*Egypt. J. Agron.* **Vol. 46**, No. 1, pp. 13 - 27 (2024)

**Egyptian Journal of Agronomy**
**http://agro.journals.ekb.eg/**

# Evaluation of Some Wheat Genotypes Under Normal and Water Deficit Conditions in North Delta

**Mohamed S. Abd El – Aty [1#]; Khaled M. Gad[2]; Mohamed A. M. Eid[3,] Marwa M. El-Nahas[4] and Mostafa O. Shehata[1]**

[1]*Department of Agronomy, Faculty of Agriculture, Kafrel-sheikh University, Kafr El-Shaikh 33516, Egypt.*
[2]*Wheat Research Dep., Field Crops Research Institute, ARC.*
[3]*Agronomy Department, Faculty of Agriculture, FayoumUniversity, Fayoum 63514.*
[4] *Crop Science Department, Faculty of Agriculture, Menoufia University, Egypt.*

Water shortage causes reduction for all the estimated morphological and productivity traits for wheat crop. So, seven bread wheat genotypes consists of three promising lines (115, 117 and 136) and four commercial cultivars (Sakha 95, Sids 14, Gemmiza 11 and Miser 2), which differ considerably in their characters were used as parents with their crosses at the Experimental Farm, Faculty of Agriculture, Kafrelsheikh University, Egypt, during the two successive seasons 2020 /2021 and 2021/2022.The objective was to estimate combining ability and nature of gene action under normal and drought conditions. The results indicated that water deficit decreased the means of all the studied traits for parents and their crosses. The GCA variance was higher than the SCA for all the studied traits under both conditions, except spike length and no. of kernel / spike under both conditions as well as 1000 kernel weight under normal condition, indicating that additive gene effects were more important than non-additive in the expression of the investigated traits. The parents Misr2 and line 136 showed the best desirable GCA effects for earliness, whereas the parents Sakha95 and Line 115 was the best general combiners for grain yield/plant and most of its components under both normal and drought conditions. The two crosses Gemmiza 11× Line 117 and Line 117 ×Line 136 were identified as promising specific combiners for earliness, while the cross Misr 2 × Line 136 for improving yielding ability under both conditions. Both additive and dominance genetic components are important in the inheritance of the studied traits. However, the values of (D) were higher than (H1) for all the studied traits, except flag leaf area under drought and Chlorophyll content (SPAD) under both conditions, revealing that the additive gene effects played the major role in the inheritance of these traits.

**Keywords:** Wheat, Water deficit, Combining ability, Types of geneaction.

## Introduction

Wheat is considered as one of the most strategic food in Egypt and overall the world. The total national wheat production reached about 9.65 million tons, which represents about 50% of the amount sufficient for local needs (E A S 2022). The local consumption of wheat is increasing each year due to the continuous increase of population. Therefore, increasing the productivity of this crop is the main goal of wheat breeders to decrease the gap between national production and consumption. Water deficit is one of the main limiting factors of cereal production that emerged in many parts of the world, including Egypt. Water scarcity is a significant environmental stress that has negative effects on wheat growth and

*Corresponding author mail: mohamed.abdelatty@agr.kfs.edu.eg
Received 28 /11 /2023; Accepted 21/ 4 / 2024
DOI: 10.21608/agro.2024.251106.1397

production AbdEl-Kreem etal., 2019, Darwish etal., 2020 and Abd El –Aty et al (2023).

Thus, there is an actual need to increase its productivity and, there is an urgent need to increase drought tolerance of the wheat cultivars to increase their production, especially in the new land. Knowledge and understanding the type of gene action controlling the inheritance of different traits is important to design an effective breeding program for developing drought tolerance cultivars. Statistical analysis of diallel crosses and genetic interpretations of such analysis have been the subjects of many research papers since about 1954 (Hayman 1954 and Griffing1956). Many results were detected by several authors with respect to genetic systems controlling grain yield and its components. Katta et al (2013) and Gomaa et al (2014) found that the additive genetic effects play amajor role in the inheritance of grain yield and most of the traits under normal and water stress conditions. On the contrary, Mohamed et al (2014) and El Hawary (2015) reported that the non- additive gene effects were more important in the inheritance of grain yield and most of its components under water stress conditions. Meanwhile, Abd El –Aty etal (2016) and Elgammaal et al (2023) found that the importance of additive and non- additive genetic variances in determining the performance of all studied characters. The objectives of the present study were to: (1) evaluate some promising and some Egyptian cultivars and their F1 crosses under normal and water deficit conditions. (2) Identify the superior or general combiners and best cross combinations. (3) Estimate combining ability, type of gene action and heritability of the studied traits.

## Materials and Methods

The present study was carried out at the Experimental Farm, Faculty of agriculture, Kafrelsheikh University, Egypt, during the 2020 /2021 and 2021/2022 successive winter growing seasons. Seven bread wheat (Tritium aestivum L.) genotypes which differed considerably in their characters were used as parents in this study. The name, pedigree and Characterization of the used genotypes are presented in Table 1.

During 2020 /2021 season, the parental genotypes were sown and all possible diallel crosses (excluding reciprocals) were made among the seven genotypes to obtain seeds of 21 F1 crosses. 2021 /2022

**TABLE 1. The name, pedigree and Characterization of the seven bread wheat genotypes used in the present study.**

| Parent | Name | Pedigree | Characterization |
|---|---|---|---|
| P1 | Sids 14 | Bow"S"Vee"S"//Bow"S"/TSI/BaniSewef 1SD293- 1SD-2SD-4SD-OSD. | Moderate tolerant |
| P2 | Sakha 95 | PASTOR//Site/MO/3/CHEN/AEGILOPSSQUARrOSA (TAUS)// BCN/4/WbLL.CMSA01Y00158S-040P0Y-040M-030ZTM-040SY-26M0Y0SY-0S. | Drought tolerant |
| P3 | Gemmiza11 | BOW"S"/KVZ"S"//7C/SER182/3/GIZA168/SAKHA61 | Susceptible |
| P4 | Misr 2 | SKAUZ/BAV92. CMSS96M03611S-1M-010SY-010M-010SY-8M-0Y-0S | Drought tolerant |
| P5 | Line115 | CIMMYT/C. 2008/29ESWYT/OCC. 549/Plot134/ Rep1/Block 7/Entry 134 | Moderate tolerant |
| P6 | Lime117 | CIMMYT/C. 2008/29ESWYT/OCC. 549/Plot141/ Rep1/Block 9/Entry 142 | Drought tolerant |
| P7 | Line136 | CIMMYT/C. 2008/ 29ESWYT/OCC.549/Plot136/Rep1/Block 8/Entry 136 | Drought tolerant |

**TABLE 2. Climatic data of the cultivated site in 2020/2021 and 2021/2022 winter seasons.**

| Month | AT °C 2020/2021 | | AT °C 2021/2022 | | RH % | | Rainfall (mm) | |
|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Max. | Min. | 2020/21 | 2021/22 | 2020/21 | 2021/22 |
| **November** | 28.4 | 25.1 | 16.7 | 15.7 | 62.5 | 65.8 | 3.2 | 0.0 |
| **December** | 22.8 | 20.1 | 12.0 | 11.5 | 67.7 | 70.5 | 0.0 | 2.8 |
| **January** | 21.6 | 17.0 | 10.4 | 7.40 | 68.1 | 72.7 | 0.0 | 2.2 |
| **February** | 21.8 | 20.1 | 10.0 | 8.70 | 68.4 | 63.4 | 0.0 | 0.2 |
| **March** | 22.3 | 20.7 | 10.7 | 9.00 | 67.1 | 60.3 | 0.0 | 0.4 |
| **April** | 31.0 | 28.2 | 13.7 | 12.0 | 60.3 | 51.9 | 0.0 | 0.0 |
| **May** | 35.8 | 33.0 | 17.9 | 17.0 | 50.0 | 52.5 | 0.0 | 0.2 |

**TABLE 3. Physical and chemical analyses of soil at the experimental sites in 2020/2021 and 2021/2022 seasons.**

| Soil Properties | 2020/2021 | 2021/2022 |
|---|---|---|
| **Mechanical analysis** | | |
| Sand | 17.1 | 16.2 |
| Silt | 37.0 | 36.3 |
| Clay | 45.9 | 47.5 |
| **Chemical analysis** | | |
| PH(1:2.5,soil: water suspension | 8.5 | 8.2 |
| EC (soil past, ds $m^{-1}$) | 2.1 | 2.4 |
| $Na^+$ | 14.4 | 14.8 |
| $K^+$ | 0.3 | 0.5 |
| $Ca^{++}$ | 4.6 | 5.3 |
| $Mg^{++}$ | 2.5 | 2.0 |
| $CO_3^{--}$ | 0.0 | 0.0 |
| $HCO_3^-$ | 5.5 | 3.8 |
| $CL^-$ | 10.1 | 15.0 |
| $SO_4^{--}$ | 6.2 | 3.8 |
| CaCo3% | 2.7 | 2.3 |
| OM% | 1.5 | 1.3 |

Soil Electrical Conductivity (EC) and soluble ions were determined in sutured soil before extract season. During 2021/2022, the 28 genotypes (seven parents and 21 F1 crosses) were evaluated under two separate irrigation experiments. The first experiment (normal irrigation) was irrigated four times after sowing irrigation (five irrigations were given through the whole season). While, the second experiment (water stress condition) was irrigated only one time after sowing irrigation (two irrigations were given through the whole season) on November 20th during the two successive seasons. The two experiments were designed in a randomized complete block design with three replications. Each parent and F1 was represented by one row per replicate. The plot size was one row, 3.0 m long and spaces between rows were 30 cm with 15 cm between plants. Seeds were sown by hand. Other agricultural wheat practices were applied at the proper time.

