

Estimation of combining ability and superiority percentage of half diallel crosses between yellow maize inbred lines for growth characters and some diseases resistance

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ABSTRACT

Half diallel cross among ten yellow maize inbred lines was made at Sakha Agriculture Research Station during the growing season 2015. The resultant 45 crosses along with two commercial hybrids as yellow checks (single crosses 162 and 168) were evaluated at two field experiments in two years 2016 and 2017. The results indicated that, years (Y) mean squares had significant effects for all traits, except resistance to downy mildew disease. Genotypes (G) and crosses (Cr) mean squares had high significant effects for all traits in the two years and its combined data. However, G x Y and Cr x Y interaction were significant or highly significant for all traits. Mean squares due to general combining ability (GCA) and specific combining ability (SCA) were highly significant for all traits in the two years and their combined analysis. On the other side, the interactions between GCA and SCA with years were highly significant for all traits. For GCA / SCA and GCA x Y / SCA x Y mean squares ratio, the data pointed out that, this ratio exceeded the unity for all studied traits in two years and their combined. The inbred line P₄ had desirable significant of (\hat{g}_i) for earliness, good plant type, resistance to downy mildew and late wilt diseases, also the inbred line P₈ had desirable significant of (\hat{g}_i) for earliness and good plant type. The single crosses; P₁ x P₃, P₆ x P₇ and P₄ x P₅ had negative and significant values of (\hat{s}_{ij}) for good plant type and earliness. The single crosses P₁ x P₂, P₁ x P₈, P₂ x P₈, P₄ x P₈, P₅ x P₈, P₆ x P₈, P₇ x P₈, P₈ x P₉ and P₈ x P₁₀ had superiority percentage in desired direction over both check cultivars *i.e.*, SC 162 and SC 168 for earliness and good plant type.

Key words: combining ability, diallel analysis, maize, downy mildew and late wilt diseases.

INTRODUCTION

Breeding for high yielding ability and resistance to main disease, especially late wilt disease caused by *Cephalosporium maydis* and downy mildew caused by *Peronosclerospora sorghi* are considered among the main targets of National Maize Breeding Program in Egypt, to reduce feed and food crisis the amount of imported yellow maize grains. The most efficient, effective, environmentally safe and economic means to control late wilt and downy mildew diseases of maize is to use resistant varieties.

Late wilt is one of the major diseases affecting maize in Egypt. Among tests to evaluate hybrids in Egypt is evaluation for yield potentiality and resistance to late wilt under artificial infection. Samra *et al.* (1962) were the first isolated the pathogen from the roots and stems of wilting maize plants in 1960 and identified the late wilt pathogen as *Cephalosporium maydis*. Sabet *et al.* (1970) reported that *C. maydis* infected young plants easily but when the plants aged, few plants were infected and none infected after approximately 50 days from sowing. The information of the type of gene action that control resistance is very important for breeders in planning the most appropriate and effective breeding method to improve the trait. El-Itriby *et al.* (1984) and Amer *et al.* (2002) reported that,

dominance and epistasis were the major contributors to inheritance of resistance to late wilt. Galal *et al.* (1979), Nawar and Salem (1985) and Mosa and Motawei (2005) indicated that, the additive gene effects played the major role in the expression of the resistance to the late wilt.

Sorghum downy mildew (SDM) is one of the most destructive diseases of maize in Egypt, especially in Delta region. The symptoms of SDM are characterized in that leaves of infected plants are narrower and more erect than those of healthy plants and diseased plants may have phylloclad tassels. In 1928 growing season, SDM disease was first identified on maize sowings adjacent to sorghum fields in Egypt (Melchers, 1931) at Giza Agricultural experimental farm belonging to the Ministry of Agriculture. The SDM disease was not listed as serious disease for either sorghum or maize in Egypt until 1975 (Salama, 1976). Since that time, this disease is of economic importance. In the last few years, SDM disease started to be one of the serious diseases on maize in Egypt, especially in Delta region as a result of wide spread of sorghum sowings in this region, which is considered the main host plant and spreader of the *P. sorghi*. Maize is also considered the second host of the downy mildew pathogen. Therefore, greater efforts are attempted by Egyptian maize breeders to look for

sources of resistance to this disease and to transfer the resistance to the commercial hybrids and varieties. Knowledge of the type of gene action of maize resistance is necessary in planning the most appropriate and effective breeding program to improve the trait. **El-Shenawy (1995)**, **Amer et al. (2002)** and **Nair et al. (2004)** found that, the additive gene effects played the major role in the expression of resistance to the downy mildew. While, **Kaneko and Aday (1980)** and **Mosa et al. (2009)** reported that, the non-additive gene action was important in controlling the behavior of resistance to downy mildew disease.

Diallel crosses have been widely used in genetic research to determine general and specific combining abilities (GCA and SCA) and nature of gene action for many traits. Analysis of diallel data is usually conducted according to the methods of **Griffing (1956)** which partition the total variation of diallel data into GCA of the parents and SCA of the crosses. Combining ability information is necessary for selection of suitable advanced lines for hybridization and identification of promising hybrids.

The main objectives of the present work are to identify the type of gene action that control the inheritance of all studied traits, estimate of general combining ability effects for ten yellow inbred lines and specific combining ability effects for their crosses and estimate the percentage of superiority for diseases resistance and some maize growth characters.

MATERIALS AND METHODS

This investigation was carried out at Sakha Agriculture Research Stations, Agric. Res. Center, Egypt, during the three summer growing seasons of 2015, 2016 and 2017. Ten yellow inbred lines of maize provided by the maize research program, Field Crop Research Institute (FCRI) of the Agricultural Research Center (ARC), Egypt, were chosen for this study. Half diallel crosses among the inbred lines was made. During 2015 growing season producing 45 yellow single crosses. The 45 F₁ hybrids and two commercial hybrids as checks (single crosses 162 and 168) were evaluated in two field experiments in the years of 2016 and 2017.

The first experiment was evaluated under artificial soil inoculation by *Cephalosporium maydis* to study the resistance to late wilt (RLW), days to 50% silking, plant height, ear height and ear position. Meanwhile, the second experiment was done under artificial inoculation of *Perenosclerospora sorghi* to study the resistance to downy mildew (RDM). The resistant plants were taken as percentage in the two years as following.

Resistance % = $\left[\frac{\text{No. of uninfected plants per plot}}{\text{No. of total plants per plot}} \times 100 \right]$

No. of total plants per plot

A randomized complete blocks design (RCBD) was used in each year for each trial with four replications. Each plot consisted of one row, 4m long, 80cm apart and the distance between hills was 25cm. All cultural practices for growing maize were conducted as recommended. Analysis of variance was carried-out according to **Steel and Torrie (1980)**. Combined analysis was done in case of errors homogeneity **Bartlett (1937)**. General (GCA) and specific (SCA) combining ability variance and effects were estimated according to **Griffing (1956)** method 4, model 1. The superiority percentage for different characters was measured by comparing each hybrid with the check hybrids.

RESULTS AND DISCUSSION

Analysis of variance of 45 F₁ and two checks for the vegetative traits, resistance to downy mildew and late wilt diseases in two years and their combined data are presented in Table 1. Results indicated that, years (Y) mean squares were highly significant for days to 50% silking, ear height, ear position and resistance to late wilt disease, while, plant height had significant years mean squares, indicating that these traits might be changed in performance from year to another. Genotypes (G) and crosses (Cr) mean squares were highly significant for all traits in the two years and their combined data, indicating the wide diversity between the genotypes and crosses used in this study. Checks (Ch) mean squares were significant and / or highly significant for all traits, except for 50% silking date, resistance to downy mildew, ear height in the first year and resistance to late wilt in the first year and their combined data. Cr vs. Ch mean squares were significant and / or highly significant for all traits, except for resistance to downy mildew in the two years and their combined data and resistance to late wilt in the second year.

Table 1: Mean squares from analysis of variance of 45 F₁ and two checks for the vegetative traits, resistance to downy mildew and late wilt diseases in two years and their combined data.

| S.O.V. | d.f. | | Days to 50% silking (day) | | | Plant height (cm) | | | Ear height (cm) | | |
|---------------|--------|------|---------------------------|----------------|----------|-------------------|----------------|-----------|-----------------|----------------|-----------|
| | Single | Comb | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. |
| Years (Y) | . | 1 | . | . | 189.59** | . | . | 14130.3* | . | . | 10019.8** |
| Rep/ Y | . | 6 | . | . | 6.662 | . | . | 1483.90 | . | . | 686.573 |
| Genotypes (G) | 46 | 46 | 19.62** | 10.60** | 27.66** | 1195.2** | 1232.3** | 2209.7** | 1431.3** | 702.98** | 1959.23** |
| Crosses (Cr) | 44 | 44 | 17.56** | 10.02** | 25.14** | 927.07** | 951.82** | 1663.7** | 1258.5** | 574.78** | 1661.13** |
| Checks (Ch) | 1 | 1 | 4.500 | 1.125 | 5.062 | 5512.5** | 9800.0** | 15006.2** | 264.50 | 1225.1** | 1314.06** |
| Cr vs Ch | 1 | 1 | 125.6** | 45.45** | 161.11** | 8673.9** | 5008.8** | 13434.6** | 10204.5** | 5821.8** | 15720.8** |
| G × Y | . | 46 | . | . | 2.566** | . | . | 217.84** | . | . | 175.147** |
| Cr × Y | . | 44 | . | . | 2.442** | . | . | 215.10** | . | . | 172.175** |
| Ch × Y | . | 1 | . | . | 0.563 | . | . | 306.250 | . | . | 175.562 |
| Cr vs Ch × Y | . | 1 | . | . | 9.973** | . | . | 230.240 | . | . | 305.590* |
| Error | 138 | 276 | 1.452 | 1.295 | 1.374 | 93.473 | 65.877 | 79.675 | 86.731 | 54.686 | 70.709 |

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

Table 1:Cont.

| SOV. | d.f. | | Ear position (%) | | | Resistance to downy mildew disease (%) | | | Resistance to late wilt disease(%) | | |
|---------------|--------|------|------------------|----------------|----------|--|----------------|----------|------------------------------------|----------------|----------|
| | Single | Comb | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. |
| Years (Y) | . | 1 | . | . | . | . | . | 116.284 | . | . | 1935.5** |
| Rep/Y | . | 6 | . | . | . | . | . | 58.266 | . | . | 28.188 |
| Genotypes (G) | 46 | 46 | 105.03** | 66.027** | 66.027** | 283.15** | 199.88** | 341.52** | 720.37** | 234.76** | 544.53** |
| Crosses (Cr) | 44 | 44 | 99.700** | 62.154** | 62.154** | 291.90** | 203.09** | 356.96** | 734.10** | 234.63** | 557.68** |
| Checks (Ch) | 1 | 1 | 93.297** | 62.384** | 62.384** | 172.05 | 250.88 | 3.705 | 16.531 | 471.24* | 155.62 |
| Cr vs Ch | 1 | 1 | 351.69** | 240.08** | 240.08** | 9.527 | 7.659 | 0.043 | 820.20** | 4.001 | 354.79* |
| G × Y | . | 46 | . | . | . | . | . | 141.51** | . | . | 410.60** |
| Cr × Y | . | 44 | . | . | . | . | . | 138.03** | . | . | 411.05** |
| Ch × Y | . | 1 | . | . | . | . | . | 419.22* | . | . | 332.15* |
| Cr vs Ch × Y | . | 1 | . | . | . | . | . | 17.143 | . | . | 469.40* |
| Error | 138 | 276 | 3.821 | 4.870 | 4.870 | 78.800 | 71.498 | 75.149 | 60.868 | 84.953 | 72.911 |

