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Agricultural Studies on Some Corn Hybrids Cultivated With Deferent Plants Densities

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Abstract

Two field experiments were carried out at the Agricultural Experiments Station of the Faculty of Agriculture, Cairo University, Giza, during 2009 and 2010 seasons to study the response of three different maize (*Zea mays* L.) single and 3-way cross (SC 10, SC 122 and TWC 321) were kindly provided by Maize Res. Dept. of Agric. Res. Center (ARC) to four population densities, i.e. 20 cm between hills (8.33 plants/m^2), 25 cm between hills (6.67plants/m^2), 30 cm between hills (5.56 plants/m^2) and 35 cm between hills (4.76 plants/m^2) on yield and yield components. Results showed that, significant differences between maize varieties in some traits of maize, i.e. plant height, number of ears/plant, barren percentage (%), LAI, number of kernels /row, grain weight/ear and grain yield/plant in both seasons and combined. Number of rows per ear, number of ears/plant, number of kernels per row, Weight of grain/ear, seed index, shilling percentage and grain yield/plant decreased significantly and gradually by increasing plant densities from 4.76 plant/m^2 to 8.33 plant/m^2. Plant height, barren percentage (%), LAI and grain yield per feddan increased significantly and gradually by increasing plant densities from 4.76 plant/m^2 to 8.33 plant/m^2. The highest grain yield/fed (4.148, 4.302 and 4.225 ton/fed) were obtained by planting 8.33 plant/m^2 in 2009, 2010 and combined, respectively. The lowest 3.300, 3.442 and 3.371 ton/fed were recorded by planting 4.76 plant/m^2 in 2009, 2010 and combined, respectively, while planting 6.67 plant/m^2 and 5.56 plant/m^2 were intermediate in grain yield/fed. Increasing plant population from 4.76 plant/m^2 to 8.33 plant/m^2 increased grain yield/fed by 25.70, 24.98 and 25.33 % in 2009, 2010 and combined, respectively, while the increased was 11.09, 8.05 and 9.52 % for plant density of 6.67 plant/m^2 in 2009, 2010 and combined, respectively. The effect of the interaction between varietals differences and plant population treatments on yield and yield components are not significant in most studied characters except number of ears/plant, LAI and grain yield/plant.

Keywords: Maize (*Zea mays* L), hybrids, plant densities and yield.

Maize (*Zea mays* L.) is a major cereal crop in Egypt and all over the world which grown principally during the summer season. Maize either in the world or in Egypt ranks the third most important cereal crop after wheat and rice, which is used for both human consumption and poultry feed. It has a great utility in agro industry. Worldwide, the total cultivated area of maize reached 160.65 million hectares in 2008; the total production was 791.5 million tons, with an average productivity of 4.93 tons of grain per hectare (Report of USDA, 2009). According to this report, Egypt grew in 2008, 0.72 million hectares and produced 6.17 million tons of grains, with an average yield of 8.58 tons per hectare. According to the same report, Egypt ranks the fourth in the world with respect of average productivity after USA, France and Italy. However, the local production of maize is not sufficient to satisfy the local consumption. So Egypt imports every year about five million tons of maize grains to reach self-sufficiency of maize production in Egypt.

Maize has been considerable as a source of carbohydrate, oil and some proteins. Therefore, efforts are focused on increasing productivity of this crop by growing high yielding new varieties under the most favorable cultural treatments. Factors that determine maize production are numerous, among which plant population density are of great importance. The optimum plant population plays a great role in increasing maize productivity (Al-Shebani, 1998).

Maize is the agronomic grass species that is most sensitive to variations in plant density. For each production system, there is a population that maximizes grain yield. Maize population for maximum economic grain yield varies between 30,000 to over 90,000 plants per hectare (Olson and Sanders, 1988). This manuscript presents an overview of the factors that affect optimum plant population, emphasizing the effects of dense stands on ear development and discussing important changes in plant traits that have contributed to increase the tolerance of modern hybrids to high plant densities.

Grain yield of maize is more affected by variations in plant population density than of other members of the grass family because of low tillering ability, monoecious floral organization, and the presence of a relatively short flowering period (Sangoi *et al.*, 2002). The ideal plant population depends on several factors, e.g., water availability, soil fertility, hybrid maturity, and row spacing. The use of lower plant densities delays canopy closure and decreases light interception, leading to high grain production per plant but low grain production per unit area (Andrade *et al.*, 1999). On the other hand, higher plant densities enhance interplant competition for assimilates, water and nutrients (Edmeades *et al.*, 2000). High plant densities also stimulate barrenness and increase the anthesis-silking interval (ASI) (Sangoi *et al.*, 2002), thereby reducing kernel number per unit area - the main yield component of maize.

Valadabai and Farahani (2010) studied planting density (70000 and 90000 plant ha^{-1}) and the planting pattern treatment (one row and two rows planting).

Treatments significantly affected the total dry weight (TDW), leaf area index (LAI), relative growth rate (RGR) and crop growth rate (CGR). In this study, results showed that physiological growth indices were increased by high density, application of 520 kg urea ha-1 and two rows planting. Consequently, our finding may give applicable advice to farmers and agricultural researchers for management and proper use of nitrogenous fertilizer in farming of maize under different planting density conditions.

Dahmardeh (2011) investigated the impacts of nitrogen (N) rate and plant density of maize. Maize produced significantly as well as grain yield at high than at low density. Grain yield and photosynthesis active radiation (PAR) absorption increase with increasing N rate and the highest amount of grain yield were obtained at 350 kg N ha^{-1} treatments. Grain yield and PAR absorption increase with increasing plant density and the highest amount of grain yield were obtained at 100,000 plants ha^{-1} treatments. It is concluded that growing maize at high density with application of 350 kg ha^{-1} N rate that could result in maximum grain yield of maize and hence increase productivity of maize crop.

