Plant Archives Vol. 26, Supplement 1, 2026 pp. 666-674 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.091

A STUDY ON CHARACTER ASSOCIATION OF MUNGBEAN LINES FOR MUNGBEAN YELLOW MOSAIC VIRUS (MYMV) RESISTANCE AND SEED YIELD.

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(Date of Receiving : 28-09-2025; Date of Acceptance : 03-12-2025)

ABSTRACT

The present investigation was carried out to identify various component characters association with MYMV resistance. The experimental material comprised of nine divergent parents and their 36 F_1 and 36 F_2 progenies. The F_1 were obtained by crossing the nine divergent parents in half-diallel fashion during *Kharif* – 2022 and F_2 were obtained by selfing half of the F_1 seeds in *Summer*- 2023. Observations were recorded on days to 50% flowering, days to maturity, plant height (cm), number of branches, number of pods per plant, pod length (cm), number of seeds per pod, 100-seed weight (gm), seed yield per plant (gm), MYMV incidence (%), MYMV intensity (%), chlorophyll index, sugar content (mg/g), protein content (%).

At the phenotypic and genotypic level, MYMV intensity, protein content had significant and positive association with MYMV incidence and chlorophyll index, sugar content had significant negative association with MYMV incidence. Present findings offer valuable implications for designing breeding programs aimed at enhancing seed yield by incorporating MYMV resistance in mungbean. In the present investigation, it could be concluded that the selection would consequently help in MYMV resistance in breeding programme effectively. On the basis of this selection criteria the parents IPM-512, IPM-409-4, IPM-410-3 and TMB-36 were found promising. The F_1 and F_2 crosses viz., TMB-36 X LGG-408, TMB-36 X IPM-409-4, IPM-512 X IPM-410-3 and IPM-410-3 X Green Gold were found superior.

Keywords: Mungbean, MYMV, Correlation, MYMV incidence, MYMV intensity.

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). 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 (24g). It is a good source of carbohydrate (62g), calorific value (347), calcium (132mg), sodium (16mg), fat (1.15 g), phosphorus (367mg), iron (6.5mg), zinc (2.68mg), vitamin-C (4 mg) for 100g 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).

Pulses are the most important and nutrient rich food preferred by most of the people for their daily consumption. Correlation studies help the breeder to decide which character should be chosen for selection to bring about the maximum increase in desirable traits. 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 81 mungbean lines for morphological, MYMV disease related and biochemical properties at Pulse Research Station, Dr. PDKV, Akola during *kharif* season 2022 and *summer* 2023.

Materials and Methods

81 mungbean lines in that 9 parents, 36 F_1 and 36 F_2 crosses made with 9 x 9 half diallel mating desing were selected for study. The selected lines comprised of promising varieties, derived lines and advanced breeding lines. The nine diverse parents TMB-36, TMB-146, AKAM-1803, Vaibhav, LGG-408, IPM-512, IPM-409-4, IPM-410-3, Green Gold. It varied in 50% flowering, days to maturity, 100 seed weight, MYMV resistance, MYMV susceptible, etc. Were crossed in diallel fashion to develop 36 F_1 's during *Kharif* – 2022 and F_2 during *Summer*- 2023. The experimental material comprised of nine parents, 36 F_1 's and 36 F_2 progenies in randomized block design with three replications during *Summer*- 2023 at Pulse Research unit, Dr. PDKV, Akola. Each entry was sown in one row of 4.0 m length in each at 60 cm apart. Each F_1 and parents were raised in two rows, each F_2 was raised in four rows having 4.0 m length, respectively. The data were recorded for

Days to 50 % flowering:

In each plot, the number of days taken for 50 per cent flowering from the date of sowing was recorded on plant basis.

Days to maturity

The number of days taken from the date of sowing to the date of Physiological maturity (pod turning brown or yellow) was recorded.

Plant height at maturity (cm)

Height of the plant was measured at last picking from the base of the plant to the tip of the main shoot in cm.

Number of branches/ plant

The total number of branches was counted at the time of maturity from five randomly selected plants and average was worked out.

Number of pods/plant

The total numbers of pods per plant were counted on randomly selected five plants from cluster at the time of maturity and average over five plants used for final confirmation.

Pod length (cm)

The average length of five pods selected at random in each selected plant was recorded and average value used for final confirmation.

Number of seeds / pod

Total number of seeds per pod and averaged over five pods in each selected plant was recorded.

100-seed weight (gm)

Weight of 100 seed selected at random from each selected plants expressed in grams.

