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Efficacy of Synthetic Insecticides against Tobacco Aphids (*Myzus persicae*) under Field Conditions

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ABSTRACT

The study was conducted to check the efficacy of synthetic insecticides against tobacco aphids in District Mardan during spring 2023. The tobacco genotype Speight G28 was grown and standard agronomic practices were followed. Experiment was laid out in Randomized Complete Block Design (RCBD) with four treatments via Confidar, Actara, Furadon and Control, replicated 3 times. Results revealed that all the tested insecticides performed better then control in managing aphids infestation. However, Confidor resulted in better control of aphids (2.31 plant-1), higher plant height (83.67 cm), number of leaves plant-1 (27.53), leaf area (69.60 cm^2), grade index (2.30%), yield (1506.70 kg ha^{-1}) as well as nicotine (3.50%) and total sugar contents (6.73%). It is concluded that performance of Confidar is superior with respect to low aphid infestation. Therefore, tobacco genotype Speight G28 should be cultivated along with judicial use of Confidor for better management of aphids infestation and getting higher tobacco yield.

INTRODUCTION

Tobacco (*Nicotiana tabacum* L.) belongs to the family Solanaceae is a significant cash crop (Lisuma *et al.,* 2021). Pakistan ranks among the top ten countries in global tobacco production (Nasrullah *et al.,* 2019). It generates 40% of all excise tax revenue for the government. This percentage represents 10% of the government's total revenue. In Pakistan, 78% of tobacco production comes from Khyber Pakhtunkhwa and act as primary contributor (Nasrullah *et al.,* 2019). Khyber Pakhtunkhwa's tobacco yield per hectare is 14% higher than the global average. Tobacco yield is higher in Pakistan than other countries but still it is considerably less than its genetic potential (Dunda *et al.,* 2023). Several factors limit tobacco yield. These factors include a lack of improved varieties, soil fertility problems, diseases, poor crop rotation, drought, socioeconomic factor, and insect pests (Bucheyeki *et al.,* 2013; Badshah *et al.,* 2013).

Insect pests pose major threat to tobacco. They can cause significant losses in tobacco production. They not only diminish the quality of the leaves but also serve as vectors for several critical tobacco diseases (Bucheyeki *et al.,* 2013). Common insect pests in tobacco cultivation include cutworms, wireworms, budworms, flea beetles, slugs, grasshoppers, aphids, and thrips. The impact of insect pest infestations on tobacco production results in substantial losses. Of these pests, aphids are the most destructive, reducing crop yield and quality by feeding on plant sap and transmitting plant viruses (Rezaei *et al.,* 2021). They damage tobacco plants by sucking sap from growing stems and young leaves. Heavy aphid infestations can cause water stress and stunted growth, resulting in thin leaves that are difficult to cure to the desired yellowish-brown color. Severely damaged leaves may either wither prematurely or ripen prematurely. Moreover, aphids are economically significant because they can transmit various viral diseases to tobacco. For example, aphids play a crucial role in transmitting a range of tobacco viral diseases in Asia and Africa (Rezaei *et al.,* 2021).

Numerous strategies have been empirically validated to alleviate the impact of these insect pests, encompassing the use of synthetic insecticides, adjustments in agronomic practices, utilization of resistant plant varieties, application of botanical substances, as well as the implementation of biological and mechanical controls (Pang *et al.,* 2023). A significant portion of the insecticides used in tobacco cultivation operates through a contact mode of action, exerting lethality to specific insects upon contact. Examples of such insecticides include dimethoate, carbaryl, cypermethrin, deltamethrin, and lambda cyhalothrin. In contrast, other insecticides employed to safeguard tobacco crops have systemic properties, as they are water soluble, allowing for absorption and distribution within plant tissues that can be ingested by insects (Reyes *et al.,* 2011). Notable examples of systemic pesticides used are neonicotinoids/nitroguanidine (imidacloprid) and dimethoate (locally systemic). Tobacco growers predominantly rely on chemical insecticides to combat aphids (Guo *et al.,* 2017).

The aphids are becoming major threat to tobacco crop in Pakistan, so there is need to develop an effective and best management strategy to control this notorious and destructive pest in the country to protect the economy of Pakistan by minimizing the crop losses. By keeping in view, the high crop losses and considering the insecticides an effective tool, the current study was conducted to control this most dangerous pest by use of insecticides.

MATERIAL AND METHODS

The experiment was carried out at Tobacco Research station, Mardan during spring 2023. Tobacco genotype Speight G28 were sown for nursery during last week of December. Health seedlings about 5-6 inches were transplanted in last week of March. The experiment was laid in Randomized Complete Block Design with four treatments including control via Confidar (Imidacloprid 700g/kg), Actara (Thiomethoxam 250g/kg) and Furadon (Carbofuron 3%; Phorate 1.9%; Fipronil 0.1% w/w) replicated 3 times. Plant to plant distance was kept 60cm and row-to- row distance was kept 90cm respectively. The size of each plot was 3 x 5.40 m. Usual agronomic practices were applied in all experimental plots uniformly.