The meteorological data of the experimental site was collected from Sakha meteorological station in 2020/2021 and 2021/2022 growing season and presented in Table 2.The studied characters were; leaf area index, chlorophyll content days to 50%heading(day), plant height (cm), spike length (cm), no. of kernels/spike, 1000-kerneles weight (g) and grain yield/plant (g). Data were measured on ten guarded plants per plot.

*Statistical and genetical Analysis.*

Collected data were subjected to the proper of statistical analysis of variance (ANOVA) of a randomized complete block design with three replications as mentioned by Snedecor and Cochran (1989). Combining ability analysis was performed according to Griffing's (1956) method 2 model 1. Hayman's approach (1954a and b) was used to estimate genetic components and ratios. The conclusions obtained from Hayman's analyses will not be generalized, but will help us to characterize our genetic material for its proper use in the future breeding programs.

## Results and Discussion

*Analysis of variance*

Analysis of variance (Table 4) showed that the mean squares due to genotypes, parents, crosses and parentsvs.crosses were highly significant for all the studied traits with some exception under normal and drought conditions.Semahegn et al (2021) reported that there was a significant genetic variation for all agronomic traits studied under both drought-stressed and non-stressed conditions.

The parent's vs. crosses mean squares for Leaf area index under normal irrigation, also no. of days to heading, plant height and grain yield/ plant under normal and water stress conditions were significant, In this respect, Abd El- Aty et al (2016), Abd El- Aty et al (2023) and El-gammal et al (2023) obtained significant mean square for genotypes of all the studied traits under normal and water stress conditions.

**TABLE 4. Analysis of variance for morphological traits of the parents and their hybrids under normal and drought conditions.**

| S.O.V. | Df | Leaf area index | | Chlorophyll content | | Days to 50% heading ( day ) | | Plant height (cm ) | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | D | N | D | N | D | N | D |
| Reps. | 2 | 0.19 | 0.01 | 0.23 | 0.04 | 2.04 | 8.82 | 1.39 | 0.15 |
| Genotypes (G) | 27 | 17.87** | 13.79** | 38.98** | 5.20* | 38.48** | 41.60** | 59.95** | 79.13** |
| Parents (P) | 6 | 29.65** | 15.05** | 38.38** | 3.94 | 79.75** | 60.65** | 153.71** | 198.16** |
| Crosses (Cr) | 20 | 14.08** | 14.01** | 39.96** | 5.73* | 27.78** | 37.95** | 34.70** | 39.52** |
| P *vs*. Cr | 1 | 22.92** | 1.75 | 22.92* | 2.10 | 4.86** | 0.10 | 2.29 | 157.15** |
| Error | 54 | 2.39 | 4.54 | 4.65 | 2.63 | 2.02 | 3.02 | 5.23 | 8.55 |
| GCA | 6 | 20.51 | 12.02 | 35.75 | 3.59 | 391.65** | 57.06** | 76.62** | 93.40** |
| SCA | 20 | 1.89 | 2.60 | 6.82 | 1.26 | 159.82** | 1.60 | 3.99** | 7.59** |
| GCA / SCA | | 2.007 | 1.078 | 0.721 | 0.780 | 4.98 | 10.48 | 3.70 | 2.12 |

N refers to normal irrigation D refers to drought irrigation

*, ** Significant at 0.05 and 0.01 levels of probability; respectively

**TABLE 4. Cont. : Analysis of variance for yield and its attributes of the parents and their hybrids under normal and drought conditions.**

| S.O.V. | DF | Spike length (cm) | | No. of kernel / spike | | 1000 kernel weight (g) | | Grain yield / plant (g) | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | D | N | D | N | D | N | D |
| | | 0.86 | 0.43 | 0.23 | 1.29 | 0.23 | 0.05 | 0.14 | 0.44 |
| Reps. | 2 | 2.61** | 2.37** | 58.16** | 60.15** | 10.45** | 7.56** | 19.15** | 21.86** |
| Genotypes (G) | 27 | 6.05** | 4.47** | 128.43** | 41.15** | 21.41** | 14.63** | 44.60** | 34.76** |
| Parents (P) | 6 | 1.68** | 1.54** | 38.99** | 127.54** | 7.65** | 5.38** | 12.28 | 17.59** |
| Crosses (Cr) | 20 | 0.49 | 6.38** | 20.00** | 35.81** | 0.48 | 8.77** | 3.81 | 30.04* |
| P *vs*. Cr | 1 | 0.46 | 0.43 | 2.34 | 4.29 | 2.34 | 1.95 | 8.06* | 6.81* |
| Error | 54 | 3.16** | 2.59** | 83.62** | 84.61** | 12.37** | 6.63** | 16.88** | 22.03* |
| GCA | 6 | 0.23 | 0.29* | 1.09 | 1.68* | 0.99 | 1.42* | 3.55* | 3.23* |
| SCA | 20 | 4.67* | 1.87* | 30.00* | 36.26* | 6.12* | 0.87 | 1.82* | 2.29* |
| **GCA/SCA** | | 4.67 | 1.87 | 29.03 | 35.36 | 6.12 | 0.87 | 1.82 | 2.29 |

N refers to normal irrigation D refers to drought irrigation. *, ** Significant at 0.05 and 0.01 levels of probability; respectively

*Mean performance and reduction percentage*

Mean performance and reduction percentage of the seven parental genotypes and their 21 F1 crosses under normal and drought conditions for all the studied traits are shown in table 5. The results revealed that wheat genotypes greatly differed in their responses under both conditions for all the studied traits. Means of leaf area index, chlorophyll content, days to 50% heading, Plant height (cm), spike length (cm), no. of kernel/ spike, 1000-kernel weight (g) and grain yield/ plant (g) were;39.38 and 34.30, 51.62 and 40.68, 97.82 and 92.72 days, 116.00 and 103.00 cm., 13.51 and 11.30 cm., 65.65 and 54.61 kern., 44.56 and 39.80 g. and 68.32 and 62.16 g. under normal and drought conditions respectively .Drought stress caused reductions in these traits by 12.80, 20.87, 5.19, 11.15, 16.39, 16.90, 10.67 and 8.98 % respectively . These results are in agreement with those obtained by Abd El- Aty et al (2016), Fouad (2018), Abd El- Aty et al (2023)and El-gammal et al (2023).

For days to heading, among parents the parental cultivar Sakha 95 and the line 136 were the earliest parents with values of 93.33 and 88.00 days under normal and drought condition respectively. The line 117 x Line 136 was the earliest ones with values of 93.67 and 88.00 days under normal and drought condition respectively. Regarding plant height, the tallest parents were Misr2 and line 117 with values of, 124.33 and 110.00 cm under normal and drought stress respectively. The two crosses Misr2 x Line115 and Line 115 x Line 117 exhibited the highest mean values of plant height under both conditions, thus these genotypes could be used to improve plant height traits.The reduction in plant height due to water stress may be attributed to the reduction in internodes' length, because of the deficiency of soil moisture. With respect to spike length, the parental Gemmiza 11 and Line 115 gave the highest mean values under both conditions.The two crosses Sids 14 x Line 115 and Gemmiza11 X Line 115 had the highest mean values of spike length.Kheiralla et al (2004), Abd El-Kareem (2019), Abd El- Aty et al (2023) and El-gammal et al (2023) found that spike length was significantly affected by water stress treatments and wheat genotypes. In addition, Siyal (2021); Mady (2023) reported that the reduction % of grain yield ranged from 0.41 to 22.39%. Al-Naggar et al. (2020) found that water stress caused a significant reduction of 9.54 % in grain yield.

The parental genotypes Sids 14 and Sakha 95 and the three crosses Sids 14 x Sakha95, Sakha 95 x Gemmiza 11 and Sakha 95 x Line 117 had the highest mean values of no. of kernel/ spike under both conditions. Regarding 1000 kernels weight, the results showed that the parental Sakha 95 and Line117, also, the crosses Sids 14 x Sakha 95, Sids 14 x line 117, Sakha 95 x Line 117 and Line 117 x Line 136 gave the heaviest 1000 kernels weight among the crosses and were of common superiority in both conditions. Decreased mean number of kernels / spike may be due to effect of water deficiency on pollination and fertilization processes.Tawfelis (2006) reported that wheat genotypes differently responded to different environmental conditions and drought stress reduced the number of 1000g weight to 9.06% compared to normal. For grain yield / plant the parental genotypes Sids 14 and Sakha 95, also the two crosses; Sakha 95 x Misr 2 and Sakha 95 x Line 115 had the highest grain yield / plant under both conditions. This is supported by Dencic et al. (2000) and El-gammal et al (2023) who found that decreasing soil moisture caused significant reduction in grain yield. Also, Salem (2005) reported that full irrigation treatment significantly maximized grain yield /ha. In addition, Siyal (2021); Mady (2023) reported that the reduction % of grain yield ranged from 0.41 to 22.39%. And, Al-Naggar etal. (2020) found that water stress caused a significant reduction of 9.54 % in grain yield.