Maize hybrids differ in their response to plant density (Echarte *et al*., 2000; Maddonni *et al*., 2001). Alias *et al.* (2010) studied the effect of plant densities on three hybrids (30 D55, Pioneer 3012 and Pioneer 3062) they observed that Pioneer-30D55 surpassed all other two hybrids (Pioneer-3012 and Pioneer-3062) with respect to all agro physiological traits i.e leaf area index at 75 days after sowing (DAS), leaf area duration (30-90 DAS), and dry matter accumulation (30-90 DAS) with significant variation between them.

The purpose of the present investigation was to study the effect of four row spacing (20, 25, 30, and 35) on Yield and its quality of maize to find out the best maize hybrid, optimum plant population for obtaining higher yield.

Materials and Methods

This study was carried out in the summer seasons of 2009 and 2010 at the Experimental Station of the Faculty of Agriculture, Cairo University, Giza, Egypt.

1.Plant material

The used three different maize (*Zea mays* L.) single and 3-way cross (SC 10, SC 122 and TWC 321) were kindly provided by Maize Res. Dept. of Agric. Res. Center (ARC).

2.Experimental Procedure

Seeds of the three hybrids of maize were sown under four population densities, i.e. 20 cm between hills (8.33 plants/m^2), 25 cm between hills (6.67plants/m^2), 30 cm between hills (5.56 plants/m^2) and 35 cm between hills (4.76 plants/m^2) , thereafter (before the 1st irrigation) were thinned to one plant / hill. The previous crop was faba bean (*Vicia faba* L.) in 2009 and 2010 season. The soil of the experimental site was clayey loam. A split-plot design with randomized complete blocks arrangement in five replicates was used. Main plots were devoted to maize variety (SC10, SXC122 and TWC321). Sub-plots were assigned to the four plant densities. Each sub-plot consisted of four ridges of 4 m length and 0.6 m width for each ridge, i.e. the experimental plot area was 9.6 m^2. Sowing dates were on May 21 in the 1st season and May 30 in the 2nd one.

3.Data recorded

A sample of 6 maize guarded plants was taken from each sub- plot after 90 days from sowing. Leaf area (LA) was detected according to Francis *et al*. (1969) as follows: Leaf length x maximum width x 0.75. At harvest, a sample of 10 guarded plants from each plot was taken randomly to measure individual plant characters , but yield per faddan was estimated from plot basis.

1. **Plant height** (in cm) (measured from ground surface to the point of flag leaf insertion).
2. **Barren stalks** (as percentage of plants bearing no ears relative to the total number of plants in each plot; an ear was considered fertile if it had one or more grains on the rachis).
3. **Number of ears per plant**, calculated by dividing number of ears per plot on number of plants per plot.
4. **Number of rows per ear,** using 10 random ears / plot at harvest.
5. **Number of kernels per row,** using the same 10 random ears / plot.
6. **Seed index (100-kernel weight)** (in g) adjusted at 15.5% grain moisture, using shelled grains of each plot.
7. **Shelling percentage (%),** estimated by dividing the grain yield per plot (adjusted at 15.5% grain moisture) on weight of ears / plot at harvest.
8. **Grain weight per ear (g),** estimated by dividing the grain yield per plot (adjusted at 15.5% grain moisture) on number of ears / plot at harvest.
9. **Grain yield per plant** (g), estimated by dividing the grain yield per plot (adjusted at 15.5% grain moisture) on number of plants / plot at harvest.

10. **Grain yield per feddan,** in ardab by adjusting grain yield / plot to feddan

4.Biometrical analysis

Analysis of variance of the split plot design was computed according to Snedecor and Cochran (1967). Combined analysis of variance across the two years was also performed if the homogeneity test was non-significant. LSD values were calculated to test the significance of differences between means according to Snedecor and Cochran (1967).

Results and Discussion

The following results were obtained from the treatment of maize varieties, plant population and their interaction.

Plant height (cm)

Data presented in Table (1) showed significant differences between maize varieties both seasons and combined. S.C10 records the highest value of plant height in first, second and combined seasons (258.8, 216.9 and 237.9 cm, respectively), while the lowest value of this criterion was in SC122 in season one, two and combined (236.4, 197.6 and 217.0 cm, respectively). It could be concluded that varieties differences between maize varieties may be due to the genetically differences between cultivars concerning partition of plant height. Plant height is a genetic trait, thus the number and length of the internodes determined the height of the stalk. In there way, plant height can vary from 0.3 m to 7 m depending on the variety and growing condition (Gyner-Hegyi *et al.*, 2002). This result is in agreement with the reported by Rokozawa and Hara (1995) and Shams El-Deeb and El-Habbak (1996).

Data presented in Table (1) illustrate that the significant differences among planting densities were found for plant height in first season and combined. Increasing plant density from 4.76 plant/m^2 to 5.56 plant/m^2 and from 5.56 plant/m^2 to 6.67 plant/m^2, and also from 6.67 plant/m^2 to 8.33 plant/m^2 significantly increased plant height by 0.861%, 1.54% and 2.28% in the first season and by 1.03%, 1.06% and 1.62% in combined season respectively. Similar result was obtained by Ali *et al*. (1994) and Hassan (2000). Yokozawz and Hara (1995) cited that the height of the final plant and the diameter of its stalk are strongly influenced by environmental conditions during stem elongation. Temperature and photo period may influence stalk length by affecting the number of internodes. It has often been observed different plant densities that maize plants are taller or mutual shading increaser, results in Table (1) indicate that the interaction between maize varieties and plant densities had no significant effect on plant height in both seasons and combined.

