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**Research Article**

# Identification of superior hybrid through exploitation of hybrid vigour in chickpea (*Cicer arietinum* L.)

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**Abstract**

Seven $F_1$ hybrids involving nine varieties/ lines of chickpea (*Cicer arietinum* L.) were evaluated to identify superior cross combination. The experiment was laid out in randomized complete bock design to estimate heterosis and heterobeltosis of grain yield and yield components. Significant differences among genotypes were observed in all the characters studied. The magnitude of hybrid vigour varied significantly between hybrids. Heterosis for plant height varied from -2.33% to 15.57%. The heterotic effects in primary and secondary branches varied from -20.06% to 58.52% and from -20.70% to 49.08% respectively. Heterosis for number of pods plant$^{-1}$, number of seeds pod$^{-1}$ and 100-seed weight respectively varied from 41.89% to 59.68%, 26.39% to 48.03% and -33.24% to 33.18%. Maximum heterosis and heterobeltosis for plant height and secondary branches were observed in cross combination K0014-10 × K0066-10 while cross K0019-10 × K0031-10 exhibited maximum heterosis and heterobeltosis for primary branches and number of seed palnt$^{-1}$ whereas cross K0014-10 × K0052-10 reflect maximum heterosis and heterobeltosis 33.18% & 30.84% for 100 seed weight and for seed yield plant$^{-1}$ 97.37% and 76.47% respectively. Broad sense heritability for different traits studied ranged from 63.14% to 77.18%. High heterosis, heritability and genetic advance were observed for number of pod plant$^{-1}$ which could be utilized for identification of best segregates from crosses K0031-10 × K0052-10, K0019-10 × K0026-10 and K0019-10 × K0031-10. Superior hybrids from this study could be used for the improvement of more than one character through selection of single plants with combination of various traits.

**Keywords:** heterosis, heterobeltosis, heritability, genetic advance, varieties.

## Introduction

Pulses play an important role in world agriculture by virtue of their high protein content and capacity for fixing atmospheric nitrogen in addition. These are also a rich source of energy, minerals and certain vitamin of B-complex group. Chickpea (*Cicer arietinum* L.) is commonly known as Bengal gram, gram, chana, etc. and is the third important leguminous crop all over the world after beans and peas (Bakhsh *et al.,* 2007). India and Pakistan is major chickpea producing countries based on its area under cultivation and grain production. Pakistan ranks second to India in terms of acreage under chickpea which is cultivated on an area of 985 thousand hectares and contributes the production of 673 thousand tones **(**Economic Survey, 2012-13**).**

Chickpea is primarily a drought tolerant crop that performs well under low inputs.. It is grown under a wide range of the South Asian environments including Indo-Pak Sub-Continent arid lands. Chickpea is used as whole grain or *dall*, sprouted grains, mature roasted dry seeds, green seeds and tender leaves as vegetable and in the preparation of variety of snacks, sweets and condiments. It is a rich source of protein both for human and animals. It is better source of digestible protein (21.1%), carbohydrate (61.5%), fat (4.5%), relatively free from anti nutritional factors and is rich in phosphorous, iron, niacin and calcium compared to other pulses (Saxena, 1990). It fulfills the deficiency of cereal diets. In all, it has much importance in our daily diet yet its production is unable to meet the demand of gradually increasing population.

In Punjab province of Pakistan, about 90% gram is cultivated in arid environment of Thal Region including the Districts of Bhakkar, Mianwali, Layyah, Khushab and some parts of Jhang. Beside aridity, chickpea production is constrained by several biotic (insect pest, diseases and weeds) and a biotic stresses (drought and low/high temperature) (Singh *et al*., 1994; Gaur *et al*., 2007). Drought is one of the most important constraints due to its wide range of environments (Summerfield *et al*., 1990) and may limit chickpea yield (Basu *et al*., 2009).

Plants adapt to drought environment either through escape, avoidance, or tolerance mechanisms (Sabaghpour *et al.*, 2003). Estimates of yield losses due to drought range from 15 to 60% which depend on geographical region and length of crop season (Sabaghpour *et. al.*, 2006). Introduction of genetically different chickpea genotypes and identification of drought tolerant through exploitation of hybrid vigor is one of the most effective practical approaches to overcome the stress condition. Breeders are utilizing the available genetic resources to develop the varieties to meet the ever changing environmental requirements. In this regard, the most important development in plant breeding is the extensive use of heterosis (Malik *et al*., 1987).

