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Research Article

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Estimates of Heterosis in F1 Hybrid Progeny of Okra (*Abelmoschus spp.* (L.) Moench)

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ABSTRACT

Heterosis breeding based on the identification of parents with desirable characteristics and their cross compatibilities is capable of producing F1 hybrids and transgressive segregants with superior yield. To achieve high degree of heterotic response, it is essential to have knowledge about performance of desirable parents. This work, therefore, involved studies on the expression of heterosis for key quantitative agro-morphologic traits by 27 F1 offspring obtained from intra-specific and 24 F1 offspring from inter-specific hybridization among ten parental accessions of okra. The performances of their F1 offspring were evaluated against the respective parents for expression of heterosis for key quantitative traits including days to 50% germination, days to 50% flowering, plant height, fresh fruit weight, length of pod and number of seeds per pod. It was observed that. the cross, T3 X T1 came out with the highest BPH for days to 50% germination while the crosses AG X T4, AG X YL and T2 X T3, respectively recorded highest BPH for (days to 50% flowering and number of branches per plant), (length of pod and Fresh fruit weight) and (Plant height and number of seeds per pod).

Keywords: *Okra, Accessions, Hybridization, Crossability, Heterosis, Yield*

INTRODUCTION

Heterosis (hybrid vigour) is the superior performance of a hybrid compared with the performance of its parents. Expression of heterosis depends on the differences in the gene frequency of the parental materials that are used for hybridisation. Mid-parent heterosis (MPH) refers to the superiority of a hybrid over the mean of its parents, while better-parent heterosis refers to superior performance of a hybrid line over the mean performance of the better-parent for a given trait. The phenomenon of heterosis has been a powerful force in the evolution of crop plants and has been exploited extensively in crop production (Birchler et al., 2003). Heterosis for increased fruit size, fruit weight and fruits per plant in okra was first reported by Vijayaraghvan and Warriar (1946).

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Heterosis is expressed as relative heterosis, heterobeltiosis and standard heterosis, depending on the criteria used to compare the performance of a hybrid.

However, from the practical point of view, standard heterosis is the most important of the three types of heterosis because it is aimed at developing desirable hybrids superior to the existing high yielding commercial varieties (Chaudhary, 1984). Heterosis is thought to result from the combined action and interaction of allelic and nonallelic factors and is usually closely and positively correlated with heterozygosity (Falconer, 1989). Further, exploitation of hybrid vigour depends on the direction and magnitude of heterosis as well as biological feasibility. An understanding of heterosis would be helpful in improving the yield ability as well as yield contributing characters. Heterosis works like a basic tool for the improvement of crops in F1 generation.

Through heterosis, seed cotton along with quality traits had been improved significantly (Naquibullah et al., 2000). Ahmad (2002) reported that substantial heterosis of 26% and 19.2% in pod length and yield per plant could be exploited by producing F2. Similarly, Wammanda (2010) reported heterosis of 10.6%, 15.4% and 17.2% in pod length, number of pods per plant and plant height respectively in okra. The ultimate goal of an okra breeder is to develop high yielding varieties (pod and seed yield), through selection and breeding, utilizing available genetic resources. Increased pod and seed yield are the outcome of inter play between genetic and non-genetic component and also, due to complex nature of gene interaction and selection. Phenotypically diverse genotypes, presumably of diverse origins, are regarded to be more effective in obtaining promising crosses (Duzyaman & Vural, 2002).

In crop breeding programme, to achieve high degree of heterotic response, it is essential to have knowledge about performance of desirable parents. There has been considerable improvement in the yield of tropical okra by pedigree selection and more recently, by the development of commercial hybrids, based on hand emasculation and pollination by Sood and Sharma (2001). It is therefore possible to enhance productivity of the local landrace varieties of okra through breeding to boost vegetable farmers' interest in large-scale cultivation of the crop and for adoption by Ghanaian and export market. Intra-specific and intra-specific hybridization among locally adapted cultivars may therefore play a very important role in producing a broad-based segregating population from which recurrent selection could be carried out to obtain hybrids which combine high yield and disease resistance with other desirable traits such as high nutritional and anthocyanin contents, as well as fruit characteristics required for export.