Seed yield /plant (gm)

Total seed weight per plant was recorded in grams (g) as mean of five plants.

MYMV incidence (%)

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

Table 1 : Scale used for MYMV reaction by World Vegetable Centre, Taiwan (AVRDC). Khattak *et al*. (2008)

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 (%):

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

Table 2 : The rating scale for scoring Mungbean Yellow Mosaic Virus disease. (Alice and Nadarajan, 2007)

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)

Total chlorophyll index (%)

The chlorophyll index 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 index in the leaves and the value of chlorophyll index was used for further calculation.

Total sugar content (Mg/g)

Total sugars (mg g^{-1} FW) Total sugar content was estimated using anthrone reagent method (Hedge and Hofreiter, 1962). 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. H_2SO_4) was added to the pellet and the tubes were kept in ice bath C for 10 min and immediately the tubes were transferred to water bath at 4 C for 30 min. Later, the tubes were cooled to room temperature and the 80 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 x Qty of extract prepared / 1000 x Weight of the sample

Protein content (%)

The nitrogen content of grain of each genotype was determined by Kjeldahl method (Li *et al*., 2010). The nitrogen percentage was multiplied by 6.25 factors for to get protein content.

All the necessary data hearts similar to the present results but positive transformations were done

The simple genotypic and phenotypic correlation coefficients were worked out from the respective variances and covariances as per the formulae suggested by Fisher (1958).

Results and Discussion

Correlation

Correlation describes the interrelationship between different characters. In any biological entity the characters are generally associated with each other. Similarly, to find out the degree of association of MYMV resistance and its contributing characters, phenotypic and genotypic correlation coefficients among the different characters have been worked out and presented in Table 3 and 4.

Phenotypic correlations

The study of the results (Table 3) revealed that days maturity had negative and non-significant correlation with days to 50 % flowering (-0.0954).

Plant height at maturity recorded positive and significant correlation with days to maturity (0.142). Also negative but non-significant association with days to 50% flowering (-0.003).

Number of branches had positive non-significant correlation with days to maturity (0.0042). Further, it exhibited significant negative correlation with plant height (-0.396). Negative and non-significant association was recorded days to 50 % flowering (-0.0553).

Number of pods per plant recorded positively significant association with days to maturity (0.132). Non-significant positive correlation with number of branches per plant (0.0369). Further, it exhibited negative and non-significant association was recorded days to 50% flowering (-0.118) and plant height (-0.009).

In pod length Positive and non-significant correlation was exhibited by days to maturity (0.0158), plant height (0.1101). Pod length had negative and significant association with number of branches per plant (-0.1377) and number of pods per plant (-0.166),

Further, it exhibited negative non-significant association with days to 50% flowering (-0.0039),

Number of seeds per pod exhibited positively significant correlation with days to 50 % flowering (0.1569) and Pod length (0.5096). Positive non-significant correlation with Number of branches (0.0165). Further it exhibited negative and significant correlations with (-0.201) and negative non-significant correlations with days to maturity (-0.0189), plant height (-0.0235).

100 seed weight recorded positive non-significant association with number of branches per plant (0.0265) and pod length (0.0718). Negatively significant association with number of pods per plant (-0.245). Negative and non-significant association with days to flowering (-0.0565), days to maturity (-0.1045), plant height (-0.0062), number of seeds per plant (-0.0129).

Chlorophyll index recorded positive significant association with only number of branches per plant (0.2534), number of pods per plant (0.2322) and 100 seed weight (0.170). Positive and non-significant association with pod length (0.0355) and number of seeds per pod (0.0659). Further, it exhibited negative significant association with days to 50 % flowering (-0.24) and plant height (-0.159). Negative and non-significant correlation with days to maturity (-0.1016).

Sugar content exhibited positively significant correlation with number of branches per plant (0.214), number of seeds per pod (0.1415), 100 seed weight (0.168), chlorophyll index (0.714). Positive and non-significant correlation with number of pods per plant (0.0403) and pod length (0.072). Further it exhibited negative and significant correlations with plant height (-0.22) and negative and non-significant correlation with days to 50% flowering (-0.076) and days to maturity (-0.1175).

Protein content exhibited positively significant correlation with days to 50 % flowering (0.195) and positive and non-significant correlation with days to maturity (0.071), plant height (0.071). Negative significant association with number of branches per plant (-0.228), number of pods per plant (-0.146), number of seeds per pod (-0.207), 100 seed weight (-0.129), chlorophyll index (-0.755) and sugar content (-0.763) and negative non-significant correlation with pod length (-0.092).

