International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(12): 346-353
www.biochemjournal.com
Received: 22-10-2025
Accepted: 24-11-2025

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Present status of *Soybean yellow mosaic virus* in agro-climatic zones of Marathwada region of the Maharashtra state

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DOI: https://www.doi.org/10.33545/26174693.2025.v9.i12Se.6534

Abstract
Yellow mosaic disease of soybean, caused by *Soybean yellow mosaic virus* (SYMV), is recognized as one of the most destructive viral diseases of soybean, severely reducing both yield and quality. Soybean (*Glycine max* (L.) Merrill) holds immense economic significance in Maharashtra, and widespread occurrence of SYMV poses a major threat to its sustainable production. The present study was conducted to evaluate the current distribution and severity of yellow mosaic disease across the key soybean-growing agro-climatic zones of the Marathwada region. Extensive field surveys were carried out during the Kharif seasons of 2023-2024 and 2024-2025, covering farmer-managed fields under the Scarcity, Moderate Rainfall and Assured Rainfall zones. The results revealed that the disease is prevalent throughout the region, confirming the widespread presence of SYMV in soybean cultivation areas. A seasonal comparison showed that the disease severity was distinctly higher in Kharif 2023-2024 than in Kharif 2024-2025, demonstrating seasonal variation in viral infection and environmental influence. Among the agro-climatic zones surveyed, the highest disease incidence was recorded in the Moderate Rainfall zone (35.43%), followed by the Assured Rainfall zone (34.33%), while the lowest incidence occurred in the Scarcity zone (31.01%). It was further observed that almost all soybean varieties cultivated in the region exhibited some level of susceptibility to yellow mosaic disease, indicating the absence of strongly resistant cultivars in farmer fields. These findings provide a comprehensive overview of the present status of SYMV in Marathwada and highlight the urgent need for effective management strategies and development of resistant varieties.

Keywords: *Soybean yellow mosaic virus* (SYMV), agro-climatic zones, disease incidence, disease severity, soybean, viral disease, yellow mosaic disease

Introduction
Soybean (*Glycine max* (L.) Merrill; 2n=40) is recognized globally as one of the most important oilseed and protein-rich legume crops. Its origin and early domestication trace back to ancient China, where it was cultivated as a sacred grain, as documented in the earliest Chinese pharmacopeia, “Pen Ts'ao Kang Mu”, compiled in 2838 B.C. by Emperor Shen Nung (Hymowitz, 1970) [7]. Over time, soybean spread beyond East Asia, reaching Europe in 1712, the United States in 1804, Brazil in 1903, and East Africa by 1907, eventually making its way to India between 1870 and 1880 (Mali & Thottappilly, 1989) [12]. Significant advancements in soybean improvement occurred during the 1940s and 1950s in the United States, where systematic breeding programs transformed the plant from a relatively inefficient fodder crop into a high-yielding erect type, establishing the U.S. as the world’s leading soybean producer (Hymowitz & Harlan, 1983) [8]. From a taxonomic perspective, Linnaeus first described the crop under different genera before Merrill (1917) [13] proposed the currently accepted name *Glycine max* (Ratnaparkhe *et al*., 2011) [18]. The genus *Glycine* falls under the family Leguminosae and includes two subgenera: *Glycine* (wild perennial species) and *Soja* (annual species), the latter comprising the cultivated soybean and its wild progenitor *Glycine soja*.
Soybean is often referred to as the “golden bean” owing to its rich nutritional composition approximately 38-43% protein and about 20% oil along with a favourable amino acid profile, including high levels of lysine, which enhances its biological value as a plant-based

protein source (Kudełka *et al.*, 2021) [10]. Historically, soybean has been deeply embedded in East Asian food culture, where it is consumed in diverse forms such as miso, shoyu, tofu, soymilk and tempeh, contributing significantly to regional nutritional security (Rizzo & Baroni, 2018 [19]; do Prado *et al*., 2022) [3].

Globally, soybean is cultivated across major agro-ecological zones. India remains one of the key producers, ranking fifth worldwide with approximately 10 million metric tons (MMT) of production (SOPA, 2020). During 2019-20, India harvested nearly 12 million hectares of soybean, producing 9.30 MMT with an average productivity of 0.78 MT/ha (USDA, 2020). In Maharashtra one of the major soybean-growing states the crop occupied 37.37 lakh hectares during the 2019 Kharif season, yielding 39.42 lakh metric tons (SOPA Databank, 2019).

