Response of Maize Hybrids and Inbred to Yield and its Components Under Irrigation Interval

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Abstract. In order to estimate some genetic parameters for five inbred lines AG116, AG-M20, MH17, MH121 and ZM4, they were entered into a complete cross-breeding program. Khalidiya - east of Ramadi in two seasons (fall 2019 and spring 2020). The comparison experiment was applied using the RCBD randomized complete block design in the order of split-plot and with three replications, where the main plots for irrigation was interval 6, while 12 days and the secondary plots for genotypes (breeds and hybrids) to estimate some characteristics of yield and its components. Parental inbred and their reciprocal and inverse hybrids differed significantly in number of days from planting to 50% tasseling, number of rows per ear, number of grains per row, grain weight and grain yield in the two seasons of the study, cross-hybrid MH17 × AG-M20 and the inverse hybrid AG116 × ZM4 outperformed in the fall season 2019 when it gave a yield of 173.00 g plant\(^{-1}\) and 169.60 g plant\(^{-1}\), respectively. In the spring season 2020, the cross-hybrid MH121×MH17 and the reverse hybrid AG116×AG-M20 recorded the highest average for the character, reaching 165.20 and 142.90 g plant\(^{-1}\), respectively.

1. Introduction
Maize crop (Zea mays L.) is one of the most important sources for human and animal consumption because it contains protein substances in its seeds estimated at 10%, 61% starch and 4% oil. It also provides a great financial income for millions of people in several countries. Despite the increase in global production of maize, which reached about 1670 million tons annually in 2015, the need to increase production remains necessary due to the increase in the uses of maize accompanied by the massive population increase. In Iraq, the total area planted with this crop for the year 2018 is estimated at about 13,95 thousand hectares, with a productivity rate of 4.5 tons ha\(^{-1}\) [1], and the reason for the decline in productivity compared to global productivity may be due to the farmers’ lack of interest in planting seeds of genotypes with high yield, especially the superior individual hybrids that are adapted to the local environmental conditions due to the high cost of imported hybrid seeds, the lack of adoption of modern technologies in agriculture and poor soil and crop service operations due to the lack of support for the agricultural sector. Hybridization and selection are one of the main pillars of maize breeding and in the development of wide genotypes, which helped plant breeders to exploit the genetic stock in various breeding programs as well as the applications of genetic statistics different genetic criteria for studying and applying them in many field crops, especially maize, with the aim of raising their productive efficiency per unit area and improving their qualitative characteristics [3,4,5,6,7]. Plant breeders emphasize the yield under stress conditions, the percentage of yield decrease or loss
as a result of stress, but the difference in production capacity can arise from factors related to adaptation rather than stress tolerance [8,9,10,11]. The distribution of water in the soil also affects the distribution of the root system, stem, leaves and other plant organs. Moisture tension of the plant varies according to the growth of the plant and the degree of the tension of moisture to which the plant is exposed. Plant breeders strive to find the best hybrids by diagnosing the best parents and using numbers of inbred line to evaluate and produce the best hybrids superior in grain yield and its components when combined with drought with heat stress to become one of the most important major constraints for food production worldwide, especially in dry and semi-dry areas, as the population continues to grow and the water resources used in crop production decline. Thus, the development of drought-resistant varieties is an issue of global concern. The study aims to introduce five inbreds of maize using the complete crossing program and evaluate them by calculating the averages of the genotypes under water stress for the field characters and the grain yield and its components, and to determine the best hybrid that gives the highest rate of yield and its components under the conditions of dry areas.

2. Materials and methods

Five inbred lines AG116, AG-M20, MH17, MH121 and ZM4 were used, and the numbers were given to the strains from (1 to 5), as they were entered into complete cross-breeding program-multiplication program. Agricultural fields belong to Khalidiya - east of Ramadi in two seasons-in Iraq (Fall 2019 and Spring 2020). Experiment was applied using the RCBD randomized complete block design in the order of split plots and with three replications, where the main plots for the irrigation interval was 6, 12 days and the secondary plots for genotypes (inbred line and hybrids) to estimate some characteristics of the yield and its components. Reciprocal cross-breeding was carried out between breeds and in two directions to obtain individual reciprocal and inverse hybrids, according to [20] according to the first method (Method 1) and the first (fixed) model. Parental, reciprocal and reverse hybrids, and therefore the number of genotypes that entered into the comparison experiment was 20 individual hybrids + 5 parental inbred = 25 genotypes, genotypes were planted for each genotype in five lines, the distance between one line and another was 0.75 m, between plants 0.25 m, and the length of the line was 2 m. In all cultivation seasons, the field was fertilized with 320 kg ha⁻¹ of dab fertilizer added to the soil during preparation of the land, and 100 kg ha⁻¹ of urea was added in two batches, half of the amount when the plant reached an average height of 25 cm and the other half at the beginning of flowering, then the genotypes were planted in a second comparison season in the spring season 2020, and the same crop and soil service operations were performed.

