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# Heterosis for yield component traits and seed yield in Mungbean (*Vigna radiata* L. Wilczek)

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**Abstract**
The present investigation was carried out at College of Agricultural, Kharpudi, during *kharif* 2016 and 2017. The material for the present investigation comprised ten parents, among these six testers, four line, and twenty four F1 derived through Line x Tester mating system including one check were evaluated to know the magnitude of heterosis for yield and yield contributing characters. With respect to seed yield per plant, the highest heterosis was recorded to the extent of 45.09%, 27.63% and 37.78% over mid parent, better parent and standard check, respectively. The promising hybrids *viz.* BM 2002-1 X BPMR 126, BM 2002-1 X BPMR 75, BM 4 X BPMR 75, JL 781 X BPMR 126, JL 781 X BPMR 75 and AKM 4 X BPMR 75 were the top five crosses based on mean *perse* performance and heterosis.

**Keywords:** heterosis, mungbean and yield components

## Introduction
Mungbean (*Vigna radiate* (L.) Wilczek) is a self pollinated legume originated in south Asia. Also known as green gram, it is short duration grain legume with wider adoptability. Mungbean is considered to be originated from *Vigna sablobata*. The origin of mungbean is supposed to be India (Vavilov, 1926 and Zukoveshij 1962) [15, 16]. In India it is one of the most important crop grown on large area. In Maharashtra it ranks second in *kharif* crop grown after Pigeonpea with area 4.30 lakh hector (ha) with production of 2.07 lakh tannes with productivity 483 kg/ha (Chief stastician Commisionarate of Agriculture Report 2013-14, Pune). It is mainly used in making Dal, snacks, curries and soup. The germinated seeds have more nutritional value compared with Asparagus or Mushroom. The food value of mungbean lie in it's high and easily digestible protein. The mungbean seeds contain approximately 25-28 % protein on dry weight basis.
Mung bean is important source of dietary protein in all over the world but in major in Asia, Africa and Latin America. The protein content and amino acids of the protein and its digestibility determines the food value of mungbean (Casey and Wriniey 1982) [1]. It is used in multiple cropping systems with cereals, groundnut, sugarcane and other crops, following an important component of crop rotation.
Mungbean has established itself as a highly valuable short duration grain legume crop having many desirable characteristics like wider adaptability, low input requirement and ability to improve the soil fertility by fixing atmospheric nitrogen with the help of symbiotic bacteria, *Rhizobium* present in root nodules. Mungbean has been recognized as a very suitable crop for mixed, inter and multiple- cropping systems as well as for various crop rotations.
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 basis for determining genetic diversity and also serves as guide to the choice of desirable parents. An attempt was, therefore made to know the magnitude of heterosis over better parent and standard variety for seed yield and its components in elite Indian mungbean genotypes. (Gwande *et al*., 2001 and Joseph and Kumar, 2000) [2].

## Materials and Methods
The parent for experiment included six genotypes of mungbean *(Vigna radiata* L. Wilczek) as males (Tester) BPMR 182, BPMR 132, BPMR 21, BPMR 126, BPMR 75 and BPMR 38. Four varietiesas females are BM 2002-1, BM 4, JL 781 and AKM 4. Each female were crossed with six selected male genotypes in L X T mating system at College of Agriculture, Kharpudi, Jalna, Maharashtra. All the genotypes (Ten parent and 24 F1, s) were evaluated in Randomized Block Design with two replication during *kharif*, 2017. Each genotype was grown in one row of three meter length with a spacing of 45cm between row and 10cm between plants. Recommended agronomic and plant protection package of practice were followed to raise

healthy crop. Data were recorded on five randomly selected competitive plants in each genotype and replication. Mean value on per plant basis were recorded for the characters, *viz* Days to 50% flowering, Days to maturity, Plant height (cm), Number of clusters per plant, Number of pods per cluster, Number of pods per plants, Number of seeds per pod, Pod length (cm), 100 seed weight (g), Seed yield per plant (g), Protein (%). The data were subjected to analysis of variance for mean performance (Panse and Sukhatme, 1995) [8] and heterosis over better parent (BP) and standard variety (SV) were calculated and tested as specified by Hays (1955) [4].