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

The mean squares of G x Y and Cr x Y interactions were highly significant for all traits. This results might indicate that, the performance of genotypes and crosses were affected by change in years. Ch x Y interaction was significant only for resistance to downy mildew and late wilt diseases. While, Cr vs. Ch x Y interaction was highly significant for 50% silking date and significant only for ear height and resistance to late wilt disease. The obtained results were in good harmony with those reported by **Abd El-Hadi et al. (2005)** where they found that, the difference among genotypes and crosses were highly significant for days to 50% silking, plant height and ear height. While, the interaction between genotypes x years exhibited significant differences for days to 50% silking. **Galal (2014)** found that, the differences among genotypes and crosses were significant or highly significant for days to 50% silking, plant height, ear height and resistance to late wilt disease. The interaction between genotypes and crosses with environments was significant and / or highly significant for all traits. This indicated that, these genotypes and crosses differed in their order from environment to another for all traits. **El-Gazzar (2015)** found that, the crosses x environment interaction was significant for days to 50% silking, plant height, ear height and resistance to downy mildew disease. **Murtadha et al. (2016)** found that, the interaction between crosses and environments was significant or highly significant for 50% silking date and plant height.

Mean performance of 45 F₁ crosses and two check hybrids for the vegetative traits, resistance to downy mildew and late wilt diseases in two years and combined data are shown in Table 2. For days to 50 % silking, the crosses means ranged from 56.25 to 66.0, 57.5 to 64.75 and 56.88 to 65.25 for the first year, the second year and their combined, respectively. The crosses; P₁ x P₄, P₂ x P₃, P₂ x P₄, P₂ x P₅, P₂ x P₈, P₂ x P₉, P₂ x P₁₀, P₃ x P₈, P₄ x P₆, P₄ x P₇, P₄ x P₈, P₅ x P₈, P₆ x P₈, P₇ x P₈, P₇ x P₉, P₈ x P₉, P₈ x P₁₀ and P₉ x P₁₀ were significantly earlier than the earliest check SC168 in two years and their combined while, the crosses; P₁ x P₂, P₁ x P₅, P₁ x P₆, P₁ x P₈, P₁ x P₉, P₁ x P₁₀, P₂ x P₇, P₄ x P₅, P₄ x P₉, P₄ x P₁₀, P₅ x P₇, P₆ x P₇, P₆ x P₁₀ and P₇ x P₁₀ were significantly earlier than both checks in the first year and their combined. Regarding plant height, the crosses means ranged from 224.25 to 290.25, 218.75 to 279.0 and 224.88 to 284.63 for the first year, the second year and their combined, respectively. The cross P₁ x P₈ in two years and their combined had desired and significant shorter plants than both checks. While, the crosses P₂ x P₈, P₃ x P₈, P₄ x P₈, P₇ x P₈, P₈ x P₉ and P₈ x P₁₀, in the first year and their combined, the cross P₁ x P₃ in the second year and their combined and the crosses; P₁ x P₁₀ and P₅ x P₈ in the first year had desired and

significant shorter plants than the shortest check SC168. Data in Table 2 concerning ear height exhibited that, the means ranged from 96.0 to 177.5, 100.75 to 148.25 and 99.75 to 160.5 for the first year, the second year and their combined, respectively. The crosses; P₁ x P₂, P₁ x P₃, P₁ x P₄, P₁ x P₇, P₁ x P₈, P₁ x P₉, P₂ x P₇, P₂ x P₈, P₂ x P₉, P₃ x P₈, P₄ x P₅, P₄ x P₇, P₄ x P₈, P₄ x P₉, P₅ x P₈, P₆ x P₇, P₆ x P₈, P₇ x P₈, P₇ x P₉, P₈ x P₉ and P₈ x P₁₀ in the two years and their combined had significant lower ear height than the two checks. While, all crosses in the first year and their combined, except P₁ x P₆, P₃ x P₄, P₃ x P₅, P₃ x P₆, P₃ x P₉, P₃ x P₁₀, P₅ x P₆, P₅ x P₁₀ and P₆ x P₉ had significant lower ear height than the two cultivar checks. For ear position, it ranged from 42.85 to 63.46, 45.05 to 60.36 and 43.99 to 61.65 for the first year, the second year and their combined, respectively. The crosses; P₁ x P₂, P₁ x P₇, P₁ x P₈, P₂ x P₅, P₂ x P₇, P₂ x P₈, P₂ x P₉, P₄ x P₇, P₄ x P₈, P₅ x P₇, P₅ x P₈, P₆ x P₇, P₆ x P₈, P₇ x P₈, P₇ x P₉ and P₈ x P₉ in the two years and their combined and the crosses; P₂ x P₄, P₂ x P₆, P₄ x P₆ and P₇ x P₁₀ in the first year and their combined had significantly better ear position than the hybrid checks in comparison. Considering resistance to downy mildew disease, the means ranged from 59.25 to 100.0, 58.5 to 100.0 and 58.88 to 100.0 for the first year, the second year and their combined, respectively. The crosses; P₁ x P₆, P₁ x P₇, P₁ x P₁₀, P₂ x P₃, P₂ x P₄, P₂ x P₇, P₃ x P₇, P₃ x P₈, P₃ x P₉, P₃ x P₁₀, P₄ x P₆, P₄ x P₇, P₄ x P₉, P₅ x P₇, P₆ x P₇, P₆ x P₈, P₆ x P₁₀, P₇ x P₉, P₇ x P₁₀, P₈ x P₉, P₈ x P₁₀ and P₉ x P₁₀ had high resistance to downy mildew disease (more than 95%), in two years and their combined. Regarding resistance to late wilt disease, the crosses means ranged from 44.25 to 100.0, 57.5 to 98.5 and 65.38 to 99.13 for the first year, the second year and their combined, respectively. The crosses; P₁ x P₄, P₂ x P₁₀ and P₄ x P₁₀ in both years and their combined and the crosses; P₁ x P₂, P₁ x P₃, P₁ x P₉, P₃ x P₅, P₃ x P₉, P₃ x P₁₀, P₄ x P₅, P₄ x P₆, P₄ x P₉, P₇ x P₁₀ and P₈ x P₁₀ in the first year and their combined, had high resistance to late wilt disease (more than 95%). It could be concluded from the obtained results that, the crosses; P₁ x P₈, P₂ x P₈, P₄ x P₈, P₇ x P₈, P₈ x P₉ and P₈ x P₁₀ were better than the two hybrid checks for the vegetative traits toward earliness, shortness, low ear height and good ear position. While the crosses; P₁ x P₃, P₃ x P₅, P₃ x P₉, P₃ x P₁₀, P₄ x P₅, P₄ x P₆, P₄ x P₉, P₇ x P₁₀ and P₈ x P₁₀ had high resistance to downy mildew and late wilt diseases (more than 95%) over two years, indicated that these single crosses could be used in maize breeding programs for improvement of these traits.

Table 2: Mean performance of 45 F₁ crosses and two check hybrids for the vegetative traits, resistance to downy mildew and late wilt diseases in two years and combined data.

