Plant Archives Vol. 25, Supplement 2, 2025 pp. 1403-1407 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.175

CROSS-FAMILY EVALUATION OF *SOYBEAN MOSAIC VIRUS* SUSCEPTIBILITY: IDENTIFYING RELIABLE INDICATOR AND RESISTANT PLANTS FOR EFFECTIVE DISEASE MANAGEMENT

Digvijay Rajaram Chavan[1*], Suresh R. Zanjare[2], Annasaheb M. Navale[1], Sachin B. Mahajan[3], Sanjay V. Kolase[1] and Yogesh S. Saindane[4]

[1]Department of Plant Pathology and Microbiology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India.
[2]Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India.
[3]Agriculture Research Station, Kasbe Digraj, Sangli, Maharashtra, India.
[4]Department of Entomology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India.
*Corresponding author E-mail: digvijayrc07@gmail.com
(Date of Receiving : 30-04-2025; Date of Acceptance : 05-07-2025)

ABSTRACT

Soybean (*Glycine max* (L.) Merrill) is an important oilseed crop with significant contributions to global protein production. Despite its importance, soybean is highly susceptible to viral pathogens, particularly Soybean mosaic virus (SMV), which can cause yield reductions of up to 94 per cent. *Soybean mosaic virus* belongs to the *Potyviridae* family and infects a broad range of plant species across multiple families. This study aimed to identify suitable indicator plants for SMV infection and explore susceptibility patterns across different plant families. A total of 525 plants from 21 species across five families (*Leguminosae, Cucurbitaceae, Solanaceae, Asteraceae,* and *Amaranthaceae*) were tested through mechanical sap transmission under controlled glasshouse conditions. Symptom expression, including Mosaic Mottling (MM), Leaf Curling (LC), Necrotic Local Lesions (NCL), Puckering (PUCK), and Distortion (DIST), was observed. Results revealed varying susceptibility levels among plant families. *Amaranthaceae* and *Leguminosae* exhibited the highest susceptibility, with *Chenopodium quinoa* and *Vigna unguiculata* emerging as effective indicator plants. *Cucurbitaceae* and *Solanaceae* displayed moderate susceptibility, while *Asteraceae* showed complete resistance. NCL was the most common symptom across susceptible species. This study highlights *Chenopodium quinoa* and *Vigna unguiculata* as reliable SMV indicator plants. Additionally, the complete resistance observed in *Asteraceae* species (*Helianthus annuus* and *Carthamus tinctorius*) suggests potential opportunities for future research into genetic resistance mechanisms against SMV, providing valuable insights for soybean disease management strategies.

Keywords: *Soybean mosaic virus*, Leguminosae, Cucurbitaceae, Amaranthaceae

Introduction

Soybean, a crop with a long history, was first cultivated in northern China around 1100 BC. Its wild ancestors, characterized by small seeds and a tough seed coat, were not suitable for human consumption unless properly cooked. Over time, the domesticated variety (*Glycine max* (L.) Merrill) evolved to grow taller, produce larger, more digestible seeds, and spread across many parts of the world. This remarkable plant (Willis, 2008) is highly adaptable and rich in high-quality protein, making it a promising solution to global protein shortages. Today, soybean is one of the most widely grown oilseed crops, with significant production in countries like India (IISR, 2022).

Having been introduced and started for commercial cultivation in the late 1960s in India, soybean is grown over 11.85 million hectares with a production of 11.87 million metric tons (SOPA, 2024a). Farmers in Madhya Pradesh quickly began using the crop as their main *Kharif* crop, and soon after, its cultivation expanded to Maharashtra, Rajasthan, Chhattisgarh, Northern Karnataka, Gujarat,

and Northern Telangana. Currently, soybean accounts for 22 per cent of the nation's overall oil production and 42 per cent of its total oil seed production (SOPA, 2024b).

Soybean is susceptible to 69 different types of viruses (Gibbs *et al*., 2008) of which 11 viruses have been reported from India (Mali, 1995). Among these eleven, *Soybean mosaic virus* (SMV) is one the major viral pathogen of soybean as it can cause yield reduction as high as 94% (IISR, 2022). SMV, belonging to family *Potyviridae*, was reported for the first time by Clinton in 1915 and in India, Nariani and Pingaley were the first to report SMV infection from New Delhi in 1960. Currently, this virus can be found in every region of the world.