2.1. Studied characters

1- Number of days from planting to 50% tasseling
2- Average Number of rows per ear
3- Average number of grains per row (row).
4- Average weight of 300 grains (g)
5- Average Plant grain yield (g)

3. Results and Discussion

3.1 Number of days from planting to 50% tasseling

It is noted in (Table 1) that the plants of inbred 5 took the least period for female flowering, which amounted to 63.17 days, while the plants of inbred 1 took the longest period of female flowering, amounting to 68.73 days for the fall season. In the spring season, inbred 4 gave the lowest average number of days for female flowering, which amounted to 69.20, which did not differ significantly with plants of inbred 3 and 5, while inbred 1 gave the highest average number of days to 50% female flowering, which amounted to 73.77 days, which is the
average of this character. In the fall season, the exchange hybrid 4×5 had the lowest number of days for female flowering, which was 59.16 days which did not differ significantly with two cross-hybrids, and the reverse hybrid 3×2 had the lowest number of female flowering days, which was 56.96 days. In the spring season, the alternating hybrid 4×5 gave the lowest average number of days for female flowering, which amounted to 62.51 days, while the reverse hybrid 5×3 gave the lowest rate of female flowering amounted to 62.49, which did not differ significantly with 3 reverse hybrids, these results came close to the findings of [13], who indicated that there are significant differences between the genotypes in the character of number of days from planting to 50% tasseling. It is noted from the results of the same table that the plants grown under irrigation interval of 12 days have excelled in this character by giving them fewer days, 56.48 and 60.26 days for the fall and spring seasons, respectively. Superiority of the irrigation interval of 12 days over the interval of irrigation of 6 days in the least number of days for female flowering, perhaps the reason for this is that the lack of water in the vicinity of the plant increases the effectiveness of the aging hormones ethylene and abscis and reduces the effectiveness of the growth hormones auxin, gibberellin and cytokinin, and then the early entry of the plant of the flowering stage [2,18,21], and this result agrees with what was found by [1,23,27] who indicated that plants exposed to water stress reduced the number of days to reach female flowering. (Table 1) indicates that there is a significant effect of the joint interaction between irrigation treatments and genotypes, as the best treatment of the reverse hybrid 3×2 planted under irrigation treatment every 12 days, which gave the least period of female flowering, amounted to 51.88 days and did not differ significantly with 8 exchange and reverse hybrids. For the fall season, but for the spring season, the two hybrids 4×5 and 5×3 grown under irrigation treatment every 12 days gave the shortest period of female flowering, 55.00 and 55.97 days respectively.

Table 1. Average number of days from planting to 50% tasseling inbred lines, their alternating crosses and reverse hybrids for maize for 6 days irrigation interval for 12 days irrigation interval for fall season 2019 and spring season 2020

