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A study on biochemical properties of mungbean lines for mungbean yellow mosaic virus (MYMV) resistance

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Abstract
Pulses are the most important and nutrient rich food preferred by most of the people for their daily consumption. Mungbean Yellow Mosaic Virus is one such diseases which reduce the grain yield tremendously However, these correlation between MYMV resistance and their related characters determined to identify the traits significantly associated with MYMV resistance. The genetic contribution of each character in building up total genetic architecture of resistance would provide a realistic basis for allocation of weightage to each of these traits which would help in genetic improvement of mungbean. The present study was undertaken to study the nine mungbean lines for MYMV incidence and MYMV intensity along with their biochemical properties related to MYMV such as chlorophyll content index, sugar content at Pulse Research Station, Dr. PDKV, Akola during *kharif* season 2022. In the present investigation, it was observed that, highest and lowest MYMV incidence was observed by the line AKAM-1803 62.50% (52.25) and TMB-36 2.83% (9.68), respectively. The highest and lowest MYMV intensity percent was recorded in the line AKAM-1803 33.75% (35.51) and TMB-36 1.60% (7.25), respectively. The highest and lowest chlorophyll content index was recorded by the line TMB-36 (58.8%) and AKAM-1803 (48.46%), respectively. The highest and lowest sugar content was recorded by the line TMB-36 (2.93 mg/g) and AKAM-1803 (1.95 mg/g), respectively From the correlation studies it was observed that, MYMV incidence had significantly positive correlation with MYMV intensity (r=1.0005*) whereas, On the other hand, MYMV incidence had negative correlation with chlorophyll content index (r=-0.924*) and sugar content (r=-0.956*).

Keywords: Mungbean, MYMV, correlation, MYMV incidence, MYMV intensity, chlorophyll, sugar

Introduction
India is a major producer and consumer of pulses in world. Pulses play a major role in Indian Agricultural Economy as well as nourishing peoples. Mungbean (*Vigna radiata* L. Wilczek) 2n=22 is one of the most important pulse crops in India. It is reported that mungbean has originated in the Indian subcontinent (De Condolle, 1884; Vavilov, 1926) [3, 8]. It is cultivated in wide range of soil and agro-ecological situations. It is widely adapted in tropical and sub-tropical climatic condition. It is palatable, easily digestible, high nutritive quality. Mungbean is an excellent source of protein (24 g). It is a good source of carbohydrate (62 g), calorific value (347), calcium (132 mg), sodium (16 mg), fat (1.15 g), phosphorus (367 mg), iron (6.5 mg), zinc (2.68 mg), vitamin-C (4 mg) for 100 g of mature Mungbean seeds Mungbean is a leguminous crop which fix the atmospheric nitrogen by symbiotic association through rhizobium (30-40 kg N/ha). It improves soil fertility and soil productivity. It is also used as green manuring crop which improve the physical properties of soil. It is help to conserve soil moisture and prevent the soil erosion. Mungbean stubbles used as excellent source of feed for animals. Sometimes grown for fodder as straw, hay. (Mogotsi, 2006) [6].

Materials and Methods
Nine mungbean lines were selected for study. The selected lines comprised of promising varieties, derived lines and advanced breeding lines. It varied in seed size, MYMV resistance, MYMV susceptible, etc.

Specific features of the lines which were selected is mentioned below

TMB-36

It is a line obtained from BARC, Trombay Mumbai and maintained at Pulses research unit, Dr. PDKV, Akola. It has recorded to be resistance for MYMV.

TMB-146

It is the line obtained from BARC, Trombay Mumbai and maintained at Pulses research unit, Dr. PDKV Akola. It has recorded to be moderately resistance.

AKAM-1803

It is the line maintained at Dr. PDKV, Akola. It has recorded to be susceptible for MYMV.

VAIBHAV

It is a *kharif* variety superior for its yield. PhuleM-9339 was isolated from the cross between the widely adapted pod shattering resistant parent KDM-1 and powdery mildew resistance parent TARM-18 through pedigree selection method. It is obtained from MPKV, Rahuri and maintained at Pulses research unit, Dr. PDKV Akola.

LGG-408

It is a line obtained from Regional agriculture research station, Lam, Guntur maintained at Pulses research unit, Dr. PDKV, Akola. The variety has round bold seeds and resistance to MYMV.

IPM-512

It is a derived line obtained from IIPR Kanpur and maintained at Pulses research unit, Dr. PDKV, Akola. It produces high stable yields of grain and recorded highly resistance to MYMV.

