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ANALYSIS OF HETEROSIS USING LINE × TESTER IN GREEN GRAM (*VIGNA RADIATA* L.)

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ABSTRACT

The present investigation was carried out at the Department of Genetics and Plant Breeding, School of Agriculture, Lovely Professional University, Phagwara, Punjab (India). The present study was undertaken by comprising 9 females or lines *viz.*, MGG- 366, MGG- 295, WGG-37 (eksheela), TM-96-2, MGG-348, MGG-347, MGG-351, Moong Tilak, Tilak Gold and 4 males or testers include Rajendran G-65, WGG-42, LGG- 460, Banshi Moong and 1 check (SML 668) were used. The inbred lines were collected from the KVK, Rudroor, Telangana and ARS, Sri Ganganagar as part of germplasm collection. Total 36 crosses which made by Line × Tester mating design during summer 2023. The hybrids (36) along with parents (13) and 1 check were grown and tested in RBD with three replications. The characters or traits studied in this research are *viz;* Days to 50 per cent flowering, Days to maturity, Plant height (cm), Number of branches per plant, 100 seeds weight (g), Grain yield per plant (g), Number of seeds per pod, Length of the pod (cm), Number of clusters per plant, Number of pods per plant, Harvest Index (%). The crosses that shown best heterosis over better parent are Days to 50 per cent flowering for the cross of MGG-348 × LGG-460, Days to Maturity for the cross of MGG- 295× LGG-460, Plant height (cm) for the cross of MGG-351 × WGG-42, Number of branches per plant for the cross of WGG- 37 (eksheela) × BANSHI MOONG, Number of pods per plant for the cross of MGG-348 × LGG-460, 100 seeds weight (g) for the cross of MGG-348 × LGG- 460, Grain yield per plant (g) for the cross of MGG-348 × LGG-460, Number of seeds per pod for the cross of MGG- 295× LGG-460, Length of pod (cm) for the cross of MGG-348 × LGG- 460, Number of clusters per plant for the cross of MGG-347× LGG-460, Harvest Index (%) for the cross of TILAK GOLD × RAJENDRAN-G-65.

***Keywords*:** Heterosis, lines, testers, RBD, clusters, Harvest Index

Introduction

Green gram known as mung or mung bean in India, is the third important pulse crop in India after chickpea and pigeon pea. It is considered as wholesome among pulses, free from heaviness and flatulence. Besides its utilisation as food in many forms, haulms are used as fodder and green manure. Due to its shorter duration, it can be fitted in several multiple cropping systems. Just like other pulse crops, inclusion of green gram in cropping systems improves soil health and fertility. (Reddy, 2014).

Greengram (*Vigna radiata* L.) is one of the most significant edible pulse crops with chromosome number 22 (Karpechenko, 1925). It is an annual short duration and is predominantly self-pollinated crop. This well-known and prehistoric pulse crop is native to Southeast Asia and is a member of the Fabaceae family (Rehman *et al.*, 2009). This small, round legume, sometimes referred to as golden gram or mung bean, is widely grown and consumed throughout the world. It is a crop with a balanced nutritional profile that contains significant levels of bioactive compounds, dietary fiber, vitamins, minerals, and protein (Gan *et al.*, 2017). To top it off, it is known to have more iron and folate than most other legumes (Keatinge *et al.*, 2011). There are also notable concentrations of essential amino acids including lysine, isoleucine, phenylalanine and leucine (Lambrides and Godwin, 2007). It is extensively treasured in India, especially by the country's large vegetarian population, because it offers an abundant supply of high-quality, readily digestible protein. It supplies high quality protein (22-24%) (Rahim *et al.*, 2010). Greengram has become a highly profitable short-duration grain legume crop (Kumari *et al.*, 2023) and due to its many desirable traits, such as increased flexibility, relatively drought tolerant, lower input requirements, and the ability to improve soil fertility by fixing atmospheric nitrogen with the help of rhizobium.