| genotypes | Fall season 2019 | Spring season 2020 |
|-----------|-----------------|--------------------|
|           | days 6 | days 12 | Mean | days 6 | days 12 | Mean |
| 1         | 72.13  | 65.33  | 68.73 | 78.44  | 69.11  | 73.77 |
| 2         | 71.44  | 64.66  | 68.05 | 77.88  | 65.77  | 71.82 |
| 3         | 69     | 62.98  | 65.99 | 76.44  | 62.11  | 69.27 |
| 4         | 68.78  | 62.64  | 65.71 | 70.82  | 67.58  | 69.2 |
| 5         | 67.23  | 59.12  | 63.17 | 73.72  | 64.83  | 69.27 |
| 1×2       | 63.23  | 55.87  | 59.55 | 68.71  | 59.99  | 64.35 |
| 1×3       | 65.11  | 57.88  | 61.5  | 66.95  | 63.11  | 65.03 |
| 1×4       | 69.22  | 54.11  | 61.66 | 70.08  | 58     | 64.04 |
| 1×5       | 64.99  | 55.88  | 60.43 | 69.09  | 60.22  | 64.65 |
| 2×3       | 68.87  | 55.27  | 62.07 | 69.12  | 57.99  | 63.55 |
| 2×4       | 69.56  | 55.03  | 62.29 | 72.56  | 59.09  | 65.82 |
| 2×5       | 70.15  | 58.63  | 64.39 | 71.09  | 58.82  | 64.95 |
| 3×4       | 68.25  | 56.73  | 62.49 | 73     | 58.08  | 65.54 |
| 3×5       | 65.72  | 52.85  | 59.28 | 70.01  | 56.97  | 63.49 |
| 4×5       | 65.77  | 52.55  | 59.16 | 70.03  | 55     | 62.51 |
| 2×1       | 64.81  | 57.08  | 60.95 | 72.06  | 60.44  | 66.25 |
| 3×1       | 64.06  | 55.77  | 59.91 | 68     | 63.11  | 65.55 |
| 4×1       | 67.11  | 53     | 60.05 | 70.18  | 58     | 64.09 |
| 5×1       | 66.08  | 54.22  | 60.15 | 69.19  | 61.22  | 65.2 |
| 3×2       | 62.04  | 51.88  | 56.96 | 70.12  | 56.98  | 63.55 |
| 4×2       | 67.87  | 52.16  | 60.01 | 72.64  | 58.98  | 65.81 |
3.2. Number of ear rows

It is noted from (Table 2) that the plants of inbred line 4 gave the highest average number of rows per ear, which amounted to 15.15 rows, and it did not differ significantly with inbred lines 2 and 5, while inbred 1 gave the lowest average for the character, which amounted to 13.55 rows, while inbred line 2, 4 and 5 gave the highest rate for the character. They reached 14.75, 15.20 and 14.95 rows for the spring season, respectively. Parents inherited its heterogeneity to their reciprocal and inverse hybrids, as the reciprocal hybrid 2×4 outperformed with the highest rate of the character reached 16.75 rows, as well as the reverse hybrid 3×2 scored with the highest average number of rows with the ear reached 17.35 rows with the ear, and in the spring season, the cross-crossed crosses 2×3, 2×4 and 3×5 excelled with the highest rate of the character reaching 15.60, 16.30 and 16.15 rows respectively, while the reverse hybrid 4×2 scored the highest rate of 16.45 rows.

Table 2. The average number of rows in the ear of the inbred lines, their alternating crosses and the reverse hybrids of maize for a 6-day irrigation interval and a 12-day irrigation interval for the fall season 2019 and the spring season 2020

| genotypes | Fall season 2019 | Spring season 2020 |
|------------|------------------|--------------------|
|            | days 6 | days 12 | Mean | days 6 | days 12 | Mean |
| 1          | 317    | 153     | 235  | 268    | 191     | 229.5 |
| 2          | 331    | 171     | 251  | 264    | 183     | 223.5 |
| 3          | 381    | 189     | 285  | 342    | 177     | 259.5 |
| 4          | 362    | 209     | 285.5| 465    | 155     | 310   |
| 5          | 300    | 118     | 209  | 437    | 160     | 298.5 |
| 1×2        | 506    | 230     | 368  | 426    | 161     | 293.5 |
| 1×3        | 550    | 329     | 439.5| 407    | 274     | 340.5 |
| 1×4        | 415    | 220     | 317.5| 428    | 255     | 341.5 |
| 1×5        | 626    | 279     | 452.5| 329    | 187     | 258   |
| 2×3        | 709    | 233     | 471  | 275    | 179     | 227   |
| 2×4        | 613    | 242     | 427.5| 445    | 186     | 315.5 |
| 2×5        | 391    | 217     | 304  | 458    | 294     | 376   |
| 3×4        | 604    | 304     | 454  | 501    | 293     | 397   |
| 3×5        | 504    | 212     | 358  | 392    | 295     | 343.5 |
| 4×5        | 512    | 224     | 368  | 271    | 295     | 283   |
| 2×1        | 499    | 221     | 360  | 508    | 289     | 398.5 |
| 3×1        | 601    | 350     | 475.5| 361    | 209     | 285   |
| 4×1        | 457    | 214     | 335.5| 456    | 214     | 335   |
| 5×1        | 658    | 336     | 497  | 330    | 306     | 318   |
| 3×2        | 704    | 292     | 498  | 385    | 302     | 343.5 |
| 4×2        | 598    | 253     | 425.5| 422    | 321     | 371.5 |
3.3. Number of grains per ear

