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# *IN VIVO* EFFICACY OF ANTIVIRAL COMPOUNDS, BOTANICALS AND BIOCONTROL AGENTS AGAINST MUNGBEAN YELLOW MOSAIC VIRUS IN MID-HILLS OF MEGHALAYA, INDIA

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**ABSTRACT**

Mungbean [*Vigna radiata* (L.) Wilczek], an important leguminous crop that belongs to family Fabaceae is a nutritionally significant crop, offering a range of health benefits. Despite India's position as the world's leading mungbean producer, the country's average yield remains surprisingly low, due to various pests and diseases. Among biotic stresses, Mungbean yellow mosaic disease (MYMD) caused by Mungbean yellow mosaic virus (MYMV) of genus *Begomovirus* and family *Geminiviridae* is a major constraint in mungbean production and the most devastating viral disease, causing yield losses ranging from 85 % to 100 %. In an effort to evaluate the efficacy of antiviral compounds, botanicals, and biocontrol agents against the disease, we conducted an experiment at the College of Agriculture, Kyrdemkulai, Research farm, Meghalaya, India during March to June, 2024 using the susceptible mungbean variety Pusa Baisakhi. Results from the field trial suggest that foliar spray with neem leaf extract reported the least mean MYMV disease incidence (15.27 %) and the highest per cent reduction over control (51.52 %). Observations also revealed that foliar spray with neem leaf extract showed highest number of pods per plant (14.53), seeds per pod (9.93), seed yield per plant (9.67 g) and seed yield per hectare (774 kg/ha) as compared to other treatments employed in the experiment.

***Key words :*** Geminivirus, Meghalaya, MYMV, Neem leaf extract, Punarnava.

## Introduction

Mungbean [*Vigna radiata* (L.) Wilczek], a native crop of India and originating from Indo-Burmese region, has been under cultivation since prehistoric times. Mungbean being a short duration and early maturing crop demonstrates remarkable versatility thriving in a large number of cropping systems. It serves as an important source of cereal-based diet worldwide and an excellent option for a balanced diet containing high iron content (40–70 ppm), high-quality protein (24 per cent) with less flatulence, carbohydrates (51 per cent), minerals (4 per cent) and vitamins (3 per cent). In addition, they play a significant role in increasing the soil fertility by fixing atmospheric nitrogen through symbiosis with *Rhizobium* species.

Worldwide, mungbean covers over 7 million ha area, with yield of 3.5 million tons mainly from Asia (Nair *et al.*, 2019). India is the world's largest producer of mungbean accounting for about 65% of world's acreage and 54% of its global production (Singh, 2011). Despite being the world's largest producer, the global average yield of mungbean remains surprisingly low, at only 384 kilograms per hectare. The low productivity of mungbean is attributed to its vulnerability to various threats like weed infestations, pest attack and pathogens such as fungi, viruses and bacteria. Among the three, Mungbean yellow mosaic virus (MYMV) which belongs to genus *Begomovirus* and family *Geminiviridae*, cause severe economic losses in mungbean by reducing seed yield and quality. Yellow mosaic disease (YMD) was first reported by Capoor and Verma from Western India in Lima bean and later in Dolichos in the late 1940s. It was first reported as a problem in mungbean from the experimental field of Indian Agricultural Research Institute, New Delhi, India in the year 1955.

The genome of this virus is circular and single-stranded, which may be monopartite (a single DNA) or bipartite (with two component DNA: DNA A and DNA B) (Mansoor *et al.*, 2003) and are encapsulated in geminate icosahedral particles (18 x 30 nm). Begomoviruses which are bipartite, are reported as causative agent of YMD of legumes in Southern Asia and are inclusively known as Yellow Mosaic Viruses (YMVs) (Qazi *et al.*, 2007). These are Mungbean Yellow Mosaic Virus (MYMV), Mungbean Yellow Mosaic India Virus (MYMIV), Horsegram Yellow mosaic Virus (HgYMV) and Dolichos Yellow Mosaic Virus (DoYMV). Of these, MYMV is more common in the southern and western regions of India (Karthikeyan *et al.*, 2014), while MYMIV is more common in the northern, central and eastern regions (Usharani *et al.*, 2004).

