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Response of white maize hybrids to plant densities and nitrogen fertilizer rates

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Abstract

Two field experiments were conducted on the Farm of Agric. Res. and Exp. Center of Fac. of Agric. Moshtohor, Benha University, Toukh Directorate, Qalyubia Governorate, Egypt, during the two successive summer growing seasons of 2016 and 2017 to study the effect of three plant population densities *i.e.* 20000, 24000 and 28000 plants/feddan (fed) and three nitrogen fertilizer rates, *i.e.* 90, 120 and 150 kg N/fed on the growth traits, yield components, yield and some kernels chemical properties of three white single cross hybrids of maize (S.C. 7071, S.C. 30K8 and S.C. 2031). The obvious results of this investigation can be summarized as follows: Increasing plant population density from 20000 to 28000 plants/fed significantly increased mean values of No. of days from planting to 50 % tasseling and silking, leaf area index, plant height (cm), ear height (cm) No. of barren plants/fed, No. of ears/fed, stover yield/fed (kg) and biological yield/fed (kg) in both seasons. On the other hand, mean values of No. of green leaves/plant, leaf area/plant (cm^2), No. of plants carried two ears/fed, No. of kernels/ear, ear weight (g), shelling (%), 100-kernel weight (g), ear yield/fed (kg), grain yield/fed (kg), harvest index, nitrogen uptake/fed (kg) and protein yield/fed (kg) were significantly decreased in the two seasons. Allmost traits of maize under study were significantly increased by increasing nitrogen fertilizer rates from 90 and 120 to 150 kg N/fed except, No. of days to 50 % tasseling and silking as well as No. of barren plants/fed were significantly decreased with increasing nitrogen rates in the both seasons, nitrogen fertilizer rate of 150 gave the best mean values for all maize traits under study. White single cross hybrids of maize were significantly differed in all maize traits under study in the both seasons. Maize hybrid of S.C. 30K8 was significantly surpassed S.C. 7071 and S.C. 2031 in mean values of No. of plants carried two ears/fed, No. of ears/fed, No. of kernels/ear, grain yield/fed and harvest index as well as gave the lowest mean values of No. of barren plants/fed and the shortest period from planting to 50 % tasseling or silking in the both seasons. Moreover, S.C. 2031 surpassed the other two maize hybrids in mean values of leaf area/plant, leaf area index, ear weight, 100-kernel weight, ear yield/fed, biological yield/fed, nitrogen uptake/fed and protein yield/fed in the two seasons. Meanwhile, S.C. 7071 recorded the highest mean values of No. of green leaves/plant, plant height, ear height, shelling % and stover yield/fed in the two seasons. The first order interactions between (20000 plants/fed X 150 kg N/fed), (24000 plants/fed X S.C. 30K8), (20000 plants/fed X S.C. 2031) and (150 kg N/fed X S.C. 30K8) as well as the second order interactions between (24000 plants/fed X 150 kg N/fed X S.C. 30K8) and (20000 plants/fed X 150 kg N/fed X S.C. 2031) were significantly recorded the greatest grain yield/fed as compared with the others interactions in the both seasons.

It could be summarized that, when planting maize hybrid of 30K8 the best plant population density was 24000 plants/fed, meanwhile, when planting maize hybrids of S.C. 2031 or S.C. 7071 the best plant population density of 20000 plants/fed with soil fertilized by 150 kg N/fed to maximized grain yield/fed.

Keywords: maize hybrids, S.C. 2031, S.C. 30K8, S.C. 7071, plant densities, Nitrogen fertilizer

Introduction

Maize (Zea mays, L.) is globally the top ranking cereal in potential grain productivity. It is considered as a 'King of cereals crops' because of its special characteristics that include its carbon pathway (C4), wider adaptability, higher multiplication ratio, desirable architecture, superior transpiration efficiency and high versatile use. In Egypt, maize is considered as one of the main cereal crops, comes the third after wheat and rice. Maize is very essential either for the human food or animal feeding and a common ingredient for industrial products. It plays a vital source of daily human food because their flour mixed with wheat flour by 20 % for bread making. Also, maize is used as a feed for livestock whether fresh, silage or grains. Therefore, a great attention should be paid to raise maize productivity by maximizing yield per unit area in order to reduce the gap between its production and consumption. Where, maize is well known for its high demand for nutrients and other production inputs. Thereby, among factors that enhances maize productivity through growing high yielding hybrids under the optimum plant population density and applying the optimum nitrogen fertilizer rate. World average cultivated area of maize in 2017 year (www.fao.org) reached 469.49 million fed one fed = 4200 m^2; the total production was 1134.75 million tonnes, with an average productivity of 2416.97 kg grain/fed. The growing area of maize in Egypt during 2017 year is about 2.192 million fed with a total grain yield of 7.10 million tonnes. The average grain yield production/fed was about 3239.19 kg. The total production supplies 40-50 % of the require consumption with a reduction gap of 50-60 % which has to be filled via importation.

Increasing plant population density of maize significantly increased No. of days from planting to 50 % tasseling and silking, leaf area index, plant height (cm), ear height (cm), No. of plants/fed, No. of barren plants/fed, No. of ears/fed, stover yield/fed (kg), ear yield/fed (kg), grain yield/fed (kg) and biological yield/fed (kg). On the other hand, No. of green leaves/plant, area of topmost ear leaf (cm^2), leaf area/plant (cm^2), No. of plants carried two ears/fed, No. of ears/plant, No. of rows/ear, No. of kernels/row, No. of kernels/ear, ear weight (g), kernels shelling (%), 100-kernel weight (g), grain yield/plant (g), harvest index (%), kernels nitrogen content, kernels crude protein content, nitrogen uptake/fed (kg) and protein yield/fed (kg) were significantly decreased **(El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; El-Koomy 2000; Agasibagil 2006; Saeed *et al.* 2007; Hassan *et al.* 2008; Sallah *et al.* 2009; Sharifi *et al.* 2009; Gozubenli 2010; Gomaa *et al*. 2011; Lashkari *et al.* 2011; Sharifi and Pirzad 2011; Zamir *et al*. 2011; Dawadi and Sah 2012; El-Gedwy *et al*. 2012; Robles *et al*. 2012; Shafi *et al*. 2012; Adeniyan 2014; Ahmadu 2014; Timlin *et al*. 2014; Imran *et al*. 2015; Karki *et al*. 2015 Mahdi and Ismail 2015; Gobeze *et al*. 2016; Mandić *et al*. 2016; Rahman *et al*. 2016; Sharanabasappa *et al*. 2017; Eyasu *et al*. 2018 and Zeleke *et al*. 2018).**

Nitrogen is the component of protoplasm, proteins, nucleic acids, chlorophyll and plays a vital role in both vegetative and reproductive phase of crop growth. Maize has been recognized as a heavy feeder and uses more of nitrogen than any other nutrient element. Many reports indicated that nitrogen fertilizer has more influence on the growth and yield of maize than any other plant nutrient because it is the nutrient most often deficient in the Egyptian soils. Thus, increasing application of nitrogen fertilizer rates led to significant increases in growth, yield and its attributes and quality characters of maize crop (**El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; Saeed *et al.* 2007; Sallah *et al.* 2009; Szulc 2009; Bamuaafa *et al.* 2010; El-Gedwy *et al.* 2011; EL-Hosary *et al.* 2011; Hokmalipour and Darbandi 2011; Dawadi and Sah 2012; Karasu 2012; Li *et al*. 2012; Kandil 2013; Radma and Dagash 2013; Adeniyan 2014; Ahmadu 2014; Delibaltova 2014; Khan *et al*. 2014; Rehman *et al*. 2014; Hafez and Abdelaal 2015; Kandil *et al*. 2016; Gharibi *et al*. 2016; Majid *et al*. 2017; Marković *et al*. 2017; Sapkota *et al*. 2017; Sharanabasappa *et al*. 2017; Takele *et al*. 2017; Ahmad *et al*. 2018** and **Zeleke *et al*. 2018).**

Several investigators showed that maize hybrids differed in growth, yield components, yield and some chemical properties **(El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; El-Koomy 2000; Agasibagil 2006; Saeed *et al.* 2007; Hassan *et al.* 2008; Sallah *et al.* 2009; Szulc 2009; Bamuaafa *et al.* 2010; Hokmalipour and Darbandi 2011; Dawadi and Sah 2012; Karasu 2012; Li *et al*. 2012; Kandil 2013; Radma and Dagash 2013; Adeniyan 2014; Ahmadu 2014; Delibaltova 2014; Khan *et al*. 2014; Rehman *et al*. 2014; Hafez and Abdelaal 2015; Karki *et al*. 2015; El-Mehy *et al*. 2016; Kinfe *et al*. 2016; Majid *et al*. 2017; Marković *et al*. 2017; Ahmad *et al*. 2018 and Eyasu *et al*. 2018).**

The aim of this investigation was designed to study the effect of plant population densities and nitrogen fertilizer rates on growth, yield components, yield and kernels chemical properties in three white single cross hybrids of maize.

Materials and Methods

Two field experiments were carried out at the Farm of Agricultural Research and the Experimental Center of Faculty of Agriculture at Moshtohor, (Toukh Directorate, Qalyubia Governorate) Benha Univ. Egypt, during the two summer successive growing seasons of 2016 and 2017. This study was to investigate the performance of three white single cross hybrids of maize, *i.e.* single cross 7071 for Tech Seed Company (S.C. 7071), single cross 30 K 08 for Pioneer hybrids (S.C. 30K8) and single cross hybrid 2031 for Misr Hytech Seed Int. (S.C. 2031) to three nitrogen fertilizers rates, *i.e.* 90, 120 and 150 kg N/fed and three plant population densities treatments (20000 plants/fed from grown in ridges 70 cm apart and 30 cm between hills), (24000 plants/fed from grown in ridges 70 cm apart and 25 cm between hills) and (28000 plants/fed from grown in ridges 70 cm apart and 21.43 cm between hills) on the growth traits, yield components, yield and kernels chemical properties.

Soil texture of the experimental site was clay of pH nearly of 8.0. The chemical and mechanical properties analysis of the experimental soil were determined according to the standard procedures described by **Black** and **Evans (1965)** and represented in Table 1 in each of the two growing seasons.

