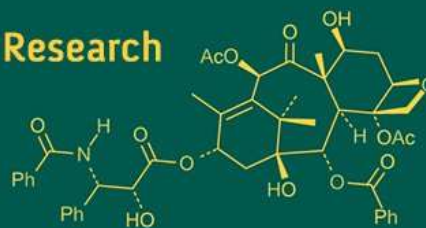
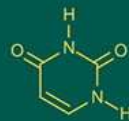
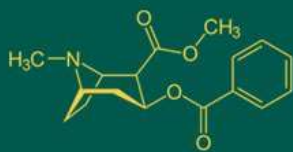


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Evaluating the bio-efficacy of botanical extracts and chemical insecticides against thrips in onion

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Abstract

A study was conducted during the onion cropping season of 2025 at the Research Farm, Faculty of Agriculture, Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala, Haryana, to evaluate the bio-efficacy of botanical extracts (Neem leaf extract, Bakane neem, Datura, Akdo, Castor oil and Neem oil) and chemical insecticides (Fipronil 80%WDG, Spinetoram 11.7 SC and Cypermethrin 25% EC) against onion thrips, *Thrips tabaci* Lindeman, in onion. The experiment was carried out in a Randomized Block Design (RBD) with ten treatments and three replications. The results revealed that Spinetoram 11.7 SC was the most effective treatment, recording the lowest mean thrips population of 14.23 and 3.48 thrips per plant with 63.98% and 72.52% reduction over the untreated control after the first and second sprays, respectively followed by Fipronil 80% WDG and Cypermethrin 25% EC. Among the botanical treatments, neem oil recorded the highest efficacy, with a mean thrips population of 18.36 and 7.81 thrips per plant after the first and second sprays, respectively, followed by neem leaf extract. The highest bulb yield of 22,617.78 kg ha⁻¹ was recorded in the Spinetoram 11.7 SC treatment, followed by Fipronil 80% WDG with 21,804.44 kg ha⁻¹, whereas the untreated control recorded the lowest yield (12,911.11 kg ha⁻¹). The study highlights the potential efficacy of Spinetoram in managing onion thrips, while neem oil emerged as the most promising botanical treatment and can be incorporated into sustainable integrated thrips management programmes in onion.

Keywords: *Thrips tabaci*, onion, botanical extracts, chemical insecticides, bio-efficacy, spinetoram, neem oil

1. Introduction

Onion (*Allium cepa* L.) belonging to the family Alliaceae is an important vegetable crop grown across diverse agroclimatic zones globally (Teshika *et al.*, 2019) [14] for its culinary, nutritional, medicinal and industrial applications (Gnanasundari *et al.*, 2023) [3]. Onion bulbs are a rich source of carbohydrates, minerals, vitamins, flavonoids and bioactive compounds which contribute to its antioxidant, antimicrobial and health-promoting properties (Ahmed *et al.*, 2025) [1]. India is the second largest producer of onion after China, making it important domestically and for export. Despite its significance, onion yield and quality is adversely affected by several biotic and abiotic stresses among which onion thrips *T. tabaci* Lindeman (Thysanoptera: Thripidae), is one of the major insects due to its widespread occurrence and severe feeding damage (Jamian *et al.*, 2024) [5]. Both nymphs and adults feed on the plant by puncturing the leaf tissues and sucking the cellular contents, causing silver discoloration, leaf curling, tip necrosis, and reduced photosynthetic activity ultimately hampering the bulb development. Severe infestations may even cause upto 90% reductions in bulb yield and quality in susceptible varieties under favourable environmental conditions (Gill *et al.*, 2015). Moreover, *T. tabaci* serves as an efficient vector of several plant viruses, further increasing the damage and economic losses.

The management of onion thrips majorly depends on synthetic insecticides due to their quick action and high level of effectiveness. However, continuous use of chemical insecticides has

caused several health and environmental hazards including insecticide resistance and adverse effects on beneficial organisms (Pandey *et al.*, 2023) ^[10]. These concerns call for environmentally sustainable alternatives that can be incorporated into integrated pest management (IPM) programmes. In this context botanical extracts have emerged as environmentally safer options due to their insecticidal, repellent, antifeedant, oviposition-deterrent and growth-regulating properties and pose less risk to beneficial organisms. Plant-derived products prepared from neem, akdo, datura and other botanicals have demonstrated considerable potential against various sucking insect pests, including thrips. Therefore, this study evaluated the bio-efficacy of selected botanical extracts and chemical insecticides for the management of onion thrips under field conditions.