Despite its economic importance, soybean productivity in India has remained comparatively low due to several interlinked constraints. Over 90% of the crop is cultivated under rainfed conditions, exposing it to periodic drought stress, plant mortality and significant yield losses (Holt *et al*., 1997) [6]. Additionally, biotic stresses, including fungal, bacterial, viral and nematode diseases, further limit production (Paroda, 1999 [16]; Joshi & Bhatia, 2003) [9]. Globally, more than 60 viruses are known to infect soybean, among which 27 are considered economically important. Notable viral pathogens include *Soybean mosaic virus*, *Cowpea mild mottle virus*, *Tobacco ringspot virus*, *Mungbean yellow mosaic virus*, *Alfalfa mosaic virus*, and *Cucumber mosaic virus*. *Soybean yellow mosaic virus* (SYMV), a member of the potyvirus group belonging to the Bean common mosaic virus lineage, has emerged as one of the significant threats across South and East Asia (Gibbs *et al*., 2008) [4].

SYMV was first reported in the United States in 1953 (Pierce, 1953) [17] and subsequently identified in India in 1960 (Nariani, 1960) [14]. It is now widespread across northern and central Indian states, including Madhya Pradesh, Punjab, Haryana, and Karnataka (Bhattacharyya *et al.*, 1999) [1]. The disease is characterized initially by small chlorotic spots that progress into yellow mosaic patches, ultimately leading to complete leaf yellowing. Infected plants bear fewer pods, resulting in yield reductions ranging from 30% to 70%, and in severe epidemics, losses may reach 80% (Malathi, 2007 [11]; Nene, 1972) [15].

In recent years, SYMV has gained prominence in the Marathwada region of Maharashtra, where soybean constitutes a major Kharif crop. Given the expanding incidence, wide host range and increasing severity of the virus, region-specific surveillance has become essential. Systematic field surveys provide critical insights into disease prevalence, hotspot identification and spatial distribution, thereby supporting timely and effective plant protection interventions. Considering these challenges, the present study was undertaken to assess the current status and incidence of SYMV across different agro-climatic zones of the Marathwada region, with the aim of generating baseline data crucial for disease management and future research.

Materials and Methods

Survey

A random survey of selected soybean crop fields, covering three Agro-climatic zones *viz.*, Scarcity Zone (SZ), Assured Rainfall Zone (ARZ) and Moderate Rainfall Zone (MRZ) of Marathwada region of the Maharashtra state were undertaken during Kharif, 2023-24 and 2024-25, to assess soybean yellow mosaic virus incidence and simultaneously collected the disease samples in paper bags and well labeled. Soybean growing pockets / fields were identified from the records available at the office of Sub-Divisional Agriculture Officers, of the respective districts. In the selected soybean crop fields, a 10 m^2 area was randomly selected and counted total number of soybean plants and number of plants showing typical soybean yellow mosaic virus symptoms were recorded and per cent disease incidence were calculated, by applying following formula,

$$\text{Per cent Disease Incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants examined}} \times 100$$

Results and Discussion

Occurrence and distribution of soybean yellow mosaic virus disease

A random survey to record yellow mosaic virus disease in soybean incidence and severity was conducted during the Kharif, 2023-24 and 2024-25 covering 157 and 182 soybean crop fields of 08 districts, distributed under three agro-climatic zones *viz.*, Scarcity zone (06), Assured Rainfall zone (07) and Moderate rainfall zone (08) of Marathwada region of the Maharashtra state (Figure 1 and Plate 1A to 1E).

The results obtained soybean yellow mosaic virus disease, tahsil-wise (Table 1), district-wise (Table 2), soybean verities wise (Table 3) and agro-climatic zone-wise (Table 4) are being interpreted herein under following sub-heads.

Tahsil-wise yellow mosaic virus disease in soybean

The results (Table 1) indicated a wide range of yellow mosaic virus disease in soybean incidence during both the years of survey. Disease incidence was ranged from 14.56 (Wadavani) to 51.13 (*Chatrapati sambhajinagar*) and 22.23 (Wadavani) to 62.96 (*Chatrapati sambhajinagar*) per cent, during *Kharif*, 2023-24 and 2024-25, respectively. However, maximum yellow mosaic virus disease in soybean incidence was recorded in *Chatrapati sambhajinagar* tahsil (51.13 and 62.96%), respectively during *Kharif*, 2023-24 and 2024-25, followed by silod tarsal (50.48%) and Parbhani tarsal (45.20%) in *Kharif*, 2023-24 and silodtarsal (46.31%) and paithan (51.59%) in 2024-25. Rest of the tahsils recorded yellow mosaic virus disease in soybean incidence in the range of 21.26 (kalamb) to 44.31 (Paithan) per cent and 23.52 (Shirur) to 51.14 (Parbhani) per cent, during *Kharif*, 2023-24 and 2024-25, respectively. Whereas, minimum disease incidence was recorded in Wadavani tahsil (14.56 and 21.52%), during *Kharif*, 2023-24 and 2024-25, respectively, followed by kalamb tahsil and Shirur tahsil (21.26 and 23.52%), Vijapur tahsil (22.19) and Kalamb tahsil (29.41%).

