e-ISSN: 2319-9857
p-ISSN: 2347-226X

Research and Reviews: Journal of Agriculture and Allied sciences

Heterosis in Blackgram (*Vigna Mungo* L. Hepper) - History and Future Thrust.

S Isha Parveen*, M Reddi Sekhar, DM Reddy and P Sudhakar.

Department of Genetics and Plant Breeding, SV Agricultural College, Tirupati, Andhra Pradesh, India.

Review Article

Received: 01/09/2013
Revised: 27/09/2013
Accepted: 02/10/2013

***For Correspondence**

*Department of Genetics and Plant Breeding, SV Agricultural College, Tirupati, Andhra Pradesh, India.

Keywords: Heterosis, Vigna mungo, F1hybrids, Heterobeltiosis

ABSTRACT

The present review highlights the past, present and future importance of heterotic studies in blackgram. Heterosis, the important genetic mechanism operates to bring superiority in F1 hybrid than their parents. Heterosis has been of immense economic value in agriculture and has important implications regarding the fitness and fecundity of individuals in natural populations. Considering blackgram (Vigna mungo L.), a pulse crop which is self pollinated, little work has been done on heterosis. This genetic tool is the basic mechanism in developing blackgram cultivars with high yielding potentials. The increase in blackgram production volume comes mainly from the increase in blackgram cultivated area. A possible breakthrough for this production limitation is to exploit hybrid vigor of the F1 for possible production of hybrid varieties. The magnitude of hybrid vigor is normally presented in terms of heterosis (superiority of the F1 hybrid over its parental mean) and heterobeltiosis (superiority of the F1 hybrid over its better parent). The results on heterosis so far in blackgram were encouraging and still there a scope to utilize this genetic phenonmenon to develop new cultivars superior than existing.

INTRODUCTION

Blackgram (*Vigna mungo* L. Hepper, 2n=2x=22), originated from central Asia and India from where it was domesticated and its progenitor is believed to be *Vigna mungo var. silvestris*, which occurs wild in India [7]. Today, this crop is grown world wide as a pulse crop, India being top in production. It is one of the nutritious pulse crops, popularly known as urdbean. Economically, its seeds are highly nutritious with protein (25-26%), carbohydrates (60%), fat (1.5%), minerals, aminoacids and vitamins. It is an important short duration pulse crop and self pollinated grain legume grown in many parts of India. However, its yield is low compared to other grain legumes. In view of declining production of pulse crops, there is a dire need to develop high yielding cultivars through exploiting genetic phenomenon so called heterosis. This tool can raise the production potential of blackgram crop. Heterosis or hybrid vigour is manifested by F1 hybrids. Hybrid varieties have contributed greatly worldwide to the production of many crop species, including the most important food crops such as maize and rice. Heterosis breeding has allowed yield breakthroughs in several crops, including cross-pollinated, often cross-pollinated and self-pollinated species. Likewise, the exploitation of heterosis to raise productivity in grain legumes, as in any other crop, depends on three major factors *viz.,* the magnitude of heterosis, feasibility of large-scale production of hybrid seeds and type of gene action involved.

In self-pollinated plant species, it is rather easy to produce hybrid seed if male sterile lines are available and can be used as the female parent. Cross and Schulz [4] discussed a development in chemical induction of male sterility. With the success in the use of hybrid rice varieties which are also a self pollinates species, the possibility of using hybrid blackgram should be explored. The high heterosis identified in this study and by Chen et al. [3] is encouraging. However, a large-scale production of hybrid seed is possible only when a male sterility system is available, coupled with the availability of insect pollen vectors. Generally, legume pollen is heavier than that of cereals and thus could not be effectively transferred by wind. These are interesting topics for blackgram breeders to investigate in the future. However, the significance of heterosis and heterobeltiosis in blackgram has rarely been studied. Keeping this in view, we are proposing the literatures/complete review on heterosis in blackgram, which colud be useful in understanding the importance of heterosis in blackgram.

Brief History of Heterosis

Shull [22] first coined the term heterosis and defined as the increased vigour of F1 over the parental means. Subsequently, Whaley [28] extended the term for the increased vigour of the F1 over the better parent, which is now termed as "Heterobeltiosis". Singh and Jain [23] 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 [10].