2. Materials and methods

2.1 Experimental Site

The field experiment was conducted during the onion cropping season of 2025 (January to May) at the Research Farm, Faculty of Agriculture, Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala, Haryana.

2.2 Procurement of seed, botanical extracts and chemicals

The seeds of onion variety Kala Patti Piyaz were procured from local market of Mullana, Ambala. For the botanical extracts the leaves of different plants were collected from the local area and then botanical extracts of neem leaf, bakane neem, datura and akdo were prepared by using cold extraction method grinding fresh plant material with distilled water, followed by filtration through muslin cloth to obtain crude extracts (Kumar *et al.* 2025) ^[7]. Moreover, the insecticides used in this study was procured from Bhatia Seeds and Pesticides store, Shahabad.

2.3 Experimental details

The experiment was laid out in a Randomized Block Design (RBD) comprising ten treatments (table 1) with three replications. Onion variety Kala Patti Piyaz was transplanted in January 2025 at a spacing of 15 × 10 cm on flat beds. All recommended agronomic practices were followed uniformly except for plant protection measures.

Table 1: Various treatments used in the experiment

Treatment Name	Dose
Neem leaf extract	50 ml/l
Bakane neem	50 ml/l
Datura	50 ml/l
Akdo	50 ml/l
Castor oil	5 ml/l
Neem oil	5 ml/l
Fipronil 80%WDG	1 ml/l
Spinetoram 11.7 SC	1 ml/l
Cypermethrin 25% EC	2 ml/l
Control	-----

2.4 Application of treatments

Neem oil, castor oil and chemical insecticides were applied at the recommended concentrations using a knapsack sprayer when the thrips population reached the economic threshold level (ETL), followed by a second application after 15 days.

2.5 Observations recorded

Observations on thrips population were recorded from ten randomly selected and tagged plants in each plot at one day before treatment and at 1, 3, 7, 10, and 14 days after each spray. The efficacy of treatments was evaluated by calculating the percent reduction in thrips population using the Henderson and Tilton (1955) formula.

2.6 Data analysis

The experimental data were subjected to analysis of variance (ANOVA) using OPSTAT software, and treatment means were compared at the 5% level of significance.

3. Result

3.1 Bio-efficacy of different treatments against thrips in onion after first spray

The bio-efficacy of different botanical extracts and chemical insecticides against *T. tabaci* after the first spray revealed significant variation among the treatments (Table 2). Among all the treatments, Spinetoram 11.7 SC proved to be the most effective, recording the lowest mean thrips population of 14.23 thrips per plant with the highest mean reduction of 63.98% over the untreated control ($p < 0.05$).

The next best treatment was Fipronil 80 WDG, which recorded a mean population of 16.17 thrips per plant and 58.78% reduction, followed by Cypermethrin 25 EC, recording 17.42 thrips per plant with 55.36% reduction. Among the botanical treatments, neem oil was found to be the most effective, recording a mean thrips population of 18.36 thrips per plant with 51.18% reduction over the control, followed by neem leaf extract, which recorded a mean population of 21.75 thrips per plant with 41.10% reduction.

Datura leaf extract recorded 23.70 thrips per plant with 38.47% reduction, followed by bakane neem extract, which resulted in a mean population of 24.25 thrips per plant with 37.93% reduction ($p < 0.05$). Akdo extract recorded 25.92 thrips per plant with 35.79% reduction, whereas castor oil was the least effective among the botanical treatments, recording a mean population of 26.03 thrips per plant with 33.59% reduction.

The untreated control maintained the highest mean thrips population 38.61 thrips per plant throughout the observation period.

