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RESPONSE OF SOME MAIZE HYBRIDS TO NITROGEN FERTILIZER SPLITTING UNDER DRIP IRRIGATION SYSTEM IN SANDY SOILS

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ABSTRACT: Two field experiments were carried out during two successive seasons (2001 and 2002) at the Experimental farm, Faculty of Agriculture, Zagazig University at Khattara, Sharkia Governorate, Egypt, to study the response of five maize hybrids (S.C. 10, S.C. 123, S.C. 124, S.C. 129 and T.W.C. 310) to four N splitting treatments (4 equal doses at planting, 20, 40 and 60 days after planting (T_1), 3 equal doses missing the 20 DAP N addition (T_2), 3 equal doses missing the 40 DAP N addition (T_3) and 3 equal doses missing the 60 DAP N addition (T_4))

Significant varietal differences could be detected in almost all growth and yield attributes where S.C. 10 outyielded the tested crosses in plant height, main ear leaf area and its content from chlorophyll, number and weight of grains/ear and hence grain yield/fad. The T.W.C. 310 hybrid had longer and thicker ears with heavier 100-grain weight and higher oil yield/fad. than the other tested hybrids but without superiority in grain yield/fad. No significant differences could be detected in each of number of ears/plant, number of rows/ear, grain protein and oil contents and protein yield/fad in both seasons.

Addition of N in four equal splits improved maize growth and grain yield and all of their attributes, as well as, protein and oil yields/fad. Missing one N addition at either 20 DAP or 40 DAP reduced growth, grain yield and protein and oil yields of maize, where the lowest averages were recorded for missing, in particular, the 20 DAP N addition. No significant differences could be detected in either grain protein content or grain oil content due to varying splitting number or pattern.

INTRODUCTION

Maize is the third most worldwide cultivated crop after wheat and rice (Eagles and Lothrop, 1994). In Egypt, it occupies the second rank after wheat, as far as, the cultivated area. However, the production still does not meet consumption, due to the ever-growing population and as well the recent use of maize grain in mixing with wheat flour. In the last decade, rice became the most competitive crop to maize during summer. Due to the higher profit obtained from growing rice, the maize cultivated area showed gradual decrease from about 1.9 million faddan in 1980 to about 1.65 million faddan in 1999 (Anonymous, 2000). Therefore, efforts devoted to increase the per unit area productivity, through the use of single, double and three way crosses, failed to fill the gap between production and consumption and hence efforts should concentrate on extension the maize cultivated area outside the Valley where soils are sandy.

Maize could be grown successfully, under sandy soil conditions, if high yielding hybrids are used and proper agronomic practices are adopted. Since these soils are very poor in its soil fertility level from all plant nutrients and in particular nitrogen, this investigation aimed at studying the effect of splitting a previously defined dose of N (120 Kg N/fad) in three or four splits given since the time of planting up to silking in different patterns of addition under a drip irrigation system.

Previous studies showed significant differences in growth and yield attributes among maize hybrids. Single crosses were found to have better growth attributes than double or three way crosses (Ragheb *et al.*, 1993 ; Abd El-Haleem, 1994 ; Basha, 1994 ; Hassan, 1995 ; El-sheikh 1998 ; Mabrouk and Aly, 1998; Zaki *et al.*, 1999 and El-Bana, 2001). As far as, plant height is concerned, Hassan (1995), Atta Allah (1998) and El-Sheikh (1998) found that S.C.10 had taller plants than T.W.C. 310, D.C. 204 and D.C. Taba. The former and T.W.C 310 had also greater ear leaf area and LAI than D.C. 204 or Giza 2 (Atta Allah, 1996 and El-Sheikh, 1998). These better growth attributes were reflected in yield attributes where El-Bana (2000) observed that single cross 10 outyielded the other hybrids (S.C. 122, S.C. 123, S.C. 124, S.C. 129 and S.C. 13) as it had better yield components. In later study, El-Bana (2001) revealed that S.C.10 had better yield attributes especially number of grains/row and ear grain weight compared with T.W.C. 310. Also, Graish *et al.*, (2001) found varietal differences between S.C. Sultan and both of S.C. 124 and S.C. 155 where the latters outyielded Sultan by 19.2% and 14.4% for grain yield /fad, in respective order.