Exploitation of Heterosis in Blackgram

A brief review of work done on heterosis of grain yield and yield components in urdbean is presented hereunder.

Singh and singh [24] studied heterosis in line X tester crosses for six characters in black-gram. They reported heterosis ver mid-parent for grain, yield cluster number, pod number and branch number. Fifty-six and 33% of the hybrids excelled the better parent and standard check respectively. Three hybrids were significantly better than both better parent and standard check. Heterosis in yield seems to be reflected through heterosis in cluster and pod number. Superiority of one tester over the other could not be established. It was visualized that two lines *viz.,* T 27 and P 1-68 and a few crosses may prove useful in future breeding programmes.

Prem Sagar and Chandra [17] studied heterosis using six diverse varieties of urdbean and reported that in most cases heterosis for plant height was significant while for pods per plant, heterosis over better parent was significant in all the crosses except two crosses.

Phundan Singh and Srivastava [16] studied 90 crosses made between 30 lines and 3 testers in blackgram in 1973 which were raised during 1974 and 1975 along with parents in RBD with three replications and reported that the range of heterosis was comparatively high for grain yield per plant (20.2 - 98.9 per cent), clusters per plant (2.2 - 93.7 per cent) and harvest index (11.6 - 39.2 per cent) whereas it was low for pods per cluster (3.2 - 13.8 per cent) and test weight (1.5 - 5.9 per cent).

Dasgupta and Das [5] studied 8 X 8 diallel analysis of blackgram and reported highly positive specific heterosis for the crosses viz., Mash 1-1 X LU 272 and Mash 1-1 X LU 241.

Shinde and Deshmukh [21] conducted a study on heterosis in the crosses of four varieties of urdbean and reported heterotic expression in five F1 hybrids among which the cross shindkheda 1-1 with T 9 was the highest yielding hybrid.

Abdul Ghafoor et al. [2] worked on blackgram to determine the heterotic effects for eight characters *viz.,* plant height, pods per plant, pod length, seeds per pod, 100-seed weight, biological yield per plant, economic yield per plant and harvest index in seven crosses involving two exotic and five local parents. They identified that crosses viz., 'NCM 87' × 'MI-5', 'NM 13-1' × 'NCM-7' and 'NM 13-1' × 'T 77' revealed the highest heterotic effects for pods per plant, harvest index and grain yield per plant and suggested that these crosses could be exploited for future mungbean improvement.

Rao [18] conducted an experiment on heterosis in urdbean using four crosses derived from seven distinct parents during *kharif* and *rabi* seasons in 1984-85 and reported that the hybrid RU 2 X PU 30 produced the highest heterosis for grain yield, number of pods per plant and number of seeds per plant. Sood and Gartan (1991a) identified the hybrids UH 45 X UH 27, HPU 392 X UH 22, UH 27 X Pant U 19, HPU 384 X UH 45 and HPU 392 X UH 2 as potential cross combinations on the basis of heterosis studies in blackgram.

Shanmugasundaram and Sreerangaswamy [20] reported heterosis of 20 hybrids in blackgram which were generated from a 5 X 5 diallel analysis and revealed that out of 20 hybrids, 18 showed heterosis ranging from 34.3 per cent (CO 5 X CO 4) to 130.7 per cent (UG 135 X UG 191) for grain yield whereas only nine hybrids showed heterosis ranging from 23.6 per cent (CO 5 X UG 135) to 23.4 per cent (UG 191 X T 9) for harvest index. Andhale et al. studied eight blackgram varieties and their ten F1 and ten F2 progenies and observed high heterosis for seed yield per plant followed by number of primary branches per plant, clusters per plant, pods per plant and seeds per pod.

Natarajan and Rathinaswamy [15] estimated the heterobeltiosis among 50 hybrids generated from 15 parents in blackgram and reported maximum heterobeltiosis for branches per plant followed by pods per plant and seed yield per plant whereas the crosses Vamban 1 X VB 3, Vamban 1 X VB 20 and Pant U 30 X TAU 5 showed high heterosis over better parent for pods per plant and seed yield per plant. Neog and Talukdar evaluated five genotypes of blackgram along with their crosses and found that the crosses viz., Pant U 19 X KU 92-1 and KU 91 X Pant U 30 exhibited high positive heterosis over the better parent for seed yield per plant.

