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FIELD EFFICACY OF SELECTED INSECTICIDES AND ACARICIDES FOR THE MANAGEMENT OF *Thrips tabaci* AND *Aceria tulipae* INFESTING GARLIC

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ABSTRACT

Field experiments were conducted for two consecutive years to evaluate the efficacy of the insecticides Spinosad (0.4 mL/L) and Spinetoram (0.8 mL/L), and the acaricides, Fenpyroximate (0.8 mL/L) and Propargite (1.0 mL/L), against onion thrips (*Thrips tabaci*) and eriophyid mite (*Aceria tulipae*) infesting garlic during the Rabi seasons of 2022-23 and 2022-24. Among the treatments, Spinetoram (T_3) was the most effective against thrips, recording a mean population range of 2.3-7.7 thrips/plant across the two seasons. Spinosad (T_4) was the next most effective treatment, with a mean thrips population of 7.9-9.4 thrips/plant. Acaricides, Fenpyroximate (T_1) and Propargite (T_2) were equally effective, at par with each other against eriophyid mites, recording mean mite populations ranging from 0.8-1.7 and 0.8-2.33 mites/plant, respectively. Pooled analysis results from the two seasons showed that Spinetoram resulted in the highest reduction in thrips population (96.5%), followed by Spinosad (91.8%). Fenpyroximate recorded the highest reduction in eriophyid mite population (87.8%), followed by Propargite (85.4%). Spinetoram recorded the highest pooled garlic bulb yield (6.10 t ha^{-1}), representing a 66.0% increase over the absolute control. Among the acaricide treatment, Propargite recorded the highest bulb yield (3.30 t ha^{-1}), corresponding to a 36.4% increase over the control. Based on efficacy and ICBR, Spinetoram (6.5) and Propargite (8.5) were identified as the most cost-effective treatments for the management of thrips and eriophyid mites, respectively. Thus, Spinetoram @ 0.8 mL/L and Propargite @ 1.0 mL/L can be recommended for the effective and economically managing thrips and eriophyid mites in garlic.

***Key words*:** Insecticides, Acaricides, *Thrips tabaci* , *Aceria tulipae*, Garlic

Introduction

Garlic (*Allium sativam* L.) is one of the important commercial bulb vegetables grown in India, China as well as in other parts of Asia and North Africa (Lawande *et al*., 2009; Ding, 2005; Etoh *et al*., 2001). The cloves are often used for seasoning and in numerous forms for their taste and flavor (Ferruci *et al*., 2010). The cloves are an excellent source of minerals and vitamins (Majewski, 2014); constituents are known for their medicinal value for multiple health risks hazards like indigestion, anti-cancer, and reduction of blood pressure, heart diseases and arthrosclerosis (Bayan *et al*., 2014). In India, garlic is grown as *Rabi* season vegetable and is mostly planted during the month of October-November and harvested in March-April. The garlic is grown in 0.015 M ha with production of 0.65 MT in India (Lawande *et al*., 2009). Globally, India rank second position next to China in terms of garlic cultivation area however the productivity is much low (5.67t/ha) than world average and is in static (Malik *et al*., 2017). The states including Madhya Pradesh, Gujarat, Rajasthan, Uttar Pradesh and Maharashtra are the major garlic growing areas in India. Of the various factors that hamper garlic production, insect pests are major constrains in India (Kalola *et al*., 2017).

Onion thrips, *Thrips tabaci* Lindeman, (Thysanoptera: Thripidae), and eriophyid mites, *Aceria tulipae* (Acaridae: Eriophyidae) are the major insect pests of garlic in India (Srinivasan *et al*., 2007; Karuppaiah *et al*., 2018). It damages the crop either by direct injury to green foliage or indirectly by virus transmission, aggravating fungal diseases (Arantha, 1974; Diaz-Montano *et al*., 2011). Thrips nymphs and the adult thrips lacerate the tissue of the plant, sucks sap of the leaf; injured plants show curling and silvery patchy blisters spots on the leaves. Under severe infestation, this may lead to a decrease in photosynthetic area, eventually formation of undersized bulbs and significant yield losses (Butani and Verma, 1976; Patel and Patel, 2012; Karuppaiah *et al*., 2018). In India, yield losses of up to 15.35 to 46.82 per cent have been reported (Changela, 1993). Mites are located at the midrib of the leaves, and causes stunting, twisting, curling and yellow mottling with a typical pig tail appearance in infected plants (Debnath and Karmakar, 2013; Ghos *et al*., 2025).