District-wise yellow mosaic virus disease in soybean incidence

Results (Table 2) revealed maximum yellow mosaic virus disease in soybean incidence 40.98% and 45.82% in *Chatrapati sambhajinagar* district, respectively, during *Kharif* 2023-24 and 2024-25, with maximum pooled incidence of 43.40%. This was followed by the districts of *viz.*, Parbhani (34.12%, 40.08% and 37.10%), Jalna (31.97%, 40.05% and 36.01%), and Nanded (32.30%,

36.99% and 34.64%) Hingoli (31.04%, 37.17% and 34.09%), Osmanabad (30.41%, 35.30% and 32.85%), Beed (30.00%, 33.07% and 31.43%) and Latur (25.10%, 32.87% and 29.08%). Overall average yellow mosaic virus disease in soybean incidence was maximum (37.66%) during *Kharif*, 2024-25 and was comparatively minimum (31.99%) during *Kharif*, 2023-24.

Variety wise yellow mosaic virus disease in soybean incidence

Result (Table 3) indicated that among overall 12 soybean varieties grown by the farmers of the Marathwada region surveyed (*Kharif*, 2023-24 and 2024-25), maximum yellow mosaic virus disease in soybean incidence was found in KDS (26.84 and 33.30%), respectively. during *Kharif*, 2023-24 and 2024-25, with pooled mean maximum incidence 30.07%. This was followed by varieties *viz*. MAUS-725 (27.10%, 30.52% and 28.81%), MAUS-725 (20.16%, 26.18% and 23.17%), JS-97-52 (20.20%, 24.80% and22.50%), KDS-992 (19.16%, 25.38% and 22.27%), TDS-753(19.20%, 22.33% and 21.76%). In rest of the varieties of soybean, the yellow mosaic virus disease in soybean incidence ranged from 12.34% to 18.08% and 15.84% to 19.70%, respectively during *Kharif*, 2023-24 and 2024-25, with pooled mean incidence in the range of 14.28% to 18.89%.

Agro-climatic zone-wise yellow mosaic virus disease in soybean incidence during *Kharif*, 2023-24 and 2024-25

Results (Table 4) revealed that among three agro-climatic zones *viz*., Scarcity zone (SZ), Assured rainfall zone (ARZ) and Moderate rainfall zone (MRZ) surveyed, maximum yellow mosaic virus disease in soybean incidence of 33.35 and 37.51 per cent, respectively during *Kharif*, 2023-24 and 2024-25, with maximum pooled mean incidence of 35.43 percent in Moderate zone, followed by Assured rainfall zone (32.45%, 36.22% and 34.33%) and Scarcity zone (27.08%, 34.94% and 31.01%). Overall average yellow mosaic virus disease in soybean incidence was maximum (36.22%) during *Kharif*, 2024-25 and was comparatively minimum (30.96%) during *Kharif*, 2022-23. Similar findings were observed by Bhugabati and Goswami (1992) [2] recorded that in bhendi crops sown during May and June, the yellow mosaic disease was found to be highest (100 percent). The disease incidence and whitefly population, however, were found to be the lowest in crops sown in the month of October. Singh *et al*. (1998) [20] surveyed the field of 20 villages of Madhya Pradesh, India and reported the incidence of yellow mosaic virus, whitefly (*Bemisia tabaci)* in soybean. Green (1999) [5] reported under survey statement (by AVRDC) that to reveal the natural occurrence of Mungbean disease caused by Gemini viruses, they collected samples of Mungbean (24 variety samples) from Bangladesh, black gram (30 samples), soybean (2 samples) from western India, Mungbean (14 samples) from Sri Lanka and not a single sample of Mungbean from Tanzania, India Thailand and Vietnam were positive for Mungbean yellow mosaic virus (MYMV) detected with nucleic acid hybridization and PCR.

