Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(6): 2174-2177
Received: 29-09-2017
Accepted: 30-10-2017

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Estimation of heterosis, inbreeding depression and heritability for fruit yield and its attributing traits in Okra (*Abelmoschus esculentus*) (L) Moench

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Abstract
The experiment comprised the study of heterosis, inbreeding depression and heritability in okra. The experimemental material consisting parents were crossed to produce five single cross hybrids (Parbhani Kranti x Shagun, Arka Anamika x PBN-1, Shagun x AKO-107, Akola bahar x PBN-13, AKO-107 x Pusa sawani) between different parents (Parbhani Kranti, Arka Anamika, Shagun, Akola Bahar, AKO-107, PBN-1, PBN-13, Pusa Sawani) along with check Ankur-40 (Hybrid). Material was evaluated during *kharif* 2013 in a randomized block design with randomization of generation replicated twice. The characters studied were plant height (cm), internodal length (cm), number of branches per plant, days to 50% flowering, fruit length (cm), fruit weight (g), fruit diameter (cm), number of fruit per plant, fruit yield per plant (g), fruit yield per ha. (q). the results were reveal that. The cross Parbhani kranti x Shagun is promising as it depicted heterotic performance for fruit yield per plant and other important yield contributing traits. Narrow sense heritability played an important role for fruit length. Inbreeding depression greatly occurred for fruit yield per plant, whereas, least inbreeding depression was observed for the traits plant height.

Keywords: Okra, Heterosis, Inbreeding depression, Heritability and yield components,

Introduction
To exploit the heterosis of potential yield components, knowledge of genetic architecture of fruit yield and its attributes is important in crop improvement. So, line x tester analysis has served as a careful tool for selection of parents for hybridization to build up a population, to determine the combining ability of parents and crosses, to further develop promising hybrids. Morever to plan appropriate breeding program in okra requires the knowledge of genetic variability, heritability and heterosis. There are a few commercial F_1 hybrids released by private seed companies which are well received in the market. Thus, exploitation of heterosis and production of F_1 hybrids in Okra is a promising area which needs to be explored. So, there is a need to generate more information regarding heterosis, combining ability, nature of gene action for various traits of a cultivar which could help in predicting the effectiveness of selection. The proposed project therefore aims at studying variability, heritability and heterosis in okra which will prove valuable in the isolation of parents for further hybridization programs as well as to identify a superior hybrid combinations of okra for general cultivation. The information generated from the experiment could be used, especially in case of exploitation of hybrid vigor. Heterobeltiosis was measured as the proportion of the deviation of the mean value from the better parent value and standard heterosis from the value of standard check.

Materials and Methods
The parents were crossed to produce five single cross hybrids (Parbhani Kranti x Shagun, Arka Anamika x PBN-1, Shagun x AKO-107, Akola bahar x PBN-13, AKO-107 x Pusa sawani) between different parents (Parbhani Kranti, Arka Anamika, Shagun, Akola Bahar, AKO-107, PBN-1, PBN-13, Pusa Sawani) along with check Ankur-40 (Hybrid). The material was evaluated during *kharif* 2013 in a randomized block design with randomization of generation replicated twice. The characters studied were plant height (cm), internodal length (cm), number of branches per plant, days to 50% flowering, fruit length (cm), fruit weight (g), fruit diameter (cm), number of fruit per plant, fruit yield per plant (g), fruit yield per ha. (q). The experimental plot size 6.3m x 3.6m and net plot size were 5.7m x 3m, spaced at 30cm x 30cm between and within rows in separate RBD for each cross. The plot were dibbled and thinned to 20 plants per row. Each plot consisted spacing of 30 cm between rows and 30 cm within row. Experiment were carried out at the Experimental Farm, Department of Agricultural Botany, College of Agriculture, Latur

Results and Discussion

The analysis of variance for randomized block design was carried out for plant height, intermodal length, days to 50 per cent flowering, number of branches per plant, number of fruit per plant, diameter of fruit, length of fruit, weight of fruit, green fruit yield per plant, fruit yield per hectare. Analysis of variance showed highly significant differences and were present among the crosses studied for all the characters. This indicated the existence of sufficient variation for effective selection for all the characters in the material studied. (table-1), Heterosis inbreeding depression and heritability of traits were shown in table 2.

Heterobeltiosis (tof Plant height (cm ranged from 1.68 (Akola Bahar x PBN-13) to 3.65 *per cent* (Arka Anamika x PBN-1) and standard heterosis ranged from -2.12 (Parbhani kranti x Shagun) to -0.63 *per cent* (Shagun x Ako-107). All five crosses recorded significant heterosis over better parent. The cross Parbhani kranti x Shagun (-2.12) recorded significant negative heterotic value over check 'Ankur-40'. More and less similar result on heterosis for above character in Okra are recorded by Singh *et al*. (1975), Lal *et al*. (1975), Kulkarni and Virupakshappa (1977) [7]. Inbreeding depression for the trait ranged from 1.33 (Akola Bahar x PBN-13) to 3.09 (Arka Anamika x PBN-1). Inbreeding depression which was observed to be significant and positive in all five crosses. Similar result are reported by Mandal and Dana (1993) [9] and Khanorkar *et al*. (2010).

