*J. Inno. Agri.*, 2(1):1-6, 2015 ISSN 2394-5389

# A need of heterosis in mungbean (*Vigna radiata* L.) for the pulses crop improvement-special review

**G. Govardhan [1*], R. Vinoth [2], K. Praveen [1], G. Selvakumar [2] and S.J.Mallikarjuna [1]**

[1*]Department of Genetics and Plant Breeding, S.V. Agricultural College, Tirupati 517502, Andhra Pradesh, India.
[2]Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India.
*Corresponding author's E-mail: govardhan.anantapur@gmail.com

Received: January 2, 2015 Accepted: February 21, 2015 Published: March 28, 2015

## ABSTRACT

**Heterosis is a complex phenomenon manifested in the superiority of a hybrid in one (or) more characters over its parents. In other words, heterosis refers to increase in fitness and vigour over the parental values. Heterosis is the increase in vigor that is observed in progenies of matings of diverse individuals from different species, isolated populations or selected strains within species or populations. Heterosis has been of immense economic value in agriculture and has important implications regarding the fitness and fecundity of individuals in natural populations. Considering mungbean (*Vigna radiata* (L.) Wilczek), a pulse crop which is self-pollinated, little work has been done on heterosis. This genetic tool is the basic mechanism in developing mungbean cultivars with high yielding potentials. The increase in pulses production volume comes mainly from the increase in mungbean cultivated area. A possible breakthrough for this production limitation is to exploit hybrid vigor of the $F_1$ for possible production of hybrid varieties. The magnitude of hybrid vigor is normally presented in terms of heterosis (superiority of the $F_1$ hybrid over its parental mean) and heterobeltiosis (superiority of the F1 hybrid over its better parent). Existence of a significant amount of dominance variance is essential for undertaking heterosis breeding programme.**

**Key words:** mungbean, heterosis, heterobeltiosis, hybrid, yield, crop improvement

Pulses are seeds of leguminous plants used as food and one of the important commodities in Indian diet as they are rich in protein content than cereals. It is also useful to cattle as it is a fodder concentrate. In pulses, the protein content ranged from 22 to 40 per cent as compared to 8 to 12 per cent in cereals. Pulses are rich in lysine content with an average of 65±7 mg/g of protein as compared to 29±7 mg/g in cereals, having 2 to 3 times more lysine content than cereals. People in developing countries get 12 per cent of protein from animal source and 80 per cent protein from plant sources, mainly from pulses. Therefore, the only practical means of solving the protein malnutrition problem is to increase greatly the production of the pulse crop.

India is the largest producer and consumer of pulses in the world accounting for 37 per cent of world area and 28 per cent of production. Pulse crops, in general give lower yield than cereal crops. Pulses are referred as the 'poor man's vegetable. Norman E. Borlaug (1973) called for protein revolution in developing world for pulses and oilseeds. He claimed that the pulses remain at low yield level and production is either static or dropping and hence he called them as 'slow runners'. This is due to the fact that pulses have been mostly grown in poor soils under rainfed condition, lack of genetic diversity, indeterminate growth habit, photoperiod sensitivity, pod shattering and susceptibility to pest and diseases (Fernandez and Shanmugasundaram, 1988). Therefore, it is necessary to undertake an in-depth analysis of the genetic architecture and nature of gene action governing yield and its component traits in this crop.

Among the pulses, mungbean or greengram (*Vigna radiata* (L.) Wilczek) is a well known crop in Asian countries. Nearly eight per cent of the area occupied by mungbean, which is the third important pulse crop of India in terms of area cultivated and production next to chickpea and pigeonpea. The area under mungbean in the India is around 3.8 million hectares with a production of 1.0 million tonnes. Low yield is attributed to several reasons *viz*., greengram cultivated as rainfed crop, as intercrop in marginal lands, poor management practices and low yield potential of varieties *etc.* Proper choice of parents for hybridization programme requires the knowledge of combining ability in the formation of systemic and successful breeding programme for the improvement of yield and its components, as it provides an indication of relative magnitude of additive and non-additive variances. The magnitude of heterosis provides basic for determining genetic diversity and serves as a guide to select desirable parent. In grain legumes, the heterosis is generally due to dominance gene effects but also due to epistatic interaction. Dominance effects were associated with heterozygosity. Therefore, in plant population, dominance effects are expected to be maximum in cross pollinated crops and minimum in self pollinated crops (Frey, 1966). For this reason, occurrence of heterosis is more in cross pollinated crops than in self pollinated crops. The results on heterosis so far in mungbean were encouraging and still there a scope to utilize this genetic phenomenon to develop new cultivars superior than existing.