| Crosses | Days to 50% silking (day) | | | Plant height (cm) | | | Ear height (cm) | | | |
|----------------------------------|------------------------------|----------------|-------|-------------------|----------------|--------|-----------------|----------------|--------|--------|
| | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | |
| P ₁ x P ₂ | 60.25 | 62.50 | 61.38 | 249.00 | 231.75 | 240.38 | 123.25 | 111.25 | 117.25 | |
| P ₁ x P ₃ | 63.75 | 63.75 | 63.75 | 248.75 | 222.50 | 235.63 | 144.50 | 124.00 | 134.25 | |
| P ₁ x P ₄ | 61.75 | 62.00 | 61.88 | 260.25 | 239.00 | 249.63 | 139.25 | 127.00 | 133.13 | |
| P ₁ x P ₅ | 61.75 | 63.00 | 62.38 | 277.00 | 264.75 | 270.88 | 149.75 | 136.25 | 143.00 | |
| P ₁ x P ₆ | 61.75 | 63.25 | 62.50 | 277.50 | 254.00 | 265.75 | 154.25 | 143.25 | 148.75 | |
| P ₁ x P ₇ | 61.50 | 64.00 | 62.75 | 270.25 | 250.00 | 260.13 | 129.25 | 118.50 | 123.88 | |
| P ₁ x P ₈ | 60.00 | 62.25 | 61.13 | 231.00 | 218.75 | 224.88 | 115.75 | 109.00 | 112.38 | |
| P ₁ x P ₉ | 61.50 | 63.25 | 62.38 | 251.25 | 239.00 | 245.13 | 138.00 | 125.00 | 131.50 | |
| P ₁ x P ₁₀ | 61.50 | 62.75 | 62.13 | 246.25 | 241.75 | 244.00 | 140.75 | 135.75 | 138.25 | |
| P ₂ x P ₃ | 60.75 | 61.50 | 61.13 | 256.00 | 242.00 | 249.00 | 144.50 | 130.50 | 137.50 | |
| P ₂ x P ₄ | 59.00 | 61.75 | 60.38 | 273.25 | 268.50 | 270.88 | 142.00 | 136.25 | 139.13 | |
| P ₂ x P ₅ | 58.00 | 61.50 | 59.75 | 267.25 | 265.00 | 266.13 | 132.00 | 132.25 | 132.13 | |
| P ₂ x P ₆ | 62.25 | 63.75 | 63.00 | 267.75 | 267.50 | 267.63 | 134.75 | 135.00 | 134.88 | |
| P ₂ x P ₇ | 61.00 | 63.50 | 62.25 | 255.50 | 246.00 | 250.75 | 111.00 | 113.50 | 112.25 | |
| P ₂ x P ₈ | 56.25 | 57.50 | 56.88 | 224.25 | 229.50 | 226.88 | 96.00 | 103.50 | 99.75 | |
| P ₂ x P ₉ | 59.00 | 61.00 | 60.00 | 261.00 | 261.00 | 261.00 | 123.00 | 119.75 | 121.38 | |
| P ₂ x P ₁₀ | 59.00 | 61.00 | 60.00 | 269.25 | 257.25 | 263.25 | 142.00 | 138.75 | 140.38 | |
| P ₃ x P ₄ | 62.25 | 63.00 | 62.63 | 260.75 | 230.25 | 245.50 | 163.00 | 139.00 | 151.00 | |
| P ₃ x P ₅ | 62.50 | 63.00 | 62.75 | 273.75 | 244.50 | 259.13 | 167.00 | 138.50 | 152.75 | |
| P ₃ x P ₆ | 66.00 | 64.50 | 65.25 | 281.25 | 248.75 | 265.00 | 177.50 | 143.50 | 160.50 | |
| P ₃ x P ₇ | 62.00 | 62.50 | 62.25 | 259.75 | 246.00 | 252.88 | 141.50 | 136.50 | 139.00 | |
| P ₃ x P ₈ | 59.25 | 60.75 | 60.00 | 244.25 | 222.75 | 233.50 | 134.25 | 120.00 | 127.13 | |
| P ₃ x P ₉ | 64.00 | 63.75 | 63.88 | 277.25 | 241.25 | 259.25 | 169.00 | 133.50 | 151.25 | |
| P ₃ x P ₁₀ | 62.75 | 64.75 | 63.75 | 257.50 | 230.25 | 243.88 | 163.50 | 137.75 | 150.63 | |
| P ₄ x P ₅ | 59.00 | 62.25 | 60.63 | 251.00 | 241.00 | 246.00 | 135.50 | 129.50 | 132.50 | |
| P ₄ x P ₆ | 59.75 | 61.50 | 60.63 | 265.00 | 248.25 | 256.63 | 136.25 | 129.75 | 133.00 | |
| P ₄ x P ₇ | 60.75 | 62.00 | 61.38 | 256.00 | 248.25 | 252.13 | 123.50 | 119.00 | 121.25 | |
| P ₄ x P ₈ | 57.00 | 60.00 | 58.50 | 239.75 | 226.50 | 233.13 | 117.00 | 112.50 | 114.75 | |
| P ₄ x P ₉ | 61.25 | 62.75 | 62.00 | 252.75 | 236.75 | 244.75 | 133.75 | 118.25 | 126.00 | |
| P ₄ x P ₁₀ | 61.50 | 63.00 | 62.25 | 250.00 | 247.50 | 248.75 | 144.00 | 135.25 | 139.63 | |
| P ₅ x P ₆ | 63.25 | 63.00 | 63.13 | 279.75 | 265.00 | 272.38 | 154.75 | 136.75 | 145.75 | |
| P ₅ x P ₇ | 61.75 | 63.25 | 62.50 | 290.25 | 279.00 | 284.63 | 149.00 | 136.00 | 142.50 | |
| P ₅ x P ₈ | 57.25 | 59.75 | 58.50 | 242.00 | 243.00 | 242.50 | 114.50 | 115.50 | 115.00 | |
| P ₅ x P ₉ | 62.25 | 64.50 | 63.38 | 278.00 | 263.50 | 270.75 | 150.50 | 138.00 | 144.25 | |
| P ₅ x P ₁₀ | 62.00 | 63.50 | 62.75 | 274.25 | 265.25 | 269.75 | 156.50 | 148.25 | 152.38 | |
| P ₆ x P ₇ | 60.50 | 62.25 | 61.38 | 262.00 | 262.50 | 262.25 | 125.25 | 121.00 | 123.13 | |
| P ₆ x P ₈ | 59.00 | 59.25 | 59.13 | 250.25 | 233.25 | 241.75 | 125.50 | 112.25 | 118.88 | |
| P ₆ x P ₉ | 63.00 | 63.50 | 63.25 | 270.50 | 267.75 | 269.13 | 152.50 | 145.75 | 149.13 | |
| P ₆ x P ₁₀ | 59.75 | 62.50 | 61.13 | 261.50 | 253.75 | 257.63 | 145.75 | 136.00 | 140.88 | |
| P ₇ x P ₈ | 57.75 | 60.50 | 59.13 | 230.25 | 229.00 | 229.63 | 102.75 | 108.00 | 105.38 | |
| P ₇ x P ₉ | 61.25 | 62.00 | 61.63 | 257.25 | 266.75 | 262.00 | 128.00 | 123.00 | 125.50 | |
| P ₇ x P ₁₀ | 60.75 | 62.25 | 61.50 | 268.00 | 262.75 | 265.38 | 137.50 | 133.75 | 135.63 | |
| P ₈ x P ₉ | 57.50 | 58.25 | 57.88 | 226.75 | 223.75 | 225.25 | 106.75 | 100.75 | 103.75 | |
| P ₈ x P ₁₀ | 56.75 | 60.50 | 58.63 | 246.00 | 230.75 | 238.38 | 132.50 | 116.75 | 124.63 | |
| P ₉ x P ₁₀ | 61.75 | 61.50 | 61.63 | 256.75 | 255.50 | 256.13 | 140.00 | 135.75 | 137.88 | |
| Checks | SC162 | 65.50 | 65.00 | 65.25 | 318.75 | 307.50 | 313.13 | 179.75 | 167.50 | 173.63 |
| | SC168 | 64.00 | 64.25 | 64.13 | 266.25 | 237.50 | 251.88 | 168.25 | 142.75 | 155.50 |
| LSD | 0.01 | 2.19 | 2.07 | 1.51 | 17.63 | 14.80 | 11.51 | 16.98 | 13.49 | 10.84 |

Table 2: Cont.

| Crosses | Ear position (%) | | | Resistance to downy mildew disease (%) | | | Resistance to late wilt disease (%) | | | |
|----------------------------------|------------------|----------------|-------|--|----------------|--------|-------------------------------------|----------------|-------|-------|
| | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | |
| P ₁ x P ₂ | 49.53 | 48.08 | 48.80 | 88.75 | 98.25 | 93.50 | 100.00 | 90.50 | 95.25 | |
| P ₁ x P ₃ | 58.06 | 55.71 | 56.88 | 92.00 | 100.00 | 96.00 | 99.00 | 91.50 | 95.25 | |
| P ₁ x P ₄ | 53.50 | 53.05 | 53.28 | 89.00 | 91.75 | 90.38 | 100.00 | 97.50 | 98.75 | |
| P ₁ x P ₅ | 54.13 | 51.48 | 52.81 | 100.00 | 94.75 | 97.38 | 58.00 | 95.25 | 76.63 | |
| P ₁ x P ₆ | 55.67 | 56.38 | 56.02 | 100.00 | 95.25 | 97.63 | 87.00 | 95.75 | 91.38 | |
| P ₁ x P ₇ | 47.89 | 47.50 | 47.69 | 97.00 | 97.50 | 97.25 | 100.00 | 86.50 | 93.25 | |
| P ₁ x P ₈ | 50.10 | 49.83 | 49.96 | 94.50 | 97.00 | 95.75 | 68.25 | 76.25 | 72.25 | |
| P ₁ x P ₉ | 54.97 | 52.30 | 53.64 | 85.75 | 86.75 | 86.25 | 100.00 | 93.00 | 96.50 | |
| P ₁ x P ₁₀ | 57.13 | 56.12 | 56.62 | 98.50 | 97.25 | 97.88 | 98.00 | 85.50 | 91.75 | |
| P ₂ x P ₃ | 56.42 | 53.96 | 55.19 | 97.50 | 100.00 | 98.75 | 100.00 | 88.50 | 94.25 | |
| P ₂ x P ₄ | 51.95 | 50.72 | 51.34 | 100.00 | 98.50 | 99.25 | 83.50 | 90.75 | 87.13 | |
| P ₂ x P ₅ | 49.39 | 50.00 | 49.69 | 93.25 | 94.00 | 93.63 | 96.00 | 89.25 | 92.63 | |
| P ₂ x P ₆ | 50.27 | 50.46 | 50.36 | 95.00 | 97.25 | 96.13 | 87.00 | 93.00 | 90.00 | |
| P ₂ x P ₇ | 43.46 | 46.12 | 44.79 | 97.75 | 98.75 | 98.25 | 95.25 | 87.25 | 91.25 | |
| P ₂ x P ₈ | 42.85 | 45.12 | 43.99 | 81.75 | 98.50 | 90.13 | 48.00 | 82.75 | 65.38 | |
| P ₂ x P ₉ | 47.13 | 45.86 | 46.49 | 59.25 | 58.50 | 58.88 | 94.25 | 95.00 | 94.63 | |
| P ₂ x P ₁₀ | 52.71 | 53.90 | 53.31 | 88.00 | 93.50 | 90.75 | 99.00 | 98.50 | 98.75 | |
| P ₃ x P ₄ | 62.46 | 60.36 | 61.41 | 83.75 | 98.50 | 91.13 | 100.00 | 90.00 | 95.00 | |
| P ₃ x P ₅ | 61.01 | 56.64 | 58.83 | 93.75 | 100.00 | 96.88 | 97.00 | 94.25 | 95.63 | |
| P ₃ x P ₆ | 63.11 | 57.55 | 60.33 | 93.25 | 98.50 | 95.88 | 100.00 | 86.00 | 93.00 | |
| P ₃ x P ₇ | 54.43 | 55.45 | 54.94 | 97.75 | 100.00 | 98.88 | 97.00 | 92.00 | 94.50 | |
| P ₃ x P ₈ | 54.97 | 53.87 | 54.42 | 100.00 | 96.50 | 98.25 | 100.00 | 89.00 | 94.50 | |
| P ₃ x P ₉ | 60.95 | 55.19 | 58.07 | 98.00 | 96.00 | 97.00 | 100.00 | 92.00 | 96.00 | |
| P ₃ x P ₁₀ | 63.46 | 59.85 | 61.65 | 97.50 | 100.00 | 98.75 | 100.00 | 94.00 | 97.00 | |
| P ₄ x P ₅ | 53.98 | 53.71 | 53.85 | 100.00 | 94.00 | 97.00 | 97.50 | 93.50 | 95.50 | |
| P ₄ x P ₆ | 51.35 | 52.27 | 51.81 | 100.00 | 98.75 | 99.38 | 100.00 | 90.00 | 95.00 | |
| P ₄ x P ₇ | 48.30 | 47.90 | 48.10 | 97.00 | 98.00 | 97.50 | 90.75 | 88.75 | 89.75 | |
| P ₄ x P ₈ | 48.85 | 49.66 | 49.25 | 100.00 | 91.50 | 95.75 | 96.75 | 90.25 | 93.50 | |
| P ₄ x P ₉ | 52.94 | 49.96 | 51.45 | 100.00 | 97.50 | 98.75 | 100.00 | 91.25 | 95.63 | |
| P ₄ x P ₁₀ | 57.54 | 54.63 | 56.08 | 97.00 | 92.50 | 94.75 | 100.00 | 98.25 | 99.13 | |
| P ₅ x P ₆ | 55.32 | 51.57 | 53.44 | 100.00 | 90.25 | 95.13 | 82.00 | 97.00 | 89.50 | |
| P ₅ x P ₇ | 51.38 | 48.71 | 50.04 | 96.00 | 98.75 | 97.38 | 86.00 | 91.75 | 88.88 | |
| P ₅ x P ₈ | 47.28 | 47.56 | 47.42 | 94.75 | 90.75 | 92.75 | 67.75 | 89.75 | 78.75 | |
| P ₅ x P ₉ | 54.09 | 52.36 | 53.23 | 88.25 | 99.00 | 93.63 | 82.25 | 89.50 | 85.88 | |
| P ₅ x P ₁₀ | 57.07 | 55.87 | 56.47 | 84.50 | 98.50 | 91.50 | 96.75 | 92.50 | 94.63 | |
| P ₆ x P ₇ | 47.63 | 45.97 | 46.80 | 96.75 | 99.00 | 97.88 | 44.25 | 97.25 | 70.75 | |
| P ₆ x P ₈ | 50.19 | 48.12 | 49.16 | 97.25 | 98.75 | 98.00 | 95.50 | 80.75 | 88.13 | |
| P ₆ x P ₉ | 56.33 | 54.44 | 55.38 | 100.00 | 92.50 | 96.25 | 76.25 | 82.25 | 79.25 | |
| P ₆ x P ₁₀ | 55.66 | 53.59 | 54.62 | 100.00 | 100.00 | 100.00 | 91.75 | 96.75 | 94.25 | |
| P ₇ x P ₈ | 44.61 | 47.19 | 45.90 | 100.00 | 90.00 | 95.00 | 78.75 | 57.50 | 68.13 | |
| P ₇ x P ₉ | 49.74 | 46.12 | 47.93 | 100.00 | 99.00 | 99.50 | 85.75 | 76.75 | 81.25 | |
| P ₇ x P ₁₀ | 51.33 | 50.97 | 51.15 | 98.50 | 100.00 | 99.25 | 99.00 | 94.25 | 96.63 | |
| P ₈ x P ₉ | 47.12 | 45.05 | 46.08 | 99.00 | 99.00 | 99.00 | 91.75 | 71.75 | 81.75 | |
| P ₈ x P ₁₀ | 53.87 | 50.66 | 52.26 | 98.25 | 100.00 | 99.13 | 98.75 | 92.75 | 95.75 | |
| P ₉ x P ₁₀ | 54.54 | 53.13 | 53.83 | 98.00 | 99.00 | 98.50 | 99.00 | 90.50 | 94.75 | |
| Checks | SC162 | 56.35 | 54.47 | 55.41 | 89.25 | 100.00 | 94.63 | 99.00 | 95.25 | 97.13 |
| | SC168 | 63.18 | 60.06 | 61.62 | 98.00 | 95.00 | 96.50 | 100.00 | 82.50 | 91.25 |
| LSD | 0.01 | 3.56 | 4.02 | 2.68 | 16.19 | 15.42 | 11.18 | 14.23 | 16.81 | 11.01 |

