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Bioefficacy Of Some Newer Insecticides Against Citrus Thrips On Sweet Orange (*Citrus sinensis* L. Osbeck)

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ABSTRACT
A field experiments to study the bioefficacy of some newer and novel insecticides against citrus thrips on sweet orange were conducted at All India Co-ordinated Research Project on Citrus, Department of Horticulture, MPKV, Rahuri during Ambia bahar of 2016. In present investigation, nine insecticidesviz. flonicamid 50% WG, flupyradifurone 200% SL, thiamethoxam 25% WG, spinetoram 11.7% SC, chlorantraniliprole 18.5% SC, cyantraniliprole 10.26% OD, tolfenpyrad 15% EC, fipronil 5% SC and spinosad 45% SC with untreated control were evaluated. Among all the treatments spinetoram 11.7% SC has emerged as the best treatment and recorded minimum thrip population and the treatmentsviz. spinosad 45% SC and cyantraniliprole 10.26% OD found at par with this treatment. These treatments registered lowest population of thrips and observed minimum scarred fruits. However, the next promising treatments were tolfenpyrad 15% EC and fipronil 5% SC.The treatment with spinetoram 11.7% SC, spinosad 45% SC and cyantraniliprole 10.26% OD recorded maximum yield of 19.28,18.30 and 18.12 t/ha, respectively. The highest B:C ratio (1:1.76) was recorded in the treatment with spinetoram 11.7% SC followed by spinosad 45% SC (1:1.59), tolfenpyrad 15% EC (1:1.56), fipronil 5% SC (1:1.55), thiamethoxam 25% WG (1:1.51) and flonicamid 50% WG @ 100 g a.i./ha (1:1.43).
Key Words: *sweet orange, citrus thrips, insecticides, bioefficacy, B:C ratio*

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INTRODUCTION

Sweet orange (*Citrus sinensis* L. Osbeck) is one of the most important citrus crop grown almost all over the world. It is also known as "Health fruit" because of its unique feature of having high value of vitamin A and B, sugars, acids, calcium, phosphorous, iron etc. Sweet orange (*Citrus sinensis*) is a highly commercial crop and in Maharashtra itself was grown on area of 99,000 ha with production of 2,45,000 MT and productivity of 2.47 MT/ha. (Anonymous, 2014). There are many constrains in citrus cultivation like disease incidence and insect pest attack which hammer the total production at great extent. In India, these crops were found to be infested by 250 pests (Butani, 1979). Under Maharashtra condition, sweet orange crop was found to be infested by 24 insects and mite pests (Koli *et al*., 1981). Among all insect pest citrus thrips (Thysanoptera) is one of the most important pest responsible greatly for quality deterioration and indirectly reduces market value of commodity at large extent. Several thrips species are important pests of citrus *viz*. *Scirtothrips citri*, *Scirtothrips dorsalis* and *Scirtothripsaurantii*.Taking into consideration the importance of thrips on sweet orange, it is felt to control the present situation.However, on the basis of review of literature, it is noticed that very little work has been done on the management of thrips on sweet orange in field conditions.Therefore, it is necessary to evaluate the efficacy of newer insecticides against thrips for its effective management. The outcomes of present investigations will be much more useful to citrus growers and future research workers in determining the control strategies, selection of pesticides and hence improving their exports and profit and attaining sustainable eco-friendly agriculture.

MATERIAL AND METHODS

I. Details of Experiments

A field experiment was carried out to evaluate the bioefficacy of some newer insecticides against citrus thrips on sweet orange(*Citrus sinensis* L. Osbeck) during February 2016 to September 2016 at sweet orange orchard of AICRP on Fruits, Department of Horticulture, MPKV, Rahuri – 413 722, Dist.