**UTILIZATION OF HETEROSIS IN MUNGBEAN**

A brief review of work done on heterosis of grain yield and yield components in mungbean is presented here under. Heterosis was recognized by Koelreuter (1763). Information on the magnitude of heterosis will be useful from the standpoint of breeding methodology. Several workers have demonstrated the existence of varying degree of heterosis for yield and other traits in grain legumes. The exploitation of heterosis by breeding hybrid varieties offers a considerable scope for improvement of greengram crop. Several workers have demonstrated the existence of varying degrees of heterosis for seed yield and other traits in greengram.

Shull (1914) first coined the term heterosis and defined as the increased vigour of $F_1$ over the parental means. Subsequently, Whaley (1952) extended the term for the increased vigour of the $F_1$ over the better parent, which is now termed as "Heterobeltiosis". William and Gilbert (1960) emphasized that the heterosis over better parent helps the breeder in eliminating the less productive crosses at $F_1$ itself. While, Singh and Jain (1970) utilized heterosis to identify the crosses which are likely to generate transgressive segregants. Yield is a dependent quantitative character, therefore, heterosis of all the contributing characters of yield need to be studied together for heterosis for yield in order to assess the genetic potential of the cross (Grafius, 1956). A brief review of work done on heterosis of grain yield and yield components in mungbean is presented hereunder.

Singh (1980) found significant heterosis for branch number, pod number and seed yield per plant and the crosses involving K 851, B 105 and pusa bold showed highest heterosis. Reddy *et al*. (1982) reported that relative heterosis was high for plant height, clusters per plant and seed yield. Patil *et al*. (1992) observed highest value for heterosis over better parent for number of pods per plant (13.96%) followed by seed yield per plant (76%). Reddy *et al*. (1992) Studied 15 $F_1$ hybrids along with parents and observed positive heterosis for days to 50% flowering, days to maturity, plant height, pods per plant and seed yield per plant.

Naidu and Satyanarayana (1993a) noted high relative heterosis and and heterobeltosis for seed yield and pods per plant and low for other characters studied. Naidu and Satyanarayana (1993b) found that heterosis for seed yield varied from -8.49% to 25.81% over the better parent values. Out of twenty crosses, eleven exceeded the better parent for seed yield. They also observed positive heterosis over better parent for clusters per plant, branches per plant, pods per plant and seed weight and negative heterosis for days to 50% flowering and maturity.

Sharma and Yadav (1993) recorded positive heterosis for plant height, primary branches per plant, pods per plant and seed yield per plant. In contrast, negative heterosis for 100 seed weight, days to 50% flowering and maturity. Reddisekhar *et al*. (1994) pointed out significant positive heterosis for seed yield per plant in association with number of pods per cluster, number of pods per plant and number of pods per cluster in a set of 8 × 8 dialllel crosses excluding reciprocal crosses. Patil *et al*. (1996) evaluated eight mungbean genotypes along with $F_1$ and $F_2$ generations of their 10 crosses and reported that high heterosis for seed yield, primary branches per plant, clusters per plant and pods per plant. Reddy (1998) observed significant positive heterosis for seed yield , primary branches per plant, clusters per plant and pods per plant in 21 $F_1$ hybrids derived from 7×7 diallel. Heterosis for seed yield was due to heterosis for pods per plant, clusters per plant and seeds per pod.

Vikas and Singh (1998) Studied thirteen mungbean parents, 30 $F_1$s and 30$F_2$ s derived from ten lines and three testers during *kharif* and *summer* and found that heterosis for seed yield was accompanied with heterosis for number of pods per plant, number of seeds per pod, 100 seed weight and harvest index in both environments. Vikas *et al*. (1998) evaluated 45 $F_1$s and revealed that in most cases, hybrid showing heterosis for seed yield per plant were also heterotic for 100 seed weight, number of seeds per pod and clusters per plant. Aher and Dahat (1999) observed high better parent heterosis for seed yield per plant (38.42%) and most of the yield contributing traits. Aher *et al*. (2000a) observed pronounced hybrid vigour for yield and most of the yield components. Moreover, mid parent and better parent heterosis for seed yield per plant was recorded to an extent of 63.45% and 61.69% respectively. Aher *et al*. (2000b) reported that maximum better parent and standard heterosis value of 42.23% and 53.65% for seed yield per plant in 28 crosses derived from ten parents respectively. The crosses showing heterosis for seed yield per plant was not heterotic for all the charaters.

