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Bioefficacy of Newer Insecticides against Cotton Leafhopper, *Amrasca biguttula biguttula* (Ishida) under HDPS & Normal Planting Methods

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ABSTRACT: The field study was conducted in the year 2021 during *Kharif* to determine the efficacy of selected new molecule insecticides against Leafhopper, *Amrasca biguttula biguttula* (Ishida) population in Cotton at Regional Agricultural Research Station(RARS), Palem, PJTSAU, Telangana, India. Due to the continuous and indiscriminate use of synthetic insecticides, there is resistance development in insects and hence the efficacy has become less reliable. To overcome this problem, the discovery of novel substances with different biochemical targets were needed, which are effective at lower doses and have less exposure to the environment.The study revealed that all the treatments were effective in reducing the leafhopper population as compared to control. Flonicamid 50 WG @ 150 gha^{-1} in HDPS (97.070 per cent) in case of Normal planting (89.620 per cent), which was shown most effective treatment indicating a reduction in the population of leafhoppers and it was followed by Afidopyropen 50 OD 1000 ml ha^{-1} and Acetamiprid 20 SP @ 150g ha^{-1}, respectively. The highest Cotton yield was recorded from Flonicamid 50 WG@150 gha^{-1} in HDPS (33.178 q ha^{-1}) and Normal planting (22.753 q ha^{-1}) followed by Afidopyropen 50 OD @ 1000 ml ha^{-1} and the least Cotton yield was obtained in Cyantraniliprole 10.26 OD @ 500 ml ha^{-1}. The highest Cost Benefit Ratio was achieved with Acetamiprid (Rs. 1:93.81), followed by Imidacloprid (Rs. 1:76.01). The Cotton growers can make an alternative spray of tested insecticides for the management of the Cotton Leafhopper population.

Keywords: Bioefficacy, Cotton, Cost Benefit Ratio, Flonicamid, HDPS, Leafhopper, Yield.

INTRODUCTION

Cotton (*Gossypium* spp) is commonly known as "White gold" of India. In India Cotton is cultivated on a 12.2 million ha area with a production of 347.05 lakh bales (170kg) and a productivity of 484 kg lint/ha^{-1} (Sarma *et al.,* 2021). In India, Telangana has the largest acreage of 20.51 lakh ha with production and productivity of 65.87 lakh bales and 545.97 kg ha^{-1}, respectively (Agriculture Statistics at Glance, 2021-2022). *Bt*-Cotton is more susceptible to attack by sucking insect pest complex *viz*., Leafhoppers, *Amrasca biguttula biguttula* (Ishida); Aphids, *Aphis gossypii* (Glover); Thrips, *Thrips tabaci* (Lindeman) and Whiteflies, *Bemisia tabaci* (Gennadius) compared to Desi Cotton. Cotton has been attacked by around 162 species of insects and mites in India, Pest control is necessary for a higher cotton output since pests damage the crop and diminish yield. Due to the Leafhopper, *Amrasca biguttula biguttula* damage estimated yield loss was reported at about 18.78 percent, whereas due to the sucking pests damage estimated yield loss decreased by about 8.45 q/ha (Sarma *et al.,* 2021). Among all other sucking pests, the cotton leafhopper is an alarming pest throughout the season both the nymphs and adult stages harm the plants by sucking the sap from leaves and transmitting various viruses and causing phytotoxic symptoms known as hopper burn which results in complete desiccation and has become one of the limiting factors in economic productivity of the crop, reducing the growth and yield. Leafhoppers are undoubtedly more severe among the many destructive sucking pests of cotton. Hence, suitable techniques to manage the sucking pest population on transgenic cotton are needed (Bheemanna *et al.,* 2015). Due to the continuous and indiscriminate use of synthetic insecticides, there is resistance and hence the efficacy has become less reliable. To overcome this problem discovery of novel substances with different biochemical targets are needed. Novel molecules are effective at lower doses and have less exposure to the environment (Udikeri *et al.,* 2010).