In all, a great deal of variation has been observed in okra (*Abelmoschus spp.* L.) particularly the West Africa type, *Abelmoschus caillei* but, no serious breeding effort have been made to harness its genetic richness to advance the improvement of the crop. Previous international efforts have been limited to intensive cultivation based on resistance to pests and diseases. There is still enormous scope for cultivar improvement in Africa particularly Ghana as we have the potential yet have not improved our local landraces to increase production of the crop to meet standards of the export market. Heterosis breeding based on the identification of parents with desirable characteristics and their cross compartibilities is capable of producing F1 hybrids and transgressive segregants with superior yield.

This study was, therefore, undertaken to elicit information about the nature and magnitude of heterosis for yield and its components in okra so as to formulate suitable breeding strategy and isolate potential parents and promising offspring for further exploitation. The main objective of this study was to investigate expression of heterosis by 27 F1 offspring from intra-specific and 24 F1 offspring from inter-specific hybridization among accessions of okra for key quantitative agro-morphological traits.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Research Farms of the Biotechnology and Nuclear Agriculture Research Institute (BNARI) of the Ghana Atomic Energy Commission (GAEC), Kwabenya, in the Greater Accra Region of Ghana. The BNARI Research Farm is located at latitude 05° 40′ N and longitude 0° 13′ W, and elevated at 76 m above sea level within the coastal savanna agro-ecological zone. Kwabenya has an annual average temperature of 28 ℃ and receives an annual rainfall less than 1000 mm. The soil at site is the Nyigbenya-Haatso series, which is a typically well-drained savanna ochrosol (Ferric Acrisol) derived from quartzite and schist (FAO/UNESCO 1994).

Planting material

Ten accessions of okra (*A. esculentus* and *A. caillei*) listed in Table 1 and 51 F1 hybrids, 24 obtained from inter-specific and 27 from intra-specific hybridization were used for the study. Total entries were 61 including 10 parental lines.

Table 1: Okra parental accessions used in the study

Accession code	Origin	Accession name	Accession owner
T1 *(A. esculentus)*	Upper East region	Yire marna 1	Amitaaba
T2 *(A. esculentus)*	Upper East region	Yire marna 2	Amitaaba
T3 *(A. esculentus)*	Upper East region	Yire marna 3	Amitaaba
T4 *(A. caillei)*	Upper East region	Yire marna 4	Amitaaba
AM *(A. caillei)*	Eastern region	Amanfrom	Ahiakpa
VT*(A. esculentus)*	Volta region	Volta	Ahiakpa
ID *(A. esculentus)*	Greater Accra region	Indiana	Ahiakpa
AG *(A. esculentus)*	Ashanti region	Agric Short	Ahiakpa
YL *(A. caillei)*	Brong-Ahafo region	Yeji Local	Ahiakpa
KB *(A. caillei)*	Ashanti region	Kortebotor pink	Ahiakpa

Experimental design and planting

An experimental plot size of 85.4 m x 25 m was pegged and marked out, within the prepared land leaving the rest of it as a periphery. Approximately 2.0 m was created around replications to serve as a control for pests and to ease movement around the field. The Randomized Complete Block Design was used with four replications, each replicate measuring 42.7 m x 12.5 m, and separated by a distance of 2.0 m from the other. Seeds of the various accessions were sown on 26th August, 2014 after a heavy downpour of rainfall that facilitated uptake of water by the seeds and boosted germination. The seeds were sown at a depth of 2.0 cm, at a spacing of 0.70 m x 0.50 m between and within rows with three to four seeds per hole later thinned to two per hill after germination.