Ten (10) plants from each treatment were randomly selected for the Aphids population (Plant^{-1}), Plant height (cm), Number of leaves (Plant^{-1}) and Leaf area (cm^2). The data was calculated and their average was taken.

Grade Index (%)

The number of mature and total leaves per plot was counted in each treatment. Following the leaf count, the grade index was determined using the following formula:

$$Grade\ Index = \frac{Number\ of\ mature\ leaves}{Total\ number\ of\ leaves\ per\ plot}\ x\ 100$$

Yield (kg ha^{-1})

The weight of the cured leaves was recorded after each plucking in each treatment. The total weight of the cured leaves was calculated by summing the yield from each plucking, and then converted to kilograms per hectare (kg ha-1).

Nicotine Content (%) and Total Sugar (%)

To record nicotine contents, the leaves were collected from each treatment at maturity and dried properly. Dried leaves were ground. One gram of ground tobacco leaf powder was measured into an Erlenmeyer flask and mixed with 10 mL of 70% perchloric acid. The flask was cover with a watch glass and heated on a hot plate until it boiled. The heat was reduced to simmer for 15 minutes. After removing the flask from the heat and letting it cool, a few drops of phenolphthalein indicator were added. The solution was then titrated with 0.1 M HCl until the pink color disappeared, and the volume of HCl used was recorded. The following formula employed by Said *et al.* (2015) was used to record nicotine contents:

$$Nicotine\ (\%) = \frac{Vol.of\ HCL\ used\ x\ Molarity\ of\ HCL\ x\ Molecular\ weight\ of\ nocotine}{Weight\ of\ sample\ x\ 100}$$

To record total sugar contents, the leaves were collected from each treatment at maturity and dried properly. Ground tobacco leaves (1.0 g) were added to an Erlenmeyer flask with 10 mL of distilled water. The flask was swirled to mix, and then 5 mL of Fehling's solution A and 5 mL of Fehling's solution B were added. The flask was swirled again to mix the solutions, and then 20 mL of NaOH was added and swirled to mix. The flask was cover with a watch glass and heated on a hot plate until it boiled. The heat was reduced to simmer for 15 minutes. The flask was remove from the heat and allowed to cool. 10 mL of sulfuric acid was added to a flask and mixed by swirling. A few drops of methylene blue indicator were then added to the flask. The solution was titrated with 0.1 M hydrochloric acid (HCl) till the blue color completely disappeared. The volume of HCl used was recorded. To calculate the total sugar content of the tobacco leaf sample, the following formula described by Lane and Eynon (1986) was used:

$$Total\ Sugar\ (\%) = \frac{Vol.of\ HCL\ used\ x\ Molarity\ of\ HCL\ x\ Molecular\ weight\ of\ nocotine}{Weight\ of\ sample\ x\ 100}$$

Statistical Analysis

Analysis of variance was used to analyze the data regarding pest infestation and damage, and treatment means were separated using the post-hoc Least Significant Difference (LSD) test at a 5% level of significance or probability.

RESULTS

Table 1

Effect of Various Insecticides on Aphid Population on Tobacco under Field Condition

Treatments	Pre-treatment Population	Post Treatment Population					Mean
		1 DAS	2 DAS	3 DAS	4 DAS	7 DAS	
Confidar	14.50	4.17 c	2.87 c	1.83 c	1.03 c	0.70 b	2.31 c
Actara	18.90	5.63 b	4.33 b	3.50 b	2.70 b	1.43 b	3.67 b
Furadon	16.03	6.97 b	5.67 b	2.70 bc	1.90 bc	1.20 b	3.71 b
Control	15.57	14.77 a	13.47 a	14.70 a	13.90 a	14.60 a	14.29 a
LSD	Ns	1.34	1.34	1.08	1.08	0.90	0.47

The means followed by different letters are significantly different at a 5% level of significance

Table 1 shows the mean number of aphids population before and after spray application. It was observed that aphid population before insecticide application was non-significant however after the application of insecticide the aphid population was significantly different in all treatments. The mean aphids population after 7 days of spray application showed considerable decline in aphid population. The lowest aphid population was recorded in Confidor (2.31) and was found best in lowering aphids infestation followed by Actara (3.67) which was statistically at par with Furadon (3.71). However highest aphid population was recorded in control (14.29).

