

**Inheritance of yield related traits in maize (*Zea mays*) under normal and drought conditions.**

\*Saif-ul-malook, Muhammad Ahsan, Qurban Ali and Aamer Mumtaz

Department of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan  
Corresponding author E-mail: [saifulmalookpbg@gmail.com](mailto:saifulmalookpbg@gmail.com)

**Abstract:** The present study was conducted in the glasshouse and research area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad during crop growing season 20012-2013. It was concluded that root and shoot length ratio, fresh shoot weight, dry root weight, and dry shoot weight are the traits used to be as criteria of selecting drought tolerance maize genotypes. It was suggested from results that K55TMS performed better for shoot length while OH3A54 was observed as best performer for root length under normal and drought condition and W187R showed good results for root shoot length ratio. These results indicated that K55TMS, OH3A54 and W187R genotypes may be selected for the development of higher yielding maize genotypes under normal and drought condition. It was founded that M4 showed significant performance for fresh shoot weight and A239 for fresh root weight while A556 for fresh root shoot weight ratio. WA3748 performed better for dry root weight and WM13RA for dry shoot weight while A545 for dry root shoot weight ratio under normal and drought condition. The better performance of maize genotypes indicated the genotypes have potential for improvement in yield and productivity under various environmental conditions. Higher heritability and genetic advance was found for plant height, 100-grain weight, grain rows per plant and grain yield per plant suggested that selection of higher yielding maize genotypes may be helpful to improve crop production and productivity. Higher specific combining ability for W64SP, A495, A509 and A50-2 may be used for developing maize synthetic varieties under drought condition. Higher specific combining ability suggested that the inbred lines may be used to develop higher yielding maize hybrid through hetosis breeding program for developing drought tolerance in maize.

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**Introduction**

Maize (*Zea mays* L.) is an important cereal crop, belongs to family *Poaceae* of specialized tribe *Maydeae*. It is a monoecious and highly cross pollinated crop among the cereals. It ranked third after wheat and rice for its nutrition and uses (Cassamon, 1999). It has 500 byproducts but mostly used as food, feed, forage, green fuel (ethanol), vegetable oil and starch. It is a backbone of poultry feed industry. Maize grain constitutes about 72% starch, 10% protein, 4.8% oil, 5.8% fiber, 3.0% sugar and 1.7% ash (Chaudhary, 1983). A huge quantity of ethanol (52 thousand million liters) is produced in Pakistan against 28.9 million tons of the world production (Govt. of Pakistan, 2012). It is grown in Pakistan at 1083 thousand hectares with production of 4271 thousand tones. Punjab contributes about 39% of total area under maize cultivation with 30% production of total produce in Pakistan while the major share belongs to Sindh and KPK with 56% area and 63% production. The average production of maize in Pakistan is 3672 kg/ha which is very low as compared to other countries (Govt. of Pakistan, 2012-13).

Maize is mainly affected by many biotic and abiotic factors. Drought badly affects plant growth

from seedling to maturity (Areous *et al.*, 2005). Drought is a second factor after soil infertility that causes reduction in maize grain yield. Maize is more susceptible to drought as compared to other cereals except barley (Banziger and Araus, 2007).

Drought causes reduction in leaf area, stem extension, root proliferation, low water use efficiency, disturbance in metabolism, enzyme activity, ionic balance and solute accumulation (Khan *et al.* 1995 and Farooq *et al.*, 2002). It reduces chlorophyll contents resulted in less photosynthesis and ultimately reduction in crop yield (Athar and Ashraf, 2005). Water stress affects silking and extend the anthesis-silking-interval (ASI) leads to lower crop yield (Edmeades *et al.*, 1992). Grain yield is a quantitative trait which depends on many factors such as plant height, plant vigor, efficient water availability, optimum nutrient availability, enhanced solar radiation interception and conversion of solar to chemical energy. Selection of genotype for water stress is complex due to genotype interaction with environment (Messmer, 2006). On the above review the present study was conducted to evaluate the genetics basis of yield related traits under drought conditions.

## Materials and Methods

The present study was conducted in the glasshouse of the Department of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan during winter 2013. The experimental material was comprised on thirty maize inbred lines viz .M14, A50-2, A239, A427-2, A495, A509, A521-1, A545, A556, A638, AES204, Antigua 1, OH8, OH28, OH33-1, OH41, OH54-3A, W64SP, W64PMS, WM13RA, WF-9, WFTMS, W187R, W10, WA3748, W82-3, K55TMS, GPF-9, USSR40, USSR150. The seed of each inbred line was grown in iron trays filled with sand at 2.5cm depth. The pH 7.8 and EC 1.7dSm<sup>-1</sup> was maintained before sowing. The data of 10 seedlings were recorded for the following traits after 30 days of seedling emergence; Shoot length, Root length, Root/shoot length ratio, Fresh shoot weight, Fresh root weight, Fresh root/shoot weight ratio, Dry root weight, Dry shoot weight and Dry root shoot weight ratio.

**Development of F<sub>1</sub> crosses:** Eight maize genotypes (5 females and 3 males) were selected on the basis of their overall performance and were crossed by using line × testers matting design during crop growing season of 2013.

**Experiment 2. Evaluation of germplasm:** The parents and F<sub>1</sub> hybrids were grown in research are of the Department of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan. The seed was sown at the depth of 2.5cm following triplicated randomized complete block design. The plot size was 4m<sup>2</sup>. The plant-to-plant and row-to-row distances were 25 and 75 cm respectively. Data was recorded for following traits from 10 guarded plants of each entry, leaves per plant, leaf area, plant height, cobs per plant, grains rows per cob, 100 seed- weight, cob girth, grain yield per plant and cob length.

**Statistical analysis:** The data was analyzed by using analysis of variance technique (Steel *et al.*, 1997) to evaluate the differences in performance among the genotypes. Line ×tester analysis (Kempthorn 1957) was used to compute combining ability effects of parents and crosses.

## Results

**Shoot Length (cm):** It was suggested from table 1 that maximum shoot length was recorded for inbred line K55TMS a value of (33.475 cm) while lowest shoot length was observed for A509 with value of 21.583cm under normal condition. It was evident from table 2 that maximum shoot length was reported for A50-2 securing the value 22.75cm while lowest shoot length was recorded for OH-8 with a value 8.828 cm under drought condition.

**Root Length (cm):** Root length varied from 35.60 cm to 25.12 cm (Table 1) under normal condition and

32.97 cm to 18.12 cm under drought condition (Table 2). The genotype A50-2 and OH3A54 performed better among all genotypes with securing value of 32.97cm while lowest performed by K55TMS (25.125cm) followed by GPF-9 with value of (26.800 cm) under normal irrigation. Maximum root length was observed for A 50-2 (32.97 cm) followed by A509 and WFTMS with values of 29.60cm, 29.90 cm respectively, while the lowest performance was observed for OH-8 (18.12cm) followed by GPF 9 and AES 204 securing the value 19.75cm, 21.25cm respectively, under drought condition

**Root shoot length ratio:** Table 1 revealed that root shoot length ratio under normal irrigation condition ranged from maximum mean value of 1.505 to minimum value of 0.763 while under drought condition the mean value range from 2.359 to 1.383 (Table 2). The highest root shoot length ratio was given by the inbred line W187-R under normal condition and was followed by inbred lines OH3A54 and AES 204 with mean values of 1470, 1.407 respectively. K55TMS showed the minimum mean value under normal irrigation condition. The inbred lines M64TMS showed the higher ratio followed by OH3A54 and OH-8 with root shoot length ratio 2.264 and 2.047 respectively. The lowest mean value for root shoot length ratio was observed for inbred line A521-1 under drought condition.

**Fresh shoot weight (g):** Table 1 showed that range for fresh shoot weight was observed maximum 3.128g to minimum mean value 1.190g for normal irrigation while minimum mean value 0.960g to maximum mean value 2.370g under drought condition (Table 2). The inbred line M4 showed the maximum mean value of fresh shoot weight followed by A239 and A427-2 with securing the mean values 2.473g and 2.732g respectively under normal condition. The inbred line USSR150 showed the minimum mean value 1.190g. The inbred lines Antigua-1 showed the top fresh shoot weight value followed by OH-41 and A521-1 fresh shoot weight 2.255g and 2.245g respectively. The lowest mean value for fresh shoot weight was observed for inbred line A556 under drought condition.

**Fresh root shoot weight ratio:** Table 1 showed that range for fresh root shoot weight ratio was observed maximum 1.84 to minimum mean value 1.15 for normal irrigation while minimum mean value 0.8899 to maximum mean value 4.533 under drought condition (Table 2). The inbred line A556 showed the maximum mean value of fresh root shoot weight ratio followed by AES204 and OH28 with securing the mean values 1.81 and 1.78 respectively under normal condition. The inbred line M4 showed minimum mean value 1.15. The inbred line A509 the top fresh shoot weight ratio value followed for A556 and

WFTMS fresh root shoot weight ratio 4.230 and 3.72 respectively. The lowest mean value 0.988 for fresh root shoot weight ratio was observed by inbred line OH8 under drought condition genotypes.

**Dry root weight (g):** Table 1 showed that range for dry root weight was observed maximum 0.987g to minimum mean value 0.370g for normal irrigation while minimum mean value 0.260g to maximum mean value 0.700g under drought condition (Table 2). The inbred line M4 showed the maximum mean value of dry root weight followed by A638 and A545 with securing the mean values 0.550 and 0.510g respectively under drought condition. The inbred line M4 showed the minimum mean value 0.250g. The inbred line WA3748 showed higher dry root weight value followed by M4 and GPF9, 0.945g and 0.710g respectively. The lowest mean value 0.370g for dry root weight was observed for inbred line A495.2 under normal condition.

**Dry shoot weight (g)** Dry shoot weight varied from 2.395g to 1.00g (Table 1) under normal condition and 2.150g to 0.325g under drought condition. The inbred line performed better under normal condition as compared to drought condition (Table 2). The genotype OH41 performed better among all genotypes with securing value of 2.395g while lowest performance was for A556 (1.0 g) followed by A509 with value of (1.015g) under normal irrigation. Dry shoot weight was observed higher for A495-2 (2.150g) followed by OH-8 and W10 with values of 1.853g, 1.470g respectively while the lowest performance was observed for OH-8 (18.12g) followed by M4 and A556 securing the value 0.325g, 0.337g respectively, under drought condition.