General and specific combining ability mean squares and their interactions with years for the vegetative traits, resistance to downy mildew and late wilt diseases in two years and their combined data are shown in Table 3. The results showed that, mean squares due to general combining ability (GCA) and specific combining ability (SCA) were highly significant for all traits in two years and their combined, indicating that additive and non-additive gene action had an important role in the inheritance of all traits. On the other side, the interactions between GCA and SCA with years were highly significant for all traits, indicating that both types of gene action were influenced by change of years. Regarding GCA / SCA mean square ratio, the data pointed out that, this ratio exceeded the unity for all studied traits in two years and their combined. This might indicate that, additive and additive x additive gene effects were more important than non-additive gene effects for the inheritance of all studied traits. The ratio of GCA x Y / SCA x Y mean square found to be exceeded the unity for all traits, indicating that the additive gene effects were more interacted with years than non-additive ones for all traits. These results agreed with those obtained by **Abd El-Hadi et al. (2005)** which reported that, the mean squares of GCA and SCA were highly significant for all studied traits *i.e.* ; days to 50% silking, plant height and ear height. The ratio GCA/SCA mean squares exceeded the unity for plant height, while the ratio GCA x Y/ SCA x Y mean squares exceeded the unity for days to 50% silking.

Motawei (2006) found that, highly significant mean squares due to GCA and SCA were detected for days to 50% silking, plant height and resistance to late wilt, indicating that both additive and non-additive gene effects are operating in the inheritance of these traits. However, additive gene effects exhibited larger contribution in the genetic control of these traits than those of non-additive genetic effects, since the ratio GCA/SCA mean squares exceeded the unity. **Akanda et al. (2007)** found that, mean squares due to GCA and SCA were significant for days to 50% silking, plant and ear height. However, additive gene effects were preponderance for the expression for these traits. **Moradi (2014)** found that, GCA and SCA were significant for days to 50% silking and plant height, indicating that additive and non-additive gene action had an important role in the inheritance of these traits. The GCA x year interaction was significant for plant height. **El-Gazzar (2015)** found that, GCA/SCA ratios revealed that the additive types of gene action were the most important expressions for days to 50% silking, plant height, ear height and resistance to downy mildew disease. **El-Shamarka et al. (2015)** found that, mean squares due to GCA and SCA were significant for number of days to 50% silking, plant height and ear height. The ratio

of GCA / SCA mean square exceeded the unity for all traits, while GCA x environment / SCA x environment mean square exceeded the unity for all traits, except days to 50% silking.

Estimates of general combining ability effects (\hat{g}_i) for the vegetative traits, resistance to downy mildew and late wilt diseases in two years and their combined data are presented in Table 4. Negative values of general combining ability effects would be desirable from the breeder point of view for all traits, except for resistance to downy mildew and late wilt diseases, where the positive values would be favored. General combining ability effects (\hat{g}_i) would be estimated wherever the significant of GCA mean square for the trait in view. The (\hat{g}_i) would be considered, when their GCA mean squares is not significant. The parental inbred line; P₂ might be considered as a good combiner for days to 50% silking, ear height and ear position in the two years and their combined data due to its negative and highly significant (\hat{g}_i) values in all cases. The parental inbred line; P₈ had highly significant (\hat{g}_i) values in negative direction for days to 50% silking, plant height, ear height and ear position in two years and their combined analysis. That parent might be considered as a good combiner for the traits in view in the two studied years. The parental inbred line; P₇ had highly significant (\hat{g}_i) values in negative direction for ear height and ear position in both years, which might consider as a good combiner parent for the traits in question, and the parental inbred lines; P₃ and P₄ considered as good combiner for plant height in the second year due to its negative and significant (\hat{g}_i) values in this concern. The parental inbred line; P₇ in the two years and P₆ in the first year had significant (\hat{g}_i) values in positive direction for resistance to downy mildew disease. While, the parental inbred line; P₄ and P₁₀ in the two years and P₃ in the first year had significant and positive (\hat{g}_i) values for the resistance to late wilt disease. These parental inbred line might be considered a good combiner for resistance to the diseases. From the obtained results, it could be summarized that, the inbred line P₈ had desirable significant of (\hat{g}_i) for earliness and dwarfness, which might indicate that this inbred line considered a good combiner for to generating genotype characterized by earliness and shortness. The inbred line P₇ for resistance to downy mildew and suitable ear height (position) and, also the inbred line P₄ for earliness, shortness and resistance to late wilt disease.

Table 3: General and specific combining ability mean squares and their interactions with years for the vegetative traits, resistance to downy mildew and late wilt diseases in two years and their combined data.

| S.O.V. | d.f. | | Days to 50% silking (day) | | | Plant height (cm) | | | Ear height (cm) | | |
|-------------------|--------|-------|---------------------------|----------------|----------|-------------------|----------------|-----------|-----------------|----------------|-----------|
| | Single | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. |
| GCA | 9 | 9 | 17.210** | 8.698** | 12.260** | 809.261** | 936.287** | 786.338** | 1322.34** | 556.078** | 864.677** |
| SCA | 35 | 35 | 1.095** | 0.914** | 0.799** | 83.270** | 58.386** | 59.252** | 55.504** | 37.655** | 38.689** |
| GCA × Y | - | 9 | - | - | 13.648** | - | - | 959.210** | - | - | 1013.74** |
| SCA × Y | - | 35 | - | - | 1.210** | - | - | 82.404** | - | - | 54.470** |
| Error term | 132 | 264 | 0.368 | 0.325 | 0.346 | 23.237 | 16.280 | 19.758 | 20.912 | 13.646 | 17.279 |
| GCA / SCA | - | - | 15.716 | 9.516 | 15.344 | 9.718 | 16.036 | 13.271 | 23.824 | 14.767 | 22.349 |
| GCA × Y / SCA × Y | - | - | - | - | 11.279 | - | - | 11.640 | - | - | 18.610 |

** Significant 0.01 levels of probability.

Table3:Cont.

| S.O.V. | d.f. | | Ear position (%) | | | Resistance to downy mildew disease (%) | | | Resistance to late wilt disease (%) | | |
|-------------------|--------|-------|------------------|----------------|----------|--|----------------|-----------|-------------------------------------|----------------|-----------|
| | Single | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. |
| GCA | 9 | 9 | 113.075** | 66.019** | 87.104** | 106.834** | 63.094** | 64.389** | 409.663** | 139.861** | 191.948** |
| SCA | 35 | 35 | 2.258** | 2.558** | 1.846** | 64.269** | 47.606** | 39.537** | 125.376** | 37.779** | 38.279** |
| GCA × Y | - | 9 | - | - | 91.990** | - | - | 105.535** | - | - | 357.576** |
| SCA × Y | - | 35 | - | - | 2.970** | - | - | 72.338** | - | - | 124.876** |
| Error term | 132 | 264 | 0.928 | 1.239 | 1.083 | 18.753 | 18.366 | 18.559 | 15.726 | 21.399 | 18.562 |
| GCA / SCA | - | - | 50.077 | 25.808 | 47.185 | 1.662 | 1.325 | 1.628 | 3.267 | 3.702 | 5.014 |
| GCA × Y / SCA × Y | - | - | - | - | 30.973 | - | - | 1.458 | - | - | 2.863 |

** Significant 0.01 levels of probability.

Table 4: Estimates of general combining ability effects (\hat{g}_i) for the vegetative traits, resistance to downy mildew and late wilt diseases in two years and their combined data.