In heterosis breeding programmes, large number of hybrids are produced and evaluated to exploit hybrid vigour, which usually requires more resources and manpower. It is possible to select the parental lines based on their genetic diversity status to effect limited crosses with better success, if there is a relationship between heterosis for yield and genetic diversity. With these ideas an experiment was conducted to study heterosis using Line × Tester Analysis in Green gram (*Vigna radiata* L.) in 2023 in plain zone of Punjab.

Materials and Methods

The experiment was laid out in Randomized Block Design with three replications. It comprising of 36 crosses, 9 females and 4 male parents and one check *viz*., SML 668 were included (Table 1). The present investigation was conducted during *summer* 2023 at Post Graduate Research Farm, School of Agriculture, LPU, Punjab. The inbred lines were collected from the KVK, Rudroor, Telangana and ARS, Sri Ganganagar.

Table 1: List of Genotypes and check used in crossing programme

Sr.	Genotypes	Source
	Lines	
1	MGG- 366	KVK, Rudroor, Telangana
2	MGG- 295	KVK, Rudroor, Telangana
3	WGG-37 (Eksheela)	KVK, Rudroor, Telangana
4	TM- 96-2	KVK, Rudroor, Telangana
5	MGG-348	KVK, Rudroor, Telangana
6	MGG-347	KVK, Rudroor, Telangana
7	MGG-351	KVK, Rudroor, Telangana
8	Moong Tilak	ARS, Sri Ganganagar
9	Tilak Gold	ARS, Sri Ganganagar
	Testers	
1	Rajendran G-65	KVK, Rudroor, Telangana
2	WGG-42	KVK, Rudroor, Telangana
3	LGG- 460	ARS, Sri Ganganagar
4	Banshi Moong	ARS, Sri Ganganagar
Check		
1	SML 668	PAU, Ludhiana

Estimation of Heterosis

The significance of differences between treatments was assessed by conducting an analysis of variance (ANOVA) for Randomized Block Design (RBD) using the procedure outlined by Panse and Sukhatme (1985) for all the metric traits studied. The performance of the F_1 hybrid was evaluated based on the heterosis over better parent and standard check, following the method proposed by Fonseca and Patterson (1968). The percent increase or decrease in F_1 hybrids over better parent and standard checks was calculated to determine heterosis, using the formulae given by Singh and Chaudhary (1977). Significance of heterosis is tested with the help of standard error using 't' test.

Heterosis over Better parent (BPH)

$$BPH\% = \frac{F1 - BP}{BP} x\ 100$$

Heterosis over standard check (SH)

$$SH\% = \frac{F1 - SC}{SC} x\ 100$$

Results and Discussion

Analysis of variance

The analysis of variance indicated that the presence of significant genetic variability among parents, hybrids and check for all the characters or traits involved. The replication mean sum of squares is highest for the trait of harvest index (11.44) whereas, the lowest mean sum of squares is with the trait of number of seeds per pod (0.003). However, in treatment mean sum of squares gives highest for the trait of days to maturity (200.37) at one percent level of significance and the lowest is towards the number of branches per plant (1.23) at one percent level of significance. Length of pod is the only trait that does not possess significance at both the level of significance. The error mean sum of squares is lowest for the trait of number of seeds per pod (0.17) and highest for harvest index (13.07). The successive results were presented in Table 2.

Table 2: Analysis of variance for experimental design in respect to different traits in green gram

Sr. No	Characters	Mean Sum of Squares		
		Replication	**Treatments**	**Error**
		(2)	**(48)**	**(98)**
1	Days to 50 per cent flowering	1.23	152.41**	2.38
2	Days to Maturity	0.57	200.37**	1.86
3	Plant height (cm)	0.245	158.68**	7.75
4	Number of branches per plant	0.11	1.23**	0.19
5	Number of pods per plant	0.88	69.91**	6.64
6	100 seeds weight (g)	0.31	31.15**	0.45
7	Grain yield per plant (g)	0.24	14.34**	1.45
8	Number of seeds per pod	0.003	2.06**	0.17
9	Length of the pod (cm)	0.09	2.07	0.06
10	Number of clusters per plant	0.05	4.32**	0.24
11	Harvest Index (%)	11.44	66.88**	13.07