**Results and Discussion**

Analysis of variance along with the estimates of gca and sca variance their ratio for eleven character is shown in Table 1. The annova showed highly significant differences for majority of character, this indicats the presence of sufficient variability in experimental material. The variance due to crosses was highly significant for all the characters except hundred seed weight, which indicated the diverse nature of selected parent for majority of the character. The mean square due to line showed highly significant differences for plant height, pod length, 100 seed weight and seed yield per plant which indicated the presence of sufficient variability for these four characters. Significant variance is due to tester for seed yield per plant. The significant variance due to line x tester interaction for all the traits except that of 100 seed weight, showed its existence among the tester and hybrid population respectively for these eleven traits. This indicated the presence of significant differences between males and females. The negative heterosis was considered to be desirable for days to 50 percent flowering and days to maturity. In other words, earliness in hybrids was desirable. Out of 24 crosses, only one cross AKM 4 X BPMR 182 (-9.09%) showed significant negative heterosis over mid parent, nineteen crosses showed negative heterosis over their respective superior parent and AKM 4 X BPMR 126 (-9.09%) is the only one cross showed significant negative heterosis over standard check (BM 2003-2) for days to 50 percent flowering. These results were in agreement with the finding of Halkunde (1992) and patil (1992) [11]. For days to maturity, two crosses *viz*, BM 4 X BPMR 132 (-4.55%) and BM 4 X BPMR 38 (-5.42%) showed significant negative heterosis over mid parent, The cross, AKM 4 X BPMR 126 (-7.49%) is the only one cross showed significant negative heterosis over better parent and none of the crosses was showed significant negative heterosis over standard check. These results are in consonance with the finding of Halkunde (1992), Kelkar (1993) [6] and Sonawane, (2015) [13]. Highest positive significant heterosis among the 24 crosses, was recorded by JL 81 X BPMR 75 (16.97%), JL 781 X BPMR 182 (11.41%) and JL 781 X BPMR182 (11.62%) over mid parent, better parent and standard check respectively for plant height (cm). Similar results are reported by Srivastava *et al.*, (2013) [14]. BM 2002-1 X BPMR 38 (27.69%) recorded highest significant positive standard heterosis and heterobeltiosis, while relative heterosis recorded by cross BM 2002-1 X BPMR 38 (38.33%), for number of clusters per plant. Similar results reported by Halkunde (1992), Patil (1992) [11] and Jahagidar (2001) [5]. Out of 24 crosses, significant positive average heterosis was recorded in five crosses and heterobeltiosis was observed in four hybrids, only one cross BM 2002-1 X BPMR 38 (11.11%) is revealed significant positive standard heterosis over the check BM 2003-2 for Number of pods per cluster. Similar results have also been reported by Patil (1992) [11] and Jahagidar (2001) [5]. JL 781 X BPMR 75 recorded (37.16%), (33.48), (35.91%), highest significant positive average heterosis, better parent heterosis and standard heterosis over check was recorded by JL 781 X BPMR 75 for number of pods per plant. These results were in agreement with the finding of Kelkar (1993) [6] and Patel *et al.*, (2009) [9]. Among the 24 crosses, seventeen crosses exhibited significant positive heterosis over mid parent, highest heterosis was recorded by BM 4 X BPMR 75 (11.61%), six crosses showed significant positive heterosis over better parent, maximum heterosis was depicted by the crosses JL 781 X BPMR 21(8.70%) and significant positive Standard heterosis over the check BM 2003-2 was recorded by only one cross. BM 2002-1 X BPMR 126 (8.26%) for number of seeds per pod. This result was in agreement with the finding of Sonawane (1995) [12] and Srivastava & Singh (2013) [14]. For 100 seed weight the highest significant positive heterosis over mid parent, better parent was recorded by JL 781X BPMR 126 (17.92%), (17.20%) with value respectively. BM 2002-1 X BPMR 75 (4.26%) showed significant positive standard heterosis. Similar results have also been reported by Halkunde (1992), Patil (1992) [11], Kelkar (1993) [6]. Maximum average heterosis and better parent heterosis s was observed in BM 4 X BPMR 75(45.83%), (33.97%) respectively, while highest standard heterosis over check BM 2003-2 was exhibited by JL 781 X BPMR 132 (19.34%) for pod length. This result was in agreement with the finding of Srivastava *et al.*, (2013) [14]. For seed yield per plant the highest mid parent and standard heterosis was recorded JL 781 X BPMR 75 (45.09%) and (37.78%) respectively and highest better parent heterosis was observed in cross BM 2002-1 X BPMR 75 (27.63%). Deth and Patil (2008) Lakshmi *et al.* (2003) [7], Srivastava *et al.*, (2013) [14], also reported the similar conclusions. Highest significant positive heterosis over mid parent crosses exhibited by BM 4 X BPMR 126 (15.35%), the significant positive better parent heterosis and standard heterosis was recorded by JL 781 X BPMR 126 (14.16%), (14.72%) respectively for protein percent. These results were in agreement with the finding of Patil *et al.* (2011) [11] Srivastava *et al.*, (2013) [14].

