MANIPULATION OF SYNTHETIC AND AQUEOUS HERBAL EXTRACTS FOR THE MANAGEMENT OF ONION THRIPS, *THRIPS TABACI*, LIND (THYSANOPTERA: THRIPIDAE)

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ABSTRACT

The study was initiated at Agricultural research institute (ARI) Swat to manipulate various synthetic chemicals as well as different herbal extracts for the management of onion thrips, *Thrips tabaci*, Lind (Thysanoptera: Thripidae). This study used a randomized complete block design with 9 treatments (including a control) and 3 replications. Diazinon 60 EC (40 mg/L), Confidor® Imidacloprid 200 SL (0.6 ml/L), Thionex® Endosulfan 35 EC(350g/l), Flonicamid 50 WG (0.3 g/L), Diafenthiuron 50 WP (0.6 g/L), Neem leaf (*Azadirachta indica*) (50 g/L), Neem seed (50 g/L), and Garlic bulb (*Allium sativum*) (25 g/L) were the synthetic and natural insecticides utilized, respectively. The analysis indicate that the untreated plot had the highest percent infestation (20.46), while the plot treated with Diafenthiuron had the lowest mean percent infestation (6.0), which was not significantly different from the plot treated with Imidacloprid (6.1) and the plot treated with Thionex® Endosulfan 35 EC. However, the mean percent infestation for Neem seed extract (11.01), Garlic bulb extract (11.01), and Neem leaf extract (10.85) was all quite close to one another. The highest mean percent reduction of thrips plant^{-1} was recorded in plot treated with Diafenthiuron (70.63) which was non-significant to Imidacloprid (70.16) followed by Thionex® Endosulfan 35 EC (69.20). The lowest percent reduction was recorded in plot treated with extracts of Neem seed (46.16) and Garlic bulb (46.16) which was statistically similar to Neem leaf (46.96). The yield obtained from Control plot was the lowest (6398kg/ha), while the yield in the Imidacloprid treated plot was the highest (10267kg/ha) and the yield in the Diafenthiuron plot was the second highest (9866kg/ha). Statistically, the yields from plots treated with botanical extracts obtained from garlic bulbs (8226kg/ha), neem seeds (8216kg/ha), and neem leaves (8205kg/ha)

were all very similar. The Diafenthiuron-treated plot had the highest Cost Benefit Ratio (18.79), followed by the imidacloprid-treated plot (18.66). In management against onion thrips, all the chemicals and herbal extracts performed admirably. When compared to other insecticides, Imidacloprid and Diafenthiuron produced the best results. When compared to untreated areas, areas treated with these insecticides have lower infestation rates, higher rates of reduction, higher yields per hectare, and better cost-effectiveness ratios.

Key Words: Herbal extracts, Onion thrips, Thripidae, Insecticide, Swat.

INTRODUCTION

Onion is one of the most commercially significant vegetable crops farmed in Pakistan. On a total of 148408 hectares of land, 2075984 tonnes of onions were produced throughout the country. In Khyber Pakhtunkhwa, onion was grown on 11974 hectares with an average yield of 223 957 tonnes (FAO, 2019). The consumption of onions has increased dramatically globally due to their health advantages. Onion is one of the most commercially significant vegetable crops farmed in Pakistan. The consumption of onions has increased dramatically globally due to their health advantages (Havey *et al.,* 2004; CSA, 2012).

Several sucking insect pests are responsible for onion damage. The most damaging insect to onions is *Thrips tabaci* (Thysanoptera: Thripidae), which is detrimental in both nymph and adult stages (Atwal, 1976). The infected leaves progressively get wrinkled, curled, and dried out. Heavy infection causes the plant to cease bulb growth and prevents the generation of flowers and seeds (Atwal, 1976). Thrips cause production losses of up to 59 percent and are widespread in all onion-growing regions (Waiganjo *et al.,* 2008).