Data collection and analysis

Using ten randomly selected plants per entry, data were collected on eight quantitative agro-morphological traits namely: Days to 50% germination (DG); Days to flowering (DF); Plant height at first fruiting (PHAFF); Length of petiole (LOPE); (v) Length of pod (LOF); Fresh fruit weight (FW); Number of branches (NOB) and Number of seeds per fruits (NSPP).

Means were subjected to Analysis of variance (ANOVA) to determine the level significance of variability among accessions for each of the parameters. Genstats Statistical Software Package (12th edition), Statsgraphics Centurion software (version 16.1) and Microsoft Excel Software (2010) edition were used for the data analyses.

Estimation of heterosis

Percent mid parent heterosis (MPH %) and better parent heterosis (BPH %) were calculated based on the formulae of Falconer and Mackay (1989).

(1) $MPH\ \% = \frac{F1 - [Pi + Pj] / 2}{[Pi + Pj] / 2} \times 100$

Where, MPH % = mid parent heterosis of F1 hybrid; F1 = mean value of F1 hybrid; Pi = mean value of first parent; Pj = mean value of second parent

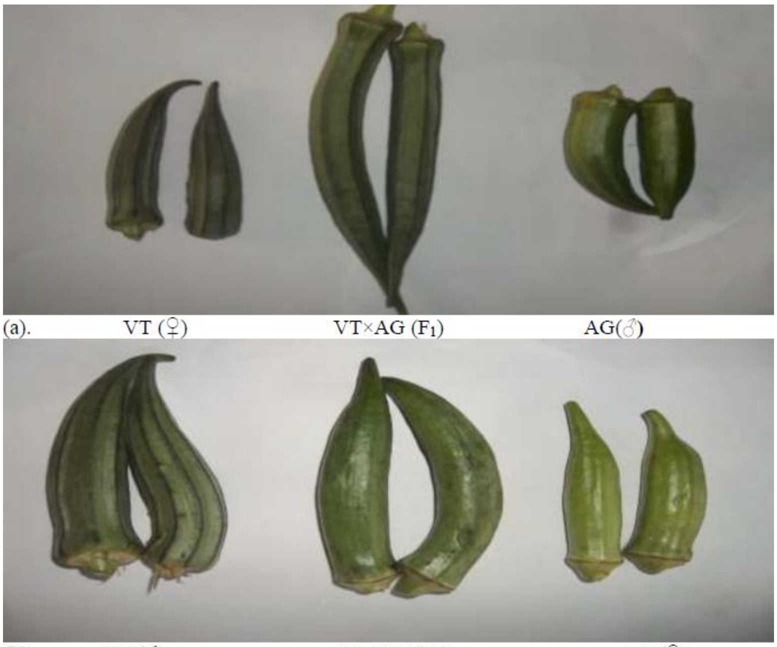
(2) $BPH\ \% = \frac{F1 - BP}{B} \times 100$

Where BPH % = heterobeltiosis of F1 Hybrid and BP = mean value of better parent.

RESULTS

Morphological traits of fresh pods of accessions

Figure 1 shows the resultant F1 for a cross between VT (♀) and Ag (♂**).** It shows improved fruit size, fruit length and fruit weight with reference to both parents indicating better-parent heterosis. In the reciprocal cross, the F1 exhibits improved fruit size compared to both parents.



(a). VT (♀) VT×AG (F_1) AG(♂)

(b). VT (♂) AG ×VT (F_1) AG (♀)

Fig. 1: Different levels of heterosis in; (a) hybridization where VT was used as female and AG as male. (b) hybridization where AG was used as female and VT as male

Estimates of heterosis

Table 2 shows estimates of mid parent heterosis (MPH) and better parent heterosis (BPH) expressed by 24 F1 hybrids obtained from inter-specific hybridization among ten local landraces of okra for seven agro-morphological quantitative traits. Generally, extensive variation was recorded with respect to both MPH and BPH ranging from -68.87 to 152.76 and -566.67 to 51.45 respectively. Most crosses produced positive MPH for length of pod (LOF) and number of seeds per plant (NSPP) and 0.00 for number of branches (NOB), relatively few of the F1 offspring gave positive values for days to flowering (DF) and plant height at first fruiting (PH).

