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Field Efficacy of Insecticides in the Management of Yellow Mosaic Disease of Horsegram

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ABSTRACT

Background: Horsegram [*Macrotyloma uniûorum* (Lam.) Verdc.] is a drought-tolerant legume widely cultivated in South Asia, known for its resilience in poor soil conditions. Yellow Mosaic Disease (YMD) poses a significant challenge to horsegram production in India, resulting in complete yield loss. So, an attempt was carried out to manage YMD in horsegram using different insecticides.

Methods: For management of YMD of horsegram, a field experiment was carried out in randomized complete block design using different insecticides.

Result: Seed treatment with imidacloprid 600 FS at 5 ml/kg and foliar spray with (pyriproxyfen 5% + diafenthiuron 25%) 30% SE at 2 ml/1 at 30, 45 and 60 days after sowing resulted in the lowest disease incidence of YMD and highest reduction of whitefly population over control with seed yield of 6.91 q/ha and B:C ratio of 1.69.

Key words: Horsegram, Management, Yellow mosaic disease.

INTRODUCTION

The horsegram YMD caused by yellow mosaic virus, which is transmitted by the whitefly species *Bemisia tabaci* (Gennadius), has been widely observed in various regions of South India (Prema and Rangaswamy, 2017). The incidence of this disease has been reported to range between 50 to 100 per cent in crops cultivated during both the summer and early rainy seasons leading to significant reductions in grain yield. Initially, symptoms appeared as a faint yellow discoloration on young leaves (Prema and Rangaswamy, 2020). As the condition progressed, the leaves showed a mosaic pattern of mottling, characterized by irregular, small, greenish-yellow patches interspersed with normal green areas (Prema and Rangaswamy, 2020a; Appu and Prema, 2024). Gradually, the mottles expanded, brightened to a vivid yellow and eventually turned completely bleached (Plate 1). Severe infection led to stunted plant growth and smaller leaves (Prema, 2013; Swapna and Prema, 2024; Swapna *et al*., 2025).

Yellow Mosaic Disease (YMD) leads to significant reductions in yield across all countries in Asia that cultivate mung bean, including India (Biswas *et al*., 2008). The disease is attributed to a Begomovirus, which is part of the *Geminiviridae* family. Geminiviruses are small plant viruses that are characterized by geminate particles measuring 16-18 nm by 30 nm, consisting of two interconnected incomplete icosahedra that encapsulate either monopartite or bipartite circular single-stranded (ss) DNA genomes, approximately 2700 nucleotides in length. The *Geminiviridae* family is recognized as the second largest family of plant viruses. The virus possesses geminate particle (16-18 nm × 30 nm) with a coat protein that encapsulates spherical, single stranded DNA genome of approximately 2.8 Kb (Appu and Prema, 2024).

Managing yellow mosaic disease in horsegram is crucial in Karnataka due to its significant impact on crop yield and farmer livelihoods (Prema *et al*., 2013). Timely intervention ensures reduced economic losses, improved crop productivity and sustainability for farmers in affected regions (Sonam *et al*., 2024; Sonam *et al*., 2025). Since not much work has been carried out on management of YMD of horsegram in Karnataka, the current research was carried out with an intention to manage YMD in horsegram using different insecticides.

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MATERIALS AND METHODS

The present research on assessment of the efficacy of various insecticides against whiteflies transmitting the YMD in horsegram was carried out during summer 2023-24 at

Main Agricultural Research Station, Dharwad, which is situated in Northern transition zone (Zone-8) of Karnataka, India. The details of the experiment and the different treatments imposed are mentioned in Table 1 and 2.

The standard agricultural practices were followed to sustain the crop. Various insecticides were applied 30 days after sowing, with subsequent applications at 15 day intervals (three times in total). Incidence of horsegram YMD was documented one day before each spray, with final observations made at physiological maturity. Per cent disease incidence was calculated by using following formula:

$$\text{Per cent disease incidence} = \frac{\text{Total number of infected plants}}{\text{Total number of plants observed}} \times 100$$

The total count of whitefly population was recorded one day prior to each spray, with final observations made at physiological maturity. Yield data was also recorded and subjected to statistical analysis.

RESULTS AND DISCUSSION

Observations on whitefly population, per cent disease incidence, seed yield and 1000 seed weight were recorded in the experiment.