Seed yield per plant recorded positive association with number of pods per plant (0.53), pod length (0.156), number of seeds per pod (0.31), 100 seed weight (0.226), chlorophyll index (0.401), and sugar content (0.242). Non-significant positive association with days to maturity (0.0915), number of branches per plant (0.0456). Negative significant association with protein content (-0.340) and negatively non-significant association with days to 50 % flowering (-0.054), and plant height (-0.015).

MYMV incidence exhibited positive and significant correlation with 50 % flowering (0.17) and protein content (0.459). Positively non-significant correlation with plant height (0.0047) and number of branches per plant (0.014). Negative significant correlation recorded by number of pods per plant (-0.24), number of seeds per pod (-0.21), 100 seed weight (-0.27), chlorophyll index (-0.629) and sugar content (-0.43). Negatively non-significant association with days to maturity (-0.004), seed yield per plant (-0.560).

MYMV intensity exhibited positive and significant correlation with 50 % flowering (0.175), protein content (0.447) and MYMV incidence (0.995). Positively non-significant correlation with number of branches per plant (0.0341). Negative significant correlation recorded by number of pods per plant (-0.258), number of seeds per pod (-0.208), 100 seed weight (-0.267), chlorophyll index (-0.623) and sugar content (-0.42) and seed yield per plant (-0.565). Negatively non-significant association with days to maturity (-0.0058).

Genotypic correlation

Genotypic correlations for most of the characters were higher than phenotypic correlations. At genotypic level (table 4), The study of the results (Table 4) revealed that days maturity had negative and non-significant correlation with days to 50 % flowering (-0.14).

Plant height at maturity recorded positive and non-significant correlation with days to maturity (0.171). Also negative but non-significant association with days to 50% flowering (-0.010).

Number of branches had positive non-significant correlation with days to maturity (0.0036). Further, it exhibited significant negative correlation with plant height (-0.4455). Negative and non-significant association was recorded days to 50 % flowering (-0.0653).

Number of pods per plant recorded positively non-significant association with days to maturity (0.1475) and number of branches per plant (0.0307). Further, it exhibited negative and non-significant association was recorded days to 50% flowering (-0.179) and plant height (-0.0388).

In pod length Positive and non-significant correlation was exhibited by days to 50% flowering

(0.0308), days to maturity (0.014), plant height (0.171). Pod length had negative and significant association with number of pods per plant (-0.27). Further, it exhibited negative non-significant association with number of branches per plant (-0.153)

Number of seeds per pod exhibited positively significant correlation with Pod length (0.618). Positive non-significant correlation with days to 50 % flowering (0.1751), plant height (0.002), Number of branches (0.0202). Further it exhibited negative and significant correlations with number of pods per plant (-0.261) and negative non-significant correlations with days to maturity (-0.0152).

100 seed weight recorded positive non-significant association with number of branches per plant (0.0338) and pod length (0.102). Negatively significant association with number of pods per plant (-0.28). Negative and non-significant association with days to flowering (-0.0693), days to maturity (-0.1259), plant height (-0.006), number of seeds per plant (-0.0212).

Chlorophyll index recorded positive significant association with number of branches per plant (0.2579), number of pods per plant (0.274). Positive and non-significant association with pod length (0.0349), number of seeds per pod (0.0701) and 100 seed weight (0.1849). Further, it exhibited negative significant association with days to 50 % flowering (-0.2833). Negative and non-significant correlation with days to maturity (-0.1121) plant height (-0.1885).

Sugar content exhibited positively significant correlation with number of branches per plant (0.223), chlorophyll index (0.755). Positive and non-significant correlation with number of pods per plant (0.0536) and pod length (0.0767), number of seeds per pod (0.1613), 100 seed weight (0.193). Further it exhibited negative and significant correlations with plant height (-0.2524) and negative and non-significant correlation with days to 50% flowering (-0.1063) and days to maturity (-0.1181).

Table 3 : Estimates of phenotypic correlation coefficient.