Ahmednagar, Maharashtra. Ten treatments including control (unsprayed) were evaluated in Randomized Block Design with three replications. Sweet orange orchard under treatments was consist of crop variety Mosambi (age of 9 years) having plot size and plant spacing of 12.0 × 6.0 m and 6.0 × 6.0 m, respectively.Three insecticidal applications were made with the help of hand operated knapsack pneumatic sprayer considering the economic threshold level (1 thrips/leaf). Insecticides (treatments) used in experiments were Flonicamid 50% WG, Flupyradifurone 200% SL, Thiamthoxam25% WG, Spinetoram 11.7% SC, Chlorantraniliprole 18.5% SC, Cyantraniliprole 10.26% OD, Tolfenpyrad 15% EC, Fipronil 5% SC, Spinosad 45% SC and Untreated control.

II. Method of insecticide application

Two trees were selected for each replication and there were three replications per treatment. The 1st application was done at new flush stage after *bahar*. The next application was done at 15 days after first application at fruit set stage. Third application was given one month after second spray at marble stage.

III. Method of preparation of spray solution

All the chemicals were applied through spray. The amount of spray solution required was estimated at each time by spraying water on trees in untreated control. The amount of insecticide required for preparing spray solution was calculated by using following formula:

$$Q \times a.i. = C \times V$$

Where, Q = Quantity of insecticide required.
a.i. = Active ingredient in product.
C = Required concentration.
V = Volume of spray solution required.

The known quantity of insecticide was mixed with little quantity of water and then the solution was poured in the bucket containing desired quantity of water. It was thoroughly stirred with the help of wooden stick and applied to sweet orange plant.

IV. Method of spraying

The insecticide spray was applied with the help of hand operated knapsack pneumatic sprayer. All the plants were treated at a time, avoiding the drifts of spray fluid on neighboring plots. Care was taken to wash the spray pump with water thoroughly well before using other insecticides. In all three applications of insecticidal sprays were given.

V. Method of recording observations

Two plants were selected from each treatment and five shoots/plant were tagged. The observations were recorded at '0' days as pre count and post count at 3rd, 7th, 10th and 14th days after each spray.

1) Number of thrips/tender shoot or flower bud were counted.
2) Marketable yield/plant (Kg) or yield (tonnes/ha) was recorded.
3) Incremental cost benefit ratio was worked out.

VI. Analysis of experimental data

The data on average population of thrips were translated into square root transformation ( ) and data in the form of percentage were transformed into arc sin values subjected to statistical analysis as suggested by Panse and Sukhatme (1985). The standard error (S.E.) and critical difference (C.D.) at 5% level of probability were calculated. The yield data was subjected to statistical analysis. Finally, an incremental cost benefit ratio of each treatment was worked out.

RESULTS AND DISCUSSION

A. Bioefficacy of treatments

The average population of thrips (nymphs / leaf) in various treatments was significantly lower than untreated control, days after spraying. The data representing average number of thrips under field condition is given in Table 1. It was observed that no significant differences were observed in average number of thrips in all treatments including untreated control at a day before spray as a pre count, indicating the uniform infestation of thrips.

It could be seen from Table 1 that on 3rd day after spray, the average number of thrips observed in different insecticidal treatments werein the range of 1.60–2.69 as against 3.67 thrips/shoot in untreated control. Among the insecticidal treatments, the treatment with spinetoram 11.7% SC @ 36 g a.i./ha observed to be the most effective and superior over rest of the treatments and recorded lowest (1.60) thrips population. The treatments with spinosad 45% SC @ 112.5; cyantraniliprole 10.26% OD @ 70 g a.i./ha were found at par with this treatment and observed thrip population in the range of 1.87–1.91 thrips/shoot. Rest of the treatments was found comparatively less effective.

The similar trends of results were found in different treatments on 7th, 10th and 14th DAS.In the present study nine insecticides were tested against thrips under field conditions and all were found effective over untreated control in reducing the pest population and increases the sweet orange yield.