The direct utilization of heterosis in leguminous crops is limited due to their cleistogamous nature of flower. Therefore, information regarding genetic parameters such as heterosis, heterobeltosis, heritability and genetic advance may be useful for selection of superior hybrids. Hybrid vigor is most commonly used to identify superior hybrids as they possess more probability of developing better segregants (Sharif *et al*., 2001). In chickpea, heterosis for seeds per plant and grain yield was reported by many researchers (Hedge *et al*., 2002, Jena & Arora, 2002; Gupta *et al*., 2003). The knowledge of heritability and genetic advance helps to identify the characters with maximum potential and helps in the selection of superior breeding material (Hamid & Cheema, 1997). High genetic advance coupled with high heritability offer most effective conditions for selection in chickpea (Parshuram *et al*., 2003; Anbessa *et al*., 2006). The present study was conducted to estimate the degree of hybrid vigor, extent of heritability and genetic advance in $F_1$ hybrids. This information can be helpful in selection of superior segregants from better hybrids for drought resistance, better adaptation and production.

## Materials and Methods

The present research work was carried out in the experimental area of the Arid Zone Research Institute, Bhakkar, Punjab, Pakistan during crop season 2013-14. Seven $F_1$ hybrids and their parents constituted the experimental material of this study. The experimental material was comprised of seven $F_1$ hybrids (K0019-10 × K0031-10, K0031-10 × K0052-10, K0066-10 × K0019-10, K0014-10 × K0052-10, K004-10 × K0066-10, K0019-10 × K0026-10 and K0017-17 ×K0037-10) involving nine varieties/ lines (K0019-10, K0031-10, K0052-10, K0066-10, K0014-10, K004-10, K0026-10, K0017-10 and K0037-10) of chickpea. The experiment was conducted in randomized block design (RCBD) with three replications. Hybridization was performed between pure lines under natural field conditions following emasculation and pollination simultaneously in the morning. The seeds of $F_1$ hybrids along with their parents were sown in 1.6m long row, maintaining plant to plant and row to row distance 10cm and 30 cm, respectively. Recommended agronomic practices like irrigation and hoeing etc. were equally provided to all the treatments to raise a good crop. Five competitive plants from $F_1$ hybrids and their parents were randomly selected from each replication to record data on Plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100 seed weight and seed yield per plant. The data were statistically analyzed using (Steel & Torrie 1980) to determine the significant differences between genotypes for parameters under consideration. Heterosis and heterobeltosis were calculated by formulae suggested by Miller and Marani (1963).

$$\text{Heterosis} = \frac{F_1 - \text{mid parent value}}{\text{Mid parent value}} \times 100$$

$$\text{Heterobeltosis} = \frac{F_1 - \text{better parent value}}{\text{Better parent value}} \times 100$$

Heritability was computed by using following formulae by Singh and Choudhary (1985). Whereas, the genetic advance (GA) was calculated according to Allard (1960).

Heritability $[h^2(bs)]$ (%) $= \frac{\sigma^2 g}{\sigma^2 p} \times 100$

Genetic advance (Δ G) = $h^2.\sigma_P.k$.

Where $h^2$= heritability, $\sigma_P$ = standard deviation of phenotypic variance, and k= selection differential (20%= 1.40)

## Results and Discussion

The increase or decrease in hybrid vigour as compared to its parents is genetically attributed to heterotic effect expressed in $F_1$ and proceeding generations. Hybrids with more heterotic effect may offer better chances of selection of desirable pure inbred lines as compared to low heterosis. These types of hybrids can be utilized for pulses improvement (Joshi, 1972; Malik *et al*., 1987). The direct utilization of hybrids in leguminous crops is limited due to their cleistogamous nature of flower and many problems involved in artificial hybridization.

The results of present study showed significant differences between genotypes for all the characters studied. The mean values showed that plant height in parental genotypes ranged from 53.10 to 60.60 cm as compared to 57.33 to 67.90 cm among hybrids (Table 1). The number of primary branches plant$^{-1}$ in parents and hybrids varied from 2.44 to 4.00 and 2.83 to 5.33, respectively. Number of secondary branches plant$^{-1}$ in parents varied from 14.97 to 19.67 while in hybrids 14.67 to 26.33. The number of pod plant$^{-1}$ among parents and hybrid ranged from 52.83 to 77.33 and 92.33 to 104.33, respectively (Table 1). Maximum primary and secondary branches plant$^{-1}$ 5.33 and 26.33 were observed in K0017-10 × K0037-10. Number of seed pod$^{-1}$ in hybrids ranged from 1.78 t0 1.93. Similarly, 100 seed weight varied from 16.29 to 28.38g. The maximum grain yield plant$^{-1}$in parents ranged from 24.65g (K0031-10) to 34.90g (K004-10); while in hybrids it ranged from 45.33g (K0019-10 × K0031-10) to 60.00g (K0014-10 × K0052-10), respectively.