IPM-409-4 (Heera)

It is a line obtained from IIPR Kanpur and maintained at Pulses research unit, Dr. PDKV, Akola. Dr. It is developed from the centre IIPR Kanpur. It is a *Kharif* and *Summer* superior variety for yield and MYMV resistance.

IPM-410-3 (Shikha)

It is a *kharif* mungbean variety which has been developed at IIPR, Kanpur in year 2016. It is a superior variety for MYMV resistance.

Green Gold

It is the derived line maintained at Dr. PDKV, Akola. It has recorded to be susceptible for MYMV.

MYMV Observations

MYMV incidence (%)

$$\text{Disease incidence} = \frac{\text{(No. of infected plants)}}{\text{(Total number of plant)}} \times 100$$

Scale used for MYMV reaction by World Vegetable Centre, Taiwan (AVRDC)

Grade	% infection	Infection Category
0	All plant free of virus symptoms	Highly resistant
1	1-10% infection	Resistant
2	11-20% infection	Moderately resistant
3	21-30% infection	Moderately susceptible
4	30-50% infection	Susceptible
5	More than 50% infection	Highly susceptible

MYMV intensity (%)

$$\text{MYMV intensity} = \frac{\text{Sum of all disease rating scale}}{\text{Total no of leaves x maximum grade}} \times 100$$

The rating scale for scoring Mungbean Yellow Mosaic Virus disease (Alice and Nadarajan, 2007) [1]

Score	Category	Reaction
1	No visible symptoms on leaves	Free
2	Small yellow specks with restricted spread covering (0.10-5.00%) leaf area of plant	Highly Resistant (HR)
3	Yellow mottling of leaves covering (5.10-10.00%) leaf area of plant	Resistant (R)
4	Yellow mottling of leaves covering (10.10-15.00%) leaf area of plant	Moderately resistant(MR)
5	Yellow mottling and discolouration of (15.10-30.00%) leaf area of plant	Moderately susceptible (MS)
6	Yellow discoloration of (30.10-50.00%) leaf area of plant	Susceptible(S)
7	Pronounced yellow mottling and discolouration of leaves and pods, reduction in leaf size and stunting of plants covering (50.10-75.00%) foliage of plant	Susceptible(S)
8	Severe yellow discoloration of leaves covering (75.10-90.00%) of foliage, stunting of plants and reduction in pod size	Highly susceptible (HS)
9	Severe yellow discoloration of leaves covering above (90.10%) of foliage, stunting of plants and reduction in pod size	Highly susceptible (HS)

Biochemical Characters

The biochemical analysis was done to infer the amount of sugar as well as chlorophyll content index in the mungbean leaf samples. The study was undertaken to understand the metabolic behaviour of selected mungbean lines.

Chlorophyll content index

The chlorophyll content in leaves were recorded at 50% flowering and 10 to 12 days after 50% flowering by using SPAD-502 chlorophyll meter. The SPAD-502 chlorophyll meter recorded the chlorophyll content index in the leaves and the value of chlorophyll content index was used for further calculation.

Sugar content

Total sugars (mg g-1 FW) Total sugar content was estimated using anthrone reagent method (Hedge and Hofreiter, 1962) [4]. Fresh leaf sample of 0.25 g was ground in 5 mL of 70% hot ethanol and centrifuged at 5000 rpm for 15 min. Then the supernatant was discarded and the pellet was air dried. After air drying 5 ml of anthrone reagent (2 g of anthrone in 1 L 10:4 v/v Conc. H2 SO4) was added to the pellet and the tubes were kept in ice bath at 4 °C for 10 min and immediately the tubes were transferred to water bath at 80 °C for 30 min. Later, the tubes were cooled to room temperature and the absorbance was read at 620 nm. A

series of standards were prepared using fructose (1 mg per 10 ml) stock solution.

- Total sugars (mg/g FW of leaf) = Concentration × Qty of extract prepared / 1000 × Weight of the sample

Results and Discussion

MYMV incidence (%)

The lowest MYMV incidence was observed by the line TMB-36 2.83% (9.68) followed by IPM-410-3 5.00% (12.88) and IPM-512 5.43% (13.42) and the height MYMV incidence was recorded in the genotype AKAM-1803 62.50% (52.25) (Table 1)

MYMV intensity (%)

The lowest MYMV intensity was observed by the line TMB-36 1.60% (7.25%) followed by IPM-410-3 2.73% (9.51) and IPM-512 2.97% (9.92) and the hight MYMV intensity was recorded in the genotype AKAM-1803 33.75% (35.52) (Table 1)

Chlorophyll content index

A decrease in chlorophyll content has been widely observed in various host plants following infection with different viruses. The highest chlorophyll content was recorded by the line TMB-36 (58.80) followed by IPM-410-3 (58.67) and IPM-512 (57.53) and the lowest protein content was recorded in the genotype AKAM-1803 (48.47) (Table 1)

