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Evaluation of Four Different Insecticides against Onion Thrips, *Thrips tabaci* (Thysanoptera: Thripidae): Implications for Monitoring and Management

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AKK: Conducted the experiment and wrote initial draft of the manuscript. IAN and AML: Designed the experiment and supervised this research work. KHQ and AG: Helped in data analyses and interpretation. SKK and AKK: Review the final draft and proofreading. All authors have read and approved the manuscript in its final form.

Key words
Insecticide efficacy, Chemical insecticides, Pest management, *Thrips tabaci*, Imidacloprid, Chlorfenapyr

ABSTRACT

Controlling onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae), which are the primary insects causing financial losses to onion farmers, has been a significant concern in pest management strategies. A variety of commercial chemical insecticides applied to agricultural fields were assessed in this study. The efficacy of four insecticides including active ingredients chlorfenapyr 360SC, profenofos 50EC, deltamethrin 2.5EC, and imidacloprid 200SL against *Thrips tabaci* in farmers field crops was assessed using a randomised complete block design (RCBD). When compared to controls, our data revealed that all of the insecticides reduced the amount of thrips. Onion thrips were first observed on August 4th (1 thrips/plant) and peaked (28 thrips/plant) in the last week of September. Four insecticides, namely chlorfenapyr 360SC, profenofos 50EC, deltamethrin 2.5 EC, and imidacloprid 200SL per acre were applied twice (in August and September). The insecticides chlorfenapyr, profenofos, deltamethrin, and imidacloprid were sprayed three times, and data were collected at 24 h, 36 h, and 72 h post-spray. The first application of insecticide was made when thrips reached the economic threshold level (ETL), and the second application was made 25 days after the first application. All insecticides showed significantly better results than the untreated check in reducing the pest population. In two spray applications, chlorfenapyr and profenofos were found to be the most effective among the four insecticides. The minimum infestation was recorded in plots treated with chlorfenapyr and profenofos compared to the control.

INTRODUCTION

The onion (*Allium cepa* L.) pertains to the Amaryllidaceae family and is grown in virtually every region of the globe in a variety of temperatures (Masood *et al*., 2021). Onions come in a variety of colours, shapses, and flavours. White, yellow, or red bulbs may be circular, flattened, or torpedo-shaped. Some are sweet, while others have a lot of spices in them. It is nearly always utilized in a wide range of meals on a daily basis (Abrha *et al*., 2020). Onion is used in a variety of climates and is not associated with any one country. Onion is one of the 2nd much widely grown vegetable crop in the world, behind tomatoes. Onion is a condiment crop that is eaten raw in salads or used as a flavouring in culinary meals (Benkeblia, 2004).

The onion is a common bulbous vegetable cultivated for its scented bulbs and leaves. It is one of the most valuable commodities that are used on a daily basis all over the world. The onion is a biennial vegetable native to Asia, and Pakistan produces over 1.6 million tons of onions yearly, accounting for 2.5 percent of global yield (Haq *et al*., 2009). The onion is a lucrative cash vegetable and spice used throughout the world with nutritional and medical benefits (Patel *et al*., 2012). The onion is a well-known spice that is cultivate and consumed all across the world in a variety of ways. Onion is a common element in Pakistani cuisine, and it is normally grown three times

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a year, in the monsoon, winter, and summer. Because onions enhance the taste and flavour of a dish, they are frequently utilized in a variety of cuisines and culinary preparations. Onion has therapeutic properties and is also suggested for medical reasons. Onions are used in a variety of goods ketchup, chutney, sauce, puree, salsa, dry soup combination, and other condiments (Ren and Zhou 2021). According to a global estimate of area and output, Onions are grown on 2.3 million hectares in 126 countries, yielding 40.0 million tons of dried onion (Baloch *et al.*, 2014). Asiatic countries contribute for roughly 62 percent of global production. In Pakistan, the onion was planted on 146.1 thousand hectares in 2019-2020, resulting in a yield of 2,058.2 tonnes. Onion consumption has increased substantially over the world, thanks in part to its health benefits. Onions are also high in flavonoids and alkenyl cysteine sulphoxides, both of which help humans avoid heart disease and other diseases (Havey *et al*., 2004).

