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Hybrid Vigour analysis for yield and yield component traits in Mungbean (*Vigna radiata* (L.) Wilczek)

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Abstract
Thirty two crosses resulting from line x tester analysis were studied to know the magnitude of heterosis over standard variety for seed yield and its components in mungbean. The promising hybrids *viz.*, VRM(Gg) 1 x VGG04-028, VRM(Gg) 1 x VGG04-005, VBN(Gg) 2 x VGG04-028 and Pusha vishal x VBN(Gg) 3 were identified, which have immense potential to exploit the hybrid vigour or to isolate desirable segregants.

Keywords: Heterosis, Mungbean, Yield, *Vigna radiata* (L).

Introduction
Greengram (*Vigna radiata* (L.) Wilczek) is one of the important grain legumes. It has the diploid chromosome number 2n = 2x = 22 (Karpechenko, 1925) [5]. It belongs to the family Fabaceae and is native of Indo-Burma (Myanmar) region of Asia. Due to its rapid growth and early maturity, it is adapted to multiple cropping systems. The present yield potential of improved varieties is not enough to attract the farmers or consumers; because of relatively smaller seed size, low yield potential and susceptibility to disease. Study of heterosis in mungbean is important for the plant breeder to find out the superior crosses in first generation itself. In addition to this, the magnitude of heterosis provides a basis for determining genetic diversity and also, serves as guide to the choice of desirable parents (Swindell and Poehlman, 1976) [10]. An attempt was, therefore made to know the magnitude of heterosis over standard parent for seed yield and its components in elite Indian mungbean genotypes.

Materials and Methods
The experimental material comprised of eight lines *viz.*, VRM(Gg) 1, CO 6, CO 7, VBN(Gg) 1, K 1, KM 2, VBN(Gg) 2 and Pusha vishal and four testers *viz.*, VGGO4-028, VGG04-005, CGG 973 and VBN(Gg) 3 These genotypes were crossed in line x tester fashion and thirty two hybrids were produced. The thirty two hybrids and their parents were sown in a randomized block design with three replications at the Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Madurai, during January 2010. Single row plots of 4m length with spacing of 40 cm between the rows and 20 cm within the rows will be applied. Twelve parents along with their thirty two hybrids and VBN(Gg) 3 is used as check from testers. The observations were recorded on five randomly selected plants for days to 50% flowering, days to maturity, plant height, number of branches per plant, number of clusters per plant, number of pods per clusters, number of pods per plant, pod length, number of seeds per pod, 100 seed weight, harvest index, protein content and seed yield per plant. Days to 50% flowering was recorded on lines basis. The data were subjected to analysis of heterosis as per the method suggested by Rai, 2001.

Results and Discussions
To exploit the phenomenon of hybrid vigour, knowledge on the magnitude and direction of heterosis is important. The extent of hybrid vigour was assessed in terms of heterosis over standard parent (standard heterosis). Though there are three types of heterosis, standard heteris is given importance for exploitation of heterotic vigour. Swaminathan *et al.* (1972) [9]

stressed the need for computing standard heterosis for commercial exploitation of hybrid vigour. Hence, for the evaluation of hybrid, standard heterosis is to be given importance rather than other two.

In the present investigation estimation of standard heterosis for different traits are presented in Table 1 and Figure 1. For earliness, a negative heterosis for days to 50% flowering and days to maturity is desirable one. The results showed that the heterosis percentage over standard variety for days to 50 per cent flowering varied from -13.16 (VRM(Gg) 1 x VGG04-028 to 0 (KM 2 x VBN(Gg) 3). In this trait, 17 crosses showed highly significant negative standard heterosis. For days to matiruty, standard heterosis varied from -10.19 (Pusha vishal x VBN(Gg) 3) to 0.64 (VRM(Gg) 1 x CGG 973 and K 1 x CGG 973). Totally 23 crosses showed highly significant negative standard heterosis. These findings were in accordance with earlier reports by Joseph and Santoshkumar (2000) [4], Gawande (2001) [3] and Reddy *et al.* (2003) [8].

