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MAGNITUDE OF HETEROSIS FOR POD YIELD AND ITS CONTRIBUTING CHARACTERS IN OKRA [*ABELMOSCHUS ESCULENTUS* (L.) MOENCH]

HIMANI B. PATEL*, D. R. BHANDERI, A. I. PATEL, R. V. TANK AND AKHILESH KUMAR
ASPEE College of Horticulture and Forestry,
Navsari Agricultural University, Navsari - 396 450 (Gujarat)
e-mail: hbp_guj@yahoo.in

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***Corresponding author**

ABSTRACT
24 F_1 hybrids from eight lines and three testers were evaluated with the objective of identifying the high yielding parents and F_1 hybrids through Line x Tester mating design to estimate the heterosisduring *Summer*-2014.The genotypes differed significantly for most of the characters studied. Theheterosiswas recorded for pod yield and its 14 component characters. As a result, three F_1 hybrids, AOL 10 - 22 x VRO-6, JOL 09 - 05 x GAO - 5 and AOL 09 - 02 x VRO-6 recorded high degree of heterosis for yield and its contributing characters. High estimates of heterosis obtain in hybrid combinations revealed considerable genetic divergence among the parental lines.

INTRODUCTION

India is the largest producer of okra [*Abelmoschus esculentus* (L.) Moench] in the world.Cultivated okra is originated in tropical Africa. It is an introduced vegetable crop in India. Although, it is a multipurpose and multifarious crop, it is extensively grown for its tender pods, which are used as a very popular, tasty and gelatinous vegetable. Okra has wide popularity in terms of cultivation and acceptability all over the world. Amongthe vegetables, contribution of rainy and summer seasoncultivated crop okra is high.In spite of its importance, no major break-through has been made in this crop and the farmers are still growing their own local varieties or open pollinated varieties. Hence, an attempt has been made to study the 'line ×tester' analysis (Kempthorne, 1957) to know the standard heterosis for interestedtraits in okra (Solankey*et al.*,2013).Hybrid vigour in okra has been first reported by Vijayaraghavan and Wariar (1946). There is very less total area under F_1 hybrids. Yield is mear universal breeding objective. The magnitude of heterosis provides a basis for genetic diversity and a guide to the choice of desirable parents for developing superior F_1 hybrids. A clear understanding forheterosis of the traits under consideration will help in deciding the appropriate breeding methods to improve the genetic makeup as well as productivity. Therefore, present investigation was carried out to estimate the magnitude of heterosis for pod yield and its contributing characters in okra.

MATERIALS AND METHODS

The present investigation was carried out at Vegetable Research Scheme, Regional Horticultural Research Station (R.H.R.S.), Navsari Agricultural University, Navsari during Late *Kharif* – 2013 (Crossing programme) and *Summer* – 2014 (Evaluation). The experimental material comprised of 11 parents who involves eight females, three males and their 24 F_1 hybrids along with one commercial check (Hybrid Mahyco-28). The above materials (36) were used for the experiment to study the heterosis. The parents and F_1s were sown in plots having rows of 10 plants with a spacing of 60x45cm in Randomized Block Design with three replications. Recommended agronomic package of practices were applied to raise a healthy crop. Observations were recorded on days to 50 % flowering, first flowering node, internodal length (cm), number of branches per plant, plant height (cm), stem diameter (cm), number of pods per plant, pod length (cm), pod diameter (cm), pod weight (g), pod yield per plant (g), pedicel length (cm), number of seeds per pod, 100 dry seed weight (g) and fiber content (%). The data was subjected to line x tester analysis suggested by Kempthorne (1957). The magnitude to heterosis as the difference in F_1s performance over standard check in percentage was calculated and presented using the methods of Turner (1953) and Hayes *et al.* (1956).

