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Response of Two Maize Hybrids Productivity to Inter-and Intra-Rows Spacing

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Abstract

Two field experiments were carried out during two summer seasons (2017 and 2018) at the Experimental Farm of the Faculty of Agriculture, Assiut University, Assiut, to study the response of two maize hybrids [Single Cross 128 (S.C. 128) and Triple Cross 310 (T.C. 310)] yield and its components for three inter-rows spacing (Rw_1= 60 cm, Rw_2= 70 cm and Rw_3= 80 cm) and three intra-rows spacing (S_1= 20 cm, S_2= 25 cm and S_3= 30 cm). Experimental design was randomized complete block design (RCBD) using split-plot in strips, where inter-row spacing allocated in the main horizontally, maize hybrids were arranged in the main vertically and intra-row spacing were occupied the sub-plots.

According to results, the maximum values of plant height and ear diameter in both seasons, ear length in the 1st season, ear grains weight and grain yield/fed. (20.4 ard.) in the 2nd season were obtained at row width 70 cm (Rw_2), moreover, ear grains weight, 100 grain weight and grain yield/fed. (25.1 ard.) were obtained at row width 60 cm (Rw_1) in the 1st season.

- The hybrid S.C. 128 gave the highest values of ear length, ear grains weight and 100-grain weight in the both seasons and grain yield/fed. (19.7 ard.) in the 2nd season, while hybrid T.C. 310 surpassed for traits of plant height and ear length in the both seasons and grain yield/fed. (24.1 ard.) in the 1st season.
- The highest values of plant height in the 2nd season and grain yield/fed. (23.6 and 19.6 ard.) in the both seasons and ear length, ear grains weight and 100-grain weight were recorded by 30 cm (S_3) hill spacing apart.
- The first order interaction H_3xRw_3 (T.C. 310 x 80 cm) achieved the maximum values of plant height and H_1xRw_1 interaction (S.C. 128 x 60 cm) for ear diameter and 100-grain weight in the both seasons, while the H_3xRw_1 (T.C. 310 x 60 cm) and H_3xRw_2 (T.C. 310 x 70 cm) for grain yield/fed. (25.9 and 20.6 ard.) in the 1st and 2nd seasons, respectively.
- The H_3xS_3 interaction (T.C. 310 x 30 cm) gave the highest values of ear length and plant height in the 1st and 2nd seasons, respectively, while the H_2xS_3 interaction (S.C. 128 x 30 cm) gave the highest ones for 100-grain weight and grain yield/fed. (20.9 ard.) in the 2nd season.
- The Rw_2xS_2 interaction (70x25 cm) showed the maximum values of plant height, as well as the Rw_1xS_3 (60x30 cm) showed the maximum ones for 100-grain weight and grain yield/fed. (26.5 ard.) in the 2nd season.
- The second order interaction $H_3xRw_3xS_3$ (T.C. 310 x 80 cm x 30 cm), as well as the $H_1xRw_3xS_2$ (S.C. 128 x 80 cm x 25 cm) gave the height values of plant height and ear diameter in the 2nd season, respectively, moreover the either H_3 or $H_1xRw_1xS_3$ interactions (either T.C. 310 or S.C. 128 x 60 cm x 30 cm) gave

the maximum ones (27.2 and 22.5 ard.) for grain yield/fed. in the 1st and 2nd seasons, respectively.

Keywords: *Maize hybrids, Inter-row spacing (row width), Intra-row spacing (hill spacing), Single Cross (S.C.) and Triple Cross (T.C.).*

Introduction

One of the most important cereal crop grown during the summer season in Egypt is corn. It is used for both human consumption and poultry feed. The attempts for increasing maize production to meet the decrease in the local production of crop, since the continuous increase of consumption. Such attempts could be achieved through numerous researchers in the scope of maize production.

Row width plays a great effect on the maize plant population. In this respect, Darwich (2009) reported that increasing distance between rows from 60 to 70 and 80 cm lead to a significant increase in growth characters, grain yield and its components due to better interception and utilization of solar radiation led to increase in photosynthetic processes. Attia *et al*. (2012) showed that increasing ridge spacing significantly increase plant and ear heights, as well as, planting on the 80 cm ridge was associated with a significant increase in ear length, 1000 kernel weight and grain yield. Gobeze *et al*. (2012) pointed out that planting maize in ridges 80 or 90 cm apart produced the highest values of all studied characters. Planting maize in ridges 70 cm apart gave the lowest values of these characters. Recently, Fahad *et al*. (2016) reported that maize plants sown in line having (60 cm) row to row distance had the highest plant height, heaviest 1000 grains weight and highest grain yield.