Table 2: Bio-efficacy of different treatments against thrips in onion after first spray

Treatment Name	Dose	PTC	1 DAS	PR	3 DAS	PR	7 DAS	PR	10 DAS	PR	14 DAS	PR	Mean	PR
Neem leaf extract	50ml/l	27.13 (5.26)	24.09 (4.96)	17.9 9	20.57 (4.59)	37.6 7	18.67 (4.38)	50.2 5	21.11 (4.65)	47.9 2	24.31 (4.98)	45.0 2	21.75 (4.80)	41.1 0
Bakane neem	50ml/l	28.70 (5.40)	26.35 (5.18)	15.2 2	24.05 (4.95)	31.0 9	21.96 (4.74)	44.6 8	23.02 (4.85)	46.3 1	25.86 (5.13)	44.7 1	24.25 (5.04)	37.9 3
Datura	50ml/l	28.30 (5.37)	25.64 (5.11)	16.3 3	23.15 (4.86)	32.7 3	21.45 (4.69)	45.1 8	23.12 (4.86)	45.3 1	25.13 (5.06)	45.5 1	23.70 (4.99)	38.4 7
Akdo	50ml/l	29.67 (5.49)	27.38 (5.28)	14.7 6	25.99 (5.15)	27.9 6	23.91 (4.94)	41.7 1	25.10 (5.06)	43.3 7	27.23 (5.27)	43.6 7	25.92 (5.20)	35.7 9
Castor oil	5ml/l	28.80 (5.41)	27.59 (5.30)	11.5 3	25.86 (5.13)	26.1 6	24.71 (5.02)	37.9 5	25.00 (5.05)	41.8 9	26.99 (5.24)	42.5 0	26.03 (5.19)	33.5 9
Neem oil	5ml/l	27.63 (5.30)	23.16 (4.86)	22.6 1	17.85 (4.28)	46.8 8	14.31 (3.85)	62.5 4	16.91 (4.17)	59.0 4	19.56 (4.48)	56.5 5	18.36 (4.49)	51.1 8
Fipronil 80%WDG	1ml/l	28.83 (5.42)	23.85 (4.93)	23.6 3	17.82 (4.28)	49.1 8	12.86 (3.66)	67.7 5	11.98 (3.53)	72.1 9	14.36 (3.86)	69.4 3	16.17 (4.28)	58.7 8
Spinetoram 11.7 SC	1ml/l	29.03 (5.43)	23.23 (4.87)	26.1 2	15.91 (4.05)	54.9 4	10.10 (3.26)	74.8 3	9.28 (3.13)	78.6 0	12.65 (3.63)	73.2 7	14.23 (4.06)	63.9 8
Cypermethrin 25% EC	2ml/l	28.67 (5.40)	24.14 (4.96)	22.2 4	19.44 (4.46)	44.2 5	15.42 (3.99)	61.0 9	12.13 (3.55)	71.6 8	15.96 (4.06)	65.8 3	17.42 (4.41)	55.3 6
Control		28.37 (5.37)	30.72 (5.59)		34.50 (5.92)		39.23 (6.30)		42.38 (6.55)		46.23 (6.84)		38.61 (6.09)	
C.D.		N/A	0.235		0.203		0.184		0.156		0.188			
SE (m)		0.09	0.078		0.068		0.061		0.052		0.063			
SE (d)		0.128	0.111		0.096		0.087		0.074		0.089			
C.V.		2.884	2.637		2.434		2.343		1.968		2.211			

3.2 Bio-efficacy of different treatments against thrips in onion after second spray

Spinetoram 11.7 SC also the most effective treatment, recording the lowest mean thrips population of 3.48 thrips per plant with a mean reduction of 72.52% ($p<0.05$). This was followed by Fipronil 80 WDG, which recorded a mean population of 4.79 thrips per plant and 66.68% reduction, while Cypermethrin 25 EC recorded a mean population of 6.12 thrips per plant with 61.67% reduction. Among the botanical treatments, neem oil was the most effective, recording a mean thrips population of 7.81 thrips per plant with 60.10% reduction, followed by neem leaf extract,

which recorded 12.99 thrips per plant with 46.60% reduction. Datura extract recorded a mean population of 15.04 thrips per plant with 40.21% reduction, followed by bakane neem extract, which recorded 16.33 thrips per plant with 36.92% reduction ($p<0.05$). Akdo extract recorded a mean population of 18.82 thrips per plant with 30.96% reduction, whereas castor oil was the least effective botanical treatment, recording a mean population of 19.79 thrips per plant with 26.71% reduction (Table 3). The untreated control recorded the highest mean thrips population of 46.27 thrips per plant during the observation period.