| Inbred lines | Days to 50% silking (day) | | | Plant height (cm) | | | Ear height (cm) | | | |
|--------------------------------|---------------------------|----------------|----------|-------------------|----------------|-----------|-----------------|----------------|-----------|-------|
| | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | |
| P ₁ | 0.931** | 0.881** | 0.906** | -2.294 | -7.606** | -4.950** | -0.344 | -2.250 | -1.297 | |
| P ₂ | -1.350** | -0.713** | -1.031** | -0.794 | 5.769** | 2.488 | -11.125** | -3.406** | -7.266** | |
| P ₃ | 2.119** | 0.975** | 1.547** | 3.706* | -11.763** | -4.028** | 20.906** | 6.906** | 13.906** | |
| P ₄ | -0.506* | -0.181 | -0.344 | -2.606 | -4.544** | -3.575* | -0.406 | -0.188 | -0.297 | |
| P ₅ | 0.181 | 0.506** | 0.344 | 12.956** | 13.581** | 13.269** | 9.000** | 7.875** | 8.438** | |
| P ₆ | 1.119** | 0.475* | 0.797** | 10.738** | 9.800** | 10.269** | 8.625** | 6.906** | 7.766** | |
| P ₇ | 0.119 | 0.319 | 0.219 | 2.456 | 8.488** | 5.472** | -11.219** | -4.844** | -8.031** | |
| P ₈ | -3.194** | -2.619** | -2.906** | -24.388** | -20.638** | -22.513** | -24.063** | -18.719** | -21.391** | |
| P ₉ | 0.650** | 0.100 | 0.375 | 0.238 | 4.113** | 2.175 | 0.500 | -1.031 | -0.266 | |
| P ₁₀ | -0.069 | 0.256 | 0.094 | -0.013 | 2.800* | 1.394 | 8.125** | 8.750** | 8.438** | |
| L.S.D | 0.05 | 0.399 | 0.375 | 0.387 | 3.169 | 2.653 | 2.911 | 3.006 | 2.428 | 2.717 |
| g _i | 0.01 | 0.525 | 0.494 | 0.510 | 4.171 | 3.492 | 3.832 | 3.957 | 3.197 | 3.577 |
| L.S.D | 0.05 | 0.595 | 0.559 | 0.577 | 4.724 | 3.954 | 4.339 | 4.482 | 3.620 | 4.051 |
| g _i -g _j | 0.01 | 0.783 | 0.736 | 0.760 | 6.218 | 5.205 | 5.712 | 5.899 | 4.765 | 5.332 |

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

Table 4: Cont.

| Inbred lines | Ear position (%) | | | Resistance to downy mildew disease (%) | | | Resistance to late wilt disease (%) | | | |
|--------------------------------|------------------|----------------|----------|--|----------------|----------|-------------------------------------|----------------|----------|-------|
| | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | |
| P ₁ | 0.505 | 0.683 | 0.594 | -2.531 | -1.375 | -1.953 | 0.646 | 0.449 | 0.548 | |
| P ₂ | -4.152** | -2.596** | -3.374** | -8.009** | -3.075* | -5.542** | -1.451 | 0.690 | -0.380 | |
| P ₃ | 7.243** | 5.451** | 6.347** | -0.069 | 4.844** | 2.388 | 11.393** | 0.596 | 5.995** | |
| P ₄ | 0.492 | 0.910* | 0.701* | 2.175 | -1.459 | 0.358 | 6.887** | 3.221* | 5.054** | |
| P ₅ | 0.841** | 0.364 | 0.603 | -0.481 | -1.525 | -1.003 | -7.626** | 3.740* | -1.943 | |
| P ₆ | 1.074** | 0.669 | 0.872* | 4.916** | 0.866 | 2.891* | -6.310** | 1.746 | -2.282 | |
| P ₇ | -4.771** | -3.633** | -4.202** | 3.828** | 3.238* | 3.533* | -5.610** | -3.126* | -4.368** | |
| P ₈ | -4.637** | -3.493** | -4.065** | 1.447 | -0.609 | 0.419 | -8.079** | -8.860** | -8.469** | |
| P ₉ | 0.108 | -1.323** | -0.607 | -1.850 | -3.591* | -2.720 | 0.896 | -3.669* | -1.387 | |
| P ₁₀ | 3.297** | 2.967** | 3.132** | 0.575 | 2.688 | 1.631 | 9.253** | 5.212** | 7.232** | |
| L.S.D | 0.05 | 0.633 | 0.732 | 0.683 | 2.847 | 2.817 | 2.832 | 2.607 | 3.041 | 2.824 |
| g _i | 0.01 | 0.834 | 0.963 | 0.899 | 3.747 | 3.709 | 3.728 | 3.432 | 4.003 | 3.718 |
| L.S.D | 0.05 | 0.944 | 1.091 | 1.018 | 4.244 | 4.2 | 4.222 | 3.886 | 4.533 | 4.210 |
| g _i -g _j | 0.01 | 1.243 | 1.436 | 1.340 | 5.586 | 5.528 | 5.557 | 5.116 | 5.967 | 5.542 |

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

Estimates of specific combining ability effects (\hat{s}_{ij}) for 45 F₁ crosses in two years and their combined data for the vegetative traits, resistance to downy mildew and late wilt diseases are presented in Table 5. The negative values would be desirable from the plant breeder point of view for all traits, except the resistance to downy mildew and late wilt diseases where the position values would be favorable. Specific combining ability effects (\hat{s}_{ij}) would be estimated wherever SCA mean square is significant. Regarding days to 50% silking it appeared that, the crosses; P₄ × P₆, P₆ × P₇ and P₆ × P₁₀ in the first year and their combined, the crosses; P₂ × P₅ and P₄ × P₅ in the first year and the crosses; P₂ × P₈, P₈ × P₉ and P₉ × P₁₀ in the second year had significant values of (\hat{s}_{ij}) in negative direction

towards earliness. For plant height, the cross; P₄ × P₅ in the two years and their combined data and the crosses; P₁ × P₂ and P₂ × P₇ in the second year and the combined data had desirable negative and significant values of (\hat{s}_{ij}). While, the cross; P₁ × P₃ in the first year and the combined analysis, the crosses; P₁ × P₁₀, P₂ × P₈ and P₆ × P₇ in the first year and the crosses; P₃ × P₁₀ and P₄ × P₉ in the second year, had desirable negative and significant values of (\hat{s}_{ij}) towards shortness. Referring to ear height, the crosses; P₁ × P₃, P₆ × P₇ and P₆ × P₁₀ had desirable negative and significant values of (\hat{s}_{ij}) in two years and their combined data. The cross; P₄ × P₅ in the first year and the combined analysis, crosses; P₁ × P₂, P₄ × P₉ and P₈ × P₉ in the second year, had negative and significant values of (\hat{s}_{ij}) for

low ear height. For ear position, the crosses; $P_1 \times P_3$ and $P_6 \times P_7$ had desirable negative and significant values of (\hat{s}_{ij}) in the two years and their combined. While, the crosses; $P_2 \times P_9$ and $P_4 \times P_6$ in the first year and the combined and the crosses; $P_5 \times P_8$, $P_6 \times P_{10}$ and $P_9 \times P_{10}$ in the first year, had negative and significant values of (\hat{s}_{ij}) for low ear position. Concerning resistance to downy mildew disease, the cross; $P_2 \times P_4$ in the two years and their combined analysis and the cross; $P_2 \times P_3$ in the first year and the combined data had positive and significant values of (\hat{s}_{ij}). While, the cross; $P_1 \times P_5$ in the first year and crosses; $P_5 \times P_9$, $P_8 \times P_9$ in the second year had desirable positive and significant values of (\hat{s}_{ij}) for resistance to downy mildew disease. For resistance to late wilt disease, the cross; $P_8 \times P_{10}$ in the two years and their combined analysis and the crosses; $P_1 \times P_7$, $P_1 \times P_9$ and $P_6 \times P_8$ in the first year and the combined data had positive and significant values of (\hat{s}_{ij}). The crosses; $P_1 \times P_2$, $P_2 \times P_5$, $P_2 \times P_7$, $P_3 \times P_8$, $P_4 \times P_5$ and $P_4 \times P_6$ in the first year and the cross; $P_6 \times P_7$ in the second year, had desirable and significant values of (\hat{s}_{ij}) for resistance to late wilt disease. From the obtained results, it might be inferred that, the single crosses; $P_1 \times P_3$, $P_6 \times P_7$ and $P_4 \times P_5$ had favorable alleles for good plant type with earliness, indicating that these new hybrids might be promising in future maize breeding program.

Superiority percentages of the 45 F_1 crosses relative to two checks SC 162 and SC 168 for the vegetative traits, resistance to downy mildew and late wilt diseases as an average of two years were presented in Table 6. It might be noted that, negative values would be desired for days to 50% silking, plant height, ear height and ear position while the positive values would be favored for the other studied traits, *i.e.*, resistance to downy mildew and late wilt diseases.

plant height, ear height and ear position, except for plant height with regard to the check cultivar SC168, where, the values in this concern did not reach the level of significant. However, the first group of crosses could be used as new hybrid.

It was noted that the crosses; $P_1 \times P_2$, $P_1 \times P_8$, $P_2 \times P_4$, $P_2 \times P_8$, $P_3 \times P_8$, $P_4 \times P_8$, $P_5 \times P_8$, $P_6 \times P_8$, $P_7 \times P_8$, $P_8 \times P_9$ and $P_8 \times P_{10}$ had significant superiority percentage in negative direction relative the two checks *i.e.*; SC 162 and SC168 for days to 50% silking, plant height, ear height and ear position. While, the crosses; $P_1 \times P_4$, $P_1 \times P_5$, $P_1 \times P_7$, $P_2 \times P_5$, $P_2 \times P_7$, $P_1 \times P_9$, $P_2 \times P_{10}$, $P_4 \times P_6$, $P_4 \times P_7$, $P_4 \times P_9$, $P_5 \times P_7$, $P_6 \times P_7$, $P_7 \times P_9$ and $P_7 \times P_{10}$ had superiority percentages in negative direction relative the two check cultivars for days to 50% silking, cultivars characterized by earliness and short stem after more evaluation in different location and years. While, the second group of crosses could be used as new hybrid cultivars characterized by earliness, where its results referred to its superiority with regard to the two cultivar checks in this respect. Concerning to the resistance to downy mildew and late wilt diseases, the results listed in Table 6 revealed that there is no significant value in positive direction in all crosses over either the check cultivar SC162 or the check cultivar SC168 for traits, which indicated the present genetic material failed to regenerate a new genotype more resistant than the two check cultivars used in the study.