Effect of different insecticides on whitefly population transmitting YMD in horsegram

After first spray (30 DAS), the results revealed that treatment T_7 [seed treatment with imidacloprid 600 FS at 5 ml/kg of seeds followed by spray with (pyriproxyfen 5% + diafenthiuron 25%) 30% SE at 2 ml/1] recorded lowest mean whitefly population of 2.86, with highest per cent reduction over control of about 69.14 per cent. This was followed by T_2 [seed treatment with imidacloprid 600 FS 5 ml/kg seeds followed by spray with imidacloprid 350 SC at 0.3 ml/l], which had mean whitefly population of 3.69 and per cent reduction over control was 60.18 per cent. The highest mean whitefly population of 9.26 was recorded in the control plot (Table 3).

After second spray (45 DAS), the results revealed that treatment T_7 [seed treatment with imidacloprid 600 FS at 5 ml/kg of seeds followed by spray with (pyriproxyfen 5% + diafenthiuron 25%) 30% SE at 2 ml/1] recorded lowest mean whitefly population of 2.53, with highest per cent reduction over control of about 71.73 per cent. This was followed by T_2 [seed treatment with imidacloprid 600 FS 5 ml/kg seeds followed by spray with imidacloprid 350 SC at 0.3 ml/l], which had mean whitefly population of 2.98 and per cent reduction over control was 66.70 per cent. The highest mean whitefly population of 8.95 was recorded in the control plot (Table 4).

After third spray (60 DAS), the results revealed that treatment T_7 [seed treatment with imidacloprid 600 FS at 5 ml/kg of seeds followed by spray with (pyriproxyfen 5% + diafenthiuron 25%) 30% SE at 2 ml/1] recorded lowest mean whitefly population of 2.08, with highest per cent reduction over control of about 74.91 per cent. This was followed by T_2 [seed treatment with imidacloprid 600 FS 5

Table 1: Details of the experiment on efficacy of various insecticides against whiteflies transmitting the YMD in horsegram.

Season and year	: Summer, 2023-24
Location	: MARS, Dharwad
Design	: Randomized complete block design
Treatments	: 12
Replications	: 3
Variety	: BGM-1
Plot size	: 3 m × 3 m
Spacing	: 45 cm × 10 cm
Soil type	: Black soil

Table 2: Details of the treatments on efficacy of various insecticides against whiteflies transmitting the YMD in horsegram.

Treatments	Description
T_1	Seed treatment with imidacloprid 600 FS at 5 ml/ kg seed
T_2	Foliar spray of imidacloprid 350 SC at 0.3 ml/l
T_3	Foliar spray of imidacloprid 70% WG at 0.2 g/1
T_4	Foliar spray of thiamethoxam 25% WG at 0.2 g/1
T_5	Foliar spray of fipronil 5% SC at 1 ml/1
T_6	Foliar spray of flonicamid 50% WG at 0.5 g/1
T_7	Foliar spray of (Pyriproxyfen 5%+Diafenthiuron 25%) 30% SE at 2 ml/1
T_8	Foliar spray of afidopyrofen 5% DC at 2 ml/l
T_9	Foliar spray of dimethoate 30% EC at 1.7 ml/1
T_{10}	Foliar spray of imidacloprid 350 SC at 0.3 ml/1
T_{11}	Foliar spray of crude neem oil at 10 ml/l
T_{12}	Control

Seed treatment with Imidacloprid 600 FS at 5 ml/kg seed was common from T_1 to T_9.



Plate 1: Progression of symptoms of yellow mosaic disease of horsegram on leaves.

Table 3: Effect of different insecticides on whitefly population at 30 days after sowing on horsegram.

