



ISSN Print: 2664-844X
 ISSN Online: 2664-8458
 IJAFS 2025; 7(2): 19-22
www.agriculturaljournals.com
 Received: 14-11-2024
 Accepted: 20-12-2024

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Innovative strategies for the management of bitter gourd mosaic virus

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DOI: <https://doi.org/10.33545/2664844X.2025.v7.i2a.274>

Abstract

A field experiment was conducted at the Vegetable Research Station, Junagadh Agricultural University, Junagadh, Gujarat, during the *Kharif* seasons of 2019-20 to 2021-22 to find out innovative strategies for the management of bitter gourd mosaic virus. The experiment was laid out in a randomized block design with seven treatments and four replications. The treatments included various combinations of biocontrol agents, pesticides, and cultural practices aimed at managing the mosaic disease in bitter gourd caused by begomoviruses. The highest net realization of Rs. 1,38,194/- was observed in treatment T₆, which involved spraying of Acephate 75% WP and neem oil, followed by Pyriproxyfen. This treatment effectively reduced mosaic disease incidence (9.26%) and significantly improved marketable fruit yield (180.35 q/ha). Among other treatments, T₅ (rotational spray of biocontrol agents and pesticides) also showed promising results with a mosaic incidence of 13.24% and a yield of 163.48 q/ha. In contrast, the control treatment (T₇) recorded the highest mosaic incidence (43.69%) and the lowest marketable fruit yield (79.79 q/ha). Overall, combination of barrier crops, mulching, sticky yellow traps, and spraying of Acephate 75% WP @ 0.15% (2 g/l) + Neem oil 1500 ppm (0.15 EC) @ 0.2% (1.5 ml/l) followed by Pyriproxyfen 10% EC @ 0.01% (1 ml/l) at 10 days interval starting from 15 days of plant emergence (T₆) was found to be the most effective and economical treatment for managing mosaic disease and enhancing the marketable yield of bitter gourd.

Keywords: Bitter gourd, mosaic disease, integrated disease management, marketable fruit yield, economics

Introduction

Cucurbitaceous crops, belonging to the family Cucurbitaceae, are crucial to global vegetable production, encompassing around 118 genera and 825 species. These crops, which include both culinary and dessert vegetables, are grown across diverse agro-climatological conditions worldwide (Ng, 1993) [13]. In Asia, where three-fourths of global vegetable cultivation occurs cucurbits including bitter gourd (*Momordica charantia* L.) contribute significantly to both the agricultural economy and dietary nutrition [7]. Bitter gourd, renowned for its nutritional and medicinal value, is an excellent source of vitamins, minerals, dietary fiber, and antioxidants, making it vital to the agricultural and healthcare sectors (Fuangchan *et al.*, 2011) [4]. In India, bitter gourd is cultivated across 99 lakh hectares, with a production of 1198 MT (Anonymous, 2019) [1].

Despite its economic importance, bitter gourd faces several challenges due to biotic stresses, particularly viral diseases. Among these, mosaic disease caused by Begomovirus, such as Bitter gourd Yellow Mosaic Virus (BGYMV), has emerged as a major obstacle to its cultivation. The mosaic disease leads to severe yield losses, affecting both the quantity and quality of the produce. These viruses are primarily transmitted by insect vectors, notably whiteflies (*Bemisia tabaci*), which further exacerbate the spread of the disease (Rajinimala *et al.*, 2005; Raj *et al.*, 2010) [17, 15]. Additionally, viral diseases such as leaf distortion and yellow vein mosaic, linked to BGYMV, have been responsible for yield losses of up to 69% in cucurbit crops (Malathi *et al.*, 2017) [8]. Viral diseases are difficult to manage, as viruses are obligate intracellular parasites and, to date, no therapeutic treatments have been developed for field control (Nicaise, 2014) [14]. The spread of viral diseases is compounded by the failure of traditional disease management methods and the uncontrolled use of insecticides to manage the vectors. This has led to environmental and health concerns, prompting the need for more sustainable management strategies.

Various plant viruses, including Begomovirus, Potyvirus, Cucumovirus, Tobamovirus, and others, have been reported to affect cucurbits globally, with seed transmission and vector-mediated spread being the primary modes of transmission (Lecoq and Desbiez, 2012; Mansilla *et al.*, 2013)^[18, 9].

