RESEARCH ARTICLE Legume Research- An International Journal, Volume 48 Issue 10: 1789-1794 (October 2025)

Efficacy of Insecticides in the Management of Whiteflies, Vector of Blackgram Yellow Mosaic Disease

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10.18805/LR-5523

ABSTRACT

Background: Blackgram (*Vigna mungo* L.), commonly known as urdbean in India, belongs to the *Leguminosae* family. Yellow mosaic disease (YMD) caused by Mungbean Yellow Mosaic Virus (MYMV) stands out as the most serious disease and a significant bottleneck for blackgram cultivation and production. Henceforth, an attempt was made to know the effective insecticide for the management of whiteflies transmitting YMD in blackgram.

Methods: The field experiment was conducted on management of whiteflies vectoring YMD of blackgram by using different combination of insecticides during *kharif* 2023 at College of Agriculture, Vijayapur, UAS, Dharwad by using randomized complete block design (RCBD).

Result: Seed treatment with imidacloprid 600 FS @ 5 ml/kg seed + foliar spray of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l achieved the highest reduction of whitefly population over control of 83.63, 91.05 and 94.10 per cent at 30 DAS, 45 DAS and 60 DAS, respectively. It also resulted in the lowest disease incidence of 13.42, 17.55, 20.80 and 24.78 per cent at 30 DAS, 45 DAS, 60 DAS and 90 DAS (physiological maturity), respectively. Additionally, it produced the maximum yield of 7.87 q/ha with the highest B: C ratio of 2.89.

Key words: Blackgram, Management, Whitefly, YMD.

INTRODUCTION

Blackgram (*Vigna mungo* L.), commonly known as urdbean in India, belongs to the *Leguminosae* family. The crop being a legume, also aids in the process of atmospheric nitrogen fixation into the soil (Archana *et al.,* 2018). Blackgram cultivation is prevalent in Bangladesh, Afghanistan, Myanmar, Pakistan, Sri Lanka, Thailand and Vietnam. Its maturity typically occurs within 90-100 days (Swaminathan *et al.,* 2023). India holds the title of the world's largest producer of blackgram, with cultivation spanning around 40.02 lakh hectares, resulting in a production of 26.31 lakh tonnes and a productivity rate of 657 kg/ha (Swapna and Prema, 2024). In India, the blackgram cultivating states include Andhra Pradesh, Bihar, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. In Karnataka, it is cultivated across roughly 0.71 lakh hectares, with a production of 0.33 lakh tonnes and a productivity rate of 466 kg/ha. Notable blackgram cultivating districts in Karnataka include Kalburgi, Bidar, Mysuru, Belagavi, Dharwad, Bagalkot and Vijayapur (Anonymous, 2023).

Yellow mosaic disease (YMD) caused by mungbean yellow mosaic virus (MYMV) stands out as the most serious disease and a significant bottleneck for blackgram cultivation and production (Prema and Rangaswamy, 2018; Swapna *et al.,* 2025). MYMV is a single-stranded DNA virus belonging to the genus Begomovirus within the family *Geminiviridae* (Appu and Prema, 2024). In India, Nariani (1960) initially documented MYMV in mungbean fields at the Indian Agricultural Research Institute (IARI) in New Delhi during the 1950s. The disease is transmitted by the hemipteran whitefly, *Bemisia tabaci* (Gennadius), in a persistent circulative manner and is not transmitted through seeds, soil or sap (Nair and Nene, 1973; Prema and Rangaswamy, 2020; Sonam *et al.,* 2024).

The symptoms of the disease manifest as small yellow flecks in the veinlets of leaves, subsequently developing more prominent and irregular yellow and green patches, alternating with each other. In susceptible genotypes, affected plants produce only a few pods that are smaller in size and deformed (Prema and Rangaswamy, 2018a; Prema and Rangaswamy, 2020a). The degree of yield loss largely depends on the age of the plant at the time of infection and the severity of the disease (Naimuddin *et al.,* 2011; Sonam *et al.,* 2025). The YMD

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How to cite this article: Swapna, B.V. and Prema, G.U. (2025). Efficacy of Insecticides in the Management of Whiteflies, Vector of Blackgram Yellow Mosaic Disease. *Legume Research.* **48(10):** 1789-1794. doi: 10.18805/LR-5523.