Maize hybrids differences on agronomic characters and grain yield. In this respect, Oraby *et al*. (2005) concluded that the single cross 10 significantly surpassed the other hybrids. Sief *et al*. (2005) and El-Bably (2007) revealed that maize cultivar (single cross 10) significantly surpassed maize cultivars single cross 122 and single cross 124 in the mean values of plant height, ear length, 100-grain weight and grain yield/fed. El-Metwally *et al*. (2011) showed a significant difference among maize hybrids in plant height, grains weight/ear and grain yield/plant. Zamir *et al*. (2011) initiate that hybrid 30Y87 was early in maturity, produced less cob length than the hybrid 31R88, similarly 1000-grain weight and grain yield of hybrid 30Y87 was significantly greater than the hybrid 31R88. Leilah *et al*. (2017) found that S.C. 128 produced the highest values when planting in ridges 80 cm apart 22 cm between hills and one plant hill. Kandil (2013) concluded that maize hybrid S.C. 10 with 429 Kg N/ha, recorded the tallest cob. Also, hybrid S.C. 10 gave the maximum 1000-kernel weight and grain yield.

Growth and grain yield of maize is more affected by variations in hill spacing than other members of the grass family. Hill spacing affected of agronomic, flowering characteristics, and grain yield. Many investigators studied the effect of plant density of maize as a spacing between hills, in this regard, Sharifai *et al*. (2012) found that highest grain yield ob-

tained at 10 plants/m^2. The highest cob length was recorded at 8 plants/m^2, while the highest values of plant height were recorded at 12 plants/m^2. Leilah *et al*. (2013**)** showed that increase in intra-row spacing from 20 to 25cm significantly increased cob diameter, 100-grain weight and grain yield. Ukonze *et al*. (2016) showed that the 70 x 30 and 60 x 40 cm spacing gave higher values of the morphological parameters than 80 x 20 cm. With regard to yield, 80 x 20 cm gave the highest average cob weight and 1000-grain weight.

The objective of this study was to determine the effects of different inter-and intra-rows spacing on yield and yield components of corn genotypes under Assiut climatic conditions.

Materials and Methods

The present research is concerned with studying the response of yield and its attributes of maize hybrids under inter- and intra-rows spacing. Two field experiments were carried out at the Experimental Farm of the Faculty of Agriculture, Assiut Univ., during 2017 and 2018 summer seasons. The soil type was clay in texture with pH of 7.8, 1.7 organic matter and having 0.72, 9.0 and 350 ppm available N, P and K, respectively (average of two seasons for the upper 30 cm of soil). Each experiment was laid out in randomized complete block design (RCBD) using a split plot in strips with three replications. Three inter-rows spacing (Rw_1, Rw_2 and Rw_3) (60, 70 and 80 cm) were allotted in the main horizontally. The two maize hybrids, Single cross 128 (S.C. 128) and Three-Way Cross 310 (T.C. 310) were assigned in the main vertically. The three intra-rows spacing (S_1, S_2 and S_3) (20, 25 and 30 cm) were distributed in the sub-plot, which were 3x3.5 m^2. The maize was planted on 28 and 26 of June in 2017 and 2018 seasons, respectively. The grains were sown in hills 20, 25 and 30 cm apart and the plants were thinned after 21 day to keep one plant/hill. The preceding crop was clover in both seasons. All cultural practices were done as recommended.

Recording data

A- Growth traits

1- Plant height (cm): was measured as the distance from the ground surface to the base of the tassel node.

B- Yield components: (10 ears as a sample were taken from each sub-plot to determine):

1- Ear length (cm). 2- Ear diameter (cm). 3- Grains weight/ear. 4- 100-grain weight (gm). Adjusted to 15.5% moisture.

C- Grain yield: (Two center rows) were harvested from each sub-plot to determine grain yield/ (ardab)/fed. after the weight of grain adjusted to 15.5% moisture.

Statistical analysis:

All the obtained data were subjected to normal statistical analysis according to Gomez and Gomez (1984). Means comparison were done using Revised Least significant differences (R-LSD) at 5% probability level.