Both positive and negative heterosis was observed in all the traits studied in different cross combination (Table 2). The heterotic effects in Table 2 showed that four out of seven $F_1$hybrids showed positive heterosis and heterobeltosis for plant height. The maximum positive heterosis for plant height was observed in K004-10 × K0066-10 (15.57). Another cross K0019-10 × K0026-10 expressed maximum negative heterosis (-2.33). Negative heterosis in plant height may be used for the development of short stature varieties. Positive heterosis for plant height in eight chickpea crosses was reported by Singh *et al*. (1973). Positive heterosis for plant height in mungbean and urdbean has been reported by Ghafoor *et al*. (1990). Negative heterosis for primary branches plant$^{-1}$ was also obtained in two hybrids under study. Maximum positive heterosis for primary branches was observed in K0019-10 × K0031-10 and K0017-10 × K0037-10. Positive heterosis for number of primary branches plant-$^{1}$ has also been reported by Jeena & Arora (2000). The cross K004-10 × K0066-10 obtained maximum positive heterosis 49.08% for secondary branches plant$^{-1}$. Only one cross K0066-10 × K0019-10 expressed negative heterosis for secondary branches out of seven $F_1$ hybrids in this study. Heterobeltosis values ranged from 21.88% to 37.69%. These results may be correlated with the results of Kamatar *et al*. (1996). All the hybrids exhibited positive heterosis for number of pods plant$^{-1}$, number of seed pod$^{-1}$ and seed yield per plant$^{-1}$. Maximum heterosis over mid parent and better parent was obtained by K0031-10 × K0052-10 (59.68% & 50.62%) in pods plant$^{-1}$. As perusal of Table 2, positive heterotic effects for number of seeds plant$^{-1}$ were not much pronounced. Maximum increase was expressed by K0019-10 × K0031-10 (48.03%) and minimum by cross K0014-10 × K0052-10 (26.39%). Only one hybrid K0014-10 × K0052-10 exhibited positive heterosis for 100 seed weight while remaining crosses showed negative heterosis and heterobeltosis for this trait. Ghafoor *et al*. (1990) and Sharif *et al*. (2001) have already reported similar findings in chickpea.

The value of heterosis and heterobeltosis for seed yield plant$^{-1}$ revealed that all the hybrids expressed increasing tendency over parental value. All the hybrids surpassed the better parental value. Heterosis value ranged from 57.15% to 97.37% while heterobeltosis ranged from 47.94% to 82.71%. Maximum positive heterosis (97.33%) was expressed by K0014-10 × K0052-10. Heterosis in chickpea for grain yield has been reported by Sharif *et al*. (2001), Hedge *et al*. (2002) and Gupta *et al*. (2003). Although the legume crops are highly self pollinated and artificial hybridization is much difficult, the commercial exploitation of heterosis in self pollinated crop has not yet been achieved. Information regarding heterosis in $F_1$'s help to identify the superior crosses for development of new varieties. Sagar & Chandra (1977) also suggested that the manifestation of heterosis in legume crops may be utilized for selection of potential crosses for genetic improvement. Therefore information regarding heterosis may be used to select and promote hybrids for selection of genotypes keeping in view the specific objective. Similarly heterotic valve manifested in different characters expressed that majority of the hybrids have negative heterobeltosis for primary branches and 100 seed weight.

However, same hybrids have positive heterosis for secondary branches, number of pods plant$^{-1}$, number of seed pod$^{-1}$ and seed yield plant$^{-1}$. The results of present study revealed that the parents K0052-10, K0031-10, K0019-10 and K0026-10 performed better in developing cross combinations. The $F_1$s hybrids K0014-10 × K0052-10, K0031-10 × K0052-10, K0019-10 × K0026-10 and K0017-10 × K0037-10 showed prominent heterotic effects for number of secondary branches plant$^{-1}$, number of pods plant$^{-1}$ and seed yield plant$^{-1}$. Therefore chances of finding out of good segregants from these hybrids are higher. Hence, the above four hybrids may be advanced and utilized for single plant selection.

**Heritability studies**

The estimates of heritability and genetic advance in Table 3 indicated low genetic advance except for number of pods plant$^{-1}$ for all the traits in this study. Heritability values ranged from 63.14% in primary branches to 77.18% in 100 seed weight. Number of seed pod$^{-1}$ exhibited low genetic advance with high heritability which indicated non additive type of gene action of this trait. Moderate to high heritability observed in number of pods plant$^{-1}$and grain yield plant$^{-1}$ may get support from the findings of previous studies reported by Rajesh *et al*. (1988), Misra (1991) and Arora (1991).

Discussion of results from above study suggests that utilization of heterosis and heritability estimates may provide clues regarding the utilization of hybrids for selection of superior segregants for yield improvement (Anbessa *et al*., 2006).

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