**Dry root shoot weight ratio** Table 1 showed that range for dry root shoot weight ratio was observed maximum 1.230 to minimum mean value 0.390 for normal irrigation while minimum mean value 0.195 to maximum mean value 0.490 under drought condition (Table 2). The inbred line A545 showed the maximum mean value of dry root shoot weight ratio followed by A239 and A W10 with securing the mean values 0.970 and 0.945 respectively under normal condition. The inbred line A495 showed the minimum mean value 0.390. The inbred line A239 showed the higher dry root shoot weight ratio value 0.490 followed by A545 and OH28 dry root shoot weight ratio 0.460 and 0.410 respectively. The lowest mean value for dry root shoot weight ratio was observed for inbred line OH8 under drought condition.

## Experiment 2

**Plant Height (cm):** Highly significant differences among all genotypes were observed for plant height

(Table 3) under normal conditions. The perusal of table 3 showed that among the parents the genotype A-509 exhibited highest value (169.05 cm) followed by A495 and A427-2 obtaining 166.50 and 161.95 cm respectively while among cross combinations A509×A50-2 showed maximum plant height (171.79 cm) while A509×A239 showed minimum plant height (132.99 cm) under normal conditions. Highest plant height was observed for A239 (170.55 cm) while lowest value for A50-2 (134.49 cm) was reported among parent inbred lines under drought conditions (table 4). Highest plant height indicates that A509×A50-2 will be useful for fodder purpose breeding as well as development of hybrid seed.

**Leaves per plant** It was revealed from table 3 that all genotypes highly and significantly different from one another in this particular case. The study of table 3 Showed that genotype A545 showed maximum number of leaves per plant (12.77) followed by A495 and A50-2 measuring 12.44 and 12.01 respectively, among the parents under normal conditions. Cross combination W64SP×A427-2 produced highest leaves per plant (12.83) while W10×A50-2 produced least number of leaves per plant (10.60) under normal conditions. Highest leaves per plant was recorded among parent genotypes for A239 (13.44) followed by A427-2 and A50-2 with 13.10, 12.51 leaves respectively, under drought conditions. Among cross combination A545×A50-2 showed the highest value for leaves per plant (13.33) while low leaves (11.10) was reported for W10×A50-2 under drought condition.

**Cobs per plant:** The result presented in table 3 revealed that among parents the maximum cobs were produced by A545 (2) followed by A50-2 and W64SP obtaining 1.88 and 1.66 under normal conditions respectively. High value for cobs per plant was observed among parent genotypes for A 50-2 (1.88) followed by W64SP and A495 with 1.55, 1.33 cobs per plant under drought conditions as shown in table 4. Among crosses, the cross A509×A427 showed the highest value for cobs per plant (2) and lowest value for A495×A50-2 with 1.00 of cobs per plant under drought conditions.

**Leaf area (cm<sup>2</sup>)** Leaf area was presented in table 3 parent inbred line A495 indicated highest value of leaf area that was 527.82 cm<sup>2</sup> followed by A545 (468.28 cm<sup>2</sup>) and W64SP (454.87 cm<sup>2</sup>) under normal conditions. Among cross combination W-64SP×A 239 exhibited highest leaf area 527.82 cm<sup>2</sup> while lowest value for W10×A427-2 (394.55 cm<sup>2</sup>) under normal.

**Table 1: Mean and statistical significance of seedling traits of maize under normal condition**

Genotypes	Shoot Length	Root Length	Root shoot length ratio	Fresh shoot weight	Fresh root weight	Fresh root shoot weight ratio	Dry root weight	Dry shoot weight	Dry root shoot weight ratio
A239	26.988 <sup>BCDEF</sup>	33.775 <sup>ABCD</sup>	1.2644 <sup>ABCDEF</sup>	2.7325 <sup>AB</sup>	4.130 <sup>A</sup>	1.35 <sup>ABCDEF</sup>	0.670 <sup>CDE</sup>	1.820 <sup>EF</sup>	0.970 <sup>B</sup>
A427-2	27.883 <sup>BCD</sup>	29.233 <sup>ABCDEF</sup>	1.0558 <sup>DEFGH</sup>	2.4733 <sup>BC</sup>	3.8533 <sup>ABC</sup>	1.77 <sup>ABC</sup>	0.480 <sup>F</sup>	1.445 <sup>NO</sup>	0.530 <sup>FGHIJKL</sup>
A495-2	25.133 <sup>CDEFG</sup>	33.033 <sup>ABCDE</sup>	1.3226 <sup>ABCD</sup>	1.6800 <sup>GHIJ</sup>	2.723 <sup>EF</sup>	1.70 <sup>ABCDE</sup>	0.370 <sup>I</sup>	1.575 <sup>LM</sup>	0.390 <sup>L</sup>
A50-2	29.000 <sup>ABC</sup>	35.300 <sup>AB</sup>	1.2172 <sup>ABCDEF</sup>	2.1600 <sup>DEF</sup>	3.170 <sup>ABCDEF</sup>	1.45 <sup>ABCDEF</sup>	0.530 <sup>DEFGHI</sup>	1.670 <sup>JK</sup>	0.790 <sup>BCDE</sup>
A509	21.583 <sup>G</sup>	27.917 <sup>BCDEF</sup>	1.3041 <sup>ABCDEF</sup>	1.8083 <sup>EF</sup>	2.675 <sup>EF</sup>	1.43 <sup>ABCDEF</sup>	0.430 <sup>GHI</sup>	1.015 <sup>R</sup>	0.425 <sup>KL</sup>
A521-1	28.837 <sup>ABC</sup>	31.700 <sup>ABCDEF</sup>	1.1041 <sup>CDEFGH</sup>	2.1650 <sup>DEF</sup>	3.200 <sup>ABCDEF</sup>	1.61 <sup>ABCDEF</sup>	0.600 <sup>CDEFG</sup>	2.360 <sup>B</sup>	0.770 <sup>BCDEF</sup>
A545	27.475 <sup>BCDE</sup>	27.725 <sup>BCDEF</sup>	1.0168 <sup>DEFGH</sup>	2.2005 <sup>CDE</sup>	3.378 <sup>ABCDE</sup>	1.54 <sup>ABCDEF</sup>	0.770 <sup>BC</sup>	1.765 <sup>GH</sup>	1.230 <sup>A</sup>
A556	28.567 <sup>ABCD</sup>	30.733 <sup>ABCDEF</sup>	1.0786 <sup>DEFGH</sup>	1.5333 <sup>IJKL</sup>	2.950 <sup>BCDEF</sup>	1.84 <sup>A</sup>	0.390 <sup>HI</sup>	1.000 <sup>R</sup>	0.645 <sup>DEFGHIJK</sup>
A638	25.750 <sup>BCDEF</sup>	34.300 <sup>ABC</sup>	1.3436 <sup>ABCD</sup>	1.7600 <sup>GHIJ</sup>	2.940 <sup>BCDEF</sup>	1.51 <sup>ABCDEF</sup>	0.480 <sup>F</sup>	1.710 <sup>GH</sup>	0.655 <sup>DEFGHIJK</sup>
AES204	23.850 <sup>CDEFG</sup>	33.600 <sup>ABCD</sup>	1.4078 <sup>ABC</sup>	1.3900 <sup>JKL</sup>	2.400 <sup>EF</sup>	1.81 <sup>AB</sup>	0.470 <sup>F</sup>	1.865 <sup>E</sup>	0.445 <sup>KL</sup>
Antigua-1	25.450 <sup>BCDEF</sup>	33.400 <sup>ABCD</sup>	1.3064 <sup>ABCDE</sup>	1.5200 <sup>IJKL</sup>	2.640 <sup>EF</sup>	1.48 <sup>ABCDEF</sup>	0.430 <sup>F</sup>	2.225 <sup>C</sup>	0.650 <sup>DEFGHIJK</sup>
GPF-9	26.800 <sup>BCDEF</sup>	25.650 <sup>EF</sup>	0.9604 <sup>F</sup>	1.5900 <sup>GHIJKL</sup>	2.160 <sup>GHI</sup>	1.28 <sup>CDEF</sup>	0.710 <sup>CD</sup>	1.290 <sup>P</sup>	0.660 <sup>DEFGHIJK</sup>
K55TMS	33.475 <sup>A</sup>	25.125 <sup>F</sup>	0.7633 <sup>H</sup>	2.3400 <sup>BCD</sup>	2.605 <sup>EF</sup>	1.25 <sup>DEF</sup>	0.600 <sup>CDEFG</sup>	1.100 <sup>O</sup>	0.740 <sup>BCDEF</sup>
M4	23.842 <sup>CDEFG</sup>	31.000 <sup>ABCDEF</sup>	1.3358 <sup>ABCD</sup>	3.1283 <sup>A</sup>	3.900 <sup>AB</sup>	1.15 <sup>F</sup>	0.945 <sup>AB</sup>	1.760 <sup>GH</sup>	0.490 <sup>IJKL</sup>
M64TMS	26.150 <sup>BCDEF</sup>	29.650 <sup>ABCDEF</sup>	1.1321 <sup>BCDEF</sup>	2.0000 <sup>DEFG</sup>	2.820 <sup>DEFGHI</sup>	1.396 <sup>ABCDEF</sup>	0.560 <sup>DEFG</sup>	1.718 <sup>GHI</sup>	0.705 <sup>DEFGHIJK</sup>
OH-28	24.200 <sup>CDEFG</sup>	27.600 <sup>CDEF</sup>	1.1410 <sup>BCDEF</sup>	1.5100 <sup>IJKL</sup>	2.670 <sup>EF</sup>	1.55 <sup>ABCDEF</sup>	0.370 <sup>I</sup>	1.855 <sup>E</sup>	0.825 <sup>BCD</sup>
OH33-1	26.500 <sup>BCDEF</sup>	34.200 <sup>ABCD</sup>	1.2872 <sup>ABCDEF</sup>	1.7100 <sup>GHIJ</sup>	2.920 <sup>BCDEF</sup>	1.78 <sup>ABC</sup>	0.610 <sup>DEF</sup>	1.295 <sup>P</sup>	0.725 <sup>CDEFGH</sup>
OH3A54	24.275 <sup>CDEFG</sup>	35.600 <sup>A</sup>	1.4702 <sup>AB</sup>	1.4250 <sup>JKL</sup>	2.355 <sup>F</sup>	1.62 <sup>ABCDEF</sup>	0.421 <sup>GHI</sup>	1.745 <sup>GHI</sup>	0.490 <sup>IJKL</sup>
OH-41	25.275 <sup>CDEFG</sup>	31.225 <sup>ABCDEF</sup>	1.2352 <sup>ABCDEF</sup>	1.6700 <sup>GHIJK</sup>	2.837 <sup>DEFGHI</sup>	1.54 <sup>ABCDEF</sup>	0.560 <sup>DEFG</sup>	2.395 <sup>B</sup>	0.625 <sup>DEFGHIJKL</sup>
OH-8	23.950 <sup>CDEFG</sup>	28.100 <sup>ABCDEF</sup>	1.1746 <sup>ABCDEF</sup>	1.5600 <sup>IJKL</sup>	2.510 <sup>EF</sup>	1.51 <sup>ABCDEF</sup>	0.490 <sup>F</sup>	1.595 <sup>KL</sup>	0.645 <sup>DEFGHIJK</sup>
USSR150	23.450 <sup>DEFG</sup>	29.600 <sup>ABCDEF</sup>	1.2608 <sup>ABCDEF</sup>	1.1900 <sup>I</sup>	1.850 <sup>J</sup>	1.62 <sup>ABCDEF</sup>	0.470 <sup>F</sup>	1.705 <sup>H</sup>	0.475 <sup>JKL</sup>
USSR40	28.450 <sup>ABCD</sup>	27.550 <sup>CDEF</sup>	0.9685 <sup>EF</sup>	1.6900 <sup>GHI</sup>	2.270 <sup>F</sup>	1.22 <sup>EF</sup>	0.560 <sup>DEFG</sup>	1.490 <sup>N</sup>	0.720 <sup>CDEFGHI</sup>
W10	30.587 <sup>AB</sup>	33.400 <sup>ABC</sup>	1.1003 <sup>CDEFGH</sup>	2.5325 <sup>BC</sup>	3.790 <sup>ABCD</sup>	1.49 <sup>ABCDEF</sup>	0.500 <sup>DEFGHI</sup>	1.390 <sup>J</sup>	0.945 <sup>BC</sup>
W187R	21.950 <sup>F</sup>	33.000 <sup>ABCDE</sup>	1.5056 <sup>A</sup>	1.4100 <sup>JKL</sup>	2.280 <sup>F</sup>	1.72 <sup>ABC</sup>	0.536 <sup>DEFGHI</sup>	2.095 <sup>D</sup>	0.550 <sup>FGHIJKL</sup>
W64SP	25.750 <sup>BCDEF</sup>	29.000 <sup>ABCDEF</sup>	1.1390 <sup>BCDEF</sup>	1.3500 <sup>JKL</sup>	2.370 <sup>EF</sup>	1.50 <sup>ABCDEF</sup>	0.430 <sup>F</sup>	1.627 <sup>JKL</sup>	0.565 <sup>DEFGHIJKL</sup>
W82-3	28.600 <sup>ABCD</sup>	26.550 <sup>DEF</sup>	0.9423 <sup>G</sup>	1.5400 <sup>GHIJKL</sup>	2.012 <sup>HI</sup>	1.34 <sup>BCDEF</sup>	0.470 <sup>F</sup>	1.450 <sup>NO</sup>	0.505 <sup>FGHIJKL</sup>
WA3748	27.200 <sup>BCDE</sup>	28.850 <sup>ABCDEF</sup>	1.0594 <sup>DEFGH</sup>	1.8700 <sup>EF</sup>	2.630 <sup>EF</sup>	1.42 <sup>ABCDEF</sup>	0.987 <sup>A</sup>	1.790 <sup>FG</sup>	0.825 <sup>BCD</sup>
WF-9	24.350 <sup>CDEFG</sup>	29.250 <sup>ABCDEF</sup>	1.2064 <sup>ABCDEF</sup>	1.4400 <sup>JKL</sup>	2.120 <sup>HI</sup>	1.51 <sup>BCDEF</sup>	0.475 <sup>F</sup>	1.495 <sup>MN</sup>	0.510 <sup>GHIJKL</sup>
WFTMS	22.650 <sup>FG</sup>	27.800 <sup>BCDEF</sup>	1.2270 <sup>ABCDEF</sup>	1.2600 <sup>JKL</sup>	2.380 <sup>EF</sup>	1.58 <sup>ABCDEF</sup>	0.490 <sup>F</sup>	1.395 <sup>O</sup>	0.480 <sup>JKL</sup>
WM13RA	23.488 <sup>DEFG</sup>	29.450 <sup>ABCDEF</sup>	1.2467 <sup>ABCDEF</sup>	1.7375 <sup>GH</sup>	2.675 <sup>EF</sup>	1.57 <sup>ABCDEF</sup>	0.480 <sup>F</sup>	2.495 <sup>A</sup>	0.660 <sup>DEFGHIJK</sup>