**, ** indicates at 5% and 1%level of significance, respectively*

Analysis of heterosis

Almost all the hybrids showed considerable amount of heterosis over better parent (Table 3). The degree of heterosis, however, differed for different characters. The crosses showing maximum heterosis over superior parent (Heterobeltiosis) are presented in Table 4.

Days to 50 per cent flowering

The hybrids MGG- 366×LGG- 460, WGG- 37 (eksheela) × RAJENDRAN-G-65, MGG-348 × LGG-460 shows highest negative heterosis over better parent. Whereas the hybrids MGG- 366×LGG- 460, MGG-348 × LGG-460 and WGG- 37 (eksheela) × RAJENDRAN-G-65 shows considerable negative heterosis over standard check which was previously reported by Narasimhulu *et al*. (2016), Thamodharan *et al*. (2016).

Days to Maturity

The hybrids MGG- 295× LGG-460, MGG-348 × LGG-460, MGG-347 × RAJENDRAN-G-65, MGG-347× LGG-460, TILAK GOLD × LGG-460 shows highest negative heterosis over better parent. Whereas the hybrids MGG- 295× LGG-460, MGG-347 × RAJENDRAN-G-65, TILAK GOLD × LGG-460 shows considerable negative heterosis over standard check SML 668 that were confirmed by the findings of Rakesh *et al*. (2014) and Narasimhulu *et al*. (2016).

Plant height (cm)

The hybrids MGG-351 × WGG-42, MGG-351 × LGG-460, shows highest negative heterosis over better parent. But, the hybrid MGG-351 × BANSHI MOONG shows negative heterosis but not significant over the better parent. Whereas, the hybrids MGG-351 × WGG- 42, MOONG TILAK × LGG-460, MOONG TILAK × BANSHI MOONG shows highest negative heterosis over standard check SML 668 which were related and confirmed by the findings of Choudhary *et al.* (2017) and Debbarma *et al.* (2022).

Number of branches per plant

The hybrids WGG- 37 (eksheela) × BANSHI MOONG, MGG-347× BANSHI MOONG, TILAK GOLD × LGG-460 shows highest positive heterosis over better parent. But, the hybrid TM-96-2 × RAJENDRAN-G-65 shows highest negative heterosis but significant over the better parent. Whereas, the hybrids MGG-347× BANSHI MOONG, TILAK GOLD × LGG-460, MGG- 295× RAJENDRAN-G-65, MGG-348 × WGG-42, TILAK GOLD × RAJENDRAN-G-65, TILAK GOLD × WGG-42 shows highest positive heterosis over standard check SML 668 were reported by the findings of Shalini *et al.* (2019).

Number of pods per plant

The hybrids MGG-348 × LGG-460, MGG- 366 × LGG- 460, MGG-347 × RAJENDRAN-G-65 shows highest positive heterosis over better parent. But, the hybrid MGG- 351 × LGG-460, MOONG TILAK × WGG-42 shows negative heterosis but significant over the better parent. Whereas, the hybrids MGG-351 × RAJENDRAN-G-65, shows highest positive heterosis over standard check SML 668 were reported by Sandhiya *et al*. (2018), Elangaimannan *et al.* (2018) and Kakde *et al.* (2019).

100 seeds weight (g)

The hybrids MGG-348 × LGG-460, TILAK GOLD × RAJENDRAN-G-65, MGG-348 × BANSHI MOONG shows highest positive heterosis over better parent. But, the hybrid MGG-351 × BANSHI MOONG shows negative heterosis but significant over the better parent. Whereas, the hybrids TILAK GOLD × RAJENDRAN-G-65, MGG- 295× LGG-460, MGG-348 × LGG-460 shows highest positive heterosis over standard check SML 668 which were reported by the findings of Rakesh *et al*. (2014) and Nath *et al*. (2018).