Throughout the growing season, farmers use many pesticides for thrips management. The insect is prevalent on the plant's inner leaves and pupates in the soil, rendering the use of pesticides ineffective. Moreover, the pest has several generations that overlap (Alimousavil et al 2007; Nault and Shelton, 2010; Shelton *et al.,* 2006). Additionally, *Thrips tabaci* has exhibited resistance to several commonly used insecticides (Martin *et al.,* 2003). The excessive use of pesticides results in pesticide residues, pest resurgence, and pest resistance, which cause environmental contamination and the extinction of beneficial insects (Adilakshmi *et al.,* 2008).

For safe application, it is necessary to combine this pesticide with other control measures, such as plant extracts. Numerous plant extracts have shown broad-spectrum action and may thus replace commercial pesticides. Botanicals are effective and environmentally benign; thus, these botanicals should be used to combat issues caused by other pesticides (Sohail *et al.*, 2015).

Botanicals and novel pesticides might be conveniently used to manage the pest at a low cost. Keeping in mind the significance of onion thrips, the purpose of this study was to assess the efficacy of botanicals and recently developed chemicals for the control of onion thrips.

MATERIALS AND METHODS

Onion thrips, *Thrips tabaci*, Lind were the focus of an experiment conducted in 2019 at the Agricultural Research Institute (ARI) Swat, which aimed to modify synthetic and herbal pesticides for their control (Thysanoptera: Thripidae). We purchased the red onion (Adama variety) seedlings from local market.

Chemical Insecticides

Diazinon 60 EC (40 mg/L), Confidor® Imidacloprid 200 SL (0.6ml/L), Thionex® Endosulfan 35 EC (350g/l), Flonicamid 50 WG (0.3g/L), and Diafenthuron 50 WP (0.6g/L) were purchased from local stores.

Botanicals Extracts

The neem seed and leaf extracts (50 g/L water) were prepared in laboratory.

S. No.	Treatments	Concentrations
1	Neem, *Azadiractha indica*, leaf	50 gm/ L of water
2	Neem, *A. indica*, seed	50 gm/ L of water
3	Garlic bulb	25g/L
4	Diafenthiuron	50 WP (0.6g/L)
5	Flonicamid	50 WG (0.3g/L)
6	Thionex® Endosulfan	35 EC (350g/l)
7	Diazinon	60 EC (40 mg/L)
8	Confidor® Imidacloprid	200SL (0.6ml/L)

9	Control	

Experimental design

The research trial was replicated three times using a Randomized Complete Block Design (RCBD) with nine treatments, including the control. Row-to-row spacing was maintained at 50cm, while plant-to-plant spacing was maintained at 10cm.

Frequency of Spraying Botanicals and chemical insecticides in the Field

During the plant's growth stage, the prepared botanical and synthetic pesticides were sprayed three times. Each spray was applied every two weeks on the field keeping in view the ETL of the pest.

Data Collection

To compare the population of onion thrips before and after spraying, 5 plants were chosen at random, and the population was recorded at regular intervals. The pre-spray data were collected 24 hours prior to spraying and then after weekly interval. The thrips were counted, and their mean was calculated. When the thrips population per plant reached 15-20, plant extracts and pesticides were applied. To determine the efficacy of each pesticide and plant extract, the number of thrips on five randomly chosen plants from each replication was recorded.

Data Analysis

Statistical software (Statistix 8.1) was used to examine the data collected. ANOVA (Analysis of Variance) was created to test the significance of difference between variables. Shiberu and Negeri, (2014) reported the efficacy percentages by using the following formulas:

$$\text{Reduction efficacy\%} = \frac{\text{Control count} - \text{Post spray count}}{\text{Control count}} \times 100$$

$$yield\ kg\ per\ ha = \frac{pods\ weight\ (kg)}{Area\ harvested\ (\text{m2})}\ x\ 10000$$

Cost Analysis

The method of Hussain *et al*., (2022) was used to calculate the cost-benefit ratio in order to determine the most beneficial therapy in terms of cost of control compared to its benefit. The formula used was,

$$Cost\ Benefit\ Ratio = \frac{estimated\ net\ benefit}{total\ expenditure}$$

Statistical Analysis

The acquired data were analyzed using an ANOVA, and the means were separated using the LSD (Least Significant Difference) test at a 5% significance level**.**