**Table 2 Mean and statistical significance of seedling traits of maize under drought condition**

Genotypes	Shoot Length	Root Length	Root shoot length ratio	Fresh shoot weight	Fresh root weight	Fresh root shoot weight ratio	Dry root weight	Dry shoot weight	Dry root shoot weight ratio
A239	14.60 <sup>DEFGHI</sup>	24.30 <sup>BCDEF</sup>	1.668 <sup>DEFGH</sup>	1.870 <sup>DE</sup>	0.700 <sup>A</sup>	3.3279 <sup>CDE</sup>	0.700 <sup>A</sup>	1.130 <sup>J</sup>	0.490 <sup>A</sup>
A427-2	15.80 <sup>CDEFG</sup>	28.20 <sup>ABCD</sup>	1.785 <sup>CD</sup>	1.52 <sup>GHIJ</sup>	0.480 <sup>BCDE</sup>	2.8098 <sup>DEG</sup>	0.480 <sup>BCDE</sup>	0.940 <sup>DEF</sup>	0.330 <sup>CDEFGH</sup>
A495-2	16.70 <sup>CDEFG</sup>	25.20 <sup>BCDEF</sup>	1.510 <sup>F</sup>	1.440 <sup>GHIJK</sup>	0.480 <sup>BCDE</sup>	0.8998 <sup>M</sup>	0.480 <sup>BCDE</sup>	2.150 <sup>A</sup>	0.320 <sup>CDEFGHI</sup>
A50-2	22.75 <sup>A</sup>	32.97 <sup>A</sup>	1.454 <sup>GHI</sup>	1.605 <sup>DEFGHI</sup>	0.480 <sup>BCDE</sup>	3.3098 <sup>CDE</sup>	0.480 <sup>BCDE</sup>	0.677 <sup>IJKLMN</sup>	0.400 <sup>ABCD</sup>
A509	21.00 <sup>AB</sup>	29.60 <sup>AB</sup>	1.412 <sup>HI</sup>	0.960 <sup>M</sup>	0.460 <sup>CDEFG</sup>	4.5331 <sup>A</sup>	0.460 <sup>DEFG</sup>	0.650 <sup>IJKLMN</sup>	0.340 <sup>BCDEFG</sup>
A521-1	19.10 <sup>ABC</sup>	26.50 <sup>BCDEF</sup>	1.383 <sup>I</sup>	2.245 <sup>AB</sup>	0.480 <sup>BCDE</sup>	3.4865 <sup>BCD</sup>	0.480 <sup>BCDE</sup>	0.650 <sup>IJKLMN</sup>	0.400 <sup>ABCD</sup>
A545	18.10 <sup>BCDE</sup>	27.40 <sup>ABCDEF</sup>	1.514 <sup>EF</sup>	1.690 <sup>DEFGH</sup>	0.510 <sup>BC</sup>	2.6982 <sup>EPG</sup>	0.510 <sup>BC</sup>	0.760 <sup>F</sup>	0.460 <sup>AB</sup>
A556	14.75 <sup>DEFGH</sup>	26.12 <sup>ABCDEF</sup>	1.782 <sup>D</sup>	1.100 <sup>LM</sup>	0.260 <sup>MN</sup>	4.2301 <sup>AB</sup>	0.260 <sup>MN</sup>	0.337 <sup>PQ</sup>	0.240 <sup>F</sup>
A638	16.00 <sup>CDEFG</sup>	24.80 <sup>BCDEF</sup>	1.560 <sup>DEFGH</sup>	1.610 <sup>DEFGHI</sup>	0.550 <sup>B</sup>	2.2915 <sup>GH</sup>	0.550 <sup>BC</sup>	0.840 <sup>F</sup>	0.380 <sup>ABCDEF</sup>
AES204	14.30 <sup>DEFGHI</sup>	21.25 <sup>EF</sup>	1.474 <sup>GHI</sup>	1.735 <sup>CDEFG</sup>	0.500 <sup>BC</sup>	3.3854 <sup>CDE</sup>	0.500 <sup>BC</sup>	0.397 <sup>OPQ</sup>	0.350 <sup>BCDEF</sup>
Antigua-1	17.37 <sup>BCDEF</sup>	28.42 <sup>ABC</sup>	1.649 <sup>DEFGH</sup>	2.370 <sup>A</sup>	0.450 <sup>DEFGH</sup>	2.4300 <sup>FGH</sup>	0.450 <sup>CDEFGH</sup>	0.667 <sup>IJKLMN</sup>	0.310 <sup>DEFGHI</sup>
GPF-9	10.85 <sup>IJK</sup>	19.75 <sup>FG</sup>	1.823 <sup>CD</sup>	1.461 <sup>GHIJK</sup>	0.280 <sup>LMN</sup>	1.3132 <sup>KLM</sup>	0.280 <sup>LMN</sup>	0.900 <sup>EF</sup>	0.200 <sup>J</sup>
K55TMS	10.50 <sup>JK</sup>	23.10 <sup>BCDEF</sup>	2.201 <sup>ABC</sup>	1.170 <sup>KLM</sup>	0.330 <sup>IJKLMN</sup>	1.1882 <sup>KLM</sup>	0.330 <sup>IJKLMN</sup>	0.940 <sup>DEF</sup>	0.210 <sup>GHI</sup>
M4	12.56 <sup>GHIJK</sup>	22.50 <sup>CDEFG</sup>	1.791 <sup>CD</sup>	1.660 <sup>DEFGH</sup>	0.250 <sup>N</sup>	4.6358 <sup>A</sup>	0.250 <sup>N</sup>	0.325 <sup>O</sup>	0.200 <sup>HI</sup>
M64TMS	9.900 <sup>JK</sup>	23.30 <sup>BCDEF</sup>	2.359 <sup>A</sup>	1.588 <sup>DEFGH</sup>	0.410 <sup>EF</sup>	1.6827 <sup>H</sup>	0.410 <sup>EF</sup>	0.702 <sup>GHIJKL</sup>	0.320 <sup>CDEFGHI</sup>
OH-28	15.60 <sup>CDEFG</sup>	26.40 <sup>ABCDEF</sup>	1.711 <sup>DEFG</sup>	1.875 <sup>CD</sup>	0.370 <sup>H</sup>	1.4623 <sup>J</sup>	0.370 <sup>H</sup>	0.965 <sup>DEF</sup>	0.410 <sup>BC</sup>
OH33-1	14.20 <sup>EF</sup>	24.60 <sup>BCDEF</sup>	1.740 <sup>DEF</sup>	1.380 <sup>GHIJK</sup>	0.330 <sup>IJKLMN</sup>	1.8836 <sup>HJK</sup>	0.330 <sup>IJKLMN</sup>	0.765 <sup>F</sup>	0.270 <sup>DEFGHI</sup>
OH3A54	10.70 <sup>HIJK</sup>	24.20 <sup>BCDEF</sup>	2.264 <sup>AB</sup>	1.680 <sup>DEFGHI</sup>	0.391 <sup>F</sup>	2.1091 <sup>GHI</sup>	0.391 <sup>F</sup>	0.780 <sup>F</sup>	0.285 <sup>DEFGHI</sup>
OH-41	15.80 <sup>CDEFG</sup>	26.90 <sup>ABCDEF</sup>	1.702 <sup>DEFG</sup>	2.255 <sup>AB</sup>	0.450 <sup>DEFGH</sup>	2.2500 <sup>GHI</sup>	0.450 <sup>DEFGH</sup>	0.610 <sup>IJKLMNO</sup>	0.370 <sup>ABCDEF</sup>
OH-8	8.25 <sup>K</sup>	18.12 <sup>G</sup>	2.047 <sup>BC</sup>	1.500 <sup>GHI</sup>	0.309 <sup>KLMN</sup>	0.9887 <sup>LM</sup>	0.309 <sup>KLMN</sup>	1.853 <sup>B</sup>	0.195 <sup>J</sup>
USSR150	13.70 <sup>F</sup>	23.30 <sup>BCDEF</sup>	1.701 <sup>DEFG</sup>	1.850 <sup>CDEF</sup>	0.392 <sup>F</sup>	1.7996 <sup>HJK</sup>	0.392 <sup>F</sup>	0.570 <sup>IJKLMNO</sup>	0.370 <sup>ABCDEF</sup>
USSR40	13.67 <sup>F</sup>	22.05 <sup>DEFG</sup>	1.619 <sup>DEFGH</sup>	1.240 <sup>JKLM</sup>	0.350 <sup>JKL</sup>	1.4819 <sup>KLM</sup>	0.350 <sup>JKL</sup>	0.812 <sup>F</sup>	0.270 <sup>DEFGHI</sup>
W10	18.40 <sup>BCDE</sup>	29.00 <sup>ABC</sup>	1.571 <sup>DEFGHI</sup>	1.360 <sup>IJKL</sup>	0.400 <sup>EF</sup>	1.2818 <sup>KLM</sup>	0.400 <sup>EF</sup>	1.470 <sup>C</sup>	0.330 <sup>CDEFGHI</sup>
W187R	16.50 <sup>CDEFG</sup>	23.50 <sup>BCDEF</sup>	1.424 <sup>HI</sup>	2.049 <sup>BC</sup>	0.340 <sup>JKLM</sup>	1.4011 <sup>KLM</sup>	0.340 <sup>JKLM</sup>	0.914 <sup>DEFG</sup>	0.310 <sup>CDEFGHI</sup>
W64SP	14.40 <sup>DEFGHI</sup>	25.60 <sup>BCDEF</sup>	1.778 <sup>DE</sup>	1.542 <sup>F</sup>	0.490 <sup>BCD</sup>	1.4969 <sup>J</sup>	0.490 <sup>BCD</sup>	1.430 <sup>C</sup>	0.370 <sup>ABCDEF</sup>
W82-3	12.80 <sup>GHIJK</sup>	21.80 <sup>DEFG</sup>	1.703 <sup>DEFG</sup>	1.550 <sup>F</sup>	0.320 <sup>IJKLMN</sup>	3.1238 <sup>CD</sup>	0.320 <sup>IJKLMN</sup>	0.410 <sup>OPQ</sup>	0.260 <sup>EF</sup>
WA3748	14.70 <sup>DEFGHI</sup>	24.45 <sup>BCDEF</sup>	1.665 <sup>DEFGH</sup>	1.690 <sup>DEFGH</sup>	0.320 <sup>IJKLMN</sup>	2.6977 <sup>DEFG</sup>	0.320 <sup>IJKLMN</sup>	0.485 <sup>MNOPQ</sup>	0.260 <sup>EF</sup>
WF-9	12.80 <sup>GHIJK</sup>	23.20 <sup>BCDEF</sup>	1.812 <sup>CD</sup>	1.421 <sup>GHIJK</sup>	0.320 <sup>IJKLMN</sup>	1.2762 <sup>KLM</sup>	0.320 <sup>IJKLMN</sup>	1.110 <sup>DE</sup>	0.330 <sup>CDEFGH</sup>
WFTMS	18.50 <sup>BCD</sup>	29.90 <sup>AB</sup>	1.627 <sup>DEFGHI</sup>	1.406 <sup>GHIJKL</sup>	0.470 <sup>BCDEF</sup>	3.7290 <sup>BC</sup>	0.470 <sup>BCDEF</sup>	0.460 <sup>NOPQ</sup>	0.360 <sup>ABCDEF</sup>
WM13RA	16.00 <sup>CDEFG</sup>	26.60 <sup>ABCDEF</sup>	1.656 <sup>DEFGH</sup>	2.305 <sup>AB</sup>	0.380 <sup>GHIJK</sup>	3.2400 <sup>CDE</sup>	0.380 <sup>GHIJK</sup>	0.550 <sup>LMNOP</sup>	0.390 <sup>ABCD</sup>

