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Field Efficacy of Novel Insecticide Afidopyropen against Leafhopper, *Amrasca biguttula biguttula* and Whitefly, *Bemisia tabaci* in Cotton

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***Abstract*:** Field trials were conducted to assess the efficacy of the novel insecticide afidopyropen against major sucking pests of cotton, *Amrasca biguttula biguttula* (Ishida) and *Bemisia tabaci* (Gennadius) during the 2020 and 2021 cropping seasons at Hisar (Haryana). Two foliar sprays of each treatment, including standard checks, were applied, and observations on target pests were recorded at 1, 3, 5, 7, and 10 days after each spray. Afidopyropen @ 50 g a.i./ha significantly reduced the target pest populations in both years, recording the lowest leafhopper (0.80 and 0.86 nymphs/leaf) and whitefly (21.13 and 2.88 adults/leaf) densities, along with the highest seed cotton yields (26.86 and 22.29 q/ha) in 2020 and 2021, respectively. Populations of natural enemies, including coccinellids and spiders, were not significantly affected, and no phytotoxic symptoms were observed on cotton. These findings reveal that afidopyropen is a highly effective, selective, and crop-safe insecticide suitable for inclusion in integrated pest management programs for sustainable cotton cultivation.

***Keywords*:** Afidopyropen, Cotton, Efficacy, Novel insecticide, Natural enemies, Sucking pests

Cotton is one of the most important cash and fibre crops in India, which is grown over an area of 12-13 million hectares with production of approximately 35-38 million bales. Haryana is one of the important cotton-growing states in India which occupied 6.48 lakh hectares area under its cultivation in 2022 (Department of Agriculture & Farmers Welfare, Haryana 2022). The majority of farmers grow *Bt* cotton which was commercialized to protect the crop from the attack of bollworms. On the other hand, *Bt* cotton suffers due to the ravages of sucking insect-pests, namely cotton leafhopper/jassid, whitefly and thrips. They damage cause substantial yield losses and degrade cotton fiber quality, increasing the need for targeted pest management practices despite the advantages offered by *Bt* cotton against chewing pests (Ali and Farooq 2018). Although several insecticides have been recommended for their management from time to time. But frequent and indiscriminate use of these insecticides led to the tolerance and development of resistance among sucking pest populations (Mahalanobish et al., 2022), highlighting the urgent need for novel chemistries with unique modes of action.

Afidopyropen, a novel insecticide, is a derivative of pyripyropene A, which is produced by the filamentous fungus *Penicillium coprobium* has strong insecticidal activity against aphids and is currently used as a control agent of sucking pests worldwide (Ryo et al., 2022). Afidopyropen modulates the transient receptor potential vanilloid (TRPV) channels in insect chordotonal organs (Horikoshi et al., 2025, Li et al., 2022), thereby disrupting feeding behavior in sap-sucking insects (Saito et al., 2014, Matsuda et al., 2020) and showed excellent insecticidal activities against common aphid species, such as green peach aphid (*Myzus persicae*), cotton aphid (*Aphis gossypii*) and bean aphid (*A. craccivora*), that damage a variety of vegetables, fruit trees, tea trees and ornamentals by sucking sap from leaves (Zhou et al., 2023, Zha et al., 2024,). Furthermore, it showed good activities against whiteflies *(Trialeurodes vaporariorum* and *B. tabaci*), mealybugs (*Pseudococcus comstocki)*, leafhoppers (*Empoasca onukii*) and psyllids and exhibited good efficacies against these insect pests in field trials, while decreasing crop damage (Ryo et al., 2022). In addition, afidopyropen shows low toxicity levels against honeybees and natural enemies, as well as against mammals. Because of environmental dynamics, afidopyropen is expected to be an eco-friendly tool for sustainable agriculture. Therefore, the present study was devised to evaluate afidopyropen 50 g/l DC formulation for its bioefficacy against leafhopper and whitefly infesting cotton and safety against natural enemies and phytotoxicity on cotton crop during *kharif* 2020 and 2021.