Table 1 : Bioefficacy of newer insecticides against thrips on sweet orange (Average of three sprays)

Sr. No.	Insecticides	Dose g a.i./ha	Pre-count	Average Number of thrips/shoot			
				3 DAS	7 DAS	10 DAS	14 DAS
1.	Flonicamid 50 % WG	100	3.05 (1.88)	2.49 (1.72)	1.68 (1.48)	1.35 (1.36)	1.64 (1.46)
2.	Flupyradifurone 200 % SL	200	3.12 (1.90)	2.67 (1.77)	1.74 (1.49)	1.42 (1.39)	1.70 (1.48)
3.	Thiamethoxam 25 % WG	50	3.07 (1.88)	2.40 (1.70)	1.61 (1.45)	1.31 (1.34)	1.59 (1.44)
4.	Spinetoram 11.7 % SC	36	2.73 (1.77)	1.60 (1.44)	0.96 (1.21)	0.80 (1.14)	1.01 (1.23)
15.	Chlorantraniprole 18.5 % SC	74	3.08 (1.89)	2.69 (1.78)	1.84 (1.53)	1.48 (1.41)	1.77 (1.50)
6.	Cyantraniliprole 10.26 % OD	70	2.73 (1.78)	1.91 (1.55)	1.28 (1.33)	0.98 (1.22)	1.27 (1.33)
7.	Tolfenpyrad 15 % EC	150	2.98 (1.85)	2.15 (1.62)	1.40 (1.38)	1.08 (1.26)	1.39 (1.37)
8.	Fipronil 5 % SC	75	3.05 (1.87)	2.21 (1.64)	1.50 (1.41)	1.25 (1.32)	1.52 (1.41)
9.	Spinosad 45 % SC	112.5	2.64 (1.76)	1.87 (1.53)	1.15 (1.29)	0.88 (1.18)	1.16 (1.28)
10.	Untreated control	-	3.53 (2.01)	3.67 (2.04)	3.27 (1.94)	3.10 (1.90)	3.13 (1.90)
	S.E.		0.05	0.04	0.04	0.03	0.03
	C.D. @ 5%		NS	0.12	0.13	0.09	0.10

Figures in parentheses are ($\sqrt{x+0.5}$) transformed values.
DAS – Days After Spray

Among these, spinetoram 11.7% SC @ 36 g a.i./ha has proved to be most promising againstthrips infesting sweet orange and recorded least (0.80-1.60) thrips/shoot survival population of thrips and obtained highest (19.28 t/ha) yieldduring the period of investigation.The treatment with spinosad 45% SC @ 112.5 g a.i./ha was found next effective treatment in controlling thrips and obtaining good yield of sweet orange. Earlier the effectiveness of spinetoram 11.7% SC and spinosad 45% SC against thrips was reported by Dharne and Bagade (2011) in chilli @ 60 g a.i./ha; Dakshina and Kumar (2011) in melon @ 8.0 lb a.i./acre; Sreenivas *et al.* (2013) in chilli @ 56 g a.i./ha and Wagh *et al.* (2016) in onion @ 0.018%.
The results of other treatments included in experiments were also corroborated with the findings of Yadav *et al.,* (2012); Patel *et al.,* (2014); Rameshbabu and Singh (2014); Jadhao *et al*. (2015); Gaurkhede *et al*. (2015) and Wagh *et al.* (2016).

B. Economics of treatments based on net profit and ICBR

I. Yield

It could be seen from the Table 2 that all the treatments were significantly superior and recorded higher yield over untreated control. The treatment with spinetoram 11.7% SC recorded highest (19.28 t/ha) yield of sweet orange followed by spinosad 45% SC (18.30 t/ha), cyantraniliprole 10.26% OD (18.12 t/ha), tolfenpyrad 15% EC (18.02 t/ha) and fipronil 5% SC (17.64 t/ha).

II. B:C ratio

The highest B:C ratio (1:1.76) was recorded in the treatment with spinetoram 11.7% SC @ 36 g a.i./ha followed by spinosad 45% SC @ 112.5 g a.i./ha (1:1.59), tolfenpyrad 15% EC @150 g a.i./ha (1:1.56), fipronil 5% SC @ 75 g a.i./ha (1:1.55), thiamethoxam 25% WG @ 50 g a.i./ha (1:1.51) and flonicamid 50% WG @ 100 g a.i./ha (1:1.43). The treatment with cyantraniliprole 10.26% OD @ 70 g a.i./ha (1:1.37),

chlorantraniliprole 18.5% SC @ 74 g a.i./ha (1:1.28) and flupyradifurone 200% SL @ 200 g a.i./ha (1:0.89) recorded comparatively less B:C ratio as these insecticides are more costly to that of others.