Conditions. Among parent genotypes W64SP showed the highest value 532.82 cm<sup>2</sup> while lowest value 358 cm<sup>2</sup> for A509 was recorded under drought

conditions while A545×A50-2 indicated the highest leaf area 532.82 cm<sup>2</sup> and lowest leaf area 399.28 cm<sup>2</sup>



for W64SP×A239 was recorded under drought condition (table 4).

**Grain rows per cob:** It was revealed from table 3 that among parent genotypes A509 exhibited highest grain rows per cob (15.94) followed by A545 and W64 SP with the grain rows per cob 15.45 and 14.01 respectively, under normal conditions. The maximum potential was observed for A495×A239 (15) while lowest value was reported for A509×A50-2 (11.50) among the cross combinations under normal conditions. Table 4 showed the highest genotypic differences for grain rows per cob. High value for grain rows per cob was observed of among parent genotypes A427-2 (16.22) while lowest for grain rows per cob was recorded for A495 (12.50) and among the cross combination W10×A239 (17.50) while lowest was recorded for A495×A239 (12.00) under drought condition.

**Cob girth (cm):** Cob girth was presented in table 3 regarding cob girth maximum value 4.55cm for cob girth was displayed by parental line A509 and minimum value 3.4 cm was observed by parental line A239 under normal conditions. Among crosses the cross A545×A50-2 exhibited the highest value 4.68 cm while minimum value for cob girth was recorded for A509×A50-2 under normal conditions. It was persuaded from table 4 that higher cob girth was recorded for A239 (4.63 cm) while lowest was for A495 (3.45cm). The F<sub>1</sub> hybrid A545×A427-2 showed higher cob girth (4.60cm) while lowest W10×A50-2 (2.74cm) under drought condition.

**100-grain weight (g):** Highly significant differences among genotypes for 100-grain weight were reported as shown in table 3. The results showed that highest value for 100grain weight was reported for inbred line W10 (10 43.43g) while lowest value was observed for A509 (29.93g) under normal conditions. Among cross combinations A509×A50-2 showed the highest value (54.53g) while lowest value was observed for W64SP×A239 with yield (29g) under normal conditions. It was persuaded from table 4 that higher 100-grain weight was found for A495 (56.03g) while lowest was reported for A239 (40.53g). The F<sub>1</sub> hybrid A495×A427-2 showed higher 100-grain weight 40.43g while A545×A239 showed lowest 100-grain weight (25.20g) under drought condition.

**Cob length (cm):** The study of table 3 revealed that genotype A50-2 showed maximum cob length (16.98) followed by W10 and A545 measuring 16.73cm and 16.18 cm respectively, among the parents under normal conditions. Cross combination W64SP×A50-2 showed highest cob length (19.00 cm) while A495×A427-2 showed lowest cob length

(12.83) under normal conditions. It was suggested from table 4 that higher cob length was recorded for A545 (18cm) while lowest was for A509 (12.15cm). Among F<sub>1</sub> hybrid A545×A239 showed higher cob length 19.50cm while lowest was reported for W10×A427-2 showed 12.83cm cob length.

**Grain yield per plant (g):** Highest value for grain yield per plant was recorded for inbred line A50-2 (163.60 g) among parent genotypes followed by A239 (158 g) and W10 (151g) under normal conditions as shown in table 3. The cross combination A509×A50-2 exhibited the maximum value (19242 g) for grain yield per plant while minimum yield was reported for A545×A239 (70.23g) under normal conditions. Higher grain yield was reported for A50-2 (166.60g) while lowest for W10 (87g) among the F<sub>1</sub> hybrid A495×A239 (195.42g) followed by A509×A50-2 (73.23g) under drought condition (Table 4).

#### Genetic components

**Plant height (cm):** It was reported from table 5 that higher heritability (99.4%) and genetic advance (207.525%) was recorded for plant height while genotypic coefficient of variance (116.916%) and phenotypic coefficient of variance (117.669%) was observed for plant height under normal irrigation condition. Under drought condition it was observed from table 6 that higher heritability (84.60%) and genetic advance (176.60%) was reported for plant height while genotypic coefficient of variance (108.83%) and phenotypic coefficient of variance (111.55%).

**Leaves Per plant:** It was persuaded from table 5 that higher heritability (69.3%) and low genetic advance was reported for number of leaves per plant under normal irrigation condition. It was also reported that high difference for genotypic coefficient of variance (6.729%) and phenotypic coefficient of variance (9.710). It was persuaded from table 6 that moderate heritability (52%) and low genetic advance (9.44%).