*Combining ability for the studied traits:*

Mean squares for general and specific combining ability for the studied traits are presented in Table 4. The mean squares of GCA were either significant or highly significant for days to heading, plant height and grain yield / plant under both conditions, while, spike length no. of kernel/ spike and 1000 kernels weight showed significant positive GCA effects under drought condition. The mean squares of SCA were either significant or highly significant for plant height, spike length, kernel yield / plant under both conditions, while days to heading, and 1000 kernels weight showed significant SCA effects under normal irrigation. These results would indicate the importance of both additive and non-additive gene effects in the inheritance of such traits. Moreover, The GCA variance was found to be higher than the SCA for all the studied traits under both conditions, except spike length and no. of kernels / spike under both conditions as well as 1000kerenel weight under normal condition, indicating that additive gene effects were more important than non-additive in the expression of these traits.

*General combining ability effects for the studied traits:*

General combining ability of parents for the studied traits under normal and water deficit conditions are presented in Table 6. From the Plant breeder's point of view, positive values of GCA effects would be of interest in most traits, while for heading and maturity, negative values would be useful. Data revealed that the parental genotype Sids 14 (P1) showed significant positive ($\hat{g}_i$) effects for Leaf area index and no. of kernels /

**TABLE 5. Means and reduction percentage( R) for the morphological traits of the parents and their hybrids under normal and drought stress conditions.**

| Genotypes | Leaf area index | | | Chlorophyll content | | | Days to 50% heading (day) | | | Plant height (cm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parents:** | N | D | R%. | N | D | R%. | N | D | R% | N | D | R%. |
| Sids 14 | 42.33 | 36.67 | 13.37 | 57.33 | 41.67 | 27.32 | 109.33 | 90.67 | 17.07 | 13.00 | 11.03 | 15.15 |
| Sakha 95 | 41.67 | 35.33 | 15.21 | 50.33 | 42.00 | 16.55 | 115.67 | 95.33 | 17.58 | 12.33 | 10.10 | 18.09 |
| Gemmiza 11 | 39.00 | 31.67 | 18.79 | 47.33 | 41.33 | 12.68 | 104.00 | 91.67 | 11.86 | 15.00 | 12.73 | 15.13 |
| Misr 2 | 34.67 | 32.00 | 7.70 | 48.00 | 38.67 | 19.44 | 124.33 | 107.67 | 13.40 | 11.33 | 9.80 | 13.50 |
| Line 115 | 36.00 | 33.00 | 8.33 | 53.67 | 41.67 | 22.36 | 118.33 | 107.67 | 9.01 | 15.00 | 12.13 | 19.13 |
| Line 117 | 40.33 | 37.00 | 8.26 | 48.67 | 40.33 | 17.14 | 122.67 | 110.00 | 10.33 | 14.33 | 10.47 | 26.94 |
| Line 136 | 35.33 | 32.67 | 7.53 | 49.67 | 41.00 | 17.46 | 115.67 | 102.00 | 11.82 | 12.67 | 9.47 | 25.26 |
| **Crosses** | | | | | | | | | | | | |
| Sids 14 x Sakha 95 | 44.33 | 37.00 | 16.54 | 56.67 | 42.33 | 25.30 | 97.33 | 93.00 | 4.45 | 117.00 | 102.00 | 12.82 |
| Sids 14 x Gemmiza11 | 40.67 | 34.00 | 16.40 | 53.33 | 41.33 | 22.50 | 103.00 | 98.00 | 4.85 | 110.67 | 97.67 | 11.75 |
| Sids 14 x Misr 2 | 40.67 | 32.00 | 21.32 | 51.00 | 38.67 | 24.18 | 100.33 | 97.00 | 3.32 | 119.67 | 105.33 | 11.98 |
| Sids 14 x Line 115 | 39.67 | 34.00 | 14.29 | 55.33 | 40.33 | 27.11 | 94.33 | 90.33 | 4.24 | 118.33 | 103.67 | 12.39 |
| Sids 14 x Line 117 | 41.67 | 36.33 | 12.81 | 54.00 | 40.00 | 25.93 | 97.67 | 93.33 | 4.44 | 119.67 | 106.00 | 11.42 |
| Sids 14 x Line 136 | 40.00 | 36.33 | 9.18 | 57.67 | 39.00 | 32.37 | 94.67 | 89.00 | 5.99 | 114.00 | 102.67 | 9.94 |
| Sakha5 x Gemmiza11 | 40.00 | 33.00 | 17.50 | 53.00 | 40.33 | 23.91 | 99.67 | 95.33 | 4.35 | 113.00 | 97.00 | 14.16 |
| Sakha 95 xMisr 2 | 43.67 | 38.33 | 12.23 | 55.67 | 41.33 | 25.76 | 98.33 | 93.00 | 5.42 | 119.00 | 108.33 | 8.97 |
| Sakha 95 xLine 115 | 41.67 | 35.00 | 16.01 | 57.00 | 42.00 | 26.32 | 94.33 | 89.00 | 5.65 | 117.00 | 103.67 | 11.39 |
| Sakha 95 x Line 117 | 40.00 | 36.67 | 8.32 | 53.67 | 41.67 | 22.36 | 99.00 | 92.33 | 6.74 | 116.33 | 106.33 | 8.60 |
| Sakha 95 x Line136 | 40.33 | 36.00 | 10.74 | 53.00 | 43.67 | 17.60 | 94.33 | 88.33 | 6.36 | 113.67 | 102.67 | 9.68 |
| Gemmiza 11 x Misr 2 | 38.00 | 30.67 | 19.29 | 49.33 | 39.67 | 19.58 | 104.00 | 99.00 | 4.81 | 116.00 | 105.00 | 9.48 |
| Gemmiza 11xLine115 | 39.00 | 35.00 | 10.26 | 52.33 | 39.00 | 25.47 | 101.00 | 95.00 | 5.94 | 114.33 | 101.33 | 11.37 |
| Gemmiza11xLine 117 | 40.00 | 36.00 | 10.00 | 50.00 | 40.67 | 18.66 | 98.33 | 95.00 | 3.39 | 113.00 | 101.33 | 10.33 |
| Gemmiza 11x Line 136 | 37.67 | 31.67 | 15.93 | 50.33 | 38.67 | 23.17 | 98.33 | 93.67 | 4.74 | 107.67 | 97.33 | 9.60 |
| Misr2x Line 115 | 37.00 | 31.67 | 14.41 | 51.67 | 39.67 | 23.22 | 97.33 | 92.33 | 5.14 | 121.33 | 109.67 | 9.61 |
| Misr 2 x Line 117 | 38.67 | 36.00 | 6.90 | 44.67 | 39.00 | 12.69 | 100.00 | 97.33 | 2.67 | 119.67 | 106.67 | 10.86 |
| Misr 2 x Line 136 | 34.67 | 33.33 | 3.87 | 47.33 | 40.67 | 14.07 | 97.33 | 92.67 | 4.79 | 117.33 | 104.67 | 10.79 |
| Line 115 x Line 117 | 39.00 | 35.00 | 10.26 | 50.67 | 42.33 | 16.46 | 95.33 | 89.33 | 6.29 | 119.67 | 109.33 | 8.64 |
| Line 115 x Line 136 | 37.67 | 31.67 | 15.93 | 45.00 | 40.33 | 10.38 | 93.00 | 86.33 | 7.17 | 114.33 | 103.67 | 9.32 |
| Line117 x Line 136 | 39.00 | 32.33 | 17.10 | 48.67 | 41.67 | 14.38 | 93.67 | 88.00 | 6.05 | 116.33 | 107.00 | 8.02 |
| Grand mean | 39.38 | 34.30 | 12.80 | 51.62 | 40.68 | 20.87 | 97.82 | 92.75 | 5.19 | 116.00 | 103.08 | 11.15 |
| L.S.D 0.05 | 2.530 | 3.489 | | 3.528 | 2.654 | | 2.329 | 2.844 | | 3.745 | 4.787 | |
| 0.01 | 3.369 | 4.647 | | 4.699 | 3.534 | | 3.101 | 3.788 | | 4.987 | 6.374 | |

