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Relative Efficacy of Some Insecticides Against the Sucking Insect Pest Complex of Cotton

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ABSTRACT

The comparative efficacy of some conventional and neonicotinoid insecticides for the management of sucking insect pests of cotton (whitefly, jassid and thrips) was determined. Six insecticides viz., Confidor 200 SL (imidacloprid)@ 100 ml acre^{-1}, Karate 1.5 EC (lambda cyhalothrin)@ 330 ml acre^{-1}, Nockout 25 SP (nitenpyram)@ 100 gm acre^{-1}, Polytrin-C 44 EC (profenofos+cypermethrin)@ 600 ml acre^{-1}, Talstar 10 EC (bifenthrin)@ 250 ml acre^{-1} and Advantage 20 EC (carbosulfan)@ 1000 ml acre^{-1} were sprayed twice in order to ascertain the reduction of the pests population on Sadori variety of cotton sown at experimental area of Nuclear Institute of Agriculture, Tandojam. All the tested insecticides caused significant reduction of whitefly, jassid and thrips at 24 hours, 72 hours and even 7 days after application. Imidacloprid followed by the nitenpyram proved to be most effective for bringing about a significant reduction in the populations of whitefly and thrips. Nitenpyram had the highest percentage reduction (73.80%) against jassid at 7th day after application but that was non-significantly different from imidacloprid(63.49%).Whereas, the conventional insecticides i.e. lambda cyhalothrin, profenofos+cypermethrin, bifenthrin and carbosulfan showed 57.93%, 52.38%, 47.61% and 42.06% reduction, respectively. Maximum extrapolated yield (2.99 tons ha^{-1}) was also obtained in imidacloprid treated plots followed by nitenpyram (2.66 tons ha^{-1}). Thus, these two insecticides were most effective for the sucking pests and in increasing seed cotton yield as compared to the conventional ones.

1. Introduction

Cotton occupies a unique position in economy of Pakistan as a fiber crop by contributing about 68% of foreign exchange earnings, 1.5% of GDP and 7 % of value addition in agriculture, moreover, 66.5% in national oil production [1]. The average cotton yield in Pakistan is about 713 kg/ha, which is substantially low as compared to other countries of the world [2]. Many factors are responsible for this low productivity, but the most serious one is the intensity of insect pest attack [3]. It is estimated that sucking and bollworms pest complex of cotton causes approximately 20-40% yield losses in Pakistan [4]. Few years back, attack of bollworms was a serious issue causing huge losses to the cotton crop but with the release of transgenic Bt cotton, this issue has been solved to some extent [5]. However, widespread cultivation of transgenic cotton has resulted in the increased attack of sucking insect pests [6].

The most important sucking insect pests are whitefly (*Bemesia tabaci* Genn.), cotton thrips (*Thrips tabaci* Lind.), jassid (*Amrasca devastans* Dist.) and cotton aphid (*Aphis gossypii* Glover) [7]. The severe attack of these sucking pests causes yellowing of leaves that inhibits both the development and growth of the plant and eventually the plant dries up due to the loss of cell sap [8]. Chavan *et al*. [9] has reported 28% of the yield losses due to the attack of sucking insect pests on cotton.

No single pest control method is sufficient for good production. With effective control of cotton pests, yield of cotton can be increased by 200-300 kg ha^{-1}[10]. The use of synthetic insecticides is among the methods that provide rapid control and also an essential part of any IPM (Integrated Pest Management) program to limit the insect pests attack on cotton [11]. Previously, various studies were conducted regarding the comparative efficacy of different synthetic insecticides against these pests [7-8, 12-15].

The insecticides with novel mode of action including neonicotinoids and growth regulators have been proved to be most effective against sucking pests as compared to the conventional insecticides [16-19]. Commercial products like thiamethoxam, thiacloprid, acetamiprid and imidacloprid that belong to neonicotinoids are also considered very important due to their insecticidal activity [20-23] and highly recommended to-date for the management of sucking pests on Bt cotton. These synthetic insecticides are also considered less harmful to

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Table 1: Details of insecticides used in the experiment

Treatment	Common Name	Trade Name	Group	Dose
T_1	Imidacloprid	Confidor 200 SL	Neonicotinoid	100 ml $acre^{-1}$
T_2	Lambda cyhalothrin	Karate 2.5 EC	Pyrethroid	330 ml $acre^{-1}$
T_3	Nitenpyram	Nockout 25 SP	Neonicotinoid	1000 gm $acre^{-1}$
T_4	Profenofos + Cypermethrin	Polytrin-C 44 EC	Organophosphate + Pyrethroid	600 ml $acre^{-1}$
T_5	Bifenthrin	Talstar 10 EC	Pyrethroid	250 ml $acre^{-1}$
T_6	Carbosulfan	Advantage 20 EC	Carbamate	1000 ml $acre^{-1}$
T_7	Control			

the predators of these pests [24]. Presently, researchers are putting efforts to test new chemistry insecticides against sucking insect pests of cotton for their efficient control. Keeping in view the significance of sucking insect pests and insecticides for their control, the study was initiated to compare the efficacy of some conventional and neonicotinoids insecticides on the sucking insect pests of cotton.