Treatment details	Whitefly population/plant						Per cent reduction of whitefly population over control
	1 DBS	1 DAS	3 DAS	5 DAS	7 DAS	Mean	
Seed treatment with imidacloprid 600 FS at 5 ml/kg seed	5.78 (2.51)*	7.34 (2.80)	8.36 (2.98)	8.54 (3.01)	9.18 (3.11)	8.36 (2.98)	9.77
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	7.24 (2.78)	4.23 (2.17)	4.22 (2.17)	3.18 (1.92)	3.12 (1.90)	3.69 (2.05)	60.18
Foliar spray of imidacloprid 70% WG at 0.2 g/l	6.45 (2.64)	5.26 (2.40)	4.34 (2.20)	4.21 (2.17)	4.09 (2.14)	4.48 (2.23)	51.67
Foliar spray of thiamethoxam 25% WG at 0.2 g/l	6.37 (2.62)	4.28 (2.19)	4.21 (2.17)	3.54 (2.01)	3.44 (1.98)	3.87 (2.09)	58.23
Foliar spray of fipronil 5% SC at 1 ml/1	7.48 (2.82)	6.24 (2.60)	5.56 (2.46)	4.98 (2.34)	4.96 (2.34)	5.44 (2.44)	41.31
Foliar spray of flonicamid 50% WG at 0.5 g/l	6.38 (2.62)	5.83 (2.52)	5.24 (2.40)	4.23 (2.17)	4.05 (2.13)	4.84 (2.31)	47.76
Foliar spray of (Pyriproxyfen 5% + Diafenthiuron 25%) 30% SE at 2 ml/l	5.49 (2.45)	3.67 (2.04)	3.26 (1.94)	2.32 (1.68)	2.18 (1.64)	2.86 (1.83)	69.14
Foliar spray of afidopyrofen 5% DC at 2 ml/l	6.57 (2.66)	4.53 (2.24)	4.75 (2.29)	4.04 (2.13)	4.54 (2.24)	4.47 (2.23)	51.78
Foliar spray of dimethoate 30% EC at 1.7 ml/l	8.22 (2.95)	7.74 (2.87)	7.57 (2.84)	7.24 (2.78)	8.22 (2.95)	7.69 (2.86)	16.93
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	7.98 (2.91)	6.26 (2.60)	5.24 (2.40)	5.29 (2.41)	6.34 (2.62)	5.78 (2.51)	37.55
Foliar spray of crude neem oil at 10 ml/l	8.34 (2.97)	8.25 (2.96)	8.42 (2.99)	7.22 (2.78)	8.02 (2.92)	7.98 (2.91)	13.85
Control	8.28 (2.96)	8.56 (3.01)	9.23 (3.12)	9.45 (3.15)	9.81 (3.21)	9.26 (3.12)	-
SEm ±	0.044	0.049	0.058	0.047	0.053	0.053	
C.D. at 5%	0.131	0.145	0.171	0.147	0.156	0.153	

Note: Seed treatment with Imidacloprid 600 FS at 5 ml/kg seed was common from T_1 to T_9.

*Figures in parenthesis indicate square root transformed values, DBS: Days before spraying, DAS: Days after spraying.

Table 4: Effect of different insecticides on whitefly population at 45 days after sowing on horsegram.

Treatment details	Whitefly population/plant						Per cent reduction of whitefly population over control
	1 DBS	1 DAS	3 DAS	5 DAS	7 DAS	Mean	
Seed treatment with imidacloprid 600 FS at 5 ml/kg seed	7.22 (2.78)*	7.51 (2.83)	7.76 (2.87)	8.08 (2.93)	8.32(2.97)	7.78 (2.88)	13.07
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	5.24 (2.40)	4.15 (2.16)	3.21 (1.93)	2.79 (1.81)	1.77 (1.51)	2.98 (1.87)	66.70
Foliar spray of imidacloprid 70% WG at 0.2 g/l	6.45 (2.64)	5.36 (2.42)	4.42 (2.22)	4.05 (2.13)	2.98 (1.87)	4.20 (2.17)	53.04
Foliar spray of thiamethoxam 25% WG at 0.2 g/l	5.32 (2.41)	4.23 (2.17)	3.29 (1.95)	2.87 (1.84)	1.85 (1.53)	3.06 (1.89)	65.81
Foliar spray of fipronil 5% SC at 1 ml/l	6.99 (2.74)	6.02 (2.55)	5.34 (2.42)	4.51 (2.24)	4.22 (2.17)	5.02 (2.35)	43.88
Foliar spray of flonicamid 50% WG at 0.5 g/l	5.33 (2.41)	4.24 (2.18)	3.39 (1.97)	2.88 (1.84)	2.33 (1.68)	3.21 (1.93)	64.13
Foliar spray of (Pyriproxyfen 5% + Diafenthiuron 25%) 30% SE at 2 ml/l	4.45 (2.22)	3.36 (1.96)	2.42 (1.71)	2.36 (1.69)	1.98 (1.57)	2.53 (1.74)	71.73
Foliar spray of afidopyrofen 5% DC at 2 ml/l	5.52 (2.45)	4.43 (2.22)	3.49 (2.00)	3.07 (1.89)	2.45 (1.72)	3.36 (1.96)	62.46
Foliar spray of dimethoate 30% EC at 1.7 ml/l	8.29 (2.96)	7.21 (2.78)	6.26 (2.60)	5.84 (2.52)	4.82 (2.31)	6.03 (2.56)	32.60
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	6.04 (2.56)	5.95 (2.54)	5.01 (2.35)	4.59 (2.26)	3.57 (2.02)	4.78 (2.30)	46.59
Foliar spray of crude neem oil at 10 ml/l	6.43 (2.63)	5.34 (2.42)	4.49 (2.23)	3.98 (2.12)	3.96 (2.11)	4.44 (2.22)	50.36
Control	8.56 (3.01)	8.59 (3.01)	9.01 (3.08)	9.21 (3.12)	8.99 (3.08)	8.95 (3.07)	-
SEm ±	0.036	0.057	0.050	0.056	0.047	0.061	
C.D. at 5%	0.107	0.168	0.147	0.166	0.139	0.179	

