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Synergistic Strategies for the Management of Thrips, *Scirtothrips dorsalis* in Pomegranate Ecosystem

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Authors' contributions

This work was carried out in collaboration among all authors. Authors RMM and SBJ did the conceptualization, carried out experiment, data analysis, draft preparation and manuscript review of the manuscript. Authors KA and GD did the manuscript review and correction and also participated in the design of the study and performed the statistical analysis of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Thrips management in pomegranate cultivation is critical due to the significant damage these pests can inflict on fruit yield and quality. The study was carried out in farmers field at Managuli, Vijayapura, College of Agriculture, Vijayapura, Karnataka during 2020-2021. The integrated management of thrips, S*cirtothrips dorsalis* in pomegranate revealed that the *in-situ* vermiculture technique along with chemicals (86.93 per cent) and botanicals (59.40 %) found to be more effective in controlling thrips than *in-situ* vermiculture technique alone (39.22 %). It also revealed that *in-situ* vermiculture technique influencing only 2-5 % pest reduction along with chemical insecticides. Whereas, *in-situ* vermiculture technique along with botanical influencing 15-20 % pest reduction and it mainly due to compatibility and positive effect of botanicals on earthworms than chemicals. However, all the treatments recorded higher yield and found significantly superior over untreated control (5.34 t/ha). By integrating these methods, pomegranate growers can achieve effective thrips control, leading to healthier crops, improved yields while promoting sustainable agricultural practices and minimizing environmental impact.

Keywords: Pomegranate; thrips; Scirtothrips dorsalis; management; B:C ratio.

1. INTRODUCTION

The pomegranate (*Punica granatum* L.), often referred to as the “Fruit of Paradise,” belongs to the Punicaceae family and is an ancient fruit with a rich history. It is widely cultivated in tropical and subtropical regions and is known as ‘Anar’ in Hindi and ‘Dalim’ or ‘Dalimbe’ in Kannada. Native to Iran, where it was first cultivated around 2000 BC, the pomegranate has since spread to various Mediterranean countries. Today, it is extensively grown in Spain, Morocco, Egypt, Iran, Afghanistan, Pakistan, Arabia, India, and other Mediterranean regions, highlighting its significance as a major fruit crop [1,2].

In India, it is regarded as a “vital cash crop”, grown in an area of 0.125 million ha with a production of 1.14 million tonnes and productivity of 12.39 MT [3]. The per cent availability of fruits per head per day is only 55 g, which is far lower than the recommended level of 85 g per head per day by Indian Council of Medical Research (ICMR). Among the pomegranate growing states, Maharashtra is the largest producer occupying 2/3rd of total area in the country followed by Karnataka, Andhra Pradesh, Gujarat and Rajasthan. Karnataka has the distinction of cultivating pomegranate under tropical conditions with an area of 19,040 ha spread across different districts *viz.*, Vijayapura, Bagalkote, Chitradurga, Koppal, Belagavi, Bengaluru, Bellary, Davangere, Gadag, Kalaburgi, Raichur and Tumkur with annual production of 2,04,640 tonnes and with an average productivity of 10.00 MT [4].

The cultivation of pomegranates in India faces significant challenges due to a wide range of pests. The issue is highlighted by the presence of 91 insect species, six mite species, and one snail pest. Noteworthy pests include the Anar butterfly (*Virachola isocrates*), thrips (S*cirtothrips dorsalis*), aphids (*Aphis punicae*), whiteflies (*Siphoninus phillyreae*), and mealybugs (*Ferrisia virgata*), which can cause substantial damage and lead to over 50 percent fruit loss [5]. Additionally, fruit-sucking moths, stem borers, other sucking pests, and the newly identified pomegranate castor semi-looper also contribute to significant crop damage [6].

Thrips are significant pests in pomegranate cultivation, posing threats to both yield and fruit quality. The proliferation of thrips species, including *S. dorsalis* (Hood), *S. oligochaetus* (Karny), *R. cruentatus* (Hood), *Frankliniella schultzei* (Trybom), *F. occidentalis* (Pergande) and *Thrips florum* (Schmutz), poses a significant challenge to pomegranate cultivation. *S. dorsalis,* in particular, inflicts extensive damage by feeding on various plant parts, resulting in deformation and discoloration, thus reducing market value. The escalating severity of *S. dorsalis* infestations necessitates increased reliance on systemic insecticides, posing sustainability concerns for high-quality, export-grade pomegranate production [6].