RESULTS AND DISCUSSION

In the present investigation, 24 F_1 hybrids derived from eight

Table 1: Estimation of standard heterosis for different characters in okra

Crosses	Dayst o 50% flowering	First flowering node	Inter-nodal length (cm)	No. of branches/ plant	Plant height (cm)	Stem diameter (cm)	No. of pods/ plant	Pod length (cm)	Pod diameter (cm)	Pod weight (g)	Pod yield/ plant (g)	Pedicel length (cm)	No. of seeds/ pod	100 dry seed weight (g)	Fiber content (%)
AOL 09 - 02 x GAO - 5	-8.98	-14.29 *	17.27 *	-66.67 **	-5.49	29.86 **	25.34 **	10.64	-11.69 *	5.76	6.5	-47.29 **	-25.57 **	8.2	-33.20 **
AOL 09 - 02 x HRB-55	-2.59	-10.71	18.52 *	-65.08 **	-30.25 **	44.87 **	-0.9	20.31 **	-7.8	-9.42	-3.85	-41.43 **	-14.89 *	23.79 **	-52.38 **
AOL 09 - 02 x VRO-6	6.39	3.57	17.11 *	-42.86 **	-35.20 **	-3.79	16.74	13.3	-13.90 *	22.77 *	14.71	-38.07 **	-16.36 **	25.40 **	-47.88 **
AOL 10 - 22 x GAO - 5	-2.28	1.79	27.94 **	-39.68 **	-17.96 *	0	9.5	16.69 *	-10	-1.31	-1.43	-44.25 **	-13.18 *	24.28 **	-12.57 **
AOL 10 - 22 x HRB-55	-7.46	-5.36	28.89 **	-44.44 **	-11.16	4.74	6.79	23.34 **	-10.51	12.3	6.47	-45.12 **	-13.86 *	14.79	-30.16 **
AOL 10 - 22 x VRO-6	-5.02	14.29 *	43.17 **	-41.27 **	-16.17 *	30.02 **	2.26	25.45 **	-10	52.36 **	17.86 *	-39.48 **	-3.07	19.45 *	-48.54 **
AOL 12 - 51 x GAO - 5	1.07	-1.79	22.61 **	-47.62 **	27.92 **	-3.79	5.88	9.13	3.39	8.38	0.6	-44.69 **	-16.59 **	-6.59	-11.51 **
AOL 12 - 51 x HRB-55	-5.48	17.86 *	40.50 **	-41.27 **	-21.78 **	33.49 **	6.33	15.66 *	-14.75 *	17.02	8.62	-44.90 **	-4.2	7.88	29.76 **
AOL 12 - 51x VRO-6	-11.26 *	-3.57	5.34	-47.62 **	-22.08 **	10.43	1.81	18.14 **	-19.32 **	9.69	-7.78	-46.64 **	-7.73	7.07	7.80 **
JOL 09 - 05 x GAO - 5	-9.44	1.79	29.36 **	-60.32 **	-23.33 **	18.33 *	9.5	1.21	-16.61 **	24.35 *	16.79	-31.24 **	-1.48	27.49 **	29.89 **
JOL 09 - 05 x HRB-55	-6.24	-1.79	25.75 **	-60.32 **	1.37	-0.32	6.79	5.44	-12.37 *	15.71	10.82	-48.59 **	-23.41 **	13.67	-55.29 **
JOL 09 - 05 x VRO-6	-5.33	-17.86 *	26.84 **	-65.08 **	-0.54	14.85	-2.26	20.44 **	-15.42 **	11.52	1.97	-37.96 **	-2.05	0.48	-55.42 **
JOL 10 - 18 x GAO - 5	-4.87	-1.79	45.68 **	-66.67 **	-10.92	20.38 *	2.71	24.55 **	-4.58	31.94 **	8.47	-44.47 **	-13.52 *	8.52	45.37 **
JOL 10 - 18 x HRB-55	-7	3.57	26.06 **	-61.90 **	-28.82 **	17.06 *	11.76	27.75 **	-27.46 **	12.3	5.37	-39.70 **	1.59	0.64	23.68 **
JOL 10 - 18 x VRO-6	2.13	25.00 **	8.16	-63.49 **	-22.08 **	-2.84	13.12	-9.31	-13.39 *	7.07	9.03	-22.13 **	-1.7	8.2	-6.75 *
JOL 11 - 12 x GAO - 5	3.2	16.07 *	-3.45	-63.49 **	-20.35 **	-2.53	19.00 *	10.46	-13.05 *	4.19	8.2	-44.90 **	-22.73 **	-8.68	7.41 **
JOL 11 - 12 x HRB-55	-12.63 *	5.36	20.09 *	-46.03 **	-16.77 *	1.42	-1.81	-6.59	-14.75 *	-8.12	-4.5	-42.73 **	-18.86 **	21.06 **	-11.77 **
JOL 11 - 12 x VRO-6	-12.33 *	-14.29 *	37.83 **	-65.08 **	-26.91 **	10.74	9.05	7.07	-17.63 **	21.20 *	7.63	-39.70 **	-16.25 **	25.72 **	-28.04 **
JOL 12 - 02 x GAO - 5	-0.76	-8.93	7.85	-65.08 **	-17.90 *	-4.74	22.17 *	-4.11	-12.54 *	-18.32	-4.5	-1.08	-17.95 **	15.27	48.68 **
JOL 12 - 02 x HRB-55	0.76	-3.57	20.57 *	-41.27 **	23.66 **	-0.16	3.62	3.93	4.41	33.51 **	13.51	-10.85 *	-16.82 **	15.92 *	27.38 **
JOL 12 - 02 x VRO-6	-5.33	-14.29 *	37.36 **	-68.25 **	0.12	15.17	15.84	26.06 **	-11.02	0.26	0.18	-39.05 **	-14.55 *	1.13	-51.72 **
JDNOL 11-01 x GAO - 5	-1.22	-1.79	20.88 *	-41.27 **	-33.65 **	17.38 *	16.29	17.05 *	-10.51	3.66	2.47	-45.34 **	-5.23	-8.68	-38.36 **
JDNOL 11-01 x HRB-55	-2.44	-10.71	12.4	-65.08 **	-5.37	12.32	-4.52	9.37	-11.86 *	-8.64	-22.06 *	-42.08 **	-3.98	-11.74	-19.58 **
JDNOL 11-01 x VRO-6	0.61	0	39.40 **	-63.49 **	-1.91	-3.79	18.10 *	16.20*	-13.05 *	-11.78	2.89	-37.31 **	-2.27	7.23	-30.42 **
CD (5%)	4.79	0.52	0.69	0.27	16.27	0.34	2.62	1.52	0.22	2.65	38.43	0.27	7.19	0.64	0.26
CD (1%)	6.39	0.69	0.92	0.36	21.72	0.45	3.50	2.04	0.30	3.54	51.30	0.36	9.59	0.86	0.35