RESULTS

Mean infestation of onion thrips/plant

Thrips are a constant problem in all onion-growing regions. In Table 1, we see that the mean % infection of onion thrips plant^{-1} 24 hours before spray application was not statistically significant. After 1st week, the plots treated with Imidacloprid had the lowest mean percent infestation (6.16), which was not statistically different from the plots treated with Endosulfan (6.30), and then the plots treated with Diazinon (7.20), which was statistically similar to the plots treated with Diafenthiuron (7.30). The untreated patch had the highest rate of infestation (17.70). Statistically, no significant interactions were found between any of the plant extracts. After 2nd week, the plot treated with Endosulfan had the lowest percent infestation (3.40), which was not significantly different from plots treated with Diafenthiuron (3.43), Imidacloprid (3.50), or Flonicamid (4.06), and then plots treated with Neem leaf (8.56), which was statistically similar to plots treated with Neem seed (8.60). The average rate of infestation was highest in the control group (20.43). After 3rd week, the plot treated with Imidacloprid had the lowest percent infestation of thrips (5.73), which was not significantly different from plots treated with Endosulfan (6.03) and Diafenthiuron (6.36), and then plots treated with Flonicamid (7.60), which was not significantly different from plots treated with Diazinon (7.90). The percentage of thrips infection was higher in the untreated plot (23.10). After 4th week, Endosulfan (4.33), which was not

statistically different from Diazinon (4.86), and Flonicamid (3.10) had the lowest percent infestation compared to the other treatments. The untreated patch had the highest rate of infestation (24.10). After 5th week, the plot treated with Diafenthiuron had the lowest percent infestation (6.43), which was not significantly different from the plots treated with Imidacloprid (6.96) and Endosulfan (7.0), and finally the plot treated with Flonicamid (7.26). The untreated patch had the highest rate of infestation (26.13). The Diafenthiuron-treated plot had the lowest percent infestation (3.20) after 6th week, followed by the Flonicamid-treated plot (4.23). The untreated patch had the highest rate of infestation (18.70). After 7week, the plot treated with Diafenthiuron (1.10) had the lowest percent infestation, tied with Imidacloprid (1.50) statistically, followed by Endosulfan (2.20), which was statistically insignificant with Diazinon (2.60) and Flonicamid (2.63). The untreated plot was reclassified as having the highest percentage of infestation (17.06).

Table.1 Mean infestation of Onion thrips plant^{-1} at different day's interval in 2019 at ARI Swat, Khyber Pakhtunkhwa, Pakistan

Treatments	Mean infestation of onion thrips plant^{-1}							
	Pre spray count	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week
Neem leaf Extract	16.56abc	10.56b	8.56c	14.60b	10.36b	11.26 b	8.20c	6.66c
Neem seed Extract	16.73ab	10.20b	9.30c	15.20b	9.36c	11.10b	8.96b	7.26b
Garlic bulb Extract	16.83a	10.40b	10.46b	14.96b	10.433b	11.33b	7.50d	6.20c
Diafenthiuron	16.80ab	7.53d	3.43e	6.36d	3.16e	6.43e	3.20h	1.10e
Flonicamid	16.73ab	8.36c	4.06e	7.60c	3.10e	7.26d	4.23g	2.63d
Endosulfan	16.33c	6.30e	3.40e	6.03d	4.33d	7.00de	4.80f	2.20d
Diazinon	16.53abc	7.20d	5.30d	7.90c	4.86d	8.13c	5.93e	2.60d
Imidacloprid	16.56abc	6.16e	3.53e	5.73d	3.20e	6.96de	5.16f	1.50e
Control	16.46bc	17.70a	20.43a	23.10a	24.10a	26.13a	18.70a	17.06a
LSD (0.05)	0.3417	0.5776	0.7643	0.8630	0.7254	0.6994	0.3961	0.4999
SE+-	0.1612	0.2724	0.3606	0.4071	0.3422	0.3299	0.1868	0.2358