Submitted: 23-05-2025 **Accepted:** 21-07-2025 **Online**: 02-08-2025

causes 85-100 per cent yield loss in the plants that are infected at the seedling stage (Nene, 1972).

The development of resistant cultivars, managing weed hosts along with insect vector and altering crop cultural techniques are among the YMD management strategies (Prema, 2013). The only quick available technique of managing viruses is to use insecticides against their vectors. With this background, the present study is aimed to identify the best insecticides in the management whiteflies, vector of YMD of blackgram by implying seed treatment as well as foliar spraying.

MATERIALS AND METHODS

To know the effectiveness of different insecticides against whiteflies transmitting blackgram YMD, the experiment was conducted during *kharif*, 2023 in a randomized complete block design (RCBD) with eleven treatments and three replications at College of Agriculture, Vijayapur with plot size of 3 m × 3 m. The blackgram genotype DBGV-5 was used in the present experimentation. Various insecticides were applied on plants at 30 days after sowing, with subsequent applications at 15 days interval (three times in total) (Table 1). The total count of adult whitefly population was recorded one day prior to each spray, one day after each spray, three days after each spray, five days after each spray, seven days after each spray, the mean value was calculated and final observations were made at physiological maturity. The incidence of blackgram yellow mosaic disease was documented one day before each spray, with final observations made at physiological maturity. Yield data was also recorded and subjected to statistical analysis. Duncan's multiple range test (DMRT) analysis was carried out using online statistical analysis tools (OPSTAT) software to compare treatment means.

RESULTS AND DISCUSSION

Effect of different insecticides on the whitefly population transmitting YMD in blackgram at different intervals

At all spray schedules, seed treatment (ST) with imidacloprid 600 FS @ 5 ml/kg seed + foliar spray (FS) of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l achieved the highest per cent reduction of whitefly population over the control. After third spray (60 DAS), the results revealed that ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l recorded highest per cent reduction of whitefly population over control (94.10%), followed by ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 30.5% SC @ 0.3 ml/l (87.07%), ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 70% WG @ 0.2 g/l) (86.66%), ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of afidopyrofen 5% DC @ 2 ml/l (85.83%). The next best treatments were ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of thiamethoxam 25% WG @ 0.2 g/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of fipronil 5% SC @ 1 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of flonicamid 50% WG @ 0.5 g/l, FS of imidacloprid 30.5% SC @ 0.3 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of dimethoate 30% EC @ 1.7 ml/l and ST with imidacloprid 600 FS @ 5 ml/kg seed, which recorded per cent reduction of 85.39, 83.96, 82.50, 80.95, 80.23 and 41.00 per cent, respectively (Table 2).

At physiological maturity, the results revealed that ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l recorded highest per cent reduction of whitefly population over control (92.07%), followed by ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 30.5% SC @ 0.3 ml/l (85.96%), ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 70% WG @ 0.2 g/l (85.54%), ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of afidopyrofen 5% DC @ 2 ml/l (84.44%). The next best treatments were ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of thiamethoxam 25% WG @ 0.2 g/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of fipronil 5% SC @ 1 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of flonicamid 50% WG @ 0.5 g/l, FS of imidacloprid 30.5% SC @ 0.3 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of dimethoate 30% EC @ 1.7 ml/l and ST with imidacloprid 600 FS @ 5 ml/kg seed, which recorded per cent reduction of 83.06, 81.28, 80.58, 78.45, 77.85 and 36.35 per cent, respectively (Table 2).

Table 1: Different insecticides used for the management of whiteflies, vector of YMD infecting blackgram.