N refers to normal irrigation D refers to drought irrigation

**TABLE 5 Cont. Means and reduction percentage ( R ) for yield and its attributes of the parents and their hybrids under normal and drought stress conditions.**

| Genotypes | Spike length (cm) | | | No. of kernel/ spike | | | 1000-kernel weight (g) | | | Grain yield/ plant (g) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parents:** | N | D | R%. | N | D | R%. | N | D | R% | N | D | R%. | |
| Sids 14 | 13.00 | 11.03 | 15.15 | 70.33 | 59.33 | 15.64 | **43.67** | 39.00 | 10.69 | 72.33 | 66.00 | 8.75 | |
| Sakha 95 | 12.33 | 10.10 | 18.09 | 74.00 | 62.00 | 16.22 | 48.67 | 43.00 | 11.65 | 74.00 | 68.33 | 7.66 | |
| Gemmiza 11 | 15.00 | 12.73 | 15.13 | 66.33 | 56.00 | 15.57 | 43.00 | 37.67 | 12.40 | 63.67 | 59.00 | 7.33 | |
| Misr 2 | 11.33 | 9.80 | 13.50 | 57.67 | 45.33 | 21.40 | 41.00 | 36.33 | 11.39 | 66.67 | 65.33 | 2.01 | |
| Line 115 | 15.00 | 12.13 | 19.13 | 62.33 | 52.00 | 16.57 | 43.00 | 38.00 | 11.63 | 68.00 | 60.33 | 11.28 | |
| Line 117 | 14.33 | 10.47 | 26.94 | 67.00 | 54.67 | 18.40 | 47.33 | 40.67 | 14.07 | 64.67 | 61.33 | 5.16 | |
| Line 136 | 12.67 | 9.47 | 25.26 | 56.00 | 45.00 | 19.64 | 44.33 | 40.00 | 9.77 | 66.33 | 62.00 | 6.53 | |
| **Crosses** | | | | | | | | | | | | | |
| Sids 14 x Sakha 95 | 12.93 | 10.67 | 17.48 | 72.33 | 61.67 | 14.74 | 46.00 | 41.67 | 9.41 | 68.33 | 67.67 | 0.97 | |
| Sids 14 x Gemmiza11 | 14.60 | 12.47 | 14.59 | 68.33 | 57.00 | 16.58 | 43.33 | 39.67 | 8.45 | 66.33 | 59.67 | 10.04 | |
| Sids 14 x Misr 2 | 12.73 | 10.40 | 18.30 | 66.00 | 53.33 | 19.20 | 42.67 | 38.00 | 10.94 | 65.00 | 60.67 | 6.66 | |
| Sids 14 x Line 115 | 14.63 | 12.57 | 14.08 | 67.33 | 55.67 | 17.32 | 43.67 | 39.00 | 10.69 | 70.00 | 62.67 | 10.47 | |
| Sids 14 x Line 117 | 14.10 | 11.93 | 15.39 | 69.33 | 59.67 | 13.93 | 46.67 | 42.00 | 10.01 | 66.00 | 62.00 | 6.06 | |
| Sids 14 x Line 136 | 13.90 | 11.67 | 16.04 | 65.33 | 52.33 | 19.90 | 44.33 | 39.00 | 12.02 | 67.00 | 62.33 | 6.97 | |
| Sakha5 x Gemmiza11 | 14.37 | 11.97 | 16.70 | 71.67 | 60.00 | 16.28 | 43.33 | 38.33 | 11.54 | 70.00 | 62.67 | 10.47 | |
| Sakha 95 x Misr 2 | 12.90 | 10.73 | 16.82 | 68.00 | 56.00 | 17.65 | 43.67 | 38.67 | 11.45 | 72.00 | 64.67 | 10.18 | |
| Sakha 95 x Line 115 | 14.07 | 11.63 | 17.34 | 68.67 | 57.67 | 16.02 | 45.00 | 40.67 | 9.62 | 71.67 | 62.00 | 13.49 | |
| Sakha 95 x Line 117 | 13.33 | 11.47 | 13.95 | 71.00 | 61.00 | 14.08 | 47.00 | 42.33 | 9.94 | 68.00 | 61.33 | 9.81 | |
| Sakha 95 x Line 136 | 13.33 | 11.13 | 16.50 | 66.67 | 57.00 | 14.50 | 47.33 | 41.33 | 12.68 | 69.67 | 61.67 | 11.48 | |
| Gemmiza 11 x Misr 2 | 13.10 | 11.50 | 12.21 | 62.67 | 52.33 | 16.50 | 43.33 | 41.00 | 5.38 | 67.33 | 59.00 | 12.37 | |
| Gemmiza 11 x Line 115 | 14.70 | 12.27 | 16.53 | 63.67 | 53.00 | 16.76 | 42.67 | 38.00 | 10.94 | 69.67 | 59.00 | 15.32 | |
| Gemmiza 11 x Line 117 | 13.23 | 11.80 | 10.81 | 65.33 | 56.33 | 13.78 | 44.00 | 39.67 | 9.84 | 65.67 | 58.67 | 10.66 | |
| Gemmiza 11 x Line 136 | 13.37 | 11.37 | 14.96 | 62.33 | 51.33 | 17.65 | 45.00 | 40.00 | 11.11 | 67.00 | 57.67 | 13.93 | |
| Misr 2 x Line 115 | 13.00 | 10.90 | 16.15 | 61.33 | 49.33 | 19.57 | 43.00 | 39.33 | 8.53 | 70.00 | 63.00 | 10.00 | |
| Misr 2 x Line 117 | 12.60 | 10.80 | 14.29 | 64.00 | 52.00 | 18.75 | 43.33 | 39.33 | 9.23 | 67.33 | 62.67 | 6.92 | |
| Misr 2 x Line 136 | 12.03 | 9.77 | 18.79 | 58.33 | 48.67 | 16.56 | 43.67 | 39.00 | 10.69 | 70.33 | 66.33 | 5.69 | |
| Line 115 x Line 117 | 14.27 | 12.10 | 15.21 | 66.00 | 55.33 | 16.17 | 44.67 | 40.00 | 10.45 | 70.67 | 60.67 | 14.15 | |
| Line 115 x Line 136 | 14.10 | 11.97 | 15.11 | 62.33 | 52.00 | 16.57 | 46.67 | 41.00 | 12.15 | 68.67 | 62.00 | 9.71 | |
| Line 117 x Line 136 | 13.40 | 11.47 | 14.40 | 64.00 | 53.00 | 17.19 | 47.33 | 41.67 | 11.96 | 66.67 | 61.67 | 7.50 | |
| Grand mean | 13.51 | 11.30 | 16.39 | 65.65 | 54.61 | 16.90 | 44.56 | 39.80 | 10.67 | 68.32 | 62.16 | 8.98 | |
| L.S.D 0.05 | 1.115 | 1.074 | | 2.503 | 3.389 | | 2.503 | 2.285 | | 4.646 | 4.272 | | |
| 0.01 | 1.484 | 1.430 | | 3.333 | 4.513 | | 3.333 | 3.043 | | 6.188 | 5.689 | | |

N refers to normal irrigation D refers to drought irrigation

**TABLE 6. General combining ability estimates of the parent for morphological traits under normal and water deficit conditions.**

| Parents: | Leaf area index | | Chlorophyll content | | Days to 50% heading ( day | | Plant height (cm ) | |
|---|---|---|---|---|---|---|---|---|
| | N | D | N | D | N | D | N | D |
| Sids 14 | 1.847** | 0.958* | 3.302** | -0.048 | 0.085 | 0.296 | -1.111** | -2.889** |
| Sakha 95 | 2.032** | 1.365** | 1.857** | 1.101** | -1.434** | -1.370** | -0.074 | -1.556** |
| Gemmiza 11 | -0.190 | -1.190** | -1.106** | -0.344 | 3.974** | 4.000** | -5.037** | -4.630** |
| Misr2 | -1.450** | -0.931* | -1.921** | -1.011** | 2.307** | 2.370** | 3.741** | 3.370** |
| Line 115 | -1.005** | -0.672 | 0.709 | 0.175 | -2.138** | -2.185** | 1.519** | 2.444** |
| Line 117 | 0.439 | 1.328** | -1.550** | 0.063 | -0.212 | 0.000 | 2.444** | 3.556** |
| Line 136 | -1.672** | -0.857* | -1.291** | 0.063 | -2.582** | -3.111** | -1.481** | -0.296 |
| LSD gi 5% | 0.552 | 0.761 | 0.770 | 0.579 | 0.508 | 0.621 | 0.817 | 1.045 |
| LSD gi 1% | 0.735 | 1.014 | 1.025 | 0.771 | 0.677 | 0.827 | 1.088 | 1.391 |

N refers to normal irrigation, D refers to drought irrigation
* and ** significant at 0.05 and 0.01 levels of probability, respectively.