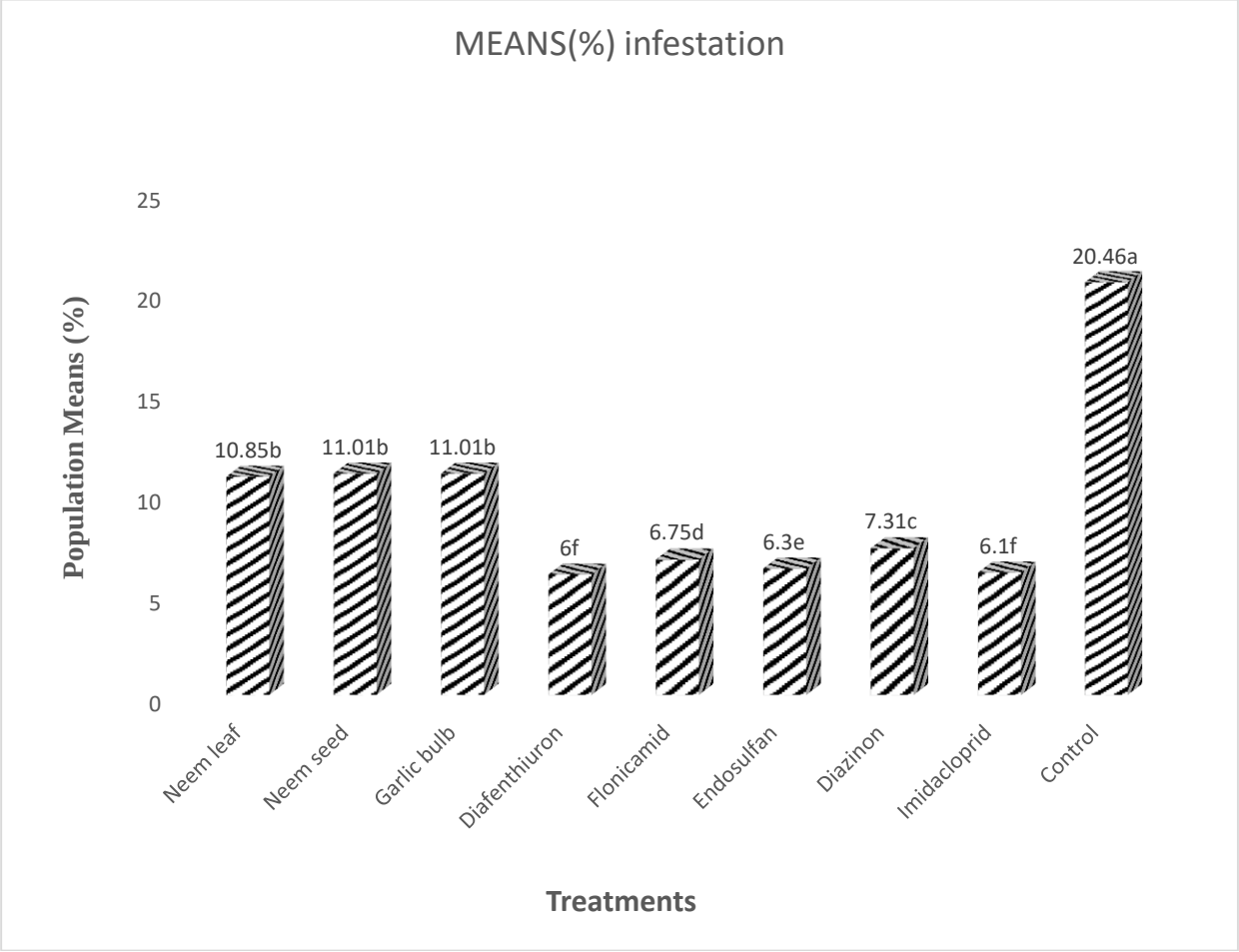
Different letters indicates that the treatments are significant at P value (0.05).

DAA means Days after Application of pesticide.

Mean Percent Infestation of Onion thrips/plant

Fig. 1 showed that the lowest mean percent infestation was recorded in plot treated with Diafenthiuron (6.0) which was statistically non-significant to Imidacloprid (6.1) followed by Endosulfan (6.3). The highest percent infestation was recorded in untreated plot (20.46). Fig (1) also showed that the mean percent infestation of onion thrips was reported similar among all the plant extracts.