Increasing plant density in cotton could be a viable alternative for increasing production and net profits (Naik *et al*., 2017). Plant spacing has a key role in managing optimum plant density according to the requirement of variety under consideration to boost

cotton productivity, especially under irrigated conditions (Nadeem *et al.,* 2010). High-Density Planting System (HDPS) is popularly known as Ultra Narrow Row (UNR) Cotton, which has row spacings less than 20 cm resulting in 2 to 2.5 lakh plants ha^{-1}, while conventional cotton is generally planted in rows at 90 to 100 cm apart it has a plant population of about 1 lakh plants ha^{-1}. The main advantage of UNR spacing is earliness as it needs fewer bolls per plant to achieve the same yield as that of conventional cotton and the crop need not be maintained for the late-formed bolls to mature. Compared to conventionally planted cotton, UNR Cotton plants produce fewer bolls but a higher percentage of total bolls are retained in the first sympodial position than in the second position (Vories and Glover 2006). Adoption of narrow plant spacing with increased plant density may create the congenial condition for sucking pest population build-up in cotton (Singh *et al.,* 2015). In this connection, the present study was carried out to evaluate the per cent reduction of leafhopper population *Bt*-Cotton under the HDPS and normal with different new molecule insecticides.

MATERIALS AND METHODS

The experiment was carried out during *Kharif*, 2021 at Regional Agricultural Research Station (RARS), Palem, PJTSAU, Telangana. The field experiment was laid out in Split Plot Design (SPD) with a plot size of 500 $m^2$with eight treatments, each replicated thrice, the size of each treatment plot was 6.0 m × 5.0 m (30m^2). The spacing between row to row and plant to plant was kept 75 cm × 10 cm (HDPS) and 90 cm × 60 cm (Normal) respectively. Cotton hybrid NCS-2778 is the test hybrid chosen for the present investigation. To determine the efficacy of insecticides, two sprays on *Bt-cotton* were applied. The first spray was carried out based on the Economic Threshold Level (ETL) of leafhoppers and the second spray was followed by subsequently after 10 days interval. The pre-count (1 day before spray) and post-count (3rd and 7th days after spray) of the leafhopper population was recorded by counting the top 3 open leaves of five randomly selected plants of each plot and per cent population reduction over control was calculated.

Table 1: Details of treatments used against cotton leafhoppers.

Main plot treatments		Subplot treatments	
M1	HDPS with spacing (75 cm × 10 cm)	T1	Afidopyropen 50% OD @ 2ml/L
M2	Normal with spacing (90 cm × 60 cm)	T2	Cyantraniliprole 10.26% OD @ 1ml/L
		T3	Clothianidin 50 WDG @ 0.3 g/L
		T4	Diafenthiuron 50% WP @1.25g/L
		T5	Flonicamid 50% WG @ 0.3g/L
		T6	Acetamiprid 20% SP @0.3g/L
		T7	Imidacloprid 17.8 % SL @ 0.4 ml/L
		T8	Untreated Control

All the molecules under study were applied as a foliar spray using a knapsack sprayer. All recommended package of practices were applied to maintain the good plant stand throughout the crop growth period. Treatments details are given in the table below (Table. 1).

Statistical analysis: The percentage reduction of the pest population in each observation was calculated by using Abbott's formula as given by Flemming and Ratnakaran (1985).

$$\text{Population reduction in percentage (PRP)} = 1 - \frac{Post - TPT}{Pre - TPT} * \frac{Pre - TPC}{Post - TPC} * 100$$

Post treatment population in the treatment = Post-TPT; Pre-treatment population in the treatment = Pre-TPT; Pre-treatment population in control = Pre-TPC; Post-treatment population in control = Post-TPC.

PRP values were transformed into corresponding angular values and subjected to ANOVA using MS-Excel and R studio, respectively.