2. Materials and Methods

The trial was carried out under field conditions during Kharif season of 2015 to determine the comparative efficacy of Confidor 200 SL (imidacloprid), Karate 2.5 EC (lambda cyhalothrin), Nock out 25 SP (nitenpyram), Polytrin-C 44 EC (profenofos+cypermethrin), Talstar 10 EC (bifenthrin) and Advantage 20 EC (carbosulfan) against the sucking insect pests of cotton on the variety, Sadori. Details of the insecticides used in the study are shown in Table 1.

The study was conducted at the experimental area of Nuclear Institute of Agriculture (NIA), Tandojam under RCBD (Randomized Complete Block Design) with seven treatments consisting of six insecticides and a control treatment replicated thrice. An area of 6 m x 3.75 m was maintained in each replicated plot of the treatments. Row to row distance was kept at 75 cm and plant to plant distance at 30 cm. All the recommended agronomic practices were followed from sowing to harvesting of cotton.

The insecticides were applied twice at their recommended doses with the help of a knapsack sprayer when the population of sucking insects reached the economic threshold level (ETL). The data of jassid, thrips and whitefly were recorded at 24 hours, 72 hours and 7 days after application of insecticides from five randomly selected plants in each replicate. The insect populations were recorded from upper, middle and lower leaves of the plants and averaged as per leaf.

The yield of each replicate was recorded at the time of picking of seed cotton in kg and then converted into tons ha^{-1}.The difference in the mean population at different time intervals and yield were analyzed by Statistix 8.1 and means were compared using LSD test at 5 percent probability level. The reduction percentage of pest was calculated with following formula :

$$Percentage\ Reduction = \frac{Population\ in\ Control - Population\ in\ each\ Treatment}{Pop.\ in\ Control} \times 100$$

3. Results and Discussion:

3.1. Efficacy of Insecticides Against Jassid

The mean percentage reduction of jassid population recorded at different time intervals after the first and second applications of different insecticides is presented in Table 2. After 24 hours of first application nitenpyram was highly effective with 91.50% reduction of jassid population followed by imidacloprid (86.92%), bifenthrin (78.43%), lambda cyhalothrin (73.85%), profenofos+ cypermethrin (65.35%) and carbosulfan (52.28%). While after 72 hours of application efficacy increased as nitenpyram and imidaclorpid gave maximum reduction (91.87%) followed by bifenthrin, carbosulfan, lambda cyhalothrin and profenofos+cypermethrin with 78.43%, 75%, 71.25% and 66.87% reduction, respectively. After 7 days of application the mean population of jassid in all the insecticide treatments had non-significant difference with each other and maximum reduction (70.83%) was recorded in plots treated with nitenpyram followed by imidacloprid and lambda cyhalothrin with reduction of 66.66%in each case. While profenofos+cypermethrin, bifenthrin and carbosulfan were less effective with 61.66%, 55.83% and 50.00% reduction, respectively. In the second application of insecticides, the trend was same and significant reduction in jassid population was achieved after 24 hours, 72 hours and 7 days of treatments (Table 3).After 7 days of second application, again nitenpyram was found to be highly effective with maximum reduction (73.80%) of jassid population followed by imidacloprid (63.49%), lambda cyahlothrin (57.93%), profenofos + cypermethrin (52.38%), bifenthrin (47.61%) and carbosulfan (42.06%).