Table 1: Tahsil-wise yellow mosaic virus disease in soybean incidence during *Kharif*, 2023-24 and 2024-25

Sr. No.	Districts	Tahsils	No of Fields (2023-24)	Av. Incidence (%) (2023-24)	No. of Fields (2024-25)	Av. Incidence (%), (2024-25)
Scarcity Zone						
1.	*Chatrapati sambhajinagar*	Gangapur	4	32.33	4	34.63
		Kannad	5	34.21	5	37.15
		Vaijapur	5	22.19	6	35.45
2.	Beed	Parali	3	31.66	4	33.56
		Wadavani	2	14.56	3	22.33
		Ashti	4	32.39	4	34.12
		Shirur	3	16.82	3	23.52
		Kaij	2	32.28	5	35.38
3.	Osmanabad	Paranda	3	31.69	3	36.65
		Bhoom	4	30.72	3	36.69
Overall Average/Total			35	27.88	40	32.94
Assured Rainfall Zone						
1.	*Chatrapati sambhajinagar*	*Chatrapati sambhajinagar*	5	51.13	7	62.96
		Sillod	7	50.48	9	60.14
		Paithan	6	44.31	6	51.59
		Phulambri	5	42.27	6	47.36
2.	Jalna	Ambad	2	34.23	3	43.50
		Bhokardan	3	40.21	4	49.56
		Jalna	3	29.16	4	31.44
		Partur	2	36.15	3	44.22
		Mantha	3	28.12	3	31.54
3.	Beed	Beed	2	29.33	3	36.60
		Kaij	3	40.40	2	34.22
		Majalgaon	2	38.36	2	39.63
		Ambajogai	2	36.25	3	42.47
4.	Osmanabad	Osmanabad	3	27.03	4	38.78
		Kalamb	3	21.26	3	29.41
		Tuljapur	3	28.33	3	36.30
		Umarga	2	35.47	2	44.52
5.	Latur	Ahmadpur	2	33.06	3	39.60
		Ausa	2	32.12	4	36.31

		Latur	4	24.30	4	35.09
		Chakur	2	26.54	3	33.81
		Udgir	3	22.27	3	30.33
		Nilanga	2	26.31	3	35.29
6.	Parbhani	Parbhani	6	45.20	5	51.14
		Gangakhed	3	34.52	4	38.15
		Pathri	4	30.45	3	33.38
		Jintur	3	30.20	3	37.14
		Selu	3	35.23	3	40.63
7.	Nanded	Kandhar	2	34.14	2	39.15
		Loha	3	27.11	2	33.41
		Deglur	3	34.26	3	42.50
8.	Hingoli	Sengaon	4	30.22	4	37.14
Overall Average / Total:			102	34.78	116	40.23
Moderate Rainfall Zone						
1.	Nanded	Nanded	4	34.65	5	40.38
		Mudkhed	2	32.58	3	34.63
		Ardhapur	3	37.55	2	32.89
2.	Hingoli	Aundha	3	35.12	5	39.02
		Basamat	4	38.08	4	46.15
		Hingoli	2	31.25	5	30.20
		Kalamnuri	2	32.10	2	36.36
Overall Average / Total			20	34.19	26	37.09

Table 2: District-wise yellow mosaic virus disease in soybean incidence during *Kharif*, 2023-24 and 2024-25

Sr. No.	Districts	No. of locations		Av. Incidence (%)		Pooled Mean Incidence (%)
		2023-2024	2024-2025	2023-2024	2024-2025	
1.	*Chatrapati sambhajinagar*	32	43	40.98	45.82	43.40
2.	Beed	20	26	30.00	33.07	31.43
3.	Jalna	12	15	31.97	40.05	36.01
4.	Latur	14	18	25.10	32.87	29.08
5.	Nanded	15	16	32.30	36.99	34.64
6.	Parbhani	14	23	34.12	40.08	37.10
7.	Hingoli	13	21	31.04	37.17	34.09
8.	Osmanabad	15	19	30.41	35.30	32.85
Overall Average/Total		135	181	31.99	37.66	--

Table 3: Yellow mosaic virus disease in soybean incidence on soybean varieties, During *Kharif*, 2023-24 and 2024-25