RESULTS AND DISCUSSION

The results of the study on the efficacy of new molecule insecticides against cotton leafhoppers are presented in the given tables (Table 2). In pre count the average leafhopper population count per five random plants was recorded in the range of 5.956 to 10.563 and 7.06 to 10.10 per 3 leaves in HDPS and Normal planting, respectively. In insecticidal treatments against the leafhopper population varied significantly at all the post-treatment counts of HDPS and Normal planting. HDPS and Normal planting at 3 DAS (days after spraying) the maximum reduction of the pest over control was recorded with 97.265 and 96.995 per cent in Flonicamid 50 WG, respectively and it has shown supremacy over other treatments, these findings are agreement with Kumari *et al*. (2021) who reported that flonicamid 50 WG has showed the reduction of leafhoppers populations effectively than other treatments which was followed by Afidopyropen 50 OD with 96.350 and 92.975 per cent, respectively. Acetamiprid 20 SP with 86.140 and 85.605 per cent, respectively and Clothianidin 50 WDG with 73.215 and 75.145 per cent followed by Imidacloprid 17.8 SL with 68.285 and 64.630 per cent respectively and statistically varied with all other treatments. The minimum reduction of leaf hopper population was observed in Diafenthiuron 50 WP with 58.450 and 57.080 per cent, respectively which was followed by Cyantraniliprole 10.26 OD with 56.475 and 53.480 per cent, respectively.

Table 2: Bioefficacy of different insecticides against cotton leafhoppers, *Amrasca biguttula biguttula*(1st and 2nd sprays) during *Kharif*, 2021.

Treatment	Pre-treatment count		Population no/3leaves/plant*					
			3DAS			7DAS		
	M1	M2	M1	M2		M1	M2	
Afidopyropen 50% OD	8.212 (2.855)	8.375 (2.891)	0.392 (0.624)	0.662 (0.782)		0.771 (0.873)	1.128 (1.062)	
Cyantraniliprole 10.26% OD	5.956 (2.436)	7.451 (2.728)	3.419 (1.842)	4.099 (2.024)		3.8705 (1.960)	5.396 (2.322)	
Clothianidin 50% WDG	6.663 (2.577)	7.294 (2.700)	2.326 (1.524)	2.156 (1.468)		2.784 (1.662)	3.055 (1.748)	
Diafenthiuron 50% WP	8.068 (2.835)	7.065 (2.650)	4.363 (2.087)	3.662 (1.905)		5.488 (2.342)	4.469 (2.111)	
Flonicamid 50% WG	7.000 (2.645)	7.928 (2.812)	0.250 (0.500)	0.269 (0.505)		0.279 (0.512)	1.150 (1.071)	
Acetamiprid 20% SP	8.706 (2.950)	7.125 (2.667)	1.578 (1.256)	1.225 (1.104)		2.373 (1.540)	1.825 (1.346)	
Imidacloprid 17.8 % SL	8.831 (2.967)	7.819 (2.796)	3.706 (1.917)	3.288 (1.812)		4.888 (2.203)	3.794 (1.947)	
Untreated control	10.563 (3.249)	10.102 (3.175)	13.858 (3.720)	12.022 (3.464)		15.229 (3.896)	14.138 (3.755)	
	F test	SEM	CD	F test	SEM	CD	F test	SEM	CD
Main plot	Sig	0.04	0.25	Sig	0.01	0.08	Sig	0.03	0.18
Subplot	Sig	0.03	0.08	Sig	0.01	0.04	Sig	0.02	0.06
Interaction	Sig	0.08	0.23	Sig	0.04	0.11	Sig	0.06	0.17

*Numerical in the parenthesis are the square root transformed values; Sig: Significant; NS: Non-Significant ; DAS: Days After Spraying

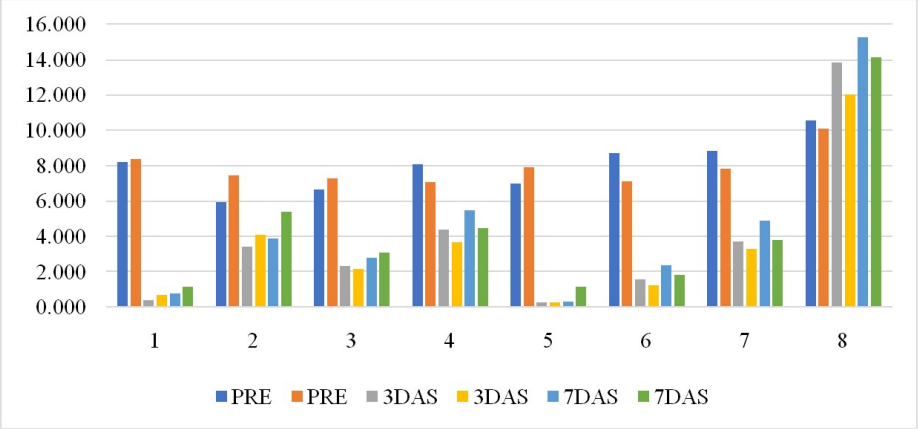

Fig. 1. Bioefficacy of different insecticides against cotton leafhoppers, *Amrasca biguttula biguttula* (1st and 2nd sprays) during *Kharif*-2021.