Table 2

Effect of Various Insecticides on Plant Height, Leaves/Plant, Leaf Area, Grade Index and Yield on Tobacco in Field Conditions

Treatments	Plant height (cm)	Leaves/ Plant	Leaf Area (cm²)	Grade index (%)	Yield (kg/ha)
Confidar	83.67 a	27.53 a	69.60 a	2.30 a	1506.70 a
Actara	83.43 a	26.50 b	67.30 b	1.70 b	1471.57 b
Furadon	82.37 b	25.87 c	61.63 c	1.30 c	1349.00 c
Control	81.63 c	24.70 d	55.70 d	1.07 d	1144.13 d
LSD	0.42	0.44	1.22	0.21	25.56

The means followed by different letters are significantly different at a 5% level of significance

From table 2 it was observed that plant height, number of leaves per plant, leaf area, grade index and yield was greatly affected with spray application. The maximum plant height, leaves per plant. Leaf area, grade index and yield was observed plots treated with Confidar (83.67, 27.53, 69.60, 2.30 and 1506.70) respectively followed by Actara treated plot having number of leaves per plant (26.50), leaf area (67.30), grade index (1.70) and yield (1471.57). In case of plant height, Confidar treated plot was statistically in line with Actara (83.43) followed by Furadon (82.37). Minimum data was observed in untreated control plot (81.63, 24.70, 55.70, 1.07, 1144.13) respectively.

Table 3

Effect of Various Insecticides on Nicotine Content (%) and Total Sugar (%) on Tobacco under Field Condition

Treatments	Nicotine Content (%)	Total Sugar (%)
Confidar	3.50 a	6.73 a
Actara	2.40 b	4.53 b
Furadon	1.67 c	4.13 b
Control	1.10 d	2.83 c
LSD	0.42	0.43

The means followed by different letters are significantly different at a 5% level of significance

Results regarding nicotine contents and total sugar contents presented in Table 3 indicated that highest nicotine contents were recorded in Confidor (3.50%) followed by Actara (2.40%). While lowest nicotine contents were recorded in control (1.10%). In case of total sugar contents, highest total sugar contents were recorded in Confidor (6.73%) followed by Actara (4.53%) as well as Furadon (4.13%). However lowest sugar contents were recorded in control (2.83%).

DISCUSSION

Among the various insecticides tested, imidacloprid (Confidor) demonstrated the lowest aphid population per leaf at 1, 2, 3, 4, and 7 days after pesticide application compared to the other pesticides. In contrast, the control plot exhibited the highest aphid population per leaf. This variation may be attributed to imidacloprid's higher efficacy for aphid control compared to thiamethoxam (Elnagar *et al.,* 2013). Moreover, previous studies have reported that imidacloprid has antifeedant properties, inhibiting larval feeding deeper into the outer leaf sheath, leading to lower larval mass gain compared to carbamate treatments (Drinkwater, 1994). Studies by Ramaprasad *et al.* (1998), and Link *et al.* (2000) have also emphasized the effectiveness of imidacloprid (Confidor) in controlling aphids, further supporting the findings of this study. Similarly, Patil and Lingappa (2000) reported the high effectiveness of Confidor against aphids compared to acephate and endosulfan, in line with the results obtained in this study. In this investigation, significant differences were observed in plant height, the number of leaves per plant, and leaf area among the different insecticides treatments. Plants treated with Confidor displayed the maximum plant height, number of leaves per plant, and leaf area, while the least favorable outcomes were observed in the Furadon treatment. The lower aphid infestation in Confidor-treated plants likely contributed to their superior vegetative growth. (Yahya *et al.,* 2017). Tobacco yield also showed significant differences among the various treatments, with the maximum yield recorded in the Confidor treatment. The higher yield in this group may be attributed to the increased number of leaves and leaf area, owing to inherent resistance against aphid attacks. The grade index varied significantly among the treatments, with the highest-grade index recorded in the Confidor treatment and the lowest in the control group. The quality of tobacco leaf is determined by its physiological characteristics, including color, texture, size, and aroma, which collectively represent its quality. Abdul and Peer (1999) conducted experiments on the effect of aphid population on flue-cured tobacco production and found that the greatest effect was measured on the yield of leaves from the middle portion of the plant. Leaves with a higher aphid population exhibited a significantly greater reduction in price due to a lower grade index. Furthermore, nicotine and sugar contents were higher in plants treated with Confidor, where aphid infestation was lower. This difference in chemical composition may be attributed to the aphids' tendency to reduce nicotine and sugar content in tobacco leaves (Cheng and Henlon, 1985).

Authors Contribution

The author Muhammad Junaid (MJ) conducted the research, Adnan Ihsan (AI) wrote the manuscript, Misbahullah (MU) supervise the overall experiment, Saddam Hussain (SH) provide tobacco genotype and Irfan Ullah (IU) statistically analyze the data.

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