Ten crosses exhibited highly significant positive standard heterosis for number of branches per plant. The minimum and maximum standard heterosis for plant height were observed in Pusha vishal x VGG04-028 (-26.07) and VBN(Gg) 2 x VBN(Gg) 3 (25.20). The heterosis percentage over the standard variety for the trait number of branches per plant varied from -36.99 (Pusha vishal x CGG 973) to 34.87 (VRM(Gg) 1 x VGG04-028). Crosses namely CO 6 x VBN(Gg) 3 and KM 2 x VGG04-028 showed significant positive standard heterosis for number of branches per plant.

For the trait number of clusters per plant standard heterosis varied between -43.22 (CO 7 x CGG 973) and 11.86 (VRM(Gg) 1 x VGG04-005) with five crosses showed highly significant positive heterosis such as VRM(Gg) 1 x VGG04-005, VRM(Gg) 1 x VBN(Gg) 3, CO 6 x CGG 973, K 1 x VGG04-005 and VBN(Gg) 2 x VBN(Gg) 3. The minimum and maximum standard heterosis for number of pods per cluster were observed in VBN(Gg) 1 x CGG 973 and VBN(Gg) 2 x CGG 973 (-13.98) and CO 6 x VBN(Gg) 3 and K 1 x VGG04-028 (22.58). The hybrids K 1 x VBN(Gg) 3, KM 2 x VGG04-005, VBN(Gg) 2 x VGG04-005 and Pusha vishal x VGG04-005 showed positive and significant standard heterosis. Standard heterosis ranged from -30.30 (K 1 x CGG 973) to 18.18 (VRM(Gg) 1 x VGG04-028). Totally, 13 cross showing highly significant and positive heterosis for number of pods per plant. The heterosis percentage over standard variety for the trait pod length varied from -21.10 (K 1 x CGG 973) to 7.29 (CO 6 x VGG04-028) (Table 1) and five crosses recorded highly significant positive standard heterosis. Joseph and Santoshkumar (2000) [4] and Gawande (2001) [3] also arrived at similar conclusions.

Fifteen crosses had highly significant positive standard heterosis over the standard variety for the character number of seeds per pod. The standard heterosis over a standard variety for hundred grain weight ranged between -19.93 (CO 7 x VBN(Gg) 3) and 26.52 (Pusha vishal x VBN(Gg) 3) and 10 crosses were recorded highly significant and positive standard heterosis. The maximum standard heterosis for harvest index was observed in Pusha vishal x VBN(Gg) 3 (43.03) (Table 1) and three hybrids namely CO 6 x VBN(Gg) 3, KM 2 x VGG04-028 and Pusha vishal x VBN(Gg) 3 showed highly significant and positive standard heterosis. Standard heterosis varied between -16.25 (K 1 x VGG04-028) and 20.19 (CO 6 x CGG 973) and 23 crosses recorded highly significant and positive heterosis over the check variety for the character protein content. Seed yield, the complex character, decides the economic worth of the hybrids.

Table 1: Estimates of standard heterosis for yield and yield components traits in mungbean