Number of ears per plant

Results presented in Table (2) showed significant differences between maize varieties both seasons and combined. The highest number of ears per plant were obtained by variety S.C122 in season two and combined (0.94) and S.C10 in season one (0.92). It could be concluded that varieties differences between maize varieties may be due to the genetically differences between cultivars concerning partition of number of ears/plant. Number of ear per plant was significantly influenced by plant densities in season one, two and combined, increasing plant density gradually decreased number of ear per plant. Planting 4.76 plant/m^2 had the highest number of ear per plant, while plating 8.33 plant/m^2 had the lowest number of ear per plant.

The interaction effect between varieties and plant densities on number of ears/plant was significant in first, second and combined seasons. (Table 2). The results pointed out that optimum plant density for high number of ears/plant was not the same for all varieties, or some are more adapted to higher plant densities i.e. S.C.10 in first, second and combined seasons. Numer of ears/plant for all varieties decreased gradually by increasing plant densities from 4.76 plant/m^2 to 8.33 plant/m^2. The highest number of ears per plant was obtained from S.C. 10 at density of 4.76 plant/m^2 in first, second and combined seasons, while the lowest number of ears per plant was obtained from all varieties (not significant between varieties) at density of 8.33 plant/m^2.

Similar results were obtained by Faisal *et al.* (1996) found that increasing plant densities from 20,000 to 24,000 plants/fad significantly increased number of ears/plant. On the contrary Tollennar and Stewart, (1992) reported that kernels per plant, ears per plant decline with increasing plant density.

Barren percentage (%)

Results obtained in Table (3) showed that percentage of barren plants varied considerably between varieties. The minimum percentage barren plants (8.1 %) were recorded with S.C.10 in second season and combined, while the highest percentage of barren plants (9.9 %) were observed in the T.W.C. 321 in second season and combined. S.C. 122 was intermediate in percentage of barren plants. Percentage of barren plants was significant influenced by plant densities (Table 3). Increasing plant density gradually increased percentage of barren plants. The highest percentage of barren plants was obtained by planting 8.33 plant/m^2, and the lowest one was recorded by planting 4.76 plant/m^2., while planting 6.67 plant/m^2 and 5.56 plant/m^2 were intermediate in barrenness percent. The increase in percentage of barren plants by increasing plant density may be due to interplant competition for nutrient, water and light at higher plant densities. Similar results were reported by Shams El-Deen and El-Habbak (1996) observed that increasing plant density from 20,000 to 30,000 plants/fad significantly increased plant height, ear height and percentage of barren plants. Ritchie and Alagarswamy (2003) indicated that high maize yields at plant densities ranging from seven to ten plants m^{-2} but barrenness occurred more frequently when plant densities exceed 10 plants m^{-2}. Thus, plant densities influence both plant growth rate (PGR) and barrenness. In relating barrenness to plant growth rate averaged about 1.0 g per day during the 30-d period bracketing silking. Maize genotypes appear to have major genetic differences in barrenness.

The interaction between varieties and plant densities on percentage of barren plants was not significant (Table 3).

Leaf area index (LAI)

Results obtained in Table (4) indicated that LAI was affected significantly by maize varieties in both seasons and combined. The minimum LAI was recorded in S.C.122 with 4.9 in season two and 5.8 in combined, while the highest LAI was observed in S.C.10 with 6.3 in season two and 6.6 in combined season unless there is no significant in season one. LAI significantly influenced by Plant density (Table 4), increasing plant density gradually increased LAI. The highest LAI was obtained by planting 8.33 plant/m^2, and the lowest LAI was obtained by planting 4.76 plant/m^2 in first, second and combined seasons. And also the interaction between varieties and plant densities on LAI was significant in season two and combined except of first season (Table 4). The results pointed out that optimum plant density for high LAI was not the same for all varieties, or some are more adapted to higher plant densities i.e. S.C.10 in second season and combined. LAI for all varieties increased gradually by increasing plant densities from 4.76 plant/m^2 to 8.33 plant/m^2. The highest LAI (8.54 and 8.85) was obtained from S.C. 10 at density of 8.33 plant/m^2 in second season and combined, respectively, while the lowest LAI was obtained from all varieties (not significant between varieties) at density of 4.76 plant/m^2.

Similar results was reported by Bangarwa *et al*. (1993) found that plant height was not affected, while LAI, leaf area duration, dry matter/plant and CGR and dry matter/ha increase in plant density. While Kamel (1997) found that LAI, dry weight/plant, 50% tasseling, number of kernels/row, ear length, number of rows/ear and grain yield/plant decreased with increasing plant population from 18,000 to 30,000 plants/fad. Eisa Nadia (1998) found that plant height, LAI, number of days to 50% tasseling and silking and percentage of barren plants increased with increasing plant density from 15,000 to 30,000 plants/fad. Saberali (2007) investigated the effects of plant density on growth and physiological indix of maize. The results showed that in high maize density (105,000) leaf area index, total dry weight and crop growth rate increased than low maize density (70,000) throughout of growth season.