**Table 1:** Analysis of variance of line X tester with respect to eleven characters in greengram (*Vigna radiata* (L.) Wilczek)

| Sorce of variability | d.f. | Days to 50% flowering | Days to maturity | Plant height (cm) | No. of clusters per plant | No. of pods per cluster | No. of pods per plant | No. of seeds per pod | Pod length (cm) | 100- seed weight (gm) | Seed yield per plant (gm) | Protein percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Replication | 1 | 2.167 | 2.340 | 0.056 | 1.401 | 0.053 | 3.967 | 0.030 | 0.750 | 0.004 | 1.512 | 0.122 |
| Crosses | 23 | 5.724** | 9.568** | 13.086** | 15.261** | 0.267** | 14.830** | 0.376** | 3.204** | 0.196 | 3.011** | 0.999** |
| Lines | 3 | 6.614 | 17.314 | 32.189 * | 29.383 | 0.517 | 3.816 | 0.778 | 10.918** | 0.738** | 5.187* | 0.120 |
| Testers | 5 | 9.466 | 15.624 | 15.666 | 22.818 | 0.289 | 26.133 | 0.536 | 2.545 | 0.057 | 7.664** | 1.835 |
| Females x Males (L X T) | 15 | 4.298** | 6.000** | 8.406** | 9.917** | 0.209 ** | 13.265** | 0.242** | 1.881** | 0.134 | 1.025* | 0.896** |
| Error | 23 | 1.010 | 1.168 | 0.858 | 1.117 | 0.053 | 1.177 | 0.045 | 0.336 | 0.105 | 0.345 | 0.177 |

**Table 2:** Percent relative heterosis, heterobeltiosis and standard heterosis in mungbean (*Vigna radiata* (L.) Wilczek)