Cross	DF	DM	PH	BR	CPP	PPC	PPP
VRM(Gg) 1 x VGG04-028	-13.16 **	-7.64 **	19.66 **	34.87 **	4.24	19.35 **	18.18 **
VRM(Gg) 1 x VGG04-005	-5.26	-0.64	20.43 **	13.68 **	11.86 **	10.75 **	12.88 **
VRM(Gg) 1 x CGG 973	-2.63	0.64	2.83	-1.06	-17.80 **	-11.83 **	-21.21 **
VRM(Gg) 1 x VBN(Gg) 3	-2.63	-0.64	13.13 **	22.14 **	10.17 **	15.05 **	14.70 **
CO 7 x VGG04-028	-7.02 **	-3.82 **	-22.18 **	-15.87 **	-23.73 **	3.23	-16.36 **
CO 7 x VGG04-005	-7.89 **	-6.37 **	-15.29 **	22.18 **	-12.71 **`	-10.75 **	-15.00 **
CO 7 x CGG 973	-7.89 **	-7.64 **	-22.17 **	-32.90 **	-43.22 **	-12.90 **	-26.21 **
CO 7 x VBN(Gg) 3	-7.89 **	-5.10 **	0.76	0.95	4.24	-8.60 *	-1.52
CO 6 x VGG04-028	-6.14 *	-4.46 **	18.07 **	-13.82 **	4.24	-3.23	6.67 *
CO 6 x VGG04-005	-4.39	-4.46 **	-8.86 **	4.13	-0.85	16.13 **	13.79 **
CO 6 x CGG 973	-7.02 **	-3.18 **	-7.82 **	4.23	9.32 **	-10.75 **	13.18 **
CO 6 x VBN(Gg) 3	-7.02 **	-3.82 **	7.12 **	5.22 *	4.24	22.58 **	15.76 **
K 1 x VGG04-028	0.00	-1.91	-1.98	8.43 **	4.24	22.58 **	1.06
K 1 x VGG04-005	-7.02 **	-3.82 **	2.42	2.01	9.32 **	16.13 **	6.06 *
K 1 x CGG 973	-1.75	0.64	-4.99 *	-7.51 **	-13.56 **	-11.83 **	-30.30 **
K 1 x VBN(Gg) 3	-3.51	-3.18 **	13.41 **	14.74 **	-7.63 *	7.53 *	-4.09
VBN(Gg) 1 x VGG04-028	-10.53 **	-3.82 **	16.39 **	3.14	-7.63 *	4.30	7.73 **
VBN(Gg) 1 x VGG04-005	-7.89 **	-3.82 **	-2.44	3.07	-6.78 *	-5.38	3.48
VBN(Gg) 1 x CGG 973	-0.88	0.00	-23.66 **	-17.98 **	-19.49 **	-13.98 **	-3.33
VBN(Gg) 1 x VBN(Gg) 3	-3.51	0.00	-24.06 **	14.77 **	-21.19 **	11.83 **	10.76 **
KM 2 x VGG04-028	-6.14 *	-3.82 **	-0.04	5.18 *	-14.41 **	18.28 **	10.15 **
KM 2 x VGG04-005	-3.51	-3.82 **	2.17	4.13	-5.93	9.68 *	6.82 *
KM 2 x CGG 973	-7.02 **	-7.01 **	-19.39 **	-9.59 **	-17.80 **	-11.83 **	-7.88 **
KM 2 x VBN(Gg) 3	0.00	-1.27	-6.38 *	8.43 **	-5.93	18.28 **	13.33 **
VBN(Gg) 2 x VGG04-028	-5.26	-4.46 **	1.00	17.91 **	1.69	18.28 **	14.24 **
VBN(Gg) 2 x VGG04-005	-7.89 **	-4.46 **	8.38 **	19.99 **	0.00	9.68 *	15.00 **
VBN(Gg) 2 x CGG 973	-8.77 **	-7.01 **	7.83 **	-2.15	-7.63 *	-13.98 **	-2.42
VBN(Gg) 2 x VBN(Gg) 3	-3.51	-3.18 **	25.20 **	8.46 **	9.32 **	5.38	14.24 **
Pusha vishal x VGG04-028	-13.16 **	-8.28 **	-26.07 **	-26.48 **	-31.36 **	5.38	-5.15
Pusha vishal x VGG04-005	-8.77 **	-8.92 **	-7.26 **	-5.29 *	-22.88 **	9.68 *	-15.76 **
Pusha vishal x CGG 973	-13.16 **	-8.92 **	-25.22 **	-36.99 **	-27.12 **	-11.83 **	-24.39 **
Pusha vishal x VBN(Gg) 3	-13.16 **	-10.19 **	-17.59 **	-14.77 **	-29.66 **	3.23	-1.06
SE	**1.05**	**0.58**	**1.30**	**0.21**	**0.24**	**0.22**	**1.19**

** Significant at 1% level. **DF** – Days to 50 per cent flowering; **DM** – Days to maturity; **PH** – Plant height; **BR** – Number of branches per plant; **CPP** – Number of clusters per plant; **PPC** – Number of pods per cluster; **PPP** – Number of pods per plant