The preceding winter crop in the two seasons was wheat (<u>Triticum</u> <u>aestivum</u>, L.). The experimental design was laid out using randomized complete block design (RCBD) using split split plot design in three replications. Each of the three plant densities were distributed in the main plots, whereas the three nitrogen fertilizer rates were arranged at random in sub plots and the three white single cross hybrids of maize were assigned at random in sub sub plots. The sub sub plot area was 10.5 m^2 and contained five ridges of 3 m long and 70 cm apart. Phosphorous fertilizer was applied in form of Calcium super phosphate (12.5 % P_2O_5) at a rate of 100 kg/fed during soil preparation in each season. Experiments were planted on May 23th and 29th of in the first season (2016) and the second season (2017), respectively. Maize plants were thinned before the first irrigation to one plant/hill. Nitrogen fertilizer was applied in form of urea (46 % N), and divided into two equal parts and applied before the first and second irrigation in each season. The first irrigation was applied after 21 days from sowing and the following irrigations were applied at 12-15 days intervals during the growing seasons. Maize plants were harvested on 17th and 23th of September in the first and the second seasons, respectively. The other agricultural practices were kept the same as normally practiced in maize fields according to the recommendations of Ministry of Agriculture and Land Reclamation, except for the factors under study.

Table 1: Chemical and mechanical properties of the experimental soil units at planting maize during 2016 and 2017 seasons.

Properties	Season	
	2016	2017
Chemical analysis		
E.C.	2.28	2.31
pH (1 :2.5)	8.12	8.09
$CaCo_3$ %	3.21	2.94
O.M %	2.28	2.31
N % (total)	0.19	0.20
N (ppm) (available)	61.93	63.72
P % (total)	0.120	0.125
P (ppm) (available)	23.80	25.12
K % (total)	0.62	0.63
K (ppm) (available)	919.06	969.98
Particle size distribution (mechanical analysis)		
Course sand %	6.93	5.50
Find sand %	27.28	28.64
Silt %	13.23	11.60
Clay %	52.58	54.26
Texture grade	Clay	Clay

Studied characteristics:

A- Growth characteristics:

1- Time of tasseling was determined as the No. of days from planting to 50 % tasseling.
2- Time of silking was determined as the No. of days from planting to 50 % silking.
3- Number of green leaves/plant at 80 days after planting.
4- Leaf area/plant (cm^2) at 80 days after planting. It was calculated from the following equation:

$$\text{Leaf area/plant} = \text{Area of topmost ear leaf X No. of green leaves/plant}$$

Where, Area of topmost ear leaf (cm^2) at 80 days after planting was estimated as described by **Stickler, 1964.** It was calculated from the following equation:

$$\text{Area of topmost ear leaf} = \text{Ear leaf length X Greatest leaf width X } 0.75$$

5- Leaf area index at 80 days after planting was estimated as described by **Stickler, 1964.** It was estimate from the following formula:

$$\text{Leaf area index} = \frac{\text{Leaf area/plant}}{\text{land area/plant}}$$

6- Plant height (cm) at harvest, from the soil surface to the top of tassel.
7- Ear height (cm) at harvest, from the soil surface to the base of the topmost ear.
8- Number of plants carried two ears/fed at harvest.
9- Number of barren plants/fed at harvest.
10- Number of ears/fed at harvest.

Ten plants were chosen from the three center ridges at random from each sub plots to determine No. of green leaves/plant, area of topmost ear leaf (cm^2), leaf area/plant (cm^2), leaf area index, plant height (cm) and ear height (cm). Whereas, the tasseling and silking dates, No. of plants carried two ears/fed, No. of barren plants/fed and No. of ears/fed were estimated from the whole plants in the three center ridges.

B- Yield and yield components:

1- Number of kernels/ear.
2- Ear weight (g).
3- Shelling %. It was calculated by using the following formula:

$$\textbf{Shelling } (\%) = \frac{\text{Weight of kernels/ear (g)}}{\text{Ear weight (g)}} X\ 100$$

4- Weight of 100–kernel (g).
5- Stover yield/fed (kg).
6- Ear yield/fed (kg).
7- Grain yield/fed (kg), adjusted to 15.5 % moisture content. It was calculated by using the following formula:

$$\textbf{Grain yield/fed (kg)} = \frac{\textbf{Ear yield/fed (kg) X Shelling \%}}{\textbf{100}}$$

8- Biological yield/fed (kg). It was calculated by using the following formula:

$$\text{Biological yield/fed (kg)} = \text{Ear yield/fed (kg)} + \text{Stover yield/fed (kg)}$$

9- Harvest index (%). It was calculated by using the following formula:

$$\text{Harvest index } (\%) = \frac{\text{Grain yield/fed (kg)}}{\text{Biological yield/fed (kg)}} X\ 100$$

Ten ears were chosen from the three center ridges at random from each sub plots to determine No. of kernels/ear, ear weight (g), kernels weight/ear (g), shelling % and 100-kernel weight. Whereas, ear yield/fed (kg), stover yield/fed (kg), grain yield/fed (kg), biological yield/fed (kg) and harvest index (%) were estimated from the whole plants in the three center ridges.

C- Chemical analysis

Maize kernels samples were taken after harvest at random from all kernels of ten ears to determine:

1- Nitrogen uptake/fed (kg) = grain yield (kg) x kernels nitrogen content (%)
Where, Kernels nitrogen content (%) was determinate according to the modified micro Kjeldahl method **(A. O. A. C., 1990).**

2- Protein yield/fed (kg) = grain yield (kg) x kernels crude protein content (%)
Where, Kernels crude protein content (%) was calculated by multiplying nitrogen content (%) X 6.25 **(A. O. A. C., 1990).**

Statistical analysis:

The analysis of variance was carried out according to the procedure described by **Gomez and Gomez (1984).** Data were statistically analyzed according to using the MSTAT-C Statistical Software Package (**Michigan State University, 1983).** Where the F-test showed significant differences among means L. S. D. test at 0.05 level was used to compare between means

Results and Discussion

Effect of plant population densities:

Results presented in Tables 2, 3 and 4 revealed that the differences between the studied three plant population densities, *i.e.* 20000, 24000 and 28000 maize plants/fed were significant on flowering, growth, yield components, yield and kernels properties during the two seasons. Data revealed that planting 20000 maize plants/fed gave the greatest mean values of No. of green leaves/plant (13.69 and 13.33 leaves), leaf area/plant (9338.38 and 8899.59 cm^2), No. of plants carried two ears/fed (2222.22 and 1600.00 plants), No. of kernels/ear (584.70 and 592.30 kernels), ear weight (215.69 and 217.08 g), shelling percentage (82.01 and 81.64 %), 100-kernel weight (34.53 and 33.58 g), ear yield/fed (3935.19 and 3992.59 kg), grain yield/fed (3214.17 and 3254.50 kg), harvest index (43.14 and 43.41 %), nitrogen uptake/fed (56.04 and 56.32 kg) and protein yield/fed (350.22 and 352.00 kg) in the first and second seasons, respectively. In the 2016 season, planting maize at plant density of 20000 plants/fed increased grain yield/fed by 3.33 and 21.09 % compared with the growing maize at plant densities of 24000 and 28000 plants/fed respectively, the respective corresponding in the second season, were 3.44 and 30.46 %. It could be noticed that planting 20000 maize plants/fed was superior to the other plant densities treatments in increasing grain yield/fed. Such increase in grain yield/fed at planting density of 20000 plants/fed could be due to the increases No. of plants carried two ears/fed, No. of kernels/ear, ear weight, shelling % and 100-kernel weight. This trend could be explained on the fact that in case of low population density produced by increasing hill spacing resulted in low competition between it for nutrient elements, soil moisture and sun light, plants would have better opportunity to produce more metabolite contents and positive effect on plant growth and productivity as well as increased translocation and consequently accumulation of metabolites through kernels and gave the maximum values of plant traits and yield components. The greatest values of No. of days from planting to 50 % tasseling (66.33 and 65.93 days), No. of days from planting to 50 % silking (69.04 and 68.81 days), leaf area index (5.355 and 5.322), plant height (315.93 and 322.59 cm), ear height (160.00 and 162.59 cm), No. of barren plants/fed (681.48 and 977.78 plants), No. of ears/fed (26785.19 and 26488.89 ears), stover yield/fed (4796.30 and 4611.11 kg) and biological yield/fed (8144.44 and 7801.85 kg) in the first and second seasons, respectively were obtained from planting 28000 maize plants/fed. Increasing population density from 20 to 24 and 28 thousand plants/fed significantly increased stover yield/fed by 18.27 and 36.39 % respectively, in the first season. The corresponding increases were 10.65 and 31.33% in the second season for the respective densities. Such increase in stover yield/fed could be due to the increase in plant height, leaf area index and No. of plants/fed. The increases in plant height by increasing plant densities is mainly due to the increased intra-specific competition among maize plants for light and decrease in light penetration, interception and photosynthetic efficiency at higher densities as well as higher dense of plants excessive shade exist which help to produce more content of gibberellin in tissues and consequently higher plants formed. These results are in harmony with those reported by **El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; El-Koomy 2000; Agasibagil 2006; Saeed *et al.* 2007; Hassan *et al.* 2008; Sallah *et al.* 2009; Sharifi *et al.* 2009; Gozubenli 2010; Gomaa *et al*. 2011; Lashkari *et al.* 2011; Sharifi and Pirzad 2011; Zamir *et al*. 2011; Dawadi and Sah 2012; El-Gedwy *et al*. 2012; Robles *et al*. 2012; Shafi *et al*. 2012; Adeniyan 2014; Ahmadu 2014; Timlin *et al*. 2014; Imran *et al*. 2015; Karki *et al*. 2015 Mahdi and Ismail 2015; Gobeze *et al*. 2016; Mandić *et al*. 2016; Rahman *et al*. 2016; Sharanabasappa *et al*. 2017; Eyasu *et al*. 2018 and Zeleke *et al*. 2018.**

Effect of nitrogen fertilizer rates:

Results in Tables 2, 3 and 4 indicated that increasing nitrogen fertilizer rates from 90 up to 150 kg N/fed caused significant increments in mean values of allmost maize characteristics except, mean values of No. of days from planting to 50 % tasseling and silking as well as No. of barren plants/fed which significantly decreased with increasing nitrogen rates in 2016 and 2017 seasons. Maize plants which fertilized by the highest nitrogen fertilizer rate (150 kg N/fed) gave significantly the greatest mean values of No. of green leaves/plant (13.47 and 13.17 leaves), leaf area/plant (8904.18 and 8646.69 cm^2), leaf area index (5.044 and 4.911), plant height (305.19 and 306.30 cm), ear height (150.00 and 150.56 cm), No. of plants carried two ears/fed (1540.74 and 1259.26 plants), No. of ears/fed (24637.04 and 23851.85 ears), No. of kernels/ear (535.99 and 546.25 kernels), ear weight (193.24 and 192.25 g), shelling percentage (81.23 and 80.59 %), 100-kernel weight (33.56 and 32.14 g), stover yield/fed (4338.89 and 4129.63 kg), ear yield/fed (4037.04 and 3920.37 kg), grain yield/fed (3270.76 and 3158.06 kg), biological yield/fed (8375.93 and 8050.00 kg), harvest index (39.19 and 39.32 %), nitrogen uptake/fed (55.90 and 54.20 kg) and protein yield/fed (349.38 and 338.73 kg) as well as recorded significantly the shortest period from planting to 50 % tasseling (64.22 and 63.78 days) and silking (66.48 and 66.15 days) as well as gave the lowest mean values of No. of barren plants/fed (177.78 and 311.11 plants) in the first and second seasons, respectively. The superiority rations in the first season between the highest nitrogen rate (150 kg N/fed) and each of 120 and 90 kg N/fed were 2.37 and 6.38 % for leaf area/plant; 2.35 and 6.30 % for leaf area index; 1.67 and 4.77 % for plant height; 6.58 and 16.43 % for ear weight; 3.55 and 7.39 % for 100-kernel weight; 3.40 and 10.21 % for stover yield/fed; 7.87 and 20.38 % for ear yield/fed; 8.34 and 21.62 % for grain yield/fed; 5.51 and 14.88 % for biological yield/fed in addition to 9.81 and 25.62 % for protein yield/fed, respectively. The increases rations in the second season when maize received 150 kg N/fed over each of 120 and 90 kg N/fed were 1.76 and 4.25 % for leaf area/plant; 1.76 and 4.22 % for leaf area index; 1.72 and 4.16 % for plant height; 6.09 and 16.44 % for ear weight; 3.08 and 7.85 % for 100-kernel weight; 2.67 and 7.11 % for stover yield/fed; 4.39 and 14.99 % for ear yield/fed; 4.73 and 16.01 % for grain yield/fed; 3.50 and 10.81 % for biological yield/fed in addition to 5.87 and 19.36 % for protein yield/fed, respectively. The increase in growth traits associated with increasing nitrogen fertilization rates may be attributed to the role of nitrogen in enhancement meristematic activity and cell division, which caused increase in internodes length, No. of internodes and both of them. The increase in maize yield and its attributes because of increasing nitrogen fertilizer rates up to 150 kg N/fed can be easily ascribed to the role of nitrogen in activating growth of plants, consequently enhancement yield components (ear dimension, No. of kernels/ear, ear weight as well as 100-kernel weight) and consequently increasing grain yield/unit area. In the other hand, nitrogen application up to 150 kg N/fed decreased the period from sowing to 50 % tasseling and silking in both seasons. This decrease may be due to enhanced growth rate and accumulate and dry matter accumulation of more assimilates and dry matter accumulation in an early stage. In addition, the increases in kernels nitrogen content % or kernels crude protein content % by raising nitrogen rates may be due to the fact that nitrogen for essential for building up to the protoplasm amino acids and proteins. These results are in compatible with those found by **El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; Saeed *et al.* 2007; Sallah *et al.* 2009; Szulc 2009; Bamuaafa *et al.* 2010; El-Gedwy *et al.* 2011; Hokmalipour and Darbandi 2011; Dawadi and Sah 2012; Karasu 2012; Li *et al*. 2012; Kandil 2013; Radma and Dagash 2013; Adeniyan 2014; Ahmadu 2014; Delibaltova 2014; Khan *et al*. 2014; Rehman *et al*. 2014; Hafez and Abdelaal 2015; Kandil *et al*. 2016; Gharibi *et al*. 2016; Majid *et al*. 2017; Marković *et al*. 2017; Sapkota *et al*. 2017; Sharanabasappa *et al*. 2017; Takele *et al*. 2017; Ahmad *et al*. 2018 and Zeleke *et al*. 2018.**

Effect of white single cross hybrids of maize:

Results presented in Tables 2, 3 and 4 showed that mean values of all growth traits, yield components, yield and kernels chemical properties were significant differences with the studied three white single cross hybrids of maize, *i.e.* S.C. 7071, S.C. 30K8 and S.C. 2031 during 2016 and 2017 seasons. The maximum mean values of No. of plants carried two ears/fed (2266.67 and 2029.63 plants), No. of ears/fed (25333.33 and 24503.70 ears), No. of kernels/ear (541.00 and 564.02 kernels), grain yield/fed (3289.30 and 3158.74 kg) and harvest index (43.20 and 42.49 %) as well as the lowest mean values of No. of barren plants/fed (207.41 and 355.56 plants) and the shortest period from planting to 50 % tasseling (64.04 and 62.93 days) and silking (66.37 and 65.19 days) during the first and second seasons, respectively, were obtained from planting maize hybrid of S.C. 30K8. Planting maize hybrid of S.C. 30K8 increased grain yield kg/fed by 6.27 and 26.77 % in the first season, corresponding to 3.00 and 18.30 % in second season, over grain yield/fed of S.C. 2031 and S.C. 7071 maize hybrids, respectively. Results may reveal the superiority of S.C. 2031 maize hybrid in mean values of leaf area/plant (9568.69 and 9302.48 cm^2), leaf area index (5.413 and 5.282), ear weight (197.42 and 195.23 g), 100-kernel weight (35.30 and 33.77 g), ear yield/fed (4053.70 and 3996.30 kg), biological yield/fed (8403.70 and 8066.67 kg), nitrogen uptake/fed (58.35 and 56.25 kg) and protein yield/fed (364.66 and 351.56 kg) in the first and second seasons, respectively. Planting maize hybrid of S.C. 2031 increased ears yield kg/fed by 1.44 and 31.47 % in 2016 season, corresponding to 3.55 and 23.74 % in 2017 season, over ears yield/fed of S.C. 30K8 and S.C. 7071 maize hybrids, respectively. Planting maize hybrid of S.C. 7071 gave the highest mean values of No. of green leaves/plant (13.75 and 13.64 leaves), plant height (311.30 and 317.22 cm), ear height (177.41 and 179.63 cm), shelling percentage (84.01 and 82.41 %) and stover yield/fed (4492.59 and 4346.30 kg) in the first and second seasons, respectively. Planting maize hybrid of S.C. 7071 increased stover yield kg/fed by 3.28 and 23.78 % in 2016 season, corresponding to 6.78 and 21.04 % in 2017 season, over stover yield/fed of S.C. 2031 and S.C. 30K8 maize hybrids, respectively. These differences may be due to the genetic differences between the three white single cross maize hybrids. Also, the differences in 100-kernel weight might be attributed to the variation in translocation rate of photosynthetic from leaves to the storing organs, *i.e.* the kernels. The superiority of S.C. 30K8 maize hybrid in grain yield/fed over the other maize hybrids might be due to the increase in yield components, namely, No. of plants carried two ears/fed, No. of ears/fed, No. of kernels/ear and harvest index. These results are in harmony with those reported by **El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; El-Koomy 2000; Agasibagil 2006; Saeed *et al.* 2007; Hassan *et al.* 2008; Sallah *et al.* 2009; Szulc 2009; Bamuaafa *et al.* 2010; EL-Hosary *et al.* 2011; Hokmalipour and Darbandi 2011; Dawadi and Sah 2012; Karasu 2012; Li *et al*. 2012; Kandil 2013; Radma and Dagash 2013; Adeniyan 2014; Ahmadu 2014; Delibaltova 2014; Khan *et al*. 2014; Rehman *et al*. 2014; Hafez and Abdelaal 2015; Karki *et al*. 2015; El-Mehy *et al*. 2016; Kinfe *et al*. 2016; Majid *et al*. 2017; Marković *et al*. 2017; Ahmad *et al*. 2018 and Eyasu *et al*. 2018** showed that hybrids markedly varied for almost growth, yield, yield components and kernels chemical properties of maize.

Table 2. Mean values of No. of days to 50 % tasseling, No. of days to 50 % silking, No. of green leaves/plant, plant leaf area (cm^2), leaf area index, plant height (cm) and ear height (cm) as affected by mean effect of plant population densities, nitrogen fertilizer rates and white single hybrids of maize during 2016 and 2017 seasons.