The growing incidence of viral diseases in bitter gourd and the heavy reliance on insecticides to control vector populations have raised the need for integrated disease management (IDM) approaches. Such approaches combine cultural practices, biological control, and chemical treatments to manage both the disease and the vectors effectively. With this in mind, the present study was undertaken to evaluate the effectiveness of various integrated management practices for controlling mosaic disease in bitter gourd. The research, conducted over three consecutive *Kharif* seasons (2019-2022) at the Vegetable Research Station, Junagadh Agricultural University, Junagadh, Gujarat, aimed to assess the impact of different treatments on disease incidence, marketable fruit yield, and economic returns. This study seeks to identify a sustainable

and economically viable solution for managing viral diseases in bitter gourd and other cucurbit crops, contributing to enhanced productivity and farmer livelihoods.

Materials and Methods

The experiment was conducted at the Vegetable Research Station, Junagadh Agricultural University, Junagadh (Gujarat), on medium black soil during three consecutive *Kharif* seasons from 2019-20 to 2021-22. The experimental soil was characterized as medium black with good drainage and high moisture-retentive capacity. The key soil parameters included a pH of 7.90, electrical conductivity (EC) of 0.72 dS/m and available N, P, K, and S at 252, 48, 315 kg/ha, and 18.54 ppm, respectively. The micronutrient levels were 8.13 ppm Fe, 12.87 ppm Mn, and 0.77 ppm Zn.

Experimental design and treatments

The study utilized a Randomized Block Design (RBD) with seven treatments replicated four times. The treatments were as follows:

Treatment No.	Treatment Details
T ₁	Spray of Arka Microbial Consortium (AMC) @ 5 ml/l at 10 days interval starting from 15 days of plant emergence
T ₂	Spray of kaolin (H ₂ Al ₂ Si ₂ O ₈ .H ₂ O) @ 2% (20 g/l) at 10 days interval starting from 15 days of plant emergence
T ₃	Spray of sea weed extract @ 0.2% (2 ml/l) at 10 days interval starting from 15 days of plant emergence
T ₄	Spray of butter milk @ 20% (200 ml/l) at 10 days interval starting from 15 days of plant emergence
T ₅	Rotational spray of T ₁ (5 ml/l)
T ₆	Spray of Acephate 75% WP @ 0.15% (2 g/l) + Neem oil 1500 ppm (0.15 EC) @ 0.2% (1.5 ml/l) followed by Pyriproxyfen 10% EC @ 0.01% (1 ml/l) at 10 days interval starting from 15 days of plant emergence
T ₇	Control

The Arka Microbial Consortium (AMC) was supplied by ICAR-IIHR Bangalore. The first spray of the pesticides was applied after 15 days of plant emergence. The treatment of barrier crop with two rows of maize, mulching with silver plastic mulch and sticky yellow traps were applied common in each treatments plot.

Crop details

The hybrid bitter gourd variety "PARAG" (Truthful Label) was sown using a bullock-drawn seed drill. The crop was planted at a spacing of 200 cm row-to-row and 50 cm plant-to-plant. Each plot measured 4.0 m x 5.0 m, with 20 plants per plot. The fertilizers and manure were applied at the recommended dose of 60:60:60 NPK kg/ha and 15-20 t/ha of organic manure. All other recommended agronomic practices were followed throughout the crop period.

Disease assessment

To evaluate the incidence of mosaic disease, 100 plants were randomly selected from each plot and percent disease incidence was calculated by using the following formula (Chothani *et al.*, 2017; Ghaghara *et al.*, 2020)^[2, 5].

$$\text{Disease Incidence (\%)} = \frac{\text{No. of plant showing symptoms}}{\text{Total no. of plant observed}} \times 100$$

Economic analysis

The Net realization, Benefit-Cost Ratio (B:C) and Incremental Cost-Benefit Ratio (ICBR) were calculated based on marketable fruit yield and input costs, including

pesticides, labor, and other expenses (Nandeesh *et al.*, 2023)^[12].

$$\text{Net Return/Realization (Rs./ha)} = \text{Additional Income} - \text{Cost of treatment}$$

$$\text{B:C ratio} = \frac{\text{Net Realization (Rs/ha)}}{\text{Cost of treatment (Rs/ha)}}$$

$$\text{ICBR} = \frac{\text{Addition Income}}{\text{Cost of treatment (Rs/ha)}}$$

Data collection and statistical analysis

The data on mosaic disease incidence, marketable fruit yield, and economics were recorded and analyzed statistically using analysis of variance (ANOVA) at a 5% level of significance to evaluate the effectiveness of different treatments.