Treatments	Dosage	Method and time of application
ST with Imidacloprid 600 FS	5 ml/kg seed	ST at the time of sowing
ST + FS of Thiamethoxam 25% WG	0.2 g/l	FS at 30, 45 and 60 DAS
ST + FS of Fipronil 5% SC	1 ml/l	FS at 30, 45 and 60 DAS
FS of Imidacloprid 30.5% SC	0.3 ml/l	FS at 30, 45 and 60 DAS
ST + Foliar spray of Imidacloprid 30.5% SC	0.3 ml/l	FS at 30, 45 and 60 DAS
ST + FS of Imidacloprid 70% WG	0.2 g/l	FS at 30, 45 and 60 DAS
ST + FS of Flonicamid 50% WG	0.5 g/l	FS at 30, 45 and 60 DAS
ST + FS of Pyriproxifen 5% + Difenthuron 25% SE	2 ml/l	FS at 30, 45 and 60 DAS
ST + FS of Afidopyrofen 5% DC	2 ml/l	FS at 30, 45 and 60 DAS
ST + FS of Dimethoate 30% EC	1.7 ml/l	FS at 30, 45 and 60 DAS
Control	-	-

*DAS- Days after sowing; Seed treatment- ST; Foliar spray- FS.

Table 2: Effect of different insecticides on whitefly population transmitting YMD in blackgram at 30 DAS, 45 DAS, 60 DAS and at physiological maturity.

Treatments	Whitefly population per plant (30 DAS)		Per cent reduction of whitefly population over control (30 DAS)	Whitefly population per plant (45 DAS)		Per cent reduction of whitefly population over control (45 DAS)	Whitefly population per plant (60 DAS)		Per cent reduction of whitefly population over control (60 DAS)	Whitefly population per plant (at physiological maturity)	Per cent reduction of whitefly population over control at harvest
	1 DBS	Mean of 1 DAS, 3 DAS, 5 DAS and 7 DAS		1 DBS	Mean of 1 DAS, 3 DAS, 5 DAS and 7 DAS		1 DBS	Mean of 1 DAS, 3 DAS, 5 DAS and 7 DAS			
ST with Imidacloprid 600 FS	6.37^{a} (2.62)*	4.23^{e} (2.17)	52.93	5.13^{c} (2.37)*	6.26^{e} (2.60)	43.14	6.34^{e} (2.62)*	6.79^{f} (2.70)	41.00	7.88^{f} (2.90)*	36.35
ST + FS of Thiamethoxam 25% WG	6.69^{cd} (2.68)	3.08^{c} (1.89)	65.70	4.86^{b} (2.32)	2.08^{c} (1.61)	81.12	3.48^{c} (1.99)	1.68^{bc} (1.48)	85.39	2.10^{bcd} (1.61)	83.06
ST + FS of Fipronil 5% SC	6.87^{bcd} (2.71)	3.19^{c} (1.92)	64.43	4.11^{c} (2.15)	2.25^{c} (1.66)	79.53	3.71^{c} (2.05)	1.85^{cd} (1.53)	83.96	2.32^{cde} (1.68)	81.28
FS of Imidacloprid 30.5% SC	8.05^{e} (2.92)	3.73^{d} (2.06)	58.49	5.01^{c} (2.35)	2.67^{d} (1.78)	75.72	4.36^{d} (2.21)	2.19^{de} (1.64)	80.95	2.67^{e} (1.78)	78.45
ST + Foliar spray of Imidacloprid 30.5% SC	6.28^{a} (2.60)	1.82^{ab} (1.52)	79.79	3.69^{ab} (2.05)	1.10^{a} (1.27)	90.00	2.68^{b} (1.78)	1.49^{b} (1.41)	87.07	1.74^{b} (1.50)	85.96
ST + FS of Imidacloprid 70% WG	6.93^{d} (2.73)	1.91^{b} (1.55)	78.75	3.74^{ab} (2.06)	1.22^{a} (1.31)	88.88	2.74^{b} (1.80)	1.54^{bc} (1.43)	86.66	1.79^{b} (1.51)	85.54
ST + FS of Flonicamid 50% WG	6.90^{d} (2.72)	3.26^{c} (1.94)	63.76	5.00^{c} (2.34)	2.28^{c} (1.67)	79.32	3.85^{c} (2.09)	2.01^{de} (1.59)	82.50	2.41^{de} (1.70)	80.58
ST + FS of Pyriproxifen 5% + Difenthuron 25% SE	6.57^{ab} (2.66)	1.47^{a} (1.40)	83.63	3.34^{a} (1.96)	0.99^{a} (1.22)	91.05	2.07^{a} (1.60)	0.68^{a} (1.09)	94.10	0.98^{a} (1.22)	92.07
ST + FS of Afidopyrofen 5% DC	6.59^{abc} (2.66)	2.09^{b} (1.61)	76.71	3.89^{b} (2.09)	1.74^{b} (1.50)	84.18	3.00^{b} (1.87)	1.63^{bc} (1.46)	85.83	1.93^{bc} (1.56)	84.44
ST + FS of Dimethoate 30% EC	6.89^{d} (2.72)	3.92^{de} (2.10)	56.38	5.08^{c} (2.36)	2.83^{d} (1.83)	74.26	4.41^{d} (2.22)	2.28^{e} (1.67)	80.23	2.74^{e} (1.80)	77.85
Control	8.45^{f} (2.99)	8.98^{f} (3.08)		10.12^{d} (3.26)	11.01^{f} (3.39)		11.01^{f} (3.39)	11.51^{g} (3.47)		12.39^{g} (3.59)	
SEm±	0.09	0.11		0.15	0.11		0.15	0.11		0.13	
CD@5%	0.28	0.32		0.43	0.33		0.44	0.32		0.38	