Like other *Potyviruses*, *Soybean mosaic virus* has filamentous particles that are roughly 7500 Å long, 120 Å in diameter, and have a central hole that is roughly 15 Å in diameter (Hajimorad *et al*., 2018). It has a wide host rage as it is reported to infect plants from *Solanaceae, Cucurbitaceae, Leguminosae* and *Caricaceae* families (Nandakishor *et al*., 2017 and Balgude *et al*., 2021). In soybean, it causes symptoms like mosaic mottling which shows irregular light and dark green patches on leaves, leaf curling which causes twisting or rolling of leaves, often downwards, necrotic local lesions which is small dead patches or spots on leaves, puckering which shows wrinkled or blistered appearance on leaf surfaces, distortion which is abnormal leaf shape and size, stunted growth, disruption in normal flowering time, reduced pod formation, seed (Brand *et al*., 1993 & Hajimorad *et al*., 2005)

Materials and Methods

The present investigation was carried out in the glass house facility of Department of Plant Pathology and Microbiology, Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra, India. Inoculation of *Soybean mosaic virus* was done by mechanical sap transmission as described by Boss (1972). Here, *Soybean mosaic virus* infected leaves of soybean crop were carefully collected from experimental fields of MPKV, Rahuri. These leaves were crushed in Potassium phosphate buffer at pH 7.0 using autoclaved mortar and pestle to prepare viral inoculums.

A total of 525 plants, belonging to 21 species distributed across 5 different families (*Leguminosae, Cucurbitaceae, Solanaceae, Asteraceae*, and *Amaranthaceae*), were tested in our study to identify good indicator plants of SMV infection. Each species was represented by 25 plants. Pot grown 10 days old plants (from germination), were selected for transmission. Leaves of test plant were covered with abrasive the carborundum powder (300 mesh) by gently blowing the air. Then leaves were inoculated by conventional leaf rub method. Immediately after inoculation, leaves were rinsed in sterile distilled water. Test plants were incubated in a vector free glass house for four weeks and daily observations were recorded to study the symptom development and incubation period. Common Symptoms studied included Mosaic Mottling (MM), Leaf Curling (LC), Necrotic Local Lesions (NLC), Puckering (PUCK) and Distortion (DIST).

Results

A total of 525 plants from 21 different plant species belonging to 5 different families viz: *Leguminosae, Cucurbitaceae, Solanaceae, Asteraceae* and *Amaranthaceae* were grown in pots and tested upon to identify good indicator plants of SMV infection. The results indicate notable differences in susceptibility, transmission efficiency, and symptom expression among various plant species. Table 1 summarizes the symptomatology, highlighting the percentage of successful transmission and the number of days required for symptoms to appear across different plants.

In *Amaranthaceae* family, *Chenopodium quinoa* having the highest transmission rate across all tested plants (64%). Both the plants showed necrotic local lesions as symptom and the symptom expression ranged between 6-10 days.

In *Leguminosae* family, 9 out of 10 crops tested were susceptible to SMV. Highly susceptible crops were *Vigna unguiculata*, *Phaseolus vulgaris* and *Phaseolus lunatus* with transmission rate of 52%, 44% and 44% respectively. The most common symptoms here were mosaic mottling, leaf curling and distortion. Along with these three symptoms, *Vigna unguiculata* also showed necrotic local lesions but did not show puckering whereas *Phaseolus lunatus* also showed puckering but not necrotic local lesions. Moderately susceptible crops included *Vigna radiata*, *Macrotyloma uniflorum*, *Vigna aconitifolia*, *Lens culinary* and *Cyamopsis tetragonoloba* with transmission rate ranging from 8% - 40%. Here, the most common symptom necrotic local lesions. *Cicer arietinum* was the only resistant species. Symptom expression timeline ranged from 4 to 27 days with *V. mungo* having the fastest symptom expression of 4-5 days whereas *Phaseolus lunatus* had the slowest symptom expression of 25-27 days.

In *Cucurbitaceae* family, 3 out of 5 crops tested viz. *Cucumis melo*, *Lagenaria siceraria* and

Momordica charantia were found to be moderately susceptible to SMV whereas the remaining two viz *Cucumis sativus* and *Luffa acutangular* were totally resistant. Here also the most common symptom was necrotic local lesions. The transmission rate for *Cucumis melo*, *Lagenaria siceraria* and *Momordica charantia* was 25%, 24% and 24% respectively and transmission rate of 8-10, 8-18 and 6-28 days respectively.