Not only the nitrogen rate, but also the time of N application are considered among the important agricultural practices used to increase maize productivity. With respect to time of N application, Gouda (1989) found that splitting N into three equal splits given before planting and before the first two irrigations increased grain yield of maize and almost all of its components. However, Shalaby *et al.*, (1990) got the highest grain yield from maize when they added N in two equal doses given before the first two irrigations or three splits given partially before planting and the first three irrigations. Similar results were reported by Basha (1994) when he added N to maize in three equal doses given before planting and the first two irrigations where this addition increased each of leaf area, No. of grains /row and /ear, ear length, ear diameter, No. of rows/ear, grain ear weight, 100-grain weight and grain yield/fad. Under sandy soil condition, El-Bana and Gomaa (1994) obtained the highest averages of each of ear length, ear diameter, number of grains/row, grain weight / ear and grain yield/fad. when they added N in four equal doses given at planting, 25, 40 and 55 days after planting. However, Mahgoub *et al.*, (1994) reported that application N in three equal splits given at planting and before 1st and 3rd irrigations significantly increased grain yield. Zeidan *et al.*, (1998) noticed that application of N at (1/3 at the, 1st irrigation + 1/3 at the 2nd irrigation + 1/3 at the 3rd irrigation) or as (1/4 at planting + ¼ at the 1st irrigation + ¼ at the 2nd irrigation + ¼ at the 3rd irrigation) significantly decreased 100-kernel weight, but increased grain oil content %, whereas grain yield/fad. and its attributes were not affected by either of these treatments.

This study was conduced in order to determine the effect of time of nitrogen application on growth, yield and its attributes and quality of five maize hybrids under sandy soil conditions.

MATERIALS AND METHODS

Two field experiments were conducted in the Experimental farm, Faculty of Agriculture Zagazig University at Khattara, Sharkia Governorate, Egypt for two successive seasons (2001 and 2002). The soil was sandy in texture with a pH average of 7.80 and organic matter of 0.50%. The available N, P and K contents of the upper 30cm soil depth were 12.1, 2.99 and 49.1 PPm, respectively. Maize was preceded by safflower in both seasons. A split plot design with three replicates was used where the main plots were occupied by five maize hybrids, whereas four patterns of N splitting were arranged at random in the sub plots. The tested maize varieties were as follows:

1- Single cross 10 (S.C.10)
2- Single cross 123 (S.C.123)
3- Single cross 124 (S.C.124)
4- Single cross 129 (S.C.129)

5- Triple cross 310 (T.W.C. 310)

Nitrogen was soil added at the level of 120 kg N / fad. in the form of ammonium sulfate (20.5%) around the drip line as follows:

T_1 = ¼ at planting + ¼ at 20 days after planting (DAP) + ¼ at 40 DAP + ¼ at 60 DAP.

T_2 = 1/3 at planting + 1/3 at 40 DAP + 1/3 at 60 DAP.

T_3 = 1/3 at planting + 1/3 at 20 DAP + 1/3 at 40 DAP.

T_4 = 1/3 at planting + 1/3 at 20 DAP + 1/3 at 60 DAP.

The plot ($16.8m^2$) included 6 rows of 4 m long and 70 cm apart. Maize was sown in June 2nd and June 4th in first and second seasons, respectively in hills 25 cm apart. Twenty days after planting, thinning to one plant/hill was made. Phosphorus as superphosphate (15.5% P_2O_5) and potassium as potassium sulphate (48% k_2O) were added at levels of 31kg P_2O_5 and 48 kg k_2O/ fad, respectively. These levels were fertigated at planting, 7, 14 and 21 DAP. Experimental fields were drip irrigated using ground water three and two times weekly before and after silking, respectively. The other cultural treatments of growing maize were followed. Maize was harvested on the last week of September in both seasons.

At 75 days after planting, a random sample of ten plants were taken from the 2nd row where the following growth attributes were determined: plant height, LAI, No. of leaves/plant and main ear leaf area. Leaf area was determined using the following formula according to Ibrahim and Abd El-Maksoud (2001):

Leaf blade area = Blade maximum width x blade length x 0.75. Chlorophyll content of the 1st ear leaf was determined using chlorophyll meter (SPAD – 502, soil – plant analysis Development (SPAD) section Minolta Camera Co., Oska, Japan) according to Castelli *et al.*, (1996).