*Figures in parenthesis are square root transformed values; DBS: Days before spray; DAS: Days after spray.

Note: No spray was given for T1; Seed treatment- ST; Foliar spray- FS.

Effect of different insecticides on the incidence of YMD in blackgram

At all spray schedules, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l recorded the lowest disease incidence. At 60 DAS, the results revealed that ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l recorded lowest disease incidence of 22.23 per cent, followed by ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 30.5% SC @ 0.3 ml/l (25.88%), ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 70% WG @ 0.2 g/l (26.15%), ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of afidopyrofen 5% DC @ 2 ml/l (27.35%). The next best treatments were ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of thiamethoxam 25% WG @ 0.2 g/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of fipronil 5% SC @ 1 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of flonicamid 50% WG @ 0.5 g/l, FS of imidacloprid 30.5% SC @ 0.3 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of dimethoate 30% EC @ 1.7 ml/l and ST with imidacloprid 600 FS @ 5 ml/kg seed with disease incidence of 28.77, 30.67, 31.78, 34.79, 37.62 and 63.32 per cent, respectively. The per cent disease incidence recorded in T11 (control) was 69.78 per cent.

At physiological maturity, the results revealed that ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l recorded lowest disease incidence of 24.78 per cent, followed by ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 30.5% SC @ 0.3 ml/l (27.65%), ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 70% WG @ 0.2 g/l (27.88%), ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of afidopyrofen 5% DC @ 2 ml/l (28.28%). The next best treatments were ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of thiamethoxam 25% WG @ 0.2 g/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of fipronil 5% SC @ 1 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of flonicamid 50% WG @ 0.5 g/l, FS of imidacloprid 30.5% SC @ 0.3 ml/l), ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of dimethoate 30% EC @ 1.7 ml/l and ST with imidacloprid 600 FS @ 5 ml/kg seed with disease incidence of 30.15, 31.22, 33.57, 36.42, 39.57 and 65.32 per cent, respectively. The per cent disease incidence recorded in T11 (control) was 81.22 per cent.

Effect of different insecticides on the average disease incidence of YMD infecting blackgram

Out of the eleven treatments, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l recorded lowest disease incidence at different days after sowing with average disease incidence of 20.60 per cent and per cent reduction over control of 64.34 per cent. ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of (pyriproxifen 5% + difenthuron 25% SE @ 2 ml/l was comparable with ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 30.5% SC @ 0.3 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 70% WG @ 0.2 g/l and ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of afidopyrofen 5% DC @ 2 ml/l. The average incidence for ST + Foliar spray of Imidacloprid 30.5% SC, ST + FS of Imidacloprid 70% WG and ST + FS of Afidopyrofen 5% DC were 22.61, 23.03 and 24.13 per cent, respectively, with per cent reductions over control of 60.86, 60.14 and 58.24 per cent, respectively. Other treatments, including ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of thiamethoxam 25% WG @ 0.2 g/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of fipronil 5% SC @ 1 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of flonicamid 50% WG @ 0.5 g/l, FS of imidacloprid 30.5% SC @ 0.3 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of dimethoate 30% EC @ 1.7 ml/l and ST with imidacloprid 600 FS @ 5 ml/kg seed showed an average disease incidence of 25.61, 26.84, 27.92, 30.20, 32.44 and 48.21 per cent, respectively and **a** per cent reduction over control was 55.68, 53.55, 51.68, 47.73, 43.86 and 16.57 per cent, respectively. The average disease incidence recorded in T11 (control) was 57.78 per cent (Table 3).