Fig 1. Means percent infestation of onion thrips plant^{-1} at all week's interval during 2019 at Swat



The same line bar shows that the treatments are non-significant at P value (0.05)

Percent reduction in thrips population plant-1

The mean percentage reduction in Onion thrips population plant^{-1} at weekly intervals is shown in Table 2. After 1st week, the thrips population per treated plot was reduced by the greatest margin (65.13 percent) compared to Endosulfan (64.40 percent), Diazinon (59.33 percent), and Diafenthiuron (52.73 percent), although these differences were not statistically significant. When compared to Garlic bulb (41.26%) and Neem seed (42.36%), Neem leaf (40.30%) showed the lowest percentage reduction.

After 2nd week, the Endosulfan -treated plot showed the highest percentage reduction (83.33), followed by those in the Diafenthiuron- and Imidacloprid-treated plots (83.13 and 82.66, respectively), and finally the Flonicamid-treated plot (82.26). (80.03). The Garlic bulb-treated plot showed the greatest percentage reduction (48.66).

After 3rd week, the plot treated with Imidacloprid showed the greatest reduction (75.10 percent), followed by Endosulfan (73.80 percent) and Diafenthiuron (60 percent) (72.40). Neem seed-treated plots had the lowest percent reduction (34.10), statistically equivalent to those treated with garlic bulb (35.10).

After 4th week, the plot treated with Flonicamid showed the highest percentage reduction (87.13), which was not significantly different from the plots treated with Diafenthiuron (86.86) and Imidacloprid (86.73). (79.80). Garlic bulb (56.63%) and neem leaf (56.90%) treated plots showed the least significant reduction (P .05). After 5th week, the plot treated with Diafenthiuron showed the largest percent reduction (75.40), followed by those treated with Imidacloprid (73.33), Endosulfan (73.20), and Flonicamid (72.16); nevertheless, these differences were not statistically significant. Neem seed (57.50) and Neem leaf (56.63) showed statistically equivalent decrease rates, while Garlic bulb (56.63%) showed the lowest (56.90).

After 6th week, the plot treated with Diafenthiuron had the largest percent reduction (83.93), followed by the plot treated with Flonicamid (77.33), and finally the plot treated with Neem seed (25.89). (52.03). After 7th week, the most effective method of control was plot-applied Diafenthiuron (93.53 percent), followed by Endosulfan (87.06), which was statistically indistinguishable from plot-applied Diazinon (84.73 percent) and plot-applied Flonicamid (84.53 percent). In contrast, Garlic bulbs exposed to the plot treatment showed the lowest percentage loss (33.66).

Table.2 Means percent reduction of Onion thrips population plant^{-1} at different days interval during 2019 at Swat

Treatments	Percent reduction thrips plant^{-1}						
	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week
Neem leaf	40.30d	57.96d	36.70d	56.90d	56.90d	56.13f	60.93d
Neem seed	42.36d	54.43e	34.10e	61.06c	57.50d	52.03g	57.40e
Garlic bulb	41.26d	48.66f	35.10de	56.63d	56.63d	59.90e	33.66f
Diafenthiuron	57.43b	83.13a	72.40b	86.86a	75.40a	82.93a	93.53a
Flonicamid	52.73c	80.03b	66.96c	87.13a	72.16b	77.33b	84.53b
Endosulfan	64.40a	83.33a	73.80ab	82.03b	73.20ab	74.33c	87.06b
Diazinon	59.33b	74.00c	65.76c	79.80b	68.86c	68.30d	84.73b