Grain yield per plant (g)

The hybrids MOONG TILAK × RAJENDRAN-G-65, MGG-348 × LGG-460, WGG-37 (eksheela) × LGG-460, shows highest positive heterosis over better parent. But, the hybrid MGG- 295 × WGG-42 shows negative heterosis but significant over the better parent. Whereas, the hybrids MGG-348 × LGG-460, MGG-366×LGG- 460, MGG- 295× LGG-460 shows highest positive heterosis over standard check SML 668 which were given in the reports of Ushakumari *et al.* (2010) and Kohakade *et al*. (2021).

Number of seeds per pod

The hybrids WGG- 37 (eksheela) × BANSHI MOONG, MGG- 295 × LGG-460, TM-96-2 × RAJENDRAN-G-65 shows highest positive heterosis over better parent. But, the hybrid MGG-348 × BANSHI MOONG shows highest negative heterosis but significant over the better parent. Whereas, the hybrids MGG-351 × LGG-460, MGG- 366×LGG- 460, MGG- 295× LGG-460 shows highest positive heterosis over standard check SML 668 were similar to the findings of Narasimhulu *et al*. (2016) and Elangaimannan *et al.* (2018).

Length of pod (cm)

The hybrids MGG-348 × RAJENDRAN-G-65, MGG-348 × LGG-460, MGG-366 × LGG-460, MGG-347× LGG-460 shows highest positive heterosis over better parent. But, the hybrid MGG-351 × BANSHI MOONG shows highest negative heterosis but not significant over the better parent. Whereas, the hybrids MGG-348 × LGG-460, MGG-348 × RAJENDRAN-G-65, MGG-347× LGG-460, MGG-295× LGG-460 shows highest positive heterosis over standard check SML 668 were supported by the findings of Sandhiya *et al*. (2018) and Kakde *et al.* (2019).

Number of clusters per plant

The hybrids TILAK GOLD × RAJENDRAN-G-65, MGG-347 × LGG-460, MGG-366 × LGG- 460 shows highest positive heterosis over better parent. But, the hybrid MOONG TILAK × WGG-42 shows highest negative heterosis but not significant over the better parent. Whereas, the hybrids MGG-347× LGG-460, MGG-348 × WGG-42, TILAK GOLD × RAJENDRAN-G-65, MGG-366 × BANSHI MOONG shows highest positive heterosis over standard check SML 668 were given under the findings of Narasimhulu *et al*. (2016) and Elangaimannan *et al.* (2018).

Harvest Index (%)

The hybrids TILAK GOLD × RAJENDRAN-G-65, TILAK GOLD × BANSHI MOONG, MOONG TILAK × RAJENDRAN-G-65 shows highest positive heterosis over better parent. But, the hybrid WGG- 37 (eksheela) × BANSHI MOONG shows highest negative heterosis but not significant over the better parent. Whereas, the hybrids MGG-295× RAJENDRAN-G-65, WGG- 37 (eksheela) × RAJENDRAN-G-65, MOONG TILAK × RAJENDRAN-G-65 shows highest positive heterosis over standard check SML 668 found similar with the findings of Kant *et al.* (2012) and Toppo *et al.* (2019).