Many insect pests attack onions including sucking insects, cutworms, and caterpillars. Among sucking insect pests, onion thrip, which is regarded the most commercially important pest of onion worldwide (Gill *et al*., 2015), is responsible for a significant drop in output. Thrips are found in all onion-growing locations in Kenya, and they can reduce yield by up to 59 percent (Muvea *et al*., 2014). Onion thrips is an annoyance that attacks commercially grown onion and causes major yield losses around the world (Karuppaiah *et al*., 2023). The potential to propagate plant diseases and the emergence of pesticide resistance are two issues that need to be addressed (John *et al*., 2011).

Currently, growers control thrips by spraying insecticides on their crops numerous times throughout the growing season. Most insecticides, on the other hand, are useless due to the behavior of onion thrips a huge number of thrips are hide in the between onion plant and inner side of leaves and other stages of onion thrips like pupu is present in the soil and the huge number of onion thrips protect between the inner leaves and onion plant and *T. tabaci* is a prolific species with many overlapping generations (John *et al*., 2011). The lack of natural parasites and the availability of various different host plants on which the pest thrives make controlling thrips even more difficult (Brewster, 2008). Onion thrips have been found to develop resistance to the majority of routinely used pesticides (John *et al*., 2011). Insects play a critical role in affecting the crop at all stages, and they are one of the leading causes of low yield. The onion thrip, a worldwide and polyphagous pest that impacts crop quantity and quality, is part of the insect family. Thripidae feed on plant sap in both adolescent and adult stages, causing assaulted plants leaves to curl, wrinkle, and dry out, preventing them from producing bulbs or seeds, as previously noted (Mouden and Leiss, 2020).

The thrips population at an all-time high during rabi-summer (December 2014 transplanted crop). On March 8, 2015, there were an average of 31.81 thrips per plant throughout the kharif-rabi season, with a high population of 61.04 thrips per plant (In August 2014, the crop was transplanted). The amount of thrips on an average plant in kharif was 8.47, with the highest activity on September 29, 2014 (27.16 thrips/pl.). Maximum temperature was extremely positively connected with thrips population in both seasons, according to correlation studies between thrips population and weather factors, while maximum and lowest relative humidity were significantly adversely correlated. Rainfall has a negative link with the number of thrips throughout the kharif season (Priyadarshini *et al*., 2017).

Several insecticides efficacy in controlling onion thrips in randomized complete block design were utilized at economic threshold level. After both applications, all of the insecticides performed much better than the untreated control in terms of lowering bug population. Thiodan 35EC was shown to be the most effective, followed by Curacron 500EC and Mospilan 20SP (Uddin *et al*., 2019). The hind wings of females are long, slender strap-like wings with long hair along the edges, whilst males have no wings. Nymphs are identical to adults; however, they don't have wings and are smaller. With her pointed ovipositor, the mature female creates slits in leaf tissue and deposits 50-60 kidney-shaped eggs. In 4 to 9 days, the eggs hatch, and the nymphs begin ingesting plant juice by lacerating leaf tissue. In 4-6 days, a nymph will progress through four stages and be well nourished. According to statistics, onion thrips can reduce yields by up to 50% (Mccune *et al*., 2020).

Thrips enter the bulb during curing through burst skin when the crop is lifted in a severe infestation. It degrades the onion's flavour and value by destroying the bulb during storage (Hasan, 2017). Thrips live between the leaf blades and the bulb of onions. Because their jaws are piercing and rasping, thrips target young and fragile leaves first. Thrips lay their eggs in the tissue of the leaves, and the nymphs hatch in four days. Thrips feed on onion's new growth and do their trademark silvery mark made on the leaves as they mature. Most regular eating causes white blast or silver top, which is a silvery-white stippled look. Thrips limit photosynthesis and increase water losses, making the plant more susceptible to disease. They go into pupal stage after a few days of feeding and emerge as young adult after a weeks. Thrips go through life cycle of 13 to 30 days may only while the temperature in the atmosphere exceeds 30 degrees celsius. The life cycle has been shortened to 10-

14 days. Thrips are especially sensitive to thrips during the early bulbing stage, reducing crop quantity and marketability. The reduction manifested itself in the form of smaller onion bulbs as a result of the feeding activity that occurred after bulbing. At an advanced stage of development. Onion thrips are milky white at first, then onion thrips change from the milky white to green and light lemon yellow after moulting having red eyes with having no wings (Mishra *et al*., 2007).