| Sr. No. | Crosses | Days to 50% flowering | | | Days to maturity | | | Plant height | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | RH | HB | SH | RH | HB | SH | RH | HB | SH |
| 1 | BM 2002-1 X BPMR 182 | 0.00 | -2.78 | 6.06* | -2.16 | -2.31 | -1.27 | 2.27 | 1.12 | 2.86 |
| 2 | BM 2002-1 X BPMR 132 | 1.33 | -2.56 | 15.15** | 4.51** | 2.21 | 8.05** | 1.90 | 0.37 | 2.10 |
| 3 | BM 2002-1 X BPMR 21 | -0.83 | -1.64 | 9.09** | -0.77 | -1.23 | -0.19 | 1.34 | -2.92 | 7.81** |
| 4 | BM 2002-1 X BPMR 126 | 0.00 | -5.88* | 3.03 | -0.79 | -3.08 | -2.05 | 4.37** | 2.81 | 4.57* |
| 5 | BM 2002-1 X BPMR 75 | 2.85 | 0.00 | 9.09** | 0.00 | 0.00 | 1.06 | 10.62** | 3.37* | 5.14** |
| 6 | BM 2002-1 X BPMR 38 | 4.83* | 2.63 | 18.18* | 3.14* | 0.29 | 7.28** | 2.29 | 0.37 | 2.10 |
| 7 | BM 4 X BPMR 182 | 7.46* | -2.70 | 9.09** | -0.62 | -1.23 | -0.50 | 0.87 | -0.19 | -0.76 |
| 8 | BM 4 X BPMR 132 | -2.47 | -10.26* | 6.06* | -4.55** | -7.35** | -2.05 | 6.71** | 5.98** | 4.57* |
| 9 | BM 4 X BPMR 21 | 4.02 | -2.16 | 9.70** | 0.31 | 0.00 | 0.12 | -4.94** | -10.81** | -0.95 |
| 10 | BM 4 X BPMR 126 | 0.00 | -1.36 | -1.52 | -03.17 | -4.68* | -5.16 | 1.46 | 0.77 | -0.57 |
| 11 | BM 4 X BPMR 75 | 2.98 | -6.76* | 4.55 | -0.78 | -1.53 | -0.50 | 1.74 | -2.94 | -5.52** |
| 12 | BM 4 X BPMR 38 | -0.56 | -7.55** | 7.58* | -5.42** | -8.72** | -2.36 | -2.83 | -3.11 | -5.14** |
| 13 | JL 781 X BPMR 182 | -1.40 | -5.41* | 6.06* | 0.92 | 0.77 | 1.83 | 11.83** | 11.41** | 11.62** |
| 14 | JL 781 X BPMR 132 | 5.26* | -2.70 | 21.21** | 5.26** | 2.94* | 8.83** | -1.53 | 2.28 | -2.10 |
| 15 | JL 781 X BPMR 21 | 0.54 | 0.00 | 12.12** | 0.46 | 0.00 | 1.06 | 4.42** | -0.69 | 10.29** |
| 16 | JL 781 X BPMR 126 | -4.34 | -5.41* | 0.00 | -2.36 | -1.54 | -3.61 | 4.21** | 3.42* | 3.62* |
| 17 | JL 781 X BPMR 75 | -2.53 | -6.49* | 4.85 | 0.00 | 0.00 | 1.06 | 16.97** | 10.08** | 10.29** |
| 18 | JL 781 X BPMR 38 | -1.85 | -3.65 | 12.12** | 1.64 | -1.16 | 5.72** | -0.38 | -1.52 | -1.33 |
| 19 | AKM 4 X BPMR 182 | 5.88* | 5.88* | 9.09** | -0.23 | -0.76 | 1.06 | -0.39 | -1.92 | -2.48 |
| 20 | AKM 4 X BPMR 132 | -4.10 | -10.25** | 6.06* | -0.38 | -2.21 | 3.39* | 0.39 | -0.77 | -2.10 |
| 21 | AKM 4 X BPMR 21 | -3.68 | -7.10* | 3.03 | -1.46 | -2.29 | -0.50 | 2.85** | -3.95* | 6.67** |
| 22 | AKM 4 X BPMR 126 | -9.09** | -8.57** | -9.09** | -6.67 | -6.11** | -7.49** | 7.23** | 5.98* | 4.57 |
| 23 | AKM 4 X BPMR 75 | 2.94 | 2.94 | 6.06* | -3.45 | -3.82* | -2.05 | 9.07** | 4.55* | 0.76 |
| 24 | AKM 4 X BPMR 38 | 2.20 | -3.65 | 12.12** | -0.22 | -6.98** | 4.17 | -0.78 | -1.56 | -3.62 |

