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Efficacy of Indigenous Botanical Pesticides Against *Thrips tabaci* on Onion

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Abstract. *Thrips tabaci* L. is a polyphagous pest of various crops including onions. It has caused considerable losses to onion production as it has developed resistance against many synthetic pesticides. Moreover, pesticides used are hazardous to humans and environment. Therefore, the effectiveness of four indigenous botanical pesticides i.e., neem (*Azadirachta indica* A. Juss.), nazboo / sweet Basil (*Ocimum basilicum* L.), zangi / nerium (*Nerium Oleander* L.), Aloevera (*Aloevera* L.) Burm. f., along with Pirate (Chlorfenapyre) as positive and water as control negative were evaluated against *T. tabaci*. The data was recorded before application and after 24, 48, 72, 96 h and 7 days of spray. Based on the population of *T. tabaci,* two sprays were done in the study. After the first spray, maximum population reduction of *T. tabaci* was recorded in pirate (97.62%) after 48 h of spray, followed by 81.83% and 74.52% reduction in aloe vera and neem treatments after 96 and 72 h of spray. A similar trend was observed after second spray, as maximum *T. tabaci* population reduction was recorded in pirate (94.79%), followed by *Aloevera* (83.06%) and neem (78.0%) treatments. Nazboo and zangi were least significant in controlling *T. tabaci.* Moreover, the highest onion yield was recorded in pirate treatment that was not significantly different from yield in *Aloevera* treatment, whereas lowest yield was obtained in control followed by nazboo and zangi treatments. Therefore, it is recommended that *Aloevera* should be included for the management of *T. tabaci* in onions.

Keywords: management, onion, plant based, pesticide, *Thrips tabaci*

Introduction

Thrips tabaci (Thysanoptera: Thripidae) is a worldwide distributed, notorious and polyphagous insect pest of many important crops, vegetables, fruits and flowers including onions (Woldemelak, 2020; Shiberu *et al*., 2013; Alston and Drost, 2008). Both nymphs and adults *T. tabaci* cause damage to onions directly by sucking cell sap using their piercing sucking mouth parts, not only from the young tender leaves of the onions but also from its flowers and fruiting bodies and indirectly by transmitting viral diseases especially Iris Yellow Spot Virus (IYSV). The feeding of *T. tabaci* on chlorophyl contents cause silvery areas on the leaves, flowers and fruits of onions as the yield losses are estimated up to 59% (Diaz-Montano *et al*., 2011; Ibrahim and Adesiyun, 2009).

Several sustainable practices are practiced worldwide to manage *T. tabaci* population on various cultivated crops, fruits and vegetables, all focusing to reduce the use of broad spectrum insecticides (Iglesias *et al*., 2021; Foster *et al*., 2010). The pesticides are not always found effective against *T. tabaci,* often leading to secondary pest re-surgence (Gao *et al*., 2012). Moreover, they have severe detrimental impacts against natural enemies and pollinators (Gogo *et al*., 2014; Whitehorn *et al*., 2012), environment and human health (Mostafalou and Abdollahi, 2013).

Recently, botanical pesticides have shown effectiveness against insect pests are ecologically safe, less toxic to natural enemies with short residual effect and cost effective due to local availability (Ali *et al*., 2012; Nathan *et al*., 2004). The efficacy of various botanicals *i.e*., *Phytolacca dodecandra* L'Hér*., Chrysanthemum cinerariaefolium* L., *Nicotiana tabacum* L. and *Azadirachta indica* A. Juss. have been largely evaluated against the onion thrips and found to be very effective (Dodia *et al*., 2008; Stoll, 2000). The plant extracts of tumha (*Citrullus colosynthis* L.), datura (*Datura innoxia* M.), neem (*A. indica*), castor (*Ricinus communis* L.), hing (*Ferula asafetida* L.), eucalyptus (*Eucalyptus* spp.)

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bitter gourd (*Memordica chrantia* L.) and garlic (*Allium sativum* L.) are also evaluated for their insecticidal efficacy against sucking insect pests including *T. tabaci* with varying degree of success (Iqbal *et al*., 2015). Therefore, considering the potential of botanical pesticides, this study was conducted to evaluate the effectiveness of locally available plants against *T. tabaci* on onions.