Onion thrips eat by punching holes in the leaf surface and sucking juice from plant cells, which is a completely different feeding strategy. Thrips produce substances that aid in the predigesting of tissue during the digestion process. They subsequently eat mesophyll cells and suck out the contents of the plant, resulting in chlorophyll depletion and lessen photosynthetic capability. It is reported that when thrips damage the leaves or bulb late appear a silvery linear lines on the leaves as a result of the injury (Rueda *et al*., 2007). The presence of microscopic black tar patches, which are thrips feces, is also linked to severe onion thrip feeding harm (Bader *et al*., 2014).

MATERIALS AND METHODS

Description of the experimental site

The study was carried out in season at the Latif Farm Agricultural Research Center (LFARC) 20212022. The LFARC is roughly a kilometer's worth of walking distance from the Noor Shah Bukhari Govt. College. Its coordinates are latitude 25.4280733, longitude 68.530677. The average annual rainfall is bimodal and irregularly distributed, with 16.51 mm (0.65 in) falling on it annually. The mean minimum temperature for a lengthy period of time is 25.44ºC (77.79ºF), and the mean maximum temperature is 38.16ºC (100.69ºF). The soil has a pH of 7.73. The texture of the soil is fine sandy loam, with proportions of sand, clay, and silt being 33, 49, and 18%, respectively.

Experimental design and management

For the experiment, the onion (*Allium sepa*) variety phulkara was utilized. When the seedlings reached the third or fourth true leaf stage, they were transferred from a raised seed bed measuring 10 m^3. There were three 4 m long ridges in each plot. The ridges were separated by 60 cm. Ten centimeters separated each plant. Plots and blocks were separated by 1 and 1.5 meters, respectively. Three replications of each treatment were included in the randomized complete block design (RCBD). For every observation, 25 plants were chosen at random and tagged from each replicated plot. Thrip counts were made on a leaf by leaf basis. Three sprays were applied at 12-day intervals beginning at the onset of infestation to evaluate the efficacy of insecticides. The top, middle, and bottom leaves of 25 randomly chosen plants were sprayed, and the population densities were measured 24 h, 36 h, and 72 h later for each replication. Only the central four rows were used to obtain all of the data. For the first four weeks following transplanting, the crop was irrigated twice a week; after that, it was only done once a week. Diammonium phosphate (DAP) and urea were applied to plots at 200 and 300 kg/ha, respectively, for fertilization. Before transplanting, the entire amount of DAP was administered, whereas the entire amount of urea was applied in two parts. One month after transplanting, half of the 100 kg was applied, and the other half at the start of the head development stage. Additional field management tasks, such as cultivation, weeding, and ridge maintenance, were completed as required. Two weeks after transplanting, treatment was put into practice. A manually controlled 15-liter backpack sprayer with a hollow cane nozzle was used to create the spray.

Treatments

The following four treatments, T1, spraying imidacloprid (200 SL) of 240ml/acre once per week, T2, spraying Deltamethrin (2.5 EC) of 600ml/acre once per week, T3, spraying profenofos (50 EC) of 500ml/acre once per week, and T4, spraying chlorfenapyr (360 SC) of 100ml/acre once per week were used in this study.

Data collection

Number of leaf per plant, plant height and leaf numbers

One week before to harvesting, measurements of the number of leaves on each plant and the number of leaves per plant were taken from 25 randomly chosen plants from each treatment plot. At the time of harvest, plant height was measured with a ruler from the soil's surface to the tip of the plant. The plant's height was determined by measuring the plant's highest point.

Yield component

The following data was gathered: total yield q/acre, marketable yield kg/row, unmarketable yield kg/row, bulb length (cm), and bulb diameters/plant (cm). Both large and small size bulbs (diameters >6.5 cm and less than 2.5 cm) are classified as unmarketable bulb yield since there is no market demand for them.