Table 5: Estimates of specific combining ability effects (s_{ij}^{\wedge}) for 45 F₁ crosses in two years and their combined data for the vegetative traits, resistance to downy mildew and late wilt diseases.

| Crosses | Days to 50% silking (day) | | | Plant height (cm) | | | Ear height (cm) | | | |
|--------------------------------------|---------------------------|----------------|---------|-------------------|----------------|-----------|-----------------|----------------|-----------|--------|
| | Y ₁ | Y ₂ | Comb | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | |
| P ₁ x P ₂ | -0.031 | 0.142 | 0.056 | -6.760 | -13.340** | -10.050* | -2.780 | -10.650** | -6.720 | |
| P ₁ x P ₃ | 0.000 | -0.295 | -0.148 | -11.510** | -5.060 | -8.280* | -13.560** | -8.210* | -10.890** | |
| P ₁ x P ₄ | 0.625 | -0.889 | -0.132 | 6.310 | 4.220 | 5.260 | 2.500 | 1.880 | 2.190 | |
| P ₁ x P ₅ | -0.063 | -0.576 | -0.319 | 7.490 | 11.850** | 9.670* | 3.590 | 3.070 | 3.330 | |
| P ₁ x P ₆ | -1.000 | -0.295 | -0.648 | 10.210* | 4.880 | 7.550 | 8.470* | 11.040** | 9.750** | |
| P ₁ x P ₇ | -0.250 | 0.611 | 0.181 | 11.240** | 2.190 | 6.720 | 3.310 | -1.960 | 0.680 | |
| P ₁ x P ₈ | 1.563** | 1.799** | 1.681** | -1.160 | 0.070 | -0.550 | 2.660 | 2.410 | 2.530 | |
| P ₁ x P ₉ | -0.781 | 0.080 | -0.351 | -5.540 | -4.430 | -4.990 | 0.340 | 0.730 | 0.530 | |
| P ₁ x P ₁₀ | -0.063 | -0.576 | -0.319 | -10.290* | -0.370 | -5.330 | -4.530 | 1.690 | -1.420 | |
| P ₂ x P ₃ | -0.719 | -0.951 | -0.835 | -5.760 | 1.070 | -2.350 | -2.780 | -0.560 | -1.670 | |
| P ₂ x P ₄ | 0.156 | 0.455 | 0.306 | 17.810** | 20.350** | 19.080** | 16.030** | 12.290** | 14.160** | |
| P ₂ x P ₅ | -1.531** | -0.483 | -1.007 | -3.760 | -1.280 | -2.520 | -3.380 | 0.230 | -1.570 | |
| P ₂ x P ₆ | 1.781** | 1.799** | 1.790** | -1.040 | 5.000 | 1.980 | -0.250 | 3.940 | 1.850 | |
| P ₂ x P ₇ | 1.531** | 1.705** | 1.618** | -5.010 | -15.180** | -10.100** | -4.160 | -5.810 | -4.980 | |
| P ₂ x P ₈ | 0.094 | -1.358** | -0.632 | -9.410* | -2.560 | -5.990 | -6.310 | -1.930 | -4.120 | |
| P ₂ x P ₉ | -1.000 | -0.576 | -0.788 | 2.710 | 4.190 | 3.450 | -3.880 | -3.370 | -3.620 | |
| P ₂ x P ₁₀ | -0.281 | -0.733 | -0.507 | 11.210** | 1.750 | 6.480 | 7.500 | 5.850 | 6.680 | |
| P ₃ x P ₄ | -0.063 | 0.017 | -0.023 | 0.810 | -0.370 | 0.220 | 5.000 | 4.730 | 4.860 | |
| P ₃ x P ₅ | -0.500 | -0.670 | -0.585 | -1.760 | -4.250 | -3.000 | -0.410 | -3.840 | -2.120 | |
| P ₃ x P ₆ | 2.063** | 0.861 | 1.462** | 7.960 | 3.780 | 5.870 | 10.470** | 2.130 | 6.300 | |
| P ₃ x P ₇ | -0.938 | -0.983 | -0.960 | -5.260 | 2.350 | -1.450 | -5.690 | 6.880* | 0.600 | |
| P ₃ x P ₈ | -0.375 | 0.205 | -0.085 | 6.090 | 8.220* | 7.150 | -0.090 | 4.260 | 2.080 | |
| P ₃ x P ₉ | 0.531 | 0.486 | 0.509 | 14.460** | 1.970 | 8.220* | 10.090* | 0.070 | 5.080 | |
| P ₃ x P ₁₀ | 0.000 | 1.330** | 0.665 | -5.040 | -7.720* | -6.380 | -3.030 | -5.460 | -4.250 | |
| P ₄ x P ₅ | -1.375* | -0.264 | -0.819 | -18.190** | -14.970** | -16.580** | -10.590** | -5.740 | -8.170* | |
| P ₄ x P ₆ | -1.563** | -0.983 | -1.273* | -1.980 | -3.930 | -2.950 | -9.470* | -4.520 | -7.000 | |
| P ₄ x P ₇ | 0.438 | -0.326 | 0.056 | -2.690 | -2.620 | -2.660 | -2.380 | -3.520 | -2.950 | |
| P ₄ x P ₈ | 0.000 | 0.611 | 0.306 | 7.900 | 4.750 | 6.330 | 3.970 | 3.850 | 3.910 | |
| P ₄ x P ₉ | 0.406 | 0.642 | 0.524 | -3.730 | -9.750** | -6.740 | -3.840 | -8.090* | -5.970 | |
| P ₄ x P ₁₀ | 1.375* | 0.736 | 1.056* | -6.230 | 2.320 | -1.950 | -1.220 | -0.870 | -1.040 | |
| P ₅ x P ₆ | 1.250* | -0.170 | 0.540 | -2.790 | -5.310 | -4.050 | -0.380 | -5.590 | -2.980 | |
| P ₅ x P ₇ | 0.750 | 0.236 | 0.493 | 15.990** | 10.000** | 13.000** | 13.720** | 5.410 | 9.570** | |
| P ₅ x P ₈ | -0.438 | -0.326 | -0.382 | -5.410 | 3.130 | -1.140 | -7.940* | -1.210 | -4.570 | |
| P ₅ x P ₉ | 0.719 | 1.705** | 1.212* | 5.960 | -1.120 | 2.420 | 3.500 | 3.600 | 3.550 | |
| P ₅ x P ₁₀ | 1.188* | 0.549 | 0.868 | 2.460 | 1.940 | 2.200 | 1.880 | 4.070 | 2.970 | |
| P ₆ x P ₇ | -1.438** | -0.733 | -1.085* | -10.040* | -2.720 | -6.380 | -9.660* | -8.620** | -9.140* | |
| P ₆ x P ₈ | 0.375 | -0.795 | -0.210 | 5.060 | -2.840 | 1.110 | 3.440 | -3.490 | -0.030 | |
| P ₆ x P ₉ | 0.531 | 0.736 | 0.634 | 0.680 | 6.910 | 3.800 | 5.880 | 12.320** | 9.100* | |
| P ₆ x P ₁₀ | -2.000** | -0.420 | -1.210* | -8.070 | -5.780 | -6.920 | -8.500* | -7.210* | -7.860* | |
| P ₇ x P ₈ | 0.125 | 0.611 | 0.368 | -6.660 | -5.780 | -6.220 | 0.530 | 4.010 | 2.270 | |
| P ₇ x P ₉ | -0.219 | -0.608 | -0.413 | -4.290 | 7.220* | 1.470 | 1.220 | 1.320 | 1.270 | |
| P ₇ x P ₁₀ | 0.000 | -0.514 | -0.257 | 6.710 | 4.530 | 5.620 | 3.090 | 2.290 | 2.690 | |
| P ₈ x P ₉ | -0.656 | -1.420** | -1.038* | -7.940 | -6.650 | -7.300 | -7.190 | -7.060* | -7.120 | |
| P ₈ x P ₁₀ | -0.688 | 0.674 | -0.007 | 11.560** | 1.660 | 6.610 | 10.940** | -0.840 | 5.050 | |
| P ₉ x P ₁₀ | 0.469 | -1.045* | -0.288 | -2.320 | 1.660 | -0.330 | -6.130 | 0.480 | -2.820 | |
| LSD S _{ij} | 0.05 | 1.049 | 0.986 | 1.018 | 8.333 | 6.974 | 7.654 | 7.905 | 6.385 | 7.145 |
| | 0.01 | 1.380 | 1.298 | 1.339 | 10.968 | 9.181 | 10.075 | 10.405 | 8.405 | 9.405 |
| LSD S _{ij} -S _{kl} | 0.05 | 1.456 | 1.370 | 1.413 | 11.572 | 9.686 | 10.629 | 10.977 | 8.868 | 9.923 |
| | 0.01 | 1.917 | 1.803 | 1.860 | 15.232 | 12.750 | 13.991 | 14.450 | 11.673 | 13.062 |

*and** Significant at 0.05 and 0.01 levels of probability, respectively.
Table 5:Cont.