Effective management of these pests requires a comprehensive understanding of their ecology and the implementation of synergistic strategies that integrate various control methods. This paper explores a multifaceted approach to thrips management in pomegranate ecosystems. Additionally, we discuss the judicious application of insecticides, emphasizing the importance of timing and targeted use to minimize non-target effects and resistance development. By integrating these strategies into a cohesive management framework, we aim to enhance the sustainability and effectiveness of thrips control in pomegranate cultivation. This approach not only addresses immediate pest pressures but also promotes long-term ecosystem health, ensuring the viability of pomegranate production in the face of ongoing agricultural challenges.

2. MATERIALS AND METHODS

Experiments on sustainability of *in-situ* vermiculture technique was carried out in farmers field at Managuli, Vijayapura and Department of Agricultural Entomology, College of Agriculture, Vijayapura (UAS, Dharwad), Karnataka during 2020-2022. Vijayapura district was situated in Northern Dry Zone (NDZ- 3) of Karnataka between 16°19 latitude, 75°70 longitude, at 532 m above mean sea level. The places lying in and around receives an average annual rainfall of 597 mm from both Southwest and Northeast monsoons distributed well over the season.

The experiment consisted of seven treatments including control and each treatment was replicated thrice using randomized completely block design (RCBD). Two trees of pomegranate plants were considered as one replication and tagged. Management practices were carried out by following all the recommended package of practices except the plant protection measures against thrips in the pomegranate gardens. Treatment details are presented in Table 1.

In-situ vermiculturing technique (Earthworms @ 200/plant (1,48,000/ha) + FYM @ 30 kg/plant + Crop residue mulching) was carried out before 30 days imposition of treatment. Treatments were imposed with help of knapsack sprayer (Fig. 1). The first spray was & taken up when the crop is uniformly infested by thrips population. Observations on the population counts of thrips were recorded by counting number of nymphs and adults from 3 terminal branches of 10 cm length per plant, by shaking the shoots on hard card board pasted with stiff white paper (30x30 cm) to facilitate easy visibility. The average number of thrips (both nymph and adult) per shoots were worked out by selecting ten random plants and population of thrips were made, prior to one day before spraying and subsequently after treatment imposition at 1, 3, 5 and 10 days after spray. The subsequent spray were taken at 15 days interval. Percentage of infestation also worked out.

Statistical data: Data was subject to ANOVA and economic analysis were carried out by using OPISTAT Software. Further, obtained data was converted into per cent reduction of pest population over control through following formula:

$$\text{Per cent reduction over control} = \frac{\text{Insect pest population in control} - \text{Insect pest population in treatment}}{\text{Insect pest population in control}} \times 100$$

B: C ratio was also calculated by dividing the gross returns by cost of cultivation.

$$\text{B: C ratio} = \frac{\text{Gross return}}{\text{Total cost of cultivation}} \times 100$$

3. RESULTS AND DISCUSSION

A. Population of thrips (*S. dorsalis*) during first spray

There was no significant difference in thrips population among all the treatments a day before imposition of treatments with a population range of 5.04 to 5.34 thrips per shoot (Table 1).

One day after spray, lowest population was recorded in T_1 + thiamethoxam 25 WG (1.28 thrips/shoot) followed by T_1 + fipronil 5 SC (1.81 thrips/shoot) and thiamethoxam 25 WG (2.00 thrips/shoot) which are on par with each other. The next best treatments were T_1 + neem based insecticide (3.12 thrips/shoot) and T_1 + FORS (3.21 thrips/shoot). Whereas, the treatment earthworms @ 200/plant (1,48,000/ha) + FYM @ 30 kg/plant + crop residue mulching applied plots recorded highest population of 4.58 thrips per shoot. However, all treatments were significantly superior over untreated control (5.13 thrips/shoot). Similar trend was also noticed for thrips at three and five days after spraying with different treatment (Table 1).

At ten days after spray, thrips population increased slightly in all the treatments. The treatment T_1 + thiamethoxam 25 WG recorded least thrips population of 0.48 per shoot and it was found to be on par with T_1 + neem based insecticide (2.01 thrips/shoot) and T_1 + FORS (2.11 thrips/shoot). Whereas, untreated control recorded the highest population of 5.83 thrips per shoot (Table 1).

