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Research Note

Association of biochemical traits with Yellow Mosaic Virus (YMV) resistance in F_3 generation of mungbean (*Vigna radiata* (L.) Wilczek)

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Abstract
Yellow Mosaic Virus (YMV) is one of the most destructive viral diseases in mungbean, significantly affecting yield and quality. The present study aimed to investigate the correlation between key biochemical traits and YMV resistance in an F_3 population derived from IPM 2-14 (resistant parent) × GGG 1 (susceptible parent) cross. Disease scoring was performed using a 1–9 scale under natural field conditions. A total of four biochemical parameters *viz.,*total protein, total phenol, total chlorophyll, and tannin content were quantified in selected 10 highly resistant and 10 highly susceptible F_3 individuals. Correlation analysis revealed a significant negative association between YMV disease score and all the biochemical traits namely, protein content (r -0.66**), phenol content (r -0.77**), chlorophyll content (r -0.76**) and tannin content (r-0.71**). These results suggests potential role of these biochemical components in conferring resistance. These findings suggest that selection based on these biochemical traits may assist in enhancing YMV resistance in mungbean.

Keywords: Mungbean, YMV, F_3 population, Disease resistance, Correlation analysis.

Mungbean (*Vigna radiata* L.) is an important short-duration pulse crop, widely cultivated in South and Southeast Asia. Mungbean, also called greengram is a self-pollinated diploid legume ($2n = 2x = 22$) belonging to the subgenus *Ceratotrophis* in the family fabaceae and subfamily Papilionoideae, with a genome size of approximately 579 Mb (Vishwakarma, 2021). According to Adsule *et al*. (1986), mungbean seeds contain 10.6% moisture, 22.9% protein, 1.2% fat, 61.8% carbohydrates, 4.4% crude fiber and 3.5% ash per 100 g. Despite its economic and nutritional importance, mungbean production is severely threatened by Yellow Mosaic Virus (YMV), a whitefly-transmitted begomovirus. The disease causes characteristic yellow patches on leaves, stunted growth, and severe yield losses ranging from 20–80% depending on the cultivar and environmental conditions, while conventional breeding for YMV resistance has made progress, understanding the physiological and biochemical basis of resistance can provide novel avenues for selection and trait-based breeding. Biochemical compounds such as total phenols, chlorophyll, tannins and proteins have been implicated in plant defense against viruses and other pathogens. Recent studies have also emphasized the importance of identifying resistant genotypes for sustainable disease management in pulses (Rajalakshmi *et al.*, 2024). However, limited information is available on the correlation between these traits and YMV resistance in segregating populations of mungbean.

This study evaluated the association of four biochemical traits with YMV resistance in an F_3 population derived from a cross between YMV-resistant (IPM 2-14) and susceptible (GGG 1) parents. The objective was to identify key biochemical indicators associated with resistance that could be used in marker-assisted selection and resistance breeding.

The experiment was conducted using 243 F_3 progenies derived from a cross between a known YMV-resistant parent (IPM 2-14) and a susceptible parent (GGG 1). The cross was made during *rabi2023–24*, F_1 plants were confirmed in *kharif 2024* using morphological and SSR markers, the F_2 generation was grown in *rabi 2024–25*, and the resulting F_3 progenies was evaluated in *summer 2025* for YMV resistance and trait selection. These F_3 progenies were raised using infector row method to ensure natural disease pressure. To ensure uniform and effective disease pressure, infector rows of the susceptible genotype (as check), LGG 450, were planted after every ten rows along with the progeny and parents (YMV resistant and susceptible) of the test material to attract whitefly vectors (*Bemisia tabaci*) and promote the natural spread of MYMV.

Each plant was visually scored for YMV symptoms using a standard 1–9 disease severity scale, where 1 = no symptoms (highly resistant) and 9 = severe chlorosis and stunting (highly susceptible). Data was recorded on YMV disease severity as per (AICRP on MULLARP, Alice and Nadarajan, 2007).

Biochemical components namely, total protein as per Lowry *et al*. (1951), phenol (mg/g), as per Sadasivam and Manikam, (1996), chlorophyll (mg/g) as per Bruinosa, (1963) and tannin content as per Reichert *et al.* (1980) were estimated for 20 F_3 plants (10 highly resistant and10 highly susceptible).

Pearson correlation coefficients were calculated between the disease score and each biochemical trait using statistical software, R and significance was tested at p<0.05 and p<0.01.

Screening of F_3 Progeny for YMV Resistance: Out of a total of 243 F_3 individuals evaluated, 172 were categorized as highly resistant (HR), 12 as moderately resistant (MR), 17 as moderately susceptible (MS), 26 as susceptible (S), and 16 as highly susceptible (HS) based on their phenotypic reaction to Yellow Mosaic Virus (YMV). This segregation pattern indicated the presence of a wide range of variability for resistance within the population, suggesting polygenic inheritance of the trait.

Variation in Biochemical Traits: A considerable variation was observed for all biochemical traits among the F_3 plants. The resistant individuals consistently exhibited higher levels of biochemical constituents compared to susceptible ones. In resistant plants, total protein content ranged from 24.1% to 27.7%, phenols from 8.00 to 13.55 mg/g, tannins from 0.20 to 0.25 mg/g, and chlorophyll from 1.18 to 1.67 mg/g. In contrast, susceptible plants recorded lower contents of protein (15.2–20.2%), phenols (4.50–7.68 mg/g), tannins (0.13–0.19 mg/g), and chlorophyll (0.68–0.88 mg/g). The higher accumulation of these compounds in resistant lines suggests their functional role in defense against YMV infection. Similar associations between physiological traits and disease tolerance were reported earlier in mungbean by Prakash *et al.* (2021) and Kumar *et al.* (2022). Variation in the biochemical components of resistant and susceptible F_3 individuals are shown in **Table 1**.