The *Solanaceae* family showed limited susceptibility, with *Capsicum annum L* showing mild infection and *Solanum melongena* being completely resistant. *Capsicum annum L* had the transmission rate of 12% and symptom expression timeline of 11-12 days. The only symptom that was shown was necrotic local lesions. Both tested crops in the *Asteraceae* family were completely resistant to SMV infection these included *Helianthus annuus* and *Carthamus tinctorius*.

Discussion

The highest susceptibility to SMV was seen in *Amaranthaceae* and *Leguminosae* family whereas *Cucurbitaceae* and *Solanaceae* family displayed moderate to low susceptibility. *Asteraceae* family was entirely resistant and necrotic local lesions were the most frequently observed symptom. Results of this study show that *Vigna unguiculata* and *Chenipodium quinoa* can be considered as good indicator plants of SMV. Also, since both the members of Asteraceae family viz: *Helianthus annuus* and *Carthamus tinctorius* showed complete resistance to SMV at both species and individual plant levels this family may contain potential resistant genes or structural barriers against SMV infection. Therefore, future studies can focus on understanding these resistance mechanisms while at the same time serving as a control group in further studies on SMV infection.

Balgude *et al*. (2021) back indexed on *Chenopodium amaraticolor* and *C. quinoa* and found necrotic local lesions on them. Chakraborty *et al.* (2016) reported the mosaic and yellowing symptoms on leaves of bottle gourd plants infected with SMV from five different crop fields of Cooch Behar district of West Bengal. Whereas, Yoon *et al*. (2017) collected samples of adzuki bean (*Vigna angularis*) featuring mosaic, mottle, yellowing, dwarfing, and leaf rolling symptoms on leaves from 18 cities of Korea in 2015 and 2016. RT-qPCR test revealed *Soybean mosaic virus* (SMV) infection in 33 samples out of 203 tested. Even, Mesa (2018) reported the SMV infection on purple passion fruit (*Passiflora edulis* f. *edulis*) in the province of Antioquia (Colombia) which was confirmed by RT-qPCR.

Table 1 : Host spectrum of soybean mosaic disease across various crops

S. N.	Name of host plants with family	Inoculated	Infected	Transmission (%)	Days for symptoms to expression	Symptoms
A) Leguminosae family						
1.	Cowpea (*Vigna unguiculata*)	25	13	52	06-23	MM, LC, NCL, DIST
2.	Mung bean (*V. radiata*)	25	10	40	07-26	MM, LC, NCL, PUCK
3.	Urd bean (*V. mungo*)	25	07	28	04-05	NCL
4.	Rajma (*Phaseolus vulgaris*)	25	11	44	21-22	MM
5.	Moth bean (*V. aconitifolia*)	25	05	20	08-09	NCL
6.	Chickpea (*Cicer arietinum*)	25	00	00	-	No symptoms
7.	Horse gram (*Macrotyloma uniflorum*)	25	08	32	05-06	NCL
8.	Lima bean (*P. lunatus*)	25	11	44	25-27	MM, LC, PUCK, DIST
9.	Lentil (*Lens culinaris*)	25	04	16	05-08	NCL
10.	Cluster bean (*Cyamopsis tetragonoloba*)	25	02	08	07-10	NCL
B) Cucurbitaceae family						
11.	Bitter gourd (*Momordica charantia*)	25	06	24	06-28	LC, NCL, PUCK

12.	Bottle gourd (*Lagenaria siceraria*)	25	06	24	08-18	LC, NCL
13.	Cucumber (*Cucumis sativus*)	25	00	00	-	No symptoms
14.	Musk melon (*C. melo*)	25	05	25	08-10	NCL
15.	Ridge gourd (*Luffa acutangular*)	25	00	00	-	No symptoms
C) Solanaceae family						
16.	Chilli (*Capsicum annum* L.)	25	03	12	11-12	NCL
17.	Brinjal (*Solanum melongena*)	25	00	00	-	No symptoms
D) Asteraceae family						
18.	Sunflower (*Helianthus annuus*)	25	00	00	-	No symptoms
19.	Safflower (*Carthamus tinctorius*)	25	00	00	-	No symptoms
E) Amaranthaceae family						
20.	Spinach (*Spinacia oleracea*)	25	06	24	09-10	NCL
21.	Amaranthus (*Chenipodium quinoa*)	25	16	64	06-10	NCL