The low level of heritability were observed for the crosses Parbhani kranti x Shagun Arka Anamika x PBN-1 and Shagun x Ako-107, whereas, moderate heritability was observed in the crosses Akola Bahar x PBN-13(37%) and Ako-107 x Pusa Sawani(44%). Similar result are reported by Singh and Singh (1979), Thaker *et al*. (1981b) and Nichal *et al*. (2006).

The character for intermodal length, heterobeltiosis ranged from -5.74 (Arka Anamika x PBN-1) to 5.81 *per cent* (Parbhani kranti x Shagun) and standard heterosis ranged from -5.26 (Ako-107 x Pusa Sawani) to 6.55 *per cent* (Parbhani kranti x Shagun). Two crosses Parbhani kranti x Shagun and Shagun x Ako-107 recorded significant heterosis over better parent. The crosses *viz.* Parbhani kranti x Shagun (6.55), Arka Anamika x PBN-1 (-4.09), Shagun x Ako-107 (-2.09), Ako-107 x Pusa Sawani (-5.26) recorded significant heterotic value over check 'Ankur-40'. Poshiya and shukla (1986) [11], Kumbhani *et al* (1993), Patil *et al*. (1996a) also reported significantly positive heterosis over better parent for intermodal length. Inbreeding depression for the trait ranged from 0.61 (Arka Anamika x PBN-1) to 3.48 (Akola Bahar x PBN-13). Inbreeding depression which was observed to be significant and positive in all five crosses. The low and high level of heritability were observed for the crosses Parbhani kranti x Shagun and Ako-107 x Pusa Sawani, respectively. Similar results are reported by Lal *et al.* (1977), Singh and Singh (1979) and Ramanjinappa *et al*. (2011). Heterobeltiosis ranged from 14.18 (Akola Bahar x PBN-13) to 25.00 *per cent* (Parbhani kranti x Shagun) and standard heterosis ranged from -9.89 (Arka Anamika x PBN-1) to 2.66 *per cent* (Parbhani kranti x Shagun). All five crosses recorded significant heterosis over better parent except the cross Ako-107 x Pusa Sawani observed non-significant. None of the crosses recorded significant heterotic value over check 'Ankur-40'. More and less similar result on heterosis for above character in Okra are recorded by Singh *et al*. (1975), Pratap and Dhankar (1980), Elangovan *et al*. (1981a) [4] and Vijay and Manohar (1986). Inbreeding depression for the trait ranged from 0.45 (Arka Anamika x PBN-1) to 12.22 (Ako-107 x Pusa Sawani). Inbreeding depression which was observed to be significant and positive in all five crosses. Similar result are reported by Changani and Shukla (1986) and Khanorkar *et al*. (2010). The low level of heritability were observed for the crosses Arka Anamika x PBN-1, Shagun x Ako-107 and Ako-107 x Pusa Sawani, whereas, high heritability was observed in the crosses Parbhani kranti x Shagun and Akola Bahar x PBN-13(72%). Similar results are reported by Bello *et al*. (2006) and Ramanjinappa *et al*. (2011) Negative heterosis for days to 50 per cent flowering is considered desirable character for induction of earliness. Heterobeltiosis ranged from -8.74 (Akola Bahar x PBN-13) to 1.13 *per cent* (Parbhani kranti x Shagun) and standard heterosis ranged from -6.00 (Akola Bahar x PBN-13) to -0.15 *per cent* (Parbhani kranti x Shagun). Two crosses Akola Bahar x PBN-13 and Ako-107 X Pusa Sawani recorded significant heterosis over better parent. The crosses Akola Bahar x PBN-13 andAko-107 x Pusa Sawani (-5.26) recorded significant negative heterotic value over check 'Ankur-40'. Kulkarni and Virupakshappa (1977) [7], Sharma and Mahajan (1978) and Vijay and Manohar (1986) reported significant heterosis for this traits. Inbreeding depression for the trait ranged from -4.40 (Akola Bahar x PBN-13) to 3.37 (Parbhani kranti x Shagun). Inbreeding depression which was observed to be significant and positive in all five crosses. Similar result are reported by Pratap and Dhankar (1980). The low and high level of heritability were observed for the crosses Parbhani kranti x Shagun and Ako-107 x Pusa Sawani, respectively, whereas, moderate estimates of 40 *per cent* heritability was observed in the cross Arka Anamika x PBN-1, high heritability was observed in the cross Shagun x Ako-107. Similar results are reported by Singh and Singh (1978) and Bello *et al*. (2006).