Treatment	Trait	No. of days to 50 % tasseling		No. of days to 50 % silking		No. of green leaves/plant		Plant leaf area (cm^2)		Leaf area index		Plant height (cm)		Ear height (%)	
	Season	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Plant population density (plants/fed) {P}															
20000		63.33	63.00	65.41	65.15	13.69	13.33	9338.38	8899.59	4.447	4.238	283.15	277.96	133.15	131.48
24000		64.67	64.11	66.93	66.37	13.33	13.22	8600.90	8554.60	4.915	4.888	297.59	300.93	146.30	147.96
28000		66.33	65.93	69.04	68.81	12.99	12.74	8033.11	7983.61	5.355	5.322	315.93	322.59	160.00	162.59
L.S.D at 5%		0.50	0.30	0.67	0.38	0.15	0.12	90.87	176.95	0.054	0.099	4.80	5.05	2.72	3.59
Nitrogen fertilizer rate (kg N/fed) {N}															
90		65.33	64.96	67.78	67.44	13.18	13.02	8370.07	8294.24	4.745	4.712	291.30	294.07	142.78	144.44
120		64.78	64.30	67.11	66.74	13.36	13.10	8698.14	8496.87	4.928	4.826	300.19	301.11	146.67	147.04
150		64.22	63.78	66.48	66.15	13.47	13.17	8904.18	8646.69	5.044	4.911	305.19	306.30	150.00	150.56
L.S.D at 5%		0.26	0.33	0.31	0.42	0.06	0.04	48.10	42.18	0.025	0.023	2.35	1.89	1.84	2.42
Maize hybrid {H}															
S.C. 7071		64.70	65.15	66.85	67.67	13.75	13.64	8423.12	8402.81	4.778	4.767	311.30	317.22	177.41	179.63
S.C. 30K8		64.04	62.93	66.37	65.19	12.66	12.24	7980.57	7732.50	4.526	4.400	281.67	279.44	128.89	128.33
S.C. 2031		65.59	64.96	68.15	67.48	13.60	13.41	9568.69	9302.48	5.413	5.282	303.70	304.81	133.15	134.07
L.S.D at 5%		0.29	0.33	0.37	0.31	0.07	0.04	74.51	47.52	0.041	0.027	1.83	2.21	1.68	2.32
F test Prob.	P x N	**	**	**	**	N.S.	N.S.	**	**	**	**	**	**	**	**
	P x H	N.S.	N.S.	N.S.	N.S.	**	**	**	**	**	**	**	**	**	**
	N x H	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	**	**	**	**	**	**	**	**
	P x N x H	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	**	**	**	**	**	**	**	**

** Significant and N.S. No significant

Table 3: Mean values of No. of plants carried two ears/fed, No. of barren plants/fed, No. of ears/fed, No. of kernels/ear, ear weight (g), shelling % and 100-kernel weight (g) as affected by mean effect of plant population densities, nitrogen fertilizer rates and white single hybrids of maize during 2016 and 2017 seasons.

Treatment	Trait	No. of plants carried two ears/fed		No. of barren plants/fed		No. of ears/fed		No. of kernels/ear		Ear weight (g)		shelling %		100-kernel weight (g)	
	Season	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Plant population density (plants/fed) {P}															
20000		2222.22	1600.00	74.07	118.52	21540.74	20355.56	584.70	592.30	215.69	217.08	82.01	81.64	34.53	33.58
24000		1348.15	1140.74	222.22	444.44	24400.00	23600.00	510.69	532.82	181.90	185.65	80.94	80.77	32.57	31.39
28000		296.30	607.41	681.48	977.78	26785.19	26488.89	417.30	406.52	142.93	135.86	79.56	78.37	30.13	28.16
L.S.D at 5%		287.88	306.84	272.80	259.02	400.14	581.61	5.45	18.20	2.93	9.20	0.26	0.15	0.43	0.43
Nitrogen fertilizer rate (kg N/fed) {N}															
90		1051.85	977.78	518.52	711.11	23822.22	23125.93	472.56	469.34	165.97	165.11	80.39	79.86	31.25	29.80
120		1274.07	1111.11	281.48	518.52	24266.67	23466.67	504.14	516.05	181.31	181.22	80.89	80.33	32.41	31.18
150		1540.74	1259.26	177.78	311.11	24637.04	23851.85	535.99	546.25	193.24	192.25	81.23	80.59	33.56	32.14
L.S.D at 5%		117.88	87.42	103.77	95.03	229.02	302.83	3.24	7.41	1.51	3.08	0.15	0.09	0.24	0.41
Maize hybrid {H}															
S.C. 7071		192.59	459.26	370.37	755.56	23155.56	22622.22	495.29	488.83	156.58	163.44	84.01	82.41	29.74	28.82
S.C. 30K8		2266.67	2029.63	207.41	355.56	25333.33	24503.70	541.00	564.02	186.52	179.92	82.27	81.77	32.18	30.54
S.C. 2031		1407.41	859.26	400.00	429.63	24237.04	23318.52	476.40	478.79	197.42	195.23	76.23	76.60	35.30	33.77
L.S.D at 5%		158.19	146.31	107.03	142.12	267.30	260.45	7.93	10.83	2.36	2.80	0.15	0.11	0.26	0.34
F test Prob.	P x N	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	P x H	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	N x H	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	P x N x H	**	**	N.S.	N.S.	**	**	**	**	**	**	N.S.	N.S.	N.S.	N.S.

** Significant and N.S. No significant

Table 4: Mean values of stover yield/fed (kg), ear yield/fed (kg), grain yield/fed (kg), biological yield/fed (kg), harvest index (%), nitrogen uptake/fed (kg) and protein yield/fed (kg) as affected by mean effect of plant population densities, nitrogen fertilizer rates and white single hybrids of maize during 2016 and 2017 seasons.

Treatment	Trait	Stover yield/fed (kg)		Ear yield/fed (kg)		Grain yield/fed (kg)		Biological yield/fed (kg)		Harvest index (%)		Nitrogen uptake/fed (kg)		Protein yield/fed (kg)	
	Season	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Plant population density (plants/fed) {P}															
20000		3516.67	3511.11	3935.19	3992.59	3214.17	3254.50	7451.85	7503.70	43.14	43.41	56.04	56.32	350.22	352.00
24000		4159.26	3885.19	3850.00	3901.85	3110.69	3146.39	8009.26	7787.04	38.82	40.44	52.24	53.44	326.48	334.00
28000		4796.30	4611.11	3348.15	3190.74	2654.26	2494.69	8144.44	7801.85	32.52	31.85	43.03	41.04	268.96	256.48
L.S.D at 5%		183.63	125.57	92.25	144.64	68.58	118.03	166.98	194.31	1.15	0.99	1.38	2.06	8.63	12.89
Nitrogen fertilizer rate (kg N/fed) {N}															
90		3937.04	3855.56	3353.70	3409.26	2689.26	2722.12	7290.74	7264.81	37.07	37.54	44.50	45.41	278.12	283.80
120		4196.30	4022.22	3742.59	3755.56	3019.10	3015.40	7938.89	7777.78	38.21	38.84	50.91	51.19	318.17	319.94
150		4338.89	4129.63	4037.04	3920.37	3270.76	3158.06	8375.93	8050.00	39.19	39.32	55.90	54.20	349.38	338.73
L.S.D at 5%		59.35	24.43	70.15	76.24	58.54	57.94	99.93	84.26	0.39	0.38	1.05	1.13	6.57	7.05
Maize hybrid {H}															
S.C. 7071		4492.59	4346.30	3083.33	3229.63	2594.72	2670.16	7575.93	7575.93	34.38	35.16	38.14	40.84	238.35	255.24
S.C. 30K8		3629.63	3590.74	3996.30	3859.26	3289.30	3158.74	7625.93	7450.00	43.20	42.49	54.83	53.71	342.66	335.67
S.C. 2031		4350.00	4070.37	4053.70	3996.30	3095.10	3066.68	8403.70	8066.67	36.90	38.05	58.35	56.25	364.66	351.56
L.S.D at 5%		57.67	44.43	68.57	42.81	55.74	33.46	98.53	69.04	0.39	0.27	0.99	0.66	6.16	4.15
F test Prob.	P x N	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	P x H	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	N x H	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	P x N x H	**	**	**	**	**	**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

** Significant and N.S. No significant

The interaction effect between plant population densities and nitrogen fertilizer rates:

Results in Table 2, 3 and 4 showed that the interaction effect among plant population densities and nitrogen fertilizer rates induced significant different on all studied traits except for No. of green leaves/plant during 2016 and 2017 seasons. Results in Tables 5, 6 and 7 indicated that the highest mean values of leaf area index (5.497 and 5.426), plant height (323.33 and 327.78 cm), ear height (163.89 and 165.00 cm), No. of barren plants/fed (444.44 and 755.56 plants), No. of ears/fed (27111.11 and 26800.00 ears), stover yield/fed (4972.22 and 4738.89 kg) and biological yield/fed (8638.89 and 8200.00 kg) in the first and second seasons, respectively were recorded from the highest plant population density (28000 plants/fed) under soil fertilized by the highest rate of nitrogen fertilizer (150 kg N/fed). While, the lowest plant population density (20000 plants/fed) under the same nitrogen fertilizer rate (150 kg N/fed) gave the maximum mean values for leaf area/plant (9648.37 and 9090.16 cm^2), No. of plants carried two ears/fed (2622.22 and 1822.22 plants), No. of kernels/ear (621.77 and 633.92 kernels), ear weight (227.63 and 230.62 g), shelling percentage (82.35 and 81.96 %), 100-kernel weight (35.81 and 34.88 g), ear yield/fed (4255.56 and 4200.00 kg), grain yield/fed (3490.51 and 3436.54 kg), harvest index (43.94 and 43.89 %), nitrogen uptake/fed (61.74 and 60.41 kg) and protein yield/fed (385.87 and 377.58 kg) as well as recorded significantly the shortest period from planting to 50 % tasseling (62.89 and 62.56 days) and silking (64.78 and 64.56 days) also gave zero barren plants/fed in the first and second seasons, respectively. The results reported here are in harmony with those obtained by **El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; Saeed *et al.* 2007; Sallah *et al.* 2009; Asif *et al.* 2010; Rafiq *et al.*2010; Abdulhamid and Adraa 2011; Attia *et al.* 2011; Bozorgi *et al.* 2011; Dahmardeh 2011; Zakkam 2011; Dawadi and Sah 2012; Moraditochaee *et al*. 2012; Adeniyan 2014; Ahmadu 2014 Timlin *et al*. 2014; Imran *et al.* 2015; Mahdi and Ismail 2015; Rahman *et al*. 2016; Sharanabasappa *et al*. 2017 and Zeleke *et al*. 2018.**

The interaction effect between plant population densities and white single maize hybrids:

Significant effect of the interaction between plant population densities and white single cross hybrids obtained for almost growth, yield components, yield and chemical properties of maize in the both seasons were significant except, No. of days from planting to 50 % tasseling and silking (Tables 2, 3 and 4). Data in Table 5, 6 and 7 showed that planting maize hybrid of S.C. 30K8 with 20000 plants/fed recorded the maximum mean values of No. of plants carried two ears/fed (3377.78 and 2622.22 plants), No. of kernels/ear (626.69 and 621.91 kernels) and harvest index (46.31 and 46.16 %) as well as gave the lowest mean values of No. of barren plants/fed (0.00 and 44.44 plants) in the first and second seasons, respectively. While, sowing the same hybrid under the highest plant density (28000 plants/fed) significantly recorded the greatest mean values of No. of ears/fed (27466.67 and 27555.56 ears) during the both seasons, respectively. The maximum grain yield/fed in the first season (3520.49 kg) was obtained from planting the same hybrid when planting by 24000 plants/fed. Results indicated that the greatest mean values of leaf area/plant (10485.65 and 9793.70 cm^2), ear weight (237.91 and 233.38 g), 100-kernel weight (38.14 and 36.94 g), ear yield/fed (4472.22 and 4288.89 kg), nitrogen uptake/fed (67.88 and 62.87 kg) and protein yield/fed (424.24 and 392.94 kg) in the both seasons, respectively, as well as grain yield/fed (3348.52 kg) in the second season were obtained from planting maize hybrid of S.C. 2031 at the lowest plant density (20000 plants/fed). Meanwhile, planting the same maize hybrid with 28000 plants/fed significantly recorded the maximum mean values of leaf area index (5.831 and 5.825) and biological yield/fed (8666.67 and 8188.89 kg) in the first and second seasons, respectively. Data showed that planting maize hybrid of S.C. 7071 at 20000 plants/fed recorded significantly the greatest mean values of No. of green leaves/plant (14.18 and 13.99 leaves) and shelling percentage (85.29 and 84.04 %) during the two seasons, respectively. However, planting maize with the highest plant density (28000 plants/fed) from the same hybrid significantly gave the maximum mean values of plant height (334.44 and 340.56 cm), ear height (193.33 and 194.44 cm) and stover yield/fed (5205.56 and 4977.78 kg) in the first and second seasons, respectively. These results agree with those reported by **El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; El-Koomy 2000; Agasibagil 2006; Saeed *et al.* 2007; Hassan *et al.* 2008; Sallah *et al.* 2009; Sharifi *et al.* 2009; Gozubenli 2010; Lashkari *et al.* 2011; Sharifi and Pirzad 2011; Zamir *et al*. 2011; Dawadi and Sah 2012; Robles *et al*. 2012; Shafi *et al*. 2012; Adeniyan 2014; Ahmadu 2014; Karki *et al*. 2015 and Eyasu *et al.* 2018** which showed that there was significantly difference among the interaction between plant densities and hybrids in growth, yield components, yield and chemical properties of maize.

The interaction effect between nitrogen fertilizer rates and white single maize hybrids:

Results in Tables 2, 3 and 4 showed that significant effect of the interaction between nitrogen fertilizer rates and white single cross hybrids obtained for almost growth, yield, yield components and kernels chemical properties of maize in the both seasons. While, No. of days from planting to 50 % tasseling and silking as well as No. of green leaves/plant were not significantly affected by the interaction between nitrogen fertilizer rates and white single cross hybrids of maize in both seasons. Planting maize hybrid of S.C. 30K8 which fertilized by the higher nitrogen rate (150 kg N/fed) recorded significantly the highest mean values of No. of plants carried two ears/fed (2711.11 and 2177.78 plants), No. of ears/fed (25822.22 and 24844.44 ears), No. of kernels/ear (583.32 and 607.94 kernels), grain yield/fed (3601.27 and 3369.55 kg) and harvest index (44.35 and 43.26 %) as well as gave the lowest mean values of No. of barren plants/fed (133.33 and 222.22 plants) in the first and second seasons, respectively. Sowing maize hybrid of S.C. 2031 under soil fertilized by 150 kg N/fed recorded the greatest mean values of leaf area/plant (9842.72 and 9489.33 cm^2), leaf area index (5.566 and 5.389), ear weight (210.60 and 206.68 g), 100-kernel weight (36.63 and 35.02 g), ear yield/fed (4405.56 and 4222.22 kg), biological yield/fed (8944.44 and 8411.11 kg), nitrogen uptake/fed (64.52 and 60.53 kg) and protein yield/fed (403.24 and 378.29 kg) during the first and second seasons, respectively. The highest mean values of plant height (317.78 and 323.33 cm), ear height (181.11 and 183.33 cm), shelling percentage (84.37 and 82.67 %) and stover yield/fed (4694.44 and 4483.33 kg) in the first and second seasons, respectively which were obtained from planting maize hybrid of S.C. 7071 when received 150 kg N/fed. These results are in agreement with those obtained by **El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; Saeed *et al.* 2007; Sallah *et al.* 2009; Szulc 2009; Bamuaafa *et al.* 2010; Hokmalipour and Darbandi 2011; Dawadi and Sah 2012; Karasu 2012; Li *et al*. 2012; Kandil 2013; Radma and Dagash 2013; Adeniyan 2014; Ahmadu 2014; Delibaltova 2014; Khan *et al*. 2014; Rehman *et al*. 2014; Hafez and Abdelaal 2015; Majid *et al*. 2017; Marković *et al*. 2017 and Ahmad *et al*. 2018** they found that growth, yield components, yield and chemical properties of maize were significantly affected by the interaction between nitrogen fertilizer rates and maize hybrids.

The interaction effect between plant population densities, nitrogen fertilizer rates and white single maize hybrids:

The effect of the interaction between the three factors under study on leaf area/plant, leaf area index, plant height, ear height, No. of plants carried two ears/fed, No. of ears/fed, No. of kernels/ear, ear weight, stover yield/fed, ear yield/fed and grain yield/fed which significant in the first and second seasons. While, No. of days from planting to 50 % tasseling and silking, No. of green leaves/plant, No. of barren plants/fed, shelling %, 100-kernel weight, biological yield/fed, harvest index, nitrogen uptake/fed and protein yield/fed were not significantly affected by these interactions (F test probability are shown in Tables 2, 3 and 4). Data in Tables 8 and 9 showed that planting maize hybrid of S.C. 30K8 with 20000 plants/fed when received 150 kg N/fed recorded the maximum mean values of No. of plants carried two ears/fed (4000.00 and 2800.00 plants) and No. of kernels/ear (678.75 and 667.44 kernels) in the first and second seasons, respectively. While, sowing the same hybrid in the highest plant density (28000 plants/fed) with soil fertilized by 150 kg N/fed significantly recorded the greatest mean values of No. of ears/fed (27733.33 and 27866.67 ears) during the both seasons, respectively. The maximum grain yield/fed in the first season (3824.20 kg) was obtained from planting the same hybrid when planting by 24000 plants/fed with soil fertilized by 150 kg N/fed. Results indicated that the greatest mean values of leaf area/plant (10830.10 and 9961.11 cm^2), ear weight (248.97 and 243.30 g) and ear yield/fed (4783.33 and 4516.67 kg) in the both seasons, respectively, as well as grain yield/fed (3543.97 kg) in the second season were obtained from planting maize hybrid of S.C. 2031 at the lowest plant density (20000 plants/fed) under soil fertilized by 150 kg N/fed. Meanwhile, planting the same maize hybrid with 28000 plants/fed with nitrogen fertilizer rate of 150 kg N/fed significantly recorded the maximum mean values of leaf area index (5.999 and 5.940) in the first and second seasons, respectively. Data showed that planting maize hybrid of S.C. 7071 at 28000 plants/fed and soil fertilized by 150 kg N/fed recorded significantly the greatest mean values of plant height (343.33 and 348.33 cm), ear height (198.33 and 198.33 cm) and stover yield/fed (5400.00 and 5083.33 kg) in the first and second seasons, respectively. These results agree with those reported by **El-Habbak 1996; El-Sheikh 1998; El-Agamy *et al.* 1999; Saeed *et al.* 2007; Sallah *et al.* 2009; Dawadi and Sah 2012; Adeniyan 2014 and Ahmadu 2014** which showed that there was significantly difference among the interaction between plant population densities, nitrogen fertilizer rates and hybrids in growth, yield components, yield and chemical properties of maize

Conclusion

It could be summarized that, the best plant population density when planting maize hybrid of 30K8 was 24000 plants/fed, meanwhile, the best plant density at planting maize hybrids of S.C. 2031 or S.C. 7071 was 20000 plants/fed with soil fertilized by 150 kg N/fed to maximized grain yield/fed.

Table 5: Mean values of No. of days to 50 % tasseling, No. of days to 50 % silking, No. of green leaves/plant, plant leaf area (cm²), leaf area index, plant height (cm) and ear height (cm) as affected by the first order interaction between plant population densities, nitrogen fertilizer rates and white single hybrids of maize during 2016 and 2017 seasons.