MM: Mosaic mottling; LC: Leaf curling; NLC: Necrotic local lesions; PUCK: Puckering; DIST: Distortion

References

Balgude, Y.S., Zanjare, S.R. and Suryawanshi, A.V. (2021). Host range studies of the virus causing mosaic disease in soybean. *International Journal of Current Microbiology and Applied Sciences*, **10**(1), 1821-1824.

Boss, L. (1972). *Soybean mosaic virus*, description of plant viruses, No. 93. Commonwealth Mycological Institute and Association of Applied Biologist, Kew England.

Brand, R.J., Burger, J.T., and Rybicki, E.P. (1993). Cloning, sequencing, and expression in *Escherichia coli* of the coat protein gene of a new *Potyvirus* infecting South African Passiflora. *Arch Virol*. **128** (1–2),29–41.

Chakraborty, P., Das, S., Saha, D. and Saha, A. (2016). First report of *Soybean mosaic virus* infecting bottle gourd plant in India. *Plant Disease*, **100**(7), 1509.

Clinton, G.P. (1915). Notes on plant diseases of Connecticut. In Conn. State Agr. *Exp. Ann. Reprt.*, 446-451.

Gibbs, A.J., Trueman, J.W.H., and Gibbs, M.J. (2008). The *Bean common mosaic virus* lineage of potyviruses, where did it arise and when? *Archives of Virology*, **153**, 2177-2187.

Hajimorad, M.R., Eggenberger, A.L., and Hill, J.H. (2005). Loss and gain of elicitor function of *Soybean mosaic virus* G7 provoking Rsv1-mediated lethal systemic hypersensitive response maps to P3. *J. Virol*., **79**(2), 1215–1222.

Hajimorad, M. R., Domier, L.L., Tolin, S.A., Whitham, S.A. and Saghai, M.A. (2018). *Soybean mosaic virus*, a successful potyvirus with a wide distribution but restricted natural host range. *Molecular Plant Pathology*, **19**(7), 1563-1579.

IISR 2022. https,//iisrindore.icar.gov.in/.

Mali, V.R. (1995). Profile of viruses naturally infecting soybean in Marathawada. Proceedings of the 10th Annual Convention Indian Society for Virology and National Symposium, Viral Diseases of Socio- Economic Importance Relevant to India, Jan. 16-18, SCTIMST, Dept. Microbiol, Trivandrum, India, pp, 34.

Mesa, H.J. (2018). Molecular characterization of *Soybean mosaic virus* (SMV) infecting purple passion fruit (*Passiflora edulis* f. *edulis*) in Antioquia, Colombia. *Archives of Phytopathology and Plant Protection*, **51**(11-12), 617-636.

Nandakishor, H.V., Kumaraswamy, B., Mane, S.S. and Amrutha V.G. (2017). Host range studies of *Soybean mosaic virus*. *International Journal of Current Microbiology and Applied Sciences*, **6**(7), 304-308.

Nariani, T.K. and Pingale, K.V. (1960). A mosaic disease of Soybean [*Glycene max* (L.) Merr.). *Indian Phytopathology*, **13**, 130-136.

SOPA, 2024a. All India state wise area, production, productivity. https,//www.sopa.org/statistics/soybeanhectaresplanted/?search_type=search_by_year&arrive=2023&starting_year_value=&ending_year_value=&submit=Search.

SOPA, (2024b). World soy oil production. https,// www.sopa.org/world-soy-oil-production/.

Willis, H.L. (2008). Soybean Plant Biology, History, Plant Structure & Growth Cycles. How to Grow Super Soybeans. Acres U.S.A. publisher, 2nd edition.

Yoon, Y., Lim, S., Jang, Y.W., Kim, B.S., Bae, D.H., Maharjan, R., Yi, H., Bae, S., Lee, Y.H., Lee, B.C., Moon, J.S., Park, C.Y. and Lee, S.H. (2017). First report of *Soybean mosaic virus* and *Soybean yellow mottle mosaic virus* in *Vigna angularis*. *Plant Disease*, **102**(3), 689.