Number of rows per ear:-

Data presented in Table (5) indicate that varieties had no significantly effected in number of ears per row in both seasons and combined. Number of rows per ear was significantly influenced by plant densities in season one, two and combined (Table 5) Increasing plant density gradually decreased number of rows per ear. Planting 4.76 plant/m^2 had the highest number of rows per ear, while plating 8.33 plant/m^2 had the lowest number of rows per ear. Interaction effect between varieties and plant densities had no significant effect on number of rows per ear. Amany Mohammed (1999) found that number of days to 50% silking, plant height and ear height increased with increasing plant densities. While, ear length, ear diameter, number of rows/ear, number of kernels/row and 100-kernels weight decreased with increasing plant densities from 20 to 35 thousand plants/fad. The highest grain yield/fad was obtained by 30,000 plants/fad.

Number of kernels per row

Results presented in Table (6) showed that maize varieties differ significantly in number of kernels per row in both seasons but no significant in combined. S.C.122 had the highest number of kernels per row (39.0) in season one and (36.9) in the season two, while S.C.10 had the lowest number of kernels per row (36.1) in season two and T.w.C.321 had the lowest number in season one. Plant density had significantly effect on number of kernels per row in both seasons and combined

(Table 6). Increasing plant density gradually increased significantly number of kernels per row, the highest number of kernels per row was obtained by plant density 4.76 plant/m^2 and the lowest one was obtained by plant density 8.33 plant/m^2 in both seasons and combined. The interaction between varieties and plant density had no significant effect on number of kernels per row in both seasons and combined. Similar results was reported by Dezfouli and Herbert (1992) reported that increased plant density during drier periods decreases the mass and diameter of cobs, diameter and number of kernels per cob, but not the number of kernels per row as well as weight of kernels.

Seed index (g)

Hybrids did not show significant effect on seed index (Table 7). Kernels weight was significantly decreased by increasing plant population from 4.76 plant/m^2 to 8.33 plant/m^2 in both season and combined (Table 7). The reduction in kernel weight at high plant population may be due to interplant competition. Similar results were reported by Eisa Nadia (1998), Hassan (2000) and Ogunlela *et al.* (2005). Such cares represent inter interplant competition for incident photosynthetic photon flax densities, soil nutrients and soil water. This results in limited supplier of carbon and nitrogen and consequent decrease in kernel number per plant and kernel size (Lomcoff and Loomis, 1994). The interaction affect between varieties and plant density on 100 grains weight was not significant on both season and combined.

Grain weight (gm)

Data presented in Table (8) indicated that varieties differ not significantly in grain weight/ear in first season and combined, except only second season in significant difference between varieties. Single cross 10 surpassed all varieties in grain weight/ear, while the T.W.C. 321 variety had the lowest grain weight/ear. The difference between varieties in weight grains/ear may be due to difference in genetic make up. Similar results were reported by Sharifi *et al*. (2009), Compean *et al*. (2009), Gozubenli (2010) and Alias *et al.* (2010). Weight of grain per ear decreased significantly and gradually by increasing plant densities from 4.76 plant/m^2 to 8.33 plant/m^2 (Table 8). Increasing plant population from 4.76 plant/m^2 to 8.33 plant/m^2 reduced weight of grain/ear by 17.84, 14.42 and 16.12 % in 2009, 2010 and combined, respectively, while reduction was 10.72, 8.66, and 9.66 % for plant density of 6.67 plant/m^2 in 2009, 2010 and combined respectively. And also increasing plant population from 4.76 plant/m^2 to 5.56 plant/m^2 reduced weight of grains/ear by 5.99, 4.26 and 5.10 % in 2009, 2010 and combined, respectively. The reduction in weight of grains/ear by increasing plant population may be due to interplant competition. High plant densities delay silk emergence that lead to decrease in kernel number per ear and reduction in total grain yield. Edmeades *et al*. (2000) found that high plant densities enhance interplant competition for assimilater, particulary during the period bracketing silking, favoring apical dominance and decreasing the ratio of ear to tassel growth rate. Similar results were reported by zeidan and Amany (2006). Maddonni *et al.* (2006), Shakarami and Rafiee (2009) and Gozubenli (2010). The interaction effect between varieties and plant population in grain weight/ear was not significant in both seasons and combined (Table 8).

Shelling percentage (%)

Shilling percentage was not significantly influenced by maize varieties in both season and combined (Table 9). Shelling percentage was significantly influenced by plant densities in 2009, 2010 and combined (Table 9). Increasing plant density y decreased significantly Shelling percentage, the highest Shelling percentage was obtained by plant density 4.76 plant/m^2 and the lowest one was obtained by plant density 8.33 plant/m^2 in first season and combined.

Said and Gaber (1999) found that increasing plant population densities significantly decreased shilling percentage. These results are in harmony with those reported by Sangoi *et al*. (2002) and Ogunlela *et al*. (2005). The interaction of varieties × plant densities had no significant effect on shilling percentage in both seasons and combined (Table 9).

Grain yield per plant (g)

Significant difference between varieties in grain yield/plant was found in 2010 and combined except season one (Table 10). S.C. 122 surpassed all varieties in grain yield/plant, while S.C. 10 and T.W. C. 321 were the lowest in the grain yield/plant in 2010 and combined respectively. The superiority of S.C. 122 might have been due to lower percentage of barren plants, longer ears, higher weight of grains/ear and higher shilling percentage. The lower ridding ability of S.C 10 and T.W.C.321 may be attributed to the lower values of ear characteristics and shelling percentage. Duncan (2002) reported that yield reduction per plant was due to the effects of interplant competition for light, water, nutrition and other potentially yield limiting environmental factors, similar results were reported by Azam *et al*. (2007), Compean *et al*. (2009), Sharifi *et al*. (2009), Alias *et al*. (2010) and Gozubenli (2010).