Correlation with Disease Severity: Correlation analysis between YMV score and biochemical constituents revealed significant negative associations for all four traits. Protein content (r = –0.66**), phenol content (r = –0.77**), chlorophyll content (r = –0.76**), and tannin content (r = –0.71**) were all strongly and negatively correlated with YMV severity (**p < 0.01**), indicating that higher levels of these compounds are associated with increased resistance (**Fig. 1**). These results imply that selection for elevated biochemical components could be effectively utilized to enhance YMV resistance in mungbean.

The present findings confirm earlier reports highlighting the role of biochemical compounds in plant defense against viral pathogens. Elevated phenolic content contributes to structural reinforcement of cell walls and inhibition of viral replication, thereby enhancing resistance (Sai *et al*., 2017). Similarly, increased protein levels may reflect enhanced synthesis of defense-related enzymes and metabolic activity during stress responses.

The strong negative association between chlorophyll content and YMV severity corresponds to the visual symptom of chlorosis in infected plants. Chlorophyll degradation is a hallmark of virus-induced oxidative stress, and its retention is a characteristic of tolerant genotypes (Choudhary *et al*., 2023). Tannins, though present in smaller quantities, also showed higher accumulation in resistant plants. Their antioxidant potential aids in scavenging reactive oxygen species (ROS) generated during infection, supporting an early defense mechanism (Lavanya *et al*., 2022; Ramarao *et al*., 2023).

Similar biochemical patterns were reported in mungbean by Shanmugapriya *et al*. (2022), who observed strong correlations between phenolic content, peroxidase activity, and YMV resistance levels. These studies, along with the present results, demonstrate that enzyme-linked phenolics and antioxidant compounds could serve as both biochemical indicators and functional defense molecules.

Collectively, the present investigation highlights that biochemical constituents such as protein, phenols, chlorophyll, and tannins play a crucial role in conferring YMV resistance. Integration of biochemical markers with

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Table 1. Variation in the biochemical components of 10 resistant and 10 susceptible F_3 individuals

S.No.	Plant No.	YMV Score	Total protein (%)	Total phenol (mg/g)	Total chlorophyll (mg/g)	Total tannins (mg/g)
1	4	0	24.6	9.59	1.67	0.22
2	6	0	24.1	8.00	1.52	0.21
3	11	0	25.3	11.97	1.49	0.20
4	26	1	25.2	10.39	1.18	0.23
5	27	0	27.4	9.47	1.27	0.23
6	34	1	25.9	13.55	1.25	0.22
7	37	0	27.7	11.04	1.28	0.23
8	41	2	27.1	8.35	1.40	0.24
9	43	0	24.8	11.44	1.42	0.22
10	50	1	26.9	11.24	1.25	0.25
11	15	2	17.3	5.60	0.88	0.19
12	24	5	18.4	4.99	0.79	0.15
13	42	2	18.1	4.95	0.68	0.16
14	48	2	17.6	7.68	0.86	0.13
15	57	6	20.2	4.53	0.76	0.17
16	60	5	18.6	6.84	0.74	0.15
17	64	2	15.2	5.45	0.81	0.17
18	71	7	18.3	4.50	0.88	0.16
19	73	5	18.0	5.11	0.69	0.15
20	76	4	19.8	6.38	0.70	0.17
Mean		2.25	22.02	8.05	1.07	0.19
Maximum		7	27.7	13.55	1.67	0.25
Minimum		0	15.2	4.50	0.68	0.13
SD			4.18	2.91	0.30	0.036

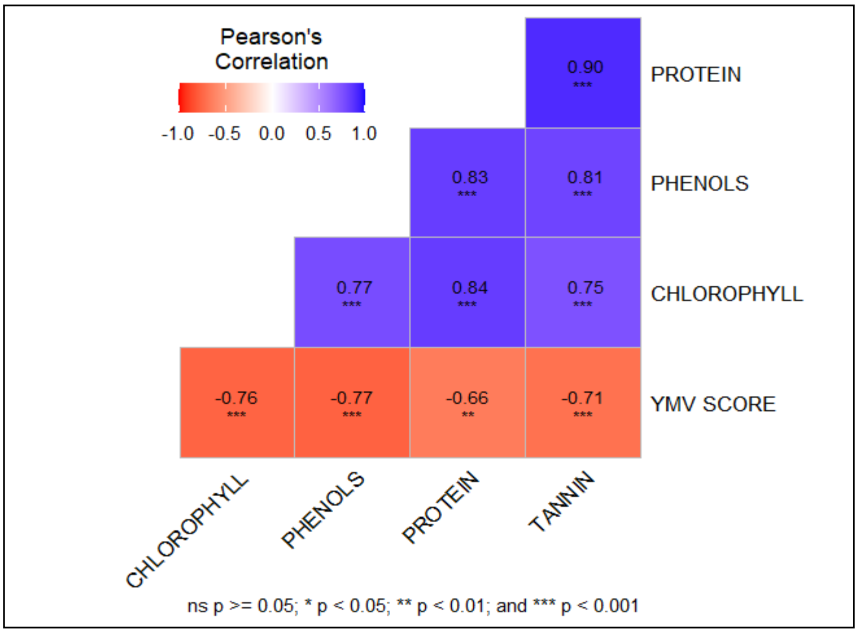

Fig. 1. Correlation coefficients between yellow mosaic disease (YMD) and biochemical components

phenotypic and molecular screening could therefore accelerate the development of durable YMV-resistant mungbean varieties.

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