**TABLE 6. Cont. General combining ability estimates of the parent for yield and its attributes under normal and water deficit conditions.**

| Parents: | Spike length (cm) | | No. of kernel / spike | | 1000 kernel weight (g) | | Grain yield / plant (g) | |
|---|---|---|---|---|---|---|---|---|
| | N | D | N | D | N | D | N | N |
| Sids 14 | 0.088 | 0.155 | 2.677** | 2.386** | -0.275 | -0.116 | 0.085 | 0.085 |
| Sakha 95 | -0.278* | -0.286* | 4.566** | 4.497** | 1.466** | 1.180** | 2.344** | 2.344** |
| Gemmiza 11 | 0.585** | 0.718** | 0.159 | 0.571 | -0.979** | -0.709** | -1.471** | -1.471** |
| Misr2 | -1.008** | -0.741** | -3.286** | -3.836** | -1.646** | -1.153** | -0.138 | -0.138 |
| Line 115 | 0.740** | 0.592** | -1.249** | -1.095** | -0.534 | -0.487 | 1.122** | 1.122** |
| Line 117 | 0.166 | 0.014 | 0.937** | 1.090** | 1.243** | 0.884** | -1.434** | -1.434** |
| Line 136 | -0.293* | -0.452** | -3.804** | -3.614** | 0.725* | 0.402 | -0.508 | -0.508 |
| LSD gi 5% | 0.243 | 0.234 | 0.546 | 0.740 | 0.546 | 0.499 | 1.014 | 1.014 |
| LSD gi 1% | 0.324 | 0.312 | 0.727 | 0.985 | 0.727 | 0.664 | 1.350 | 1.350 |

N refers to normal irrigation D refers to drought irrigation
* and ** significant at 0.05 and 0.01 levels of probability, respectively.

spike under both conditions as well as chlorophyll content under normal irrigation**.**

The parental cultivar Sakha 95 (P2) exhibited significant positive ($\hat{g}_i$) effects forleaf area index**,** chlorophyll content, no. of kernel / spike**,** 1000 kernel weight (g) and grain yield / plant under both conditions**,** while it showed significant negative ($\hat{g}_i$) effectsfor days to heading under both conditions and plant height under drought condition. Such negative ($\hat{g}_i$) effects revealed that this cultivar might be the best general combiner for earliness and shortness. The parent Gemmiza 11 (P3) expressed significant positive ($\hat{g}_i$) effects for days to heading (towards earliness plants) under both conditions and spike length under both conditions. Also, it expressed significant negative ($\hat{g}_i$) effects for plant height (towards shortness plants) under both conditions. The parental cultivar Misr 2 (P4) exhibited significant positive ($\hat{g}_i$) effects for days to heading and plant height under both conditions. However; it gave significant undesirable or insignificant ($\hat{g}_i$) effectsforothertraits. The parental line 115 (P5) appeared to be the best general combiner for days to heading, spike length and grain yield / plant under both conditions. The parental line 117 (P6) could be considered as a good combiner for improving leaf area index under drought condition and no. of kernel / spike and 1000-kernel weight under both condition. The parental line 136 (P7) seemed to be a good combiner for plant height and 1000 kernels weight under normal irrigation, and earliness under both conditions, . These results indicated that the previous parents may be useful in hybrid breeding programs for improving the grain yield under both normal and water deficit conditions. It is worthnoticedthatin the present study, the parents who possessed high ($\hat{g}_i$) effects for grain yield exhibited desirable ($\hat{g}_i$) effects for one or more of the traits contributing to grain yield. These results are in agreement with those reported by Jatoi et al (2014), El-Hosary et al (2015), Abd El-Aty et al (2016) and El gammal et al (2023).

*Specific combining ability for the studied traits:*

Specific combining ability of the crosses for all the studied traits under normal and water deficit conditions is shown in Table 7.Thecrosses with higher SCA values may be considered useful for the development of new recombinants in wheat breeding program. High values of specific combining ability (SCA)detect the best hybrid combinations resulting from the non-additive effects of genes.

The cross Sakha 95 xMisr 2 under both conditions and the three crosses Sids 14 x Line 136, Gemmiza 11 x Line 115 and Gemmiza 11 x Line 117 under drought condition showed significant positive or highly significant desirable S C A affectsfor leaf area index. Therefore, these crosses are considered as good specific combiners for this trait under such conditions. With respect chlorophyll content, the crosses; Sids 14 x Line 136, Sakha 95 xMisr 2, Sakha 95 xLine 115 and Sakha 95 xLine 115under normal condition, andthe crosses Sakha 95 xLine 115 and Line 115 x Line 117under drought condition exhibited significant positive or highly significant desirable S C A effects for this trait.

Regarding days to 50 % heading, two crosses Gemmiza 11 x Line 117 and Line 117 x Line 136 under both conditions and the cross Sids 14 x Line

**TABLE 7. Specific combining ability estimates of the crosses for morphological traits under normal and water deficit conditions.**

| Crosses | Leaf area index | | Chlorophyll content | | Days to 50% heading ( day ) | | Plant height (cm ) | |
|---|---|---|---|---|---|---|---|---|
| | N | D | N | D | N | D | N | D |
| Sids 14 x Sakha 95 | 1.074 | 0.380 | -0.111 | 0.602 | 0.861 | 1.324 | 2.185* | 3.361* |
| Sids 14 x Gemmiza11 | -0.370 | -0.065 | -0.481 | 1.046 | 1.120 | 0.954 | 0.815 | 2.102 |
| Sids 14 x Misr 2 | 0.889 | -2.324* | -2.000* | -0.954 | 0.120 | 1.583* | 1.037 | 1.769 |
| Sids 14 x Line 115 | -0.556 | -0.583 | -0.296 | -0.472 | -1.435* | -0.528 | 1.926 | 1.028 |
| Sids 14 x Line 117 | 0.000 | -0.250 | 0.630 | -0.694 | -0.028 | 0.287 | 2.333* | 2.250 |
| Sids 14 x Line 136 | 0.444 | 1.935* | 4.037** | -1.694* | -0.657 | -0.935 | 0.593 | 2.769* |
| Sakha 95 x Gemmiza11 | -1.222 | -1.472 | 0.630 | -1.102 | -0.694 | -0.046 | 2.111* | 0.102 |
| Sakha 95 xMisr 2 | 3.704** | 3.602** | 4.111** | 0.565 | -0.361 | -0.750 | -0.667 | 3.435* |
| Sakha 95 xLine 115 | 1.259 | 0.009 | 2.815** | 0.046 | 0.083 | -0.194 | -0.444 | -0.306 |
| Sakha 95 xLine 115 | -1.852** | -0.324 | 1.741* | -0.176 | 2.824** | 0.954 | -2.037* | 1.250 |
| Sakha 95 xLine 115 | 0.593 | 1.194 | 0.815 | 1.824* | 0.528 | 0.065 | -0.778 | 1.435 |
| Gemmiza 11 x Misr 2 | 0.259 | -1.509 | 0.741 | 0.343 | -0.102 | -0.120 | 1.296 | 3.176* |
| Gemmiza 11 x Line 115 | 0.815 | 2.565** | 1.111 | -1.509* | 1.343* | 0.435 | 1.852 | 0.435 |
| Gemmiza 11 x Line 117 | 0.370 | 1.565** | 1.037 | 0.269 | -3.250** | -1.750* | -0.407 | -0.676 |
| Gemmiza 11 x Line 136 | 0.148 | -0.583 | 1.111 | -1.731* | -0.880 | 0.028 | -1.815 | -0.824 |
| Misr 2 x Line 115 | 0.074 | -1.028 | 1.259 | -0.176 | -0.657 | -0.602 | 0.074 | 0.769 |
| Misr 2 x Line 117 | 0.296 | 1.306 | -3.481** | -0.731 | 0.083 | 2.213** | -2.519* | -3.343* |
| Misr 2 x Line 136 | -1.593* | 0.824 | -1.074 | 0.935 | -0.213 | 0.657 | -0.926 | -1.491 |
| Line 115 x Line 117 | 0.185 | 0.046 | -0.111 | 1.417* | -0.139 | -1.231 | -0.296 | 0.250 |
| Line 115 x Line 136 | 0.963 | -1.102 | -6.037** | -0.583 | -0.102 | -1.120 | -1.704 | -1.565 |
| Line 117 x Line 136 | 0.852 | -2.435** | -0.111 | 0.861 | -1.361* | -1.639* | -0.630 | 0.657 |
| LSD S i 5% | 1.366 | 1.884 | 1.906 | 1.433 | 1.258 | 1.536 | 2.022 | 2.585 |
| LSD S i 1% | 1.819 | 2.509 | 2.538 | 1.909 | 1.675 | 2.046 | 2.693 | 3.443 |

N refers to normal irrigation D refers to drought irrigation

* and ** significant at 0.05 and 0.01 levels of probability, respectively.

**TABLE 7. Cont. Specific combining ability estimates of the crosses for yield and its attributes under normal and water deficit conditions.**