B. Population of thrips (*S. dorsalis*) during Second spray

The pre-treatment counts made a day before spray indicated that there was no significant difference among the treatments. However, the thrips population ranged from 3.12 to 5.99 thrips per shoot (Table 1).

The data on thrips population recorded after the first spray revealed that T_1 + thiamethoxam 25 WG was superior to other treatments in reducing the thrips population from 3.12 to 1.32 thrips per shoot followed by T_1 + fipronil 5 SC (1.97 thrips/shoot) and thiamethoxam 25 WG (2.08 thrips/shoot). Although the treatment earthworms @ 200/plant (1,48,000/ha) + FYM @ 30 kg/plant + crop residue mulching applied plants recorded minimum thrips population of 3.20 thrips per shoot. Among different treatments, the highest population recorded in T_1 + neem based insecticide and T_1 + FORS with mean population of 3.38 and 3.42 thrips per shoot, respectively and these were superior over untreated control (6.02 thrips/shoot). Similar trend was observed at three and five days after spraying of different botanical and chemical insecticides.

The least number of thrips recorded at ten days after spraying indicated that T_1 + thiamethoxam 25 WG, T_1 + fipronil 5 SC and thiamethoxam 25 WG significantly reduced the thrips population of 0.58, 0.71 and 0.92 per shoot, respectively and are on par with each other. Earthworms @ 200/plant (1,48,000/ha) + FYM @ 30 kg/plant + crop residue mulching applied plots recorded highest thrips population of 2.68 per shoot compared to other treatments included in the study and it was superior over control (6.91 thrips/shoot) (Table1).

C. Mean population and per cent reduction over untreated control

The data on the efficacy of various treatments in reducing the pest population after first and second spray are furnished in Table 1. The treatment T_1 + thiamethoxam 25 WG was superior over other treatments in reducing the thrips population by 86.93 per cent. The other treatments in descending order of their efficacy were T_1 + fipronil 5 SC (82.58 %), thiamethoxam 25 WG (80.34 %), T_1 + neem based insecticide (59.40 %) and T_1 + FORS (56.16 %) and earthworms @ 200/plant (1,48,000/ha) + FYM @ 30 kg/plant + crop residue mulching (39.22 %) (Table 1).

D. Yield and cost economics of different insecticides on pomegranate during 2021

The estimated yield and cost of economics of different insecticides are presented in the Table 2. The imidacloprid 17.8 SL treated plots recorded the highest yield of 16.25 t/ha followed by thiamethoxam 25 WG (14.07 t/ha), flonicamid 50 WG (13.94 t/ha), fipronil 5 SC (12.91 t/ha), neem based insecticide (10.02 t/ha), FORS (9.73 t/ha), *L. lecanii* (9.15 t/ha) and the treatment applied with earthworms @ 200/plant (1,48,000/ha) + FYM @ 30 kg/plant + Crop residue mulching (6.84 t/ha). However, all the treatments recorded higher yield and found significantly superior over untreated control (5.34 t/ha) (Table 2).

The highest B:C ratio of 1: 6.82 was registered in imidacloprid 17.8 SL treated plots, followed by thiamethoxam 25 WG (1: 5.88), flonicamid 50 WG (1: 5.77), fipronil 5 SC (1: 5.39), neem based insecticide (1: 4.18), FORS (1: 4.08), *L. lecanii* (1: 3.78) and the treatment applied with earthworms @ 200/plant (1,48,000/ha) + FYM @ 30 kg/plant + Crop residue mulching (1: 2.85). The lowest C: B ratio of 1: 2.25 was recorded in untreated control (Table 2).

The yield data highlights the differences in treatment effectiveness but does not thoroughly explain the underlying factors contributing to higher yields. Factors such as cost of cultivatoion, cost of protection, the mode of action, persistence, and systemic nature of certain treatments, like thiamethoxam, could have resulted in better pest control and, consequently, higher yields. Additionally, treatments that reduced pest populations more quickly and for longer periods likely allowed plants to thrive with less damage. A deeper analysis of the treatments' interaction with plant physiology and pest resistance could provide more insight into the yield differences.