| Sr. No. | Crosses | No. of clusters per plant | | | No. of pods per cluster | | | No. of pods per plant | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | RH | HB | SH | RH | HB | SH | RH | HB | SH |
| 1 | BM 2002-1 X BPMR 182 | -8.53** | -9.23** | -9.23** | 9.09 | -2.33 | -6.67 | 9.09 | 1.83 | 0.91 |
| 2 | BM 2002-1 X BPMR 132 | 4.55 | 2.99 | 6.15 | -8.24 | -9.30 | -13.33* | 0.94 | -1.83 | -2.73 |
| 3 | BM 2002-1 X BPMR 21 | 11.81** | 9.23** | 9.23** | 2.38 | 0.00 | -4.44 | 6.61 | 2.54 | 10.00* |
| 4 | BM 2002-1 X BPMR 126 | 3.03 | 1.49 | 4.62 | 4.88 | 0.00 | -4.44 | 17.30** | 8.59* | 26.36** |
| 5 | BM 2002-1 X BPMR 75 | 10.94** | 9.23** | 9.23** | 19.51** | 13.95* | 8.89 | 20.93** | 19.26** | 18.18** |
| 6 | BM 2002-1 X BPMR 38 | 38.33** | 27.69** | 27.69** | 21.95** | 16.28* | 11.11* | 18.23** | -1.83 | -2.73 |
| 7 | BM 4 X BPMR 182 | 10.24** | 9.38** | 7.69* | 3.80 | -8.89 | -8.89 | 6.60 | -3.83 | 2.73 |
| 8 | BM 4 X BPMR 132 | 9.23** | 5.97* | 9.23** | 1.15 | -2.22 | -2.22 | 8.84* | 2.13 | 9.09 |
| 9 | BM 4 X BPMR 21 | 7.20* | 6.35* | 3.08 | 6.98 | 2.22 | 2.22 | 7.01 | 6.78 | 14.55** |
| 10 | BM 4 X BPMR 126 | 9.23** | 5.97* | 9.23** | -7.14 | -13.33 | -13.33* | -11.20** | -14.48** | -0.91 |
| 11 | BM 4 X BPMR 75 | 6.35* | 6.35* | 3.08 | 2.38 | -4.44 | -4.44 | 18.57** | 12.77** | 20.45** |
| 12 | BM 4 X BPMR 38 | 13.56** | 6.35* | 3.08 | 0.00 | -6.67 | -6.67 | 15.04** | -7.23 | -0.91 |
| 13 | JL 781 X BPMR 182 | 14.06** | 14.06** | 12.31** | -1.33 | -9.76 | -17.78** | 18.16** | 8.93 | 10.91* |
| 14 | JL 781 X BPMR 132 | -9.92** | -11.94** | -9.23** | 13.25** | 11.90.* | 4.44 | 13.49** | 8.93 | 10.91* |
| 15 | JL 781 X BPMR 21 | 15.87** | 14.06** | 12.31** | -4.88 | -4.88 | -13.33* | -0.43 | -2.97 | 4.09 |
| 16 | JL 781 X BPMR 126 | 2.29 | 0.00 | 3.08 | 10.00** | 7.32 | -2.22 | 22.50** | 10.93** | 29.09** |
| 17 | JL 781 X BPMR 75 | 14.96** | 14.06** | 12.31** | 17.50** | 14.63* | 4.44 | 37.16** | 33.48** | 35.91** |
| 18 | JL 781 X BPMR 38 | 10.92** | 3.13 | 1.54 | 2.50 | 0.00 | -8.89 | 1.09 | -16.96** | -15.45** |
| 19 | AKM 4 X BPMR 182 | 5.79* | 0.00 | -1.54 | 4.23 | 0.00 | -17.78** | 24.34** | 14.16** | 17.27** |
| 20 | AKM 4 X BPMR 132 | 14.52** | 5.97* | 9.23** | -6.33 | -11.90 | -17.78** | 12.96** | 7.96 | 10.91* |
| 21 | AKM 4 X BPMR 21 | 24.37** | 19.35** | 13.85** | 7.69 | 2.44 | -6.67 | 1.30 | -0.85 | 6.36 |
| 22 | AKM 4 X BPMR 126 | 16.13** | 7.46* | 10.77** | 2.63 | 0.00 | -13.33** | -15.77** | -20.70 | -7.73 |
| 23 | AKM 4 X BPMR 75 | 15.00** | 9.52** | 6.15* | 5.26 | 2.56 | -11.11** | 16.44** | 12.83* | 15.91** |
| 24 | AKM 4 X BPMR 38 | 26.79** | 24.56** | 9.23** | 7.89 | 5.13 | -8.89* | 31.89** | 7.96 | 10.91* |