Material and Methods

Treatments. The four local plants Neem (*Azadirachta indica* A. Juss.), Nazboo (*Ocimum basilicum* L.), Zangi (*Nerium Oleander* L.) *Aloevera* (L.) Burm. f., along with pirate (Chlorfenapyre) as positive and water as negative control were used in the study. All the plants were collected from the surroundings of the Sindh Agriculture University, Tandojam, Pakistan. Five kilograms of each plant was thoroughly washed with tap water and then air dried under the shade. Afterwards, materials were cut into small pieces and boiled in 10 L of water for 60 min. The solution was then sieved through fine muslin cloth to remove extra particles and get fine stock solution of the plants. In final solution, 125 g detergent powder was added to avoid the clotting of materials. Final stock solution of plants was then appropriately stored in the refrigerator at laboratory (temperature 30±5ºC and relative humidity 60±5%) of Plant Protection Research Institute, Tandojam for further study. The calibration of water and botanical extract solutions was done as per their recommended dose before applying in the individual replicated plots. Considering the population development of *T. tabaci*, two sprays of botanicals were carried out during the study.

Experimental layout, data collection and analysis. The experiments were carried out during onion season 2019 at Plant Protection Research Institute, Tandojam. The experiment was arranged in a Randomized Complete Block Design (RCBD) where each treatment was replicated five times, having a replicate plot size of 30x15 sq feet.

The number of *T. tabaci* was counted taken 24 h before spraying the botanicals whereas subsequent observations were taken 24, 48, 72, 96 h and one week after the spray. Fifteen onion plants were randomly selected from each replication to count the number of *T. tabaci*. The collected data were analyzed using analysis of variance with STATISTIX 8.1 software. The means with a significant difference were separated using the Least Significant Difference (LSD) test at a 5% probability level. Moreover, the percentage reduction in pest population after the application of botanical pesticides was calculated using Abbots (1925) formula as given below:

$$\text{Corrected \%} = \left(1 - \frac{\text{n in T after treatment}}{\text{n in Co treatment}}\right) \times 100$$

Results and Discussion

First spray of botanical pesticides against *Thrips tabaci* on onion. The population of *T. tabaci* on onions due to the application of various botanical pesticides i.e., neem, *Aloevera*, zangi, nazboo compared with pirate and negative control as shown in (Table 1). A significant effect of botanicals especially *Aloevera* and neem was recorded on the population reduction of *T. tabaci*. However, pirate was found to be most effective. According to results, pre-population of *T. tabaci* before 1st spray ranged between 26.55±1.80 thrips per plant in control to 28.90±1.77 thrips per plant in *Aloevera* treatment. Therefore, a non-significant (F = 0.31; P = 0.9061) difference was recorded among treatments for *T. tabaci* population. However, the application of

Table 1. Impact of different botanical pesticides against *Thrips tabaci* population on onion after 1st spray

Botanicals	Pre-treatment	24-h	48-h	72-h	96-h	One week	% population reduction after week
~~Neem~~	~~27.80±1.53a~~	~~12.80±0.62c~~	~~8.63±0.49c~~	~~7.15±0.42d~~	~~7.83±0.45c~~	~~8.32±0.49c~~	~~70.08%~~
Aloe vera	28.17±1.47a	9.73±0.58d	6.42±0.45d	5.72±0.40d	5.02±0.43d	5.78±0.40d	79.47%
Zangi	28.90±1.77a	17.40±0.86b	13.95±0.65b	12.30±0.51c	12.47±0.52b	14.33±0.53b	50.40%
Nazboo	28.63±1.69a	19.33±0.83b	15.85±0.55b	14.50±0.46b	14.18±0.60b	15.00±0.53b	47.61%
Pirate	28.78±1.49a	1.07±0.18e	0.65±0.13e	3.23±0.28e	3.20±0.25d	4.55±0.22d	84.19%
Control	26.55±1.80a	27.33±1.78a	27.27±1.46a	28.07±1.27a	27.62±1.32a	26.95±1.39a	-1.51%

Means followed by same letter in same column are not significantly different; LSD values @ P < 0.05 [Pre-spray = 4.3909; 24-h = 2.6222; 48-h = 2.0617; 72-h = 1.7883; 96-h = 1.8949; One week = 1.9352]

botanical pesticides and pirate reduced the population considerably at 24 h of the application and showed a highly significant (F = 90.56; P < 0.001) among treatments. The lowest population of *T. tabaci* after 24 h was recorded in pirate (1.07±0.18 thrips per plant), followed by *Aloevera* (9.73±0.58 thrips per plant), and neem (12.80±0.62 thrips per plant). Among botanicals, nazboo and zangi treated onions showed relatively higher populations of *T. tabaci* i.e., 19.33±0.83 and 17.40±0.65thrips per plant, respectively whereas the highest population (27.33±1.78 thrips per plant) was recorded in control.