Data presented in Table (10) illustrate that the significant differences among planting densities were found for grain yield/plant in both seasons and combined. Increasing plant densities from 4.76 plant/m^2 to 5.56 plant/m^2, from 5.56 plant/m^2 to 6.67 plant/m^2 and from 6.67 plant/m^2 to 8.33 plant/m^2 and also from 4.76 plant/m^2 to 8.33 plant/m^2 significantly decreased grain yield/plant by 191.4, 177.7, 155.7 % and 146.1 in the first season, by 201.9, 187.8, 169.7 and 151.5 % in the second season and by 196.6, 182.7, 162.7 and 148.8 % in the combined season.

Plants grown at the higher population densities produced the lowest grain yield per plant, while the highest grain yield per plant in both seasons and combined (Table 10). These results could be due to the highest competition between plants in the dense population. Tokatlidis and Koutroubas (2004) found that the increased gap between pollen shedding and silking under higher plant density constituter key factor for increased ear barrenness and therefore influences negatively the final grain yield. Similar results were obtained by Boyat *et al*. (1990), Sangoi (1996), Akamn (2002), Xue *et al*. (2002), Lauer and Rankin (2004), Maddonni *et al.* (2006), Zeidan and Amany (2006), Ahmad *et al*. (2007) and Shakarami and Rafiee (2009).

The interaction effect between varieties and plant densities on grain yield/plant was significant in second season and combined except of first season (Table 10). The results pointed out that optimum plant density fofr high grain yield/plant was not the same for all varieties, or some are more adapted to higher plant densities i.e. S.C.122 and T.W.C. 321 in second season and combined. Grain yield/plant for all varieties decreased gradually by increasing plant densities from 4.76 plant/m^2 to 8.33 plant/m^2. The highest grain yield per plant (208.3 and 200.8 gm) was obtained from S.C. 122 and S.C. 10 at density of 4.76 plant/m^2 in second season and combined respectively, while the lowest grain per plant was obtained from all varieties (not significant between varieties) at density of 8.33 plant/m^2.

Grain yield per feddan

Data presented in Table (11) showed in significant differences between maize varieties in both senasons and combined. Grain yield per feddan significantly influenced by plant densities (Table 11). Increasing plant density gradually increased grains yield/fed. The highest grain yield/fed (4.148, 4.302 and 4.225 ardab/fed were obtained by planting 8.33 plant/m^2 in 2009, 2010 and combined respectively. The lowest 3.300, 3.442 and 3.371 ardab/fed were recorded by planting 4.76 plant/m^2 in 2009, 2010 and combined respectively, while planting 6.67 plant/m^2 and 5.56 plant/m^2 were intermediate in grain yield/fed. Increasing plant population from 4.76 plant/m^2 to 8.33 plant/m^2 increased grain yield/fed by 25.7, 24.98 and 25.33 in 2009, 2010 and combined respectively, while the increased was 11.09, 8.05 and 9.52 for plant density of 6.67 plant/m^2 in 2009, 2010 and combined respectively.

Increasing plant density from 5.56 plant/m^2 to 6.67 plant/m^2 not significant grain yield/fed in both seasons and combined. Gouda et al. (1993) reported that maize grain yield was significantly increased by raising plant density from 20,000 to 24,000 plant/fed, while Ragheb et al. (1993) reported that grain yield was not significant affected by increasing plant population density from 20,000 to 24,000 plant/fed. These results are in harmony with those reported by Amany Mohammed (1999), Said and Gaber (1999), Maddonni *et al.* (2006), Zeidan and Amany (2006) and Dahmardeh (2011). The interaction between varieties and plant population did not significantly affect grain yield/plant in both seasons and combined.

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الملخص العربي

دراسات زراعية علي بعض هجن الذرة الشامية المنزرعة في كثافات نباتية مختلفة

المتولي عبدالله المتولي[1]، علي ابومندور[1] ، سيد احمد سفينة[1] و بركات الله غلام رباني
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أجريت تجربتان حقليتان بمحطة التجارب الزراعية لكلية الزراعة جامعة القاهرة بالجيزة ، خلال موسمي 2010،2009. كان الهدف من هذا البحث دراسة إستجابة بعض هجن الذرة الشامية الفردية و الثلاثية (هـ.ف 10 ، هـ.ف 122 و هـ. ث 310) للزراعة في أربع كثافات نباتية مختلفة و هي 20 سم بين الجور (8.33 نبات /م^2)، 25 سم بين الجور (6.67 نبات/ م^2)، 30 سم بين الجور (5.56 نبات /م^2) و 35 سم بين الجور (4.76 نبات/ م ^{2}) علي محصول الذرة و مكوناتة. و كانت أهم النتائج المتحصل عليها كالأتي: وجود إختلاف معنوي بين هجن الذرة الشامية في بعض الصفات طول النبات ، عدد كيزان النبات، نسبة النباتات الغير حاملة، دليل مساحة الاوراق، عدد حبوب الصف، وزن حبوب الكوز و وزن حبوب النبات خلال موسمي الزراعة و متوسط الموسمين. كما اظهرت النتائج أنة كلما إزداد عدد النباتات في المتر المربع (من 4.76 الي 8.33 نبات/م^2) كان هناك تأثير معنوي عالي بالانخفاض في قيم بعض الصفات وهي عدد صفوف الكوز، عدد كيزان النبات، عدد حبوب الصف، وزن حبوب الكوز، دليل البذرة، نسبة التفريط، و محصول حبوب النبات. كما أعطت بعض الصفات زيادة معنوية عالية بالزيادة في عدد النباتات في المتر المربع (من 4.76 الي 8.33 نبات/م^2) وهي طول النبات ، نسبة النباتات الغير حاملة ، دليل مساحة الاوراقو محصول حبوب الفدان. و سجل أعلي محصول من حبوب و حدة المساحة (4.148، 4.302 و 4.225 طن/فدان) عندما زرعت الهجن في اعلي كثافة نباتية (8.33 نبات/م^2) خلال موسم 2009 و 2010 و متوسط الموسمين علي التوالي. كما سجل اقل محصول من وحدة المساحة (3.300، 3.442 و 3.371 طن/فدان) في الكثافة النباتية المنخفضة(4.76 نبات/م^2) خلال موسم 2009و 2010 و متوسط الموسمين علي التوالي. كما أوضحت النتائج أنة بزيادة الكثافة النباتية من 4.76 الي 8.33 نبات/م^2 أدي إلي زيادة في محصول حبوب الفدان بـ 25.70، 24.98 و 25.33 % خلال موسم 2009 و 2010 و متوسط الموسمين علي التوالي، بينما إزداد محصول الفدان بـ 11.09، 8.05 و 9.52 % عند زيادة الكثافة النباتية من 4.76 الي 6.67 نبات/م^2 خلال موسمي 2009 و 2010 و متوسط الموسمين علي التوالي. كما اوضحت النتائج أن تأثير التفاعل بين الأصناف و الكثافة النباتية كان غير معنوي في بعض الصفات ما عدا عدد كيزان النبات، دليل مساحة الاوراق و محصول حبوب النبات.