Table 1. **Contd.,**

Cross	PL	SPP	HS	HI	PRT	YLD
VRM(Gg) 1 x VGG04-028	3.14	22.00 **	-9.56 **	-0.26	12.90 **	23.35 **
VRM(Gg) 1 x VGG04-005	6.44 **	16.67 **	24.88 **	1.59	9.07 **	43.23 **
VRM(Gg) 1 x CGG 973	-7.63 **	2.67	-6.10 **	-30.63 **	1.93	-14.25 **
VRM(Gg) 1 x VBN(Gg) 3	-6.36 **	0.67	-7.58 **	-24.83 **	9.17 **	9.18 *
CO 7 x VGG04-028	-10.08 **	-10.00 **	1.98	-22.23 **	12.44 **	-33.21 **
CO 7 x VGG04-005	-11.95 **	10.00 **	-4.45 *	-29.52 **	5.49 **	-22.21 **
CO 7 x CGG 973	-8.73 **	0.00	-4.45 *	-15.38 **	-1.77	-38.53 **
CO 7 x VBN(Gg) 3	-3.81	5.33	-19.93 **	-25.48 **	10.40 **	-27.73 **
CO 6 x VGG04-028	7.29 **	9.33 **	-15.98 **	-30.99 **	16.61 **	-14.67 **
CO 6 x VGG04-005	-1.27	8.67 **	10.38 **	-11.63 *	4.45 **	18.84 **
CO 6 x CGG 973	-5.08 *	-11.33 **	-12.69 **	-40.64 **	20.19 **	-23.67 **
CO 6 x VBN(Gg) 3	0.59	13.33 **	12.52 **	39.78 **	2.01 *	28.49 **
K 1 x VGG04-028	-4.15	10.67 **	19.60 **	-32.47 **	-16.25 **	16.48 **
K 1 x VGG04-005	2.12	8.67 **	17.79 **	7.08	14.88 **	18.17 **
K 1 x CGG 973	-21.10 **	-10.67 **	-2.47	-52.71 **	7.73 **	-27.57 **
K 1 x VBN(Gg) 3	-0.85	9.33 **	4.61 *	-37.82 **	2.87 **	-4.53
VBN(Gg) 1 x VGG04-028	6.02 **	4.67	-7.58 **	-40.75 **	14.81 **	-9.38 *
VBN(Gg) 1 x VGG04-005	3.73	3.33	-4.94 *	11.09 *	12.88 **	-11.50 **
VBN(Gg) 1 x CGG 973	-9.15 **	-12.00 **	1.15	-17.08 **	-8.37 **	-24.98 **
VBN(Gg) 1 x VBN(Gg) 3	-0.42	-3.33	3.62	10.13	-12.65 **	6.25
KM 2 x VGG04-028	1.10	10.00 **	3.46	31.86 **	13.16 **	9.11 *
KM 2 x VGG04-005	4.07	0.00	1.98	-26.14 **	16.58 **	-5.12
KM 2 x CGG 973	-11.69 **	-7.33 **	-1.65	-39.80 **	-4.17 **	-26.92 **
KM 2 x VBN(Gg) 3	-0.85	4.67	-8.07 **	-13.31 *	11.33 **	-5.14
VBN(Gg) 2 x VGG04-028	3.47	25.33 **	12.69 **	6.30	15.74 **	40.42 **
VBN(Gg) 2 x VGG04-005	4.58 *	14.00 **	-11.53 **	7.77	12.83 **	5.74
VBN(Gg) 2 x CGG 973	-10.00 **	2.00	-12.69 **	-17.88 **	13.60 **	-22.51 **
VBN(Gg) 2 x VBN(Gg) 3	1.61	12.00 **	-19.11 **	-18.02 **	10.53 **	-9.88 *
Pusha vishal x VGG04-028	7.12 **	10.00 **	16.64 **	8.99	-4.21 **	1.70
Pusha vishal x VGG04-005	6.10 **	12.67 **	24.71 **	-5.26	-3.74 **	3.01
Pusha vishal x CGG 973	1.95	-0.67	6.75 **	-19.25 **	14.12 **	-30.07 **
Pusha vishal x VBN(Gg) 3	5.00 *	-12.00 **	26.52 **	43.03 **	10.34 **	-12.94 **
SE	**0.17**	**0.27**	**0.08**	**4.09**	**0.24**	**0.83**

* Significant at 1% level. **PL** – Pod length; **SPP** – Number of seeds per pod; **HS** – Hundred seed weight; **HI** – Harvest index; **PRT** – Protein content; **YLD** – Seed yield per plant.