Table 4: The crosses showing maximum heterobeltiosis

Sr. No.	Characters	Crosses	Heterobeltiosis (%)
1	Days to 50% flowering	MGG-348 × LGG-460	-25.97
2	Days to maturity	MGG-295 × LGG-460	-19.20
3	Plant height (cm)	MGG-351 × WGG-42	-22.55
4	Number of branches per plant	WGG-37 (Eksheela) × Bansi Moong	28.28
5	Number of pods per plant	MGG-348 × LGG-460	33.30
6	100-seed weight (g)	MGG-348 × LGG-460	44.88
7	Grain yield per plant (g)	MGG-348 × LGG-460	53.75
8	Number of seeds per pod	MGG-295 × LGG-460	33.37
9	Pod length (cm)	MGG-348 × LGG-460	67.21
10	Number of clusters per plant	MGG-347 × LGG-460	44.94
11	Harvest index (%)	Tilak Gold × Rajendran-G-65	21.12

Table 3: Percent heterosis for eleven quantitative characters in green gram

S. No.	Hybrids	Days to 50 percent flowering		Days to Maturity		Plant height (cm)		Number of branches per plant		Number of pods per plant		100 seeds weight (g)	
		BP	SH	BP	SH	BP	SH	BP	SH	BP	SH	BP	SH
1	MGG 366 × Rajendran-G-65	13.19**	22.56**	15.85**	10.99**	32.29**	12.19**	1.55	27.10**	4.91	-1.75	-11.15**	-8.33**
2	MGG- 366× WGG- 42	13.89**	23.31**	33.88**	28.27**	0.95	-8.54*	-15.5**	5.81	-2.40	0.19	8.84**	12.29**
3	MGG- 366×LGG- 460	-17.36**	-10.53**	17.49**	12.57**	-1.61	-17.2**	-10.82	11.61	24.13**	3.41	13.03**	16.62**
4	MGG-366 × Banshi Moong	4.86	13.53**	44.81**	38.74**	17.86**	-14.2**	1.55	27.10**	-4.11	-20.1**	-15.05**	-12.36**
5	MGG- 295× Rajendran-G-65	18.90**	46.62**	2.71	18.85**	26.19**	7.02	1.62	21.29**	10.61	3.59	-7.58**	-0.90
6	MGG- 295 × WGG-42	28.57**	55.64**	18.75**	39.27**	1.56	-7.99*	-1.08	18.06*	0.65	3.32	-12.26**	-5.92*
7	MGG- 295× LGG-460	1.30	17.29**	-19.2**	-5.24**	-6.80	-21.55	-7.03	10.97	17.22*	5.07	10.65**	18.65**
8	MGG- 295 × Banshi Moong	40.65**	63.91**	4.91**	23.04**	25.82**	-8.40*	6.49	27.10**	-2.98	-13.04*	-16.84**	-10.83**
9	WGG- 37 × Rajendran-G-65	-23.42**	-9.02**	2.26	18.32**	5.22	-15.9**	-15.57*	-9.03	-4.91	-10.95	6.11*	3.92
10	WGG- 37 × WGG-42	5.06*	24.81**	17.26**	38.74**	29.17**	3.29	-9.09	-3.23	-1.67	0.94	-4.42	-7.45**
11	WGG- 37 × LGG-460	5.84*	22.56**	1.78	19.90**	26.05**	0.80	-3.16	-1.29	-6.67	-28.1**	8.40**	4.97*
12	WGG- 37 × Banshi Moong	21.29**	41.35**	2.65	21.47**	27.16**	-7.42	28.28**	20.00**	4.66	-19.3**	14.60**	10.97**
13	TM-96-2 × Rajendran-G-65	-3.64	19.55**	-0.90	14.66**	23.69**	4.90	-21.6**	-15.48*	-3.12	-3.51	13.50**	11.32**
14	TM-96-2 × WGG-42	4.35	26.32**	18.92**	38.22**	-0.24	-9.62*	-1.21	5.16	-15.18*	-12.93*	4.96*	2.95
15	TM-96-2 ×	5.19*	21.80**	2.70	19.37**	-1.96	-17.5**	0.00	1.94	-27.7**	-28.0**	-7.34**	-9.12**