Results of (Table 3) for the fall season indicated that the plants of inbred line 3 and 4 outperformed the number of grains per ear by giving the highest average of the character amounted to 285.0 and 285.5 grains for the two strains respectively, while in the spring season the plants of inbred line 4 scored the highest rate of the number of grains per ear reached 310.0 grains. Genetic divergence between the breeds was reflected on the exchange and inverse hybrids resulting from it, as the reverse hybrid 3×2 for the fall season gave the highest number of grains per ear, reaching 498.0 grains per ear, and it did not differ significantly with the reverse hybrid 5×1, which reached 497.0 grains per ear, and the cross hybrid 2×3 gave higher average for the character was 471.0 grains, as for the spring season, the highest value of the character was 397.0 grains per ear for the cross-hybrid 3×4 while it reached the highest value of the number of grains per ear is 398.0 grains per ear for the reverse hybrid 2×1. It is noted from the results of the same table that the 6 day irrigation treatment was superior by giving it the highest average number of grains per ear, which
amounted to 515.1 and 390.2 grains per ear for the two seasons in succession, while the 12-
day irrigation treatment gave the average number of grains per ear amounted to 239.2 and
241.7 grains per ear respectively and for the two seasons , with the ear in the 12-day irrigation
treatment, length of the ear was reduced, which led to a decrease in the number of grains, in
addition to the water tension, which negatively affected the preparation of nutrients and the
activity of enzymes and hormones inside the plant, which was reflected in the process of pollination and fertilization, and consequently the number of grains in the ear, this result agrees with [14,25] who found that the water tension caused a decrease in the number of grains in the maize, with regard to the interaction between irrigation treatments and genotypes, it was found that the 2×3 cross-hybrid and the 3×2 reverse hybrid for the 6-day irrigation treatment had the highest rate of binary interaction, which amounted to 709 and 704 grains of the two hybrids, respectively, while the irrigation 12-day treatment of the reverse hybrid 3×1 was higher, average of the character was 350 grains per ear and did not differ significantly with 4 reciprocal and inverse crosses, as for the spring season, the alternating hybrid 3×4 and the reverse hybrid 2×1 had the highest average number of grains per ear, reaching 501 and 508 grains per ear, for the 6-day irrigation treatment for the two hybrids in sequence, while the hybrid 4×5 recorded the lowest rate of 271 grains per ear, while the 12-
day irrigation treatment gave the hybrid 4×2 the highest rate of binary interaction amounted to 321 grains in the ear, while the hybrid 2×1 recorded the lowest rate of interaction reached 161 grain in the ear.

Table 3. The average number of grains per ear for inbred lines, their alternating crosses and reverse hybrids for maize for a 6-day irrigation interval and a 12-day irrigation interval for the fall season 2019 and the spring season 2020