Conventional organophosphates, carbamates, pyrethroids, phenylpyrazoles and organochlorin miticides are widely used against these pests. However, repeated use of broad-spectrum chemicals can result in reduced efficacy, development of resistance and adverse effects on beneficial arthropods (Martin *et al*., 2003; Allen *et al*., 2005; Shelton *et al*., 2006). Therefore, evaluation of newer chemistry insecticides and miticides with novel modes of action, lower effective doses and greater selectivity is essential. Their judicious rotation based on different modes of action can improve pest control and help delay resistance development. Hence, the present study was undertaken to evaluate selected newer insecticides and acaricides for the effective management of *T. tabaci* and *A. tulipae* in garlic and their potential integration into IPM programmes.

Materials and Methods

Experimental site and details

A field experiment was conducted during the *Rabi* season for two consecutive years 2022-23 and 2023-24 at the research farm of ICAR-Directorate of Onion and Garlic Research (ICAR-DOGR), Pune, Maharashtra, India. Garlic cultivar 'Bhima Purple' was planted on raised beds measuring 1.2 × 5.0 m, with a spacing of 15 × 10 cm. All recommended agronomic practices were followed throughout the crop period, except for pest management practices imposed as experimental treatments. The experiment was laid out in a randomized block design (RBD) comprising five treatments, including an untreated control, with three replications. The commercial formulation of insecticides and acaricides including Fenpyroximate 5% EC @ 0.8 ml L^{-1}, Propargite 57% EC @ 1.0 ml L^{-1}, Spinetoram 11.7 SC @ 0.8 ml L^{-1}, and Spinosad 45% SC @ 0.4 ml L^{-1} were obtained and evaluated. The untreated control received no insecticide or acaricide application. Four applications were made at 40, 55, 70 and 85 days after planting (DAP). The respective treatments were applied using a knapsack sprayer fitted with a suitable nozzle, ensuring uniform coverage of the crop foliage.

Assessment of thrips

The population of onion thrips, *T. tabaci*, was assessed by randomly selecting 10 plants from each plot in each replication. The numbers of nymphs and adults present on the selected plants were counted visually. Observations were recorded immediately before each spray (pre-treatment count) and at 1, 3 and 5 days after treatment (DAT). The observations were used to determine the treatment-wise reduction in thrips population and the efficacy of each insecticide treatment. Treatment wise percent reduction of thrips population over control (ROC) was estimated using following formula:

$$\text{ROC (\%)} = \frac{\text{Thrips population in control - Thrips population in treatment}}{\text{Thrips population in control}} \times 100$$

Assessment of eriophyd mite

The incidence of bulb mite, *Aceria tulipae* (Keifer), was assessed by selecting a 1 m^2 area at the centre of each plot to minimize border effects. The number of mite-infested or symptomatic plants within the selected area was recorded before treatment and at 7 days after each spray. Five symptomatic leaves were randomly collected from each plot/replication and examined under a stereomicroscope at 20× magnification to confirm the presence of eriophyid mites. The number of mites observed on the infested leaves was also recorded and expressed as mites per leaf. Treatment wise percent reduction of mite population over control (ROC) was estimated using following formula:

$$\text{ROC (\%)} = \frac{\text{Mites population in control - Mites population in treatment}}{\text{Mites population in control}} \times 100$$

Estimation of bulb yield and ICBR

At physiological maturity, garlic bulbs from the net plot area were harvested, cured, and graded based on marketable quality. The marketable bulb yield was recorded and expressed in tonnes per hectare (t ha^{-1}). The percentage increase in marketable bulb yield over the untreated control was calculated by comparing the yield obtained under each treatment with that of the untreated control, following formula:

$$\text{Yield increased over control (\%)} = \frac{\text{Yield from treatment - Yield from control}}{\text{Yield from control}} \times 100$$

Table 1: Bio-efficacy different insecticides formulation against sucking pests of garlic (2022-23).