	LGG-460												
16	TM-96-2 × Banshi Moong	-1.29	15.04**	4.05**	20.94**	18.55**	-13.7**	0.69	-5.81	-15.7*	-16.1**	-1.63	-3.52
17	MGG-348 × Rajendran-G-65	0.00	18.80**	7.01**	19.90**	24.35**	5.46	-3.11	20.65**	-4.81	-10.85	-4.76*	-6.73**
18	MGG-348 × WGG-42	0.00	18.80**	25.23**	40.31**	3.06	-10.4**	0.00	24.52**	-15.21*	-12.96*	11.05**	4.10
19	MGG-348 × LGG-460	-25.97**	-14.29**	-14.9**	-4.71**	-0.43	-16.2**	-2.59	21.29**	33.30**	4.80	44.88**	15.10**
20	MGG-348 × Banshi Moong	17.42**	36.84**	8.41**	21.47**	16.27**	-15.3**	-6.74	16.13*	9.50	-13.91*	20.43**	-4.32
21	MGG-347 × Rajendran-G-65	4.24	29.32**	-15.4**	-2.09	35.74**	15.12**	-1.17	9.03	16.41**	12.36*	2.68	6.69**
22	MGG-347 × WGG-42	5.59*	27.82**	10.42**	38.74**	22.48**	10.97**	-5.85	3.87	-7.64	-5.19	8.26**	12.48**
23	MGG-347× LGG-460	4.55	21.05**	-18.7**	-4.19*	42.71**	20.13**	-10.53	-1.29	15.69*	11.67	-17.78**	-14.57**
24	MGG-347× Banshi Moong	20.00**	39.85**	-1.72	19.90**	48.59**	8.18	19.30**	31.61**	-19.4**	-22.2**	-16.97**	-13.72**
25	MGG-351 × Rajendran-G-65	23.64**	53.38**	-1.36	14.14**	-9.45*	-23.2**	1.20	9.03	-4.03	14.14*	-19.84**	-2.48
26	MGG-351 × WGG-42	24.84**	51.13**	16.52**	40.31**	-22.5**	-29.8**	-2.42	3.87	-20.0**	-4.88	-13.47**	5.27*
27	MGG-351 × LGG-460	5.84*	22.56**	-0.44	17.28**	-14.0**	-27.6**	-2.47	1.94	-46.1**	-36.0**	-18.76**	-1.17
28	MGG-351 × Banshi Moong	43.87**	67.67**	-0.43	19.90**	-7.42	-32.6**	6.79	11.61	-29.7**	-16.3**	-31.09**	-16.17**
29	MOONG TILAK × Rajendran-G-65	1.29	18.05**	15.84**	34.03**	35.21**	-13.1**	1.80	9.68	-20.2**	-25.3**	-24.55**	-26.11**
30	MOONG TILAK × WGG-42	3.87	21.05**	18.67**	39.79**	32.60**	-14.7**	-1.82	4.52	-36.6**	-35.1**	-0.53	-6.76**
31	MOONG TILAK × LGG-460	5.84*	22.56**	13.78**	34.03**	19.03**	-23.4**	3.09	7.74	14.83	-23.0**	-0.22	-24.86**
32	MOONG TILAK × Banshi Moong	19.35**	39.10**	13.78**	34.03**	3.73	-33.2**	-3.09	1.29	12.13	-25.5**	5.78	-18.00**
33	TILAK GOLD × Rajendran-G-65	0.00	23.31**	5.69**	16.75**	24.87**	5.90	14.97*	23.87**	-2.63	-8.81	21.63**	19.12**
34	TILAK GOLD × WGG-42	1.24	22.56**	23.70**	36.65**	-0.34	-13.1**	16.36*	23.87**	-23.3**	-21.2**	5.39*	-1.21
35	TILAK GOLD × LGG-460	6.49**	23.31**	-13.3**	-4.19	3.55	-12.8**	23.75**	27.74**	-1.97	-10.17	13.34**	-14.33**
36	TILAK GOLD × Banshi Moong	19.35**	39.10**	7.11**	18.32**	14.32**	-16.8**	10.63	14.19*	-0.72	-9.02	3.83	-19.52**
S.E.		**1.19**		**1.02**		**2.55**		**0.36**		**2.35**		**0.55**	
C.D. 5%		**2.38**		**2.04**		**5.09**		**0.71**		**4.68**		**1.09**	
C.D. 1%		**3.16**		**2.70**		**6.76**		**0.94**		**6.22**		**1.44**	

**, ** indicates at 5% and 1% level of significant, respectively. (Standard Check: - SC: SML 668)*

Table 3: Percent heterosis for eleven quantitative characters in green gram (Contd...)