Treatment	Trait	No. of days to 50 % tasseling		No. of days to 50 % silking		No. of green leaves/plant		Plant leaf area (cm²)		Leaf area index		Plant height (cm)		Ear height (%)	
	Season	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Interaction between nitrogen fertilizer rates and plant population densities															
	90	63.67	63.44	66.00	65.67	13.52	13.26	8984.28	8687.36	4.278	4.137	276.67	270.56	128.89	126.67
20000	120	63.44	63.00	65.44	65.22	13.69	13.32	9382.48	8921.23	4.468	4.248	284.44	278.89	133.89	132.22
	150	62.89	62.56	64.78	64.56	13.86	13.41	9648.37	9090.16	4.594	4.329	288.33	284.44	136.67	135.56
	90	65.33	64.78	67.56	67.11	13.19	13.13	8330.93	8385.27	4.761	4.792	290.56	294.44	143.33	145.56
24000	120	64.56	64.00	66.89	66.22	13.36	13.22	8653.13	8567.28	4.945	4.896	298.33	301.67	146.11	147.22
	150	64.11	63.56	66.33	65.78	13.46	13.31	8818.63	8711.25	5.039	4.978	303.89	306.67	149.44	151.11
	90	67.00	66.67	69.78	69.56	12.82	12.68	7795.00	7810.07	5.197	5.207	306.67	317.22	156.11	161.11
28000	120	66.33	65.89	69.00	68.78	13.02	12.74	8058.80	8002.09	5.373	5.335	317.78	322.78	160.00	161.67
	150	65.67	65.22	68.33	68.11	13.11	12.80	8245.53	8138.67	5.497	5.426	323.33	327.78	163.89	165.00
L.S.D at 5%		0.45	0.57	0.54	0.73	N.S.	N.S.	83.31	73.06	0.043	0.040	4.07	3.27	3.19	4.19
Interaction between plant population densities and maize hybrids															
	S.C. 7071	63.11	63.67	64.89	65.89	14.18	13.99	9009.00	8927.06	4.290	4.251	291.11	296.67	162.78	165.00
20000	S.C. 30K8	62.78	61.67	65.00	63.67	12.89	12.33	8520.48	7978.00	4.057	3.799	270.00	254.44	115.00	108.89
	S.C. 2031	64.11	63.67	66.33	65.89	14.00	13.67	10485.65	9793.70	4.993	4.664	288.33	282.78	121.67	120.56
	S.C. 7071	64.78	64.78	67.11	67.11	13.77	13.84	8350.16	8453.58	4.772	4.831	308.33	314.44	176.11	179.44
24000	S.C. 30K8	63.78	62.78	65.89	64.89	12.72	12.29	7979.20	7833.53	4.560	4.476	280.00	282.22	129.44	130.56
	S.C. 2031	65.44	64.78	67.78	67.11	13.51	13.53	9473.34	9376.69	5.413	5.358	304.44	306.11	133.33	133.89
	S.C. 7071	66.22	67.00	68.56	70.00	13.30	13.09	7910.20	7827.79	5.273	5.219	334.44	340.56	193.33	194.44
28000	S.C. 30K8	65.56	64.33	68.22	67.00	12.36	12.11	7442.03	7385.98	4.961	4.924	295.00	301.67	142.22	145.56
	S.C. 2031	67.22	66.44	70.33	69.44	13.30	13.02	8747.09	8737.06	5.831	5.825	318.33	325.56	144.44	147.78
L.S.D at 5%		N.S.	N.S.	N.S.	N.S.	0.13	0.06	129.05	82.30	0.071	0.046	3.17	3.83	2.91	4.01
Interaction between nitrogen fertilizer rates and maize hybrids															
	S.C. 7071	65.22	65.89	67.44	68.44	13.60	13.56	8181.71	8223.21	4.645	4.668	303.89	310.56	173.33	176.67
90	S.C. 30K8	64.67	63.44	67.00	65.78	12.48	12.18	7683.58	7571.98	4.360	4.308	275.00	272.78	125.56	124.44
	S.C. 2031	66.11	65.56	68.89	68.11	13.46	13.33	9244.92	9087.52	5.230	5.160	295.00	298.89	129.44	132.22
	S.C. 7071	64.78	65.11	66.89	67.67	13.77	13.64	8456.19	8420.00	4.797	4.776	312.22	317.78	177.78	178.89
120	S.C. 30K8	63.89	62.89	66.33	65.11	12.68	12.23	8019.78	7740.01	4.547	4.405	282.78	280.00	129.44	128.89
	S.C. 2031	65.67	64.89	68.11	67.44	13.62	13.41	9618.44	9330.60	5.442	5.298	305.56	305.56	132.78	133.33
	S.C. 7071	64.11	64.44	66.22	66.89	13.88	13.72	8631.46	8565.22	4.893	4.856	317.78	323.33	181.11	183.33
150	S.C. 30K8	63.56	62.44	65.78	64.67	12.81	12.32	8238.35	7885.53	4.671	4.487	287.22	285.56	131.67	131.67
	S.C. 2031	65.00	64.44	67.44	66.89	13.73	13.48	9842.72	9489.33	5.566	5.389	310.56	310.00	137.22	136.67
L.S.D at 5%		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	129.05	82.30	0.071	0.046	3.17	3.83	2.91	4.01

Table 6: Mean values of No. of plants carried two ears/fed, No. of barren plants/fed, No. of ears/fed, No. of kernels/ear, ear weight (g), shelling % and 100-kernel weight (g) as affected by the first order interaction between plant population densities, nitrogen fertilizer rates and white single hybrids of maize during 2016 and 2017 seasons.

Treatment	Trait	No. of plants carried two ears/fed		No. of barren plants/fed		No. of ears/fed		No. of kernels/ear		Ear weight (g)		shelling %		100-kernel weight (g)	
	Season	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Interaction between nitrogen fertilizer rates and plant population densities															
	90	1866.67	1377.78	177.78	222.22	21066.67	20000.00	547.32	540.40	201.53	201.72	81.61	81.28	33.24	32.10
20000	120	2177.78	1600.00	44.44	133.33	21555.56	20311.11	585.02	602.60	217.90	218.90	82.06	81.69	34.52	33.77
	150	2622.22	1822.22	0.00	0.00	22000.00	20755.56	621.77	633.92	227.63	230.62	82.35	81.96	35.81	34.88
	90	1066.67	977.78	400.00	666.67	24044.44	23155.56	476.62	492.28	165.00	170.88	80.46	80.38	31.26	29.94
24000	120	1377.78	1155.56	177.78	488.89	24355.56	23644.44	510.17	534.96	183.22	188.52	80.97	80.84	32.68	31.62
	150	1600.00	1288.89	88.89	177.78	24800.00	24000.00	545.27	571.21	197.48	197.54	81.40	81.07	33.77	32.60
	90	222.22	577.78	977.78	1244.44	26355.56	26222.22	393.75	375.33	131.37	122.74	79.12	77.93	29.24	27.36
28000	120	266.67	577.78	622.22	933.33	26888.89	26444.44	417.22	410.60	142.82	136.24	79.63	78.45	30.03	28.16
	150	400.00	666.67	444.44	755.56	27111.11	26800.00	440.93	433.63	154.60	148.58	79.94	78.74	31.10	28.96
L.S.D at 5%		204.17	151.41	179.73	164.60	396.67	524.52	5.62	12.83	2.62	5.33	0.26	0.16	0.42	0.71
Interaction between plant population densities and maize hybrids															
	S.C. 7071	444.44	933.33	88.89	222.22	19688.89	19644.44	579.13	585.55	192.94	206.11	85.29	84.04	31.80	31.34
20000	S.C. 30K8	3377.78	2622.22	0.00	44.44	22755.56	21333.33	626.69	621.91	216.21	211.76	83.20	82.83	33.63	32.46
	S.C. 2031	2844.44	1244.44	133.33	88.89	22177.78	20088.89	548.29	569.45	237.91	233.38	77.53	78.06	38.14	36.94
	S.C. 7071	133.33	266.67	222.22	711.11	23333.33	22444.44	504.68	517.95	155.07	170.52	84.02	82.82	29.76	28.66
24000	S.C. 30K8	2711.11	2088.89	177.78	400.00	25777.78	24622.22	546.34	594.00	193.10	183.90	82.49	82.39	32.77	31.17
	S.C. 2031	1200.00	1066.67	266.67	222.22	24088.89	23733.33	481.05	486.50	197.53	202.52	76.32	77.10	35.18	34.34
	S.C. 7071	0.00	177.78	800.00	1333.33	26444.44	25777.78	402.07	363.00	121.72	113.68	82.73	80.38	27.66	26.46
28000	S.C. 30K8	711.11	1377.78	444.44	622.22	27466.67	27555.56	449.98	476.15	150.26	144.11	81.11	80.08	30.13	28.00
	S.C. 2031	177.78	266.67	800.00	977.78	26444.44	26133.33	399.85	380.40	156.81	149.78	74.85	74.65	32.59	30.01
L.S.D at 5%		273.99	253.41	185.38	246.17	462.98	451.11	13.74	18.76	4.09	4.86	0.25	0.19	0.46	0.59
Interaction between nitrogen fertilizer rates and maize hybrids															
	S.C. 7071	88.89	311.11	666.67	1022.22	22800.00	22133.33	466.92	455.27	144.01	149.51	83.58	82.12	28.87	27.81
90	S.C. 30K8	1866.67	1866.67	311.11	533.33	24888.89	24177.78	502.34	509.84	170.80	164.09	81.85	81.28	30.83	29.37
	S.C. 2031	1200.00	755.56	577.78	577.78	23777.78	23066.67	448.42	442.90	183.09	181.74	75.75	76.19	34.04	32.22
	S.C. 7071	177.78	444.44	266.67	800.00	23244.44	22622.22	496.62	491.17	157.72	164.42	84.09	82.45	29.71	28.84
120	S.C. 30K8	2222.22	2044.44	177.78	311.11	25288.89	24488.89	537.34	574.28	187.66	181.99	82.28	81.86	32.29	30.64
	S.C. 2031	1422.22	844.44	400.00	444.44	24266.67	23288.89	478.45	482.70	198.57	197.26	76.30	76.66	35.23	34.06
	S.C. 7071	311.11	622.22	177.78	444.44	23422.22	23111.11	522.32	520.06	168.00	176.38	84.37	82.67	30.63	29.80
150	S.C. 30K8	2711.11	2177.78	133.33	222.22	25822.22	24844.44	583.32	607.94	201.11	193.69	82.67	82.15	33.41	31.61
	S.C. 2031	1600.00	977.78	222.22	266.67	24666.67	23600.00	502.32	510.76	210.60	206.68	76.65	76.96	36.63	35.02
L.S.D at 5%		273.99	253.41	185.38	246.17	462.98	451.11	13.74	18.76	4.09	4.86	0.25	0.19	0.46	0.59

Table 7: Mean values of stover yield/fed (kg), ear yield/fed (kg), grain yield/fed (kg), biological yield/fed (kg), harvest index (%), nitrogen uptake/fed (kg) and protein yield/fed (kg) as affected by the first order interaction between plant population densities, nitrogen fertilizer rates and white single hybrids of maize during 2016 and 2017 seasons.

