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Efficacy of neem, *pongamia* and fish oils alone and as synergists with insecticides for the management of whitefly, *Bemisia tabaci* (Gennadius) on tomato

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ABSTRACT: Insecticides alone and in combination with neem, *pongamia* and fish oils were evaluated against whitefly, *Bemisia tabaci* on tomato under Poly house conditions. Among the insecticides tested, spinosad followed by imidacloprid and fipronil were effective against *B. tabaci* and recorded a mortality of 84.55%, 84.17% and 79.39%, respectively. When neem/*pongamia*/fish oils were used together @ 3ml/l each, resulted in 75% mortality of *B. tabaci*. Oils alone gave upto 48.75% mortality of *B. tabaci*. All the oils showed synergism with different insecticides tried against whitefly and highest synergism was recorded with neem oil followed by fish oil and *pongamia* oil. Additional mortality upto16% of *B. tabaci* was observed when these oils were used along with different insecticides. Neem oil in combination with spinosad gave upto 92.31% mortality of whitefly followed by spinosad with fish oil (91.68% mortality). Other effective combinations with neem oil were imidacloprid (89.67%) and fipronil (89.38%). In general, neem and fish oils were promising as synergists with the insecticides tried against whitefly on tomato.

Keywords: Whitefly, *Bemisia tabaci*, neem oil, *pongamia* oil, fish oil, synergists

INTRODUCTION

Bemisia tabaci (Gennadius) is a serious cosmopolitan sucking pest and imparts direct damage to the crop by desapping and also acts as a vector of leaf curl virus disease in tomato (Jones, 2003). Continuous feeding affects the physiology of plant leading to detrimental effect on all stages of the crop. *B. tabaci* acts as a vector of several Gemini viruses such as leaf curl virus of tomato and okra, tobacco leaf curl virus and yellow mosaic virus of beans (Markham *et al.,* 1994). Yield losses due to direct and indirect damage caused by whiteflies were reported to the extent of 20 to 100 per cent in tomato (Rapisarda and Garzia, 2002).

B. tabaci has tremendous potential to develop resistance to insecticides. To date, *B. tabaci* has shown resistance to more than 40 active ingredients of insecticides (Whalon *et al.*, 2013). One of the alternative options for the effective control of insect pests known to be resistant to insecticides is to use synergists along with insecticides. Oils of plant origin have been reported for the reduction of whitefly infestation (Sastry, 1989; Butler *et al.*, 1991; Csizinsky *et al.,* 1997). Various seed oils *viz*., cotton seed oil, neem oil, *Pongamia* oil, *mahua* oil and sesamum oil were reported to synergise the toxicity of the insecticides to varying levels and can also be used in resistance monitoring studies as inhibitors of MFO's in place of costly synthetic synergists like piperonyl but oxide (Suneel Kumar and Sannaveerappanavar, 2003). Keeping in view the availability and economy of the synergists, two plant origin oils *viz*., neem and *pongamia* oils and fish oil were tried as synergists along with various insecticides *viz.*, dimethoate 30 EC, imidacloprid 17.8 SL, spinosad 45 SC and fipronil 5 SC against *B. tabaci* on tomato.

MATERIALS AND METHODS

Evaluation of oils and insecticides

These trials were conducted on tomato at ICAR-Indian Institute of Horticultural Research, Bengaluru (12°58'N; 77°35'E), India during February-April, 2014. The experiment was laid out in a Randomized Block Design with three replications. The seedlings of tomato cultivar 'Arka Rakshak' were transplanted at a spacing of 45 cm x 60 cm on beds in the Poly house. The recommended package of practices was followed for cultivation of the crop. Various treatments (Table 1) *i.e.*, oils and insecticides at recommended doses were given

Table 1. Efficacy of botanical/fish oils in the management of whiteflies on tomato