S. No.	Hybrids	Grain yield per plant (g)		Number of seeds per pod		Length of pod (cm)		Number of clusters per plant		Harvest Index (%)	
		BP	SH	BP	SH	BP	SH	BP	SH	BP	SH
1	MGG 366 × Rajendran-G-65	-4.80	12.46	-21.3**	3.66	2.61	7.09	-17.76*	-29.38**	6.12	3.66
2	MGG- 366× WGG- 42	-6.93	9.95	-31.9**	-10.37	-1.83	-15.7**	12.50*	27.12**	-1.36	-10.37
3	MGG- 366×LGG- 460	12.52	32.93**	-6.94	22.56**	51.67**	43.31**	43.92**	20.34**	0.17	22.56
4	MGG-366 × Banshi Moong	-16.32*	-1.14	-19.1**	6.71	3.81	-14.2**	20.88**	24.29**	-10.13	6.71
5	MGG- 295× Rajendran-G-65	-22.34**	-7.25	6.37	1.83	15.65**	4.72	-5.79	1.13	-6.56	1.83
6	MGG- 295 × WGG-42	-25.99**	-11.61	17.48*	2.44	10.09	-5.51	-5.50	6.78	-20.52	2.44
7	MGG- 295× LGG-460	2.43	22.33**	33.77**	23.17**	45.83**	37.80**	4.74	12.43	-10.84	23.17
8	MGG- 295 × Banshi Moong	-1.63	17.49*	10.71	-5.49	8.41	-8.66	-41.05**	-36.72**	-17.78	-5.49
9	WGG- 37 × Rajendran-G-65	19.20*	-3.03	0.64	-3.66	0.87	-8.66	-9.66	-10.17	7.02	-3.66
10	WGG- 37 × WGG-42	7.24	-9.43	16.78*	1.83	10.81	-3.15	-0.50	12.43	-14.03	1.83
11	WGG- 37 × LGG-460	27.96**	4.09	11.26	2.44	30.83**	23.62**	-46.59**	-46.89**	-19.65	2.44
12	WGG- 37 × Banshi Moong	7.77	-12.33	36.13**	-1.22	37.84**	20.47**	0.55	3.39	-27.16	-1.22
13	TM-96-2 × Rajendran-G-65	-4.54	-3.13	28.03**	22.56**	26.09**	14.17**	19.08*	2.26	0.73	22.56
14	TM-96-2 × WGG-42	-10.57	-9.25	3.85	-1.22	23.85**	6.30	0.50	13.56*	5.59	-1.22
15	TM-96-2 × LGG-460	-4.62	-3.21	3.21	-1.83	16.67**	10.24*	27.70**	6.78	11.08	-1.83
16	TM-96-2 × Banshi Moong	-4.49	-3.08	-26.9**	-30.5**	21.36**	-1.57	10.99	14.12*	11.04	-30.49
17	MGG-348 × Rajendran-G-65	15.06	4.92	-7.69	9.76	53.28**	47.24**	-1.52	10.17	12.77	9.76
18	MGG-348 × WGG-42	-1.90	-10.54	-26.15	-12.20	23.77**	18.90**	23.50**	39.55**	-3.10	-12.20
19	MGG-348 × LGG-460	53.75**	40.21**	3.08	22.56**	67.21**	60.63**	-0.51	11.30	10.61	22.56
20	MGG-348 × Banshi Moong	27.44**	16.22*	-41.5**	-30.5**	17.21**	12.60*	-5.56	5.65	0.66	-30.49
21	MGG-347 × Rajendran-G-65	-20.76**	-14.64	3.05	3.05	-1.74	-11.02*	7.30	7.91	-13.25	3.05
22	MGG-347 × WGG-42	-10.41	-3.50	-6.10	-6.10	0.92	-13.4**	-4.50	7.91	0.48	-6.10
23	MGG-347× LGG-460	-10.39	-3.47	0.61	0.61	46.67**	38.58**	44.94**	45.76**	-1.19	0.61
24	MGG-347× Banshi Moong	-9.76	-2.80	-20.7**	-20.7**	8.41	-8.66	4.40	7.34	-0.20	-20.73