MYMV is transmitted primarily by a polyphagous pest, whitefly (*Bemisia tabaci*) in a persistent (circulative) manner. Shad *et al.* (2005) reported that the virus generally does not spread through mechanical inoculation or via seeds. However, they noted that a particular strain of MYMV found in Thailand was an exception, as it could be transmitted mechanically. The early symptoms of this disease appear as yellow-coloured spots scattered over entire leaf blade which eventually takes yellow mosaic like pattern before the leaves turn completely yellow. The infected plants produce very few flowers and deformed pods or no pods at all. Management of this disease using chemicals like insecticides and pesticides can reduce whitefly populations, partially decreasing disease incidence. However, complete eradication of the disease is challenging and the persistent use of these chemicals has harmful effect on the environment. Therefore, identifying eco-friendly compounds is a prerequisite for effectively managing the disease and the vector. Considering this background information, the current study was undertaken to identify the most effective eco-friendly compound in managing the disease.

## Materials and Methods

A field experiment was carried out in a randomized block design (RBD) with 3 replications to evaluate the efficacy of antiviral compounds, botanicals and biocontrol agents against MYMV on mungbean during the pre-kharif season (March to June) of 2024 at the College of Agriculture, Kyrdemkulai, Research farm, Meghalaya, India. A susceptible variety of mungbean Pusa Baisakhi was directly sown in a 1.5 m × 1.5 m plot with row-to-row and plant-to-plant distance of 30 cm and 10 cm respectively. A total of seven treatments were used including control. The first spraying was done using hand sprayer at 20 days after sowing (DAS) and the second, third, and fourth spraying was done at an interval of 10 days. The details of the treatments used in the experiment are given in Table 1.

**Source of treatments**

- Neem leaf extract and Punarnava root extract- Water extraction method (Singh *et al.*, 2011)
- Salicylic acid and Chitosan - Himedia
- UmComb and UmMet- Biopesticide production unit, School of Crop Protection, CPGS-AS, Umiam, Meghalaya, India.

Per cent disease incidence and per cent reduction over control was calculated as per the formula given below:

**Table 1 :** Treatments used for management of MYMV disease.

| S. no. | Treatments | Dosage | Method of application |
|---|---|---|---|
| $T_1$ | Neem leaf extract | 5% | Foliar spray |
| $T_2$ | *Boerhaavia diffusa* (Punarnava) root extract | 5% | Foliar spray |
| $T_3$ | Salicylic acid | 0.2% | Foliar spray |
| $T_4$ | Chitosan | 0.02% | Foliar spray |
| $T_5$ | UmMet (*Metarhizium anisopliae*) | 5% | Foliar spray |
| $T_6$ | UmComb (Consortium of *Trichoderma harzianum*, *Beauveria bassiana*, *Metarhizium anisopliae*, *Verticillium lecanii*, *Pseudomonas fluorescens*) | 2.5% | Foliar spray |
| $T_7$ | Water (control) | – | Foliar spray |

**Per cent disease incidence (%)**

$$= \frac{Number\, of\, diseased\, plants}{Total\, number\, of\, plants\, assessed} \times 100 \text{ (Nene, 1972)}$$

**Per cent reduction over control** $= \dfrac{C - T}{C} \times 100$

(Vincent, 1927)

where, C- per cent disease incidence of control

T- per cent disease incidence of treatment

**Yield parameters**

Randomly five plants from each treatment plot were selected at the harvesting stage for assessing yield parameters:

i. Number of pods/plant
ii. Number of seeds/pod
iii. Seed yield (g) /plant
iv. Seed yield (kg/ha)

**Statistical analysis**

The data pertaining to management of MYMV was statistically analysed by using Fisher's method of ANOVA in randomized block design (RBD).

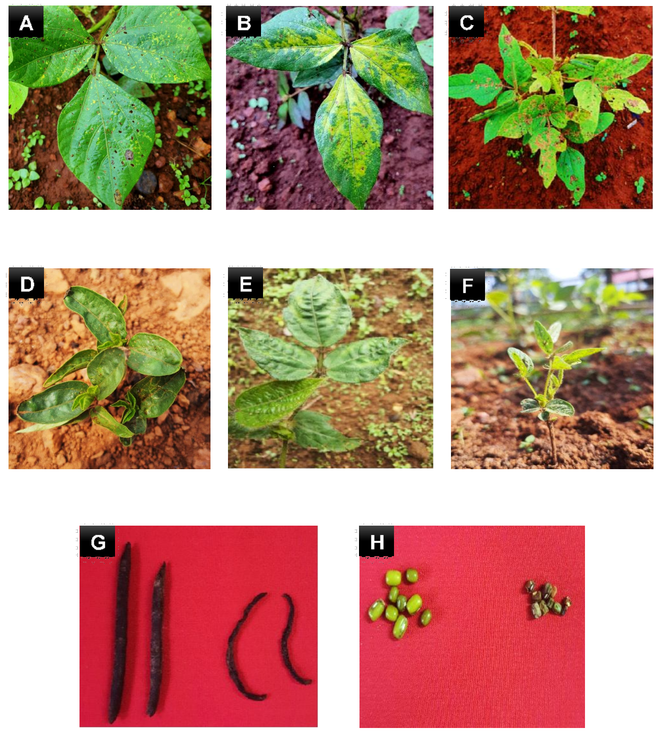


**Fig. 1 :** Symptoms of MYMV disease observed in the field: A- scattered yellow spots, B- yellow mosaic pattern, C- complete yellowing of leaf, D- puckering, E- reduced leaf size, F- stunting, G- reduced pod size, H- shriveled seed.