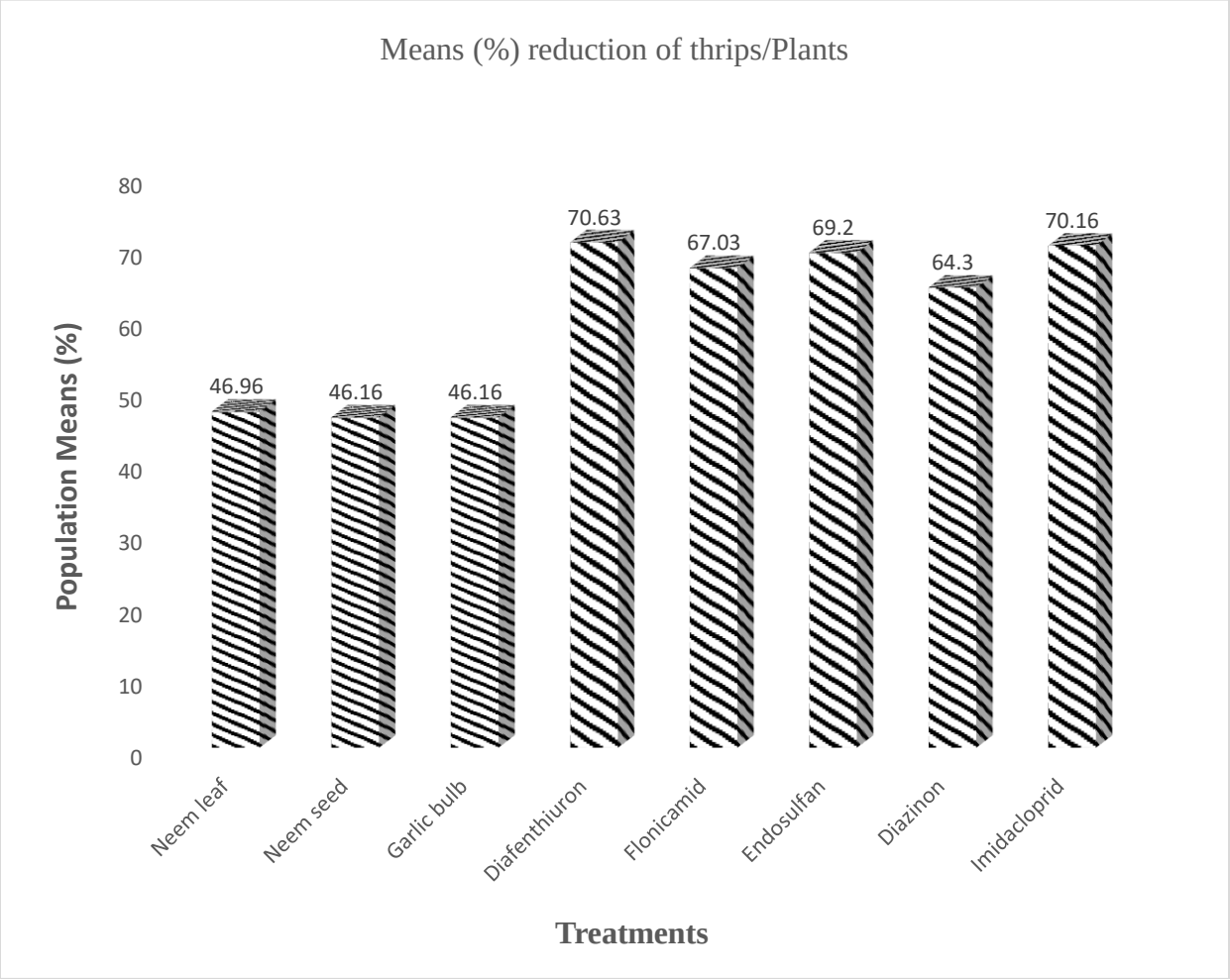
Imidacloprid	65.13a	82.66a	75.10a	86.73a	73.33ab	72.40c	91.20a
LSD $_{(0.05)}$	3.4954	2.0938	2.2256	2.5596	2.5459	2.1665	2.6824
SE+-	1.6297	0.9762	1.0377	1.1934	1.1870	1.0101	1.2507

Different letters indicates that the treatments are significant at P value (0.05)

Mean Percent Reduction in Onion thrips plant^{-1}

As shown in Fig. 2, the mean percentage reduction of thrips per plant was greatest in the Diafenthiuron-treated plot (70.63), followed by the Imidacloprid-treated plot (70.16), and finally the Endosulfan -treated plot (69.20). Plots treated with Neem seed (46.16 percent) and garlic bulbs (46.16 percent) had the same statistically significant reduction as Neem leaf (46.96 percent).