The crosses T2 X T4 and AG X YL produced highest MPH (152.76) and BPH (51.45) values for NOB and LOP respectively. While the cross ID X KB and VT X KB (-53.59 and -566.67) recorded least values in PHAFF and NOB for MPH and BPH respectively. Values recorded by the crosses T3 X KB and AG X T4 (10.78 and 1.77) as well as VT X KB and ID X KB (-30.93 and -121.03) emerged highest and least for MPH and BPH respectively for DF. Again, the cross T1 X AM recorded highest MPH (24.22) and the cross T3 X T4 recorded the highest BPH (-24.85) for PH, while ID X KB (-53.59 and 468.13) gave least values.

Similarly, AG X YL registered highest MPH (51.60) and BPH (51.45) for LOF, while ID X T4 and T2 X YL gave the least values (-17.49 and -76.57). With respect to DG, values of the crosses T1 X YL and AG X AM (-9.98 and -24.01) as well as ID X AM and T2 X KB (-48.77 and -200) gave highest and least MPH and BPH respectively. Also VT X YL and AG X YL (17.17and 12.54) and ID X T4 (-22.52 and -49.59) scored highest and least values for FFW, while VT X YL and T1 X YL (36.87 and 18.42) and T3 X KB (-35.39 and -102.68) emerged highest and least for NSPP.

Table 2: Estimates of percent (%) mid parent heterosis (MPH) and better parent heterosis (BPH) expressed for seven quantitative traits by 24 F1 offspring obtained by inter-specific hybridization