Abdul Ghafoor et al. [1] crossed six cultivars of blackgram in a diallel fashion and concluded that hybrid vigour was less influenced by genetic distance, whereas parents with high general combining ability and good average performance were heterotic. Sharma (2000) derived the information on heterosis in six urdbean parents and their 15 hybrid progenies and reported that the hybrids exhibited maximum heterosis for seed yield per plant, followed by seeds per pod and clusters per plant. They concluded that the highest value of heterosis over better parent was recorded for seed yield per plant in the hybrid TPU 4 X NP 21 (92.8 per cent).

Mohar Singh Sharma and Chahota [13] evaluated 48 urdbean hybrids derived from 12 lines and four testers in a Line X Tester mating fashion to estimate the heterosis for 10 yield related traits and reported significant heterosis for seed yield in 30 cross combinations over the best control (UG 218). They observed that out of 48 cross combinations, 26 and 45 crosses had revealed significantly negative heterosis over the best control for days to 50 per cent flowering and maturity.

Gopi Krishnan et al. [9] carried out the heterosis studies in a 8 X 8 diallel of urdbean and revealed the highest heterosis and heterobeltiosis of 185.74 per cent and 153.94 per cent respectively for seed yield per plant in the hybrid K4686 X HPU 7. They reported that high heterosis for seed yield was manifested through components heterosis viz., pods per plant and clusters per plant.

Vaithiyalingan [28] conducted a study on heterosis in 30 different hybrids of urdbean which are derived from 6 X 5 Line X Tester analysis and reported the heterosis to the extent of 139.66 per cent and 116.39 per cent over the mid parent and better parent, respectively for seed yield per plant and also observed that the promising parents for seed yield and pods per plant identified were VBG 23 and LBG 20 whereas the four promising hybrids identified for many desirable traits were VBG 23 X VBN 2, LBG 20 X T9, LBG 20 X VBG 2 and VBG 52 XADT 5.

Saravanan et al. [26] conducted a heterosis study involving 30 different hybrids of urdbean resulting from a 6 X 6 complete diallel and observed the heterosis to the extent of 101.74 per cent (Direct), 103.48 per cent (Reciprocal) over mid parent and 52.25 per cent (Direct), 53.56 per cent (Reciprocal) over better parent respectively for grain yield per plant. They reported that the crosses between high X high and high X low *gca* parents exhibited greater heterosis whereas the promising parents which showed high heterosis for seed yield per plant were LEG 611 and LU 160.

Elangaimannan et al. [6] evaluated heterosis in five inter-varietal crosses of urdbean during *rabi*, 2006 and observed significant positive heterobeltiosis for number of clusters per plant, number of pods per plant and seed yield per plant in all the crosses.

Muhammad Zubair et al. [14] studied heterotic effects over mid parent and better parent values for yield and its components in an 8 parental diallel involving 5 exotic and 3 local mungbean genotypes. Hybrids were evaluated along with their parents in the field of National Agricultural Research Centre, Islamabad, Pakistan. High level of hybrid vigour was observed for plant height, number of pods per plant and grain yield per plant. Considering overall performance, the superior F1s were NM 51 x VC 3902, NM 51 x VC 4982, NM 20-21 x VC 1163, NM 51 x VC 3301 and VC 3301 x VC 1163 that revealed strong heterotic effects for number of pods per plant, number of grain per pod and grain yield per plant.

Thangavel [27] studied twenty one hybrids of black gram developed through Line X Tester matting design to estimate relative heterosis, heterobeltiosis and standard heterosis. Based on the superior performances the hybrid combinations NO 30-26X VBN 2, RTU-14 X VBN 2,AKU-98-01 XVBN2 and H70 X VBN1 showed higher relative heterosis, heterobeltiosis and standard heterosis for most of the yield contributing traits of interest.