The character for fruit length, heterobeltiosis ranged from 0.39 (Arka Anamika x PBN-1) to 20.00 *per cent* (Shagun x Ako-107) and standard heterosis ranged from -1.62 (Parbhani kranti x Shagun) to 10.20 *per cent* (Shagun x Ako-107). Three crosses Parbhani kranti x Shagun, Shagun x Ako-107 and Akola Bahar x PBN-13 recorded significant heterosis over better parent. All five crosses recorded significant positive heterotic value over check 'Ankur-40', except the cross Parbhani kranti x Shagun recorded negative and non-significant heterotic value over check 'Ankur-40'. Indicates the exploitation of hybrid vigour for hybrid development programme. Singh *et al*. (1977), Sharma and Mahajan (1978), Elangovan *et al*. (1981) [4] and Elangovan *et al*. (1981a) [4] reported the significant positive heterosis over mid parent and better parent for this trait. Inbreeding depression for the trait ranged from 3.16 (Arka Anamika x PBN-1) to 6.27 (Akola Bahar x PBN-13). Inbreeding depression which was observed to be significant and positive in all five crosses. Similar result are reported by Thaker *et al*. (1982) and Singh *et al.* (2004). The cross Parbhani kranti x Shagun (75%). showed high level of heritability, whereas, low level of heritability was depicted by the crosses Shagun x AKO-107, Akola Bahar x PBN -13 and AKO-107 x Pusa Sawani. Similar results are reported by Lal *et al.* (1977) and Thaker *et al*. (1981b) and Jindal *et al*. (2010)

The character for fruit weight, heterobeltiosis ranged from -7.62 (Ako-107 x Pusa Sawani) to 11.46 *per cent* (Parbhani kranti x Shagun) and standard heterosis ranged from 5.82 (Ako-107 x Pusa Sawani) to 14.46 *per cent* (Arka Anamika x PBN-1). All five crosses recorded significant heterosis over better parent except the cross Arka Anamika x PBN-1

recorded non-significant heterosis over better parent. All five crosses recorded significant positive heterotic value over check 'Ankur-40', except better parent in the cross Arka Anamika x PBN-1indicates no scope for exploitation of hybrid vigour in these crosses. More and less similar result on heterosis for above character in Okra are recorded by Sharma and Mahajan (1978), Pratap and Dhankar (1980) and El-Maksoud *et al*. (1986). Inbreeding depression for the trait ranged from -2.44 (Arka Anamika x PBN-1) to 8.09 (Shagun x Ako-107). Inbreeding depression which was observed to be significant and positive in all five crosses indicating chance of selection of plants in the subsequent generation. Similar result are reported by Changani and Shukla (1986) and Panda P.K. (1998) [10]. The low level of heritability were observed for the crosses Parbhani Kranti x Shagun, Shagun x AKO-107, Akola Bahar x PBN-13 and AKO-107 x Pusa Sawani, high heritability was observed in the cross Arka Anamika x PBN-1(77%). Similar results are reported by Thaker *et al.* (1981b) and Jindal *et al*. (2010).

The charater for diameter of fruit, heterobeltiosis ranged from -2.17 (Ako-107 x Pusa Sawani) to 11.42 *per cent* (Parbhani kranti x Shagun) and standard heterosis ranged from -1.63 (Ako-107 x Pusa Sawani) to 7.73 *per cent* (Parbhani kranti x Shagun). The crosses recorded significant heterosis over better parent in three crosses *viz.* Parbhani kranti x Shagun, Arka Anamika x PBN-1 and Ako-107 x Pusa Sawani. In the crosse Parbhani kranti x Shagun recorded significant positive heterotic value and cross Ako-107 x Pusa Sawani recorded significant negative heterotic value over check 'Ankur-40'. Singh *et al*. (1975), Elangovan *et al*. (1981a) [4] and Kumbhani *et al*. (1993) reported the significant positive heterosis over mid parent and better parent for this trait. Inbreeding depression for the trait ranged from 2.22 (Ako-107 x Pusa Sawani) to 8.46 (Arka Anamika x PBN-1). Inbreeding depression which was observed to be significant and positive in all five crosses. Similar result are reported by Yadav (2002). The low level of heritability were observed for the crosses Shagun x AKO-107 and Akola Bahar x PBN-13, whereas, moderate heritability was observed in the cross Arka Anamika x PBN-1 (55%) and high estimates of narrow sense of heritability were observed for the crosses Parbhani Kranti x Shagun and AKO-107 x Pusa Sawani. Similar results are reported by Lal *et al.* (1977), Bello *et al*. (2006) and Jindal *et al*. (2010).