الكلمات الدالة: الذرة الشامية ، الهجن، الكثافة النباتية، المحصول.

Table (1): Effect of plant densities and maize varieties on plant height (cm).

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean
8.33 pl/m^2	265	248	254	**255.5 a**	222	199	203	**208**	243	223	228	**231.6 a**
6.67 pl/m^2	260	237	253	**249.8 b**	219	199	200	**206**	240	218	226	**227.9 b**
5.56 pl/m^2	255	232	251	**246.0 bc**	216	199	200	**205**	236	216	225	**225.5 bc**
4.76 pl/m^2	255	229	247	**243.9 c**	211	193	203	**203**	233	211	225	**223.2 c**
Mean	**258.8 a**	**236.4 c**	**251.1 b**		**216.9 a**	**197.6 b**	**201.4 b**		**237.9 a**	**217.0 c**	**226.3 b**	

LSD value at 0.05:

Season one. Variety (A): 6.11 Plant densities (B): 4.056 Interaction (A×B): NS

Season two. Variety (A): 12.75 Plant densities (B): NS Interaction (A×B): NS

Combined. Variety (A): 6.5 Plant densities (B): 3.230 Interaction (A×B): NS

Table (2): Effect of plant densities and maize varieties on ears per plant.

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	**SC 122**	**TWC 321**	**Mean**	**SC 10**	**SC 122**	**TWC 321**	**Mean**	**SC 10**	**SC 122**	**TWC 321**	**Mean**
8.33 pl/m^2	0.84 d	0.88 cd	0.90 bc	**0.873 b**	0.88 cde	0.90 cd	0.86 de	**0.88 b**	0.86 g	0.89 efg	0.88 fg	**0.88 c**
6.67 pl/m^2	0.90 bc	0.86 cd	0.86 cd	**0.873 b**	0.82 e	1.00 ab	0.88 cde	**0.90 b**	0.86 g	0.93 cd	0.87 g	**0.89 c**
5.56 pl/m^2	0.94 b	0.90 bc	0.90 bc	**0.913 a**	0.88 cde	1.02 a	1.02 a	**0.973 a**	0.91 def	0.96 bc	0.96 bc	**0.943 b**
4.76 pl/m^2	1.00 a	0.90 bc	0.90 bc	**0.933 a**	1.02 a	1.04 a	0.94 bc	**1.000 a**	1.01 a	0.97 b	0.92 de	**0.966 a**
Mean	**0.92 a**	**0.88 b**	**0.89 b**		**0.90 b**	**0.94 a**	**0.90 b**		**0.91 b**	**0.94 a**	**0.90 b**	

LSD value at 0.05:

Season one.	Variety (A): 0.023	Plant densities (B): 0.0234	Interaction (A×B): 0.040
Season two.	Variety (A): 0.040	Plant densities (B): 0.0405	Interaction (A×B): 0.070
Combined.	Variety (A): 0.021	Plant densities (B): 0.0230	Interaction (A×B): 0.040

Table (3): Effect of plant densities and maize varieties on barren percentage (%).

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean
8.33 pl/m^2	15.4	15.9	16.00	**15.80 a**	16.0	14.8	16.6	**15.80 a**	15.7	15.4	16.3	**15.80 a**
6.67 pl/m^2	6.3	7.1	8.7	**7.32 b**	5.5	7.1	8.6	**7.06 b**	5.9	7.0	8.6	**7.19 b**
5.56 pl/m^2	5.5	5.6	7.5	**6.18 b**	5.4	6.5	6.5	**6.15 bc**	5.4	6.1	7.0	**6.16 bc**
4.76 pl/m^2	5.5	6.5	7.6	**6.53 b**	5.5	5.5	5.5	**5.50 c**	5.5	6.0	6.6	**6.02 c**
Mean	**8.2**	**8.8**	**9.9**		**8.1 b**	**8.5 ab**	**9.3 a**		**8.1 b**	**8.5 b**	**9.6 a**	

LSD value at 0.05:

Season one. Variety (A): NS Plant densities (B): 1.695 Interaction (A×B): NS

Season two. Variety (A): 0.991 Plant densities (B): 1.457 Interaction (A×B): NS

Combined. Variety (A): 1.090 Plant densities (B): 1.098 Interaction (A×B): NS

Table (4): Effect of plant densities and maize varieties on leaf area index.