Treatment	Avg. No. of thrips per plant(Mean of three replications and five observation per replication)						AEMPP	
	Before spray	40 DAS	55 DAS	70 DAS	85 DAS	Mean	Before spray	55 DAS
T_1- Fenpyroximate 5% EC	15.1(3.89)	19.9(4.46)	25.1(5.01)	15.7(3.96)	20.2(4.49)	20.2(4.49)	10.0 (3.16)	1.67(1.29)
T_2-Propargite 57% EC	16.1(4.01)	17.0(4.12)	30.9(5.56)	16.1(4.01)	21.3(4.62)	21.3(4.61)	11.0 (3.32)	2.33(1.53)
T_3-Spinetoram 11.7% SC	15.6(3.95)	3.7(1.92)	2.7(1.64)	0.5(0.71)	2.3(1.52)	2.3(1.52)	9.0(3.00)	6.67(2.58)
T_4-Spinosad 45% SC	16.6(4.07)	6.2(2.49)	16.8(4.10)	0.6(0.77)	7.9(2.81)	7.9(2.81)	12.0 (3.46)	6.67(2.58)
T_5-Control	15.9(3.99)	52.6(7.25)	108.7(10.43)	24.1(4.91)	61.8(7.86)	61.8(7.86)	11.3 (3.56)	12.67(3.56)
CD@ (0.05)	NS	6.09	3.62	4.0	4.57	1.29	NS	1.144
AEMPP: Avg. No. of Eriophyid mites per plant(Mean of three replications and five observation per replication)								

Treatment wise percent reduction of thrips population over control (ROC) was estimated using following formula

$$\text{ROC (\%)} = \frac{\text{Thrips in control - Thrips in treatment}}{\text{Thrips in control}} \times 100$$

Treatment wise Incremental Cost-Benefit Ratio (ICBR) was calculated to work out the economic benefit of each treatment and effective treatment using following formula:

$$\text{Incremental Benefit Cost Ratio (ICBR)} = \frac{\text{Input cost of the treatment}}{\text{Value of additional bulb yield}}$$

Data analysis

The observations recorded on thrips and mite populations and yield were subjected to statistical analysis using analysis of variance (ANOVA) appropriate for the randomized block design (RBD). The significance of differences among treatment means was tested at the 5 per cent level of significance. The data obtained during two consecutive years were subjected to pooled analysis to determine the overall treatment effects across years. The pooled data were analysed using the appropriate ANOVA, considering year and treatment effects and their interaction. When significant differences among treatment means were observed, mean separation was carried out using Tukey's Honestly Significant Difference (HSD) test at the 5 per cent level of significance. The statistical analyses were performed using appropriate statistical software.

Results and Discussion

The year-wise efficacy of different treatments against thrips and eriophyid mites, based on pre- and post-treatment population counts, is presented in Tables 1 and 2, respectively. During *Rabi* 2021-22, among the different treatments evaluated, T_3-Spinetoram was found to be the most effective treatment against thrips, recording the lowest mean population (2.3 thrips/plant). It was statistically at par with T_4-Spinosad, which recorded a mean population of 7.9 thrips per plant.

In the case of eriophyid mites, T_1-Fenpyroximate was the most effective treatment, recording the lowest mean mite population of 1.7 mites per plant, followed by T_2-Propargite, which recorded 2.33 mites per plant. The mite populations recorded in these two treatments were statistically at par with each other, indicating comparable efficacy against eriophyid mites. Similarly, during the Rabi 2022-23, T_3-Spinetoram was the most effective treatment against thrips, recording the lowest mean population of 7.7 thrips per plant, followed by T_4-Spinosad, which recorded 9.4 thrips per plant. With respect to eriophyid mites, both T_1-Fenpyroximate and T_2-Propargite recorded an identical mean population of 0.8 mite per plant,

Table 2: Bio-efficacy different insecticides formulation against sucking pests of garlic (2023-24).

Treatment	Avg. No. of thrips per plant(Mean of three replications and five observation per replication)						AEMPP	
	Before spray	40 DAS	55 DAS	70 DAS	85 DAS	Mean	Before spray	55 DAS
T_1- Fenpyroximate 5% EC	22.8(4.77)	22.0 (4.69)	33.6(5.80)	7.1(2.66)	17.5(4.18)	20.6(4.54)	4.3(2.07)	0.8(0.89)
T_2-Propargite 57% EC	27.5(5.24)	19.1(4.37)	23.7(4.87)	6.9(2.63)	17.7(4.21)	19.0(4.36)	4.0(2.00)	0.8(0.89)
T_3-Spinetoram 11.7% SC	30.1(5.49)	0.5(0.71)	0.6(0.77)	6.7(2.59)	0.6(0.77)	7.7(2.77)	4.0(2.00)	4.9(1.10)
T_4-Spinosad 45% SC	37.5(6.12)	0.4(0.63)	1.1(1.05)	7.3(2.70)	0.6(0.77)	9.4(3.07)	4.3(2.07)	5.2(1.22)
T_5-Control	43.1(6.57)	88.2(9.39)	81.3(9.02)	19.7(4.44)	72.6(8.52)	61.0(7.81)	4.3(2.07)	7.8(1.67)
CD@ (0.05)	NS	9.2	6.3	3.38	6.79	2.27	ns	1.59
AEMPP: Avg. No. of Eriophyid mites per plant(Mean of three replications and five observation per replication)								