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches	No. of pod /Plant	Pod length (cm)	No. of seeds/ pod (gm)	100-seed wt. (gm)	Chlorophyll Index	Sugar content (mg/g)	Protein content (%)	Seed yield/ Plant (gm)	MYMV incidence (%)	MYMV Intensity (%)
Days to 50% flowering	1**	-0.0954	-0.003	-0.0553	-0.118	-0.0039	0.1569*	-0.0565	-0.24**	-0.076	0.195**	-0.054	0.17**	0.1756**
Days to maturity		1**	0.142*	0.0042	0.132*	0.0158	-0.0189	-0.1045	-0.1016	-0.1175	0.071	0.0915	-0.004	-0.0058
Plant height (cm)			1**	-0.396**	-0.009	0.1101	-0.0235	-0.0062	-0.159*	-0.22**	0.105	-0.015	0.0047	-0.0111
No. of branches				1**	0.0369	-0.1377*	0.0165	0.0265	0.2534**	0.214**	-0.228**	0.0458	0.014	0.0341
No. of pods /Plant					1**	-0.166**	-0.201**	-0.245*	0.2322**	0.0403	-0.146*	-0.53**	-0.24**	-0.258**
Pod length (cm)						1**	0.5096**	0.0718	0.0355	0.072	-0.092	0.156*	-0.110	-0.106
No. of seeds/ pod (gm)							1**	-0.0129	0.0659	0.1415*	-0.207**	0.31**	-0.21**	-0.208**
100-seed wt. (gm)								1**	0.170**	0.168**	-0.129*	0.226**	-0.27**	-0.267**
Chlorophyll index									**1****	0.714**	-0.755**	0.401**	-0.629**	-0.623**
Sugar content (mg/g)										**1****	-0.763**	0.242**	-0.43**	-0.42**
Protein content (%)											**1****	-0.340**	0.459**	0.447**
Seed yield/ Plant (gm)												**1****	-0.560	-0.565**
MYMV incidence (%)													**1****	0.995**
MYMV Intensity (%)														**1****

* Significant at 5 % level, ** Significant at 1 % level

Table 4 : Estimates of genotypic correlation coefficient.

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches	No. of pod /Plant	Pod length (cm)	No. of seeds/ pod (g)	100-seed wt. (gm)	Chlorophyll Index	Sugar content (mg/g)	Protein content (%)	Seed yield/ Plant (gm)	MYMV incidence (%)	MYMV Intensity (%)
Days to 50% flowering	1**	-0.14	-0.010	-0.0653	-0.179	0.0308	0.1751	-0.0693	-0.283*	-0.1063	0.2168	-0.0459	0.2137	0.2032
Days to maturity		1**	0.171	0.0036	0.147	0.014	-0.0152	-0.1259	-0.1121	-0.1181	0.0727	0.0745	-0.0017	-0.0093
Plant height (cm)			1**	-0.4455**	-0.038	0.171	0.002	-0.006	-0.1885	-0.252*	0.1365	-0.0078	-0.0025	-0.0156
No. of branches				1**	0.030	-0.153	0.0202	0.0338	0.2579*	0.2238*	-0.23*	0.057	0.013	0.0343
No. of pods /Plant					1**	-0.27*	-0.261*	-0.28**	0.274*	0.0536	0.1852	0.752**	-0.295**	-0.3103**
Pod length (cm)						1**	0.618**	0.102	0.0349	0.0767	-0.1018	0.1813	-0.1259	-0.1194
No. of seeds/ pod (g)							1**	-0.0212	0.0701	0.1613	-0.2423	0.379**	-0.2348*	-0.2299*
100-seed wt. (gm)								1**	-0.283*	-0.1063	0.2168	0.222*	-0.3034**	-0.2881**
Chlorophyll index									**1****	0.755**	-0.77**	0.4406**	-0.638**	-0.631**
Sugar content (mg/g)										**1****	-0.80**	0.2846*	-0.4564**	-0.4427**
Protein content (%)											1**	-0.3833**	0.4722**	0.4595**
Seed yield/ Plant (gm)												**1****	-0.6199**	-0.6266**
MYMV incidence (%)													**1****	0.9987**
MYMV Intensity (%)														**1****

* Significant at 5 % level, ** Significant at 1 % level

Protein content exhibited positive and non-significant correlation with days to 50 % flowering (0.2168), days to maturity (0.0727), plant height (0.1365), number of pods per plant (0.1852). Negative significant association with number of branches per plant (-0.237), chlorophyll index (-0.755) and sugar content (-0.807). Negative non-significant correlation with pod length (-0.1018), number of seeds per pod (-0.2423) and 100 seed weight (-0.1399).

Seed yield per plant recorded positive association with number of pods per plant (0.752), number of seeds per pod (0.379), 100 seed weight (0.222), chlorophyll index (0.4406), sugar content (0.284). Non-significant positive association with days to maturity (0.0745), number of branches per plant (0.057), pod length (0.1813). Negative significant association with protein content (-0.383) and negatively non-significant association with days to 50 % flowering (-0.0459), and plant height (-0.0078).