Sugar content (mg/g)

The sugar molecules is one of the three main constituents found in food. The body breaks down carbohydrates into glucose which is the main source of energy for bodys cells, tissues and organs. The highest sugar content was recorded in the line TMB-36 (2.29 mg/g) followed by IPM-410-3 (2.82 mg/g) whereas, lowest sugar content was recorded by the line AKAM-1803 (1.95 mg/g). (Table 1)

Correlation studies

The correlation analysis was done between the MYMV incidence, MYMV intensity and biochemical parameters to study the significant influence of biochemical properties related to MYMV. It was observed that MYMV incidence had significantly positive correlation with MYMV intensity (r = 1.005*). Also, MYMV incidence and MYMV intensity had negative correlation with chlorophyll content index (r =-0.92*) and sugar content (r =-0.95*). Whereas, both biochemical parameters chlorophyll content index and sugar content had negatively significant association with the MYMV incidence and MYMV intensity (Table 2).

The mean of chlorophyll content index and sugar content was 53.06 and 2.51 (mg/g) respectively for all the selected Mungbean lines. The chlorophyll content index was observed in the range 48.46-58.8, sugar content in the range 1.95-2.93 (mg/g) in the mungbean lines studied. For all the evaluated parameters F test was found to be significant. Biochemical parameters chlorophyll content index and sugar content showed a strong negative correlation with disease incidence and disease intensity. Similar results in this direction was also observed by Mantesh *et al.*, (2020) [5] where mungbean lines were studied for biochemical changes induced by MYMV. Also a study was reported by Sinha *et al.*, (2010) [7] where they observed similar pattern of correlation between MYMV infection, chlorophyll content index and sugar content which was in accordance with the present study.

Table 1: MYMV incidence, MYMV intensity, chlorophyll content index and sugar content of the selected mungbean lines

Sl. No.	Parents	MYMV incidence (%)	MYMV intensity (%)	Chlorophyll content index	Sugar content (mg/g)
1	TMB-36	2.83 (9.68)	1.60(7.25)	58.8	2.93
2	TMB-146	37.67(37.85)	20.17(26.68)	50.33	2.48
3	AKAM-1803	62.50(52.25)	33.75(35.51)	48.46	1.95
4	VAIBHAV	52.60(46.49)	28.37(32.18)	49.00	2.17
5	LGG-408	10.33(18.72)	5.73(13.85)	52.30	2.57
6	IPM-512	5.43(13.42)	2.97(9.91)	57.53	2.71
7	IPM-409-4	9.67(18.11)	5.25(13.24)	53.30	2.61
8	IPM-410-3	5.00(12.88)	2.73(9.51)	58.66	2.82
9	GREEN GOLD	42.50(40.69)	22.97(28.63)	49.20	2.33
	Parent Mean	25.3927.78)	13.73 (19.64)	53.06	2.51
	Range	2.83(9.68)-62.50(52.25)	1.60(7.25)-33.75(35.51)	48.4-58.8	1.95-2.93
	F test	S	S	S	S

Note: Figures in parenthesis are transformed value and S denotes Significant

Table 2: Correlation between the MYMV incidence, MYMV intensity and biochemical parameters

Variables	MYMV incidence (%)	MYMV intensity (%)	Chlorophyll content	Sugar content (mg/g)
MYMV incidence (%)	1	1.005**	-0.92*	-0.95*
MYMV intensity (%)		1	-0.93*	-0.95*
Chlorophyll content			1	0.91*
Sugar content (mg/g)				1

Note: *significance at 5% and **significance at 1%

Conclusion

Based on correlation studies MYMV incidence and MYMV intensity had negatively significant correlation with chlorophyll content and sugar content. Chlorophyll content had positively significant correlation with sugar content. Thus, correlation studies indicated that selection based on lesser MYMV incidence, lesser MYMV intensity, higher chlorophyll content, higher sugar content and ultimately maximum resistance found for MYMV in mungbean lines.

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Author Contributions

Anjali Talape: Designed the model, analysed the data, computational framework original draft preparation, and wrote the manuscript. Dr. E. R. Vaidya: Conceived the original idea Designed the model and Project Administration. Dr. S. S. Lander: Supervision and Investigation. Dr. M. N Ingole: Visualization and Supervision. Shri. R.D. Walke Supervision and Methodology. Dr. S. D. Jadhao: Supervision and Methodology. Shradha S. Aherkar: Reviewing and Editing. Himaja G: Support and helping hand.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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