| genotypes | Fall season 2019 | Spring season 2020 |
|------------|-----------------|-------------------|
|            | days 6 | days 12 | Mean | days 6 | days 12 | Mean |
| 1          | 14     | 13.1    | 13.55 | 14     | 13.2    | 13.6  |
| 2          | 15.4   | 14.5    | 14.95 | 15.2   | 14.3    | 14.75 |
| 3          | 14.2   | 14      | 14.1  | 14     | 14      | 14    |
| 4          | 15.1   | 15.2    | 15.15 | 15.4   | 15      | 15.2  |
| 5          | 15.5   | 14.2    | 14.85 | 15.3   | 14.6    | 14.95 |
| 1×2        | 17.3   | 13.8    | 15.55 | 14.5   | 13.5    | 14    |
| 1×3        | 15     | 14.8    | 14.9  | 15.1   | 14.7    | 14.9  |
| 1×4        | 13.5   | 13.5    | 13.5  | 13.1   | 13      | 13.05 |
| 1×5        | 15.5   | 15      | 15.25 | 14.2   | 14      | 14.1  |
| 2×3        | 16.6   | 15.7    | 16.15 | 17.4   | 13.8    | 15.6  |
| 2×4        | 17.3   | 16.2    | 16.75 | 17.5   | 15.1    | 16.3  |
| 2×5        | 16.2   | 14.9    | 15.55 | 13.5   | 13.6    | 13.55 |
| 3×4        | 16.5   | 15.8    | 16.15 | 14.6   | 14.2    | 14.4  |
| 3×5        | 16.9   | 16.5    | 16.7  | 16.3   | 16      | 16.15 |
| 4×5        | 15.8   | 15.4    | 15.6  | 15.8   | 15.1    | 15.45 |
| 2×1        | 14.9   | 14.3    | 14.6  | 14.3   | 14.4    | 14.35 |
| 3×1        | 17.2   | 16.7    | 16.95 | 16.1   | 15.6    | 15.85 |
| 4×1        | 15.4   | 15      | 15.2  | 14.2   | 14      | 14.1  |
| 5×1        | 16.3   | 16      | 16.15 | 14.2   | 14.3    | 14.25 |
| 3×2        | 18.8   | 15.9    | 17.35 | 17.2   | 14.4    | 15.8  |
| 4×2        | 16.7   | 15.6    | 16.15 | 17     | 15.9    | 16.45 |
| 5×2        | 15.2   | 14.1    | 14.65 | 13.1   | 13      | 13.05 |
| 4×3        | 14.9   | 15      | 14.95 | 14.8   | 15      | 14.9  |
| 5×3        | 17.5   | 15.1    | 16.3  | 17.7   | 15.1    | 16.4  |
3.4. Weight 300 tablets (g)

(Table 4) highest average weight of 300 grains reached 77.00 g, and did not differ significantly with 4 inbred lines, as for the spring season, inbred 3 and 5 achieved an average of 85.90 and 87.10 g for the two inbred line respectively. These differences between the inbred lines were reflected in their reciprocal and inverse hybrids. In the fall season, the two exchange hybrids 3x4 and 4x5 had the highest mean of 98.85 and 99.10 g, respectively, and the reverse hybrid 4x3 scored the highest rate of 96.20 g. It did not differ significantly with the reverse hybrid. 5x4 as for the spring season, cross-hybrid 4x5 had the highest average weight of 300 grains that reached 88.05 g and did not differ significantly with 4 cross-cross hybrids, while the inverse hybrid 5x4 scored the highest average of 90.80 g, these results agreed with the findings of [12,14,16] that there were significant differences between the genotypes, results of the same table indicate the superiority of the 6-day irrigation treatment by giving it a greater weight of 300 grains, which reached 86.10 and 84.38 g for the fall and spring seasons, respectively, compared to the 12-day irrigation treatment, which recorded 81.48 and 79.93 g for the two seasons, respectively, this result agrees with the findings of [4,7,8] that water stress caused a reduction in grain weight in the ear of maize plants.

As for the interaction between irrigation treatments and genotypes, it was shown in (Table 4) the plants of the hybrid 4x5 for the 6-day irrigation treatment gave the highest rate of binary interaction amounting to 103.8 g and did not differ significantly with the hybrid 3x4 and the hybrid 4x3, while the hybrid gave 4x 3 for irrigation treatment 12 days the highest rate of interaction reached 96.2 g and did not differ with 4 cross and inverse hybrids for the fall season, as for the spring season, the hybrid 3x1 for the irrigation treatment 6 days scored the highest rate for the character reached 94.0 g.

Table 4. Average weight of 300 grains (g) for the inbred lines and their cross and reverse hybrids of maize for 6 days irrigation interval for 12 days irrigation interval for fall season 2019 and spring season 2020