Effect of various insecticides on the yield of blackgram infected with YMD

The grain yield of blackgram crop infected with YMD was calculated per plot after harvesting and was converted into quintals per hectare. Maximum yield per hectare was recorded in ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l with seed yield of 7.87 q/ha with the highest B: C ratio of 2.53, followed by ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 30.5% SC @ 0.3 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of imidacloprid 70% WG @ 0.2 g/l and ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of afidopyrofen 5% DC @ 2 ml/l which recorded seed yield of 6.95 q/ha, 6.79 q/ha and 6.48 q/ha, respectively with the B: C ratio of 2.51, 2.46 and 1.86, respectively. The next best treatments were ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of thiamethoxam 25% WG @ 0.2 g/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of fipronil 5% SC @ 1 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of flonicamid 50% WG @ 0.5 g/l, FS of imidacloprid 30.5% SC @ 0.3 ml/l, ST with imidacloprid 600 FS @ 5 ml/kg seed + FS of dimethoate 30% EC @ 1.7 ml/l and ST with imidacloprid 600 FS @ 5 ml/kg seed) recorded seed yield of 5.60 q/ha, 5.41 q/ha, 5.28 q/ha, 5.04 q/ha, 4.45 q/ha and 4.30 q/ha, respectively with the B: C ratio of 2.13, 1.96, 1.69, 1.89, 1.63 and 1.70, respectively. The lowest yield per hectare was recorded in T11 (control) which recorded a seed yield of 3.36 q/ha with B: C ratio of 1.28 (Table 3 and 4).

The above investigations are in conformity with the findings of Hugar *et al.* (2020), who conducted the field experiments at Agricultural Research Station, Dharwad during *kharif*, 2016 and 2017 on the efficacy of a combi-product (diafenthiuron 30% + pyriproxyfen 8% SE) against

Table 3: Effect of different insecticides on YMD infecting blackgram at 30 DAS, 45 DAS, 60 DAS and at physiological maturity.

Treatments	Disease incidence (%)				Average disease incidence (%)	Per cent reduction over control	Yield (q/ha)	B:C ratio
	30 DAS	45 DAS	60 DAS	Physiological maturity				
ST with Imidacloprid 600 FS	25.03^{d}	39.16^{d}	63.32^{e}	65.32^{e}	48.21^{e}	16.57	4.30^{ab}	1.70
	(30.02)*	(38.74)	(52.73)	(53.92)	(43.85)			
ST + FS of Thiamethoxam	17.88^{abc}	25.64^{ab}	28.77^{b}	30.15^{ab}	25.61^{abc}	55.68	5.60^{d}	2.13
25% WG	(25.01)	(30.42)	(32.44)	(33.30)	(30.29)			
ST + FS of Fipronil 5% SC	18.70^{bc}	26.77^{abc}	30.67^{bc}	31.22^{abc}	26.84^{bcd}	53.55	5.41^{d}	1.96
	(25.62)	(31.16)	(33.63)	(33.97)	(31.09)			
FS of Imidacloprid 30.5% SC	19.45^{bc}	30.15^{bc}	34.79^{cd}	36.42^{cd}	30.20^{cd}	47.73	5.04^{bcd}	1.89
	(26.17)	(33.30)	(36.15)	(37.12)	(33.18)			
ST + Foliar spray of Imidacloprid	13.95^{a}	22.97^{a}	25.88^{ab}	27.65^{ab}	22.61^{ab}	60.86	6.95^{e}	2.51
30.5% SC	(21.93)	(28.64)	(30.58)	(31.72)	(28.22)			
ST + FS of Imidacloprid 70% WG	14.11^{a}	23.98^{a}	26.15^{ab}	27.88^{ab}	23.03^{ab}	60.14	6.79^{e}	2.46
	(22.07)	(29.32)	(30.76)	(31.87)	(28.50)			
ST + FS of Flonicamid 50% WG	18.89^{bc}	27.45^{abc}	31.78^{bc}	33.57^{bcd}	27.92^{bcd}	51.68	5.28^{cd}	1.69
	(25.76)	(31.60)	(34.31)	(35.41)	(31.77)			
ST + FS of Pyriproxifen 5%	13.42^{a}	21.98^{a}	22.23^{a}	24.78^{a}	20.60^{a}	64.34	7.87^{f}	2.53
+ Difenthuron 25% SE	(21.49)	(27.96)	(28.13)	(29.85)	(26.86)			
ST + FS of Afidopyrofen	16.56^{ab}	24.33^{a}	27.35^{ab}	28.28^{ab}	24.13^{ab}	58.24	6.48^{e}	1.86
5% DC	(24.01)	(29.55)	(31.53)	(32.13)	(29.31)			
ST + FS of Dimethoate	21.23^{cd}	31.34^{c}	37.62^{d}	39.57^{d}	32.44^{d}	43.86	4.45^{bc}	1.63
30% EC	(27.43)	(34.04)	(37.83)	(38.98)	(34.57)			
Control	30.44^{e}	49.67^{e}	69.78^{f}	81.22^{f}	57.78^{f}		3.36^{a}	1.28
	(33.48)	(44.81)	(56.65)	(64.32)	(49.82)			
SEm±	1.35	1.64	1.82	1.96	1.78		0.28	
CD@5%	3.98	4.84	5.37	5.78	5.25		0.83	