Fig. 2. Means percent reduction in onion thrips/plant at all week's interval at Swat during 2019



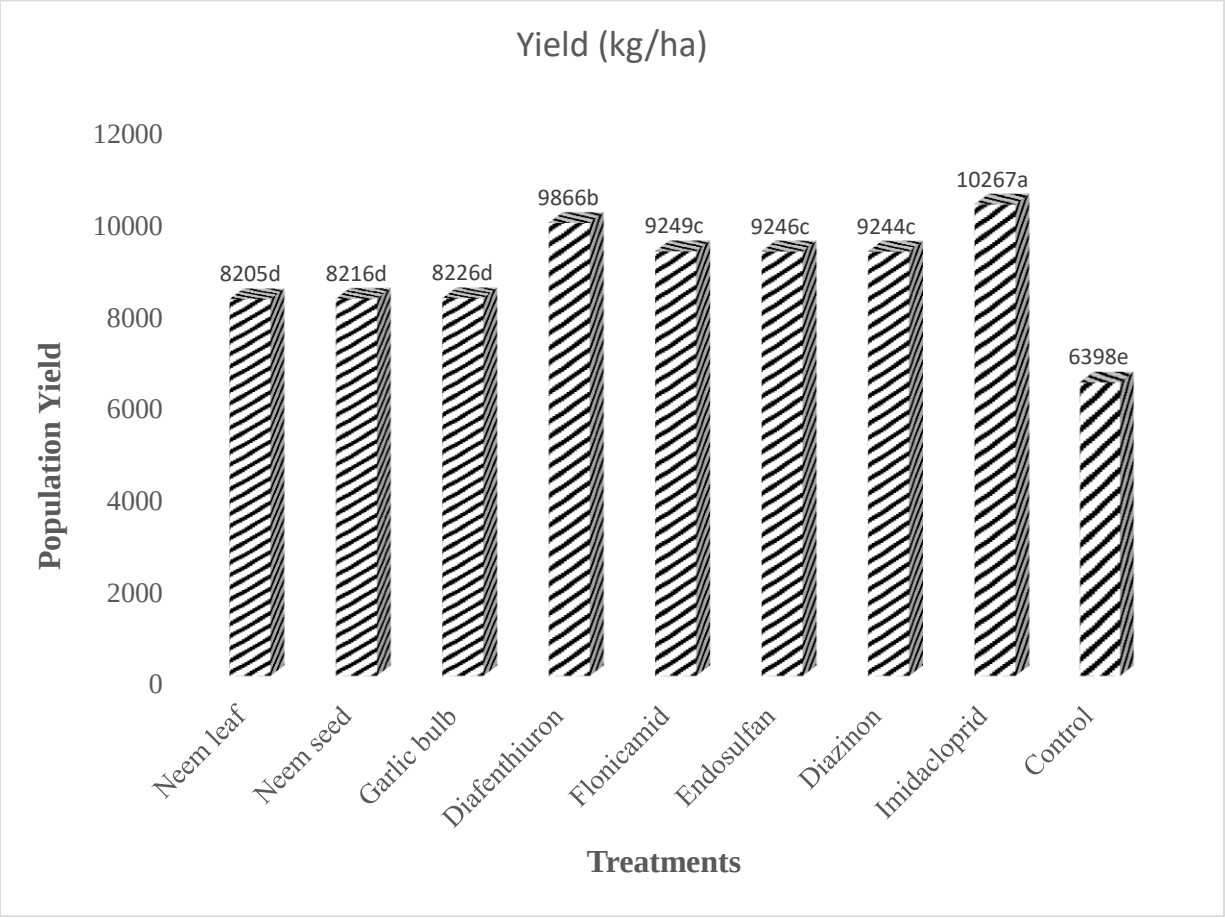
The same line bare showed that the treatments are non-significant at P value (0.05)

Yield kgha^{-1} and cost analysis of the applied treatments

It can be seen in Fig. 3 that the plot treated with Imidacloprid produced the maximum yield (10267 kg/ha), followed by the plot treated with Diafenthiuron (9866 kg/ha). However, the yield in the Control plot was the lowest (6398 kg/ha). The yield statistics for Neem seed (8216 kg/ha), Neem leaf (8205 kg/ha), and garlic bulb (8226 kg/ha) all came out to be very similar.