Note: Seed treatment with Imidacloprid 600 FS at 5 ml/kg seed was common from T_1 to T_9.

*Figures in parenthesis indicate square root transformed values, DBS: Days before spraying, DAS: Days after spraying.

Table 5: Effect of different insecticides on whitefly population at 60 days after sowing on horsegram.

Treatment details	Whitefly population/plant						Per cent reduction of whitefly population over control
	1 DBS	2 DAS	3 DAS	5 DAS	7 DAS	mean	
Seed treatment with imidacloprid 600 FS at 5 ml/kg seed	7.13 (2.76)*	7.42 (2.81)	7.37 (2.81)	7.99 (2.91)	8.23 (2.95)	7.75 (2.87)	6.26
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	4.15 (2.16)	4.06 (2.14)	3.12 (1.90)	2.70 (1.79)	2.08 (1.61)	2.99 (1.87)	63.85
Foliar spray of imidacloprid 70% WG at 0.2 g/l	5.36 (2.42)	4.27 (2.18)	3.33 (1.96)	2.96 (1.86)	1.89 (1.55)	3.11 (1.9)	62.36
Foliar spray of thiamethoxam 25% WG at 0.2 g/l	4.23 (2.17)	4.14 (2.15)	3.20 (1.92)	2.68 (1.78)	2.32 (1.68)	3.09 (1.89)	62.70
Foliar spray of fipronil 5% SC at 1 ml/l	5.90 (2.53)	4.93 (2.33)	4.25 (2.18)	3.42 (1.98)	3.13 (1.91)	3.93 (2.11)	52.45
Foliar spray of flonicamid 50% WG at 0.5 g/l	4.24 (2.18)	4.15 (2.16)	3.30 (1.95)	2.79 (1.81)	2.48 (1.73)	3.18 (1.92)	61.55
Foliar spray of (Pyriproxyfen 5% + Diafenthiuron 25%) 30% SE at 2 ml/l	3.36 (1.96)	2.89 (1.84)	2.27 (1.66)	1.68 (1.48)	1.46 (1.40)	2.08 (1.60)	74.91
Foliar spray of afidopyrofen 5% DC at 2 ml/l	4.43 (2.22)	4.34 (2.20)	3.40 (1.97)	2.98 (1.87)	2.36 (1.69)	3.27 (1.94)	60.46
Foliar spray of dimethoate 30% EC at 1.7 ml/l	7.20 (2.77)	6.12 (2.57)	5.17 (2.38)	4.75 (2.29)	3.73 (2.06)	4.94 (2.33)	40.24
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	4.95 (2.33)	4.86 (2.32)	3.92 (2.10)	3.50 (2.00)	2.48 (1.73)	3.69 (2.05)	55.38
Foliar spray of crude neem oil at 10 ml/l	5.34 (2.42)	4.25 (2.18)	3.40 (1.97)	2.89 (1.84)	2.87 (1.84)	3.35 (1.96)	59.46
Control	7.92 (2.90)	7.96 (2.91)	8.12 (2.94)	8.47 (2.99)	8.53 (3.00)	8.27 (2.96)	-
SEm ±	0.038	0.043	0.044	0.048	0.046	0.036	
C.D. at 5%	0.112	0.126	0.131	0.141	0.135	0.107	

Note: Seed treatment with Imidacloprid 600 FS at 5 ml/kg seed was common from T_1 to T_9.