| Crosses | Spike length (cm) | | No. of kernel / spike | | 1000-kernal weight (g) | | Grain yield / plant (g) | |
|---|---|---|---|---|---|---|---|---|
| | N | D | N | D | N | D | N | D |
| Sids 14 x Sakha 95 | -0.390 | -0.499 | -0.565 | 0.176 | 0.250 | 0.806 | -2.417 | 2.269 |
| Sids 14 x Gemmiza11 | 0.414 | 0.297 | -0.157 | -0.565 | 0.028 | 0.694 | -0.602 | -1.065 |
| Sids 14 x Misr 2 | 0.140 | -0.310 | 0.954 | 0.176 | 0.028 | -0.528 | -3.269** | -3.657** |
| Sids 14 x Line 115 | 0.292 | 0.523 | 0.250 | -0.231 | -0.083 | -0.194 | 0.472 | 0.231 |
| Sids 14 x Line 117 | 0.332 | 0.468 | 0.065 | 1.583 | 1.139 | 1.435* | -0.972 | -0.398 |
| Sids 14 x Line 136 | 0.592 | 0.668* | 0.806 | -1.046 | -0.676 | -1.083 | -0.898 | -0.731 |
| Sakha 95 x Gemmiza11 | 0.547 | 0.238 | 1.287* | 0.324 | -1.713* | -1.935** | 0.806 | 0.861 |
| Sakha95 xMisr 2 | 0.673* | 0.464 | 1.065 | 0.731 | -0.713 | -1.157* | 1.472 | -0.731 |
| Sakha 95 xLine 115 | 0.092 | 0.031 | -0.306 | -0.343 | -0.491 | 0.176 | -0.120 | -1.509 |
| Sakha 95 x Line 117 | -0.068 | 0.442 | -0.157 | 0.806 | -0.269 | 0.472 | -1.231 | -2.139 |
| Sakha 95 x Line 136 | 0.392 | 0.575* | 0.250 | 1.509 | 0.583 | -0.046 | -0.491 | -2.472* |
| Gemmiza 11 x Misr 2 | 0.010 | 0.227 | 0.139 | 0.991 | 1.398* | 3.065** | 0.620 | -1.731 |
| Gemmiza 11 x Line 115 | -0.138 | -0.340 | -0.898 | -1.083 | -0.380 | -0.602 | 1.694 | 0.157 |
| Gemmiza 11 x Line 117 | -1.031** | -0.229 | -1.417* | 0.065 | -0.824 | -0.306 | 0.250 | -0.139 |
| Gemmiza 11 x Line 136 | -0.438 | -0.195 | 0.324 | -0.231 | 0.694 | 0.509 | 0.657 | -1.806 |
| Misr 2 x Line 115 | -0.245 | -0.247 | 0.213 | -0.343 | 0.620 | 1.176* | 0.694 | 0.565 |
| Misr 2 x Line 117 | -0.071 | 0.231 | 0.694 | 0.139 | -0.824 | -0.194 | 0.583 | 0.269 |
| Misr 2 x Line 136 | -0.179 | -0.336 | -0.231 | 1.509 | 0.028 | -0.046 | 2.657* | 3.269** |
| Line 115 x Line 117 | -0.153 | 0.197 | 0.657 | 0.731 | -0.602 | -0.194 | 2.657* | 0.157 |
| Line 115 x Line 136 | 0.140 | 0.531 | 1.731* | 2.102* | 1.917** | 1.287* | -0.269 | 0.824 |
| Line 117 x Line 136 | 0.014 | 0.608* | 1.213 | 0.917 | 0.806 | 0.583 | 0.287 | 0.528 |
| LSD S i 5% | 0.602 | 0.580 | 1.352 | 1.830 | 1.352 | 1.234 | 2.509 | 2.307 |
| LSD S i 1% | 0.802 | 0.772 | 1.800 | 2.437 | 1.800 | 1.644 | 3.342 | 3.073 |

N refers to normal irrigation D refers to drought irrigation

* and ** significant at 0.05 and 0.01 levels of probability, respectively.

115 under normal condition showed significant negative desirable SCA effects for this trait.These crosses could be utilized in breeding program for improving earliness.

For plant height, the data showed that the cross Sids 14 x Sakha 95 under both conditions and the two crosses Sids 14 x Line 117 and Sakha 95 x Gemmiza11under normal condition as well as the two crosses Sakha 95 x Misr 2 and Gemmiza 11 x Misr2 under drought condition expressed significant positive SCA effects towards tallness. On the other hand, the cross Misr 2 x Line 117 under both conditions and the cross Sakha 95 x Line 115 under normal condition expressed desirable significant negative SCA effects towards shortness. For spike length, only the cross Sakha 95 xMisr 2 under normal condition and the two crossesSids 14 x Line 136 and Line 117 x Line 136 under drought condition had significant and positive SCA effects.

Regarding number of kernels/spike, the cross Line 115 x Line 136 under both conditions and the cross Sakha 95 x Gemmiza11under normal condition exhibited significant and positive SCA effects. For 1000-kernel weight, the two crosses Gemmiza 11 x Misr 2 and Line 115 x Line 136under both conditions and the two crosses;Sids 14 x Line 117 and Misr 2 x Line 115 had significant and positive SCA effects under drought condition. Thus, these crosses are considered to be promising for improving this trait.

Regarding grain yield/plant, the data showed that only the crosses; Misr 2 x Line 136 under both conditions and Line 115 x Line 117under normal condition exhibited significant positive SCA effects. So, it could be concluded that they might be of interest in wheat breeding programs as most of them are good combiners for the studied traits. Also, these crosses might be of interest to develop new cultivars or produce pure lines under drought stress condition. These results are in agreement with those reported by Katta et al (2013) Mohamed et al (2014), Abd El-Aty et al (2016) and El gammal et al (2023).

*Estimates of Genetic components and heritability:*

Estimations of the genetic components (D, H1, H2, and h2), gene distribution (F) and environmental component (E) according to Hayman (1954a and b) for all the studied traits are given in Table (8). It is revealed that the additive component "D" was highly significant and positive for all the studied traits under both conditions. The dominance component (H1) was

**TABLE 8. Estimate of genetic components of variation in a diallel wheat crosses for morphological traits.**

| Component | Flag leaf area (cm2) | | Chlorophyll content(SPAD) | | Days to heading | | Plant height (cm) | |
|---|---|---|---|---|---|---|---|---|
| | N | D | N | D | N | D | N | D |
| Additive effect ( D) | 9.11±** 1.38 | 3.56*± 0.96 | 11.30 **± 3.41 | 3.56 *± 0.96 | 25.91 ** ± 1.29 | 19.14** ± 0.82 | 49.54** ± 1.28 | 63.00 **± 2.11 |
| Dominance effect($H_1$) | 5.04* ± 3.33 | 6.33* ± 2.30 | 25.14**± 8.22 | 6.33*± 2.3 | 5.86* ± 3.12 | 4.65 *± 1.97 | 15.77** ± 3.07 | 22.67** ± 5.07 |
| Dominance effect($H_2$) | 4.58** ± 2.93 | 6.57**± 2.03 | 19.26**± 7.24 | 6.57* ± 2.03 | 4.67±* 2.75 | 2.76* ± 1.74 | 7.56**± 2.71 | 14.73** ± 4.47 |
| Dominance loci (h2) | 3.90* ± 1.97 | 1.36*± -0.39 | 3.54 *± 0.86 | -0.39± 0.13 | 1.84 *± 0.58 | -1.17*± 0.51 | 1.82*± 0.42 | 27.97** ± 3.00 |
| Gene distribution (F) | 3.23 *± 0.67 | -1.89± 0.29 | -0.71± 0.19 | -1.89 ± 0.29 | 4.99*± 3.11 | -6.08* ± 1.96 | 27.0** ± 3.06 | 35.3** ± 5.05 |
| Environmental component( E ) | 0.77± 0.49 | 1.46 ± 0.34 | 1.51 ± 1.10 | 1.46 ± 0.34 | 0.67 ± 0.46 | 1.08 ± 0.29 | 1.70± 0.45 | 2.75 ± 0.74 |
| $( H1/D)^{0.05}$ Degree of dominance | 0.74 | 1.33 | 1.49 | 2.56 | 0.48 | 0.49 | 0.56 | 0.60 |
| Proportion of p and d (H2/4H1) | 0.23 | 0.67 | 0.19 | 0.21 | 0.20 | 0.15 | 0.12 | 0.16 |
| Proportion of d and r( $K_D/K_r$) | 1.10 | 0.46 | 0.96 | 0.53 | 1.51 | 0.51 | 2.87 | 2.75 |
| Heritability ( $h_n$ ) | 0.70 | 0.31 | 0.59 | 0.36 | 0.86 | 0.88 | 0.81 | 0.74 |
| Correlation coefficient (r) | 0.78* | 0.51 | 0.14 | 0.08 | 0.45 | 0.11 | 0.72* | 0.74* |

N refers to normal irrigation D refers to drought irrigation
* and ** significant at 0.05 and 0.01 levels of probability, respectively

**TABLE 8. Cont. Estimate of genetic components of variation in a diallel wheat crosses yield traits.**

| Component | Spike length (cm) | | No. of kernel / spike | | 1000 kernel weight (g) | | Grain yield / plant (g) | |
|---|---|---|---|---|---|---|---|---|
| | N | D | N | D | N | D | N | D |
| Additive effect ( D) | 1.87*± 0.11 | 1.35*± 0.10 | 42.06**± 0.28 | 41.12 ** 0.50 | 6.38**± 0.41 | 4.25* ±0.83 | 12.26**± 1.13 | 6.46*± 1.46 |
| Dominance effect($H_1$) | 0.62 ± 0.25 | 0.67 ± 0.24 | 2.06*± 0.67 | 22.68**± 5.07 | 2.44*± 0.99 | 3.84* ± 1.99 | 10.61**± 2.71 | 6.34* ± 3.51 |
| Dominance effect($H_2$) | 0.41 ± 0.22 | 0.54 ± 0.21 | 1.67* ± 0.59 | 1.85*± 1.00 | 1.67* ± 0.87 | 3.59**± 1.75 | 4.84**± 2.39 | 6.74** ± 3.09 |
| Dominance loci (h2) | 0.15 ± 0.02 | 1.12* ± 0.14 | 3.36*± 0.40 | 6.00*± 0.71 | - 0.28 ± 0.05 | 1.33*± 1.10 | 1.60*± 0.56 | 4.56* ± 2.07 |
| Gene distribution (F) | 0.83± 0.25 | 0.41± 0.20 | 6.90* ± 0.67 | 35.34**± 5.05 | 2.05 *± 0.99 | 2.13* ± 1.98 | 11.72**± 2.70 | 3.49*± 0.15 |
| Environmental component (E) | 0.15 ± 0.04 | 0.70 ± 0.14 | 0.75± 0.10 | 2.75 ± 0.74 | 0.75 ± 0.15 | 0.63 ± 0.29 | 2.59 ± 0.40 | 2.12± 0.21 |
| $( H1/D)^{0.05}$ Degree of dominance | 0.58 | 0.70 | 0.22 | 0.60 | 0.62 | 0.95 | 0.93 | 0.82 |
| Proportion of p and d (H2/4H1) | 0.16 | 0.20 | 0.21 | 0.16 | 1.70 | 0.23 | 0.11 | 0.27 |
| Proportion of d and r( $K_D/K_r$) | 2.24 | 1.56 | 2.18 | 2.75 | 1.70 | 1.72 | 3.10 | 1.02 |
| Heritability ( $h_n$ ) | 0.72 | 0.66 | 0.94 | 0.74 | 0.69 | 0.44 | 0.46 | 0.54 |
| Correlation coefficient (r ) | 0.11 | 0.45 | 0.83** | 0.70* | 0.83** | 0.73* | 0.30 | 0.89** |

N refers to normal irrigation, D refers to drought irrigation
* and ** significant at 0.05 and 0.01 levels of probability, respectively.

highly significant for all the studied traits except of spike length under both irrigation treatments. These results indicated that both additive and dominance genetic components are important in the inheritance of the studied traits.