According to Table 3, the plot treated with Diafenthiuron had the highest CBR (18.79), followed by the plot treated with Imidacloprid (18.66). In contrast, Neem leaf had the highest cost-effectiveness ratio (4.10).

Fig. 3. Yield kg ha^{-1} at different treatments in onion crop during 2019 at Swat



The same line bare showed that the treatments are non-significant at P value (0.05)

Table 3. Cost Analysis of different treatments against Onion Thrips crop

Treatments	Yield (kg/ha^{-1}) A	Gross income (Rs.) B	Cost of control ha^{-1} (Rs.) C	Return over control (Rs.) ha^{-1} D	Estimated net benefit (Rs. ha^{-1}) E (D-C)	C:B F(D/C)
Neem leaf	8205	164100	8800	36140	27340	4.10
Neem seed	8216	164320	10980	164320	153340	14.96
Garlic bulb	8226	164520	9950	164520	154570	16.53
Diafenthiuron	9866	197320	10500	197320	186820	18.79
Flonicamid	9249	184980	11200	184980	173780	16.51
Endosulfan	9246	184920	11970	184920	172950	15.44
Diazinon	9244	184880	11560	184880	173320	15.99
Imidacloprid	10267	205340	11000	205340	194340	18.66
Control	6398	127960				

DISCUSSION

In 2019, the onion thrips were the focus of this study, which aimed to determine the efficacy of chemical pesticides and plant extracts in combating this pest. Randomized complete block design (RCBD) with three replicates was used to carry out the experiment. A total of five plants from each row were picked at random. The crop was treated four times, every 14 days, while it was growing. When the thrips population reached ETL, the use of pesticides and botanicals began. It was shown that the insect population was not statistically significant before spray application across all treatments. These results were consistent with those of Hussain et al (2022). Thrips populations began to rise in February and peaked in April. Another group that came to a similar conclusion was Hussain and colleagues (1997). The sudden decline in the thrips population could be the result of several factors, including crop maturity, leaf hardening, and the thrips' migration to other crops. Similar results were reported by Hussain et al. (1997), Hyder et al. (1987), and Ullah et al. (2010).

Comparing the effectiveness of chemical pesticides to that of botanical extracts, the former consistently outperformed the latter. The diafenthiuron-treated patch had the smallest average population. Consensus was reached between Deole et al. (2018) and these findings. Diafenthiuron 50 WP at 300 g.a.i/ha was shown to be the most efficient in lowering the thrips population on onion, according to a study conducted by Zala et al. (2014). Best results against onion thrips were also seen while using the drug Imidacloprid. These results corroborated those of Das et al (2017). Imidacloprid sprays were most effective against onion thrips in all three treatments. These results are consistent with those of Singh and Kumar (2011) and Kidd et al. (2011), who also found that Imidacloprid was effective at reducing thrips populations (1991).

The extracts from chemicals and plants have an impact on harvest size. When compared to other pesticides, the yield from using the chemical Imidacloprid was significantly higher. Waiganjo (2004) and Das et al. (2001) also reported a result that was very similar (2017). It was also shown that Imidacloprid had the highest CBR (1:18).

Infestations of onion thrips are notoriously challenging to eradicate because the mobile stages typically reside in the inner leaves, where they are less likely to come into contact with insecticide residues. Considering these factors, we undertook the current study to assess existing literature and address the obstacles it has revealed. The damage caused by onion thrips is still a problem today. Researchers must pay close attention to the thrips population if they want to control it.

CONCLUSION

In this study, we found that the chemical and botanical extract treatments were equally effective at reducing onion thrips populations. In contrast, the chemical insecticides Imidacloprid and Diafenthiuron offered far better outcomes than conventional pesticides and had a major impact on crop productivity.

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