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean
8.33 pl/m^2	9.2	8.6	8.6	**8.78 a**	8.54 a	6.34 cd	7.14 b	**7.34 a**	8.85 a	7.47 b	7.86 b	**8.06 a**
6.67 pl/m^2	7.5	6.7	7.5	**7.18 b**	6.70 bc	5.28 e	6.02 d	**6.00 b**	7.05 c	5.97 d	6.75 c	**6.59 b**
5.56 pl/m^2	5.8	6.0	6.0	**5.93 c**	5.48 e	4.34 f	5.26 e	**5.03 c**	5.65 d	5.17 e	5.62 d	**5.48 c**
4.76 pl/m^2	5.4	5.3	5.2	**5.27 d**	4.50 f	3.52 g	4.30 f	**4.10 d**	4.92 ef	4.41 g	4.73 fg	**4.68 d**
Mean	**6.9**	**6.6**	**6.8**		**6.3 a**	**4.9 c**	**5.7 b**		**6.6 a**	**5.8 c**	**6.2 b**	

LSD value at 0.05:

Season one.	Variety (A): NS	Plant densities (B): 0.377	Interaction (A×B): NS
Season two.	Variety (A): 0.406	Plant densities (B): 0.287	Interaction (A×B): 0.497
Combined.	Variety (A): 0.246	Plant densities (B): 0.236	Interaction (A×B): 0.408

Table (5): Effect of plant densities and maize varieties on number of rows per ear.

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean
8.33 pl/m^2	12.0	12.0	12.0	**12.0 b**	12.0	12.0	12.0	**12.0 c**	12.0	12.0	12.0	**12.0 c**
6.67 pl/m^2	12.0	12.0	12.8	**12.2 b**	12.4	12.0	12.0	**12.1 bc**	12.2	12.0	12.4	**12.2 bc**
5.56 pl/m^2	12.0	12.0	12.8	**12.2 b**	12.8	12.4	12.8	**12.6 ab**	12.4	12.2	12.8	**12.4 b**
4.76 pl/m^2	12.8	12.8	13.2	**12.9 a**	12.8	13.6	13.2	**13.2 a**	12.8	13.2	13.2	**13.0 a**
Mean	**12.2**	**12.2**	**12.7**		**12.5**	**12.5**	**12.5**		**12.4**	**12.4**	**12.6**	

LSD value at 0.05:

Season one.	Variety (A): NS	Plant densities (B): 0.438	Interaction (A×B): NS
Season two.	Variety (A): NS	Plant densities (B): 0.534	Interaction (A×B): NS
Combined.	Variety (A): NS	Plant densities (B): 0.341	Interaction (A×B): NS

Table (6): Effect of plant densities and maize varieties on number of kernels per row.

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	**SC 122**	**TWC 321**	**Mean**	**SC 10**	**SC 122**	**TWC 321**	**Mean**	**SC 10**	**SC 122**	**TWC 321**	**Mean**
8.33 pl/m^2	35	36	33	**34.73 c**	34	34	34	**33.80 d**	34	35	34	**34.27 d**
6.67 pl/m^2	38	38	36	**37.60 b**	35	37	37	**36.27 c**	37	38	37	**36.93 c**
5.56 pl/m^2	39	40	37	**38.87 b**	37	37	39	**37.93 b**	38	39	38	**38.40 b**
4.76 pl/m^2	41	41	39	**40.47 a**	38	40	40	**39.47 a**	40	40	40	**39.97 a**
Mean	**38.4 a**	**39.0 a**	**36.5 b**		**36.1 b**	**36.9 ab**	**37.6 a**		**37**	**38**	**37**	

LSD value at 0.05:

Season one.	Variety (A): 1.67	Plant densities (B): 1.321	Interaction (A×B): NS
Season two.	Variety (A): 1.146	Plant densities (B): 0.857	Interaction (A×B): NS
Combined.	Variety (A): NS	Plant densities (B): 0.774	Interaction (A×B): NS

Table (7): Effect of plant densities and maize varieties on seed index (g).

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean
8.33 pl/m^2	33.7	32.4	33.4	**33.15 d**	35.0	34.8	34.2	**34.67 d**	34.3	33.6	33.8	**33.91 d**
6.67 pl/m^2	37.2	36.2	38.0	**37.14 c**	37.3	37.6	36.2	**37.04 c**	37.3	36.9	37.1	**37.09 c**
5.56 pl/m^2	40.4	40.1	41.6	**40.70 b**	39.6	39.6	39.0	**39.40 b**	40.0	39.9	40.3	**40.05 b**
4.76 pl/m^2	42.6	42.0	43.5	**42.70 a**	42.4	42.4	42.4	**42.40 a**	42.5	42.2	43.0	**42.55 a**
Mean	**38.5**	**37.7**	**39.1**		**38.6**	**38.6**	**38.0**		**38.5**	**38.1**	**38.5**	

LSD value at 0.05:

Season one. Variety (A): NS Plant densities (B): 1.424 Interaction (A×B): NS

Season two. Variety (A): NS Plant densities (B): 0.922 Interaction (A×B): NS

Combined. Variety (A): NS Plant densities (B): 0.831 Interaction (A×B): NS

Table (8): Effect of plant densities and maize varieties on grain weight per ear (g).