A further reduction in the population of *T. tabaci* was recorded in all the treatments at 48 h interval after the application of botanical pesticides, as the lowest population among botanical treatments was observed in *Aloevera* (6.42±0.45 thrips per plant), followed by neem (8.633±0.49 thrips per plant), nangi (13.95±0.65 thrips per plant) and nazboo (15.85±0.55 thrips per plant). Moreover, *T. tabaci* population recorded in Pirate and control plots were 0.65±0.13 and 27.27±1.46 thrips per plant, respectively. Overall results showed a highly significant (F =153.95; P < 0.001) difference in the population of *T. tabaci* recorded 48 h after the application of botanical pesticides.

After 48 h of the application, it has been observed in the study that the population of *T. tabaci* started re-building slowly in Pirate treatment. In contrast, the population continuously but slowly declined in the botanical pesticide treatments till 72 and 96 h (*Aloevera* and nazboo treatments) of the application. Accordingly, a highly significant difference in the population of *T. tabaci* was recorded after 72 h (F = 195.53; P < 0.001), 96-h (F = 168.90; P < 0.001) and one week (F = 142.22; P < 0.001) of the application. Overall, after one week of application of pesticides, the highest population reduction of *T. tabaci* (84.19%) was recorded in Pirate with an observed population of 4.55±0.22 thrips per plant, followed by *Aloevera* (5.78±0.40 thrips per plant with 79.47% reduction) and neem (8.32±0.49 thrips per plant with 70.08% reduction). The lowest population reduction (47.61%) was recorded in nazboo with an observed population of 15.00±0.53 thrips per plant, followed by 14.33±0.53 thrips per plant recorded in zangi treatment (50.40% reduction) as stated in (Table 1).

Corrected percentage reduction in *T. tabaci* population on onions after first spray. According to results given in Fig. 1, the maximum reduction (97.62%) in *T. tabaci*

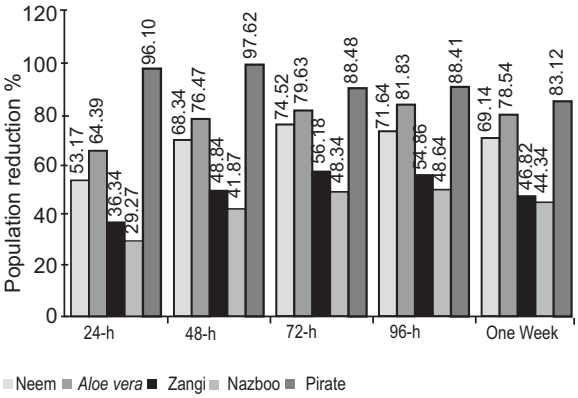

Fig. 1. Corrected percentage population reduction of *Thrips tabaci* on onions after 1st spray of botanical pesticides.

population was recorded in Pirate after 48 h of the application whereas, in the remaining treatments i.e., neem, *Aloevera*, zangi and nazboo, maximum population reduction of *T. tabaci* was recorded as 74.52, 79.63, 56.18 and 48.64%, respectively. Moreover, after one week of applying botanicals, the maximum reduction in *T. tabaci* population was recorded in pirate (83.12%), followed by 78.54% reduction in *Aloevera*. The population reduction calculated in neem, zangi and nazboo treatments after one week of application was 69.14, 46.82, 44.34%, respectively.

Second spray of botanical pesticides against *Thrips tabaci* on onion. Like the first spray, pre-population of *T. tabaci* before second spray also exhibited a non-significant difference (F = 0.51; P = 0.7673) as the population ranged between 34.10±2.01 thrips per plant (control) to 38.02±1.93 thrips per plant in pirate treatment as shown in (Table 2). However, the application of botanical pesticides showed effectiveness to reduce *T. tabaci* population even after 24 h of application with a highly significant (F = 101.21; P < 0.001) difference among treatments. After 24 h of application, the lowest mean population of *T. tabaci* was recorded in Pirate (1.07±0.18 thrips per plant), followed by *Aloevera* (13.50±0.55 thrips per plant), and neem (15.85±0.85 thrips per plant). Moreover, the highest mean population was recorded in control (37.43±2.19 thrips per plant), followed by nazboo and zangi with population of 25.15±1.33 and 22.85±1.17 thrips per plant, respectively. Due to the application of various botanicals and pirate, a further reduction in *T. tabaci* population was recorded in all the treatments at subsequent observations intervals with significant differences among the treatments.