Table 2: Comparison of percentage reduction of jassid at different time intervals after first application

Treatments		Mean percentage reduction of jassid		
		After 24 hours	After72 hours	After 7 days
T_1	Imidacloprid 200 SL	86.92 (0.20) c	91.87 (0.13) c	66.66 (0.40) b
T_2	Lambda cyhalothrin 2.5 EC	73.85 (0.40) bc	71.25 (0.46) b	66.66 (0.40) b
T_3	Nitenpyram 25 SP	91.50 (0.13) c	91.87 (0.13) c	70.83 (0.35) b
T_4	Profenofos + Cypermethrin 44 EC	65.35 (0.53) bc	66.87 (0.53) b	61.66 (0.46) b
T_5	Bifenthrin 10 EC	78.43 (0.33)bc	78.43 (0.33) bc	55.83 (0.53) b
T_6	Carbosulfan 20 EC	52.28 (0.73) b	75.0 (0.40) bc	50.00 (0.60) b
T_7	Control	(1.53) a	(1.60) a	(1.20) a
	LSD	0.40	0.30	0.27
	F	12.96	25.16	11.15
	P	0.00	0.00	0.00

*Values are percentage reduction in a respective treatment. Values in parenthesis represent mean population at different time intervals. Means in a column sharing same letter are not significantly different at $p<0.005$

Table 3: Comparison of percentage reduction of jassid at different time intervals after second application

Treatments		Mean percentage reductionof jassid		
		After 24 hours	After72 hours	After 7 Days
T_1	Imidacloprid 200 SL	78.33 (0.26) cd	82.30 (0.20) b	63.49 (0.46) bc
T_2	Lambda cyhalothrin 2.5 EC	72.5 (0.33) bcd	70.79 (0.33) b	57.93 (0.53) bc
T_3	Nitenpyram 25 SP	89.16 (0.13) d	88.49 (0.13)b	73.80 (0.33) c
T_4	Profenofos + Cypermethrin 44 EC	66.66 (0.40) bc	64.60 (0.40) b	52.38 (0.60) bc
T_5	Bifenthrin 10 EC	72.5 (0.33) bcd	76.99 (0.26) b	47.61 (0.66) bc
T_6	Carbosulfan 20 EC	55.83 (0.53) b	59.29 (0.46) b	42.06 (0.73) b
T_7	Control	(1.20) a	(1.13) a	(1.26) a
	LSD	0.23	0.33	0.37
	F	20.61	9.46	6.00
	P	0.00	0.00	0.004

*Values are percentage reduction in a respective treatment. Values in parenthesis represent mean population at different time intervals. Means in a column sharing same letter are not significantly different at $p<0.005$.

The findings of present study showed that nitenpyram followed by imidacloprid performed best among the different insecticides against jassid population. This has been supported by the findings of many previous studies [7, 25-30]. Ahmed *et al*. [24] also confirmed that neonicotinoids i.e. nitenpyram and imidacloprid are very effective in reducing the population of jassid below economic threshold level. Moreover, Irshad *et al*. [31] reported that nitenpyram and acephate reduced the jassid population below ETL seven days after application. Whereas Adam *et al.* [32] observed that nitenpyram significantly reduced jassid population over a span of 14 days.

3.2. Efficacy of Insecticides Against Whitefly

The results in Table 4 revealed that all the insecticide treatments caused significant reduction of whitefly population even after 7 days of first application. After 24 hours of application the mean value data revealed that imidacloprid was highly effective with maximum reduction (74.5%) of whitefly population followed by nitenpyram (69.00%) while carbosulfan, bifenthrin, profenofos+cypermethrin and lambda cyhalothrin were statistically similar with each other having reduction of 63.33%, 61.16%, 60% and 53.33%, respectively. After 72 hours of application the mean population of whitefly in imidacloprid, nitenpyram, bifenthrin, lambda cyhaothrin and profenofos+cypermethrin were statistically at par with 77.73%, 72.96%, 71.73%, 68.19% and 65.90% reduction, respectively. While after 7 days of application efficacy of the insecticide decreased and imidacloprid gave maximum reduction of 63.24% followed by nitenpyram (51.38%), profenofos+cypermethrin (48.61%), lambda cyhalothrin (46.04%), bifenthrin (43.47%) and carbosulfan (42.09%).The somewhat different order of effectiveness was observed in the second application of insecticides where after 7 days of application imidacloprid was highly effective and proved more lethal to whitefly showing highest percent reduction of 66.24% followed by nitenpyram (53.87%), bifenthrin (48.38%), profenofos + cypermethrin (46.29%), lambda cyhalothrin (43.06%) and carbosulfan (40.96%) (Table 5).