*Figures in parenthesis indicate square root transformed values, DBS: Days before spraying, DAS: Days after spraying.

ml/kg seeds followed by spray with imidacloprid 350 SC at 0.3 ml/l], which had mean whitefly population of 2.99 and per cent reduction over control was 63.85 per cent. The highest mean whitefly population of 8.27 was recorded in the control plot (Table 5).



Plate 2: Management of YMD in horsegram by using different insecticides.

At physiological maturity, the results revealed that treatment T_7 [seed treatment with imidacloprid 600 FS at 5 ml/kg of seeds followed by spray with (pyriproxyfen 5% + diafenthiuron 25%) 30% SE at 2 ml/1] recorded lowest mean whitefly population of 3.25, with highest per cent reduction over control of about 60.80 per cent. This was followed by T_2 [seed treatment with imidacloprid 600 FS 5 ml/kg seeds followed by spray with imidacloprid 350 SC at 0.3 ml/l], which had mean whitefly population of 3.99 and per cent reduction over control of 51.87 per cent. The highest mean whitefly population of 8.29 was recorded in the control plot (Table 6).

Effect of different insecticides on the incidence of YMD in horsegram

The data analysis from the experiment revealed that treatment T_7 [seed treatment with imidacloprid 600 FS at 5 ml/kg of seeds followed by spray with (pyriproxyfen 5% + diafenthiuron 25%) 30% SE at 2 ml/1] three times at 15-day intervals resulted in the lowest disease incidence of 4.55, 10.05, 16.18 and 23.86 per cent at 30 DAS, 45 DAS, 60 DAS and at physiological maturity, respectively with 59.46 per cent disease reduction over control, followed by T_2 [seed treatment with imidacloprid 600 FS 5 ml/kg seeds followed by spray with imidacloprid 350 SC at 0.3 ml/l] with disease incidence of 4.68, 11.86, 19.11 and 30.38 per cent at 30 DAS, 45 DAS, 60 DAS and at physiological maturity, respectively with 52.45 per cent disease reduction over control. The highest incidence was observed in the control plot with 11.85, 25.67, 42.38 and 58.85 per cent at 30 DAS, 45 DAS, 60 DAS and at physiological maturity, respectively (Plate 2, Table 7).

Table 6: Effect of different insecticides on whitefly population at physiological maturity on horsegram.

Treatment details	Whitefly population/ plant	Per cent reduction of whitefly population over control
Seed treatment with imidacloprid 600 FS at 5 ml/kg seed	7.26 (2.79)*	12.42
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	3.99 (2.12)	51.87
Foliar spray of imidacloprid 70% WG at 0.2 g/l	5.27 (2.40)	36.43
Foliar spray of thiamethoxam 25% WG at 0.2 g/l	4.55 (2.25)	45.11
Foliar spray of fipronil 5% SC at 1 ml/l	5.23 (2.39)	36.91
Foliar spray of flonicamid 50% WG at 0.5 g/l	4.98 (2.34)	39.93
Foliar spray of (Pyriproxyfen 5% + Diafenthiuron 25%) 30% SE at 2 ml/l	3.25 (1.94)	60.80
Foliar spray of afidopyrofen 5% DC at 2 ml/l	4.87 (2.32)	41.25
Foliar spray of dimethoate 30% EC at 1.7 ml/l	6.15 (2.58)	25.81
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	5.03 (2.35)	39.32
Foliar spray of crude neem oil at 10 ml/l	6.54 (2.65)	21.11
Control	8.29 (2.96)	-
SEm ±	0.051	
C.D. at 5%	0.151	

Note: Seed treatment with Imidacloprid 600 FS at 5 ml/kg seed was common from T_1 to T_9.

*Figures in parenthesis indicate square root transformed values.