Treatment	Reduction of whiteflies over control (%)*				
	Pre-count (whiteflies/15 cm²)	3 DAT	7 DAT	10 DAT	Mean
Neem oil @ 5 ml/l	20.01	44.39 (41.77)^{ef}	47.62 (43.63)^{e}	47.12 (43.35)^{de}	46.38
Pongamia oil @ 5 ml/l	18.99	39.45 (38.90)^{f}	40.38 (39.44)^{f}	42.56 (40.72)^{e}	40.80
Fish oil @ 5 ml/l	18.99	45.63 (42.49)^{e}	50.00 (45.00)^{e}	50.61 (45.35)^{d}	48.75
Neem Oil 1 ml + *Pongamia* Oil 1ml + Fish Oil 1 ml/l	18.99	55.61 (48.22)^{d}	57.15 (49.11)^{d}	51.64 (45.94)^{d}	54.80
Neem Oil @ 2 ml + *Pongamia* Oil 2 ml + Fish Oil 2 ml/l	18.99	66.73 (54.78)^{c}	64.30 (53.32)^{c}	64.38 (53.35)^{c}	65.14
Neem Oil @ 3 ml + *Pongamia* Oil 3 ml + Fish Oil 3 ml/l	20.01	75.33 (60.22)^{b}	76.08 (60.79)^{b}	73.58 (59.07)^{b}	75.00
Dimethoate 30 EC @ 2.5 ml/l	18.99	75.24 60.18)^{b}	76.21 (60.81)^{d}	77.03 (61.37)^{b}	76.16
Imidacloprid 17.8 SL @ 0.5 ml/l	20.01	86.41 (68.51)^{a}	82.13 (64.99)^{a}	83.97 (66.47)^{a}	84.17
Spinosad 45 SC @ 0.25 ml/l	21.99	85.17 (67.35)^{a}	83.36 (65.94)^{ab}	85.13 (67.42)^{a}	84.55
Fipronil 5 SC @ 1.5 ml/l	21.99	82.70 (65.52)^{a}	77.36 (61.60)^{b}	78.10 (62.12)^{b}	79.39
Control	20.01	0.00^{g}(0.00)	0.00^{f}(0.00)	0.00^{g} (0.00)	0.00
CD (p=0.05)	NS	3.02	2.64	3.07	—
CV (%)	—	3.56	3.12	3.63	—

*Mean of 3 replications
Figures in parentheses are arc sine transformed values
In a column treatment means denoted with same alphabet are statistically non-significant.

at 45 days after transplanting of tomato. Observations on the number of whiteflies (nymphs and adults) were recorded on three randomly selected plants from each replication representing three leaves from top, middle and bottom Pre count observations of *B. tabaci* was recorded before spraying and post spray observations were recorded on 3rd, 7th and 10th day after spraying. Data on the number of whiteflies per plant was transformed to per cent mortality and then to arc sine transformation before subjecting to ANOVA and treatment means were compared using DMRT.

Evaluation of synergistic efficacy of oils: These trials were carried out on tomato under Polyhouse conditions during February-April, 2015 using the cultivar 'Arka Rakshak'. The experiment was laid out in a Randomized Block Design with three replications. The crop was raised as mentioned above under evaluation of oils and insecticides. Two sprays of various treatments (Table 2) *i.e.*, combination of various oils at 2 ml/l along with insecticides *viz.,* dimethoate, imidacloprid, spinosad and fipronil. The doses of insecticides used were lower than the field recommended doses (Table 2). Two sprays were given starting from 45 days after transplanting at 14 days interval. Observations on the number of whiteflies (nymphs and adults) were recorded on three randomly selected plants from each replication. From each leaf, 15cm² area was considered for whitefly count. representing three leaves from top, middle and bottom. Pre count of *B. tabaci* was recorded before spraying and post spray observations were recorded on 3rd, 7th and 10th day after spraying. Data on the number of insects per plant was converted to per cent mortality and then arc sine transformed before subjecting them to ANOVA and treatment means were compared using DMRT.

RESULTS AND DISCUSSION

Efficacy of botanical/fish oil and insecticides against whiteflies on tomato:

3 DAS: Among the various treatments imposed, average reduction in the whitefly revealed that

Table 2. Efficacy of plant/fish oils as synergists with insecticides in the management of whiteflies on tomato