OFFSPRING	DF		PH		LOF		DG		FFW		NOB		NSPP	
	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH
T1 X AM	-15.25	-43.18	**24.22**	-68.44	-2.20	-12.07	-18.00	-77.14	2.22	1.16	-15.91	0.00	-2.80	-15.29
T2 X AM	5.65	-35.23	-21.63	-196.34	34.71	-24.38	-38.83	-150.15	-7.08	-10.73	-10.17	0.00	-28.63	-60.89
T3 X AM	-19.49	-59.82	-1.13	-153.85	0.80	-15.04	-44.50	-160.36	2.87	1.03	39.13	0.00	-19.68	-102.68
ID X AM	-3.77	-58.92	-33.12	-245.01	-13.83	-21.16	-48.77	-123.33	-17.89	-39.68	-33.30	0.00	-14.91	-64.59
VTX AM	-21.07	-47.78	-33.51	-169.28	8.10	11.64	-33.29	-75.05	-0.52	-2.50	0.00	-333.33	2.34	-5.03
AGXAM	-24.02	-70.53	-21.41	-140.91	1.37	-42.62	-21.12	-24.01	-3.70	-18.37	-38.07	-286.60	11.50	7.27
T1 X T4	-4.03	-9.86	0.21	-36.57	2.49	1.38	-38.83	-92.37	-2.30	-3.86	121.17	0.00	3.47	-6.25
T2 X T4	-2.92	-17.14	-6.02	-51.17	-15.03	-19.52	-15.09	-90.09	-5.53	-12.10	**152.76**	0.00	6.54	-15.26
T3 X T4	-11.56	-19.67	12.21	**-24.85**	3.11	-3.24	-45.45	-140.24	-2.17	-2.90	47.55	0.00	13.71	-42.68
ID X T4	-3.93	-25.26	-11.63	-66.01	-17.49	-19.46	-44.50	-100.23	-22.52	-49.59	-47.24	0.00	-23.43	-72.94
VT X T4	-3.71	-25.02	-14.52	-48.80	5.29	-5.69	-28.15	-56.29	-5.56	-6.24	35.69	0.00	2.90	-6.36
AG X T4	10.56	**1.77**	-26.36	-60.50	3.46	-54.79	-33.36	-39.11	-7.66	-26.53	35.39	**26.80**	-5.69	-12.71
T1 X KB	-20.67	-63.64	-50.94	-361.56	10.90	-2.00	-40.93	-138.57	3.29	-0.05	-20.00	0.00	-28.97	-57.63
T2 X KB	-5.74	-38.09	-49.11	-407.42	7.11	-9.57	-46.27	-200.00	-0.20	-1.24	-15.53	0.00	0.63	-37.27
T3 X KB	**10.78**	-30.77	-47.53	-439.01	1.08	-20.00	-41.53	-190.09	0.75	-3.53	-26.67	0.00	-35.39	-157.32
ID X KB	-30.84	-121.03	-53.59	-468.13	5.52	-4.87	-49.93	-153.81	-2.52	-18.34	-68.87	0.00	-25.00	-97.91
VT X KB	-30.93	-74.26	-29.07	-249.19	9.41	8.35	-40.36	-106.19	2.79	-1.48	-21.21	-566.67	1.45	0.98
AG XKB	-17.75	-77.69	-48.07	-288.20	11.01	-22.37	-32.15	-48.02	-6.87	-18.93	-48.57	-420.00	0.51	-2.54
T1 X YL	1.37	-35.61	6.08	-135.82	3.93	-57.12	**-9.98**	-69.28	-12.77	-37.90	21.18	0.00	27.91	**18.42**
T2 X YL	8.34	-46.66	0.63	-176.47	-4.06	-76.57	-13.54	-110.21	8.96	2.04	30.27	0.00	-0.87	-2.63
T3 X YL	0.00	-48.72	-20.67	-261.52	16.88	-45.94	-35.12	-150.15	-9.39	-35.02	-26.67	0.00	0.94	-14.68
ID X YL	-14.73	-96.84	-32.39	-299.14	11.58	-39.20	-39.98	-115.47	6.65	5.10	-18.18	0.00	5.98	-8.34
VT X YL	-12.25	-51.47	-23.49	-175.37	26.01	-3.63	-25.61	-68.86	**17.17**	-2.33	-36.00	-466.67	**36.87**	11.39
AG X YL	4.38	-46.42	-29.89	-187.62	**51.60**	**51.45**	-26.95	**-32.05**	16.83	**12.54**	-8.67	-193.40	-7.73	-46.47

Bolded and underlined values respectively represent highest and lowest heterosis combiners for each trait. DF=days to 50% fruiting; PH = Plant height at first fruiting; LOF = Length of pod; DG = Days to 50% germination; FFW=Fresh fruit weight; NOB= Number of branches per plant; NSPP = number of seeds per pod.

Estimates of mid-parent heterosis (MPH) and better-parent heterosis (BPH) expressed by 27 F1 hybrids obtained from intra-specific hybridization among four cultivars of *A. caillei* and six *A. esculentus* for six agro-morphological quantitative traits are presented in Table 3. Generally, extensive variation was recorded with respect to both MPH and BPH ranging from -55.75 to 102.12 and -107.81 to 102.78 respectively. Most crosses produced positive MPH for length of pod (LOF), length of petiole (LOPE), plant height (PH) and days to 50% germination (DG), but relatively few of the F1 offspring gave positive values for BPH.

The cross T3 X T1 produced the highest MPH (102.78) and BPH (102.12) values for DG, while the cross T3 X AG (-107.81) recorded the least values for NSPP and the cross ID X VT (-55.75) for BPH and MPH respectively. Values recorded by the crosses ID X AG and T2 X AG (1.33 and 18.65) as well as the cross T3 X T2 (-46.54 and -22.99) gave the highest and least values for BPH and MPH respectively for LOPE. Again, the crosses T3 X VT and VT X AG recorded the highest MPH (30.25) and the cross T3 X T4 the highest BPH (7.32) for LOP, while ID X VT and AG X T3 (-55.75 and - 75.26) gave the least MPH and BPH values respectively.