* - Significant at 5% and ** - Significant at 1%

lines and three testers were evaluated using Line x Tester analysis with one commercial check hybrid (Hybrid Mahyco-28). Significant variation was observed among treatments for all the characters except number of pods per plant. The interaction like females vs. males and parents vs. hybrids showed significant differences for most of the characters indicated that the selected material was appropriate for the study of manifestation of heterosis and gene effects involved in inheritance of different traits.

Heterosis was estimated as per cent increase or decrease of F_1 values over standard check hybrid (Standard heterosis); Hybrid Mahyco-28. The nature and magnitude of heterosis are presented in Table 1.

In the present study, the range of standard heterosis was -22.06 to 17.86 per cent. Among 24 hybrids, only one hybrid AOL 10-22 x VRO-6 exhibited significant standard heterosis for yield and its attributing characters.

Pod yield is a complex trait. It is the end product of several basic yield components. The standard heterosis is more useful from practical point of view. Out of 24 hybrids, only one hybrid AOL 10-22 x VRO-6 exhibited significant positive standard heterosis for yield per plant. These findings are in agreement with those of Manivannan *et al.* (2007), Hosamani *et al.* (2008), Singh *et al.* (2013), Kumar *et al.* (2013), Solankey *et al.* (2013), Nagesh *et al.* (2014), Jethava (2014) and Kumar (2014).

Number of pods per plant is another important trait that determine yield of okra but in this investigation, it was not much contributed to the increasing yield parameter. The hybrid, AOL 09 – 02 x GAO – 5, expressed positive significant heterosis over standard check for this character. Positive heterosis for number of pods per plant reported by Manivannan *et al.* (2007), Hosamani *et al.* (2008), Singh *et al.* (2013), Solankey *et al.* (2013), Kumar *et al.* (2013), Nagesh *et al.* (2014), Jethava (2014) and Kumar (2014).