Treatments	I spray					II spray					
	Reduction of whiteflies over control (%)*										
	Pre-count (whiteflies/ 15 cm²)	3 DAS	7 DAS	10 DAS	Mean	Pre-count (whiteflies/ 15 cm²)	3 DAS	7 DAS	10 DAS	Mean	Overall mean
Dimethoate 2 ml + Neem Oil 2 ml /l	18.99	81.08 (64.26)^{e}	84.43 (66.79)^{f}	83.30 (65.90)^{def}	82.94	14.01	83.93 (66.49)^{c}	78.15 (62.14)^{e}	82.65 (65.47)^{defg}	81.58	82.26
Dimethoate 2 ml + *Pongamia* Oil 2 ml/l	21.99	76.31 (60.96)^{e}	78.87 (62.65)^{g}	79.43 (63.06)^{f}	78.21	17.01	78.59 (62.47)^{d}	70.11 (56.90)^{f}	76.72 (61.31)^{g}	75.14	76.68
Dimethoate 2 ml + Fish Oil 2 ml/l	20.01	78.66 (62.57)^{ef}	81.06 (64.23)^{g}	82.37 (65.21)^{ef}	80.70	14.01	82.70 (65.43)^{c}	71.78 (57.92)^{f}	81.08 (64.44)^{efg}	78.52	79.61
Imidacloprid 0.3 ml + Neem Oil 2 ml/l	21.99	90.50 (72.15)^{b}	93.33 (75.03)^{ab}	87.22 (69.09)^{bcd}	90.35	15.99	87.99 (69.72)^{b}	90.59 (72.14)^{a}	88.39 (70.34)^{abc}	88.99	89.67
Imidacloprid 0.3 ml + *Pongamia* Oil 2 ml/l	18.99	85.86 (67.91)^{cd}	87.81 (69.59)^{de}	82.29 (65.17)^{ef}	85.32	17.01	83.98 (66.41)^{c}	82.64 (65.46)^{cd}	84.04 (66.61)^{cdef}	83.55	84.44
Imidacloprid 0.3 ml + Fish Oil 2 ml/l	23.01	94.04 (76.06)^{a}	89.99 (71.56)^{cd}	86.21 (68.31)^{cde}	90.08	14.01	91.99 (73.56)^{a}	85.89 (67.94)^{bc}	87.01 (69.03)^{bcde}	88.30	89.19
Spinosad 0.15 ml + Neem Oil 2 ml/l	21.99	94.04 (76.06)^{a}	94.40 (76.48)^{a}	90.10 (71.99)^{ab}	92.85	17.01	91.99 (73.56)^{a}	92.18 (73.93)^{a}	91.17 (73.12)^{ab}	91.78	92.31
Spinosad 0.15 ml + *Pongamia* Oil 2 ml/l	23.01	89.39 (70.99)^{b}	88.92 (70.59)^{de}	88.23 (69.93)^{abc}	88.85	15.99	87.99 (69.72)^{b}	84.30 (66.72)^{cd}	88.33 (70.12)^{abcd}	86.87	87.86
Spinosad 0.15 ml + Fish Oil 2 ml/l	21.99	92.93 (74.58^{a}	92.18 (73.85)^{bc}	91.14 (72.85)^{a}	92.08	15.99	91.99 (73.56)^{a}	89.14 (70.80)^{ab}	92.74 (74.54)^{a}	91.29	91.68
Fipronil 1 ml + Neem Oil 2 ml/l	21.99	88.16 (69.94)^{bc}	92.18 (73.85)^{bc}	89.24 (70.87)^{abc}	89.86	15.99	89.27 (70.97)^{b}	89.14 (70.80)^{ab}	88.33 (70.12)^{abcd}	88.91	89.38
Fipronil 1 ml + *Pongamia* Oil 2 ml/l	21.99	84.62 (66.96)^{d}	86.66 (68.58)^{ef}	86.30 (68.28)^{cde}	85.86	17.01	83.98 (66.41)^{c}	81.19 (64.30)^{de}	81.14 (64.29)^{fg}	82.10	83.98
Fipronil 1 ml + Fish Oil 2 ml/l	21.99	89.39 (70.99)^{b}	88.84 (70.55)^{de}	89.18 (70.85)^{abc}	89.14	15.99	87.99 (69.72)^{b}	84.44 (66.78)^{cd}	85.49 (67.65)^{cdef}		
Control	23.01	0.00^{g} (0.00)	0.00^{h} (0.00)	0.00^{g} (0.00)	0.00	17.01	0.00^{e} (0.00)	0.00^{g} (0.00)	0.00^{h} (0.00)	0.00	0.00
CD (p=0.05)	NS	2.39	2.53	3.59	-	NS	2.14	3.14	4.65	-	-
CV (%)	-	2.19	2.31	3.36	-	-	1.99	3.04	4.38	-	-

*Mean of 3 replications; Note: Figures in parentheses are arc sine transformed values; In a column treatment means denoted with same alphabet are statistically non-significant

imidacloprid followed by spinosad and fipronil were effective against whitefly by recording a reduction of 86.41%, 85.17% and 82.70% in the incidence of the pest. The next effective treatments were oil combinations *viz*., neem oil, *pongamia* oil and fish oil @ 3 ml/l followed by dimethoate which gave 75.33% and 75.24% mortality of whiteflies respectively. However, among the botanicals/fish oils either alone or in combination, could give only up to 48.75% of mortality of whiteflies (Table 1).

7 DAS: Seven days after spraying, highest per cent reduction of whiteflies revealed that spinosad followed by imidacloprid and fipronil were effective against whitefly by recording a reduction of 83.36%, 82.13%, and 77.36% in the incidence of the pest. The next effective treatments were neem oil, *pongamia* oil and fish oil @ 3 ml/l followed by neem oil, *pongamia* oil and fish oil @ 2 ml/l, neem oil, *pongamia* oil and fish oil @ 1 ml/l and dimethoate gave 76.08%, 64.30%, 57.15% and 76.21% mortality of the whiteflies, respectively. However, among the botanicals/fish oils alone, fish oil resulted in 50 per cent mortality of whiteflies followed by neem and *pongamia* oil with 47.62% and 40.38% morality (Table 1). Similar trend of efficacy in various treatments was observed during 10 DAS also.