| Sr. No. | Crosses | No. of seeds per pod | | | 100 seed weight | | | Pod length | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | RH | HB | SH | RH | HB | SH | RH | HB | SH |
| 1 | BM 2002-1 X BPMR 182 | 9.09** | 0.80 | -3.08 | 7.55 | 3.75 | 0.00 | 16.20** | 0.00 | -4.67 |
| 2 | BM 2002-1 X BPMR 132 | 0.00 | -2.40 | -6.15** | 1.53 | -5.08 | -8.51 | 4.17 | -3.85 | -8.34 |
| 3 | BM 2002-1 X BPMR 21 | 4.60* | 0.00 | -3.85* | 4.84 | 0.44 | -3.19 | 5.38 | -5.77 | -10.17* |
| 4 | BM 2002-1 X BPMR 126 | 9.16** | 4.80* | 8.26** | 3.49 | -1.77 | -5.32 | 13.57** | 8.65 | 3.57 |
| 5 | BM 2002-1 X BPMR 75 | 2.46 | 0.00 | 3.85 | 12.90* | 8.17 | 4.26 | 23.67** | 11.54* | 6.32 |
| 6 | BM 2002-1 X BPMR 38 | 5.17** | -2.40 | -6.15** | 5.68 | 2.65 | -1.06 | 12.64* | -5.77 | -10.17* |
| 7 | BM 4 X BPMR 182 | 9.00** | 8.49** | -11.45** | 6.95 | 0.48 | -10.00 | 26.90** | 22.67** | -15.67** |
| 8 | BM 4 X BPMR 132 | -0.89 | -6.72* | -14.62** | 13.35* | 9.90 | -7.87 | 21.52** | 9.09 | -12.01* |
| 9 | BM 4 X BPMR 21 | 6.85** | 2.63 | -10.00** | -5.73 | -10.84 | -21.28** | 10.53 | 2.44 | -23.01** |
| 10 | BM 4 X BPMR 126 | 8.18** | 3.48 | -8.46** | 11.20 | 6.14 | -8.09 | 16.36** | 1.05 | -12.01* |
| 11 | BM 4 X BPMR 75 | 11.61** | 5.04* | -3.85* | -5.73 | -10.84 | -21.28** | 45.83** | 33.97** | 2.66 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 12 | BM 4 X BPMR 38 | 8.49** | 7.48 | -11.54** | -3.89 | -10.30 | -18.51** | 25.71** | 25.71** | -19.34** |
| 13 | JL 781 X BPMR 182 | 3.17 | -0.87 | -12.31** | -0.36 | -2.61 | -12.77* | 10.43 | 2.27 | 17.51** |
| 14 | JL 781 X BPMR 132 | 1.71 | 0.00 | -8.46** | 8.79 | 7.71 | -7.87 | 0.00 | 0.00 | 19.34** |
| 15 | JL 781 X BPMR 21 | 9.17** | 8.70** | -3.85* | 9.18 | 7.47 | -5.11 | 22.35** | 18.18** | -4.67 |
| 16 | JL 781 X BPMR 126 | 3.48* | 3.48 | -8.46** | 17.92** | 17.20* | 1.49 | 19.13** | 14.73** | -0.09 |
| 17 | JL 781 X BPMR 75 | 6.84** | 5.04* | -3.85* | 11.63 | 9.88 | -2.98 | 30.54** | 27.27** | 2.66 |
| 18 | JL 781 X BPMR 38 | 3.60* | 0.00 | -11.54** | 2.05 | -0.94 | -10.00 | 13.92* | 2.27 | -17.51** |
| 19 | AKM 4 X BPMR 182 | 7.69** | 3.48 | -8.46** | -3.15 | -4.99 | -14.89* | 18.01** | 10.47 | -12.92* |
| 20 | AKM 4 X BPMR 132 | 5.13** | 3.36 | -5.38** | 2.63 | 1.23 | -12.77* | 2.30 | 1.14 | -18.42** |
| 21 | AKM 4 X BPMR 21 | 7.42** | 6.96** | -5.38** | 10.24 | 8.92 | -3.83 | 8.33 | -5.81 | -16.59** |
| 22 | AKM 4 X BPMR 126 | 3.48* | 3.48 | -8.46** | 3.69 | 3.44 | -10.43 | 2.44 | -16.84** | -0.09 |
| 23 | AKM 4 X BPMR 75 | 0.85 | -0.84 | -9.23** | 5.12 | 3.86 | -8.30 | 25.00** | -11.63* | -2.84 |
| 24 | AKM 4 X BPMR 38 | 2.70 | -0.87 | -12.31** | -1.44 | -3.98 | -12.77* | -10.26 | -18.60 | -35.84** |