MYMV incidence exhibited positive and significant correlation with protein content (0.4722). Positively non-significant correlation with 50 % flowering (0.2137), number of branches per plant (0.013). Negative significant correlation recorded by number of pods per plant (-0.295), number of seeds per pod (-0.2348), 100 seed weight (-0.3034), chlorophyll index (-0.638) and sugar content (-0.456) and seed yield per plant (-0.6199). Negatively non-significant association with days to maturity (-0.0017), plant height (0.0025).

MYMV intensity exhibited positive and significant correlation with protein content (0.459) and MYMV incidence (0.998). Positively non-significant correlation with 50 % flowering (0.2032), number of branches per plant (0.0343). Negative significant correlation recorded by number of pods per plant (-0.3103), number of seeds per pod (-0.2299), 100 seed weight (-0.2881), chlorophyll index (-0.621) and sugar content (-0.442) and seed yield per plant (-0.626). Negatively non-significant association with days to maturity (-0.0093) and plant height (-0.0156).

Correlation coefficient is an important statistical constant, which indicates the degree of association among the various characters. The efficiency of

selection depends upon the direction and magnitude of association between yield and its component. The genotypic correlation was generally higher than phenotypic correlation indicating the inherent association between various traits.

In present investigation major emphasis was given on seed yield and MYMV resistance which is a complex character and is dependent on number of component characters. In general, the genotypic correlation coefficients were higher than phenotypic correlation coefficient indicating limited role of the environment in expression of the traits in genotypes.

Phenotypic and genotypic correlation of days to 50% flowering was non-significant and negatively correlated with seed yield. The character days to maturity showed positive and non-significant correlation with seed yield. Similar results have been reported by Mhanta and Sao (2019) for days to 50 per cent flowering. Phenotypic and genotypic correlation of days to 50% flowering was significant and positively correlated with MYMV incidence and MYMV intensity similar results shows in Alam *et al.* (2014).

Plant height at maturity recorded positive and significant correlation with days to maturity. Also negative but non-significant association with days to 50% flowering. similar results were recorded by Khatik *et al*. (2022). Further, that plant height at maturity recorded positive and significant correlation with days to maturity similar results were recorded by Khatik *et al*. (2022), Choudhary *et al*. (2016) and Anita *et al*. (2022). Also the Choudhary *et al*. (2016) reported similar result with present investigation were plant height shows negative correlation with seed yield per plant.

Number of branches had positive non-significant correlation with days to maturity. Further, it exhibited significant negative correlation with plant height. Negative and non-significant association was recorded days to 50 % flowering. Similar results found in Choudhary *et al*. (2016), Kate *et al*. (2017) and Chaoudhary (2016). Also in the present investigation number of branches positively correlation with seed yield per plant similarly results were recorded by Garg *et al*. (2017), Anita *et al*. (2022), Kadam *et al*. (2023) and Singh *et al*. (2016). Number of branches per plant had positively correlation with MYMV similar results found in Vadilvel *et al*. (2019),

Number of pods per plant recorded positively non-significant association with days to maturity and number of branches per plant similar pattern found in Prasaniya *et al*. (2022) and Anita *et al*. (2022). Further, it exhibited negative and non-significant association was recorded days to 50% flowering and plant height similar pattern found in Kadam *et al*. (2023) and Khan *et al*. (2024).

In pod length Positive and non-significant correlation was exhibited by days to 50% flowering, days to maturity, plant height Similar result found in Parsaniya *et al*. (2022) and Singh *et al*. (2016). Pod length had negative and significant association with number of pods per plant. Further, it exhibited negative non-significant association with number of branches per plant similar results found in Kumar *et al*. (2020) and Kadam *et al*. (2023).

Number of seeds per pod exhibited positively significant correlation with Pod length similar results were recorded by Parsaniya *et al*. (2022). Positive non-significant correlation with days to 50 % flowering, plant height, Number of branches similar results were recorded by Anita *et al*. (2022), Choudhary *et al*. (2016) and Khatik *et al*. (2022). Further it exhibited negative and significant correlations with number of pods per plant and negative non-significant correlations with days to maturity similar results were recorded by Alam *et al*. (2014) and Marawar *et al*. (2020).