Table 3: Pooled mean of thrips, mites, and bulb yield as influenced by insecticide and acaricides treatments.

Treatment	Thrips(Avg. nos./plant)				Mites(Avg. nos./plant)				Yield(t/ha)			
	Year 1	Year 2	Pooled	ROC %	Year 1	Year 2	Pooled	ROC %	Year 1	Year 2	Pooled	IOC %
T_1- Fenpyroximate 5% EC	20.2	20.6	20.1[b]	67.7	1.7	0.8	1.2[a]	87.8	4.6	1.7	3.2[b]	33.5
T_2-Propargite 57% EC	21.3	19.0	19.1[b]	69.4	2.3	0.8	1.5[a]	85.4	4.1	2.5	3.3[b]	36.4
T_3-Spinetoram 11.7% SC	2.3	7.7	2.2[a]	96.5	6.7	4.9	5.8[b]	3.6	6.3	5.9	6.1[a]	65.6
T_4-Spinosad 45% SC	7.9	9.4	5.1[a]	91.8	6.7	5.2	5.9[b]	42.1	6.3	5.5	5.9[a]	64.5
T_5-Control	61.8	61.0	62.4[c]	67.7	12.7	7.8	10.2[c]	87.8	2.7	1.5	2.1[b]	
CD@ (0.05)	1.29	2.27	5.81		1.14	1.59	3.10				1.82	
*Means followed by the same letter(s) are not significantly different												

indicating that both miticidal treatments were equally effective in suppressing the eriophyid mite population during 2022-23. Overall, the results indicated that Spinetoram were comparatively effective against thrips, whereas Fenpyroximate and Propargite were effective against eriophyid mites during both years of experimentation. The pooled analysis of thrips and eriophyid mite populations, garlic bulb yield, percentage reduction in pest population over the absolute control, and percentage increase in bulb yield over the control under different treatments is presented in Table 3. The pooled results revealed that T_3-Spinetoram was the most effective treatment against thrips, recording a 96.5 per cent reduction in thrips population over the absolute control, followed by T_4-Spinosad, which recorded a 91.8 per cent reduction. Similarly, the highest suppression of eriophyid mites was recorded in T_1-Fenpyroximate, with an 87.8 per cent reduction in mite population over the absolute control, followed by T_2-Propargite, which recorded an 85.4 per cent reduction.

Spinosad and Spinetoram, belonging to the spinosyn group of insecticides, are among the most widely used insecticides for the management of thrips worldwide (Bao *et al.*, 2014; Jones *et al.*, 2005; Shi *et al.*, 2021). Spinosyns exert their insecticidal activity primarily by interacting with nicotinic acetylcholine receptors (nAChRs) in the insect nervous system, resulting in neuronal excitation, paralysis, and ultimately death of the insect (Sparks *et al.*, 2021). The effectiveness of Spinetoram against thrips has also been demonstrated in several studies. Wakil *et al.*, (2022) reported that the combined application of *Beauveria bassiana* and Spinetoram resulted in the lowest populations of both larval and adult *T. tabaci* in onion, along with reduced foliage damage. Similarly, Basavaraj *et al.*, (2024) demonstrated effective suppression of *T. tabaci* populations in cotton following Spinetoram application. Furthermore, Siebert *et al.*, (2016) found that Spinetoram applied in combination with a surfactant effectively controlled onion thrips, *T. tabaci*, on cotton seedlings. More recently, Tian *et al.*, (2025) reported that *T. tabaci* populations remained largely susceptible to Spinetoram. Collectively, these findings support the efficacy of Spinetoram as an important component of thrips management and suggest that its performance may be further enhanced when integrated with compatible biological control agents or adjuvants.