MATERIAL AND METHODS

The field experiments on bioefficacy of afidopyropen 50 g/l DC against leafhopper and whitefly on cotton were conducted for two consecutive years during *Kharif* 2020 and 2021 at Research Area, Department of Genetics and Plant Breeding (Cotton Section), CCS HAU, Hisar. The experiments were conducted in Randomized Block Design with six treatments and four replications. Afidopyropen 50 g/l

DC was evaluated at its three different doses (25, 35 and 50 g a.i./ha) against leafhopper and whitefly. Thiamethoxam 25% WG (25 g a.i./ha) and dimethoate 30% EC (225 g a.i./ha) were kept as standard checks for leafhopper and whitefly whereas one untreated control was also kept. One additional treatment was also kept for recording the observations on phytotoxicity of afidopyropen 50 g/l DC @ 100 g a.i./ha with three replications. The plot size was kept as 21.87 sq. m and plant spacing was maintained at 67.5×30 cm (row×plant). Non-Bt cotton crop variety, H 1098i (*Gossypium hirsutum*) was sown on May 9, 2020 and May 12, 2021 and the crop was maintained by following recommended Package of Practices except for insect-pest management. The insecticide application was initiated after crossing the economic thresholds for leafhopper (2 nymphs/leaf) and whitefly (6-8 adults/leaf) using battery operated knapsack sprayer and spray volume was kept @ 500 liters/ha. Cotton crop was sprayed with respective treatments on 16th and 28th July during 2020 and 7th and 19th August during 2021.

The observations on leafhopper nymphs and whitefly adults were recorded before spray and 1, 3, 5, 7 and 10 days after each spray from three leaves (upper, middle and lower canopy) each of five randomly selected and tagged plants per replication. The observations on natural enemies including coccinellids and spiders were also recorded on above five tagged plants. Phytotoxicity observations like chlorosis, necrosis, wilting, scorching, hyponasty and epinasty were also recorded after first spray in afidopyropen 50 g/l DC @ 50 and 100 g a.i./ha and untreated control. Picking of seed cotton was done at appropriate boll opening stage and yield was recorded in kg/plot and converted into q/ha. The population data was subjected to square root transformation before processing for analysis of variance using OPSTAT software (Sheoran et al., 1998).

RESULTS AND DISCUSSION

Efficacy against leafhopper, *A. biguttula biguttula:* Based on the mean of all sprays, the population of leafhopper varied from 0.80 to 3.15 nymphs/leaf and 0.86 to 3.45 nymphs/leaf during 2020 and 2021, respectively (Table 1). During both years, the population of leafhoppers showed non-significant differences among the treatments before spray. All the insecticide treatments significantly suppressed the population of leafhoppers at 1, 3, 5, 7 and 10 days after spray during both years. Treatment with afidopyropen 50 g/l DC @ 50 g a.i./ha resulted in the significantly lowest population of leafhopper, *i.e.,* 0.80 and 0.86 nymphs/leaf during 2020 and 2021, respectively.

Efficacy against whitefly, *B. tabaci:* The mean population of whitefly varied from 21.13 to 44.10 adults/leaf and 2.88 to 9.29 adults/leaf during 2020 and 2021, respectively (Table 1). Before spray, the whitefly population did not vary significantly across the treatments during both the years. All the insecticide treatments significantly suppressed the population of whitefly at 1, 3, 5, 7 and 10 days after spray during both years. Among the treatments, the lowest population of whitefly was recorded in afidopyropen 50 g/l DC @ 50 g a.i./ha*i.e.,* 21.13 and 2.88 adults/leaf during 2020 and 2021, respectively.

The superior efficacy of afidopyropen may be attributed to its rapid feeding cessation and prolonged residual activity, which effectively suppresses pest resurgence. Its unique mode of action targeting TRPV channels likely confers efficacy even against insect populations showing resistance to conventional neonicotinoids and organophosphates (Saito et al., 2014, Matsuda et al., 2020). Field evaluations confirmed that afidopyropen significantly suppressed *A. biguttula biguttula* (Kumar et al., 2022) and whitefly populations in cotton, comparable to or better than other insecticides (Sharma et al., 2019, Kumar et al., 2022). Sharma et al. (2019) also support the superior efficacy of afidopyropen among newer insecticides against sucking pests of cotton.

Effect on natural enemies: Natural enemies including coccinellids and spiders were recorded after each spray on cotton during both years and the pooled data are presented in

Table 1. Effect of afidopyropen and other insecticidal treatments against leafhopper, whitefly and seed cotton yield

Treatments	Dose (g a.i./ha)	Leaf hopper (No. of nymphs/leaf)			Whitefly (No. of adults/leaf)			Seed cotton yield (q/ha)		
		2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
Afidopyropen 50 g/l DC	25	1.95	1.82	1.86	34.58	5.89	20.23	21.95	19.20	20.58
Afidopyropen 50 g/l DC	35	1.40	1.38	1.39	27.49	5.17	16.33	24.01	20.12	22.06
Afidopyropen 50 g/l DC	50	0.80	0.86	0.83	21.13	2.88	12.01	26.86	22.29	24.58
Thiamethoxam 25% WG	25	1.52	1.74	1.63	33.14	6.06	19.6	22.41	20.00	21.20
Dimethoate 30% EC	225	1.82	1.94	1.88	30.24	5.05	17.65	22.52	19.89	21.20
Untreated control	-	3.15	3.45	3.30	44.10	9.29	26.69	20.35	18.06	19.20
CD (p=0.05)		0.05	0.07	0.06	0.17	0.08	0.13	1.99	1.72	1.73