Table 3: Bioefficacy of different treatments against thrips in onion after second spray

Treatment Name	Dose	PTC	1 DAS	PR	3 DAS	PR	7 DAS	PR	10 DAS	PR	14 DAS	PR	mean	PR
Neem leaf extract	50ml/l	24.31 (4.98)	21.35 (4.67)	18.3 3	16.39 (4.11)	44.8 3	11.11 (3.41)	41.6 6	8.54 (3.01)	60.9 5	7.58 (2.84)	69.5 7	12.99 (3.84)	46.6 0
Bakane neem	50ml/l	25.86 (5.13)	23.56 (4.90)	15.2 6	19.46 (4.47)	38.4 3	15.08 (3.95)	25.5 9	12.34 (3.58)	46.9 5	11.20 (3.42)	57.7 3	16.33 (4.24)	36.9 2
Datura	50ml/l	25.13 (5.06)	22.57 (4.80)	16.4 7	18.17 (4.32)	40.8 5	13.41 (3.73)	31.9 3	11.09 (3.40)	50.9 3	9.97 (3.24)	61.2 9	15.04 (4.09)	40.2 1
Akdo	50ml/l	27.23 (5.27)	25.19 (5.07)	13.9 6	22.32 (4.78)	32.9 4	17.81 (4.28)	16.5 5	14.93 (3.93)	39.0 5	13.85 (3.79)	50.3 6	18.82 (4.52)	30.9 6
Castor oil	5ml/l	26.99 (5.24)	25.29 (5.08)	12.8 4	22.43 (4.79)	32.0 0	19.00 (4.42)	10.1 7	16.62 (4.14)	31.5 0	15.64 (4.02)	43.4 3	19.79 (4.61)	26.7 1
Neem oil	5ml/l	19.56 (4.48)	16.59 (4.13)	21.1 2	10.58 (3.33)	55.7 3	5.59 (2.47)	63.5 5	3.73 (2.06)	78.8 1	2.57 (1.75)	87.1 9	7.81 (3.04)	60.1 0
Fipronil 80%WDG	1ml/l	14.36 (3.86)	11.75 (3.50)	23.9 1	7.12 (2.76)	59.4 4	3.10 (1.90)	72.4 2	1.24 (1.32)	90.3 9	0.73 (1.11)	95.0 2	4.79 (2.41)	66.6 8
Spinetoram 11.7 SC	1ml/l	12.65 (3.63)	9.84 (3.22)	27.6 3	5.19 (2.38)	66.4 5	1.69 (1.48)	82.9 4	0.49 (1.00)	95.6 9	0.19 (0.83)	98.5 6	3.48 (2.09)	72.5 2
Cypermethrin 25% EC	2ml/l	15.96 (4.06)	13.34 (3.72)	22.2 4	8.78 (3.05)	54.9 9	4.81 (2.30)	61.5 3	2.36 (1.69)	83.5 7	1.32 (1.35)	91.9 3	6.12 (2.69)	61.6 7
Control		46.23 (6.84)	49.70 (7.09)		56.50 (7.55)		36.23 (6.06)		41.57 (6.49)		47.37 (6.92)		46.27 (6.82)	
C.D.		0.188	0.182		0.158		0.128		0.109		0.105			
SE (m)		0.063	0.061		0.053		0.043		0.036		0.035			
SE (d)		0.089	0.086		0.075		0.06		0.052		0.05			
C.V.		2.211	2.249		2.173		2.117		1.994		1.994			