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean
8.33 pl/m^2	169.6	171.0	165.2	**168.6 d**	180.8	175.6	173.8	**176.8 d**	175.2	173.3	169.5	**172.7 d**
6.67 pl/m^2	176.0	186.4	187.2	**183.2 c**	192.7	187.2	186.4	**188.7 c**	184.3	186.8	186.8	**186.0 c**
5.56 pl/m^2	181.2	198.4	199.2	**192.9 b**	201.8	195.6	195.9	**197.8 b**	191.5	197.0	197.6	**195.4 b**
4.76 pl/m^2	201.0	209.2	205.4	**205.2 a**	209.4	205.6	204.7	**206.6 a**	205.2	207.4	205.1	**205.9 a**
Mean	**181.9**	**191.3**	**189.3**		**196.2 a**	**191.0 b**	**190.2 b**		**189.1**	**191.1**	**189.7**	

LSD value at 0.05:

Season one. Variety (A): NS Plant densities (B): 9.294 Interaction (A×B): NS

Season two. Variety (A): 5.090 Plant densities (B): 3.439 Interaction (A×B): NS

Combined. Variety (A): NS Plant densities (B): 4.871 Interaction (A×B): NS

Table (9): Effect of plant densities and maize varieties on shilling percentage (%).

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean
8.33 pl/m^2	88.51	89.45	87.96	**88.60 c**	88.02	88.03	88.50	**4.148 a**	88.26	88.73	88.18	**88.39 d**
6.67 pl/m^2	89.22	91.06	90.17	**90.10 b**	90.51	91.20	90.93	**3.666 b**	89.88	91.08	90.51	**90.49 c**
5.56 pl/m^2	90.50	91.70	91.90	**91.35 a**	92.85	93.05	93.02	**3.611 b**	91.70	92.35	92.44	**92.16 b**
4.76 pl/m^2	91.14	92.73	92.44	**92.06 a**	93.99	94.28	95.04	**3.300 c**	92.52	93.48	93.74	**93.25 a**
Mean	**89.84**	**91.18**	**90.56**		**91.34**	**91.64**	**91.87**		**90.59**	**91.41**	**91.21**	

LSD value at 0.05:

Season one. Variety (A): NS Plant densities (B): 1.126 Interaction (A×B): NS

Season two. Variety (A): NS Plant densities (B): 0.222 Interaction (A×B): NS

Combined. Variety (A): 0.599 Plant densities (B): 0.618 Interaction (A×B): NS

Table (10): Effect of plant densities and maize varieties on grain yield per plant (g).

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean	SC 10	SC 122	TWC 321	Mean
8.33 pl/m^2	143.6	148.9	146.0	**146.1 d**	151.8 f	152.8 ef	149.9 f	**151.5 d**	147.7 e	150.8 e	147.9 e	**108.8 a**
6.67 pl/m^2	154.2	156.1	156.9	**155.7 c**	155.9 ef	187.8 c	165.4 de	**169.7 c**	155.0 de	172.0 c	161.1 d	**105.8 b**
5.56 pl/m^2	174.1	179.7	179.4	**177.7 b**	174.2 d	197.0 abc	192.2 bc	**187.8 b**	174.1 c	188.3 b	185.8 b	**105.0 b**
4.76 pl/m^2	198.0	190.5	185.8	**191.4 a**	203.7 ab	208.3 a	193.6 bc	**201.9 a**	200.8 a	199.4 a	189.7 b	**105.1 b**
Mean	**167.4**	**168.8**	**167.0**		**171.4 b**	**186.5 a**	**175.3 b**		**169.4 b**	**177.6 a**	**171.1 b**	

LSD value at 0.05:

Season one. Variety (A): NS Plant densities (B): 8.366 Interaction (A×B): NS

Season two. Variety (A): 8.606 Plant densities (B): 7.615 Interaction (A×B): 13.17

Combined. Variety (A): 5.757 Plant densities (B): 2.544 Interaction (A×B): 9.63

Table (11): Effect of plant densities and maize varieties on grain yield per feddan (tone).

Plant Densities	Season one (2009)				Season two (2010)				Combined			
	SC 10	**SC 122**	**TWC 321**	**Mean**	**SC 10**	**SC 122**	**TWC 321**	**Mean**	**SC 10**	**SC 122**	**TWC 321**	**Mean**
8.33 pl/m^2	4.10	4.23	4.11	**4.148 a**	4.31	4.40	4.20	**4.302 a**	4.20	4.31	4.15	**4.225 a**
6.67 pl/m^2	3.66	3.68	3.65	**3.666 b**	3.74	3.75	3.66	**3.719 b**	3.70	3.71	3.65	**3.692 b**
5.56 pl/m^2	3.65	3.63	3.56	**3.611 b**	3.65	3.50	3.61	**3.589 bc**	3.65	3.57	3.58	**3.600 b**
4.76 pl/m^2	3.40	3.28	3.22	**3.300 c**	3.50	3.46	3.36	**3.442 c**	3.45	3.37	3.30	**3.371 c**
Mean	**3.70**	**3.70**	**3.63**		**3.80**	**3.78**	**3.70**		**3.75**	**3.74**	**3.67**	

LSD value at 0.05:

Season one. Variety (A): NS Plant densities (B): 0.222 Interaction (A×B): NS

Season two. Variety (A): NS Plant densities (B): 0.180 Interaction (A×B): NS

Combined. Variety (A): NS Plant densities (B): 0.141 Interaction (A×B): NS