25	MGG-351 × Rajendran-G-65	-21.16**	-5.23	6.71	6.71	2.61	-7.09	8.05	6.21	-0.30	6.71
26	MGG-351 × WGG-42	-14.05*	3.32	10.98	10.98	1.83	-12.60*	10.00	24.29**	-16.10	10.98
27	MGG-351 × LGG-460	0.97	21.37**	24.39**	24.39**	28.33**	21.26**	4.60	2.82	2.09	24.39
28	MGG-351 × Banshi Moong	-17.93**	-1.35	0.00	0.00	-3.70	-18.1**	-2.20	0.56	-5.41	0.00
29	MOONG TILAK × Rajendran-G-65	90.30**	29.07**	-9.05	10.37	12.17*	1.57	-1.13	-1.13	17.91	10.37
30	MOONG TILAK × WGG-42	0.80	-14.87	-8.79	10.67	-1.74	-11.02*	-51.50**	-45.20**	-10.12	10.67
31	MOONG TILAK × LGG-460	16.81	-5.83	-13.9**	4.45	26.67**	19.69**	3.95	3.95	4.43	4.45
32	MOONG TILAK × Banshi Moong	0.03	-24.3**	-14.1**	4.27	-1.74	-11.02*	-5.49	-2.82	12.21	4.27
33	TILAK GOLD × Rajendran-G-65	22.83*	-16.50*	-3.82	-7.93	6.09	-3.94	53.29**	31.64**	21.12	-7.93
34	TILAK GOLD × WGG-42	11.63	-5.73	12.59	-1.83	-5.36	-16.5**	14.5*	29.4**	-1.33	-1.83
35	TILAK GOLD × LGG-460	16.77	-5.85	-12.45	-19.4**	27.50**	20.47**	48.65**	24.29**	8.38	-19.39
36	TILAK GOLD × Banshi Moong	0.72	-23.8**	0.74	-17.1**	2.68	-9.45	22.53**	25.99**	19.56	-17.07
S.E.		**0.93**		**0.38**		**0.20**		**0.38**		**2.02**	
C.D. 5%		**1.86**		**0.75**		**0.41**		**0.77**		**4.02**	
C.D. 1%		**2.47**		**0.99**		**0.54**		**1.02**		**5.34**	

*, ** indicates at 5% and 1% level of significant, respectively. (Standard Check: - SC: SML 668)

Conclusion

The present investigation on 36 mungbean hybrids revealed several promising crosses with superior heterosis over the better parent for key agronomic and yield traits. Notably, MGG-348 × LGG-460 exhibited significant heterosis for days to 50% flowering, number of pods per plant, 100-seed weight, grain yield per plant, and pod length, making it a highly desirable combination for yield improvement. MGG-295 × LGG-460 excelled for days to maturity and number of seeds per pod, while MGG-351 × WGG-42 showed superiority for plant height. Crosses such as WGG-37 × Banshi Moong, MGG-347 × LGG-460, and Tilak Gold × Rajendran-G-65 also demonstrated advantages for specific traits like branches per plant, clusters per plant, and harvest index. Overall, the results confirm the potential of these crosses in exploiting heterosis and developing high-yielding, early-maturing, and efficient mungbean genotypes for future breeding programs.

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