At harvest, ear number /plant and grain yield ardab/fad. were determined from the inner three rows and adjusted to 15.5% moisture (one ardab = 140 kg). A random sample of 15 ears from each plot was taken where the following characters were recorded: ear length, ear diameter, number of rows/ear, number of grains/row, number of grains/ear, 100-grain weight and grain weight /ear. To determine crude protein and oil contents, samples of dried grains were ground to fine powder and N content was determined using the modified micro - Kijeldahl apparatus as described by A.O.A.C (1980). The obtained values were multiplied by 6.25 to calculate crude protein percentage. Oil content was extracted by Diethyl ether in a soxhlet apparatus according to A.O.A.C (1980).

Analysis of variance and combined analysis for the two seasons were carried out as described by Snedecor and Cochran (1981). For comparison between means, Duncan's multiple range test was applied (Duncan, 1955). In interaction tables, capital and small letters were used to compare both rows and columns averages, respectively.

RESULTS AND DISCUSSION

A- Growth attributes:

A-1-cultivar differences:

Results in Table (1) show significant differences among maize cvs, as far as plant height, main ear leaf chlorophyll and area, as well as LAI at 75 days after planting (DAP). In both seasons, S.C. 10 had the tallest plants whereas S.C. 124 had the shortest ones. The other cultivars had in between averages. The former cultivar had also higher main ear leaf chlorophyll content than the rest of cultivars which had at par lower averages. Regarding main ear leaf area and LAI, S.C.10 again had the heighest averages whereas T.W.C. 310 had the lowest ones. The other three single crosses i.e. 123, 124 and 129 had in between at par averages.

These data ascertain the superiority of S.C. 10 in plant height as reported by Hassan (1995) and Atta Allah (1998) and in LAI as reported by Atta Allah (1996) and EL-Sheikh (1998).

The higher main ear leaf chlorophyll content and as well the higher main ear leaf area and LAI recorded by S.C. 10 refer to a superiority in aspects of photosynthesis by this cultivar and hence a greater capacity in dry mater production than the rest of the tested cultivar.

A-2. Nitrogen splitting effect:

It is quite clear from Table (1) that the different splitting treatments had significant effects on each of maize growth attributes. Regarding plant height, addition of N in four equal splits since the time of planting and in 20 days intervals up to 60 DAP produced the tallest plants whereas its addition in three equal splits given at planting, 40 and 60 DAP gave the shortest ones as observed in the 2nd season and ascertained by the combined analysis. Splitting of N in three equal splits as in T_3, T_4 give plants with intermediate plant height averages.

These results indicate clearly that missing the addition of N at 20 DAP as in T_2 retarded the early growth of maize plants, as its addition in four doses as in T_1 or in three splits as in T_3 and T_4 afforded plants an early improved growth as expressed herein in longer plants. The data further indicate that addition of three

Table (1) : Plant height, main ear leaf chlorophyll content, main ear leaf area and leaf area index as affected by cultivars and different N splitting treatments in the two seasons and their combined.

Main effects and interaction	Plant height (cm)			Main ear leaf chlorophyll content ♦			Main ear leaf area (cm^2)			Leaf area index (LAI)		
	2001	2002	Combined	2001	2002	Combined	2001	2002	Combined	2001	2002	Combined
Cultivars (C)												
S.C. 10	251.5a	265.8a	258.7a	40.83a	44.93a	42.87a	657.0a	737.5a	697.2a	4.880a	5.057a	4.968a
S.C. 123	238.2b	247.1b	242.7b	36.83b	40.41b	38.62b	608.5b	700.8b	654.7b	4.172b	4.805b	4.489b
S.C. 124	221.0c	238.7c	229.8c	36.83b	40.35b	38.59b	608.0b	701.7b	654.9b	4.169b	4.811b	4.490b
S.C. 129	238.0b	246.6b	242.3b	36.38b	40.07b	38.23b	604.9b	701.9b	653.4b	4.148b	4.813b	4.480b
T.W.C. 310	239.9b	246.2b	243.0b	36.51b	40.40b	38.45b	545.7c	694.9b	620.3c	3.795c	4.765b	4.280c
F. test	*	*	*	*	*	*	**	**	**	*	*	*
N splitting treatments (N):												
T1	245.9a	256.5a	251.2a	38.85a	43.50a	41.17a	633.4a	736.0a	684.7a	4.436a	5.046a	4.741a
T2	234.3b	243.1c	238.7c	35.46c	38.85d	37.15d	580.5c	687.3c	633.9d	4.064d	4.713c	4.389d
T3	234.8b	248.6b	241.7b	38.24a	42.02b	40.13b	603.8b	711.5b	657.6b	4.242b	4.878b	4.560b
T4	235.9b	247.3b	241.6b	37.35b	40.55c	38.95c	601.6b	694.7c	648.1c	4.189c	4.763c	4.476c
F. test	**	**	**	**	**	**	**	**	**	**	**	**
Interaction :												
CXN	N.S	N.S	N.S	N.S	N.S	N.S	**	**	**	N.S	N.S	N.S

♦ Determined using chlorophyll meter (SPAD).