**Cobs per plant:** High heritability (78.3%) and genetic advance (27.446) showed that cobs per plant may be controlled by additive gene effect as well as dominance effect of genes respectively. It was reported from table 5 that genotypic coefficient of variance (15.462%) and phenotypic coefficient of variance (19.759%) for number of cobs per plant under normal condition. Under drought condition table 6 indicated that moderate heritability (65.8%) and high genetic advance (20%) was observed that indicated dominance and additive effect of gene was present. **Leaf area (cm<sup>2</sup>):** Higher heritability (65%

**Table 3 Mean and statistical significance of yield related traits of maize under normal condition**

Genotypes	Plant height	Leaves per plant	Cobs per plant	Leaf area	Grain rows per cob	Cob Girth	Grain yield per plant	100-grain weight	Cob length
A-495	166.50 <sup>FG</sup>	12.445 <sup>ABCDE</sup>	1.553 <sup>BC</sup>	527.82 <sup>A</sup>	13.167 <sup>HJK</sup>	4.396 <sup>AB</sup>	130.90 <sup>FG</sup>	30.780 <sup>J</sup>	15.833 <sup>CDEF</sup>
A-509	169.05 <sup>CD</sup>	12 <sup>ABCDEF</sup>	1.110 <sup>D</sup>	409.54 <sup>FGHI</sup>	15.944 <sup>AB</sup>	4.580 <sup>AB</sup>	138.07 <sup>DEF</sup>	31.770 <sup>GHI</sup>	13.500 <sup>GH</sup>
W-64SP	155.94 <sup>KL</sup>	10.053 <sup>J</sup>	1.663 <sup>ABC</sup>	454.87 <sup>BCDEG</sup>	17 <sup>A</sup>	4.550 <sup>AB</sup>	141.83 <sup>BE</sup>	29.933 <sup>J</sup>	15.367 <sup>DEF</sup>
W-10	136.94 <sup>O</sup>	11.833 <sup>BCDEFGH</sup>	1 <sup>D</sup>	477.51 <sup>ABCD</sup>	13.943 <sup>EF</sup>	3.683 <sup>C</sup>	151 <sup>C</sup>	43.433 <sup>D</sup>	16.733 <sup>BCD</sup>
A-545	142.70 <sup>N</sup>	12.776 <sup>AB</sup>	2 <sup>A</sup>	468.28 <sup>ECDE</sup>	15.453 <sup>BCD</sup>	3.740 <sup>C</sup>	127.52 <sup>GH</sup>	33.633 <sup>FGH</sup>	16.183 <sup>BCDE</sup>
A427-2	161.95 <sup>L</sup>	10.500 <sup>J</sup>	1 <sup>D</sup>	353.64 <sup>I</sup>	14.017 <sup>EF</sup>	4.403 <sup>AB</sup>	125.88 <sup>GH</sup>	34.387 <sup>FG</sup>	11.650 <sup>J</sup>
A50-2	134.49 <sup>P</sup>	12.017 <sup>ABCDEF</sup>	1.886 <sup>AB</sup>	408.58	13.167 <sup>HJK</sup>	4.293 <sup>B</sup>	163.60 <sup>B</sup>	32.300 <sup>GHI</sup>	16.980 <sup>BC</sup>
A-239	146.18 <sup>M</sup>	12.000 <sup>ABCDEF</sup>	1.333 <sup>CD</sup>	458.11 <sup>BCDEF</sup>	12 <sup>LMN</sup>	3.403 <sup>CD</sup>	158.03 <sup>C</sup>	27.623 <sup>A</sup>	12.100 <sup>J</sup>
A-495 × A427-2	158.06 <sup>J</sup>	11.167 <sup>FGHI</sup>	1.86 <sup>AB</sup>	479.76 <sup>ABCD</sup>	13.057 <sup>HJKL</sup>	3.476 <sup>CD</sup>	84.00 <sup>K</sup>	35.267 <sup>F</sup>	12.833 <sup>HJ</sup>
A-495 × A50-2	167.72 <sup>DEF</sup>	11.477 <sup>EF</sup>	1 <sup>D</sup>	454.47 <sup>BCDEF</sup>	14.390 <sup>DEFG</sup>	2.586 <sup>E</sup>	126.92 <sup>GH</sup>	40.067 <sup>E</sup>	17.500 <sup>B</sup>
A-495 × A-239	166.13 <sup>FG</sup>	12.609 <sup>ABCD</sup>	1 <sup>D</sup>	447.62 <sup>BCDEF</sup>	15.723 <sup>BC</sup>	4.266 <sup>B</sup>	138.09 <sup>DEF</sup>	45.920 <sup>C</sup>	15.500 <sup>DEF</sup>
A-509 × A427-2	169.71 <sup>C</sup>	12.406 <sup>ABCDE</sup>	1.666 <sup>BC</sup>	417.06 <sup>EF</sup>	15.723 <sup>BC</sup>	4.396 <sup>AB</sup>	155.45 <sup>BC</sup>	38.933 <sup>E</sup>	16.933 <sup>BC</sup>
A-509 × A50-2	171.79 <sup>B</sup>	10.979 <sup>HJ</sup>	1 <sup>D</sup>	414.97 <sup>EF</sup>	11.500 <sup>N</sup>	3.630 <sup>C</sup>	192.42 <sup>A</sup>	54.533 <sup>A</sup>	17.467 <sup>B</sup>
A-509 × A-239	132.99 <sup>P</sup>	11.948 <sup>ABCDH</sup>	1 <sup>D</sup>	451.34 <sup>BCDEF</sup>	13.390 <sup>GHIJ</sup>	3.533 <sup>CD</sup>	119.66 <sup>HI</sup>	50.777 <sup>B</sup>	14.667 <sup>FG</sup>
W-64SP × A427-2	155.05 <sup>L</sup>	12.832 <sup>A</sup>	1 <sup>D</sup>	444.41 <sup>CDEF</sup>	12.453 <sup>JKLMNI</sup>	4.553 <sup>AB</sup>	163.27 <sup>B</sup>	40.423 <sup>E</sup>	17.333 <sup>B</sup>
W-64SP × A50-2	165.72 <sup>G</sup>	11.720 <sup>CDEF</sup>	1.663 <sup>ABC</sup>	414.69 <sup>EF</sup>	14.757 <sup>BCDE</sup>	3.496 <sup>CD</sup>	133.06 <sup>EF</sup>	35.333 <sup>F</sup>	19.000 <sup>A</sup>
W-64SP × A-239	157.50 <sup>JK</sup>	12.682 <sup>ABC</sup>	1.0000 <sup>D</sup>	527.82 <sup>A</sup>	14.723 <sup>CDEF</sup>	4.580 <sup>AB</sup>	74.76 <sup>KL</sup>	29 <sup>J</sup>	13.333 <sup>GHI</sup>
W-10 × A427-2	165.17 <sup>GH</sup>	11.812 <sup>BCDEF</sup>	1.0000 <sup>D</sup>	394.55 <sup>GHI</sup>	12.500 <sup>JKLMN</sup>	3.586 <sup>C</sup>	146.66 <sup>CD</sup>	24.800 <sup>L</sup>	12.333 <sup>HJ</sup>
W-10 × A50-2	163.91 <sup>H</sup>	10.609 <sup>J</sup>	1.0000 <sup>D</sup>	498.18 <sup>ABC</sup>	14 <sup>EF</sup>	2.693 <sup>E</sup>	163.32 <sup>B</sup>	23.700 <sup>L</sup>	15.887 <sup>CDEF</sup>
W-10 × A-239	165.83 <sup>G</sup>	11.611 <sup>BEFGH</sup>	1.887 <sup>AB</sup>	434.53 <sup>DEFGH</sup>	12.667 <sup>JKLM</sup>	2.630 <sup>E</sup>	103.60 <sup>J</sup>	39 <sup>E</sup>	16.167 <sup>BCDE</sup>
A-545 × A427-2	170.06 <sup>A</sup>	12.609 <sup>ABCD</sup>	1.0000 <sup>D</sup>	454.59 <sup>BCDEF</sup>	11.833 <sup>MN</sup>	4.390 <sup>AB</sup>	112.63 <sup>U</sup>	33.743 <sup>FGH</sup>	16.333 <sup>BCDE</sup>
A-545 × A50-2	168.05 <sup>cde</sup>	11.012 <sup>GHIJ</sup>	1.886 <sup>AB</sup>	388.28 <sup>HI</sup>	12.167 <sup>JKLMN</sup>	4.680 <sup>A</sup>	146.53 <sup>CD</sup>	31.700 <sup>HJ</sup>	15.333 <sup>EF</sup>
A-545 × A-239	154.28 <sup>L</sup>	12.609 <sup>ABCD</sup>	1.0000 <sup>D</sup>	502.67 <sup>AB</sup>	13.667 <sup>FGHI</sup>	3.200 <sup>D</sup>	70.23 <sup>L</sup>	40.457 <sup>E</sup>	15.300 <sup>EF</sup>

and genetic advance for leaf area was reported for normal irrigation while environmental variance (1222.795%), genotypic variance (2285.011%) and phenotypic variance (3507.805%).

genotypic coefficient of variance (505.422%) and phenotypic coefficient of variance (775.892%). In case of drought condition table 4.2.4 indicated that high heritability (70%) and genetic advance (136.093%) for leaf area under drought condition.

**Grain rows per cob:** It was found from table 5 that higher heritability (87.1%) and genetic advance (36.987%) was reported for grain rows per cob while genotypic coefficient of variance (20.837%) and phenotypic coefficient of variance (23.933%) was observed for grain rows per cob under normal irrigation condition. It was observed from table 6 that higher heritability (63%) and genetic advance (32%) was reported for plant height while genotypic coefficient of variance (18.13%) and phenotypic coefficient of variance (21.96%) was observed for Grain rows per cob drought condition.

**Cob girth (cm<sup>2</sup>):** It was persuaded from table 5 that higher heritability (93.2%) and genetic advance (29.479%) was reported for cob girth under normal irrigation condition which indicated that genes were controlled by additive gene effects. It was also reported that high difference for genotypic coefficient of variance (16.608%) and phenotypic coefficient of variance (17.825%). It was persuaded from table 4.2.4 that moderate heritability (65.9%) and low genetic advance (20%). was reported that indicated the dominance gene of action.

**Grain yield per plant (g):** Table 5 showed the high heritability (97.5%) and genetic advance (169.662) for cobs per plant may be controlled by as dominance effect well as additive gene effect of genes. It was reported from table 5 that genotypic coefficient of variance (955%) and phenotypic coefficient of variance (980.045%) for number of grain yield per plant under normal condition under drought condition. Table 6 indicated that moderate heritability (69%) and high genetic advance (128.767%) was observed that

indicated dominance and additive effect of gene was present.

**100-grain weight (g):** It was reported from table 5 that higher heritability (98.1%) and genetic advance (413.459%) was observed for 100-grain weight while genotypic coefficient of variance (232.935%) and phenotypic coefficient of variance (237.423%) was observed for 100-grain weight under normal irrigation

condition. Under drought condition, it was observed from table 4.2.4 that higher heritability (67%) and genetic advance (209.35%) was reported for plant height while genotypic coefficient of variance (219.35%) and phenotypic coefficient of variance (225.10%) was observed for 100-grain weight drought condition.