Table 4: Comparison of percentage reduction of whitefly at different time intervals after first application

	Treatments	Mean percentage reduction of whitefly		
		After 24 hours	After72 hours	After 7 Days
T_1	Imidacloprid 200 SL	74.5 (1.53) d	77.73 (1.26) c	63.24 (1.86) b
T_2	Lambda cyhalothrin 2.5 EC	53.33 (2.80)b	68.19 (1.80) bc	46.04 (2.73) b
T_3	Nitenpyram 25 SP	69.00 (1.86)cd	72.96 (1.53) bc	51.38 (2.46) b
T_4	Profenofos + Cypermethrin 44 EC	60.00 (2.40)bc	65.90 (1.93) bc	48.61 (2.60) b
T_5	Bifenthrin 10 EC	61.16 (2.33) bc	71.73 (1.60) bc	43.47 (2.86)b
T_6	Carbosulfan 20 EC	63.33 (2.20) bcd	62.36 (2.13) b	42.09 (2.93)b
T_7	Control	(6.00)a	(5.66) a	(5.06) a
	LSD	0.73	0.74	1.09
	F	39.00	39.13	7.94
	P	0.00	0.00	0.00

*Values are percentagereductionin a respective treatment. Values in parenthesis represent mean population at different time intervals. Means in a column sharing same letter are not significantly different at p<0.005.

Table 5: Comparison of percentage reduction of whitefly at different time intervals after second application

Treatments		Mean percentage reduction of whitefly		
		After 24 hours	After72 hours	After 7 Days
T_1	Imidacloprid 200 SL	71.24 (1.80) c	79.19 (1.40) c	66.77 (2.06) d
T_2	Lambda cyhalothrin 2.5 EC	58.46 (2.60) b	65.37 (2.33) bc	43.06 (3.53) b
T_3	Nitenpyram 25 SP	68.05 (2.00) bc	72.36 (1.86) bc	53.87 (2.86) c
T_4	Profenofos + Cypermethrin 44 EC	64.85 (2.20) bc	68.35 (2.13) bc	46.29 (3.33) bc
T_5	Bifenthrin 10 EC	67.09 (2.06) bc	70.28 (2.00) bc	48.38 (3.20) bc
T_6	Carbosulfan 20 EC	62.77 (2.33) bc	64.33 (2.40) b	40.96 (3.66) b
T_7	Control	(6.26) a	(6.73) a	(6.20) a
	LSD	0.68	0.96	0.57
	F	49.27	33.34	47.85
	P	0.00	0.00	0.00

*Values are percentagereductionin a respective treatment. Values in parenthesis represent mean population at different time intervals. Means in a column sharing same letter are not significantly different at p<0.005.

These findings showed that imidacloprid gave the best results (77.73% and 79.17% reduction after 72 hours of first and second application) against whitefly among different insecticides tested in the study which is in agreement with that of Mohan and Katiyar [33] who reported that imidacloprid significantly reduced the population of whitefly in cotton. Khattak *et al*. [26] also documented similar results of significant reduction in the whitefly population after 24, 72 and even 120 hours of spray of imidacloprid. Our results are also in accordance with that of Shivanna *et al*. [15] and Abbas *et al*. [34] who reported that imidacloprid was the most effective for the control of cotton whitefly.

3.3. Efficacy of Insecticides Against Thrips

The results showed significant differences in the mean percentage reduction of thrips after 24 hours, 72 hours and 7 days of two applications. It is evident from Table 6 that all the insecticides caused significant reduction of thrips even at 7 days of first application. After 24 hours of application the mean number of thrips in all the insecticide treatments had non-significant difference between one another. Imidacloprid was superior over others with 66.30% reduction of thrips and it was followed by nitenpyram (64.31%), carbosulfan (57.12%), lambda cyhalothrin (55.13%), profenofos+cypermethrin (49.00%) and bifenthrin (45.94%). While after 72 hours of treatments efficacy was increased and highest percent reduction was observed in plots treated with imidacloprid (70.61%) and nitenpyram (66.35%). Carbosulfan (61.13%), lambda cyhalothrin (60.03%) profenofos+cypermethrin (50.55%) and bifenthrin (48.49%) were found comparatively less effective. Seven days after treatment imidacloprid (68.51% reduction) ranked first among all the treatments. The next best insecticides were nitenpyram (58.72%), carbosulfan (56.60%) and lambda cyhalothrin (50.08%) all being statistically at par with each other followed by profenofos+cypermethrin (42.41%) and bifenthrin (39.15%) both being statistically different from control. Similar results were observed after the second application of insecticides as well. Imidacloprid (70.35%) followed by nitenpyram (56.07%) and carbosulfan (53.57%) showed highest reduction percentage after seven days of second application. Whereas lambda cyhalothirn (52.5%), profenofos+cypermethrin (45.35%) and bifenthrin (40.53%) caused relatively less percentage reduction of thrips (Table 7).