III. ICBR

The highest incremental cost benefit ratio (ICBR) (1:19.01) was recorded in the treatment with thiamethoxam 25% WG @ 50 g a.i./ha followed by spinetoram 11.7% SC @ 36 g a.i./ha (1:13.98), fipronil 5% SC @ 75 g a.i./ha (1:11.00), flonicamid 50% WG @ 100 g a.i./ha (1:8.67) and spinosad 45% SC @ 112.5 g a.i./ha (1:8.62). The treatments with tolfenpyrad 15% EC @ 150 g a.i./ha (1:8.45), cyantraniliprole 10.26% OD @ 70 g a.i./ha (1:3.38), chlorantraniliprole 18.5% SC @ 74 g a.i./ha (1:3.14) and flupyradifurone 200% SL (1:0.23) recorded comparatively less ICBR as these insecticides are more costly to that of other insecticides.

In the present studies, application of different insecticides was found to be promising in getting higher yield and higher ICBR. These findings are in accordance with Jadhao*et al.* (2015) who recorded highest ICBR (1:40.00) in fipronil 5% SC @ 0.005%. Misra (2015) recorded highest gherkin fruit yield in cyantraniliprole @ 90 and 105 g a.i./ha during both 2009-10 (4.94-5.08 t/ha) and 2010-11 (5.02-5.14 t/ha) registering 99.19-104.84 and 93.08-97.69% increase in fruit yield over untreated control, respectively.

Table 2 : Economics of treatments based on net profit and ICBR

Sr. No.	Treatment	Yield	Gross Returns	Cost of Cultivation	Cost of Spraying	Total cost of Cultivation	Net Income	B:C Ratio	ICBR
1.	Flonicamid 50 % WG	16.76	335200	132921	4680	137601	197599	1:1.43	1:8.67
2.	Flupyradifurone 200 % SL	15.03	300600	132921	25930	158851	141749	1:0.89	1:0.23
3.	Thiamethoxam 25 % WG	17.01	340200	132921	2398	135319	204881	1:1.51	1:19.01
4.	Spinetoram 11.7 % SC	19.28	385600	132921	6509	139430	246170	1:1.76	1:13.98
5.	Chlorantraniprole 18.5 % SC	16.46	329200	132921	10996	143917	185283	1:1.28	1:3.14
6.	Cyantraniliprole 10.26 % OD	18.12	362400	132921	20026	152947	209453	1:1.37	1:3.38
7.	Tolfenpyrad 15 % EC	18.02	360400	132921	7783	140704	219696	1:1.56	1:8.45
8.	Fipronil 5 % SC	17.64	352800	132921	5290	138211	214589	1:1.55	1:11.00
9.	Spinosad 45 % SC	18.30	366000	132921	8282	141203	224797	1:1.59	1:8.62
10.	Untreated control	14.73	294600	132921	-	133921	161679	1:1.20	-

Note : Labour charges - Rs.600/spraying

Price of sweet orange - Rs.20000/ton

Fonicamid	- Rs.260/30 gm	Chlorantraniliprole	- Rs.830/60 ml
Flupyradifurone	- Rs.1500/100 ml	Cyantraniliprole	- Rs. 2350/150 ml
Thiamethoxam	- Rs.450/250 gm	Tolfenpyrad	- Rs.3600/lit
Spinetoram	- Rs.1700/180 ml	Fipronil	- Rs.40/100 ml
		Spinosad	- Rs.1170/75 ml

CONCLUSION

From present experiment it was concluded that recently many novel insecticides had been developed which assured the eco friendly protection from insect pest problem in the field. It was found that for management of citrus thrips spinetoram found to be the best treatment as it possesses good bioefficacy against pest as well as has ideal ICBR and was eco friendly in nature. Other treatments including thiamethoxam, spinosad, fipronil etc. also gives better results in management of citrus thrips.

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