Jahagirdar (2001) observed high degree of positive relative heterosis and heterobeltiosis for seed yield per plant, pods per plant, branches per plant and clusters per plant. They also reported negative heterosis for days to flowering and days to maturity over mid parent and better parent. Loganathan *et al*. (2001) reported significant heterosis over mid parent (58.75%) and better parent (97.48%) respectively for grain yield per plant among 42 different hybrids resulting from 7×7 complete diallel including reciprocals. They also reported pronounced hybrid vigour for yield and its components. Cheralu *et al*. (2002) found very high heterobeltosis for seed yield per plant, clusters per plant and pod wall thickness among 30 crosses derived from five lines and six testers. Khattak *et al.* (2002) noticed significant positive heterosis for seed yield per harvest index, branches per plant, clusters per plant, pods per cluster and biological yield in a half diallel cross involving six diverse mungbean genotypes. Reddy *et al*. (2003) deduced significant positive heterosis to the extent of 110.77% and 77.54 % over mid and better parents respectively for seed yield per plant among 28 hybrids derived from 8x8 diallel excluding reciprocals.
Sawale *et al*. (2003) pointed out significant heterosis over mid and better parent for number of pods per plant, pods per cluster, 100 seed weight and seed yield per plant in inter-varietal crosses of mung obtained from six parental lines.

Dethe and patil (2008) revealed that significant positive heterosis for seed yield associated with earliness, plant height, pods per plant, clusters per plant and 100 seed weight in most of the crosses derived from 7×7 diallel analysis. Sirohi *et al*. (2008) reported significant positive heterosis over mid parent and better parent for number of pods per plant and seed yield per plant for the cross PDM 84-146 × MUM-2. Patel *et al*. (2009) carried out heterosis studies for 28 $F_1$s derived from 8× 8 diallel excluding reciprocals during *summer*. They reported that PDM 87 × K 851 had highest heterobeltosis of 62.50 per cent along with component traits like pods per plant, days to 50% flowering, days to maturity and 100 seed weight.

Reddy *et al*. (2011) depicted eleven out of twenty crosses had significant positive heterosis over mid parent and better parent for seed yield per plant along with yield attributing traits such as pods per plant and 100 seed weight. Sathya and Jayamani (2011) evaluated fifty six $F_1$ hybrids derived from four lines and fourteen exotic testers in a line × tester mating design for heterosis. They reported that the most of the hybrids had heterotic vigour for yield and yield attributing traits namely plant height, number of clusters per plant, 100 seed weight and single plant yield. Singh and Chauhan (2011) evaluated 24 $F_1$s derived from six lines and four testers for manifestation of heterosis for yield components and they found maximum heterosis for number of pods per plant (68.97%), followed by number of fruiting clusters per plant (32.66%), plant height (31.72%), 100 seed weight (27.82%) number of branches per plant (26.98%), number of pods per cluster (20.0%) and days to flower (-4.60%). Sujatha *et al*. (2011) evaluated twenty hybrids derived from two lines and ten testers and concluded that moderate to high heterosis was observed for seed yield per plot and its components like plant height, clusters per plant, pods per cluster and pods per plant.

Kumar and Prakash (2011) evaluated twenty hybrids which were obtained from five lines and four testers and observed positive and significant heterobeltiosis for branches per plant, pods per plant, 100 seed weight clusters per plant, total chlorophyll and seed yield per plant. Bhagora *et al*. (2013) evaluated twenty one crosses resulting from 7 × 7 diallel excluding reciprocals and observed highest heterosis to the extent of 111.46 % over mid parent and 56.76 % over better parent for seed yield per plant along with heterosis of either one or more yield components.
Srivastava and Singh (2013) noticed highest heterosis of 80.76% over standard variety and 72.39% over better parent for seed yield per plant and its components in the cross Narendra Mung 1 × PS 16

from a study of twenty eight $F_1$ crosses resulting from 8 × 8 diallel excluding reciprocals. Patil *et al*. (2014) carried out heterosis studies for 28 $F_1$s derived from 8 × 8 diallel excluding reciprocals and observed high heterotic effects for days to flowering, days to maturity, branches per plant, clusters per plant, pods per plant, seed yield per plant and 100 seed weight. They also reported that heterotic response for seed yield per plant was mainly due to high heterotic response for branches per plant, clusters per plant, pods per plant, pod length and seeds per pod.