Table 6: Comparison of percentage reduction of thrips at different time intervals after first application

	Treatments	Mean percentage reduction of thrips		
		After 24 hours	After72 hours	After 7 Days
T_1	Imidacloprid 200 SL	66.30 (2.20) b	70.61 (1.86) c	68.51 (1.93) d
T_2	Lambda cyhalothrin 2.5 EC	55.13 (2.93) b	60.03 (2.53) bc	50.08 (3.06) bcd
T_3	Nitenpyram 25 SP	64.31 (2.33) b	66.35 (2.13) c	58.72 (2.53) cd
T_4	Profenofos + Cypermethrin 44 EC	49.00 (3.33) b	50.55 (3.13) b	42.41 (3.53) bc
T_5	Bifenthrin 10 EC	45.94 (3.53) b	48.49 (3.26) b	39.15 (3.73) b
T_6	Carbosulfan 20 EC	57.12 (2.80)b	61.13 (2.46) bc	56.60 (2.66) bcd
T_7	Control	(6.53)a	(6.33) a	(6.13) a
	LSD	1.54	0.95	1.14
	F	8.63	23.67	13.44
	P	0.00	0.00	0.00

*Values are percentage reduction in a respective treatment. Values in parenthesis represent mean population at different time intervals. Means in a column sharing same letter are not significantly different at p<0.005.

Table 7: Comparison of percentage reduction of thrips at different time intervals after second application

	Treatments	Mean percentage reduction of thrips		
		After 24 hours	After72 hours	After 7 Days
T_1	Imidacloprid 200 SL	68.58 (1.80) b	69.98 (1.60) b	70.35 (1.66) c
T_2	Lambda cyhalothrin 2.5 EC	50.08 (2.86) b	56.28 (2.33) b	52.5 (2.66) bc
T_3	Nitenpyram 25 SP	67.53 (1.86) b	63.78 (1.93) b	56.07 (2.46) bc
T_4	Profenofos + Cypermethrin 44 EC	52.35 (2.73) b	54.97 (2.40) b	45.35 (3.06) bc
T_5	Bifenthrin 10 EC	41.88 (3.33) b	48.78 (2.73) b	40.53 (3.33) b
T_6	Carbosulfan 20 EC	60.55 (2.26) b	57.59 (2.26) b	53.57 (2.60) bc
T_7	Control	(5.73) a	(5.33) a	(5.60) a
	LSD	1.61	1.40	1.64
	F	6.64	7.31	5.36
	P	0.00	0.00	0.00

*Values are percentage reduction in a respective treatment. Values in parenthesis represent mean population at different time intervals. Means in a column sharing same letter are not significantly different at p<0.005.

These results are in line with Wahla *et al*. [35] who reported that imidacloprid proved most effective for the control of cotton thrips. Our findings proved that imidacloprid was highly effective against whitefly, thrips and jassid. These findings are also in accordance with the studies conducted by various scientists [16-17, 36-37] who reported imidacloprid as the most efficacious among the tested insecticides in a number of trials.

3.4. Seed Cotton Yield

The results presented in Table 8 revealed that significant variation was found among the insecticide treatments and certain treatments gave more yields as compared to control (1.7 tons ha^{-1}). However, highest seed cotton yield was recorded in imidacloprid (2.99tons ha^{-1}) followed by nitenpyram (2.66tons ha^{-1}) and lambda cyhalothrin (2.45 tons ha^{-1}) and found statistically at par with each other. It is also evident from the data that yield in carbosulfan (2.08tons ha^{-1}), profenofos+cypermethrin (2.08tons ha^{-1}) and bifenthrin (2.02tons ha^{-1}) were non-significantly different from each other and also they failed to surpass the yield of untreated control.

Table 8: Comparison of mean yield (tons ha^{-1}) as affected by different tested insecticides

	Treatments	Mean Yield(tons ha^{-1})
T_1	Imidacloprid 200 SL	2.99 a
T_2	Lambda cyhalothrin 2.5 EC	2.45 ab
T_3	Nitenpyram 25 SP	2.66 ab
T_4	Profenofos + Cypermethrin 44 EC	2.08 bc
T_5	Bifenthrin 10 EC	2.02 bc
T_6	Carbosulfan 20 EC	2.08 bc
T_7	Control	1.70 c

*Means in a column sharing same letter are not significantly different at p<0.005.

4. Conclusion

From present study it is concluded that imidacloprid and nitenpyram were highly effective as compared to the other insecticides and can be recommended to growers for the management of sucking insect pest complex of cotton. The plots treated with these insecticides also produced comparatively more seed cotton yield than other treated plots and also out yielded the control treatment.

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