| Genotypes | Fall season 2019 | Spring season 2020 |
|-----------|-----------------|--------------------|
|           | days 6          | days 12 Mean       | days 6          | days 12 Mean |
| 1         | 78              | 67.5               | 72.75           | 84.5          | 64.3          | 74.4          |
| 2         | 84.1            | 69.9               | 77               | 82.9          | 76.5          | 79.7          |
| 3         | 81.2            | 71                 | 76.1             | 87.9          | 83.9          | 85.9          |
| 4         | 70.1            | 59.1               | 64.6             | 83.1          | 78.5          | 80.8          |
| 5         | 77.1            | 72.2               | 74.65            | 89.8          | 84.4          | 87.1          |
| 1x2       | 86              | 76.9               | 81.45            | 86.6          | 86.8          | 86.7          |
| 1x3       | 82.2            | 83                 | 82.6             | 87.6          | 82.5          | 85.05         |
| 1x4       | 94.2            | 87.4               | 90.8             | 82.7          | 90            | 86.35         |
| 1x5       | 82.9            | 83.3               | 83.1             | 83.3          | 62.2          | 72.75         |
| 2x3       | 90.4            | 85.4               | 87.9             | 64.5          | 62.3          | 63.4          |
| 2x4       | 82.5            | 82.4               | 82.45            | 86.9          | 87.6          | 87.25         |
| 2x5       | 76.9            | 73.2               | 75.05            | 82.8          | 81.5          | 82.15         |
| 3x4       | 103.1           | 94.6               | 98.85            | 82.5          | 87.2          | 84.85         |
| 3x5       | 95.2            | 90.9               | 93.05            | 89.9          | 84.1          | 87            |
| 4x5       | 103.8           | 94.4               | 99.1             | 88.1          | 88            | 88.05         |
| 2x1       | 82.1            | 77.9               | 80               | 82            | 83.1          | 82.55         |
| 3x1       | 87.1            | 84                 | 85.55            | 94            | 69.3          | 81.65         |
the 12-day irrigation treatment, the hybrid scored 5×4 highest rate of binary interaction reached 91.0 g and did not differ significantly with the cross-hybrid 1×4 which reached 90.0 g.

3.5. Plant grain yield

Table 5, genotypes varied significantly among themselves, as inbred line 3 gave the highest average of 78.65 g and did not differ significantly with inbred line 2 and 4, while inbred line 1 gave the lowest average of 61.65 g for the fall season, while the spring season gave inbred lines 5, 4 and 3 the highest average which was 88.05, 84.25 and 83.40 g, respectively, and the parents inherited its variance to their reciprocal and inverse hybrids. reverse hybrid 5×1 had the highest mean of the character amounted to 169.60 g, and it did not differ significantly with the reverse hybrid 3×1 it reached 165.20 g, as for the spring season, the reciprocal hybrid 4×3 and the inverse hybrid scored the highest average for the character, which reached 165.20 and 142.90 g, respectively, reason for the superiority of these hybrids and giving them a high yield is due to the superiority in yield components and leaf area. [4,6,14,28] showed similar results when they indicated significant differences between genotypes in individual plant yield. It is noted from the results of the same table that the plants grown under the 6-day irrigation intervals were superior to the individual plant yield by giving them an average yield of 166.28 and 134.76 g for the fall and spring seasons in sequence, so that the yield was almost halved by the effect of the decrease in the number of irrigation days when the 12-day irrigation treatment achieved the lowest average of the yield reached 76.63 and 75.54 g for the fall and spring seasons, respectively, reason for the decrease in grain yield under conditions of low soil moisture may be attributed to the effect on the growth and development of the crop, long irrigation interval of 12 days had a significant effect on the decrease in grain weight and the number of grains in the ear. Water stress leads to a lack of processing of photosynthetic materials into fertilized grains, because of the abortion of fertilized grains, their number decreases and some of them wither, and the water stress also led to the early female flowering, which led to a shortening of the growth stages, these results were reinforced by what was found by [12,14,29] who indicated that the grain yield of maize plants subjected to water stress decreased significantly and attributed this to the small size of the ear and the decrease in the number of grains in the ear and the weight of the grains in it. The results of the statistical analysis indicate that there is a significant interaction for the two study factors, meaning that all genotypes decreased grain yield for the 12-day irrigation interval treatment compared to the 6-day irrigation treatment for the two seasons, days suitable for high-efficiency irrigation when it achieved the highest value of the binary interaction with a yield of 224.0 g when the irrigation treatment was 6 days and did not differ significantly with 4
reciprocal and inverse crosses, while the response of other combinations 2 x 3 and 5 x 4 when
the 12 day irrigation treatment achieved the highest mean yield reached 123.2 and 121.4 g,
respectively, while the response of other formulations was 5x2 different when irrigating 12
days, with the lowest mean for the character reaching 55.2 g for the fall season, as for the
spring season, the alternating and inverse hybrids 3x4 and 2x1 at 6 days were used for
irrigation with high efficiency when they achieved the highest value of the binary interference
with a yield of 190.4 and 186.0 g, respectively, while the response of other combinations was
3x2 and 4x2 at Irrigation treatment 12 days achieved the highest mean yield of 102.9 and
101.0 g respectively, while the response of other formulations 2x3 was different when
irrigating 12 days by achieving the lowest mean of the characteristic amounted to 43.5 g.
These results are consistent with the results of previous studies carried out by [12].