## Results and Discussion

Various symptoms of MYMV were observed at different crop growth stages in the field, namely, scattered yellow spots, yellow mosaic pattern, complete chlorosis of leaves, puckering, reduced size of leaves, stunting of plant, reduced pod size and shriveled seeds (Fig. 1). The findings of this investigation demonstrated that at 30 DAS, no symptoms of MYMV were observed in any of the plants. By 40 DAS, a low level of disease incidence was detected. However, when comparing all treatments, including the control group, there were no statistically significant differences in disease incidence at this stage. The disease incidence of MYMV showed a consistent increase from 40 DAS onwards, continuing to rise until 70 DAS. As the crop matured, the effects of different treatments became more pronounced. Significant differences among the treatments were observed at 50, 60 and 70 DAS.

Among the treatments, neem leaf extract showed the least mean disease incidence (15.27%), followed by punarnava root extract (18.75%), mean disease incidence of salicylic acid and UmComb was statistically at par (19.50% and 19.90%, respectively), UmMet (27.77%), chitosan (29.16%) and the maximum mean disease incidence was seen in case of control (31.50%). When comparing the per cent reduction over control, neem leaf extract showed the highest reduction (51.52%), followed by punarnava root extract (40.50%) and the least was noted in the case of chitosan (7.42%) (Table 2, Fig. 2).

The present findings are found in agreement with the findings of Rehman *et al.* (2024) who tested five different treatments, $T_1$-NLE (neem leaves extracts), $T_2$-TLE (tobacco leaves extracts), $T_3$- combination (TLE+NLE+ neem kernels), $T_4$- insecticide (Movento) and T5-control, against whitefly in greenhouse as well as in field condition and reported that adult whitefly population count was lowest in NLE treated tomato plants and highest in un-treated plants in both the condition. Similar finding was observed by Asaduzzaman *et al.* (2015), who reported that oral ingestion of azadirachtin is highly lethal to whiteflies and acts as strong antifeedant. After neem leaf extract, punarnava root extract showed the lowest mean disease incidence of 18.75% which agrees with the findings of Verma and Baranwal (2011). They reported that the roots of *Boerhaavia diffusa* (punarnava) have been shown to contain potent endogenous virus inhibitory proteins called as BD-SRIP that confer strong systemic resistance in several plants against a number of plant viruses. Kumar and Kumar (2015) study produced comparable findings and stated that *Boerhaavia diffusa* (punarnava) could potentially

**Table 2 :** Effect of different treatments on per cent disease incidence and per cent reduction over control of MYMV.

| Treatments | Per cent disease incidence (%) | | | | | Per cent reduction over control (%) |
|---|---|---|---|---|---|---|
| | 40 DAS | 50 DAS | 60 DAS | 70 DAS | Mean | |
| **$T_1$** | $7.40\pm1.856^{a}$ (15.79) | $12.96\pm1.85^{b}$ (21.1) | $20.37\pm1.85^{d}$ (26.83) | $20.37\pm1.85^{d}$ (26.83) | $15.27\pm1.22^{d}$ (23.73) | 51.52 |
| **$T_2$** | $7.40\pm1.85^{a}$ (15.79) | $14.81\pm1.85^{b}$ (22.63) | $25.55\pm1.67^{c}$ (30.36) | $27.22\pm0^{c}$ (31.45) | $18.75\pm1.18^{cd}$ (25.66) | 40.50 |
| **$T_3$** | $7.40\pm1.85^{a}$ (15.79) | $16.66\pm0^{b}$ (24.09) | $25.92\pm1.85^{c}$ (30.61) | $27.77\pm0^{c}$ (31.8) | $19.50\pm0.46^{c}$ (26.49) | 38.09 |
| **$T_4$** | $9.26\pm1.85^{a}$ (17.71) | $24.07\pm1.85^{a}$ (29.38) | $40.73\pm1.85^{ab}$ (39.66) | $42.59\pm1.85^{ab}$ (40.74) | $29.16\pm0.8^{b}$ (32.68) | 7.42 |
| **$T_5$** | $9.26\pm1.85^{a}$ (17.71) | $24.07\pm1.85^{a}$ (29.38) | $37.03\pm1.85^{b}$ (37.48) | $40.73\pm1.85^{b}$ (39.66) | $27.77\pm0.8^{b}$ (31.8) | 11.84 |
| **$T_6$** | $7.40\pm1.85^{a}$ (15.79) | $18.51\pm1.85^{b}$ (25.48) | $25.92\pm1.85^{c}$ (30.61) | $27.77\pm0^{c}$ (31.8) | $19.90\pm0.8^{c}$ (26.16) | 36.82 |
| **$T_7$** | $9.26\pm1.85^{a}$ (17.71) | $25.92\pm1.85^{a}$ (30.61) | $44.44\pm0^{a}$ (41.81) | $46.29\pm1.85^{a}$ (42.87) | $31.50\pm0.8^{a}$ (34.41) | 0.00 |
| **S.E (m) ±** | 1.37 | 1.60 | 1.67 | 1.34 | | |
| **CD @ 5 %** | 4.22 | 4.93 | 5.14 | 4.13 | | |