Efficacy of plant/fish oil as synergists with insecticides against whiteflies on tomato

First spray

3 DAS: Among the various treatment combinations imposed, average reduction in the whitefly revealed that spinosad at 0.15 ml in combination with neem oil was most effective followed by combination of imidacloprid 0.3 ml with neem oil and spinosad with fish oil against whitefly by recording a reduction of 94.04%, 94.04% and 92.93%, respectively (Table 2).

7 DAS: Highest per cent reduction in the whitefly revealed that combination of neem oil with spinosad and imidacloprid were effective against whitefly by recording a reduction of 94.40% and 93.33%, respectively. The next effective treatment combination was spinosad with fish oil with a reduction of 92.18% (Table 2).

10 DAS: Combination of fish oil with spinosad was proven to be effective with highest reduction of whitefly population 91.14%. This was followed by neem oil combination with spinosad and fipronil with 90.10% and 89.24% reduction in the whitefly (Table 2).

On overall basis, after 1st spray, spinosad was proven to be most effective in combination with neem oil and fish oil with average per cent reduction of 92.85% and 92.08% in whitefly population followed by imidacloprid in combination with neem oil and fish oil with 90.35% and 90.08% reduction of *B. tabaci.*

Second spray

After second spray that was taken after an interval of 14 days of first spray, post spray observations were recorded on 3,7 and 10 DAS. The trend of different treatment combinations was found to be similar to that of 1st spray.

Mean reduction of *B. tabaci* over two sprays revealed, spinosad was most effective in combination with neem oil and fish oil with per cent reduction of 92.31% and 91.68% followed by imidacloprid in combination with neem oil with 89.67%. (Table 2).

Among the treatments imposed, in the first spray, all the oils showed synergism with different insecticides tried against whitefly on tomato. Among the three oils tried, highest synergism was observed with neem oil followed by with fish oil and *Pongamia* oil. By adding different oils there was an increase up to 16% additional mortality of the pest with different insecticides (Table 2). Neem oil in combination with spinosad gave up to 92.85% mortality of whitefly followed by with imidacloprid (90.35%) and fipronil (89.86%) and dimethoate (82.94%). Fish oil in combination with spinosad gave up to 92.08% mortality of whitefly followed by with imidacloprid (90.08), fipronil (89.14%) and dimethoate (80.70%) (Table 2). Similar trend has been observed after the second spray also (Table 2).

Suneel Kumar and Sannaveerappanavar (2003) recorded sesamum oil and *Pongamia* oil synergism with synthetic pyrethroids *viz*., fenvalerate and deltamethrin against diamondback moth under laboratory conditions. Similarly, they observed the toxicity of lambda-cyhalothrin synergism to a greater extent by sesamum oil followed by *Pongamia* oil against *Plutella xylostella*. Similar observations for synergism of fenvalerate toxicity to field populations of *Helicoverpa armigera* were reported by Sundaramoorthy and Chitra (1992) and Manoharan and Uthamasamy (1993). Gavi Gowda (1996) opined that *Pongamia* oil acted as an MFO inhibitor and the inhibition of the oxidases by *Pongamia* oil may be the reason for synergism of methomyl toxicity.

Under laboratory conditions, Sridhar and Jhansi Rani (2010) observed deltamethrin @ 0.5 ml/l + *Pongamia* oil (0.2%) showing maximum efficacy (86.67%), followed by deltamethrin (0.5 ml/l) + *Pongamia* oil (0.1%) against *P. xylostella*. However, under field conditions, *Pongamia* oil (0.2%) with deltamethrin (1 ml/l) showed good synergism both in terms of reducing *P. xylostella* and in realizing marketable yields of cabbage.

Onkaranaik *et al.*, (2017) assessed the synergistic effect of two plant oils *viz*., neem and *Pongamia* and a fish oil on the bio efficacy of flubendiamide 480 SC and indoxacarb14.5% SC against diamondback moth (DBM), *P. xylostella* on cabbage and found to be highly synergistic in enhancing the efficacy of these insecticides both under laboratory and field conditions. In the present study, neem and fish oils were found very effective synergising efficacy of tested chemicals against whitefly on tomato and they can be opted for the insecticide resistance management as a component of integrated pest management of whitefly on tomato particularly under Polyhouse conditions.

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