Table 5. Average individual Plant grain yield (g) of inbred lines, their cross-hybrids and
cross-hybrids of maize for a 6-day irrigation interval for a 12-day irrigation interval for the
fall season 2019 and the spring season 2020

| Genotypes | Fall season 2019 | Spring season 2020 |
|-----------|-----------------|--------------------|
|           | days 6 | days 12 | Mean | days 6 | days 12 | Mean |
| 1         | 83.8    | 39.5    | 61.65 | 83    | 41.3    | 62.15 |
| 2         | 105.4   | 42.8    | 74.1   | 84.1  | 52.7    | 68.4  |
| 3         | 110.5   | 46.8    | 78.65  | 114.9 | 51.9    | 83.4  |
| 4         | 98.8    | 43.3    | 71.05  | 126.7 | 41.8    | 84.25 |
| 5         | 92.3    | 34.8    | 63.55  | 132.8 | 43.3    | 88.05 |
| 1×2       | 161.7   | 69.7    | 115.7  | 165.1 | 50.7    | 107.9 |
| 1×3       | 182.9   | 110.6   | 146.8  | 134.3 | 96      | 115.2 |
| 1×4       | 146.4   | 73.3    | 109.9  | 158.9 | 100.2   | 129.6 |
| 1×5       | 206.8   | 80.3    | 143.6  | 108.4 | 48.1    | 78.25 |
| 2×3       | 222.8   | 123.2   | 173    | 98.5  | 43.5    | 71    |
| 2×4       | 180.1   | 74.2    | 127.2  | 167.1 | 58.9    | 113   |
| 2×5       | 105.9   | 55.8    | 80.85  | 145.6 | 96.8    | 121.2 |
| 3×4       | 217.1   | 114.7   | 165.9  | 190.2 | 100.1   | 145.2 |
| 3×5       | 189.5   | 74.3    | 131.9  | 150.4 | 96.9    | 123.7 |
| 4×5       | 186.9   | 75.1    | 131    | 95.1  | 90.3    | 92.7  |
| 2×1       | 150     | 70.2    | 110.1  | 186   | 99.7    | 142.9 |
| 3×1       | 215.8   | 114.6   | 165.2  | 138.7 | 54      | 96.35 |
| 4×1       | 154.8   | 71.7    | 113.3  | 127.7 | 48.7    | 88.2  |
| 5×1       | 224     | 115.2   | 169.6  | 107.9 | 100.9   | 104.4 |
| 3×2       | 194.1   | 81.9    | 138    | 118.6 | 102.9   | 110.8 |
| 4×2       | 185.7   | 74.9    | 130.3  | 163   | 101     | 132   |
| 5×2       | 158.7   | 55.2    | 107    | 146.6 | 93.9    | 120.3 |
| 4×3       | 210.2   | 86.8    | 148.5  | 127.8 | 76.9    | 102.4 |
| 5×3       | 171.5   | 65.4    | 118.5  | 170   | 100.5   | 135.3 |
| 5×4       | 201.2   | 121.4   | 161.3  | 137.8 | 97.4    | 117.6 |
| Mean      | 166.28  | 76.63   | 134.76 | 75.54 |        |       |
| LSD 5%    | Irrigation interval | 10.47 | 4.82 |
|           | genotypes       | 11.76 | 9.3  |
|           | Interaction      | 17.03 | 13.1 |
4. Conclusion

Irrigation interval of 6 days was characterized by giving the highest average grain yield, and the increase in the irrigation period was characterized by improving the efficiency of water use in the spring season, and this is the evidence of the ability of maize hybrids to adapt to water scarcity conditions, although the treatment of irrigation 12 days had a bad effect on the behavior of the inbred. Maize hybrids, which led to a noticeable decrease in the yield of grains and its components, although some of the hybrids were distinguished in an acceptable yield under water stress conditions.

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