## CONCLUSION

The literature available on heterosis in mungbean is too small and still there is much scope to conduct extensive study in this crop. At the end, it can be concluded that the enormous effort is still needed to utilize heterosis as a tool to develop new promising cultivars by selecting diversified germplasm, as high heterosis is the outcome from parents with diverse genetic background. The results on heterosis so far in mungbean were encouraging and still there a scope to utilize this genetic phenomenon to develop new cultivars superior than existing. Future research should be directed in this area.

## REFERENCES


Aher, R.P and Dahat, D.V. 1999. Heterosis and inbreeding depression in mungbean (*Vigna radiata* (L.) Wilczek). *Agricultural Science Digest (Karnal)*. 19(3): 155-158.

Aher, R.P., Sonawane, V.P and Dahat, D.V. 2000a. Heterosis in mungbean (*Vigna radiata* (L.) Wilczek). *Indian Journal of Agricultural Research*. 34(2): 134-137.

Aher, R.P., Surve, P.P and Dahat, D.V. 2000b. Heterosis for yield and yield components in mungbean (*Vigna radiata* (L.) Wilczek). *Agricultural Science Digest*. 20(1): 5-8.

Bhagora, N.B., Nizama, J.R and Patel, S.R. 2013. Hybrid vigour study in mungbean [*Vigna radiata* (L.) Wilczek]. *Asian Resonance*. 2(4): 51-55.

Cheralu, C and Satyanarayana, A. 2002. Heterosis for preharvest sprouting, yield and yield components in mungbean (*Vigna radiata* (L.) Wilczek). *Indian Journal of Pulses Research*. 15(2): 128-130.

Dethe, A.M and patil, J.V. 2008. Heterosis studies in mungbean (*Vigna radiata* (L) Wilczek). *Legume research*. 31(1): 36-39.

Fernaadez, G. C. J. and S. Shanmugasundaram. 1988. The AVRD mungbean improvement program: past, present and future. In: proceeding of the second international mungbean symposium, Asian Vegetables Research Centre, Shanhua, Taiwan: 58-70.

Frey, K.J. 1966. *Plant Breeding.*Lowastate University, Press, Ames, Lowa, USA.

Gilbert, N. 1958. Diallel crosses in plant breeding. *Heredity*. 12:477-492

Grafius, J.E.1956. Components of yield in oats, a geometric interaction. *Agronomy Journal*. 48:419-423.

Jahagirdar, J.E. 2001. Heterosis and combining ability studies for seed yield and yield components in mungbean (*Vigna radiata* (L.) Wilczek). *Indian Journal of Pulses Research*. 14(2): 141-142.

Khattak, G.S.S., Haqa, M.A., Marwata, E.U.K., Ashrafb, M and Srinives, P. 2002. Heterosis for seed yield and yield components in mungbean (*Vigna radiata* (L) Wilczek). *Science Asia*. 28: 345-350.

Koelreuter, D. J. G. 1763. Var Laufige Nachricht von einigen das Geschlecht der pflazen betreffenden Versuchen und Beobachtunger, Fortsetzung 1, Ostwalds, Klassiker der exaken Wissenschaften Nr. 41, Leipzig: Engelman 1763.

Kumar, B.S and Prakash, M. 2011. Heterosis for biometric and biochemical components in mungbean (*Vigna radiata* (L.) Wilczek.). *Karnataka Journal Agricultural Science*. 24(4): 523-524.

Lognathan, P., Saravanan, K., Thangavel, P and Ganesan, J. 2001. Heterosis for yield and yield components in greengram (*Vigna radiata* (L) Wilczek). *Legume research.* 24(2): 77-81.

Naidu, N.V and Satyanarayana, A. 1993a. Heterosis and combining ability in mungbean (*Vigna radiata* (L.) Wilczek). *Indian Journal of Pulses Research.* 6(1): 38-44.

Naidu, N.V and Satyanarayana, A. 1993b. Heterosis for yield and its components in mungbean (*Vigna radiata* (L.) Wilczek). *Indian Journal of Pulses Research*. 6(1): 102-105.

Norman E. Borlaug. 1973. Building a protein revolution on grain legumes. Max Milner (Eds.). In: Nutritional Improvement of Food Legumes by Breeding Protein Advisory Group of United Nation: 7-11.

Patel, M.B., Patel, B.N., Salviya, J.J and Tikka, S.B.S. 2009. Heterosis and genetic architecture of yield, yield contributing traits and yellow mosaic virus in mungbean (*Vigna radiata* (L) Wilczek). *Legume research*. 32(4): 260-264.