Results and discussion

Effect of different treatments on bitter gourd mosaic virus: The effectiveness of various treatments in managing mosaic disease of bitter gourd is presented in Table 1. All treatments significantly reduced mosaic disease incidence compared to the control (T₇), which recorded the highest disease incidence (43.69%). The lowest disease incidence (9.26%) was observed in T₆ (Spray of Acephate 75% WP @ 0.15% + Neem oil 1500 ppm @ 0.2% followed by Pyriproxyfen 10% EC @ 0.1% at 10-day intervals starting from 15 days after plant emergence).

Table 1: Effect of different treatments on bitter gourd yellow mosaic virus (BYMV)

Treatment No.	Disease Incidence (%)			Pooled
	Kharif - 2019	Kharif - 2020	Kharif - 2021	
T ₁	31.52(26.83)*	33.47 (29.91)*	32.95 (29.08)*	32.65 (28.61)*
T ₂	23.57(15.49)	25.99(18.70)	25.16 (17.58)	24.92 (17.25)
T ₃	28.08(21.66)	30.16(24.75)	29.50 (23.75)	29.26 (23.38)
T ₄	28.86(22.80)	30.91(25.88)	30.21 (24.82)	30.00 (24.50)
T ₅	20.28 (11.51)	22.86(14.60)	22.07 (13.62)	21.76 (13.24)
T ₆	16.04 (7.13)	19.17(10.28)	19.25 (10.37)	18.20 (9.26)
T ₇	41.76 (43.86)	43.67(47.18)	39.54 (40.03)	41.66 (43.69)
S.Em.±	1.04	1.00	1.08	0.60
C.D. at 5%	3.09	2.97	3.22	1.71
C.V.%	9.75	8.17	9.53	9.12
Y				
S.Em.±				0.39
C.D. at 5%				1.12
Y x T				
S.Em.±				1.04
C.D. at 5%				NS

* Figures in parentheses are retransformed values Angular transformation used

This was followed by T₅ (Rotational spray of T₁, T₃, and Pyriproxyfen 10% EC), which recorded an incidence of 13.24%, and T₂ (Spray of Kaolin @ 2%), which recorded 17.25% incidence. The higher effectiveness of T₆ may be attributed to the synergistic action of Acephate and Neem oil in managing vectors and preventing disease spread, with additional support from Pyriproxyfen for vector control.

The control treatment (T₇) exhibited the highest disease incidence, underscoring the impact of unmanaged mosaic disease in bitter gourd. The results align with previous findings by Mohan *et al.* (1995) ^[11], Ilhe *et al.* (2017) ^[6] who reported Neem oil's effectiveness in pest and disease management. Likewise; Effectiveness of neem based insect repellent and insecticides were also reported by Dhawan *et al.* (2002) ^[3] and Misra (2003) ^[10].

Effect of different treatments on marketable fruit yield

The marketable fruit yield across treatments is shown in Table 2. The highest pooled marketable yield (180.35 q/ha) was achieved in T₆ (Spray of Acephate 75% WP @ 0.15% (2 g/l) + Neem oil 1500 ppm (0.15 EC) @ 0.2% (1.5 ml/l) followed by Pyriproxyfen 10% EC @ 0.1% (1 ml/l) at 10 days interval starting from 15 days of plant emergence), indicating its superior efficacy in both disease management and yield enhancement. This was followed by T₅ (Rotational

spray of T₁ (5 ml/l), T₃ (2 ml/l) and Pyriproxyfen 10% EC @ 0.1% (1 ml/l) at 10 days interval starting from 15 days of plant emergence) (163.48 q/ha) and T₂ (T₀ + Spray of kaolin (H₂Al₂Si₂O₈.H₂O) @ 2% (20 g/l) at 10 days interval starting from 15 days of plant emergence) (143.77 q/ha).

