

Combining Ability and Heterosis in Line x Tester Crosses of Summer Squash (*Cucurbita pepo* L.)

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Introduction. Cucurbits play a significant role in human nutrition, especially in tropical countries where their consumption is high. Cucurbit crops constitute a major portion of vegetables and are grown in different regions of the Sudan. Squash was ranked fourth among the world's most popular cucurbits preceded by watermelon, cucumber and melon (7). In Sudan squash production is confined to urban areas where there is a good potential for local market and export.

The mating design (Line x Tester) suggested by Kempthorne (4) has been extensively used to estimate GCA and SCA variances and their effects. Also, it is used in understanding the nature of gene action involved in the expression of economically important quantitative traits. Thus, GCA and SCA estimates, which are useful in devising breeding strategies, were reported in some cucurbits (2). *Cucurbita pepo* L. was reported to be adapted to hybrid production (8). Lopez-Anido et al. (5) reported that non-additive gene actions were of major relative importance for vegetative characters (leaf number, leaf diameter and plant height) and precocious fruit number. Also they reported the importance of additive and non-additive gene actions for total fruit number and days to first harvest. In early reports significant heterosis has been reported in crosses between certain varieties of *C. pepo* (1). Firpo et al. (3) reported superior heterosis for total fruit number and precocious fruit number in crosses between inbred lines derived from a summer squash (*C. pepo*) population. Also they concluded that inbreeding and crossing methods could be a useful tool in increasing the population means for yield traits through hybrid or synthetic variety production. Crosses between inbred lines derived from different populations (interpopulation crosses) were reported to increase heterosis (6). The objectives of this study were to measure and evaluate additive and non-

additive gene action, GCA, SCA and heterosis among 14 hybrids resulting from the crossing of seven lines with two testers.

Materials and Methods. The experimental material consisted of seven inbred lines, which have been designated as 1,2,3,4,5,10,12 derived from a summer squash (*C. pepo*) population. The population developed from a cross between the commercial cultivar "Eskandarany" and breeding lines obtained from Cornell University (USA), which are segregating for Zucchini yellow mosaic virus resistance (ZYMR) and powdery mildew resistance (PMR). The two testers are cv. "Eskandarany" (E) and ZYMR and PMR cv. "Whitaker" (W) obtained from Cornell University. The seven lines and the two testers were crossed in a line x tester (L x T) design. The resulting 14 hybrids with their nine parents were evaluated in a randomized complete block design with three replications. The following characters were evaluated on a plot (10 plants) basis: number of days from sowing to the first pistillate flower (DFL), Ovary length at anthesis (OL), total number of marketable fruits per plant (TNF) and plant vigor (PLV). For PLV a scale of 1=small, 2= intermediate and 3=vigorous was used. Statistical analysis was performed according to Kempthorne (4) and software MSTAT-C Version 4.1 was used. Heterosis over mid parent was computed for all characters measured.

Results and Discussion. The mean squares for the four characters are shown in Table 1. Variability among genotypes was highly significant ($P \leq 0.01$) for the four characters. No significant difference was observed among lines, while variability among testers was significant for TNF ($P \leq 0.01$). Crosses and lines x testers showed significant differences for OL and TNF ($P \leq 0.01$). High significant differences were observed among parents for DFL and OL, while parents versus crosses showed significant differences for all characters.

Table 1. Mean squares of the four characters: number of days to flowering (DFL), ovary length (OL), total number of marketable fruits (TNF) and plant vigor (PLV).

Sources of var.	df	MEAN SQUARES			
		DFL	OL	TNF	PLV
Replications	2	198.3	0.494	0.012	2.8
Genotypes	22	278.87**	1.79**	24.3**	0.33*
Lines (L)	6	39.9 ns	0.478 ns	5.23 ns	0.20 ns
Testers (T)	1	26.88 ns	0.945 ns	62.4**	0.09 ns
L x T	6	29.9 ns	0.433**	10.12**	0.103 ns
Crosses (C)	13	34.29 ns	0.493**	11.9**	0.15 ns
Parents (P)	8	277.21**	2.98**	0.57 ns	0.23 ns
P vs C	1	3471.6**	9.09**	375.2**	3.44**
Error	44				

*, ** Significant at 0.05 and 0.01 level of probability, respectively

Table 2: Average heterosis (expressed as above mid parent) for the 14 crosses.

Cross	OL (%)	DFL (%)	TNF (%)	PLV (%)
1xW	-16.1	-36.7	115.3	32.8
2xW	-5.3	-26.6	126.8	28.9
3xW	-5.5	-30.2	182.4	33.3
4xW	-10.8	-24.6	90.0	3.7
5xW	-10.8	-38.5	182.2	15.9
10xW	-4.4	-15.8	52.6	2.1
12xW	-7.5	-25.9	99.2	14.1
1xE	9.7	-16.6	92.0	50.0
2xE	19.8	-6.6	260.4	42.9
3xE	1.9	-19.9	65.7	20.7
4xE	13.9	-5.8	102.8	31.7
5xE	15.1	-20.5	140.2	27.1
10xE	24.5	-18.0	120.3	13.2
12xE	25.1	-5.4	67.6	34.5

The ratio of σ^2 GCA to σ^2 SCA was less than one for the four characters indicating the importance of non-additive gene action for these characters. Lopez-Anido et al. (5) reported the importance of non-additive gene actions for vegetative characters, leaf number, leaf diameter and plant height. Also they reported the importance of additive and non-additive gene actions for total fruit number and precocious production.

None of the female parents or testers showed significant estimates of GCA or SCA for DFL. However, the tester Whitaker was late (51 days) compared to Eskandarany (36 days) while the average of the lines is (58 days). But, the crosses were earlier, with an average of 40 days. The contribution of lines to total variance is 53.7% and that for L x T is 40.3%.

The female parent (10) is a good combiner for long ovary as shown by its significant GCA estimate. Among the testers Whitaker showed a significant negative GCA although it has a relatively long ovary (7.8 cm), while Eskandarany, which has a small ovary (5.4cm) showed a significant positive GCA estimate. However, the lines have an average ovary length of 4.8 cm. The contribution of lines to total variance is 44.7% and that for LxT is 40.6%.

The tester Whitaker is a good combiner for yield as shown by its significant positive GCA estimate, while Eskandarany showed a significant negative GCA estimate. The contribution of lines to total variance is 20.3%, 40.4% for testers, and 39.3% for Lx T.

None of the lines or testers showed significant GCA or SCA for plant size. Nevertheless, the contribution to total variance of lines, testers and LxT is 63.2%, 4.7% and 32.1% respectively.

Heterosis was superior for total fruit number, but low for the other characters (Table 2). Similar results regarding superior heterosis for total fruit number

were reported (3). Mean separation showed that the five top crosses with respect to yield involved Whitaker as a common parent. Thus, they can be used as high yielding commercial F1 hybrids.

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