**Table 4 Mean and statistical significance of yield related traits of maize under Drought condition**

Genotypes	Plant Height	Leaves per plant	cobs/plant	Leaf area	Grain rows per cob	Cob Girth	Grain yield per plant	100-grain weight	Cob length
A-495	147.68 <sup>M</sup>	12.500 <sup>ABCDEF</sup>	1.333 <sup>CD</sup>	463.11 <sup>BCDEF</sup>	12.50JKL	3.453 <sup>CD</sup>	155.03 <sup>C</sup>	56.033 <sup>A</sup>	12.600 <sup>J</sup>
A-509	163.45 <sup>L</sup>	11.000 <sup>J</sup>	1.000 <sup>D</sup>	358.64 <sup>L</sup>	14.51DEF	4.453 <sup>AB</sup>	128.88 <sup>GH</sup>	52.277 <sup>B</sup>	12.150 <sup>J</sup>
W-64SP	168.00 <sup>FG</sup>	12.945 <sup>ABCDE</sup>	1.553 <sup>BC</sup>	532.82 <sup>A</sup>	13.66FGHI	4.446 <sup>AB</sup>	133.90 <sup>FG</sup>	47.420 <sup>C</sup>	16.333 <sup>CDEF</sup>
W-10	159.56 <sup>J</sup>	11.667 <sup>FGHI</sup>	1.886 <sup>AB</sup>	484.76 <sup>ABCD</sup>	13.55FGHIJ	3.526 <sup>CD</sup>	87.00 <sup>K</sup>	44.933 <sup>D</sup>	13.333 <sup>HIJ</sup>
A-545	169.22 <sup>DEF</sup>	11.977 <sup>EF</sup>	1.000 <sup>D</sup>	459.47 <sup>BCDEF</sup>	14.89CDE	2.636 <sup>E</sup>	129.92 <sup>GH</sup>	42.123 <sup>E</sup>	18.000 <sup>B</sup>
A427-2	167.63 <sup>FG</sup>	13.109 <sup>ABCD</sup>	1.000 <sup>D</sup>	452.62 <sup>BCDEF</sup>	16.22B	4.316 <sup>B</sup>	141.09 <sup>DEF</sup>	41.957 <sup>E</sup>	16.000 <sup>DEF</sup>
A50-2	134.49 <sup>P</sup>	12.517 <sup>BCDEF</sup>	1.886 <sup>AB</sup>	413.58 <sup>FGHI</sup>	13.66FGHI	4.343 <sup>B</sup>	166.60 <sup>B</sup>	41.567 <sup>E</sup>	17.480 <sup>BC</sup>
A-239	170.55 <sup>CD</sup>	13.443 <sup>A</sup>	1.110 <sup>D</sup>	414.54 <sup>FGHI</sup>	16.00B	4.630 <sup>AB</sup>	141.07 <sup>DEF</sup>	40.533 <sup>E</sup>	14.000 <sup>GH</sup>
A-495 × A427-2	171.21 <sup>C</sup>	12.906 <sup>ABCDE</sup>	1.666 <sup>ABC</sup>	422.06 <sup>EF</sup>	16.22B	4.446 <sup>AB</sup>	158.45 <sup>BC</sup>	40.433 <sup>E</sup>	17.433 <sup>BC</sup>
A-495 × A50-2	157.33 <sup>KL</sup>	12.448 <sup>ABCDEF</sup>	1.000 <sup>D</sup>	456.34 <sup>BCDEF</sup>	13.89EFGH	3.583 <sup>CD</sup>	122.66 <sup>HI</sup>	36.833 <sup>F</sup>	15.167 <sup>FG</sup>
A-495 × A-239	173.29 <sup>B</sup>	11.479 <sup>HIJ</sup>	1.000 <sup>D</sup>	419.97 <sup>EF</sup>	12.00L	3.680 <sup>C</sup>	195.42 <sup>A</sup>	36.767 <sup>F</sup>	17.967 <sup>B</sup>
A-509 × A427-2	144.20 <sup>N</sup>	13.276 <sup>AB</sup>	2.000 <sup>A</sup>	473.28 <sup>BCDE</sup>	15.95BC	3.790 <sup>C</sup>	130.52 <sup>GH</sup>	35.887 <sup>FG</sup>	16.683 <sup>BCDE</sup>
A-509 × A50-2	155.78 <sup>L</sup>	13.109 <sup>ABCD</sup>	1.000 <sup>D</sup>	507.67 <sup>AB</sup>	14.16DEFG	3.250 <sup>D</sup>	73.23 <sup>L</sup>	35.243 <sup>FGH</sup>	15.800 <sup>EF</sup>
A-509 × A-239	178.56 <sup>A</sup>	13.109 <sup>ABCD</sup>	1.000 <sup>D</sup>	459.59 <sup>BCDEF</sup>	12.33KL	4.440 <sup>AB</sup>	115.63 <sup>J</sup>	35.133 <sup>FGH</sup>	16.833 <sup>BCDE</sup>
W-64SP × A427-2	169.55 <sup>CDE</sup>	11.512 <sup>GHIJ</sup>	1.886 <sup>AB</sup>	393.28 <sup>HI</sup>	12.66IJKL	4.730 <sup>A</sup>	149.53 <sup>CD</sup>	34.277 <sup>GHI</sup>	15.833 <sup>EF</sup>
W-64SP × A50-2	138.44 <sup>O</sup>	12.333 <sup>BCDEF</sup>	1.000 <sup>D</sup>	482.51 <sup>ABCD</sup>	14.44DEF	3.733 <sup>C</sup>	154.40 <sup>C</sup>	33.800 <sup>GHI</sup>	17.233 <sup>BCD</sup>
W-64SP × A-239	167.33 <sup>G</sup>	12.111 <sup>DEFGH</sup>	1.887 <sup>AB</sup>	439.53 <sup>DEFGH</sup>	13.16GHIJK	2.680 <sup>E</sup>	106.60 <sup>J</sup>	33.200 <sup>HIJ</sup>	16.667 <sup>BCDE</sup>
W-10 × A427-2	166.67 <sup>GH</sup>	12.312 <sup>BCDEF</sup>	1.000 <sup>D</sup>	399.55 <sup>GHI</sup>	13.00HIJKL	3.636 <sup>C</sup>	149.66 <sup>CD</sup>	32.280 <sup>J</sup>	12.833 <sup>HIJ</sup>
W-10 × A50-2	165.41 <sup>H</sup>	11.109 <sup>J</sup>	1.000 <sup>D</sup>	503.18 <sup>ABC</sup>	14.50DEF	2.743 <sup>E</sup>	166.32 <sup>B</sup>	31.433 <sup>J</sup>	16.387 <sup>CDEF</sup>
W-10 × A-239	157.44 <sup>KL</sup>	10.553 <sup>J</sup>	1.663 <sup>ABC</sup>	459.87 <sup>BCDEF</sup>	17.50A	4.600 <sup>AB</sup>	144.83 <sup>DE</sup>	31.400 <sup>J</sup>	15.867 <sup>DEF</sup>
A-545 × A427-2	159.00 <sup>JK</sup>	13.182 <sup>ABC</sup>	1.000 <sup>D</sup>	449.41 <sup>CDEF</sup>	15.22BCD	4.630 <sup>AB</sup>	77.76 <sup>KL</sup>	29.123 <sup>K</sup>	13.833 <sup>GHI</sup>
A-545 × A50-2	156.55 <sup>L</sup>	13.332 <sup>A</sup>	1.000 <sup>D</sup>	532.82 <sup>A</sup>	12.95HIJKL	4.603 <sup>AB</sup>	166.27 <sup>B</sup>	26.300 <sup>L</sup>	17.833 <sup>B</sup>
A-545 × A-239	167.22 <sup>G</sup>	12.220 <sup>CDEF</sup>	1.663 <sup>ABC</sup>	419.69 <sup>EF</sup>	15.25BCD	3.546 <sup>CD</sup>	136.06 <sup>EF</sup>	25.200 <sup>L</sup>	19.500 <sup>A</sup>

**Cob length (cm):** It was persuaded from table 5 that higher heritability (88.1%) and genetic advance (59.815%) was observed for cob length. Higher genetic coefficient of variance (33.235%) and phenotypic coefficient of variance (38.235%) while environmental variance (0.721) and genotypic variance (5.359) which showed the higher variation among genotypes for cob length under normal condition (Table 5). In case of drought condition also high heritability (74%) and genetic advance (61%)

was reported that indicated the dominance gene of action and additive gene of action (Table 6).

**Analysis of variance:** Analysis of variance was performed for all seedling and agronomic traits. Significant differences were observed among all genotypes under normal irrigation and drought condition. Mean squares of traits are present in table 7 and 8.

**General Combining ability**

**Table 5 Genetic component for various agronomic traits of maize under normal irrigation condition**

Traits	Plant height	Leaves Per plant	Cobs Per plant	Leaf Area	Grain Rows per Cob	Cob Girth	Grain yield Per Plant	100 grain weight	Cob Length
Grand Mean	161.24	12.354	1.3277	452.10	14.274	3.9087	136.12	37.572	15.903
Environmental variance	1.214	0.368	0.057	1222.795	0.442	0.048	33.68	1.686	0.721
Genotypic variance	188.515	0.831	0.205	2285.011	2.974	0.649	1300.358	87.518	5.359
Phenotypic variance	189.729	1.2	0.262	3507.807	3.416	0.697	1334.038	89.205	6.081
Genotypic coefficient of variance	116.916	6.729	15.462	505.422	20.837	16.608	955.303	232.935	33.699
Phenotypic coefficient of variance	117.669	9.71	19.759	775.892	23.933	17.825	980.045	237.423	38.235
Heritability h <sup>2</sup> (bs)	99.4	69.3	78.3	65.1	87.1	93.2	97.5	98.1	88.1
Genetic advance %	207.525	11.943	27.446	89.7123	36.987	29.479	169.662	413.459	59.815

**Table 6 Genetic component for various agronomic traits of maize under drought condition**

Traits	Plant Height	Leaves per plant	Leaf area	Grain yield per plant	Grain rows per plant	Cobs per plant	Cobs length	Cob girth	100-grain Weight
Grand Mean	159.74	11.854	1.3277	447.10	13.793	3.8587	133.12	36.072	15.403
Environmental variance	4.3	0.5	423.62	296.81	0.55	0.043	0.46	0.116	2.23
Genotypic variance	155.19	0.66	3876.28	1305.47	2.6	0.096	7.17	0.706	85.32
Phenotypic variance	159.5	1.16	4299.9	1602.28	3.15	0.139	7.63	0.822	87.55
Genotypic coefficient of variance	108.83	5.32	823.06	894.46	18.13	8.153	41.77	18.427	219.35
Phenotypic coefficient of variance	111.55	9.31	913.01	1097.83	21.96	11.847	44.44	21.444	225.1
Heritability h <sup>2</sup> (bs)	84.6	52	70	69	63	56.8	74	65.9	67
Genetic advance %	176.72	9.44	136.093	128.767	32	14	61	20	209.35