Sr. No.	Soybean verities	No. of locations		Av. Incidence (%)		Pooled Mean Incidence (%)
		2023-2024	2024-2025	2023-2024	2024-2025	
1.	TDS-753	17	20	19.20	22.33	21.76
2.	MAUS-731	18	24	20.16	26.18	23.17
3.	MAUS-725	21	29	27.10	30.52	28.81
4.	KDS-726	23	30	26.84	33.30	30.07
5.	MAUS-158	14	19	16.12	20.28	18.20
6.	MAUS-71	15	17	17.16	19.35	18.25
7.	JS-97-52	18	21	20.20	24.80	22.50
8.	KDS-992	18	24	19.16	25.38	22.27
9.	MAUS-1520	11	15	13.14	17.41	15.27
10.	MAUS-162	10	16	12.34	16.68	14.51
11.	JS-93-05	12	14	12.72	15.84	14.28
12.	MAUS-612	16	18	18.08	19.70	18.89

Table 4: Agro-climatic zone-wise yellow mosaic virus disease in soybean incidence during *Kharif*, 2023-24 and 2024-25

Sr. No.	Agro-climatic Zone	No. of Locations		Av. Incidence (%)		Pooled Mean Incidence (%)
		2023-2024	2024-2025	2023-2024	2024-2025	
1.	Scarcity zone	35	40	27.08	34.94	31.01
2.	Assured rainfall zone	102	116	32.45	36.22	34.33
3.	Moderate rainfall Zone	20	26	33.35	37.51	35.43
	Overall Average/ Total	157	182	30.96	36.22	--

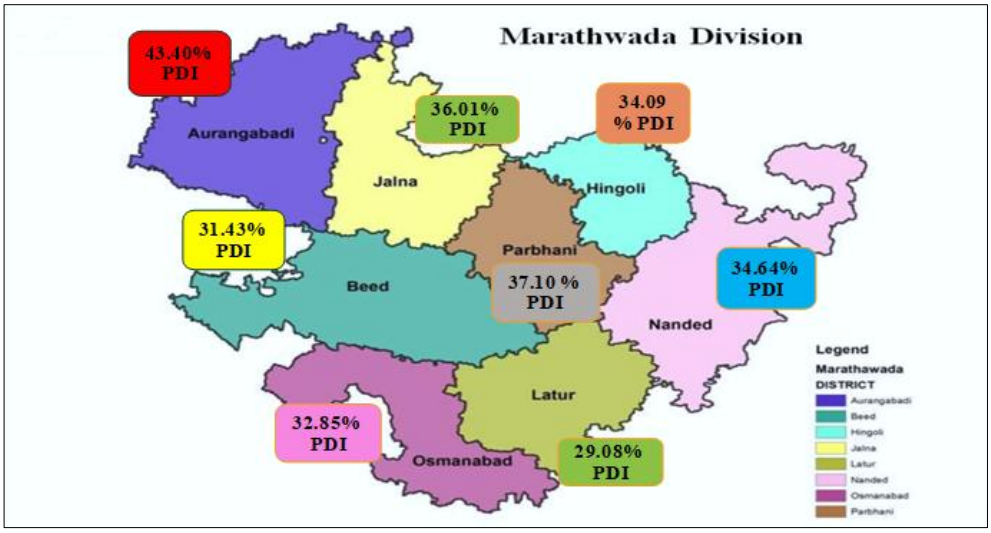

Fig 1: Various Districts of Marathwada region surveyed for YMV disease

Plate 1: A Collection of YMV diseased samples from Assured rainfall zone

Plate 1B: Collection of YMV diseased samples from Assured rainfall zone

Plate 1C: Collection of YMV diseased samples from Moderate rainfall zone

Plate 1: D Collection of YMV diseased samples from Moderate rainfall zone

Plate 1E: Collection of YMV diseased samples from Scarcity zone

Plate 1F: Collection of YMV diseased samples from Scarcity zone

Conclusions

Yellow mosaic disease continues to remain one of the major limiting factors in securing profitable soybean production in the Marathwada region. The present investigation confirms that *Soybean yellow mosaic virus* is widely distributed across all surveyed locations, affecting almost every soybean-growing area. Disease comparison across seasons revealed a comparatively higher intensity during Kharif 2024-25 than in Kharif 2023-24, highlighting the increasing vulnerability of the crop. Among the agro-climatic zones, the Moderate Rainfall Zone and Assured Rainfall Zone exhibited the highest disease severity, while the Scarcity Zone recorded relatively lower intensity. These findings emphasize the urgent need for region-specific disease management strategies and promotion of resistant varieties to minimize yield losses.

Acknowledgment

The authors are grateful to Department of Plant Pathology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani for providing facilities to conduct this research and survey. The authors are also grateful to all those who helped for providing useful information during survey.

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