Similarly, the cross T3 X T1 registered the highest MPH (102.78) and BPH (102.12) for DG, while the crosses ID X VT and AG X ID gave the least values (-30.37 and -86.67). With respect to NSPP values, the cross T2 X T3 (13.24 and 32.73) gave the highest and the least MPH and BPH values respectively. Also, the cross T2 X T3 (44.92 and 47.30) scored highest and least values for PH, while the cross T3 X AG (18.75 and 5.05) gave the highest MPH and BPH values and the crosses VT X AG and ID X AG (-27.40 and -45.27) least for stem FFW.

Table 3: Estimates of percent (%) mid parent heterosis (MPH) and better parent heterosis (BPH) expressed for six quantitative traits by 27 F1 offspring obtained by intra-specific hybridization

OFFSPRING	LOPE		LOP		DG		NSPP		PH		FFW	
	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH	MPH	BPH
T2 X T1	2.19	-15.03	10.02	4.48	30.95	19.44	27.90	3.52	8.58	2.25	8.69	4.47
T3 X T1	-4.72	-21.91	-0.41	-5.75	**102.78**	**102.12**	19.68	-17.35	-4.49	-16.65	-8.73	-10.71
VT X T1	0.35	-17.02	6.78	-9.24	3.70	-23.33	-18.35	-41.16	11.48	4.29	-0.02	-1.53
AG X T1	-6.99	-38.24	4.55	-60.08	5.56	-38.33	-10.31	-24.27	15.73	7.10	-11.29	-28.93
T1 X T2	-20.45	-41.49	-10.78	-17.64	46.43	30.55	-5.69	-13.64	37.29	32.94	3.60	-0.79
T3 X T2	<u>-22.99</u>	-46.54	-17.34	-21.06	30.16	22.22	24.57	2.93	14.02	11.57	-2.13	-7.29
ID X T2	18.62	-9.36	-33.94	-41.12	-1.58	-16.67	-21.63	-35.50	0.51	-4.62	0.95	-13.07
VT X T2	-13.31	-37.67	-11.97	-31.69	8.33	-22.22	-9.14	-46.97	-8.18	-25.66	5.12	-0.12
AG X T2	-18.63	<u>-79.92</u>	-3.03	-75.26	-2.26	<u>-80.56</u>	-4.83	-28.23	15.66	0.00	-11.29	-22.83
T1 X T3	-13.24	-16.59	-27.81	-34.83	13.23	0.00	11.87	-28.71	-3.03	-15.03	-7.20	-9.20
T2 X T3	6.94	-11.07	6.61	3.75	101.59	100.00	**32.73**	**13.24**	**47.30**	**44.92**	-20.39	-27.94
VT X T3	1.05	-6.38	0.97	-19.19	-7.41	-19.45	-8.20	-103.84	24.62	8.09	-25.00	-27.04
AG X T3	9.66	-13.60	-1.66	<u>-79.97</u>	-3.03	-83.33	-12.81	-84.56	27.42	9.79	-13.81	-34.05
T1 X ID	1.54	-8.63	-9.73	-14.06	-23.15	0.00	-1.35	-26.71	10.01	-1.97	1.48	-18.22
T2 X ID	11.42	-18.28	10.15	4.08	49.21	41.67	-11.6	-24.79	12.45	8.12	-21.26	-38.48
VTX ID	1.71	-7.14	2.08	-7.35	-23.70	-40.00	-31.41	-102.25	4.52	-17.23	-19.74	-36.32
AG X ID	12.68	-3.87	6.73	-47.17	-26.50	-86.67	-8.99	-51.63	11.54	-11.19	-10.71	-14.56
T1 X VT	-8.54	-14.09	2.02	-14.39	-3.70	-16.67	-29.47	-54.44	5.38	-2.20	<u>-27.40</u>	-12.76
T2 X VT	14.11	-4.47	-7.93	-10.63	77.78	72.22	-15.42	-54.90	17.37	3.96	-14.40	-20.72
T3 X VT	1.01	-6.35	22.54	**7.32**	0.00	-33.33	-6.65	-94.19	8.54	-8.50	-1.07	1.91
ID X VT	-4.7	-14.24	<u>-55.75</u>	-12.02	<u>-30.37</u>	-46.67	-6.45	-50.01	14.34	-5.07	-19.81	<u>-45.27</u>
AGX VT	2.52	-25.19	12.48	2.68	-2.23	-31.11	-26.90	-41.88	-2.95	-5.87	-18.48	-38.45
VTX AG	12.24	-13.19	**30.25**	-0.69	-5.56	-43.33	<u>-34.66</u>	-47.58	-18.42	-20.54	14.75	0.22
T1X AG	5.00	-20.82	5.64	-57.7	20.94	-16.67	2.15	-7.91	0.58	-9.56	18.04	5.05
T2X AG	**18.65**	-26.92	26.92	-23.06	8.59	-63.89	-4.18	-7.74	-10.43	-30.67	-17.32	-29.51
T3X AG	18.43	0.22	45.32	-18.26	-19.70	-77.78	-26.61	<u>-107.81</u>	3.01	-20.53	**18.72**	**5.64**
IDX AG	18.02	**1.33**	7.68	-2.36	0.00	-46.67	-34.59	-86.64	<u>-15.33</u>	<u>-44.39</u>	1.18	-1.97