Onion thrips leaf damage

Before any treatment was applied, all plants and plant parts were inspected for leaf damage, and this inspection was done every week after that. A scale of 0 to 5 was used to score each leaf on a plant: 0 represents no damage to the leaf, 1 represents up to 20% of the total leaf area damaged, 2 represents 21–40% of the total leaf area damaged, 3 represents 41-60% of the total leaf area damaged, 4 represents 61–80% of the total leaf area damaged, and 5 represents more than 80% of the total leaf area damaged.

Data analysis

Statistics 8.1 was utilized for data analysis. An analysis of variance (ANOVA) was performed on the mean value of the recorded data. In the event that there was a significant difference between the treatments, the mean separation was calculated at the 5% significance level using Gomez's significance difference. Thrips population suppression (%) as a percentage of densities observed on the control treatment was used to express the results. The following formula was used to determine the percent reduction in thrips population above control (Zainab *et al*., 2016). In this case, T stands for treatments, Co for controls, and n for the total number of insects in the population.

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

RESULTS

Two factors were investigated in this study: the first was the population fluctuation of *Thrip tabaci* and the second was the efficiency of different pesticides. Most insecticidal treatments considerably reduced the onion *T. tabaci* population after 24 h, 36 h, and 72 h of spraying compared to the untreated control plot. Chlorpenapyr was superior insecticides providing more than 94.05% suppression. However, profenofos and deltamethrin gave satisfactorly results i.e., more than 70-80% control. Imidacloprid pesticides also gave fair result i.e., 58.07 % suppression. Four different insecticides were used to control onion *T. tabaci* chemically, including imidacloprid, deltamethrin, profenofos, and chlorfenapyr.

The combined data on thrips in 2021–2022 (Fig. 1) revealed that the eighth standard week of the fourth week of September was a very active time for thrips. The first to fifth standard week, which falls between the first week of August and the first week of September, had the lowest population (1/leaf), while the eighth to ninth (20-21/leaf) standard week, which falls between the fourth and fifth weeks of September, and the eighth to sixteenth (14-11/leaf) standard week, which falls between the third week of September and the second week of November, maintained the highest population. The 9th and 10th standard weeks, which correspond to the 4th and 5th weeks of September, were when the peak population (28-21/leaf) was seen.

The results of correlation studies (Fig. 2) between the population of thrips and environmental parameters showed that the population of thrips had a significant negative correlation with temperature (minimum and average), relative humidity (minimum and average), and weekly total rainfall, but a significant positive correlation with temperature difference. However, there was a non-significant negative association discovered between the maximum temperature and the thrips population with the highest relative humidity. This suggests that while thrips populations increase in response to temperature differences, their activity decreases in response to high temperatures, high relative humidity, and substantial weekly rainfall.

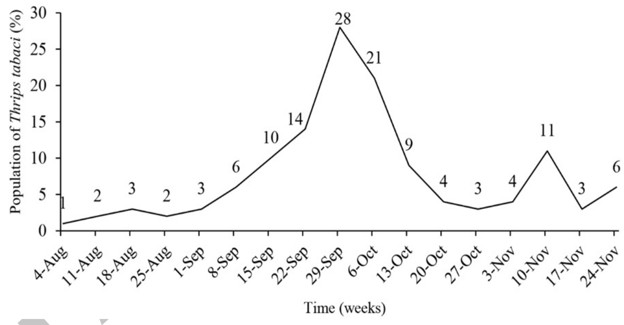

Fig. 1. *Thrips tabaci* population was recorded during the experiments based on weeks from 4th August to 24th November in Tandojam.