In a study by Soehendi and Srinives [25], all crosses showed significant yield heterosis over the mid-parent and better-parent. Crosses showing heterosis for grain yield also showed heterosis for pod length, number of seeds per pod, and plant height. However, only plant height expressed heterobeltiosis. Superiority over the mid-parent for grain yield ranged from 52.2 to 95.7% and that over the better parent ranged from 31.8 to 78.5%. The highest heterosis over the mid- and better parent was shown in the cross SM x LM. They concluded that in self-pollinated crops, hybrid seeds can be produced using a male sterile line as the female parent. The detected yield heterosis must be reasonably high to compensate for the cost of seed production

Karande et al. [12] worked on heterotic effects over mid parent, better parent and standard check parent values for ten yield and yield attributing components in 7 different genotypes of black gram. They reported high heterotic effects for branches/plant, flowers/plant, pods/plant, seeds/pod, biological yield, seed yield. High heterotic response for seed yield per plant was mainly due to pods per plant and number of seeds per pod. Among 21 crosses they evaluated, only six crosses viz., COBG 653 x Udid No.55, PKV U-15 x IPU 02–33, Udid No. 55 x PKV

U-15, COBG 653 x PKV U-15, IPU 02–33 x KU 96-3 and KU 96-3 x KU 99–33 exhibited highly significant and maximum heterosis for better parent (BP) and economic heterosis (CP) for number of pods per plant, pod length, pod breadth, number of seeds per pod and seed yield per plant.

Srivastava and Singh [26] evaluated twenty eight crosses resulting from 8 x 8 diallel excluding reciprocal and explored the magnitude of heterosis over better parent and standard variety for yield and its components in blackgram. Results revealed that the highest heterosis to the extent of 80.76% over standard variety and 72.39% over better parent for seed yield per plant in the cross Narendra Mung-1 x PS-16, which exhibited high heterosis percentage for yield and yield components. In their study, the promising hybrids viz. Pusa Baisakhi x Pusa bold (vishal), Pusa Baisakhi x Pant M-3, Narendra Mung-1 x PS-16, Pusa Baisakhi x Pusa-105, Pusa Baisakhi x ML-613 were identified which have increased potential to exploit the hybrid vigour or to isolate the desirable segregants.

Isha parveen et al. [11] explored magnitude of heterosis over mid parent and better parent for seed yield and its components in blackgram (*Vigna mungo*), for which a field experiment was conducted through diallel analysis of 8 parental line and their 28 hybrids. In this study, the highest heterosis to the extent of 116.81 % over mid parent and 101.63 % over better parent for No. of pods per plant was observed in the cross LBG20 X PBG107, which exhibited high heterosis (%) and *per se* performance for either one or more yield components. The promising hybrids *viz*., PBG 107 X LBG 749, LBG 17 X LBG 770, LBG 17 X LBG 749 and LBG 20 X LBG 749 were identified, which have immense potential to exploit the hybrid vigour or to isolate desirable segregants. As per their results, heterosis for yield in urdbean is reflected through number of pods per plant number of cluster per plant and number of pods per cluster.

CONCLUSIONS

The literature available on heterosis in blackgram 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. Commercialization of hybrid cultivars in blackgram can be justified by exploring and utilizing the significant heterosis for yield. Future research should be directed in this area.