Bolded and underlined values represent highest and lowest heterosis combiners respectively for each trait. LOPE= Length of petiole; LOP = Length of pod; DG = Days to 50% germination; NSPP = number of seeds per pod; PH=Plant Height; FFW = Fresh fruit weight.

DISCUSSIONS

Analysis of variance (ANOVA) exhibited significant differences among treatments for all the characters in all the crosses under study. These results are in agreement with observations of Louis et al. (2013) and Mostofa et al. (2011) who also recorded significantly high heterosis over mid and better parent (s) for all studied traits. This indicated the presence of appreciable genetic diversity for the characters showing significant variances. Wide genetic variability among the parents utilized for the hybridization could have accounted for greater hybrid vigour of the F1 offspring (Hallauer & Miranda 1988). Higher yield is the basic objective of all crop improvement programmes and unless a new hybrid has a potential equal to or exceeding that of current cultivar or hybrid, it will fetch no success even if it has excellent quality.

The cross, T3 X T1 came out with the highest BPH for days to 50% germination while the crosses AG X T4, AG X YL and T2 X T3, recorded highest BPH for (days to 50% flowering and number of branches per plant), (length of pod and Fresh fruit weight) and (Plant height and number of seeds per pod) respectively. From the mean performance of the genotypes, it is evident that, in general, the mean values of crosses were desirably higher than those of some parents for days to 50% germination, fruit length, average fresh fruit weight and harvest duration. Therefore, it can be inferred that heterosis breeding would be advantageous in okra improvement compared to the open pollinated cultivars as hybrids will have the advantage of higher yields together with uniform maturity, size and color of the fruits.

The results suggest that heterosis for fruit yield is obtained through component heterosis. Even the slight hybrid vigor for individual yield components may have additive or synergistic effects on yield. The study further demonstrates the presence of heterosis for important quantitative traits in okra. In the present study, the significance of the heterotic performance was highly affected by the genetic background of parental genotypes. The high heterosis among these germplasm for most of the characteristics studied indicates that considerable potential exist in these materials for developing hybrids. The results suggest that yield of okra can be substantially increased through heterosis breeding. It also suggests that hybrid vigor is available for commercial production of hybrid okra and that isolation of pure lines from the progenies of heterotic F1s is a possible way to enhance the fruit yield of okra.

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