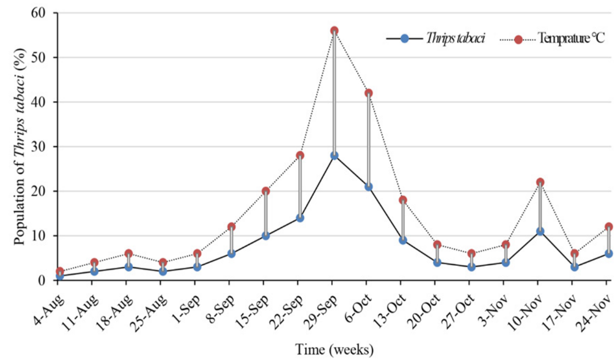

Fig. 2. *Thrips tabaci* population's correlation with temperature was recorded during the experiments from 4th August to 24th November in Tandojam.

The information reveals notable variations in the effectiveness of the tested pesticides. Insecticides containing chlorfenapyr 360SC and profenofos 50EC proved to be significantly effective against thrips with the reduction percentage (97.06% and 82.04%) of thrips after 24 h spraying with respect of controlled plot. They were followed by deltamethrin 2.5 EC and imidacloprid 200SL with 70.02% and 58.07 % reduction percentage of thrips, respectively. With a reduction percentage of 58.07%, imidacloprid 200SL was shown to be the least efficient insecticide against thrips. In comparison, the population of thrips increased by 9.55% in the control.

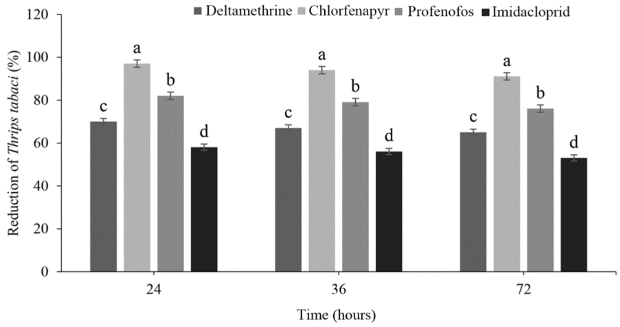

Fig. 3. Efficacy of four different insecticides after 24, 36, and 72 h of spray on onion crop, the reduction percent of *Thrips tabaci* was recorded during the experiments in Tandojam.

According to the statistics, 36 h after the treatment was applied, the reduction of thrips with chlorfenapyr 360SC and profenofos 50EC, respectively, was 94.01% and 79.08% (Fig. 3). In terms of statistics, these therapies were comparable to one another. In addition, thrips control was achieved with deltamethrin 2.5 EC and imidacloprid 200SL, which respectively provided 67.03% and 56.06% and were statistically equivalent. Among thripicides, imidacloprid 200SL was the least successful, reducing thrips by only 56.06%. This indicates that the way each treatment handled the pest was consistent. Once more, there was a 20.28% rise in the pest population in the control plot. As a result, every insecticide that was tested outperformed the untreated control by a large margin.

However, at 72 h of spray reduction of the thrips caused by deltamethrin 2.5 EC (65.03%) was slightly higher than with imidacloprid 200SL (53.07%) (Fig. 3). But again, these were statistically on a par with each other. Among the other two insecticides, chlorfenapyr 360SC proved useful with 91.09% reduction percentage, followed by profenofos 50EC (76.05%). In contrast, the thrips population in the control plot increased by 25.74%. All of the treatments reduced the number of thrips by more than 80–95% and were thus noticeably better than the untreated control.

The total effectiveness of various insecticide treatments at various times after application differed greatly in terms of thrips population decrease (Fig. 3). Out of the four pesticides that were assessed for this study, the one that reduced thrips the most was chlorfenapyr 360SC (94.05%), which was followed closely by profenofos 50EC (79.05%) and deltamethrin 2.5 EC, which was the least effective at 55.73%. A moderate result of 67.36% decrease was recorded by imidacloprid 200SL. It was noted that the infestation of thrips was significantly reduced 24 h after spraying profenofos 50EC and chlorfenapyr 360SC, respectively, in comparison to the control. The remaining medicines, including imidacloprid 200SL and deltamethrin 2.5 EC, were shown to be only marginally effective against thrips, resulting in 70.02% and 58.07% mortality, respectively. A similar pattern was observed 36 h after the spray, with profenofos 50EC (79.08%) and chlorfenapyr 360SC (94.01%) being the most effective. The remaining therapies, imidacloprid 200SL and deltamethrin 2.5 EC, show mediocre outcomes with reductions of 67.03% and 56.06%, respectively. Chlorfenapyr 360SC ranked top in thrips reduction (91.01%) 72 h after spraying again, followed by Profenofos 50EC (76.05%). It was discovered that the other two treatments, imidacloprid 200SL and deltamethrin 2.5 EC, were only marginally successful in reducing thrips, achieving reductions.