The pooled bulb yield data showed that T_3-Spinetoram recorded the highest mean garlic bulb yield of 6.10 t ha^{-1}, followed by T_4-Spinosad, which recorded 5.91 t ha^{-1} (Table 4). The corresponding percentage increase in bulb yield over the absolute control was 66.0 per cent with Spinetoram and 64.0 per cent with Spinosad. Among the acaricides, T_2-Propargite recorded the highest mean garlic bulb yield of 3.30 t ha^{-1}, corresponding to a 36.4 per cent increase in yield over the absolute control. This was followed by T_1-Fenpyroximate, which resulted in a 33.5 per cent increase in bulb yield over the control. Overall, the pooled analysis indicated that Spinetoram and Spinosad provided substantial suppression of thrips and were associated with higher garlic bulb yields, while Fenpyroximate and Propargite exhibited higher efficacy

Table 4: Pooled Analysis of Variance (ANOVA) and Treatment × Year Interaction Effects.

Source	Thrips			Eriophyid mites			Garlic bulb yield (t/ha)		
	df	F Value	P value	df	F Value	P value	df	F Value	P value
Year	1	1.94	0.235 ^{NS}	1	9.09	0.039*	1	11.03	0.029*
Treatment	4	265.61	0.000*	4	21.94	0.006*	4	14.84	0.011*
Year × Treatment	4	0.843	0.512 ^{NS}	4	8.16	0.001*	4	6.33	0.003*
Error	24	-	-	16	-	-	16	-	-
Significance level	-		p≤ 0.05			p≤ 0.05			p≤ 0.05

Table 5: Effect of different treatments on bulb yield and Incremental Cost-Benefit Ratio.

Treatment	Average bulb Yield (t/ha)	Yield increase (t/ha)	Economics*Input cost(Rs. ha^{-1}) A	Extra yield(t/ha)	Value of extra yield (Rs/ha)#B	ICBR (B/A)
T_1- Fenpyroximate 5% EC	3.16	1.1	5520	1.1	38500	7.0
T_2-Propargite 57% EC	3.30	1.2	4960	1.2	42000	8.5
T_3-Spinetoram 11.7% SC	6.10	4.0	21600	4.0	140000	6.5
T_4-Spinosad 45% SC	5.91	3.8	21600	3.8	133000	6.2
T_5-Control	2.10	-	-	-	-	-
#Garlic market rate@ 50 per kg						

against eriophyid mites. Among the miticidal treatments, Propargite resulted in a comparatively higher bulb yield and percentage increase in yield over the control. The consistent performance of these treatments across the two experimental seasons indicates their potential for effective management of thrips and eriophyid mites and for improving garlic bulb yield under the experimental conditions. The incremental benefit cost of each treatment was worked out using input cost of the treatment and value of addition yield obtained with that treatment. Sharma and Sharma *et al*., (2026) reported that the application of Propargite and Fenpyroximate effectively suppressed eriophyid mite populations infesting seabuckthorn. The efficacy of Propargite can be attributed to its mode of action, as it interferes with mitochondrial energy metabolism by disrupting oxidative phosphorylation, thereby reducing energy production and ultimately causing paralysis and mortality of the mites. Fenpyroximate, a mitochondrial electron transport inhibitor, also acts on the respiratory system of mites, contributing to rapid suppression of mite populations. The findings of the present study are conformity with those of previous reports (Palaskar *et al*., 2023).

The best insecticide treatments for thrips and the best miticide treatments for mites were chosen by comparing the ICBR ratios of 7.0, 8.5, 6.5, and 6.2 (Table 5). According to the ICBR calculation, Propargite was the most cost-effective acaricide for eriophyd mites, whereas Spinotoram was the most cost-effective insecticide for thrips. In comparison to insecticide treatment, the yield was significantly lower even though acaricide treatment had a higher ICBR. This implies that thrips is a prominent garlic pest that significantly reduces productivity compared to mites.

Conclusion

Based on the efficacy and incremental benefit–cost ratio (ICBR), Spinetoram @ 0.8 mL/L and Propargite @ 1 mL/L were found to be effective treatments for the management of thrips and mites, respectively, in garlic. Their effective pest suppression and favourable economic returns indicate their potential for practical use in garlic cultivation. Therefore, these treatments can be incorporated into the existing integrated pest management (IPM) package for effective and economically viable management of thrips and mites in garlic.

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Conflicts of Interest: There are no conflicts among authors.

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