| Crosses | Ear position (%) | | | Resistance to downy mildew disease (%) | | | Resistance to late wilt disease (%) | | | |
|--|------------------|----------------|----------|--|----------------|-----------|-------------------------------------|----------------|-----------|--------|
| | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | Y ₁ | Y ₂ | Comb. | |
| P ₁ X P ₂ | 0.186 | -1.674 | -0.744 | -1.390 | 7.230 | 2.920 | 12.590** | -3.010 | 4.790 | |
| P ₁ X P ₃ | -2.679** | -2.090* | -2.385** | -1.500 | 3.130 | 0.810 | -3.130 | -2.090 | -2.610 | |
| P ₁ X P ₄ | -0.491 | -0.205 | -0.348 | -11.350** | -6.990 | -9.170* | 4.250 | 7.580 | 5.920 | |
| P ₁ X P ₅ | -0.207 | -1.232 | -0.719 | 10.630** | 0.130 | 5.380 | -21.360** | 2.690 | -9.340* | |
| P ₁ X P ₆ | 1.095 | 3.361** | 2.228* | 5.240 | -3.820 | 0.710 | -2.300 | 5.260 | 1.480 | |
| P ₁ X P ₇ | -0.839 | -1.215 | -1.027 | 1.250 | 0.140 | 0.690 | 16.750** | 0.000 | 8.380* | |
| P ₁ X P ₈ | 1.236 | 0.971 | 1.103 | -2.690 | 3.510 | 0.410 | -14.830** | -4.460 | -9.650* | |
| P ₁ X P ₉ | 1.364 | 1.278 | 1.321 | -6.220 | -3.760 | -4.990 | 10.240** | 5.870 | 8.060* | |
| P ₁ X P ₁₀ | 0.335 | 0.806 | 0.570 | 6.030 | 0.440 | 3.230 | -2.210 | -11.830** | -7.020 | |
| P ₂ X P ₃ | 0.337 | -0.559 | -0.111 | 11.100** | 4.830 | 7.970* | 1.840 | -2.630 | -0.400 | |
| P ₂ X P ₄ | 2.618** | 0.742 | 1.680 | 13.460** | 7.580* | 10.520** | -17.500** | -0.760 | -9.130* | |
| P ₂ X P ₅ | -0.290 | 0.565 | 0.138 | 5.340 | -0.930 | 2.210 | 12.910** | -5.250 | 3.830 | |
| P ₂ X P ₆ | 0.357 | 0.720 | 0.539 | 1.490 | 3.960 | 2.730 | -1.400 | -1.880 | -1.640 | |
| P ₂ X P ₇ | -0.613 | 0.685 | 0.036 | 7.430 | 3.210 | 5.320 | 10.120** | 0.040 | 5.080 | |
| P ₂ X P ₈ | -1.350 | -0.458 | -0.904 | -10.440** | 6.730 | -1.850 | -24.840** | -0.530 | -12.680** | |
| P ₂ X P ₉ | -1.822* | -1.890 | -1.856* | -22.140** | -26.810** | -24.480** | 5.160 | 7.630 | 6.400 | |
| P ₂ X P ₁₀ | 0.576 | 1.868 | 1.222 | -4.840 | -5.810 | -5.330 | 1.110 | 6.400 | 3.750 | |
| P ₃ X P ₄ | 1.736* | 2.338* | 2.037* | -16.210** | -0.330 | -8.270* | -6.490 | -3.120 | -4.800 | |
| P ₃ X P ₅ | -0.063 | -0.836 | -0.450 | -2.030 | 3.280 | 0.630 | 2.940 | 1.790 | 2.370 | |
| P ₃ X P ₆ | 1.802* | -0.236 | 0.783 | -5.050 | -2.660 | -3.850 | 6.700 | -8.120* | -0.710 | |
| P ₃ X P ₇ | -1.033 | 1.963* | 0.465 | -0.510 | -1.480 | -1.000 | -0.970 | 6.580 | 2.800 | |
| P ₃ X P ₈ | -0.630 | 0.251 | -0.190 | 6.240 | -5.280 | 0.480 | 8.470* | 4.970 | 6.720 | |
| P ₃ X P ₉ | 0.607 | -0.599 | 0.004 | 5.440 | -0.550 | 2.440 | -0.500 | 4.750 | 2.120 | |
| P ₃ X P ₁₀ | -0.077 | -0.231 | -0.154 | 2.520 | -0.930 | 0.790 | -8.860* | -2.130 | -5.500 | |
| P ₄ X P ₅ | -0.342 | 0.769 | 0.214 | 5.930 | -0.340 | 2.790 | 7.920* | -3.830 | 2.050 | |
| P ₄ X P ₆ | -3.210** | -0.971 | -2.090* | 0.530 | 3.970 | 2.250 | 11.210** | -4.990 | 3.110 | |
| P ₄ X P ₇ | -0.415 | -1.039 | -0.727 | -3.460 | 0.720 | -1.370 | -4.770 | -3.390 | -4.080 | |
| P ₄ X P ₈ | 0.003 | 0.574 | 0.289 | 4.000 | -3.210 | 0.400 | 5.730 | 3.490 | 4.610 | |
| P ₄ X P ₉ | -0.654 | -1.296 | -0.975 | 7.300 | 7.050 | 7.170 | 4.000 | 1.430 | 2.710 | |
| P ₄ X P ₁₀ | 0.754 | -0.913 | -0.079 | -0.200 | -8.450* | -4.330 | -4.350 | 3.590 | -0.380 | |
| P ₅ X P ₆ | 0.412 | -1.130 | -0.359 | 3.190 | -5.840 | -1.330 | 1.900 | 5.290 | 3.590 | |
| P ₅ X P ₇ | 2.314** | 0.317 | 1.316 | -3.870 | 1.660 | -1.110 | 4.650 | 1.310 | 2.980 | |
| P ₅ X P ₈ | -1.920* | -0.980 | -1.450 | -2.790 | -8.690* | -5.740 | -6.090 | 7.500 | 0.710 | |
| P ₅ X P ₉ | 0.152 | 1.652 | 0.902 | -4.520 | 8.840* | 2.160 | -5.710 | -2.690 | -4.200 | |
| P ₅ X P ₁₀ | -0.057 | 0.875 | 0.409 | -11.870** | 1.890 | -4.990 | 2.830 | -6.800 | -1.980 | |
| P ₆ X P ₇ | -1.669* | -2.733** | -2.201* | -8.500 | -0.380 | -4.440 | -24.640** | 12.380** | -6.130 | |
| P ₆ X P ₈ | 0.764 | -0.720 | 0.022 | -3.590 | 3.120 | -0.240 | 19.900** | -3.010 | 8.450* | |
| P ₆ X P ₉ | 2.152* | 3.425** | 2.788** | 4.560 | -1.400 | 1.580 | -11.430** | -6.450 | -8.940* | |
| P ₆ X P ₁₀ | -1.702* | -1.715 | -1.709 | 2.130 | 3.050 | 2.590 | 0.070 | 1.520 | 0.790 | |
| P ₇ X P ₈ | 1.029 | 2.646** | 1.838* | 2.350 | -8.630* | -3.140 | -0.800 | -12.760** | -6.780 | |
| P ₇ X P ₉ | 1.410 | -0.594 | 0.408 | 5.640 | 4.080 | 4.860 | -5.600 | -6.000 | -5.800 | |
| P ₇ X P ₁₀ | -0.184 | -0.031 | -0.108 | -0.330 | 0.680 | 0.170 | 5.270 | 1.840 | 3.550 | |
| P ₈ X P ₉ | -1.348 | -1.801 | -1.574 | 5.150 | 7.930* | 6.540 | 5.070 | -3.570 | 0.750 | |
| P ₈ X P ₁₀ | 2.216** | -0.483 | 0.867 | 1.780 | 4.520 | 3.150 | 7.390* | 8.380* | 7.880* | |
| P ₉ X P ₁₀ | -1.861* | -0.175 | -1.018 | 4.800 | 4.630 | 4.710 | -1.240 | -0.970 | -1.100 | |
| LSD S _{ij} | 0.05 | 1.666 | 1.924 | 1.795 | 7.485 | 7.408 | 7.447 | 6.855 | 7.996 | 7.426 |
| | 0.01 | 2.191 | 2.533 | 2.362 | 9.853 | 9.751 | 9.802 | 9.023 | 10.526 | 9.775 |
| LSD S _{ij} - S _{kl} | 0.05 | 2.313 | 2.672 | 2.493 | 10.395 | 10.288 | 10.342 | 9.520 | 11.105 | 10.313 |
| | 0.01 | 3.045 | 3.517 | 3.281 | 13.684 | 13.542 | 13.613 | 12.531 | 14.617 | 13.574 |

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

Table 6: Superiority percentages of the 45 F₁ crosses relative to two checks SC 162 and SC 168 for the vegetative traits, resistance to downy mildew and late wilt diseases as an average of two years.

| Crosses | Days to 50% silking (day) | | Plant height (cm) | | Ear height (cm) | |
|----------------------------------|---------------------------|----------|-------------------|----------|-----------------|----------|
| | SC 162 | SC 168 | SC 162 | SC 162 | SC 168 | SC 162 |
| P ₁ x P ₂ | -5.93** | -4.29** | -23.23** | -4.57* | -32.47** | -24.60** |
| P ₁ x P ₃ | -2.30* | -0.59 | -24.75** | -6.45** | -22.68** | -13.67** |
| P ₁ x P ₄ | -5.16** | -3.51** | -20.28** | -0.89 | -23.33** | -14.39** |
| P ₁ x P ₅ | -4.40** | -2.73** | -13.49** | 7.54** | -17.64** | -8.04** |
| P ₁ x P ₆ | -4.21** | -2.54** | -15.13** | 5.51** | -14.33** | -4.34 |
| P ₁ x P ₇ | -3.83** | -2.15* | -16.93** | 3.28 | -28.66** | -20.34** |
| P ₁ x P ₈ | -6.31** | -4.68** | -28.18** | -10.72** | -35.28** | -27.73** |
| P ₁ x P ₉ | -4.40** | -2.73** | -21.72** | -2.68 | -24.26** | -15.43** |
| P ₁ x P ₁₀ | -4.78** | -3.12** | -22.08** | -3.13 | -20.38** | -11.09** |
| P ₂ x P ₃ | -6.31** | -4.68** | -20.48** | -1.14 | -20.81** | -11.58** |
| P ₂ x P ₄ | -7.46** | -5.85** | -13.49** | 7.54** | -19.87** | -10.53** |
| P ₂ x P ₅ | -8.43** | -6.83** | -15.01** | 5.66** | -23.90** | -15.03** |
| P ₂ x P ₆ | -3.45** | -1.76 | -14.53** | 6.25** | -22.32** | -13.26** |
| P ₂ x P ₇ | -4.60** | -2.93** | -19.92** | -0.45 | -35.35** | -27.81** |
| P ₂ x P ₈ | -12.83** | -11.31** | -27.54** | -9.93** | -42.55** | -35.85** |
| P ₂ x P ₉ | -8.05** | -6.44** | -16.65** | 3.62 | -30.10** | -21.95** |
| P ₂ x P ₁₀ | -8.05** | -6.44** | -15.93** | 4.51* | -19.15** | -9.73** |
| P ₃ x P ₄ | -4.02** | -2.34* | -21.60** | -2.53 | -13.03** | -2.89 |
| P ₃ x P ₅ | -3.83** | -2.15* | -17.25** | 2.88 | -12.03** | -1.77 |
| P ₃ x P ₆ | 0.00 | 1.75 | -15.37** | 5.21** | -7.56** | 3.22 |
| P ₃ x P ₇ | -4.60** | -2.93** | -19.24** | 0.40 | -19.94** | -10.61** |
| P ₃ x P ₈ | -8.05** | -6.44** | -25.43** | -7.30** | -26.78** | -18.25** |
| P ₃ x P ₉ | -2.10* | -0.39 | -17.21** | 2.93 | -12.89** | -2.73 |
| P ₃ x P ₁₀ | -2.30* | -0.59 | -22.12** | -3.18 | -13.25** | -3.14 |
| P ₄ x P ₅ | -7.08** | -5.46** | -21.44** | -2.33 | -23.69** | -14.79** |
| P ₄ x P ₆ | -7.08** | -5.46** | -18.04** | 1.89 | -23.40** | -14.47** |
| P ₄ x P ₇ | -5.93** | -4.29** | -19.48** | 0.10 | -30.17** | -22.03** |
| P ₄ x P ₈ | -10.34** | -8.78** | -25.55** | -7.44** | -33.91** | -26.21** |
| P ₄ x P ₉ | -4.98** | -3.32** | -21.84** | -2.83 | -27.43** | -18.97** |
| P ₄ x P ₁₀ | -4.60** | -2.93** | -20.56** | -1.24 | -19.58** | -10.21** |
| P ₅ x P ₆ | -3.25** | -1.56 | -13.01** | 8.14** | -16.06** | -6.27* |
| P ₅ x P ₇ | -4.21** | -2.54** | -9.10** | 13.00** | -17.93** | -8.36** |
| P ₅ x P ₈ | -10.34** | -8.78** | -22.56** | -3.72* | -33.77** | -26.05** |
| P ₅ x P ₉ | -2.87** | -1.17 | -13.53** | 7.49** | -16.92** | -7.23** |
| P ₅ x P ₁₀ | -3.83** | -2.15* | -13.85** | 7.09** | -12.24** | -2.01 |
| P ₆ x P ₇ | -5.93** | -4.29** | -16.25** | 4.12* | -29.09** | -20.82** |
| P ₆ x P ₈ | -9.38** | -7.80** | -22.80** | -4.02* | -31.54** | -23.55** |
| P ₆ x P ₉ | -3.07** | -1.37 | -14.05** | 6.85** | -14.11** | -4.10 |
| P ₆ x P ₁₀ | -6.31** | -4.68** | -17.72** | 2.28 | -18.86** | -9.41** |
| P ₇ x P ₈ | -9.38** | -7.80** | -26.67** | -8.83** | -39.31** | -32.23** |
| P ₇ x P ₉ | -5.55** | -3.90** | -16.33** | 4.02* | -27.72** | -19.29** |
| P ₇ x P ₁₀ | -5.75** | -4.10** | -15.25** | 5.36** | -21.89** | -12.78** |
| P ₈ x P ₉ | -11.30** | -9.75** | -28.07** | -10.57** | -40.25** | -33.28** |
| P ₈ x P ₁₀ | -10.15** | -8.58** | -23.87** | -5.36** | -28.22** | -19.86** |
| P ₉ x P ₁₀ | -5.55** | -3.90** | -18.20** | 1.69 | -20.59** | -11.33** |
| LSD | 0.05 | 1.148 | 8.747 | | 8.240 | |
| | 0.01 | 1.512 | 11.514 | | 10.847 | |