Treatment	Trait	Stover yield/fed (kg)		Ear yield/fed (kg)		Grain yield/fed (kg)		Biological yield/fed (kg)		Harvest index (%)		Nitrogen uptake/fed (kg)		Protein yield/fed (kg)	
	Season	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Interaction between plant population densities and nitrogen fertilizer rates															
	90	3311.11	3361.11	3583.33	3716.67	2912.01	3015.57	6894.44	7077.78	42.30	42.68	49.77	51.07	311.07	319.20
2000	120	3544.44	3533.33	3966.67	4061.11	3239.99	3311.39	7511.11	7594.44	43.17	43.66	56.60	57.48	353.73	359.23
	150	3694.44	3638.89	4255.56	4200.00	3490.51	3436.54	7950.00	7838.89	43.94	43.89	61.74	60.41	385.87	377.58
	90	3938.89	3733.33	3494.44	3650.00	2805.30	2928.05	7433.33	7383.33	37.77	39.69	46.28	49.12	289.26	306.99
24000	120	4188.89	3911.11	3866.67	3955.56	3124.07	3192.54	8055.56	7866.67	38.81	40.64	52.51	54.22	328.20	338.88
	150	4350.00	4011.11	4188.89	4100.00	3402.69	3318.58	8538.89	8111.11	39.88	40.99	57.92	56.98	361.98	356.13
	90	4561.11	4472.22	2983.33	2861.11	2350.47	2222.75	7544.44	7333.33	31.15	30.25	37.44	36.04	234.02	225.22
28000	120	4855.56	4622.22	3394.44	3250.00	2693.24	2542.26	8250.00	7872.22	32.64	32.22	43.61	41.87	272.57	261.72
	150	4972.22	4738.89	3666.67	3461.11	2919.08	2719.07	8638.89	8200.00	33.76	33.07	48.05	45.20	300.30	282.49
L.S.D at 5%		102.80	42.31	121.50	132.05	101.39	100.36	173.08	145.94	0.68	0.66	1.82	1.96	11.37	12.23
Interaction between plant population densities and maize hybrids															
	S.C. 7071	3772.22	3833.33	3411.11	3727.78	2910.10	3133.21	7183.33	7561.11	40.49	41.42	44.91	49.58	280.67	309.86
20000	S.C. 30K8	3116.67	3144.44	3922.22	3961.11	3263.86	3281.75	7038.89	7105.56	46.31	46.16	55.32	56.51	345.76	353.22
	S.C. 2031	3661.11	3555.56	4472.22	4288.89	3468.55	3348.52	8133.33	7844.44	42.61	42.66	67.88	62.87	424.24	392.94
	S.C. 7071	4500.00	4227.78	3250.00	3477.78	2731.87	2880.59	7750.00	7705.56	35.20	37.36	39.67	43.89	247.94	274.30
24000	S.C. 30K8	3600.00	3438.89	4266.67	4050.00	3520.49	3337.17	7866.67	7488.89	44.68	44.54	59.25	57.23	370.29	357.71
	S.C. 2031	4377.78	3988.89	4033.33	4177.78	3079.71	3221.41	8411.11	8166.67	36.57	39.43	57.79	59.20	361.22	369.99
	S.C. 7071	5205.56	4977.78	2588.89	2483.33	2142.20	1996.67	7794.44	7461.11	27.44	26.71	29.83	29.05	186.43	181.57
28000	S.C. 30K8	4172.22	4188.89	3800.00	3566.67	3083.55	2857.29	7972.22	7755.56	38.61	36.78	49.91	47.38	311.93	296.10
	S.C. 2031	5011.11	4666.67	3655.56	3522.22	2737.05	2630.12	8666.67	8188.89	31.51	32.07	49.36	46.68	308.52	291.76
L.S.D at 5%		99.89	76.96	118.76	74.14	96.54	57.96	170.66	119.59	0.68	0.46	1.71	1.15	10.67	7.19
Interaction between nitrogen fertilizer rates and maize hybrids															
	S.C. 7071	4244.44	4177.78	2794.44	2972.22	2338.72	2449.30	7038.89	7150.00	33.40	34.20	33.54	36.72	209.65	229.51
90	S.C. 30K8	3444.44	3450.00	3605.56	3555.56	2952.17	2893.29	7050.00	7005.56	42.02	41.41	48.36	48.65	302.23	304.07
	S.C. 2031	4122.22	3938.89	3661.11	3700.00	2776.89	2823.76	7783.33	7638.89	35.80	37.02	51.60	50.85	322.47	317.84
	S.C. 7071	4538.89	4377.78	3105.56	3277.78	2615.11	2710.66	7644.44	7655.56	34.41	35.35	38.51	41.51	240.68	259.42
120	S.C. 30K8	3661.11	3605.56	4027.78	3922.22	3314.45	3213.37	7688.89	7527.78	43.24	42.80	55.29	54.70	345.55	341.84
	S.C. 2031	4388.89	4083.33	4094.44	4066.67	3127.74	3122.17	8483.33	8150.00	36.98	38.37	58.92	57.37	368.27	358.56
	S.C. 7071	4694.44	4483.33	3350.00	3438.89	2830.33	2850.51	8044.44	7922.22	35.32	35.93	42.35	44.29	264.71	276.79
150	S.C. 30K8	3783.33	3716.67	4355.56	4100.00	3601.27	3369.55	8138.89	7816.67	44.35	43.26	60.83	57.78	380.20	361.11
	S.C. 2031	4538.89	4188.89	4405.56	4222.22	3380.67	3254.12	8944.44	8411.11	37.91	38.76	64.52	60.53	403.24	378.29
L.S.D at 5%		99.89	76.96	118.76	74.14	96.54	57.96	170.66	119.59	0.68	0.46	1.71	1.15	10.67	7.19

Table 8: Mean values of plant leaf area (cm^2), leaf area index, plant height (cm), ear height (cm), No. of plants carried two ears/fed and No. of barren plants/fed as affected by the second order interaction between plant population densities, nitrogen fertilizer rates and white single hybrids of maize during 2016 and 2017 seasons.

Trait			Plant leaf area (cm^2)		Leaf area index		Plant height (cm)		Ear height (%)		No. of plants carried two ears/fed	
PD	**NF**	**MH**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
		S.C. 7071	8685.57	8651.91	4.136	4.120	285.00	288.33	158.33	160.00	266.67	666.67
	90	S.C. 30K8	8157.34	7819.32	3.884	3.723	265.00	246.67	111.67	103.33	2933.33	2400.00
20000		S.C. 2031	10109.92	9590.85	4.814	4.567	280.00	276.67	116.67	116.67	2400.00	1066.67
	120	S.C. 7071	9048.77	8960.62	4.309	4.267	291.67	298.33	163.33	165.00	400.00	933.33
		S.C. 30K8	8581.75	7973.95	4.087	3.797	271.67	255.00	115.00	108.33	3200.00	2666.67
		S.C. 2031	10516.93	9829.13	5.008	4.681	290.00	283.33	123.33	123.33	2933.33	1200.00
		S.C. 7071	9292.66	9168.64	4.425	4.366	296.67	303.33	166.67	170.00	666.67	1200.00
	150	S.C. 30K8	8822.35	8140.73	4.201	3.877	273.33	261.67	118.33	115.00	4000.00	2800.00
		S.C. 2031	10830.10	9961.11	5.157	4.743	295.00	288.33	125.00	121.67	3200.00	1466.67
		S.C. 7071	8127.00	8348.38	4.644	4.771	301.67	310.00	173.33	178.33	0.00	133.33
	90	S.C. 30K8	7686.13	7676.10	4.392	4.386	273.33	275.00	126.67	126.67	2133.33	1866.67
		S.C. 2031	9179.66	9131.34	5.246	5.218	296.67	298.33	130.00	131.67	1066.67	933.33
		S.C. 7071	8386.11	8459.75	4.792	4.834	310.00	315.00	176.67	178.33	133.33	266.67
24000	120	S.C. 30K8	8032.13	7839.75	4.590	4.480	280.00	283.33	130.00	131.67	2800.00	2133.33
		S.C. 2031	9541.16	9402.33	5.452	5.373	305.00	306.67	131.67	131.67	1200.00	1066.67
		S.C. 7071	8537.37	8552.61	4.878	4.887	313.33	318.33	178.33	181.67	266.67	400.00
	150	S.C. 30K8	8219.34	7984.76	4.697	4.563	286.67	288.33	131.67	133.33	3200.00	2266.67
		S.C. 2031	9699.19	9596.39	5.542	5.484	311.67	313.33	138.33	138.33	1333.33	1200.00
		S.C. 7071	7732.57	7669.35	5.155	5.113	325.00	333.33	188.33	191.67	0.00	133.33
	90	S.C. 30K8	7207.27	7220.52	4.805	4.814	286.67	296.67	138.33	143.33	533.33	1333.33
		S.C. 2031	8445.17	8540.35	5.630	5.694	308.33	321.67	141.67	148.33	133.33	266.67
		S.C. 7071	7933.68	7839.63	5.289	5.226	335.00	340.00	193.33	193.33	0.00	133.33
28000	120	S.C. 30K8	7445.47	7406.32	4.964	4.938	296.67	301.67	143.33	146.67	666.67	1333.33
		S.C. 2031	8797.24	8760.34	5.865	5.840	321.67	326.67	143.33	145.00	133.33	266.67
		S.C. 7071	8064.35	7974.40	5.376	5.316	343.33	348.33	198.33	198.33	0.00	266.67
	150	S.C. 30K8	7673.36	7531.10	5.116	5.021	301.67	306.67	145.00	146.67	933.33	1466.67
		S.C. 2031	8998.87	8910.51	5.999	5.940	325.00	328.33	148.33	150.00	266.67	266.67
L.S.D at 5%			223.53	142.56	0.123	0.081	5.49	6.63	5.04	6.96	474.57	438.93

Table 9: Mean values of No. of ears/fed, No. of kernels/ear, ear weight (g), stover yield/fed (kg), ear yield/fed (kg) and grain yield/fed (kg) as affected by the second order interaction between plant population densities, nitrogen fertilizer rates and white single hybrids of maize during 2016 and 2017 seasons.