Table 3: Bioefficacy based on percent population reduction over control of different insecticides against cotton leafhoppers, *Amrasca biguttula biguttula* (1st and 2nd sprays) during *Kharif*, 2021.

Treatment	Per cent population reduction over control**					
	3DAS			7DAS		
	M1	M2		M1	M2	
Afidopyropen 50% OD	96.350 (73.021)[b]	92.975 (70.201)[b]		93.195 (74.875)[b]	90.295 (71.197)[a]	
Cyantraniliprole 10.26% OD	56.470 (58.208)[g]	53.480 (52.536)[f]		54.975 (45.988)[g]	49.595 (43.864)[f]	
Clothianidin 50% WDG	73.215 (65.523)[d]	75.145 (58.621)[d]		71.120 (57.499)[d]	70.005 (56.781)[c]	
Diafenthiuron 50% WP	58.450 (59.675)[f]	57.080 (55.321)[e]		51.635 (47.830)[f]	54.300 (47.418)[e]	
Flonicamid 50% WG	97.265 (78.306)[a]	96.995 (73.601)[a]		97.070 (80.144)[a]	89.620 (71.844)[a]	
Acetamiprid 20% SP	86.140 (67.991)[c]	85.605 (59.841)[c]		81.025 (64.170)[c]	81.810 (64.755)[b]	
Imidacloprid 17.8 % SL	68.285 (63.462)[e]	64.630 (57.785)[d]		61.765 (51.803)[e]	65.310 (53.901)[d]	
	F test	SEM	CD	F test	SEM	CD
Main plot	NS	0.36	---	Sig	0.45	2.72
Subplot	Sig	0.11	0.32	Sig	0.12	0.36
Interaction	Sig	0.29	0.84	Sig	0.33	0.95

**Numerical in the parenthesis is the arcsine transformed values; Sig: Significant ; NS: Non-Significant; DAS: Days After Spraying

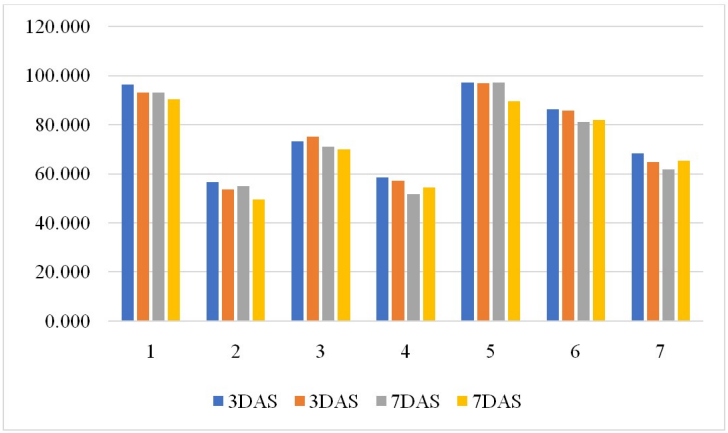

Fig. 2. Column chart of bioefficacy of different insecticides based on percent population reduction over control (1st and 2nd sprays) during *Kharif*, 2021.