Table 2. Impact of different botanical pesticides against *Thrips tabaci* population on onion after 2nd spray

Botanicals	Pre-treatment	24-h	48-h	72-h	96-h	One week	% population reduction after week
Neem	36.15±2.03a	15.85±0.85c	12.72±0.56c	10.10±0.50c	8.92±0.49d	9.63±0.54c	73.35%
Aloe vera	37.22±2.07a	13.50±0.55c	12.12±0.55c	7.42±0.56c	6.87±0.53cd	7.98±0.52c	78.55%
Zangi	34.95±2.12a	22.85±1.17b	18.90±0.78b	16.18±0.68b	14.90±0.53b	16.98±0.66b	51.41%
Nazboo	36.32±2.16a	25.15±1.33b	21.23±1.06b	17.73±0.81b	16.27±0.68b	18.25±0.82b	49.75%
Pirate	38.02±1.93a	1.07±0.18d	2.02±0.16d	3.23±0.28d	4.82±0.42d	6.45±0.43c	83.03%
Control	34.10±2.01a	37.43±2.19a	38.68±1.96a	38.92±2.32a	40.53±2.66a	41.05±2.61a	-20.38%

Means followed by same letter in same column are not significantly different; LSD values @ $P < 0.05$ [Pre-spray = 5.5765; 24-h = 3.3942; 48-h = 2.8247; 72-h = 3.0413; 96-h = 3.3258; One week = 3.3444]

Although a slight rise in *T. tabaci* population was recorded in Pirate treatment after 48 h but a continuously and slowly declined in the botanical pesticides till 72- and 96 h (*Aloevera* and nazboo treatments) of the application.

Overall, after one week of application of pesticides, the highest population reduction of *T. tabaci* (83.03%) was recorded in Pirate, followed by *Aloevera* (78.55%) and neem (73.35%) whereas the lowest population reduction (49.75%) was recorded in nazboo, followed by zangi treatment (51.41%) as stated in (Table 2).

Corrected percentage reduction in *T. tabaci* population on onions after second spray. Fig. 2 showed the corrected percentage reduction in *T. tabaci* population using Abbot's formula after second application of the botanical pesticides. Compared to first spray, a slightly more population reduction of *T. tabaci* was recorded in all the treatments during the second spray. After one week of the application of botanicals, the maximum reduction in *T. tabaci* population was recorded in pirate (84.29%), followed by 80.55% reduction in *Aloevera*. The population reduction calculated in neem, zangi and nazboo treatments after one week of application was 76.53, 58.63 and 55.54%, respectively.

After applying botanical pesticides, yield of onion is given in (Fig. 3) which showed a highly significant ($F = 54.57$; $P < 0.001$) difference among various treatments. The highest yield of onions was recorded in Pirate (6.26±0.18 tons per acre) treatment, which was not significantly different from the yield obtained from *Aloevera* (6.03±0.18 maunds per acre) treatment. Among botanicals, the lowest onion yield was recorded from nazboo (4.54±0.10 maunds per acre) that was non-significant with the yield given by zangi (4.59±011 maunds per acre) treatment. The yield recorded in neem

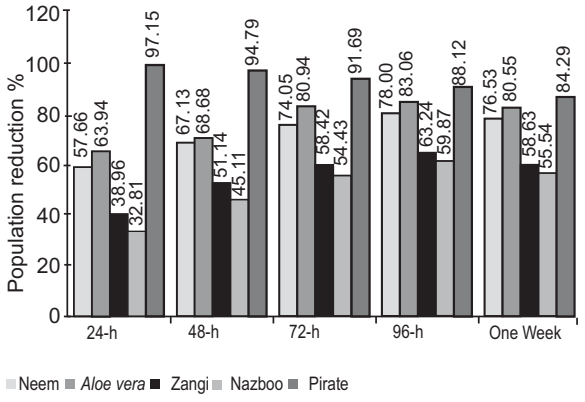

Fig. 2. Corrected percentage population reduction of *Thrips tabaci* on onions after 2nd spray of botanical pesticides.

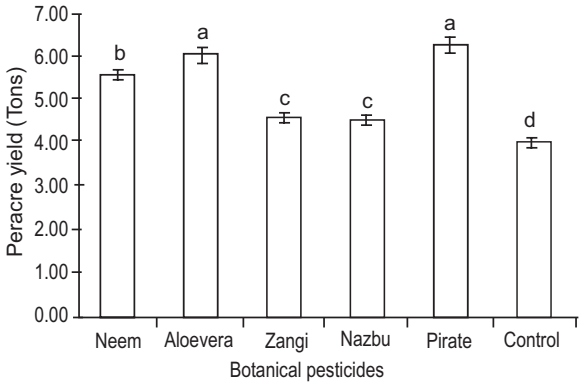

Fig. 3. Effect of various botanical pesticides on the yield of onions, means followed by same letters are not significantly different (LSD = 9.082; $P < 0.05$).

treatments was 5.57±0.11 maunds per acre whereas overall, the lowest yield of onions was recorded from control i.e., 4.02±0.12 maunds per acre.