**Table 7 Line × tester ANOVA for various agronomic traits of maize under normal irrigation condition**

SOV	D F	Plant height	Leaves per plant	Cobs per plant	Leaf area	Grain rows per cob	Cob girth	Grain yield per plant	100 Grain weight	Cob length
Replication	2	0.969	0.782	0.085	4973.193	5.896	0.001	48.488	3.095	0.013
Genotypes	2/2	378.241	2.031	0.468	5792.818	7.297	1.346	2634.397	176.723	11.44
Parents	7	566.69	3.214	0.464	8424.82	11.917	0.613	540.376	66.371	13.155
Crosses	1/4	133.89	1.581	0.468	4876.615	5.483	1.613	3689.345	221.436	10.422
Parents vs Crosses	1	2479.865	0.041	0.492	195.662	0.364	2.734	2523.269	323.201	13.674
Lines	4	69.785	1.429	0.015	1806.838	4.75	2.326	3050.768	448.561	4.851
Testers	2	221.155	5.775	0.088	2279.254	3.401	1.707	9977.277	164.45	19.382
Lines x Tester	8	144.14	0.609	0.789	7060.843	6.369	1.233	2436.65	122.12	10.968
Error	4/4	1.213	0.368	0.057	1222.789	4.282	0.048	33.68	1.686	0.721
Total	6/8	123.185	0.918	0.191	2811.634	5.305	0.466	875.524	58.357	4.168

**Plant height (cm):** For plant height table 9 showed the best general combining ability for A50-2 (3.318) followed by A545 and A506 with 2.341, 1.657 respectively while A 239 and A509 showed the lowest general combining ability -4.206, -4.659 respectively under normal condition while under drought condition

as shown in table 10 inbred line A50-2 showed the highest general combining ability followed by W-64SP and A509 with obtained value .82, .62 respectively and poorest general combining ability revealed by A239 and A427-2 respectively.



**Leaves per plant:** Regarding to leaves per plant, W64SP and A427-2 showed the good general combining ability with obtained value of 0.4197, 0.2930 respectively while lowest general combining ability (.7128) was recorded for A50-2 (Table 9). It was persuaded from table 10 that leaves per plant showed the best general combining ability for W64SP (0.539) followed by A-239 and A427-2 with 0.420, .2931 respectively while A50-2 and AW-10 showed the lowest general combining ability -.713, -.539 respectively under drought condition (Table 10).

**Cobs per plant:** Genotype A495 (Table 9) with a value of (0.887) showed the best general combining ability for cobs per plant while A-239 showed the lowest value for general combining ability under normal condition. In table 10 inbred lines A427-2 and A50-2 exhibited the high general combining ability for cobs per plant while A239 with value of -0.089 showed the poor general combining ability under drought condition.

**Table 8 Line × tester ANOVA for various agronomic traits of maize under drought condition**

SOV	D F	Plant height	Leaves per plant	Cobs per plant	Leaf area	Grain rows per cob	Cob	Grain yield per plant	100 Grain weight	Cob length
Replication	2	0.869	0.682	1.782	4873.193	0.316	0.001	48.488	3.095	0.0134
Genotypes	2/2	328.241	2	1.031	4792.818	6.473	1.346	2634.397	176.723	11.4396
Parents	7	516.694	3.214	3.114	7424.82	7.952	0.613	540.376	66.371	13.1549
Crosses	1/4	113.898	1.081	1.431	4776.615	5.483	1.613	3689.345	221.436	10.4223
Parents vs Crosses	1	2239.865	0.141	0.121	185.662	9.976	2.734	2523.269	323.201	13.6738
Lines	4	59.785	1.329	1.329	1706.838	4.75	2.326	3050.768	448.561	4.8512
Testers	2	201.155	4.675	4.675	2179.254	3.401	1.707	9977.277	164.45	19.3825
Lines x Tester	8	144.14	0.609	0.609	7160.843	6.369	1.233	2436.65	122.12	10.9679
Error	4/4	1.213	0.368	0.368	1122.789	0.426	0.048	33.68	1.686	0.7214
Total	6/8	123.185	0.918	0.918	2711.634	2.379	0.466	875.524	58.357	4.1682

**Leaf area (cm<sup>2</sup>):** The range of combining ability - 20.538 to 12.286 reported from table 9 for leaf area under normal irrigation. The maximum value of general combining ability among parents was reported for A495 with securing the value of 12.286 while low general combining ability was observed for A509 followed by A509 and A50-2 with values of -20.538 and -14.212 respectively under normal irrigation. A495 showed the best general combiner for leaf area. In case of drought condition, it was observed a range -20.212 to 15.286 of general combiner for leaf area under drought condition (table 10).

**Cob girth (cm<sup>2</sup>):** With regards to cob girth, table 9 indicated the range for general combining for cob girth maximum 0.497 to minimum -0.743. It was suggested that W64SP was best combiner and have high value of general combining (0.497) while W10 (-0.74) showed the poorest value of general combining ability under drought condition. Selection on the basis of cob girth may helpful to developed high yielding genotypes under normal irrigation. While under drought condition it was reported that A427-2 was a best general combiner with a value of

(0.467) and W10 was a poor general combiner under drought condition (table 10).

**Grain rows per cob:** It was concluded from table 9 that grain rows per cob indicate that A495 was best general combiner and have high value of general combining (0.887) while A-545 (-0.940) showed the poorest value of general combining ability under condition. While in case of grain rows per cob (table 4.2.9) under drought condition inbred line A495 proved to be the best general combiner with value of 0.887 followed by the inbred line A239 had value of 0.531 (Table 10).

**100-grain weight (g):** The greatest effect of general combining effect was reported for 100-grain weight for A509 with the value of 10.429 which showed A509 was a best general combiner while W10 exhibited the poor general combining ability with the value of -8.475 under normal condition as shown in table 9 good value of general combining ability showed additive effect of genes. It was persuaded that a range 10.765 to -8.475 for 100-grain weight was reported under drought condition as showed in table 10.

**Cob length (cm):** For cob length (table 9 and table 10) it was shown that the best general combining ability was found for A50-2 (1.309) followed by W64SP and A509 with 0.828, 0.628 respectively, while W10 and A239 showed the lowest general combining ability -0.932 to 0.735 respectively under normal and drought condition respectively.

**Grain yield per plant (g):** The range of combining ability 27.138 to -27.438 reported from table 9 for grain yield per plant under normal irrigation. The maximum value of general combining ability among parents was reported for A509 with securing the value of 27.138 while low general combining ability was observed for A239 followed by A545 and A495 with values of -18.908 and -12.370 respectively under normal irrigation (Table 9). A509 showed the best general combiner for grain yield per plant. In case of drought condition it was observed a range -28.744 to -23.908 of general combiner for grain yield per plant under drought condition (Table 10).

#### Specific Combining ability

**Plant height (cm):** Specific combining ability among crosses was recorded as table 11 showed. It was observed that highly significant specific combining ability was obtained for a cross A545×A427-2 along with value 9.706 and poorest specific combining ability for plant height along with value -7.980 While under drought condition sing cross W10×A239, as table 12 revealed that high value of specific combining ability (2.106) was reported for plant height.

**Leaves per plant:** For leaves per plant (table 11) a cross A495×A50-2 exhibited the highly and significant specific combining ability (0.4387) which show the dominance effect of genes while single cross A-495×A427-2 showed the significant but negative value (-0.8771) of specific combining ability. Regarding to leaves per plant (tables 12) indicates that single cross A495×A239 showed the highest specific combining ability (0.439) while A495×A427-2 showed the poorest specific combining ability (-0.877) under drought condition.

**Cobs per plant:** Regarding to Cobs per plant (table 11) indicates that single cross W-10×A-239 showed the highest specific combining ability while A-545×A427-2 showed the poorest specific combining ability under normal condition while (table 12) indicates that high value for specific combining ability (0.547) of a sing cross A-545×A50-2 was recorded while poorest value of combining ability (-0.340) of W10×A50-2 and A495 × A50-2 was observed under drought condition.

**Leaf area (cm<sup>2</sup>):** With respect to leaf area, highest value of specific combining ability (69.972) was recorded for a single cross W10×A50-2 followed by A545×A239 with a value of 46.370. Highest negative effect was observed by a cross A545×A50-2 with negative value of -46.022 under normal condition as shown in table 11. Specific combining ability by a single cross W10×A50-2 scoring the value of 69.972 followed by cross W64SP×A427-2 and A545×A239

**Table 9 General combining ability for various agronomic traits of maize under normal condition**

Parents	Plant height	Leaves per plant	Cobs per plant	Leaf area	Grain rows per cob	Cob girth	Grain yield per plant	100 Grain weight	Cob length
A-495	-0.151	-0.1213	0.03	12.286	0.887	-0.27	-12.37	2.765	-0.45
A-509	1.657	-0.0946	-0.044	-20.538	0.034	0.14	27.138	10.429	0.628
W-64SP	-4.695	0.5394	-0.045	13.975	0.474	0.497	-5.013	-2.367	0.828
W-10	0.848	-0.528	0.03	-5.909	-0.448	-0.743	9.153	-8.475	-0.932
A-545	2.341	0.2046	0.03	0.186	-0.948	0.377	-18.908	-2.352	-0.072
A427-2	0.888	0.293	0.045	6.427	-0.39	0.367	3.694	-2.979	-0.575
A50-2	3.318	-0.7128	0.044	-14.212	-0.141	-0.296	23.744	-0.586	1.309
A-239	-4.206	0.4197	-0.089	7.785	0.531	-0.071	-27.438	3.565	-0.735

**Table 10 General combining ability for various agronomic traits of maize under drought condition**

Parents	Plant height	Leaves per plant	Cobs per plant	Leaf area	Grain rows per cob	Cob girth	Grain yield per plant	100 Grain weight	Cob length
A-495	-0.45	-0.121	0.03	15.286	0.887	-0.27	-12.37	10.765	-0.45
A-509	0.628	-0.095	-0.044	-14.538	0.034	0.14	22.138	2.429	0.628
W-64SP	0.828	0.539	-0.045	13.975	0.474	0.397	-5.013	-2.367	0.828
W-10	-0.932	-0.528	0.03	-5.909	-0.448	-0.743	9.153	-8.475	-0.932
A-545	-0.072	0.205	0.03	0.186	-0.948	0.377	-23.908	-3.352	-0.072
A427-2	-0.575	0.293	0.045	6.427	-0.39	0.467	3.694	-1.979	-0.575
A50-2	1.309	-0.713	0.044	-20.212	-0.141	-0.296	28.744	-0.586	1.309
A-239	-0.735	0.42	-0.089	4.785	0.531	-0.071	-22.438	3.565	-0.735

scoring the value 59.087 and 46.370 respectively, under drought condition (table 12).