Heterobeltiosis for number of fruit per plant ranged from 12.16 (Shagun x Ako-107) to 16.66 *per cent* (Parbhani kranti x Shagun) and standard heterosis ranged from 0.97 (Akola Bahar x PBN-13) to 5.45 *per cent* (Arka Anamika x PBN-1). All crosses recorded significant heterosis over better parent. In the crosses Arka Anamika x PBN-1, Shagun x Ako-107 recorded significant positive heterotic value over check 'Ankur-40'. Significant heterosis for this trait was caused due to higher magnitude of dominance (h) and additive x additive (i) components. Singh *et al*. (1975), Lal *et al*. (1975), El-Maksoud *et al*. (1986) and Chantana Vicharat (1990) reported the significant heterosis over better parent for this trait Inbreeding depression for the trait ranged from 0.85 (Arka Anamika x PBN-1) to 8.92 (Parbhani kranti x Shagun). Inbreeding depression which was observed to be significant and positive in all five crosses. Similar result are reported by Thaker *et al*. (1982), Mandal and Dana (1993) [9] and Khanorkar *et al*. (2010). The low level of heritability were observed for the crosses Parbhani Kranti x Shagun, Shagun x AKO-107 and AKO-107 x Pusa Sawani, high level heritability was observed in the cross Akola Bahar x PBN-13 (60%). Similar result are reported by Swamy Rao and Ramu (1975), Thaker *et al.* (1981b) and Ramanjinappa *et al*. (2011).

Fruit yield per plant (g) is one of the important trait determining the performance of hybrids, positive heterosis in this trait used would be beneficial. Highly significant positive heterosis over better parent. Heterobeltiosis ranged from 8.53 (Ako-107 x Pusa Sawani) to 23.27 *per cent* (Parbhani kranti x Shagun) and standard heterosis ranged from 9.31 (Ako-107 x Pusa Sawani) to 21.17 *per cent* (Arka Anamika x PBN-1). All crosses recorded significant heterosis over better parent. All crosses recorded significant positive heterotic value over check 'Ankur-40'. Heterosis for green fruit yield per plant (g) is desirable for phenomenon as per Sharma and Mahajan (1978), Poshiya and shukla. (1986) [11] and Chantana and vicharat (1990). Inbreeding depression for the trait ranged from 5.67 (Ako-107 x Pusa Sawani) to 13.86 (Parbhani kranti x Shagun). Inbreeding depression which was observed to be significant and positive in all five crosses. Similar results are reported by Thaker *et al*. (1982).

Low level of narrow sense heritability were observed for the crosses Shagun x AKO-107 and AKO-107 x Pusa Sawani, whereas, high estimates of narrow sense heritability were observed for the crosses Parbhani Kranti x Shagun, Arka Anamika x PBN-1 and Akola Bahar x PBN-13. Similar results are reported by Similar result are reported by Swamy Rao and Ramu (1975), Thaker *et al.* (1981b) and Gangashetty *et al*. (2010). Heterobeltiosis for fuit yield per hectare ranged from 8.53 (Ako-107 x Pusa Sawani) to 23.26 *per cent* (Parbhani kranti x Shagun) and standard heterosis ranged from 9.15 (Ako-107 x Pusa Sawani) to 20.99 *per cent* (Arka Anamika x PBN-1). All crosses recorded significant heterosis over better parent. All crosses recorded significant positive heterotic value over check 'Ankur-40'. More and less similar result on heterosis for above character in Okra are recorded by Lal *et al*. (1975), Singh *et al*. (1975), Wankhade (1989), Jadhav *et al*. (2003) [5] and Bhalekar S.G *et al.* (2004) [2].

Inbreeding depression for the trait ranged from 5.67 (Ako-107 x Pusa Sawani) to 13.86 (Parbhani kranti x Shagun). Inbreeding depression which was observed to be significant and positive in all five crosses. Similar results are reported by Thaker *et al*. (1982) and Weerasekar *et al*. (2007). Low level of narrow sense heritability were observed for the crosses Shagun x AKO-107, Akola Bahar x PBN-13 and AKO-107 x Pusa Sawani, whereas, high estimates of narrow sense of heritability were observed for the crosses Parbhani Kranti x Shagun and Arka Anamika x PBN-1. Similar results are reported by Bello *et al*. (2006) and Jindal *et al*. (2010).

Conclusion

The present investigation suggests that the cross Parbhani kranti x Shagun is promising as it depicted heterotic performance for fruit yield per plant and other important yield contributing traits. Narrow sense heritability played an important role for fruit length. Inbreeding depression greatly occurred for fruit yield per plant, whereas, least inbreeding depression was observed for the traits plant height.

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