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

Table 6:Cont.

| Crosses | Ear position (%) | | Resistance to downy mildew disease (%) | | Resistance to late wilt disease (%) | |
|----------------------------------|------------------|----------|--|----------|-------------------------------------|----------|
| | SC 162 | SC 168 | SC 162 | | SC 162 | SC 168 |
| P ₁ x P ₂ | -11.93** | -20.80** | -1.19 | -3.11 | -1.94 | 4.38 |
| P ₁ x P ₃ | 2.65 | -7.69** | 1.45 | -0.52 | -1.94 | 4.38 |
| P ₁ x P ₄ | -3.84* | -13.53** | -4.49 | -6.34 | 1.67 | 8.22 |
| P ₁ x P ₅ | -4.69* | -14.30** | 2.91 | 0.91 | -21.11** | -16.02** |
| P ₁ x P ₆ | 1.10 | -9.09** | 3.17 | 1.17 | -5.92 | 0.14 |
| P ₁ x P ₇ | -13.93** | -22.61** | 2.77 | 0.78 | -3.99 | 2.19 |
| P ₁ x P ₈ | -9.84** | -18.92** | 1.18 | -0.78 | -25.62** | -20.82** |
| P ₁ x P ₉ | -3.19 | -12.95** | -8.86 | -10.62* | -0.65 | 5.75 |
| P ₁ x P ₁₀ | 2.18 | -8.11** | 3.43 | 1.43 | -5.54 | 0.55 |
| P ₂ x P ₃ | -0.40 | -10.43** | 4.35 | 2.33 | -2.97 | 3.29 |
| P ₂ x P ₄ | -7.35** | -16.68** | 4.88 | 2.85 | -10.30* | -4.52 |
| P ₂ x P ₅ | -10.32** | -19.36** | -1.06 | -2.97 | -4.63 | 1.51 |
| P ₂ x P ₆ | -9.11** | -18.27** | 1.59 | -0.38 | -7.34 | -1.37 |
| P ₂ x P ₇ | -19.17** | -27.31** | 3.83 | 1.81 | -6.05 | 0.00 |
| P ₂ x P ₈ | -20.61** | -28.61** | -4.76 | -6.60 | -32.69** | -28.35** |
| P ₂ x P ₉ | -16.10** | -24.55** | -37.78** | -38.98** | -2.57 | 3.70 |
| P ₂ x P ₁₀ | -3.79* | -13.49** | -4.10 | -5.96 | 1.67 | 8.22 |
| P ₃ x P ₄ | 10.83** | -0.34 | -3.70 | -5.56 | -2.19 | 4.11 |
| P ₃ x P ₅ | 6.17** | -4.53** | 2.38 | 0.39 | -1.54 | 4.80 |
| P ₃ x P ₆ | 8.88** | -2.09 | 1.32 | -0.64 | -4.25 | 1.92 |
| P ₃ x P ₇ | -0.85 | -10.84** | 4.49 | 2.47 | -2.71 | 3.56 |
| P ₃ x P ₈ | -1.79 | -11.68** | 3.83 | 1.81 | -2.71 | 3.56 |
| P ₃ x P ₉ | 4.80* | -5.76** | 2.50 | 0.52 | -1.16 | 5.21 |
| P ₃ x P ₁₀ | 11.26** | 0.05 | 4.35 | 2.33 | -0.13 | 6.30 |
| P ₄ x P ₅ | -2.82 | -12.61** | 2.50 | 0.52 | -1.68 | 4.66 |
| P ₄ x P ₆ | -6.50** | -15.92** | 5.02 | 2.98 | -2.19 | 4.11 |
| P ₄ x P ₇ | -13.19** | -21.94** | 3.03 | 1.04 | -7.60 | -1.64 |
| P ₄ x P ₈ | -11.12** | -20.07** | 1.18 | -0.78 | -3.74 | 2.47 |
| P ₄ x P ₉ | -7.15** | -16.50** | 4.35 | 2.33 | -1.54 | 4.80 |
| P ₄ x P ₁₀ | 1.21 | -8.99** | 0.13 | -1.81 | 2.06 | 8.64 |
| P ₅ x P ₆ | -3.56 | -13.27** | 0.53 | -1.42 | -7.86 | -1.92 |
| P ₅ x P ₇ | -9.69** | -18.79** | 2.91 | 0.91 | -8.49 | -2.60 |
| P ₅ x P ₈ | -14.42** | -23.04** | -1.99 | -3.89 | -18.92** | -13.70** |
| P ₅ x P ₉ | -3.93* | -13.62** | -1.06 | -2.97 | -11.58** | -5.88 |
| P ₅ x P ₁₀ | 1.91 | -8.36** | -3.31 | -5.18 | -2.57 | 3.70 |
| P ₆ x P ₇ | -15.54** | -24.05** | 3.43 | 1.43 | -27.16** | -22.47** |
| P ₆ x P ₈ | -11.28** | -20.22** | 3.56 | 1.55 | -9.27* | -3.42 |
| P ₆ x P ₉ | -0.05 | -10.13** | 1.71 | -0.26 | -18.41** | -13.15** |
| P ₆ x P ₁₀ | -1.43 | -11.36** | 5.67 | 3.63 | -2.97 | 3.29 |
| P ₇ x P ₈ | -17.16** | -25.51** | 0.39 | -1.55 | -29.86** | -25.34** |
| P ₇ x P ₉ | -13.50** | -22.22** | 5.15 | 3.11 | -16.35** | -10.96* |
| P ₇ x P ₁₀ | -7.69** | -16.99** | 4.88 | 2.85 | -0.51 | 5.90 |
| P ₈ x P ₉ | -16.84** | -25.22** | 4.62 | 2.59 | -15.83** | -10.41* |
| P ₈ x P ₁₀ | -5.68** | -15.19** | 4.76 | 2.73 | -1.42 | 4.93 |
| P ₉ x P ₁₀ | -2.85 | -12.64** | 4.09 | 2.07 | -2.45 | 3.84 |
| LSD | 0.05 | 2.043 | 8.495 | | 8.368 | |
| | 0.01 | 2.689 | 11.182 | | 11.015 | |

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

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الملخص العربي

القدرة على التآلف والنسبة المئوية للتفوق في التهجين النصف دائري بين سلالات مرباه داخليا للذرة الصفراء لصفات النمو والمقاومة لبعض الامراض

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أجريت هذه الدراسة في محطة البحوث الزراعية بسخا- مركز البحوث الزراعية حيث تم إجراء التهجين النصف تبادلي في موسم 2015 بين عشر سلالات مرباه داخليا للذرة الصفراء. تم تقييم الخمسة و أربعون هجيناً فردياً أصفر بالإضافة إلى هجينين للمقارنة وهما هجين فردي 162 وهجين فردي 168 في تجربتين منفصلتين خلال الموسمين 2016-2017. أشارت النتائج أن الاختلافات بين السنوات كانت معنوية أو عالية المعنوية لجميع الصفات محل الدراسة ماعدا المقاومة لمرض البياض الزغبي. كما أوضحت النتائج أن الاختلافات بين التراكيب الوراثية وبين الهجن كانت عالية المعنوية لجميع الصفات تحت الدراسة في كلا العامين والتحليل المشترك بينما كان تفاعل كلا من التراكيب الوراثية والهجن مع السنوات كان معنوي أو عالي المعنوية لجميع الصفات محل الدراسة. أشارت النتائج إلى أن تباين القدرة العامة والخاصة على التآلف كان عالي المعنوية لجميع الصفات محل الدراسة في كلا العامين والتحليل المشترك، كما أوضحت النتائج أن تفاعل كلا من القدرة العامة والخاصة على التآلف كان عالي المعنوية لجميع الصفات محل الدراسة في كلا العامين والتحليل المشترك، كما أوضحت النتائج أن الفعل الجيني المضيف كان الأكثر أهمية في وراثته كل الصفات محل الدراسة في كلا العامين والتحليل المشترك، كما أوضحت النتائج أن الفعل الجيني المضيف كان الأكثر تفاعلاً مع السنوات عن الفعل الجيني الغير مضيف في كل الصفات محل الدراسة في كلا العامين والتحليل المشترك. أظهرت (السلالة 4) قدرة عامة على التآلف معنوية للتبكير ومواصفات النبات الجيد والمقاومة لمرض البياض الزغبي والذبول المتأخر، كما أظهرت (السلالة 8) قدرة عامة على التآلف معنوية ومرغوبة للتبكير ومواصفات النبات الجيد. أشارت النتائج إلى أن الهجن الفردية (السلالة 1 × السلالة 3 ، السلالة 6 × السلالة 7 و السلالة 4 × السلالة 5) لديها أليات مرغوبة وقدرة خاصة على التآلف معنوية وسالبة للتبكير ومواصفات النبات الجيد، كما أشارت النتائج إلى تفوق الهجن الفردية (السلالة 1 × السلالة 2، السلالة 1 × السلالة 8، السلالة 2 × السلالة 8، السلالة 4 × السلالة 8، السلالة 5 × السلالة 8، السلالة 6 × السلالة 8، السلالة 7 × السلالة 8، السلالة 8 × السلالة 8، السلالة 9 × السلالة 8 و السلالة 10) عن هجينين المقارنة وهما الهجين الفردي 162 والهجين الفردي 168 للتبكير ومواصفات النبات الجيد.