$T_1$ (Neem leaf extract), $T_2$ (Punarnava root extract), $T_3$ (Salicylic acid), $T_4$ (Chitosan), $T_5$ (UmMet), $T_6$ (UmComb), $T_7$ (Control)
Arc sine transformed values are indicated by figures in parenthesis.

**Table 3 :** Effect of different treatments on yield parameters of mungbean.

| Treatments | No. of pods /plant | No. of seeds/pod | Seed yield /plant (g) | Seed yield (Kg/ha) |
|---|---|---|---|---|
| **$T_1$** | 14.53 | 9.93 | 9.67 | 774 |
| **$T_2$** | 14.07 | 9.67 | 9.17 | 734 |
| **$T_3$** | 13.73 | 9.47 | 8.68 | 698 |
| **$T_4$** | 12.27 | 8.67 | 7.57 | 609 |
| **$T_5$** | 13.47 | 9.07 | 8.15 | 654 |
| **$T_6$** | 14.00 | 9.40 | 8.66 | 693 |
| **$T_7$** | 9.20 | 5.33 | 3.84 | 307 |
| **S.E (m)±** | 0.16 | 0.07 | 1.34 | |
| **C.D (5 %)** | 0.49 | 0.21 | 4.31 | |

$T_1$ (Neem leaf extract), $T_2$ (Punarnava root extract), $T_3$ (Salicylic acid), $T_4$ (Chitosan), $T_5$ (UmMet), $T_6$ (UmComb), $T_7$ (Water control).

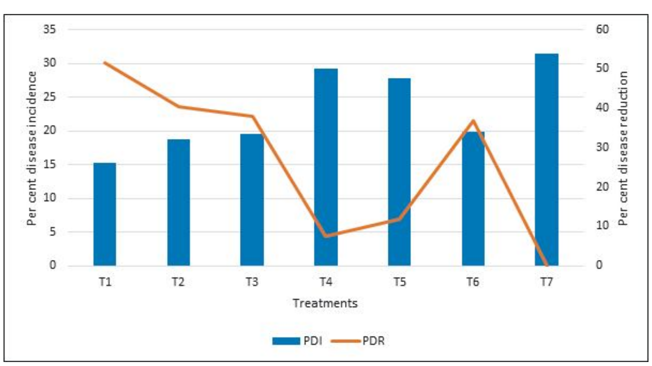


**Fig. 2 :** Effect of different treatments on per cent disease incidence and per cent reduction over control of MYMV.

serve as a prophylactic agent against the yellow vein mosaic disease affecting okra plants.

In respect of yield parameters, among the treatments, neem leaf extract showed a higher number of pods plant$^{-1}$ (14.53), seeds pod$^{-1}$ (9.93), seed yield plant$^{-1}$ (9.67 g) and seed yield (774 kg/ha) and least was observed in case of control (Table 3). These findings correspond with those of Bediako *et al.* (2014), who reported that neem-treated plants gave the highest yield due to the release of nutrients such as nitrogen by the neem for faster vegetative growth and development of the fruits.

## Conclusion

The study reveals that MYMV poses a severe threat to legume production in Meghalaya, causing substantial yield losses. Neem leaf extract emerged as a promising natural control measure, demonstrating significant disease reduction and improved yield parameters. These findings provide valuable insights for farmers and researchers to implement integrated management strategies for sustainable legume cultivation in the region.

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