*, ** and N.S indicate significant at 0.05, 0.01 and insignificant, respectively.

splits of N was less efficient than its addition in four splits. Since the soil of experimental site was sandy, leaching losses might have been greater when N was given in three splits of 40 kg N each compared with its addition in four doses of 30 kg N each.

Concerning the effect of splitting of N on the main ear leaf chlorophyll content, it is evident from Table (1) that addition of N in four equal doses was effective to increase this content compared with the other splitting treatments where the combined analysis shows that the lowest content was produced by addition of N in three equal splits as in T_2. This was also true regarding main ear leaf area and LAI.

These data are quite interesting as they indicate that maize plants with higher main ear leaf chlorophyll content and area as well as higher LAI could have better photosynthesis and hence more photoassimilates were available for growth which was expressed in more elongation by these plants and hence they had taller plants than the other splitting treatments and in particular T_2 which had the shortest plants and lowest averages from all the growth attributes tabulated in Table (1). Similar results were obtained by Basha (1994) and EL-Bana and Gomaa (1994) as they reported the importance of N application prior to maize tasseling.

A-3- Interaction effect:

No significant varietal response could be detected to affect all growth attributes except main ear leaf area in the two seasons and their combined.

It is evident that the five hybrids under study recorded the highest main ear leaf area averages when they received N in fours splits. This effect was more pronounced on S.C. 10 than the rest of the tested cultivars (Table 1a).

Table (1-a): Main ear leaf area (cm^2) as affected by the interaction between maize cultivars and N splitting treatments (combined data).

N splitting treatments	Cultivars				
	S.C. 10	S.C. 123	S.C. 124	S.C. 129	T.W.C. 310
T_1	A 762.8a	B 675.3a	B 674.2a	B 672.3a	C 638.9a
T_2	A 661.0d	B 632.8c	B 633.7c	B 633.6c	C 608.5b
T_3	A 691.0b	B 660.2b	B 660.3b	B 660.6a	C 616.1b
T_4	A 674.2c	B 650.4b	B 651.3b	B 647.1b	C 617.9b

B- Ear number / plant and ear length and diameter:

B-1- Cultivar differences:

Data in Table (2) show the number of ears / plant, as well as, ear length and diameter. No significant differences could be detected in the ear number / plant among the tested maize cvs in the two seasons and their combined. All hybrids had mostly one main ear. However significant differences could be detected in both ear length and diameter in the two seasons and their combined where S.C. 10 had longer ears than the rest of hybrids which had at par ear length. Regarding ear diameter significant differences were, also, observed among the tested hybrids where T.W.C. 310 followed by S.C.10, with significant differences, had greater ear diameter than the other three single crosses which had at par lower averages.

In the literature several workers reported significant differences among maize hybrids regarding ear length (Ragheb *et al.*, 1993 and EL-Bana, 2000 and ear diameter (Abd EL-Haleem, 1994) and hence are in harmony with the present findings except those of the number of ears/plant where EL-Bana (2001) reported significant varietal differences between two maize hybrids.

B.2- Nitrogen splitting effect:

It is evident from Table (2) that the different splitting treatments were without significant effect on the number of ears / plant but had significant effects on ear length and diameter. In both seasons, giving N in four equal splits produced the longest ears with the widest diameter compared with the other splitting treatments. Also splitting N in three equal splits as in T_2 gave the shortest and the narrowest ears among the other splitting treatments.

These results are rather expected as giving N in four splits improved plant growth as shown in Table (1) regarding plant height, main ear leaf chlorophyll content and area and in turn more assimilates were available for improving ear length and diameter but were without influence on ear number /plant. These data are in accordance with those reported by Gouda (1989), Shalaby *et al.*, (1990) and Basha (1994).