*PTC: Pre Treatment Count; DAS: Days after Spray; PR: Per cent Reduction

4.3 Effect of different treatments on bulb yield of onion

The bulb yield of onion differed significantly among the treatments. Spinetoram 11.7 SC recorded the highest bulb yield of 16.96 kg per plot and 22,617.78 kg ha⁻¹, followed by Fipronil 80% WDG with 16.35 kg per plot and 21,804.44 kg ha⁻¹, and Cypermethrin 25% EC with 15.68 kg per plot and 20,906.67 kg ha⁻¹. Among the botanical treatments, neem oil produced the highest yield of 13.94 kg per plot and 18,591.11 kg ha⁻¹, followed by neem leaf extract with 12.67

kg per plot and 16,897.78 kg ha⁻¹. Bakane neem, datura extract, akdo extract, and castor oil recorded progressively lower yields, while the untreated control produced the lowest yield of 9.68 kg per plot and 12,911.11 kg ha⁻¹. Statistical analysis revealed significant differences among the treatments, with Spinetoram 11.7 SC being statistically at par with Fipronil 80% WDG and Cypermethrin 25% EC, whereas neem oil was the most effective botanical treatment (Table 4).

Table 4: Effect of different treatments on yield of onion

Treatment Name	Yield/plot	Yield/ha
Neem leaf extract	12.67	16897.78
Bakane neem	12.38	16502.22
Datura	12.09	16115.56
Akdo	11.56	15408.89
Castor oil	11.10	14800
Neem oil	13.94	18591.11
Fipronil 80%WDG	16.35	21804.44
Spinetoram 11.7 SC	16.96	22617.78
Cypermethrin 25% EC	15.68	20906.67
Control	9.68	12911.11
C.D.	1.262	
SE(m)	0.422	
SE(d)	0.596	
C.V.	5.514	

4. Discussion

The present study showed that Spinetoram 11.7 SC was the most effective treatment among the insecticides for reducing onion thrips population which is in corroboration with results recorded by Joseph (2014) [6], Melissa *et al.* (2016) [8] and Wakil *et al.* (2023) [15]. The effective results could be attributed to its direct effect on nicotinic acetylcholine and GABA receptors and prolonged residual activity, which effectively controlled both nymphs and adult thrips. Spinetoram 11.7 SC was followed by Fipronil 80% WDG due to its action on GABA-gated chloride channels, which disrupt nerve impulse transmission and cause the death of the insect. Similar findings have been reported by Hosamani *et al.* (2012) [4] and Shitole *et al.* (2002) [12]. Cypermethrin 25% EC also provided effective reduction of thrips because of its stomach poison activity, which disrupts the sodium channel function in the insect nervous system. Among the botanical treatments, neem oil was the most effective followed by neem leaf extract due to the presence of azadirachtin and other limonoids, which act as antifeedant, repellent, discourage oviposition and interfere with insect growth regulation. Similar observations were reported by. Datura extract also showed moderate efficacy because of presence of alkaloids and other secondary metabolites which have insecticidal and repellent properties. Comparable findings for neem-based products and botanical extracts were also reported by Shettima *et al.* (2022), Rashid *et al.* (2025) [11], Paidi Satyanarayana and Singh (2016) [9] and Sule (2006) [13]. Overall, the results indicate that chemical insecticides especially Spinetoram were more effective as compared to botanical extract for the effective management of onion thrips under field conditions, but these botanicals especially neem oil can be used as promising sustainable alternative in integrated pest management (IPM) programmes

5. Conclusion: This study showed that both chemical insecticides and botanical extracts effectively reduced the

population of *Thrips tabaci* and improved onion bulb yield under field conditions. Spinetoram 11.7 was the most effective treatment recording the lowest mean thrips population, maximum percent reduction after both sprays, and the highest bulb yield, among all the treatments evaluated. Fipronil 80% WDG and Cypermethrin 25% EC are also effective alternatives as they also provided effective reduction in thrips population and enhanced bulb yield. Among the botanical treatments, neem oil was the most effective, telling its potential as sustainable alternative for thrips management, followed by neem leaf extract, whereas Datura, Bakane neem, Akdo, and castor oil showed comparatively lower efficacy. The findings suggest that Spinetoram may be recommended as an effective chemical option for rapid and effective thrips control, while neem oil represents a promising eco-friendly alternative that can be integrated into sustainable integrated pest management (IPM) programmes to reduce dependency on synthetic insecticides and promote environmentally sustainable onion production.

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