(A)


(B)

(A-B) Release of Earthworms, *Eudrilus eugeniae*


(C)


(D)


(E)

(C-E) Watering, mulching and spraying of insecticides

Fig. 1. Operations of *In-situ* vermiculturing and spraying of chemicals in pomegranate ecosystem

Table 1. Integrated management for thrips in pomegranate during 2021-22

Tr. No.	Treatments	Mean no. of thrips per shoot										Mean	Per cent reduction over control
		1st spray					2nd spray						
		1 DBS	1 DAS	3 DAS	5 DAS	10 DAS	1 DBS	1 DAS	3 DAS	5 DAS	10 DAS		
T1	Earthworms @ 200/plant (1,48,000/ha) + FYM @ 30 kg/plant + Crop residue mulching	5.04 (2.35)	4.58 (2.25)^{a}	4.45 (2.22)^{b}	4.20 (2.16)^{b}	3.75 (2.06)^{b}	3.38 (1.96)	3.20 (1.92)^{b}	3.18 (1.91)^{b}	2.99 (1.86)^{b}	2.68 (1.78)^{b}	3.63	39.22
T2	T1 + Neem based insecticide (10,000 ppm)	5.21 (2.38)	3.12 (1.90)^{b}	2.41 (1.70)^{c}	1.48 (1.41)^{c}	2.01 (1.58)^{c}	3.86 (2.08)	3.38 (1.96)^{b}	2.91 (1.84)^{b}	1.99 (1.57)^{c}	2.09 (1.60)^{b}	2.42	59.40
T3	T1 + FORS (Fish Oil Rosin Soap)	5.18 (2.38)	3.21 (1.92)^{b}	2.55 (1.74)^{c}	1.62 (1.45)^{c}	2.11 (1.61)^{c}	3.92 (2.10)	3.42 (1.97)^{b}	3.00 (1.87)^{b}	2.45 (1.71)^{bc}	2.58 (1.75)^{b}	2.62	56.16
T4	T1 + Thiamethoxam 25 WG	5.07 (2.36)	1.28 (1.33)^{c}	1.00 (1.22)^{d}	0.31 (0.90)^{d}	0.48 (0.98)^{d}	3.12 (1.90)	1.32 (1.34)^{c}	0.87 (1.17)^{c}	0.40 (0.94)^{d}	0.58 (1.03)^{c}	0.78	86.93
T5	T1 + Fipronil 5 SC	5.34 (2.34)	1.81 (1.51)^{c}	1.09 (1.26)^{d}	0.47 (0.98)^{d}	0.73 (1.10)^{d}	3.21 (1.92)	1.97 (1.57)^{c}	1.10 (1.26)^{c}	0.44 (0.96)^{d}	0.71 (1.10)^{c}	1.04	82.58
T6	Thiamethoxam 25 WG	5.27 (2.40)	2.00 (1.58)^{c}	1.16 (1.28)^{d}	0.58 (1.03)^{d}	0.81 (1.14)^{d}	3.49 (1.99)	2.08 (1.60)^{c}	1.28 (1.33)^{c}	0.56 (1.02)^{d}	0.92 (1.19)^{c}	1.17	80.34
T7	Control	5.11 (2.36)	5.13 (2.37)^{a}	5.32 (2.41)^{a}	5.68 (2.48)^{a}	5.83 (2.51)^{a}	5.99 (2.54)	6.02 (2.55)^{a}	6.32 (2.61)^{a}	6.57 (2.65)^{a}	6.91 (2.72)^{a}	5.97	-
	S.Em.±	**NS**	**0.16**	**0.17**	**0.10**	**0.12**	**0.18**	**0.15**	**0.15**	**0.11**	**0.13**	**-**	-
	CD (P=0.05)	**NS**	**0.50**	**0.52**	**0.31**	**0.38**	**0.57**	**0.46**	**0.46**	**0.33**	**0.39**	**-**	-
	CV (%)	**8.24**	**9.22**	**11.34**	**8.41**	**9.49**	**8.29**	**8.52**	**9.77**	**8.50**	**9.30**	**-**	-

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values; Means in the columns followed by the same alphabet do not differ significantly by DMRT (P = 0.05); DBS-Day before spray; DAS-Days after spray; FYM= Farm yard manure;

Table 2. Cost benefit ratio of different botanicals and chemical insecticides against major sucking pests of pomegranate during 2021-22.