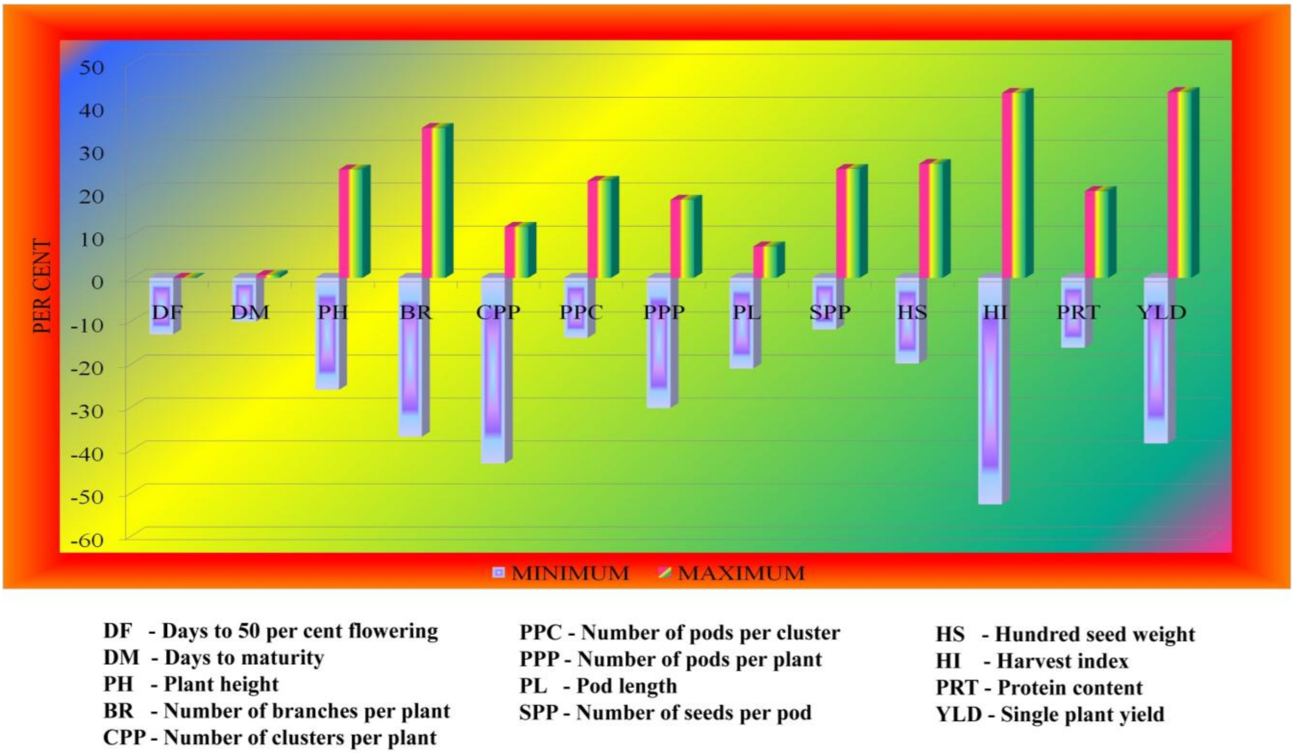

Fig 1: Range of standard heterosis for different traits

The high expression of heterosis for seed yield was evident in the present investigation. Similar results were reported earlier by Patil *et al.* (1996) [6], Aher *et al.* (2000) [1], Joseph and Santoshkumar (2000) [4], Gawande (2001) [3] and Reddy *et al.* (2003) [8]. For single plant yield, seven crosses recorded highly significant and positive standard heterosis over the standard variety.

Thus in the present investigation, among 32 hybrids analyzed, a total of four cross combinations *viz.*, VRM(Gg) 1 x VGG04-028, VRM(Gg) 1 x VGG04-005, VBN(Gg) 2 x VGG04-028 and Pusha vishal x VBN(Gg) 3 was found to have superior mean, *sca* effects and standard heterosis for many of the characters. Hence, these hybrids can be effectively utilized for commercial heterosis breeding programme.

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