In both HDPS and Normal planting 7 DAS (days after spraying), Flonicamid 50 WG was shown supremacy in reducing leafhopper population over control with 97.070 and 89.620 per cent, respectively which was followed by Afidopyropen 50 OD with 93.195 and 90.295 per cent, respectively which was followed by Acetamiprid 20 SP with the 81.025 and 81.810 per cent, respectively and Clothianidin 50 WDG with reduction of 71.120 and 70.005 per cent, respectively. The minimum reduction of leafhopper population was observed in Imidacloprid 17.8 SL with the reduction of 61.765 and 65.310 per cent, respectively which is followed by Diafenthiuron 50 WP with 51.635 and 54.300 per cent and Cyantraniliprole 10.26 OD with the reduction of 54.975 and 49.595 per cent, respectively these are found to be least effective but significantly and statistically superior over the control. The present study results are comparable with the findings of Meghana *et al*. (2018) who reported that maximum mortality of jassids was found in Flonicamid treated plots. Baraskar and Paradkar (2020) reported that Flonicamid 50WG was effective in controlling the cotton leafhopper population. Similar results are also reported by Bharpoda *et al*. (2014) and the results derive support from the findings of Nemade *et al*. (2017) reported that Flonicamid gives the best results by lowering the leafhoppers population. Kadam *et al*. (2014) reported that Clothianidin and Imidacloprid were affecting reducing the populations of leafhoppers and the present findings are in line with the findings of Suman *et al.* (2021) reported that the Afidopyropen was found to be effective against leafhopper population.

Table 4: Effect of different insecticides on Cotton yield in HDPS and Normal planting and Incremental Benefit: Cost Ratio (ICBR) for analysis of insecticidal treatments.

Treatments	Conc. (g a.i ha^{-1})	Cotton Yield (q ha^{-1}) HDPS	Cotton Yield (q ha^{-1}) Normal	Incremental yield over control (q ha^{-1})	Value of incremental yield over control (q ha^{-1})	Cost of treatments (Rs ha^{-1})	Incremental net profit	Incremental Cost: Benefit ratio
Afidopyropen 50% OD	1000	29.808^{b}	22.434^{a}	7.373	57874.125	3500	54374.125	1:16.535
Cyantraniliprole 10.26% OD	500	20.608^{d}	17.435^{c}	3.178	24943.375	5288	19655.875	1:4.717
Clothianidin 50% WDG	150	25.240^{c}	17.778^{c}	7.463	58580.625	2563	56018.125	1:22.861
Diafenthiuron 50% WP	625	24.730^{c}	20.618b	4.113	32283.125	3125	29158.125	1:10.331
Flonicamid 50% WG	150	33.178^{a}	22.753^{a}	10.425	81836.250	2000	79836.250	1:40.918
Acetamiprid 20% SP	150	25.795^{c}	19.820^{b}	5.975	46903.750	500	46403.750	1:93.808
Imidacloprid 17.8 % SL	250	24.803^{c}	18.025^{c}	6.778	53203.375	700	52503.375	1:76.005
Control		18.548^{e}	15.968^{d}	2.580	20253.000			
SEm±		0.358		—	—	—	—	—
CD		1.037		—	—	—	—	—

Yield. The data on (Table 4) Cotton yield in HDPS and Normal spacing revealed that all the insecticidal treatments registered significantly higher cotton yield over untreated control. Among the all treatments, Flonicamid 50 WG @ 150gha^{-1} recorded higher cotton yield (33.18 q ha^{-1})and (22.76 q ha^{-1}) respectively, followed by Afidopyropen 50OD @ 1000 mlha^{-1} (29.88 q ha^{-1}) and (22.43 q ha^{-1}), respectively and were on par with each other. The leastcotton yield was obtained in Cyantraniliprole 10.26 OD @ 500 ml ha^{-1} (20.68 q ha^{-1}) and (17.44 q ha^{-1}), respectively. The highest Cost-Benefit Ratio was achieved with Acetamiprid (Rs. 1:93.81) and which was followed by Imidacloprid (Rs.

1:76.01) which is followed by Flonicamid (Rs.1:40.92), respectively.

CONCLUSION

Based on the findings of the present study, it can be inferred that the insecticide Flonicamid 50WP @ 150gha^{-1} was found to be most effective against the leafhopper population. Next, best treatment was Afidopyropen 50 OD @ 1000 mlha^{-1}. These are the best chemical insecticides for control of the cotton leafhoppers population under both the HDPS and Normal planting conditions.

FUTURE SCOPE

Considering the importance of cotton sucking pests, suitable and effective insecticides with different mode of actions and less persistent insecticides should be selected based on the field investigations.

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Conflict of interest. None.

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