100 seed weight recorded positive non-significant association with number of branches per plant and pod length. Negatively significant association with number of pods per plant. Negative and non-significant association with days to flowering, days to maturity, plant height, number of seeds per plant similar results were recorded by Choudhary *et al*. (2016), Garg *et al*. (2017), Das *et al*. (2015), Parsaniya *et al*. (2022) Marawar *et al*. (2020). In present investigation 100 seed weight had negatively correlation with MYMV similar results were recorded by Alam *et al*. (2014).

In the present investigation chlorophyll index recorded positive significant association with number of branches per plant, number of pods per plant. Positive and non-significant association with pod length, number of seeds per pod and 100 seed weight. Further, it exhibited negative significant association with days to 50 % flowering. Negative and non-significant correlation with days to maturity, plant height similar results were recorded by Supreetha *et al*. (2023) and Lalinia and Khameneh (2014), and Sunayana *et al*. (2017). Also in the present investigation chlorophyll content negatively correlated with MYMV incidence and MYMV intensity similar result found in Sinha *et al*. (2010) and Dutta *et al*. (2015) in black gram.

Protein content exhibited positive and non-significant correlation with days to maturity, plant height, and number of pods per plant. Negative significant association with number of branches per plant, chlorophyll index. Negative non-significant correlation with pod length, number of seeds per pod and 100 seed weight. Similar results were found in Kate *et al*. (2017) and Anita *et al*. (2022) and Kumar *et al*. (2020).

Seed yield per plant recorded positive association with number of pods per plant, number of seeds per pod, 100 seed weight, chlorophyll index, sugar content. Non-significant positive association with days to maturity, number of branches per plant, pod length. Negative significant association with protein content and negatively non-significant association with days to 50 % flowering, and plant height. Similar results were recorded by Anita *et al*. (2022), Kate *et al*. (2017), Mahanta and Sao (2019), Khatik *et al*. (2022), Das and Barua (2015), Choudhary *et al*. (2016), Garg *et al*. (2017), Kadam *et al*. (2023), Singh *et al*. (2016), Khan *et al*. (2024), Kumar *et al*. (2020), Marawar *et al*. (2020) and Parsaniya *et al*. (2022).

MYMV incidence and MYMV intensity exhibited positive and significant correlation with protein content. Positively non-significant correlation with 50 % flowering, number of branches per plant. Negative significant correlation recorded by number of pods per plant, number of seeds per pod, 100 seed weight, chlorophyll index and sugar content and seed yield per plant. Negatively non-significant association with days to maturity, plant height. Similar results were recorded by Alam *et al*. (2014) for traits 100 seed weight, seeds per pod, pods per plant, days to 50% flowering, days to maturity. Also Vadivel *et al*. (2019) show similar results MYMV disease scores with trait plant height, Number of branches, number of pods per plant, pod length, number of seeds per pod, 100-seed weight. Sinha and Shrivastava (2010) reported reduction in chlorophyll index has been reported in many host plants infected with different viruses, for MYMV incidence and MYMV intensity had positive significant correlation with protein content and negative significant correlation with chlorophyll index and sugar content.

Conclusion

At the phenotypic and genotypic level, Seed yield per plant recorded positive association with number of pods per plant, number of seeds per pod, 100 seed weight, chlorophyll index, sugar content, Non-significant positive association with days to maturity, number of branches per plant, pod length. Negative significant association with protein content and negatively non-significant association with days to 50 % flowering and plant height. MYMV incidence exhibited positive and significant correlation with protein content. Positively non-significant correlation with 50 % flowering, number of branches per plant. Negative significant correlation recorded by number of pods per plant, number of seeds per pod, 100 seed weight, chlorophyll index, and sugar content and seed yield per plant. Negatively non-significant association with days to maturity, plant height.

Thus, correlation studies indicated that selection of genotypes for seed yield and MYMV resistance would simultaneously result in selection of genotypes with high yield, minimum MYMV incidence, minimum MYMV intensity, maximum sugar content and chlorophyll index, minimum protein content. Thus it can be concluded that selection made on the basis of suggested yield and MYMV contributing traits may improve MYMV resistance in mungbean. on the basis of seed yield per plant, MYMV incidence, MYMV intensity, chlorophyll index, sugar content, protein content and ultimately maximum resistance to MYMV.

Acknowledgements

The authors are thankful to all the members who are part of the research work for their support and help and for providing necessary facilities to carry out this experimental work.

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.Dr. Archana Thorat: Supervision and Methodology. V.T. Kogade: Reviewing and Editing. : Support and helping hand.

Conflict of Interest The authors declare no competing interest.

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