Results and Discussion

A- The main effects:

The presented data in Table 1 showed that the main effect inter-row spacing= row width (Rw) had significantly effect on the plant height, ear

length and grains weight/ear in the second season, moreover it had highly significantly effect on grains yield/fed. in the first season only. The ear diameter and 100-grain weight had non-significant affected by this trial in the both seasons. The tallest plants (253.0 and 243.1 cm) and the thickest ear (4.4 and 4.1 cm) in both seasons, the tallest ear (20.8 cm) in the 1st season, the heaviest ear grains (158.0 g), and the maximum grain yield/fed. (20.4 ard.) in the 2nd season were realized by Rw_2 (70 cm). Meanwhile, the highest ear grains weight (182.0 g), the heaviest 100-grain (33.2 g) and the maximum grain yield/fed. (25.1 ard.) were realized by Rw_1 (60 cm) in the 1st season. On the contrary, the minimum means values (250.6 and 231.1 cm) and (20.2 and 18.7 cm) in both seasons as well as (4.0 cm), (141.3 g), (29.0 g) and (18.1 ard.) in the 2nd season, were realized by Rw_1 (60 cm) for plant height, ear length, ear diameter, ear grains weight, 100-grain weight and grain yield/fed., respectively. Kandil *et al*. (2017) concluded that sown maize plants in width row (70 cm) produced the highest ear length, ear diameter, grains weight/ear and 100-grain weight. Therefore, the larger availability of solar radiation probably allowed plants to set more grains per ear and to produce heavier grains. These results are in good accordance with those stated by Mahgoub and El-Shenawy (2006), Darwich (2009), Attia *et al*. (2012), Gobeze *et al*. (2012) and Fahad *et al*. (2016).

As for, the main effect maize hybrids (H) had significantly effect on the plant height and 100-grain weight or highly significantly effect on grains yield/fed. in the 1st season only (Table 1). On the other hand, the ear length, ear diameter and grains weight/ear traits had non-significant affected by this trial in the both seasons.

The hybrid H_3 (T.C. 310) surpassed the hybrid H_1 for the plant height, ear length in both season and for grains yield/fed. in the 1st season only. On the contrary, the hybrid H_1 surpassed hybrid H_3 for ear diameter, grains weight/ear and 100-grain weight in both seasons. This result may be due to the genetic factors. Ahmed, Howida (2011) found that Single cross Watania 4 surpassed in the mean values of ear diameter, 200 grain weight and grains yield/fed. than Triple cross 310 in the both seasons. These results are in agreement with those found by Mahgoub and El-Shenawy (2006), El-Bably (2007), Attia *et al*. (2012), El-Metwally *et al*. (2017) and Kandil *et al*. (2017).

The data in Table 1 revealed that the main effect intra-row spacing= hill spacing (S) had significantly effect on the plant height, 100-grain weight and grains yield/fed. in the second season only. The other studied traits had non-significant affected by this trial in both seasons.

The hill-spacing S_3 (30 cm) recorded the tallest plant (240.6 cm) in the 2nd season and the maximum grain yield/fed. (23.6 and 19.6 ard.) in the 1st and 2nd seasons, respectively. Meanwhile, intra-row spacing S_3 also recorded the longest ear (20.5 cm), the best grains weight/ear (182.6 g) and the heaviest 100-grain (33.1 g) in the 1st season. On the other hand, the hill-spacing 25 cm apart (S_2) gave the minimum values (20.3 cm) for ear

length and (33.0 g) for 100-grain weight in the 1st season, as well as the minimum ones (21.7 and 18.6 ard.) for grain yield/fed. in the 1st and 2nd seasons, respectively. This is logic, hence the distribution of plants in S_3 may be favorable the light intensity, therefore, the plant height and the other studied traits must be increased in tall and information of grains. These results are in harmony with those stated by Sener *et al*. (2004), El-Metwally *et al*. (2011), Sharifai *et al*. (2012) and Ukonze *et al*. (2016).