Sl. No.	Treatments	Yield (t/ha)	Gross returns (Rs/ha)	Total Cost of protection (Rs/ha)	Total cost of production (Rs/ha)	Net returns (Rs/ha)	B:C ratio
1	Earthworms @ 200/plant (1,48,000/ha) + FYM @ 30 kg/plant + Crop residue mulching	6.84	615600	2000	215343	400257	1 : 2.85
2	Neem based insecticide (10,000 ppm)	10.02	901800	2085	215428	686372	1 : 4.18
3	*Lecanicillium lecanii* (1x10^8 conidia/g)	9.15	823500	4250	217593	605907	1 : 3.78
4	FORS (Fish Oil Rosin Soap)	9.73	875700	1200	214543	661157	1 : 4.08
5	Imidacloprid 17.8 SL	16.25	1462500	1080	214423	1248077	1 : 6.82
6	Flonicamid 50 WG	13.94	1254600	4050	217393	1037207	1 : 5.77
7	Fipronil 5 SC	12.91	1161900	2100	215443	946457	1 : 5.39
8	Thiamethoxam 25 WG	14.07	1266300	1920	215263	1051037	1 : 5.88
9	Control	5.34	480600	-	213343	267257	1 : 2.25

Note: Market price of pomegranate Rs. 90/ kg

From the above results, it was evident that the *in-situ* vermiculture technique along with chemicals and botanicals found to be more effective in controlling sucking pests over *in-situ* vermiculture technique alone. Thiamethoxam likely outperformed other treatments due to its systemic nature and rapid action on the insect nervous system, providing prolonged protection. Its novel mode of action as a neonicotinoid enhances its effectiveness against sucking pests. In contrast, the combination of vermiculture and botanicals may have been less effective because botanicals typically offer slower, shorter-lasting pest control, and vermiculture mainly improves soil health rather than directly targeting pests. Further investigation into these differences could lead to better integration of these methods in pest management. The literature pertaining to integrated approach were not available in pomegranate. So the separate studies on *in-situ* vermiculturing, chemical and botanical management in pomegranate were discussed.

Ananda et al. [7] and Bartual et al. [8] documented that neonicotinoid insecticides *viz*., imidacloprid, flonicamid and acetamiprid were more effective in controlling pomegranate aphids. Kadam [9] and Nagaraj et al. [10] reported that spraying of thiamethoxam was most effective against thrips followed by fipronil, imidacloprid and acetamiprid. These results are in confirmation with Bedse [11] and Ananda et al. [7] who revealed that new generation insecticides *viz*., imidacloprid, thiamethoxam and acetamiprid were most effective in controlling whiteflies in pomegranate. Ananda [12] stated that significantly highest reduction of mealybug population was recorded from thiamethoxam, imidacloprid and dimethoate treated plot.

Ananda et al. [13] reported that NSKE, FORS and *V. lecanii* (1x10^{-8} conidia/g) treated plots were effective in minimizing aphids, thrips, whiteflies and mealybugs population in pomegranate. *In-situ* vermiculturing showed reduced citrus leaf miner in citrus ecosystem [14], reduction in the pest load of grape [15] and lesser pest load of woolly aphid, early shoot borer, scale and root grub in sugarcane ecosystem [16]. Kadam [9] and Mohammad et al. [17] reported that higher cost benefit ratio (B:C) was recorded in imidacloprid followed by thiamethoxam, flonicamid, fipronil, neem oil, FORS, *Verticillium lecanii* and *in-situ* vermiculturing plots and these results were confirmatory with the present findings.

4. CONCLUSION

In conclusion, managing thrips in pomegranate cultivation requires a holistic and integrated approach that combines multiple strategies for optimal effectiveness. By implementing cultural practices, utilizing physical and mechanical controls, introducing biological agents, and applying selective chemical treatments judiciously, growers can effectively control thrips populations while minimizing crop damage and environmental impact. Regular monitoring and adherence to action thresholds ensure that interventions are timely and targeted, reducing the risk of resistance and enhancing overall pest management. This integrated pest management approach not only protects pomegranate crops but also promotes sustainable agricultural practices, leading to healthier plants and more resilient production systems.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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