Genetic components are important in the inheritance of the studied traits.

However, the values of (D) were higher than (H1) for all the studied traits, except flag leaf area under drought and Chlorophyll content (SPAD) under both conditions, revealing that the additive gene effects played the major role in the inheritance of these traits. These findings coincided with those obtained previously from combining ability analysis of variance in this study.

This conclusion is in well agreement with those reported by Saleh (2011), Katta et al (2013), Mohamed et al (2014), Abd El-Aty et al (2016) and El gammal et al (2023).

Highly significant values for dominance components associated with gene distribution (H2) were detected for all the studied characters except spike length under both conditions. All the H2

values were smaller than the H1 values for all the traits, indicating that the positive and negative alleles, at the loci of the studied traits, are not equal in proportion to the parents. The estimator (h2) values which refer to the dominance effects over all heterozygous loci were significant positive for all the studied traits except chlorophyll content (SPAD) and Days to 50% heading under drought as well as, 1000 kernel weight under normal irrigation, indicating that the dominance effect was mainly due to heterozygosity and confirming the H1 and H2 results in all crosses for these traits. The values of (F) which measure the relative frequency of dominant to recessive alleles in the parents was positive and significant for most of the studied traits under both conditions, implying the excess of dominant alleles in the parents.

The estimated average degrees of dominance (H1/D)0.5 was less than unity for all the studied traits, except flag leaf area (cm2) under drought andchlorophyll content (SPAD) under both conditions, reflecting the presence of partial dominance and confirming that the additive gene action is the main component of genetic variance for these traits.

The average frequency of negative vs. positive alleles in the parents could be detected by computing the ratio of (H2/4H1). If the distribution of both positive and negative gene among the parents is equal (U = V = 0.5), the ratio is expected theoretically to be 0.25. The results showed that the values of H2/4H1 were less than 0.25 for all the studied traits under both conditions, indicating that the positive and negative alleles were not equally distributed among the parents.

The (KD/KR) ratio (which refers to dominant to recessive genes) in the parents was greater than unity for all studied traits in both conditions, with few exceptions indicating that dominant genes were more common in the parents than recessive ones. The correlation coefficient (r) between parental mean (Yr) and the (Wr+Vr) for each array was positive and significant for flag leaf area under normal condition and plant height, spike length as well as 1000 kernel weight under both conditions, and for grain yield / plant under drought condition. However, for the remaining traits were insignificant, indicating a bidirectional dominance. Similar results regarding genetic parameters and ratios derived from Hayman's analysis were obtained for most of the studied traits by, Saleh (2011), Abd El-Hamed (2013), Farshadfar et al (2013), Abd El-Aty et al (2016) and El gammal et al (2023).

## Discussion

The presence of genetic variability among the testedgenotypes for traits related to stress tolerance is important for successful breeding, which aimed todevelop cultivars adapted to a range of water stress conditions. Noreldin and Mahmoud (2017) and, Shalaby et al (2020). Water deficit caused reductions in the traits; flag leaf area, chlorophyll content, days to 50% heading, Plant height (cm), spike length (cm), no. of kernel/ spike, 1000-kernel weight (g) and grain yield/ plant (g) by 12.80, 20.87, 5.19, 11.15, 16.39, 16.90, 10.67 and 8.98% respectively . These results are in agreement with those obtained by Abd El-Aty et al (2016), Fouad (2018), Abd El-Aty et al (2023) and El-gammal et al (2023). Many results were detected by several authors with respect to genetic systems controlling grain yield and its components. Katta et al (2013) and Gomaa et al (2014) found that the additive genetic effects play a major role in the inheritance of grain yield and most of the traits under normal and water stress conditions. On the contrary, Mohamed et al (2014) and El Hawary (2015) reported that, the non- additive gene effects was more important in the inheritance of grain yield and most of its components under water stress conditions. Meanwhile, Abd El–Aty et al (2016) and Elgammaal et al (2023) reported the importance of additive and non- additive genetic variances in determining the performance of all studied characters.

The mean squares of GCA in the present study were either significant or highly significant for days to heading, plant height and grain yield / plant under both conditions, while, spike length no. of kernel/ spike and 1000 kernels weight gave significant positive GCA effects under drought condition. The mean squares of SCA were either significant or highly significant for plant height, spike length, kernel yield / plant under both conditions, while days to heading, and 1000 kernels weight showed significant SCA effects under normal condition. These results would indicate the importance of both additive and non-additive gene effects in the inheritance of such traits

Estimations of the genetic components (D, H1, H2, and h2), gene distribution (F) and environmental component (E) according to Hayman (1954a and b) for all the studied traits revealed that, the additive component "D" was highly significant and positive for all the studied traits under both conditions. The dominance component (H1) was highly significant for all the studied traits except of spike length under both irrigation treatments. These results indicated that both additive and dominance genetic components are important in the inheritance of the studied traits. In general, It could be recommended that, the genotypes which had the highest value for any trait under study, either morphological or yield traits, is considered a good combiner for this trait and could be used in breeding programs to develop new promising lines or hybrid wheat varieties.

## Conclusion

Theparents Misr 2 and line 136 showed the best desirable GCA effects for earliness, while, the parents Sakha 95 and Line 115 appeared to bethe best general combiners for grain yield/plant and most of its components under both conditions two crosses Gemmiza 11× Line 117 and Line 117 × Line 136 were identified as promising specific combiners for earliness, while the cross Misr 2× Line 136 for improving yielding ability under both conditions .

*Conflicts of interest.*

The authors declare that, there search was conducted in the absence of any commercial or relationships that could be construed as potential conflict of interest.

*Author contributions:*

Concept utilization: M.S.A.E.A., K.M.G., M.A.M.E., M.M.E.N. and M.O.S.; methodology, M.S.A.E.A., K.M.G., M.A.M.E. and M.M.E.N., formal analysis M.S.A.E.A. and K.M.G. investigation, M.O.S., data curation, M.S.A.E.A., M.A.M.E. and M.M.E.N. writing original draft preparation, M.S.A.E.A., writing review and editing M.S.A.E.A., K.M.G. and M.M.E.N., All authors have read and agreed to the published version of the manuscript.

## References

**Abd El – Aty, M. S. M.; K.E.M. Gad, Y. A. M. Hefny and M. O. S. Mosa (2023)** Performance of some wheat (*Triticum aestivum* L.) genotypes and their drought tolerance indices under normal and water stress. Egyptian J. Soil Sci .63, No.4 PP 601 – 612 .

**Abd El- Aty M S, M. M. Kamara, M .S. M. Abduo (2016).** Genetic analysis of some bread wheat crosses under normal and water stress conditions. Egypt J. Plant Breed. 20 (6) 907 – 928.

**Abd El-Hamed, E.A.M. (2013).** Genetic analysis of some bread wheat crosses under normal and water stress conditions. Egypt J. Plant Breed. 17:(2) 42-56.

**Abd El-Kareem, T.H.A.; Abdelhamid, E.A. M.; Elhawary, M.N.A. (2019).** Tolerance indices and cluster analysis to evaluate some bread wheat genotypes under water deficit conditions. Alexandria Journal of Agricultural sciences, 64(4)245-256:.

**Al-Naggar, A. M. M.; El-Shafi, M. A. E.M. A.; El-Shal, M. H., and Anany, A. H. (2020).** Evaluation of Egypt. Wheat landraces (Triticum aestivum L.) For drought tolerance, agronomic, grain yield and quality traits. Plant Archives, 20: 3487-3504.

**Darwish, M. A. H.; El-Hawary, M. and Moustafa, A. T. H.(2020**).Evaluation of some bread wheat genotypes under normal and reduced irrigations. Journal of Plant Production, 11(11):1115-1120. DOI:10.21608/jpp.2020.130948.

**Dencic, S, Kastori, R, Kobiljski, B, Duggan, B (2000).** Evaluation of grain yield and its components in wheat cultivars and landraces under near optimal and drought conditions', Euphytica, 113(1), pp. 43-52.doi: 10.1023/A: 003997700865.