| Sr. No. | Crosses | Yield/plant | | | Protein % | | |
|---|---|---|---|---|---|---|---|
| | | RH | HB | SH | RH | HB | SH |
| 1 | BM 2002-1 X BPMR 182 | 16.18* | 7.99 | 8.05 | -2.65 | -5.97 | -4.19 |
| 2 | BM 2002-1 X BPMR 132 | 3.41 | -2.33 | -2.28 | 1.80 | -0.59 | -0.95 |
| 3 | BM 2002-1 X BPMR 21 | 4.06 | 1.00 | 1.05 | 9.88** | 5.01 | 9.41** |
| 4 | BM 2002-1 X BPMR 126 | 28.33** | 25.80** | 31.11** | 14.40** | 11.25** | 11.80** |
| 5 | BM 2002-1 X BPMR 75 | 29.14** | 27.63** | 27.77** | 10.47** | 7.97* | 7.38* |
| 6 | BM 2002-1 X BPMR 38 | -0.06 | -12.32 | -12.27 | -4.42 | -8.10 | -5.45 |
| 7 | BM 4 X BPMR 182 | -1.62 | -1.81 | -15.60* | -0.78 | -4.07 | -2.25 |
| 8 | BM 4 X BPMR 132 | 2.29 | 0.37 | -10.72 | 3.47 | 1.13 | 0.77 |
| 9 | BM 4 X BPMR 21 | 7.47 | 2.59 | -3.39 | 11.27** | 6.44 | 10.90** |
| 10 | BM 4 X BPMR 126 | -2.34 | -11.09 | -7.38 | 15.35** | 12.28** | 12.83** |
| 11 | BM 4 X BPMR 75 | 27.87** | 8.52 | 17.22** | 9.02** | 6.65 | 6.08 |
| 12 | BM 4 X BPMR 38 | 3.38 | -2.72 | -16.71* | -8.87 | -12.30 | -9.77 |
| 13 | JL 781 X BPMR 182 | 5.74 | 2.17 | -5.38 | -2.39 | -8.00 | -6.26 |
| 14 | JL 781 X BPMR 132 | 40.28** | 1.69 | 27.11** | 3.46 | -1.45 | -1.80 |
| 15 | JL 781 X BPMR 21 | 21.57** | 1.42 | 13.33** | 14.57** | 6.87* | 11.35** |
| 16 | JL 781 X BPMR 126 | 27.82** | 20.46** | 25.55** | 20.33** | 14.16** | 14.72** |
| 17 | JL 781 X BPMR 75 | 45.09** | 26.13** | 37.78** | 10.30** | 5.16 | 4.59 |
| 18 | JL 781 X BPMR 38 | 16.56* | 6.02 | -2.28 | 11.10** | 4.25 | 7.25 |
| 19 | AKM 4 X BPMR 182 | -4.29 | -7.78 | -14.49* | -3.71 | -7.03 | -5.27 |
| 20 | AKM 4 X BPMR 132 | 6.60 | 4.43 | -3.16 | 1.02 | -1.40 | -1.76 |
| 21 | AKM 4 X BPMR 21 | 8.73 | 7.90 | 1.61 | 4.37 | -0.30 | 3.87 |
| 22 | AKM 4 X BPMR 126 | 10.55 | 4.48 | 8.88 | 9.38** | 6.32 | 6.84 |
| 23 | AKM 4 X BPMR 75 | 27.11** | 23.86** | 21.11** | 11.82** | 9.23* | 8.64* |
| 24 | AKM 4 X BPMR 38 | 17.49* | 6.59 | -1.17 | 11.38** | 7.05 | 10.13** |

## Conclusion

The promising hybrids *viz.* BM 2002-1 X BPMR 126, BM 2002-1 X BPMR 75, BM 4 X BPMR 75, JL 781 X BPMR 126, JL 781 X BPMR 75 and AKM 4 X BPMR 75 had high seed yield and yield contributing characters, were the top five crosses based on mean *perse* performance and heterosis. Seed yield is the complex character decides the economic worth of the hybrids. The high expression of heterosis for seed yield was evident in the present investigation. The exploitation of hybrid vigor could be done in these crosses and it might be helpful in the improvement of this crop.

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