Table 2: Effect of different treatments on marketable fruit yield of bitter gourd

Treatment	Marketable fruit yield (q/ha)			Pooled
	Kharif - 2019	Kharif -2020	Kharif - 2021	
T ₁	101.44	87.69	88.94	92.69
T ₂	149.19	140.44	141.69	143.77
T ₃	130.63	121.25	123.13	125.00
T ₄	121.19	104.31	106.19	110.56
T ₅	167.94	160.44	162.06	163.48
T ₆	186.19	176.19	178.69	180.35
T ₇	80.63	75.63	83.13	79.79
S.Em.±	5.87	5.18	5.85	3.26
C.D. at 5%	17.44	15.40	17.39	9.25
C.V.%	8.77	8.38	9.27	8.82
Y				
S.Em.±				2.13
C.D. at 5%				6.05
Y x T				
S.Em.±				5.65
C.D. at 5%				NS

The lowest marketable yield (79.79 q/ha) was recorded in the control treatment (T₇), reflecting the adverse impact of mosaic disease on productivity. The significant increase in yield in T₆ can be attributed to its effective reduction of mosaic disease, ensuring healthier plants and higher productivity.

Economic analysis

The economic evaluation of treatments is presented in Table 3. T₆ provided the highest net realization (Rs. 1,38,190/-) due to its high yield and effective cost management. The B:C ratio of T₆ was 10.92, and the ICBR was 1:11.92, making it the most economical treatment.

While T₃ recorded the highest B:C ratio (11.56) and ICBR (1:12.56), it was less effective in controlling mosaic disease and had a comparatively lower yield (125.00 q/ha). The high net returns and yield observed in T₆ can be credited to the combined efficacy of Acephate, Neem oil, and Pyriproxyfen in managing vectors and disease incidence effectively.

Table 3: Economics of different treatments applied for the management of bitter gourd yellow mosaic virus (BYMV)

Treatment No.	Marketable fruit yield (kg/ha)	Fruit yield increased over control (kg/ha)	Additional income (From column No.4) (Rs.)	Cost of treatment (Pesticides, labour charge etc.) (Rs/ha)	Net realization (Rs.)	B:C ratio	ICBR
T ₁	9269	1290	19,350	10,350	9,000	0.87	1:1.87
T ₂	14377	6398	95,970	49,500	46,470	0.94	1:1.94
T ₃	12500	4521	67,815	5,400	62,415	11.56	1:12.56
T ₄	11056	3077	46,155	27,000	19,155	0.71	1:1.71
T ₅	16348	8369	1,25,535	12,000	1,13,535	9.46	1:10.46
T ₆	18035	10056	1,50,840	12,650	1,38,190	10.92	1:11.92
T ₇	7979	-	-	-	-	-	-

Note: Quantity of solution used for spraying: 500 liters/ha/spray; Number of pickings: 10; Price of bitter gourd fruit: Rs.15/kg

Cost of Treatments

Sr. No.	Treatment Details		Price (Rs.)
1	Arka Microbial Consortium (AMC)	:	Rs.260/lit.
2	Kaolin	:	Rs.500/kg
3	Sea weed extract	:	Rs.100/lit.
4	Butter milk	:	Rs.25/lit.
5	Pyriproxyfen 10% EC	:	Rs.1700/lit.
6	Acephate 75% WP	:	Rs.650/kg
7	Neem oil 1500 ppm	:	Rs. 400/lit.
8	Labour charge for foliar spray	:	Rs. 500/spray/ha

Conclusion

The integrated management of mosaic disease in bitter gourd proved highly effective in reducing disease incidence, enhancing yield, and improving economic returns. Among the treatments evaluated, treatment of barrier crop with two rows of maize + mulching with silver plastic mulch + sticky yellow traps + spray of acephate 75% WP @ 0.15% + Neem oil 1500 ppm @ 0.2% followed by Pyriproxyfen 10% EC @ 0.1% at 10-day intervals emerged as the most efficient strategy. This comprehensive approach effectively combined cultural, chemical, and biological practices, demonstrating its superiority over other treatments. The findings underscore the potential of integrated pest and disease management strategies to sustainably address viral diseases in bitter gourd while maximizing economic returns. This approach not only ensures higher productivity but also minimizes the environmental and health risks associated with excessive pesticide use, offering a practical solution for bitter gourd growers.

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