Table 7: Effect of different insecticides on YMD in horsegram at 30 DAS, 45 DAS, 60 DAS and at physiological maturity.

Treatment details	Per cent disease incidence					Per cent reduction over control
	30 DAS	45 DAS	60 DAS	At physiological maturity	Average disease incidence	
Seed treatment with imidacloprid 600 FS at 5 ml/kg seed	6.84 (15.16)*	22.40 (28.25)	35.90 (36.81)	46.59 (43.04)	27.93 (31.90)	20.83
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	4.68 (12.49)	11.86(20.14)	19.11 (25.92)	30.38 (33.45)	16.50 (23.97)	52.45
Foliar spray of imidacloprid 70% WG at 0.2 g/l	5.06 (13.00)	14.81 (22.63)	22.72 (28.47)	34.02 (35.68)	19.15 (25.95)	42.19
Foliar spray of thiamethoxam 25% WG at 0.2 g/l	4.37 (12.07)	15.90 (23.50)	23.01 (28.66)	32.00 (34.45)	18.82 (25.71)	45.75
Foliar spray of fipronil 5% SC at 1 ml/l	5.49 (13.55)	15.45 (23.15)	24.43 (29.62)	35.88 (36.80)	20.31 (26.79)	39.03
Foliar spray of flonicamid 50% WG at 0.5 g/l	5.22 (13.21)	16.19 (23.73)	22.76 (28.49)	32.65 (34.85)	19.21 (25.99)	44.52
Foliar spray of (Pyriproxyfen 5% + Diafenthiuron 25%) 30% SE at 2 ml/l	4.55 (12.32)	10.05 (18.48)	16.18 (23.72)	23.86 (29.24)	13.66 (21.69)	59.46
Foliar spray of afidopyrofen 5% DC at 2 ml/l	4.76 (12.60)	16.35 (23.85)	23.03 (28.68)	34.32 (35.86)	19.62 (26.29)	41.68
Foliar spray of dimethoate 30% EC at 1.7 ml/l	7.84 (16.26)	19.98 (26.55)	28.18 (32.06)	38.35 (38.26)	23.59 (29.06)	34.83
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	9.49 (17.94)	24.01 (29.34)	30.12 (33.29)	42.05 (40.43)	26.42 (30.93)	28.55
Foliar spray of crude neem oil at 10 ml/l	10.96 (19.33)	25.37 (30.24)	34.57 (36.01)	49.39 (44.65)	30.07 (33.25)	16.07
Control	11.85 (20.14)	25.67 (30.44)	42.38 (40.62)	58.85 (50.10)	34.69 (36.08)	-
SEm ±	0.090	0.429	0.695	0.755	0.618	
C.D. at 5%	0.266	1.267	2.052	2.227	1.824	

Note: Seed treatment with Imidacloprid 600 FS at 5 ml/kg seed was common from T_1 to T_9.

*Figures in parenthesis indicate arc sine transformed values, DAS: Days after sowing.

Table 8: Economics of management of YMD in horsegram.

Treatment details	1000 seed weight (g)	Yield (q/ha)	Gross returns (Rs./ha)	Cost of cultivation (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Seed treatment with imidacloprid 600 FS at 5 ml/kg seed	35.09	3.82	20780.80	16600.00	4180.80	1.25
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	39.82	6.22	33836.80	19132.00	14704.80	1.77
Foliar spray of imidacloprid 70% WG at 0.2 g/l	38.53	5.56	30246.40	18460.00	11786.40	1.63
Foliar spray of thiamethoxam 25% WG at 0.2 g/l	39.04	6.02	32748.80	18049.60	14699.20	1.81
Foliar spray of fipronil 5% SC at 1 ml/l	35.24	4.68	25459.20	19060.00	6399.20	1.34
Foliar spray of flonicamid 50% WG at 0.5 g/l	38.17	5.52	30028.80	21730.00	8298.80	1.38
Foliar spray of (Pyriproxyfen 5% + Diafenthiuron 25%) 30% SE at 2 ml/l	40.56	6.91	37590.40	22264.00	15326.40	1.69
Foliar spray of afidopyrofen 5% DC at 2 ml/l	37.22	5.44	29593.60	22250.00	7343.60	1.33
Foliar spray of dimethoate 30% EC at 1.7 ml/l	35.21	4.28	23283.20	18799.60	4483.60	1.24
Foliar spray of imidacloprid 350 SC at 0.3 ml/l	37.05	4.36	23718.40	18482.00	5236.40	1.28
Foliar spray of crude neem oil at 10 ml/l	36.29	4.13	22467.20	18950.00	3517.20	1.18
Control	34.33	3.24	17625.60	15650.00	1975.60	1.13
SEm ±	0.043	0.092				
C.D. at 5%	0.128	0.273				

Note: Seed treatment with Imidacloprid 600 FS at 5 ml/kg seed was common from T_1 to T_9.
MSP: Rs. 5440/q.