DISCUSSION

A field study in 2020-21 focused on monitoring and management of onion thrips, (*Thrips tabaci,* Lindemann). During the examination, it was revealed that pest populations increased in lockstep with crop phenology. During the investigation, it was revealed that the pest population was low in the early phases of the crop, but as the crop proceeded, the onion thrip population gradually increased. Between September 29th and October 6th, the onion thrip population rose significantly. Hazara *et al.* (1999) observed that temperature and crop phenology favoured *T. tabaci* in onion crops. The current study backs up the findings of (Bhonde *et al*., 2019) who discovered that maximum temperature has a significant positive relationship with *T. tabaci* infestation during the kharif season, but relative humidity has a significant negative relationship.

In comparison to the untreated control, the results of this study demonstrated that all of the treatments were successful in controlling *T. tabci* at various intervals following each pesticide application. Ali et al. (2015) used curacron, confidor, and thiodan to control *T. tabaci* in onion crops. According to Ali *et al*. (2015) and Karuppaiah *et al*. (2023) the maximum temperature encouraged the growth of *T. tabaci* in onion crops. The current analysis supports the findings of Bhonde *et al*. (2019), who reported a substantial positive correlation between *T. tabaci* infestation and the maximum and lowest temperatures throughout the kharif season, but a significant negative correlation between relative humidity and infestation. According to the data, chlorfenapyr was the most effective pesticide for controlling thrips, followed by profenofos, and imidacloprid was the least effective.

However, when the data was analyzed together, it was discovered that all of the insecticidal treatments were significantly successful in controlling onion thrips on onion crops. As a result, the findings of this study are remarkably comparable to those of Uddin *et al*. (2019), who demonstrated the effectiveness of several pesticides in controlling onion thrips on onion crops. At the economic threshold, five pesticides were treated twice. After treatment, all insecticides outperformed the untreated control in terms of bug population reduction. Thiodan proved to be the most effective, followed by curacron and karate (John *et al*., 2011). Bhonde et al. (2019) discovered that acetamiprid, dimethioate, spinosad, and imidacloprid outperformed lambda-cyhalothrin in controlling thrips on cabbage. Baloch *et al*. (2014) used the thrips-controlling thiodan, profenofos, to spray onion fields.

All of the other pesticides were much more effective against the pest than the control, with the exception of actara. The findings of this study accord with those of Lin *et al*. (2020), who reported that applying carbosulfan 20EC and spinetoram 120SC to infested garlic plants reduced the population density of *T. tabaci* and resulted in the maximum production throughout two study seasons. When comparing the total average performance of synthetic insecticides against onion thrip populations to pretreatment counts, the study discovered that chlorpenapyr had the highest spray efficacy, followed by chlorpenapyr and deltamethrin. Because the pest population was under control, all of the synthetic insecticides tested were effective against onion thrips, and their potency was well established even 15 days after application. On the basis of onion pest population reduction, the pesticides were ranked chlorpenapyr > profenofos > deltamethrin > imidacloprid.

When compared to the control, the results of this investigation demonstrated that all of the insecticides efficiently inhibited the onion thrip. The pest population in untreated (check) plots remained stable throughout the research period. Chlorpenapyr pesticide outperformed profenofos and deltamethrin in controlling thrip on onion crops. These findings are consistent with the findings that all treatments had a considerably reduced population of sucking insect pests than the control plot.

CONCLUSION

Based on the findings of this study, it can be concluded that all insecticides tested were successful in reducing onion thrip populations on onion crops, with especially chlorpenapyr proving to be more effective and significantly reducing onion thrip populations than the other insecticides examined.

DECLARATIONS

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Statement of conflict of interest

The authors have declared no conflict of interest.

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