In okra, the pod length and weight are the important yield components. Such high heterotic response would be useful for obtaining higher pod yield. In case of pod length, 12 hybrids showed significant positive heterosis over standard check. Increased pod length in heterotic hybrids of okra has been observed in the present investigation, confirmed by Manivannan *et al.* (2007), Hosamanie *t al.* (2008), Solankey *et al.* (2013), Singh *et al.* (2013), Kumar *et al.* (2013), Nagesh *et al.* (2014) and Kumar (2014).

Individual pod weight is yet another character contributing directly to the yield. Both the parents and hybrids exhibited wider variation for this trait in the present study. Such an increase in pod weight can be attributed to the conglomeration of favourable genes in the hybrids (Indu Rani and Veeraragavathatham, 2013). In case of pod weight, 6 hybrids showed significant positive heterosis over standard check. AOL 10 - 22 x VRO-6 has maximum pod weight over standard heterosis. Similar result have been reported by Manivannan *et al.* (2007), Hosamani *et al.* (2008), Solankey *et al.* (2013), Kumar *et al.* (2013) and Nagesh *et al.* (2014).

Plant height at fully matured stages is one of the important ideotype in okra for higher yield. The estimates of heterosis revealed that 14 hybrids showed significant negative heterosis over standard check. The above results are in conformably with the findings of Lyngdoh *et al.* (2013), Singh *et al.* (2013), Kumar *et al.* (2013) and Jethava (2014).

In case of stem diameter, positive heterosis is desirable. The estimates of heterosis revealed that 8 hybrids showed significant positive heterosis over standard check. Jethava (2014) also reported similar results in okra.

With regards to pedicel length, negative heterosis is desirable. The estimates of heterosis revealed that 23 hybrids showed significant negative heterosis over standard check. Similar finding was found by Kumar (2014).

With respect to 100 dry seed weight, positive heterosis is desirable. The estimates of heterosis revealed that 8 hybrids showed significant positive heterosis over standard check. Similar results have been observed by Manivannan *et al.* (2007) and Kumar (2014).

For fiber content, negative heterosis is desirable. The estimates of heterosis revealed that 16 hybrids showed significant negative heterosis over standard check. A similar observation was reported by Kumar (2014) and Jethava (2014) for this trait.

Number of seeds per pod not much contributed to the increasing yield parameter. In case of number of seeds per pod, 14 hybrids showed significant negative heterosis over standard check. Similar observations were reported by Manivannan *et al.* (2007), Solankey *et al.* (2013), Nagesh *et al.* (2014), Jethava (2014) and Kumar (2014) for this trait.

Manifestation of heterosis for all the characters in one cross may not be possible but the exploitation of hybrid vigour for yield-attributing traits will significantly improve the crop performance over existing hybrid or variety (Hosamani *et al.*, 2008). Some crosses for fruit yield traits which were non-heterotic, may be ascribed to cancellation of positive and negative effects showed by the parents involved in a cross combination and can also happen when the dominance is not unidirectional (Gardner and Eberhart, 1966; Mather and Jinks, 1982).

While formulating suitable breeding methodology for the improvement in this crop, attention must be paid for the improvement of visual appearance as well as the biochemical qualitative aspects too, besides the productivity. AOL 10 - 22 x VRO-6 have medium green pod colour as well as pod stalk colour, which could be preferred by okra consumers. It has also low level of pest-diseases reaction. Therefore, AOL 10-22 x VRO-6 could be exploited commercially due to the high yield coupled with low pest-diseases (Yellow Vein Mosaic Virus, Okra Enation Leaf Curl Virus and Okra Shoot and Fruit Borer) reaction.

It is clear from the above discussion that this hybrid was found to be the most promising for pod yield and other desirable traits. It is also clear that the high degree of non additive gene action for all the component traits observed in the present study favours breeding methodology such as biparental mating, recurrent selection and diallel selective mating (Jensen, 1970) may be resorted to, than conventional pedigree or backcross techniques which would leave the unfixable components of genetic variances unexploited for yield and its components. So, it can be identify as the potential hybrid combination for commercial exploitation in other climate

against this hybrid check.

The disparities in interpretation between the present study and previous reports might be due to differences in parental materials used and the environment under which the trial was conducted because estimates of gene effects change with environments and genotypes (Das *et al.*, 2013).

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