*Figures in parenthesis are arc sine transformed values; DAS: Days after sowing.

Note: No spray was given for T1; Seed treatment- ST; Foliar spray- FS.

Table 4: Economics of management of YMD infecting blackgram.

Treatments	Yield (q/ha)	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	BC ratio
ST with Imidacloprid 600 FS	4.30	31855.62	18790	13065.62	1.70
ST + FS of Thiamethoxam 25% WG	5.60	41468.96	19440	22028.96	2.13
ST + FS of Fipronil 5% SC	5.41	40048.54	20450	19598.54	1.96
FS of Imidacloprid 30.5% SC	5.04	37319.43	19732	17587.43	1.89
ST + Foliar spray of Imidacloprid 30.5% SC	6.95	51411.90	20522	30889.90	2.51
ST + FS of Imidacloprid 70% WG	6.79	50254.04	19850	30404.04	2.46
ST + FS of Flonicamid 50% WG	5.28	39097.88	23120	15977.88	1.69
ST + FS of Pyriproxifen 5% + Difenthuron 25% SE	7.87	58229.57	23654	34575.57	2.53
ST + FS of Afidopyrofen 5% DC	6.48	47938.04	25730	22208.04	1.86
ST + FS of Dimethoate 30% EC	4.45	32965.37	20190	12775.37	1.63
Control	3.36	24853.81	19400	5453.81	1.28

Note: MSP: Rs. 7400/q.

Note: No spray was given for T1; Seed treatment- ST; Foliar spray- FS.

whiteflies on cotton. The pooled data of two seasons as the impact of three sprays revealed 89.00 per cent reduction of whitefly in (diafenthiuron 30% + pyriproxyfen 8% SE) @ 1200ml/ha applied treatment. The results were also in agreement with Bala (2023), who evaluated the bio-efficacy of the combined product (diafenthiuron 30% + pyriproxyfen 8% SE) against yellow mite and whitefly in chilli ecosystem. Results inferred that (diafenthiuron 30% + pyriproxyfen 8% SE) @1200 ml/ha was most effective in controlling yellow mite and whitefly in chilli.

CONCLUSION

Among all the treatments, seed treatment with imidacloprid 600 FS @ 5 ml/kg seed + foliar spray of (pyriproxifen 5% + difenthuron 25% SE) @ 2 ml/l was found to be more efficient in managing whiteflies vectoring YMD in blackgram, followed by seed treatment with imidacloprid 600 FS @ 5 ml/kg seed + foliar spray of imidacloprid 30.5% SC @ 0.3 ml/l.

Conflict of interest

The authors declare that there are no conflicts of interest.

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