**Grain rows per cob:** Grain rows per cob as revealed from table 11 a single cross W64SP×A50-2 showed the highest value of specific combining ability (0.920) while W10×A239 showed the highly negative and non-significant effect for specific combining ability under normal condition. While under drought condition, a single cross A509 × A427-2 showed the maximum specific combining ability 2.576 and A-509 ×A50-2 give the poorest specific combining ability -1.897 (table 12).

**Cob girth (cm<sup>2</sup>):** With regards to cob girth, high value for specific combining ability (2.106) of a single cross W10×A239 was recorded while poorest value of combining ability (-2.488) of W-64SP×A-239 was observed under normal condition (Table 11). Under drought condition cob girth (table 4.2.10) single cross A495 ×A239 scored the maximum value 0.895 of specific combining ability while A545×A239 show the poor specific combining ability -0.819.

**100-grain weight (g):** 100 grain weight (table 11) single cross W64SP×A427-2 exhibited the higher specific combining ability (8.317) which show the dominance effect of genes while single cross W64SP×A-239 showed the significant but negative value (-8.950) of specific combining ability. It was observed that a single cross W10×A239 showed the maximum specific combining ability 6.291 while A509×A427-2 showed the negative but significant value -6.169 under drought condition (table 12).

**Cob length (cm):** For cob length highest specific combining ability was exploited by a cross W10×A239 with scoring value of 2.106 while poor specific combining ability showed by A495 × A427-2 with the value of -1.870 under normal and drought condition (Table 11 and table 12). Table 10 showed the high specific combining ability (2.106) of a single cross W10×A-239 while W64SP×A-239 indicated the poor performance.

**Grain yield per plant (g):** Grain yield per plant (table 11) single cross A495×A239 exhibited the high and specific combining ability (49.194) show the dominance effect of genes while single cross A495×A427-2 showed negative value (-36.032) of specific combining ability under normal condition. Specific combining ability was recorded as table 4.10 observed that higher specific combining ability was obtained for single cross A495×A239 with 49.194 followed by W64SP×A427-2 with value 35.878 and poor specific combining ability for A495 × A427-2 with value -36.032 (table 12).

### Discussions

Fakorede and Ayoola (1981) reported that a strong genetic relationship lies between selection of higher yielding maize genotypes and seedling vigour

of maize. It was concluded that germination percentage, total dry matter, germination index, relative growth rate and growth rate as criteria for selection of seedling vigour after 30-days of germination. Eagles (1982) reported that the elite lines endosperm and embryo were of great importance as compared to the female parents in determining the differences of germination period and relative growth of maize seedlings (Nass *et al.*, 2000 and Khidse *et al.* (1983) reported from an experiment that the non-additive genetic effects contributing for grain size and seedling vigour traits of sorghum, *viz.*, seedling volume, plumule length, radicle length and root/shoot fresh and dry weights of maize seedlings. Pozzi *et al.* (1985) concluded that the accumulation of dry matter greatly varied among seedlings in maize genotypes. Seedling dry and fresh weights were useful traits for the selection of cold tolerance genotypes of maize. Higher shoot length depicted that higher biomass of the crop may be produced due to more water contents and inbred line with higher shoot length may be selected for fodder breeding as well as for quantitative traits. Similar result was reported by Mehdi *et al.*, (2001). Smith and Smith (1989) reported that heterosis can be used for maintenance of germplasm and pedigree similarities among maize hybrids. High value for grain rows per cob was observed of among parent genotypes A427-2 (16.22) while lowest for grain rows per cob was recorded for A495 (12.50) and among the cross combination W10×A239 (17.50) while lowest was recorded for A495×A239 (12.00) under drought condition. Hebert (1990) reported from an experiment that specific combining ability played an important role in genetic variation among F<sub>1</sub> hybrid and inbred lines of maize genotypes. Ajala (1992) concluded from an experiment on maize that seedling vigour, early maturity, higher standability and higher yielding traits related to grain yield can be used to select higher yielding maize genotypes. Juvik *et al.* (1993) reported from an experiment that simple mass selection can improve the grain yield and field emergence in maize. It was concluded that the grain yield and quality can be improved by simple selection. High value for grain rows per cob was observed of among parent genotypes A427-2 (16.22) while lowest for grain rows per cob was recorded for A495 (12.50) and among the cross combination W10×A239 (17.50) while lowest was recorded for A495×A239 (12.00) under drought condition. Higher grain rows per cob indicated that selection of higher grain yielding maize genotypes may be useful to improve maize yield and production. Similar results were reported by Ivankhenko and Klimo (1991).

**Table 11 Specific combining ability for various agronomic traits of maize under normal condition**

Crosses	Plant height	Leaves per plant	Cobs per plant	Leaf area	Grain rows per cob	Cob girth	Grain yield per plant	100 Grain weight	Cob length
A-495 × A427-2	-6.801	-0.8771	0.546	12.719	-0.943	-0.334	-36.032	-2.172	-1.87
A-495 × A50-2	0.436	0.4387	-0.34	8.063	0.141	-0.561	-13.162	0.235	0.913
A-495 × A-239	6.365	0.4384	-0.207	-20.782	0.803	0.895	49.194	1.937	0.957
A-509 × A427-2	3.046	0.3351	0.4	-17.16	2.576	0.176	-4.086	-6.169	1.152
A-509 × A50-2	2.692	-0.0858	-0.266	1.394	-1.897	0.073	12.834	7.038	-0.198
A-509 × A-239	-5.737	-0.2492	-0.134	15.765	-0.678	-0.249	-8.747	-0.869	-0.954
W-64SP × A427-2	-5.259	0.1277	-0.266	59.087	-1.134	-0.024	35.878	8.317	1.352
W-64SP × A50-2	2.979	0.0213	0.398	-33.407	0.92	-0.417	-14.379	0.634	1.135
W-64SP × A-239	2.28	-0.149	-0.132	-25.68	0.215	0.441	-21.499	-8.95	-2.488
W-10 × A427-2	-0.691	0.1751	-0.34	-54.299	-0.166	0.249	5.101	-1.399	-1.888
W-10 × A50-2	-4.38	-0.0224	-0.34	69.972	1.085	0.019	1.718	-4.892	-0.218
W-10 × A-239	5.071	-0.1527	0.68	-15.673	-0.92	-0.269	-6.819	6.291	2.106
A-545 × A427-2	9.706	0.2392	-0.34	-0.347	-0.332	-0.067	-0.861	1.422	1.252
A-545 × A50-2	-1.726	-0.3517	0.547	-46.022	-0.248	0.886	12.989	-3.014	-1.632

**Table 12 Specific combining ability for various agronomic traits of maize under drought condition**

Crosses	Plant height	Leaves per plant	Cobs per plant	Leaf area	Grain rows per cob	Cob Girth	Grain yield per plant	100 Grain weight	Cob length
A-495 × A427-2	-1.870	-0.877	0.546	12.719	-0.943	-0.334	-36.032	-2.172	-1.870
A-495 × A50-2	0.913	0.439	-0.340	8.063	0.141	-0.561	-13.162	0.235	0.913
A-495 × A-239	0.957	0.438	-0.207	-20.782	0.803	0.895	49.194	1.937	0.957
A-509 × A427-2	1.152	0.335	0.400	-17.160	2.576	0.176	-4.086	-6.169	1.152
A-509 × A50-2	-0.198	-0.086	-0.266	1.394	-1.897	0.073	12.834	7.038	-0.198
A-509 × A-239	-0.954	-0.249	-0.134	15.765	-0.678	-0.249	-8.747	-0.869	-0.954
W-64SP × A427-2	1.352	0.128	-0.266	59.087	-1.134	-0.024	35.878	8.317	1.352
W-64SP × A50-2	1.135	0.021	0.398	-33.407	0.920	-0.417	-14.379	0.634	1.135
W-64SP × A-239	-2.488	-0.149	-0.132	-25.680	0.215	0.441	-21.499	-8.950	-2.488
W-10 × A427-2	-1.888	0.175	-0.340	-54.299	-0.166	0.249	5.101	-1.399	-1.888
W-10 × A50-2	-0.218	-0.022	-0.340	69.972	1.085	0.019	1.718	-4.892	-0.218
W-10 × A-239	2.106	-0.153	0.680	-15.673	-0.920	-0.269	-6.819	6.291	2.106
A-545 × A427-2	1.252	0.239	-0.340	-0.347	-0.332	-0.067	-0.861	1.422	1.252
A-545 × A50-2	-1.632	-0.352	0.547	-46.022	-0.248	0.886	12.989	-3.014	-1.632
A-545 × A-239	0.379	0.112	-0.207	46.370	0.580	-0.819	-12.128	1.592	0.379

Singh *et al.* (1998) concluded from an experiment that moderate estimates of heritability and genetic advance; positive and significant genotypic correlation was found for grain yield per plant with plant height, cob length, grains per cob, 100-seed weight and number of cobs per plant. Similar findings were reported by Ali *et al.*, (2011a); Ali *et al.*, (2013) and Ali *et al.*, (2014). Pandey *et al.* (2000) concluded that increasing the moisture stress was major cause of decrease in crop growth rate, leaf area, shoot dry matter, plant height and harvesting index. Nigussie and Zelleke (2001) concluded that specific combining ability effects were significant for plant height, days taken to tasseling, days taken to silking and grain yield per plant. The mid parent heterosis showed a range of -11.6-21.9% for grain yield per plant. Similar findings were reported by Ali *et al.*, (2013), Ali *et al.*, (2014) and Ahsan *et al.* (2010). It was suggested that increased fresh shoot length, fresh root weight and decreased stomata frequency and epidermal cell size may be useful criteria for selection under drought conditions. Ali *et al.* (2011a) conducted an experiment on 40 maize genotypes at seedling stage and concluded that root length, root dry weight, leaf temperature, root density and shoot dry weight were significantly correlated with each other at genotypic and phenotypic levels and hence may be used as selection criteria for higher yielding maize genotypes. Ali *et al.* (2011b) estimated genetic variability and association among different seedling traits of 40 maize genotypes. It was concluded that selection may be made on the basis of shoot length and shoot weight. Similar results were reported by Nevado and Cross (1990); Ajala (1992) and Elhosary *et al.*, (1994).

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