REFERENCES

1. Abdul Ghafoor, Zahoor Ahmad and Afsari S. Cluster analysis and correlation in black gram germplasm. Pakistan J Biol Sci. 2000; 3(5): 836-839.
2. Abdul Ghafoor, Zubair Md, Ahmed Bakhsh and Bashir, Md. Heterosis among seven parents and their crosses in mungbean. Pakistan J Agric Res. 1990; 11(3): 169-173.
3. Chen XW, Sorajjapinun, Reiwthongchum S and Srinives P. Identification of parental mungbean lines for production of hybrid varieties. Chiang Mai University J. 2003; 2(2):97-105.
4. Cross JW and Schulz PJ. Chemical induction of male sterility. In: K.R. Shivanna and V.K. Sawhney, eds, Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge, UK. pp. 218-236; 1997.
5. Dasgupta T and Das PK. Genetics of yield in black gram. Indian J Genet Plant Breed. 1987; 47(3): 265-270.
6. Elangaimannan R, Anbuselvam Y, Venkatesan M and Karthikeyan P. Heterosis and inbreeding depression for yield and yield attributes in urdbean. Madras Agric J. 2008; 95 (7/12): 453-457.
7. Lukoki LR. Marechal and Otoul E. Les ancetres sauvages des haricots cultives: *Vigna radiata* (L.) Wilczek et *V.mungo* (L.) Hepper. Bull Jard Bot Nat Belgique. 1980; 50: 385-391
8. Ghafoor A, Ahmad Z, Afzal M and Qureshi AS. Influence of genetic diversity and combining ability in determining hybrid vigour in black gram (*Vigna mungo* L. Hepper). J Genet Plant Breed. 2000; 54(2): 125-131.
9. Gopi Krishnan A, Reddisekhar M, Raja Reddy K and Subramanyam Reddy K. Heterosis and combining ability studies in urdbean (*Vigna mungo* L. Hepper). Legume Res. 2003; 26(4): 280-283.
10. Grafius JE. Components of yield in oats, a geometric interaction. Agronomy Journal. 1956; 48:419-423.
11. Isha parveen S, Redid Sekhar M, Reddy DM and Suhakar P. Heterosis and combining ability for yield and yield components in urdbean (*vigna mungo* l. hepper); 2012.
12. Karande SP, Rewale AP and Nilakh SB. Heterosis for yield and yield attributing traits in black gram (*Vigna mungo* (L) Hepper.). Bioinfolet. 2013; 10 (2): 679-684.
13. Mohar Singh Sharma SK and Chahota RK. Heterosis in urdbean (*Vigna mungo* L. Hepper). Crop Res. 2003; 26(1): 131-134.
14. Muhammad Zubair, Saif Ullah Ajmal and Shaukat Ali. Heterosis for yield related attributes in mungbean vigna radiata (L.) wilczek. Pak J Bot. 2010; 42(5): 3209-3214
15. Natarajan C and Rathinaswamy R. Heterosis and inbreeding depression in black gram. Madras Agricultural Journal. 1999; 86(7-9): 447-450.
16. Phundan Singh and Srivastava AN. Heterosis in black gram. Curr Sci. 1981; 50: 683-684.

17. Premsagar and Chandra S. Heterosis and combining ability in urdbean. Indian Journal of Genetics and Plant Breed. 1977; 37(3): 420-424.
18. Rao SS. Heterosis and inbreeding depression in urdbean. Indian J Pulses Res. 1991; 4(1): 23-27.
19. Saravanan K, Sabesan T, Thangavel P, Siddesh Kumar J and Ganesan J. Heterosis for yield and yield components in black gram (*Vigna mungo* L. Hepper). Legume Res. 2004; 27(3): 209-212.
20. Shanmugasundaram P and Sreerangaswamy SR. Heterosis and inbreeding in black gram (*Vigna mungo*). Madras Agric J. 1995; 82(2): 131-134.
21. Shinde NV and Deshmukh RB. Heterosis in urdbean. Indian Journal of Pusles Research. 1989; 2(2): 119-124.
22. Shull GH. Methods of Plant Breeding by Hayes HK, Immer FR and Smith DC. McGraw hill company, New York. pp.53; 1914.
23. Singh KB and Jain RP. Heterosis in mung bean. Indian Journal of Genetics and Plant Breeding. 1970; 30: 244-250.
24. Singh KB and Singh JK. Heterosis and combining ability in black gram. Indian J Genet Plant Breed. 1970; 31(3): 491-498.
25. Soehendi R and Srinives P. Significance of heterosis and heterobeltiosis in an f_1 hybrid of mungbean (*Vigna radiata* (L.) Wilczek) for hybrid seed production. SABRAO J Breed Genet. 2005; 37(2): 97-105.
26. Srivastava RL and Singh G. Heterosis for yield and its contributing characters in mungbean (*Vigna radiata* (L.)wilczek). Indian Journal of Scientific Research. 2013; 4 (1):131-134.
27. Thangavel P. Studies on heterosis in black gram (*Vigna mungo* (L.) Hepper). Int J Recent Sci Res. 2010; 1(12): 204-205.
28. Vaithiyalingan M. Heterosis for yield and yield components in black gram (*Vigna mungo*). J Ecobiol. 2004; 16(2): 87-91.
29. Whaley WG. In heterosis (ed' John W Groven). IoWa State college press, Ames. 1952.