 (3.80)^{h}	19.86 (4.46)^{e}	16.75 (4.09)^{e}	42.16
T_{10} - Horticultural Mineral oil (HMO) @ 2%	21.33	15.33 (3.92)^{ef}	13.75 (3.71)^{g}	17.71 (4.21)^{d}	15.60 (3.95)^{d}	46.15
T_{11} - Propargite 57 EC @ 0.1%	20.96	6.21 (2.49)^{a}	2.13 (1.46)^{a}	1.56 (1.25)^{a}	3.30 (1.82)^{a}	88.61
T_{12} - Untreated check	21.1	23.11 (4.81)^{h}	28.09 (5.30)^{j}	35.69 (5.97)^{g}	28.96 (5.38)^{g}	-
SEd	**0.0440**	**0.0384**	**0.0300**	**0.0523**	**0.0442**	
CD (p=0.05)	**-**	**0.0797**	**0.0622**	**0.1085**	**0.0916**	
CV%	**NS***	**1.29**	**1.1**	**1.66**	**1.49**	-

* NS – Non significant

Each value is the mean of three replications

Figures in parentheses are square root transformed values

In a column, means followed by common letter(s) is /are not significantly different by LSD at P=0.05%

Table 3. Evaluation of plant derivatives and natural oils for their efficacy against two spotted spider mite *T. urticae* Koch in Jasmine ecosystem. Season - Summer 2015 (Location - Allanganallur Block, Madurai District)

Treatments	Pre treatment count	Mean population leaf $^{-1}$ after				% reduction over untreated check
		I st Spray	II nd Spray	III rd Spray	Cumulative Mean	
T_1 - Soapnut extract (*Sapindus marginatus*) @ 10%	20.76	14.40 (3.80)^{c}	10.68 (3.27)^{de}	17.38 (4.69)^{c}	14.15 (3.76)^{c}	55.31
T_2 - Garlic bulb extract (*Allium sativum*) @ 10%	20.41	14.57 (3.82)^{c}	10.99 (3.31)^{e}	17.60 (4.71)^{c}	14.39 (3.79)^{c}	54.57
T_3 - Pongamia oil (*Pungamia pinnata*) @ 3%	20.83	14.04 (3.75)^{c}	10.27 (3.20)^{d}	16.95 (4.68)^{c}	13.75 (3.71)^{c}	56.57
T_4 - Neem oil (*Azadirachta indicia*) @ 3%	21.44	10.79 (3.28)^{b}	7.24 (2.69)^{bc}	11.33 (3.72)^{b}	9.79 (3.13)^{b}	69.10
T_5 - Nochi leaf extract (*Vitex negundo*) @ 5%	20.22	11.01 (3.32)^{b}	7.43 (2.73)^{c}	11.53 (3.77)^{b}	9.99 (3.16)^{b}	68.46
T_6 - Tulsi leaf extract (*Ocimum sanctum*) @ 10%	20.53	10.59 (3.25)^{b}	6.95 (2.64)^{b}	10.98 (3.70)^{b}	9.51 (3.08)^{b}	69.98
T_7 - Fish Oil Rosin Soap (FORS) @ 20%	20.26	16.56 (4.07)^{d}	12.56 (3.54)^{f}	21.36 (4.88)^{d}	16.83 (4.10)^{d}	46.87
T_8 - Cashew Nut Shell Liquid (*Anacardium occidentale*) (CNSL) @ 3%	20.66	19.90 (4.46)^{g}	15.08 (3.88)^{h}	26.03 (5.46)^{f}	20.34 (4.51)^{g}	35.79
T_9 - Propolis @ 0.75%	20.86	18.67 (4.32)^{f}	14.75 (3.84)^{h}	23.98 (5.04)^{e}	19.13 (4.37)^{f}	39.59
T_{10} - Horticultural Mineral oil (HMO) @ 2%	20.41	17.64 (4.20)^{e}	13.37 (3.66)^{g}	23.01 (4.90)^{e}	18.01 (4.24)^{e}	43.14
T_{11} - Propargite 57 EC @ 0.1%	20.46	6.60 (2.57)^{a}	2.22 (1.49)^{a}	1.57 (1.79)^{a}	3.46 (1.86)^{a}	89.06
T_{12} - Untreated check	20.54	24.31 (4.93)^{h}	31.86 (5.64)^{i}	38.84 (6.23)^{g}	31.67 (5.63)^{h}	-
SEd	**0.0491**	**0.0336**	**0.0407**	**0.0545**	**0.0442**	
CD (p=0.05)	**-**	**0.0696**	**0.0843**	**0.1131**	**0.0918**	
CV%	**NS***	**1.08**	**1.5**	**1.62**	**1.43**	**-**

* NS – Non significant

Each value is the mean of three replications

Figures in parentheses are square root transformed values

In a column, means followed by common letter(s) is /are not significantly different by LSD at P=0.05%

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