Patil, A. B., Desai, N. C., Chuahan, D. A and Chougule G. R. 2014. Heterosis for seed yield and yield attributing traits in mungbean (*Vigna radiata* L. Wilczek.). *Bioinfolet*. 11(2a):386-390.

Patil, A.J., Wanjari, K.B., Patil, A.N., Rout, B.R and Ghawghawa, P.B. 1992. Studies on heterosis in mungbean. *Journal of soils and crops*. 2(1): 1-4.

Patil, V.S., Deshmukh, R.S and Patil, J.V. 1996. Heterosis and inbreeding depression in mungbean. *Journal of Maharashtra Agricultural Universities.* 21(1): 152-154.

Reddisekhar, M., Raja Reddy, K and Raja Reddy, C. 1994. Heterosis for yield and yield components in mungbean (*Vigna radiata* (L.) Wilczek). *Indian Journal of Genetics and Plant Breeding.* 54(1): 1-5.

Reddy, D.K.R, Venkateswarlu, M.C., Obaiah, M.C and Jyothi, G.L.S. 2011. Heterosis for yield and yield components in greemgram (*Vigna radiata* (L) Wilczek). *Legume research*. 34(3): 207-211.

Sirohi, S.P.S., Gaurav, S.S., Singh, S.P and Yadav, R. 2008. Heterosis in mungbean. *Progressive Research*. 1: 35-37.

Reddy, K.H.P. 1998. Heterosis in greengram (*Vigna radiata* (L.) Wilczek). *Annals of Agricultural Research.* 19(1): 26-29.

Reddy, P.R., Sreeramulu, C., Raghuram and Reddy, P. 1982. Heterosis and combining ability for yield and its components in greengram (*Vigna radiata* (L) Wilczek). *Genetic Agararia.* 36:297-307.

Reddy, V.L.N., Reddisekhar, M., Reddy, K.R and Reddy, K.H.P. 2003. Heterosis for yield and its components in mungbean (*Vigna radiata* (L) Wilczek). *Legume research*. 26(4): 248-253.

Sathya, M and Jayamani, P. 2011. Heterosis and combining ability studies in greengram. *Journal of Food Legumes.* 24(4): 282-287.

Sawale, V.S., Patil, J.V., Deshmukh, R.B and Kute, N.S. 2003. Heterosis and inbreeding depression for yield and yield components in mungbean (*Vigna radiata* (L) Wilczek). *Legume research*. 26(2): 134-136.

Sharma, D.J and Yadav, R.K. 1993. Heterosis and inbreeding depression in mungbean. *Indian Journal of Pulses Research.* 6(2): 191-193.

Shull, G.H. 1914. *Methods of Plant Breeding* by Hayes, H.K., Immer, F.R and Smith, D.C. 1955.McGraw hill company, New York.53.

Singh, K.B and Jain, R.P. 1970. Heterosis in mung bean.*Indian Journal of Genetics and Plant Breeding.* 30: 244-250.

Singh, M. 1980. Genetic and immunochemical analysis of heterosis in greengram (*Vigna radiata* (L) Wilczek). *Thesis Abstract*, HAU, Hissar. 6(4):305-306.

Singh, S.K and Chauhan, B.P.S. 2011. Heterosis studies in mungbean. *Progressive Agriculture.* 11(1): 160-162.

Srivastava, R.L and Singh, G. 2013. Heterosis for yield and its contributing characters in mungbean

(*Vigna radiata* (L.) wilczek). *Indian Journal of Science Research.* 4(1): 131-134.

Sujatha, K., Kajjidoni, S.T., Patil, P.V and Somashekar,G. 2011. Heteosis for productivity related traits involving diverse parents for powdery mildew reaction in mungbean. *Journal of food legumes.* 24(2): 101-105.

Vikas and Singh, S.P. 1998. Heterosis for yield and its contributing characters over environments in mungbean (*Vigna radiata* (L.) Wilczek). *Annals of Biology –Ludhiana*. 14(2): 175-179.

Vikas, Paroda, R.S and Singh, S.P. 1998. Heterosis in line x tester crosses for yield and yield contributing characters in mungbean (*Vigna radiata* (L.) Wilczek). *Annals of Biology Research.* 3(2): 217-222.

Whaley, W.G. 1952. In heterosis (ed' John W Groven). Iowa State college press, Ames.

.