The botanical pesticides used in the study i.e., neem, *Aloevera*, zangi and nazboo exhibited their pesticidal potential against *T. tabaci* in onions with *Aloevera* being the most effective, followed by neem, zangi and nazboo. It has been mentioned that since the ancient times, botanicals are used in agriculture and warehouses to protect cultivated crops and stored products from various noxious insect pests. However, after the 19th century their use has been studied on a scientific and systematic basis due to their low residue effects that are considered eco-friendly and less hazardous to humans and livestock (Senthil-Nathan, 2015; Morgan, 2004). Accordingly, several botanical pesticides have been tested for their efficiency against crop pests including thrips (Nisha *et al*., 2012). Among botanicals, only the Neem has been evaluated against more than 500 crop pests including *T. tabaci* as most of them are reported to be susceptible at its various concentrations (Senthil-Nathan, 2015). Moreover, *Nicotiana* spp., *Phytolacca dodecandra*, *Securidaca longipedunculata* and *Nicotiana tabacum* have also significantly reduce *T. tabaci* population under field condition (Shiberu *et al*., 2013). Among other widely used plant extracts against *Thrips* spp. includes *Artemisia arborescens, A. indica* L., *Chrysanthemum cinerariifolium, Datura stramonium, Dodonaea angustifolia* L., *Dianthus caryophyllus, Melaleuca alternifolia, Nicotiana glauca, Origanum majorana, Ocimum gratissimum, Rosmarinus officinalis,* and *Tagetes minuta* (Shiberu and Negeri, 2017; Omosa *et al.* 2016; Fitiwy *et al.,* 2015; Prabhu *et al.,* 2011). Similar to the above studies, *Aloe vera* and neem were found effective in reducing the population of *T. tabaci* considerably as their performance was at par with the synthetic pesticide (pirate) used in the study. Thus, our results are in accordance with the findings of Mishra *et al.* (2007), who reported that various neem-based formulations obtained from its leaves, seeds, or oils were found effective in reducing thrips population significantly. hence, their use is recommended in different cultivated and vegetable crops due to less residual effects. Various botanical oils i.e., sesame, cotton, groundnut and sunflower along with Karate 5% EC (lambda–cyhalothrin) when evaluated against *T. tabaci*, although showed their effectiveness against it, but their performance was less than Karate. However, effectiveness of all the tested oils become more lethal to *T. tabaci* at higher concentrations (Wessal *et al*., 2019). Studies also suggested that plant extracts generally exhibited more lethal effects against *T. tabaci* when its population is comparatively less or moderate (Nault and Shelton, 2012).

In the present study, *Aloevera* was found most effective in controlling *T. tabaci* on onions. Traditionally, *Aloevera* is mainly evaluated for its insecticidal properties against stored grain pests has been reports by Mallavadhani *et al*. (2016). The excellent repellent and contact toxicity of the extracts of various parts of *Aloevera* against *Sitophilus oryzae* L. significant impact of *Aloevera* and tobacco extracts than garlic and Goosefoot in the population reduction of Aphids in Canola (*Brassica napus* L.) is also reports by Sarwar (2013). Another study also confirmed the combined effect of neem seed kernel ± *Aloevera* ± Calotropis ± Clerodendron against diamondback moth and Cowpea Aphids under laboratory conditions (Chandrashekharaiah and Sannaveerappanavar, 2013). The botanical pesticides or essential oils generally showed pesticidal properties mainly because they contain various organic chemicals such as alkaloids, steroids, phenols, flavonoids, glycosids, glucosinolates, quinones, tanins, terpenoids, salanine and jasmolone etc. (Sarwar, 2015). Moreover, plant extracts and their essential oils exhibited a wide range of biological activities against the target insect pests and includes repellents, attractants, anti-feedants, ovi position deterrents and fertility reducers, causing egg sterility along with inhibitors of metamorphosis (Saniewski *et al*., 2014; Nerio *et al*., 2010; Koschier and Sedy, 2003 and 2002).

Conclusion

All the botanical pesticides i.e., neem, *Aloevera*, zangi and nazboo were found effective to reduce the population of *T. tabaci* with *Aloevera* and neem being comparatively more effective as their performance was comparable with synthetic pesticides (pirate) used in the study. Considering the less hazardous to nature, application of *Aloevera* extracts should be included in the integrated management programs of *T. tabaci,* not only in onions but also in other crops.

Conflict of Interest. The authors declare they have no any conflict of interest.

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