B- The interaction effects:

The presented data in Table 2 declared that the all studied traits had non-significant affected by the interaction between maize hybrids and row width (HxRw) in the both seasons. However, the tallest plants (261.8 and 251.0 cm) and the longest ear (20.5 cm) followed by (20.4 and 20.0 cm) were recorded by (H_3xRw_3) and (H_1xRw_2) followed by (H_3xRw_3), while the shortest ones (243.3 and 229.7 cm) and (20.0 and 18.0 cm) were recorded by (H_1xRw_3) and (H_1xRw_3 and H_1xRw_1) in the 1st and 2nd seasons, respectively. Meanwhile, the best ear diameter (4.5 and 4.1 cm) and the heaviest 100-grain (34.0 and 30.0 g) were recorded by H_1xRw_1, as well as the maximum grain yield/fed. (25.5 and 20.6 ard.) were recorded by H_3xRw_1 and H_3xRw_2 in the 1st and 2nd seasons, respectively, while the minimum ones (4.0 cm), (27.7 g) and (16.7 ard.) were achieved by H_3xRw_1 for ear diameter, ear grains weight and grain yield/fed. in the 2nd season, respectively. Fahad *et al*. (2016) demonstrated that Hybrid-3025 sown in ridges having a 60 cm row to row distance produce more grain yield as compared to Azam variety.

Regarding to the interaction between maize hybrids and hill spacing (HxS), the data in Table 3 revealed that the plant height in the 2nd season and ear diameter in the 1st season had significantly affected by the (HxS) interaction. The other traits either in the 1st or/and in the 2nd season(s) had non-significant affected by this trial. The tallest plant (249.7 cm) and the longest ear (20.7 cm) were obtained by (H_3xS_3), while the shortest plant (225.7 cm) and thinnest ear (4.3 cm) were obtained by (H_1xS_1) and (H_1xS_2) or (H_3xS_3) in the 2nd and 1st seasons, respectively. Meanwhile, the heaviest 100-grain (29.2 g) and the maximum grain yield/fed. (20.9 ard.) were realized by (H_1xS_3), while the minimum 100-grain weight (27.2 g) and grain yield/fed. (17.1 ard.) were realized by (H_3xS_3) and (H_3xS_2) in the 2nd season, respectively. Sener *et al*. (2004) establish that maize hybrids react differently to various plant population density. Meanwhile, Kandil *et al*. (2017) showed that there were varietal differences in response to intra-row spacing.

As for, the first order interaction (RwxS) the data in Table 4 cleared that the plant height had significantly affected by this trial in the 2nd season only, while the other traits either in the 1st or/and the 2nd season(s) had non-significant affected by this trials. The tallest plants (246.2 followed by 245.3 cm) were recorded by (Rw_2xS_2 followed by Rw_3xS_3), while the shortest ones (229.8 cm followed by 231.3 cm) were recorded by (Rw_1xS_2 followed by Rw_1xS_1) in the 2nd season. Meanwhile, the heaviest 100-grain (34.0 g) and the maximum grain yield/fed. (26.5 ard.) were achieved by (Rw_1xS_3) in the 2nd season, respectively. Mahgoub and El-Shenawy (2006) decided that planting maize on 80 cm row of plant densities of 25-30 thousand plants/fed. (17.20 cm between hills) maximized grain yield. Kandil *et al*. (2017) came the same conclusion.

Concerning the second order interaction (HxRwxS), the data in Table 5 showed that the plant height, ear diameter and grains weight/ear had significantly or highly significantly affected by the HxRwxS interaction in the 2nd season only, respectively, while the other traits either in the 1st or/and in the 2nd season9s) had non-significant affected by this trial. The tallest plant (258.7 cm), the thickest ear (4.2 cm) and the maximum ear grains weight (177.8 g) were recognized by ($H_1xRw_3xS_2$) in the 2nd season, respectively, as well as the maximum grains yield/fed. (27.2 and 22.5 ard.) were recorded by $H_3xRw_1xS_3$ and $H_1xRw_1xS_3$ in the 1st and 2nd seasons, respectively. Sharifai *et al*. (2012) reported that the highest grain yield due to increase plant population and reduce row spacing depended mainly on different factors, like the hybrid type in use. Similar finding was mentioned by Kandil *et al*. (2017).

Conclusion

It could be concluded that sown either S.C. 128 or T.C. 310 at 60 cm row width and hill spacing of 30 cm apart maximized maize productivity under the environmental conditions of Assiut Governorate, Egypt.