Trait			No. of ears/fed		No. of kernels/ear		Ear weight (g)		Stover yield/fed (kg)		Ear yield/fed (kg)		Grain yield/fed (kg)	
PD	NF	MH	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
		S.C. 7071	19333.33	19066.67	548.49	537.56	179.70	187.43	3550.00	3650.00	3133.33	3500.00	2656.73	2931.92
	90	S.C. 30K8	22400.00	20933.33	577.66	555.22	200.77	195.73	2933.33	2983.33	3550.00	3666.67	2946.45	3022.69
		S.C. 2031	21466.67	20000.00	515.81	528.42	224.13	222.00	3450.00	3450.00	4066.67	3983.33	3132.85	3092.09
		S.C. 7071	19733.33	19600.00	581.31	592.88	195.13	208.60	3800.00	3866.67	3433.33	3766.67	2933.06	3167.14
20000	120	S.C. 30K8	22533.33	21333.33	623.65	643.07	217.93	213.27	3150.00	3166.67	3900.00	4050.00	3244.43	3357.51
		S.C. 2031	22400.00	20000.00	550.10	571.83	240.63	234.83	3683.33	3566.67	4566.67	4366.67	3542.49	3409.51
		S.C. 7071	20000.00	20266.67	607.58	626.20	204.00	222.30	3966.67	3983.33	3666.67	3916.67	3140.51	3300.58
	150	S.C. 30K8	23333.33	21733.33	678.75	667.44	229.93	226.27	3266.67	3283.33	4316.67	4166.67	3600.69	3465.06
		S.C. 2031	22666.67	20266.67	578.97	608.11	248.97	243.30	3850.00	3650.00	4783.33	4516.67	3730.32	3543.97
		S.C. 7071	23066.67	21866.67	472.68	489.20	140.80	157.40	4266.67	4033.33	2950.00	3216.67	2463.93	2655.32
	90	S.C. 30K8	25200.00	24266.67	504.68	540.98	172.90	167.23	3433.33	3350.00	3866.67	3800.00	3172.63	3114.53
		S.C. 2031	23866.67	23333.33	452.50	446.67	181.30	188.00	4116.67	3816.67	3666.67	3933.33	2779.33	3014.28
		S.C. 7071	23333.33	22533.33	504.48	515.89	154.87	171.43	4516.67	4266.67	3233.33	3533.33	2717.64	2928.02
24000	120	S.C. 30K8	25733.33	24666.67	543.03	597.04	195.73	188.40	3616.67	3450.00	4316.67	4116.67	3564.64	3395.56
		S.C. 2031	24000.00	23733.33	483.01	491.97	199.07	205.73	4433.33	4016.67	4050.00	4216.67	3089.95	3254.05
		S.C. 7071	23600.00	22933.33	536.87	548.77	169.53	182.73	4716.67	4383.33	3566.67	3683.33	3014.04	3058.41
	150	S.C. 30K8	26400.00	24933.33	591.30	643.99	210.67	196.07	3750.00	3516.67	4616.67	4233.33	3824.20	3501.41
		S.C. 2031	24400.00	24133.33	507.65	520.87	212.23	213.83	4583.33	4133.33	4383.33	4383.33	3369.84	3395.90
		S.C. 7071	26000.00	25466.67	379.60	339.05	111.53	103.70	4916.67	4850.00	2300.00	2200.00	1895.49	1760.66
	90	S.C. 30K8	27066.67	27333.33	424.68	433.33	138.73	129.30	3966.67	4016.67	3400.00	3200.00	2737.43	2542.66
		S.C. 2031	26000.00	25866.67	376.97	353.60	143.83	135.23	4800.00	4550.00	3250.00	3183.33	2418.50	2364.91
		S.C. 7071	26666.67	25733.33	404.08	364.75	123.17	113.23	5300.00	5000.00	2650.00	2533.33	2194.65	2036.81
28000	120	S.C. 30K8	27600.00	27466.67	445.34	482.74	149.30	144.30	4216.67	4200.00	3866.67	3600.00	3134.28	2887.03
		S.C. 2031	26400.00	26133.33	402.24	384.31	156.00	151.20	5050.00	4666.67	3666.67	3616.67	2750.79	2702.95
		S.C. 7071	26666.67	26133.33	422.53	385.20	130.47	124.10	5400.00	5083.33	2816.67	2716.67	2336.45	2192.53
	150	S.C. 30K8	27733.33	27866.67	479.91	512.38	162.73	158.73	4333.33	4350.00	4133.33	3900.00	3378.93	3142.18
		S.C. 2031	26933.33	26400.00	420.35	403.30	170.60	162.90	5183.33	4783.33	4050.00	3766.67	3041.85	2822.49
L.S.D at 5%			801.9	781.35	23.79	32.49	7.08	8.40	173.01	133.29	205.71	128.43	167.22	100.38

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استجابة هجن الذرة الشامية البيضاء للكثافات النباتية ومعدلات التسميد النيتروجيني

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قسم المحاصيل . كلية الزراعة . جامعة بنها . مصر

أجريت تجربتان حقليتان في مزرعة مركز البحوث والتجارب الزراعية بكلية الزراعة بمشتهر جامعة بنها (مركز طوخ ـ محافظة القليوبية ـ مصر) خلال الموسمين الصيفيين ٢٠١٦ و ٢٠١٧ لدراسة تأثير ثلاثة كثافات نباتية (٢٠٠٠٠ ، ٢٤٠٠٠ و ٢٨٠٠٠ نبات/فدان) وثلاثة معدلات من التسميد النيتروجيني (٩٠، ١٢٠ و ١٥٠ كجم نيتروجين/فدان) على صفات النمو الخضري، مكونات المحصول، المحصول وبعض الصفات الكيميائية لثلاثة هجن فردية للذرة الشامية البيضاء (الهجين الفردي ٧٠٧١، الهجين الفردي ٣٠ك٨ والهجين الفردي ٢٠٣١). ويمكن تلخيص أهم النتائج فيما يلي:ـ

أدت زيادة الكثافة النباتية من ٢٠ إلى ٢٨ ألف نبات /فدان إلى زيادة معنوية في متوسط قيم صفات عدد الأيام من الزراعة حتى ظهور ٥٠ % من النورات المذكرة والمؤنثة، دليل مساحة الأوراق، إرتفاع النبات (سم)، إرتفاع الكوز، عدد النباتات المذكرة/فدان، عدد الكيزان/فدان، محصول الحطب/فدان (كجم) والمحصول البيولوجي/فدان (كجم) بينما إنخفضت معنوياً متوسط قيم صفات عدد الأوراق الخضراء/نبات، مساحة أوراق النبات (سم^2)، عدد النباتات الحاملة لكوزين/فدان، عدد حبوب الكوز، وزن الكوز (جم)، نسبة التفريط (%)، وزن ١٠٠ حبة، محصول الكيزان/فدان (كجم)، محصول الحبوب/فدان (كجم)، دليل الحصاد (%)، النيتروجين الممتص/فدان (كجم) ومحصول البروتين/فدان (كجم) خلال موسمي الدراسة.

زادت معنوياً معظم صفات الذرة الشامية المدروسة بزيادة معدلات التسميد النيتروجيني من ٩٠ و ١٢٠ إلى ١٥٠ كجم نيتروجين/فدان ما عدا عدد الأيام من الزراعة حتى ظهور ٥٠ % من النورات المذكرة والمؤنثة وعدد النباتات المذكرة/فدان قلت معنوياً بزيادة التسميد النيتروجيني في كلا الموسمين. إضافة السماد النيتروجيني بمعدل ١٥٠ كجم نيتروجين/فدان أعطى معنوياً أفضل القيم في جميع الصفات المدروسة.

أوضحت النتائج أن الإختلافات بين الهجن الفردية البيضاء للذرة الشامية تحت الدراسة كانت معنوية في جميع الصفات المدروسة خلال موسمي الزراعة. تفوق الهجين الفردي ٣٠ك٨ على كل من الهجين الفردي ٧٠٧١ و الهجين الفردي ٢٠٣١ في قيم صفات عدد النباتات الحاملة لكوزين/فدان، عدد الكيزان/فدان، عدد حبوب الكوز، محصول الحبوب/فدان ودليل الحصاد وأيضا أعطى أقل قيم في صفة عدد النباتات المذكرة/فدان وأقصر فترة زمنية من الزراعة حتى ظهور ٥٠ % من النورات المذكرة والمؤنثة في كلا الموسمين. بينما سجل الهجين الفردي ٢٠٣١ أعلى متوسط للقيم في صفات مساحة أوراق النبات، دليل مساحة الأوراق، وزن الكوز (جم)، وزن ١٠٠ حبة، محصول الكيزان/فدان، المحصول البيولوجي/فدان، النيتروجين الممتص/فدان ومحصول البروتين/فدان في كلا الموسمين. أما الهجين الفردي ٧٠٧١ تفوق في متوسط قيم صفات عدد الأوراق الخضراء/نبات، إرتفاع النبات (سم)، إرتفاع الكوز، نسبة التفريط ومحصول الحطب/فدان خلال موسمي الزراعة.

التفاعلات من الدرجة الأولى (٢٠٠٠٠ نبات/فدان X ١٥٠ كجم نيتروجين/فدان)، (٢٤٠٠٠ نبات/فدان X الهجين الفردي ٣٠ك٨)، (٢٠٠٠٠ نبات/فدان X الهجين الفردي ٢٠٣١) و(١٥٠ كجم نيتروجين/فدان X الهجين الفردي ٣٠ك٨) والتفاعلات من الدرجة الثانية (٢٤٠٠٠ نبات/فدان X ١٥٠ كجم نيتروجين/فدان X الهجين الفردي ٣٠ك٨) و(٢٠٠٠٠ نبات/فدان X ١٥٠ كجم نيتروجين/فدان X الهجين الفردي ٢٠٣١) حققت معنويا أعلى محصول حبوب مقارنة بالمعاملات الأخري في كلا الموسمين.

توصي النتائج بأن أفضل كثافة نباتية عند زراعة الهجين الفردي ٣٠ك٨ هي ٢٤٠٠٠ نبات/فدان بينما عند زراعة كل من الهجين الفردي ٢٠٣١ أو ٧٠٧١ تكون ٢٠٠٠٠ نبات/فدات مع التسميد بـ ١٥٠ كجم نيتروجين/فدان حيث عظمت إنتاجية محصول الحبوب بوحدة المساحة.