Table 2. Effect of afidopyropen and other insecticidal treatments on the population of natural enemies in cotton

Treatments	Population of spiders (per plant)	Population of coccinellids (per plant)
Afidopyropen 50 g/l DC @ 25 g a.i./ha	0.48	0.32
Afidopyropen 50 g/l DC @ 35 g a.i./ha	0.42	0.28
Afidopyropen 50 g/l DC @ 50 g a.i./ha	0.40	0.29
Thiamethoxam 25% WG @ 25 g a.i./ha	0.35	0.27
Dimethoate 30% EC @ 225 g a.i./ha	0.40	0.33
Untreated control	0.53	0.39
CD (p=0.05)	(NS)	(NS)

Table 2. Non-significant differences were observed in the population of spiders and coccinellids before and after 1, 3, 5, 7 and 10 day(s) of spray during both years. Patil et al. (2017) reported that afidopyropen was not only effective in reducing whitefly incidence but also compatible with natural enemies, making it a suitable candidate for use in integrated pest management (IPM) programs. The lower population levels observed in the current study, particularly in 2021, may also be attributed to favourable environmental conditions for insecticide performance and timely applications. The non-significant differences in coccinellid and spider populations before and after insecticidal sprays indicate that afidopyropen is selective in its activity and does not adversely affect non-target beneficial arthropods. Patil et al. (2017) also observed that afidopyropen was safe to key predators such as coccinellids and spiders when applied in cotton fields, highlighting its suitability for integrated pest management (IPM) programs for sustainable cotton production.

Seed cotton yield: Maximum seed cotton yield was obtained with afidopyropen 50 g/l DC @ 50 g a.i./ha during 2020 (26.86 q/ha) and 2021 (22.29 q/ha), which was significantly superior over rest of the treatments. Rest of the treatments except afidopyropen 50 g/l DC @ 25 g a.i./ha resulted in non-significant increase in yield over untreated control during both years.The significantly higher seed cotton yield recorded with afidopyropen 50 g/l DC @ 50 g a.i./ha in both years can be attributed to its superior efficacy in suppressing key sap-sucking pests like leafhoppers and whiteflies. This reduction in pest pressure likely minimized crop damage and improved plant vigor and boll retention, leading to better yield outcomes. Kumar et al. (2022) also reported a significant increase in cotton yield following afidopyropen application due to its quick action and prolonged protection. Sharma et al. (2019) observed a positive correlation between the reduction in sucking pest population and seed cotton yield enhancement.

Phytotoxicity: Phytotoxicity studies revealed that there were no phytotoxicity symptoms such as chlorosis, necrosis, wilting, scorching, hyponasty and epinasty were observed at either afidopyropen 50 g/l DC @ 50 or 100 g a.i./ha at 1, 3, 5, 7 and 10 day(s) after first spray on cotton during both years. The absence of phytotoxicity symptoms throughout the observation period clearly indicated the crop safety of afidopyropen at both tested doses. No adverse effects on cotton plants were observed even at higher application rates, suggesting a wide margin of safety for this insecticide. Sharma et al. (2019) also reported no visible phytotoxic effects of afidopyropen in cotton trials conducted across multiple locations. Additionally, the phytotoxicity evaluations conducted by Saito et al. (2014) in other crops supported afidopyropen's favorable environmental and plant safety profile.

CONCLUSION

Afidopyropen 50 g/l DC @ 50 g a.i./ha consistently provided the most effective control of *A. biguttula biguttula* and *B. tabaci*, resulting in the lowest pest densities and highest seed cotton yields. Its high selectivity, absence of phytotoxicity, and compatibility with natural enemies highlight its potential as a sustainable insecticidal option within integrated pest management (IPM) frameworks for cotton.

AUTHOR'S CONTRIBUTION

AJ: Methodology, performed experiments: AJ and PR: Data analysis, wrote original draft, AJ, AKR, KSM, SL: Conceptualization, designed the research, Supervision and Review, AJ, SL, PR: Review, editing. All authors read and approved the manuscript.

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