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استجابة إنتاجية هجينين للذرة الشامية للمسافة بين وداخل الخطوط

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الملخص

نفذت تجربتان حقليتان خلال الموسمين الصيفيين ٢٠١٧ ، ٢٠١٨ في مزرعة التجارب بكلية الزراعة جامعة أسيوط لدراسة تأثير ثلاث مسافات بين الخطوط (٦٠ ، ٧٠ ، ٨٠ سم) وثلاث مسافات بين الجور (٢٠ ، ٢٥ ، ٣٠ سم) لهجينين من الذرة الشامية هما الهجين الفردي (ه.ف.) ١٢٨ والهجين الثلاثي (ه.ث.) ٣١٠ علي المحصول ومكوناته. وكان التصميم المستخدم هو القطاعات الكاملة العشوائية بترتيب الأحواض المنشقة في شرائح حيث تم وضع المسافة بين الخطوط أفقياً وهجن الذرة الشامية رأسياً والمسافة بين الجور في الوحدة المنشقة مرة واحدة.
وأوضحت النتائج أن:

- كانت أعلا القيم لصفات طول النبات وقطر الكوز في كلا الموسمين، وطول الكوز في الموسم الأول، ووزن الحبوب للكوز ومحصول الحبوب للفدان في الموسم الثاني للمسافة بين الخطوط ٧٠ سم، علاوة علي ذلك كانت أعلا القيم لصفات وزن الحبوب للكوز، وزن ١٠٠ حبة ومحصول الحبوب للفدان (٢٥،١ أردب) للمسافة بين الخطوط ٦٠ سم في الموسم الأول.
- تفوق الـ ه.ف. ١٢٨ لصفات قطر الكوز، وزن الحبوب للكوز، ووزن ١٠٠ حبة في كلا الموسمين ومحصول الحبوب للفدان (١٩،٧ اردب) في الموسم الثاني، بينما تفوق الـ ه.ث. ٣١٠ لصفات طول النبات ، طول الكوز في كلا الموسمين ومحصول الحبوب للفدان (٢٤،١ أردب) في الموسم الأول.
- سجلت المسافة بين الجور ٣٠ سم أعلا القيم لصفات طول النبات في الموسم الثاني ومحصول الحبوب للفدان (٢٣،٦ و ١٩،٦ أردب) في كلا الموسمين، وطول الكوز ووزن الحبوب للكوز ووزن ١٠٠ حبة في الموسم الأول.
- حقق التفاعل الثنائي (ه.ث. ٣١٠ × المسافة بين الخطوط ٨٠ سم) أعلا القيم لصفة طول النبات والتفاعل الثنائي (ه.ف. ١٢٨ × ٦٠ سم) لصفات قطر الكوز ووزن ١٠٠ حبة في كلا الموسمين، بينما التفاعلان (ه.ث. ٣١٠ × ٦٠ سم) و(ه.ث. ٣١٠ × ٧٠سم) لصفة محصول الحبوب للفدان (٢٥،٩ و ٢٠،٦ أردب) في الموسم الأول والثاني علي الترتيب.
- أعطي التفاعل الثنائي (ه.ث. ٣١٠ × المسافة بين الجور ٣٠ سم) أعلا القيم لصفتي طول الكوز وطول النبات في الموسم الأول والثاني علي الترتيب، بينما أعطي التفاعل الثنائي (ه.ف. ١٢٨ × المسافة بين الجور ٣٠ سم) أعلا قيم لصفة وزن ١٠٠ حبة ومحصول الحبوب للفدان (٢٠،٩ أردب) في الموسم الثاني.
- أظهر التفاعل الثنائي (المسافة بين الخطوط ٧٠ سم × المسافة بين الجور ٢٥ سم) أعلا القيم لصفة طول النبات، كما أن التفاعل الثنائي (المسافة بين الخطوط ٦٠ سم × المسافة بين الجور ٣٠ سم) أعلا القيم لصفة وزن ١٠٠ حبة ومحصول الحبوب للفدان (٢٦،٥ أردب) في الموسم الثاني.
- أعطي التفاعل الثلاثي (ه.ث. ٣١٠ × المسافة بين الخطوط ٨٠ سم × المسافة بين الجور ٣٠ سم) والتفاعل (ه.ف. ١٢٨ × ٨٠ سم × ٢٥ سم) أعلا القيم لصفة طول النبات وقطر الكوز في الموسم الثاني علي الترتيب، وعلاوة علي ذلك أعطي التفاعلان الثلاثي (إما ه.ث. ٣١٠ أو ه.ف. ١٢٨ × المسافة بين الخطوط ٦٠ سم × المسافة بين الجور ٣٠ سم) أعلا القيم لصفة محصول الحبوب للفدان (٢٧،٢ و ٢٢،٥ أردب) في الموسم الأول والثاني علي الترتيب.