**Economic Affairs Sector (E. A. S.).Bulletin of**

**The Agricultural Statistics Part (1)** winter crops (2022) Arab republic of Egypt Minister of agriculture and land Reclamation.

**Elgammaal**, **A, A; R. M. Koumber, H. M. Ashry and I. A. Marey, (2023).** Assessment of some Promising Bread Wheat Genotypes under Water Deficit Conditions JSAES 2023, 2(3), 17-37. DOI: 10.21608/jsaes.2023.214901.103**.**

**El-Hawary, M.N.A. (2015).** Genetic analysis of various yield contributing and physiological traits in bread wheat under normal and water deficit conditions. Egypt. J. Plant Breed. 19 (3):13-36.

**El-Hosary, A.A., S.A. Sedhom, M.K. Khlifa and K. A. Bayoumi (2015). H**eterosis and combining ability analysis for bread wheat under stress and normal irrigation treatments. Egypt. J. Plant Breed. 19(5): 87-10.

**Farshadfar, E., F. Rafiee and H. Hasheminasab (2013).** Evaluation of genetic parameters of agronomic and morpho-physiological indicators of drought tolerance inbread wheat (Triticum aestivum L.) using diallel mating design. Aust. J. Crop Sci.7(2): 268-275.

**Fouad, HM (2018).** Correlation, path and regression analysis in some bread wheat (Triticum aestivum L.) genotypes under normal irrigation and drought conditions. Egypt J. Agron. Vol. 40, No. 2, pp133-144.

**Gomaa, M.A., M.N.M. El-Banna, A.M. Gadalla, E.E. Kandil and A.R.H. Ibrahim (2014).** Heterosis, combining ability and drought susceptibility index in some crosses of bread wheat (Triticum aestivum L.) under water stress conditions.MiddleEastJ. ofAgric.Res., 3(2).338-345.

**Griffing's, B. (1956)**. Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci. 9: 463-493.

**Hayman, B. I. (1954a)**.The analysis of variance f diallel tables. Biometrics10:235-244.

**Hayman, B. I. (1954b).** The theory and analysis of diallel crosses. Genetics39:789-809.

**Jatoi, W.A., M.J. Baloch, N.U. Khan, M. Munir, A.A. Khakwani, N.F. Vessar, S.A. Panhwar and S. Gul (2014).** Heterosis for yield and physiological traits in wheat under water stress conditions. J. Anim. Plant Sci. 24(1): 252-261.

**Katta, Y.S., M.S. Abdelaty, A.A. Hagras and A.M. Sharshar (2013**). Combining ability and heterosis for bread wheat under stress and normal irrigation treatments. Egypt. J. Plant Breed.17(2):16-41.

**Kheiralla, K, El-Morshidy, M, M H Motawea, Saeid, A (2004).** ‹Performance and stability of some wheat genotypes under normal and water stress conditions›, AssiutJ.Agric. Sci., 35, pp. 74-94.

**Mady, B. E. M. (2023)**. A contribution to improve wheat response against drought stress. (MSc), Kafrelsheikh University., Egypt..

**Mohamed, A.A., K.I.M. Ibrahim, H.S. Ibrahim and Amany N. Sayed (2014**). Heterosis and combining ability for some agronomic and physiological traits in bread wheat crosses under water stress condition. Egypt. J. Plant Breed. 3(18): 551 -582.

**Noreldin, T, M. S. M. Mahmoud (2017).** Evaluation of some Wheat Genotypes under Water Stress Conditions in Upper Egypt Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (6): 257 – 265.

**Saleh, S.H. (2011).** Genetic parameters of diallel crosses in bread wheat under normal irrigation and drought conditions. Egypt J. Plant Breed. 15(3): 85-107.

**Salem, M. A. (2005).** Effect of nitrogen rates and irrigation regimes on yield and yield components of bread wheat (Triticum aestivum L.) Genotypes under newly reclaimed land conditions'. J. Agric. Sci., Mansoura Univ., Egypt, 30, pp. 6481-6490

**Semahegn Y, Shimelis H, Laing M, Mathew I (2021).** Genetic variability and association of yield and yield components among bread wheat genotypes under drought-stressed. Australian Journal of Crop Science. AJCS 15(06):863-870 doi: 10.21475/ajcs.21.15.06.p2987.

**Semahegn Y., Shimelis H., Laing M., Mathew I. (2020)** Evaluation of bread wheat (*Triticum aestivum* L.) genotypes for yield and related traits under drought stress conditions Acta Agriculture Scandinavia, Section B – Soil &Science Volume 70, Issue6 https://doi.org/10.1080/09064710.2020.1767802**S**

**Shalaby M. M, E. H. Galal l, M.B. Ali, A. Amro and A. El amly (2020).** Growth and yield responses of ten wheat (Triticum aestivum L) genotypes to drought SVU- International Journal of Agricultural Science, 2(2):117, Doi:10.21608/svuijas.2020.31707.1011.

**Siyal, A.L.(2021)**.Yield from genetic variability of bread wheat (Triticum aestivum L.) genotypes under water stress condition: A case study of tandojam, Sindh .Pure and Applied Biology, 10 (3). DOI: 10. 19045 / bspab.2021. 100087.

**Snedecor, G.W. and W.G. Cochran (1989)** Statistical Method. 8th cd. Iowa State Univ. Press, Ames. Iowa. USA

**Tawfelis, M (2006).** 'Using biplot technique in wheat breeding under different environmental stresses', Egypt J. Plant Breed, 10, pp. 167- 200.

**تقييم بعض التراكيب الوراثية للقمح تحت ظروف الري العادي ونقص المياه في شمال الدلتا**

**محمد سعد مغازي عبدالعاطي[١]، خالد محمد جاد[٢]، محمد عبدالسلام عيد[٣]، مروي محمد النحاس[٤] و مصطفي عمرشحاته[١]**
[١] قسم المحاصيل – كلية الزراعة – جامعة كفرالشيخ
[٢] قسم بحوث القمح – معهد المحاصيل الحقلية –مركز البحوث الزراعية
[٣] قسم المحاصيل – كلية الزراعة – جامعة الفيوم
[٤] قسم المحاصيل – كلية الزراعة – جامعة المنوفيه

يؤدي نقص مياه الري الي نقص قيم متوسطات الصفات الخضرية والمحصول ومكوناته لمحصول القمح . لذلك تم تقييم سبعة تراكيب وراثية مختلفة وتضم ثلاث سلالات مستوردة (سلالة ١١٧،١١٥ و ١٣٦) وأربعة أصناف محلية ( سخا ٩٥، سدس١٤، جميزة١١ و مصر٢) بالإضافة الي الهجن الناتجة منها في المزرعة البحثية بكلية الزراعة –جامعةكفرالشيخ - خلال موسمي ٢٠٢١/٢٠٢٠ و ٢٠٢٢/٢٠٢١ في تصميم القطاعات الكاملة العشوائية بثلاث مكررات، تحت ظروف الري العادي ( أربعة ريات بالإضافة الي رية الزراعة ) ونقص الري ( رية واحدة بالإضافة الي رية الزراعة )، بهدف تقدير القدرة علي التآلف وطبيعة الفعل الجيني لبعض الصفات الخضرية والمحصول ومكوناته . وقد أظهرت النتائج أن نقص عدد مرات الري أدي الي نقص قيم متوسطات جميع الصفات المدروسة للآباء وهجنها بالمقارنة بالري العادي .

كانت قيم تباين القدرة العامة علي الائتلاف أعلا منها لقيم تباين القدرة الخاصة علي الائتلاف لجميع الصفات المدروسة فيما عدا صفتي طول السنبلة وعدد حبوب السنبلة لكلا المعاملتين، بالإضافة الي وزن الالف حبة تحت ظروف الري العادي، مما يوضح أن الفعل الجيني المضيف كان أكثر أهمية في وراثة هذه الصفات . وتشير النتائج الي أن الصنف مصر٢ والسلالة ١٣٩ كانا الأفضل في القدرة العامة علي الائتلاف بالنسبة لصفة التبكير، في حين كان الصنف سخا ٩٥ والسلالة ١١٥ هما الافضل في القدرة العامة علي الائتلاف لصفة محصول الحبوب ومعظم مكوناته تحت ظروف الري العادي ونقص الري.

أشارت النتائج الي أن الهجينين جميزة ١١ × سلالة ١١٤ و سلالة١١٧ × سلالة ١١٦ يعتبران من الهجن المتميزة في قدرتهما الخاصة علي التآلف لصفة التبكير تحت ظروف الري العادي ونقص المياه، في حين كان الهجين مصر × سلالة ١٣٦ الأفضل لصفة المحصول تحت ظروف الري العادي ونقص المياه . كان الفعل الجيني المضيف (D) والفعل السيادي ( H١) هامين في وراثة الصفات المدروسة وكان الفعل الجيني المضيف أكثر أهمية في وراثة جميع الصفات المدروسة تحت ظروف الري العادي ونقص المياه فيما عدا صفتي مساحة الورقة العلم ومحتوي الكلوروفيل تحت ظروف نقص مياه الري. مما يدل علي امكانية استخدام هذه الهجن في برامج التربية لتحسين القدرة المحصولية تحت ظروف الري العادي وظروف نقص مياه الري.