Effect of different insecticides in the management of HgYMD with respect to 1000 seed weight, seed yield and benefit: Cost ratio

Thousand seed weight was recorded in all treatment blocks after harvest, the highest 1000 seed weight was recorded in T_7 (40.56 g), followed by T_4 (39.82 g), T_2 (39.04 g), T_3 (38.53 g), T_6 (38.17 g), T_8 (37.22 g), T_{10} (37.05 g) and T_{11} (36.29 g). The least 1000 seed weight was recorded in control treatment T_{12} (34.33 g), followed by T_1 (35.09 g), T_9 (35.21 g) and T_5 (35.24 g).

The yield was notably superior in chemical treatment T_7 [seed treatment with imidacloprid 600 FS at 5 ml/kg of seeds followed by spray with (pyriproxyfen 5% + diafenthiuron 25%) 30% SE at 2 ml/1] (6.91 q/ha) with gross return of 37590.40 Rs/ha and net return of 15326.40 Rs/ha with B:C ratio of 1.69. But in T_4 treatment with an yield of 6.02 q/ha, the gross returns and net returns was 32748.80 Rs/ha and 14699.20 Rs/ha, respectively and B:C ratio was 1.81, which was highest when compared to T_7 treatment because of difference in cost of chemicals. Whereas, control treatment (T_{12}) recorded the lowest yield of 3.24 q/ha with 17625.60 Rs/ha gross returns and net returns of 1975.60 Rs/ha with 1.13 B:C ratio (Table 8).

Similar results were obtained by Hugar *et al*. (2020) who conducted the field experiments during *Kharif*, 2016 and 2017 on the evaluation of a combi-product (diafenthiuron 30% + pyriproxyfen 8% SE) efficacy against whiteflies on cotton. The pooled data of two seasons as impact of three sprays revealed 89.00 per cent reduction of whitefly in (diafenthiuron 30% + pyriproxyfen 8% SE) at 1200 ml/ha applied treatment.

The results were also in agreement with Prasad *et al*. (2024) who conducted field experiment during *Rabi* 2020-21 to evaluate the efficacy of nine insecticides against whitefly. The results revealed that diafenthiuron 50 WP at 1.25 g/l was most effective in reducing the whitefly population (75.23%) and YMD incidence (13.51%) followed by spiromesifen 240 SC at 1.0 ml/l (65.19% and 17.17%) and thiomethoxam 25 WG at 0.2 g/l (54.64% and 21.27%), while thiocloprid 21.7 SC at 1.0 ml/l (20.21% and 48.88%) and spinoteram 11.7 SC at 1.0 ml/l (25.16% and 43.91%).

The field experiment conducted on management of whiteflies vectoring YMD of blackgram by using different combination of insecticides revealed that seed treatment with imidacloprid 600 FS at 5 ml/kg seed + foliar spray of (pyriproxifen 5% + difenthuron 25% SE) at 2 ml/ l achieved the highest reduction of whitefly population over control, lowest disease incidence and maximum yield of 7.87 q/ha with the highest B: C ratio of 2.89 (Swapna and Prema, 2025).

CONCLUSION

Seed treatment with imidacloprid 600 FS (5 ml/kg) followed by spraying (pyriproxyfen 5% + diafenthiuron 25%) 30% SE (2 ml/l) effectively managed YMD in horsegram, achieving the lowest disease incidence (4.55% to 23.86% from 30 DAS to physiological maturity) and the highest reduction of

whitefly population over control (69.14% to 74.79% from 30 DAS to 60 DAS). This treatment yielded 6.91 q/ha with a B:C ratio of 1.69.

Conflict of interest

The authors declare no conflict of interest.

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