B-3- Interaction effect:

The interaction between cultivars and the different N splitting treatments did not affect significantly either the number of ears / plant or ear length and diameter.

C- Grain weight / ear and its attributes:

C-1 Cultivar differences:

It is evident from Table (3) that cultivars under study varied

Table (2) : Ear number / plant, ear length and ear diameter as affected by cultivars and different N splitting treatments in the two seasons and their combined.

Main effects and interaction	Ear number / plant			Ear length (cm)			Ear diameter (cm)		
	2001	2002	Combined	2001	2002	Combined	2001	2002	Combined
Cultivars (C)									
S.C. 10	1.016	1.023	1.020	18.00a	19.19a	18.60a	4.250b	4.267b	4.259b
S.C. 123	1.002	1.001	1.002	16.56b	16.94b	16.75b	4.162c	4.176bc	4.169c
S.C. 124	0.999	0.999	0.999	16.02b	17.40b	16.71b	4.164c	4.170bc	4.167c
S.C. 129	0.999	0.999	0.999	16.11b	17.27b	16.69b	4.146c	4.155c	4.150c
T.W.C. 310	1.002	1.006	1.004	16.05b	16.28b	16.17b	4.327a	4.376a	4.351a
F. test	N.S	N.S	N.S	*	*	*	*	*	*
N splitting treatments (N):									
T1	1.011	1.015	1.013	18.08a	18.87a	18.48a	4.292a	4.321a	4.306a
T2	0.997	0.999	0.998	15.50b	16.31c	15.91c	4.126d	4.140c	4.133d
T3	1.006	1.007	1.006	16.43b	17.51b	16.97b	4.257b	4.279b	4.268b
T4	1.000	1.002	1.001	16.18b	16.98bc	16.58b	4.163c	4.175c	4.169c
F. test	N.S	N.S	N.S	*	**	**	*	*	**
Interaction :									
CXN	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

*, ** and N.S indicate significant at 0.05, 0.01 and insignificant, respectively.

Table (3) : Row number /ear, grain number and weight/ear and 100-grain weight as affected by cultivars and different N splitting treatments in the two seasons and their combined.

Main effects and interaction	Row number/ear			Grain number / ear			100-grain weight (gm)			Grain weight (gm)/ear		
	2001	2002	Combined	2001	2002	Combined	2001	2002	Combined	2001	2002	Combined
Cultivars (C)												
S.C. 10	11.42	11.47	11.45b	434.2a	480.4a	457.3a	29.58b	30.44b	30.01b	128.9a	147.8a	138.4a
S.C. 123	11.49	11.40	11.45b	424.8b	465.4b	445.1b	27.68c	27.75c	27.72c	118.4b	131.4b	124.9b
S.C. 124	11.44	11.74	11.59b	422.0b	465.7b	443.9b	27.56c	28.56c	28.06c	118.1b	131.6b	124.9b
S.C. 129	11.25	11.73	11.49b	411.8c	454.5c	433.2c	27.08c	28.41c	27.75c	111.0c	127.0c	119.0c
T.W.C. 310	12.30	12.70	12.50a	371.5d	411.3d	391.4d	30.79a	32.06a	31.43a	110.8c	129.2c	120.0c
F. test	N.S	N.S	*	**	**	**	*	*	*	**	**	**
N splitting treatments (N):												
T1	11.43	11.71	11.57	423.7a	463.2a	443.5a	29.70	30.67	30.18	120.2a	140.2a	130.2a
T2	11.56	11.81	11.68	403.3c	451.5c	427.4d	26.80	27.74	27.27	111.8b	126.2c	119.0c
T3	11.72	11.92	11.82	413.2b	456.3b	434.7b	29.42	30.06	29.74	119.1a	137.2a	128.2a
T4	11.62	11.79	11.70	411.3b	450.8c	431.0c	28.25	29.31	28.78	118.7a	130.0b	124.4b
F. test	N.S	N.S	N.S	**	**	**	N.S	N.S	N.S	**	**	**
Interaction :												
CXN	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	*	N.S	N.S

*, ** and N.S indicate significant at 0.05, 0.01 and insignificant, respectively.

significantly regarding grain number / ear, 100-grain and grain weight / ear. However row number /ear did not vary significantly among cultivars in the two seasons though the combined analysis detected significant differences in favour of T.W.C 310 where the rest of cultivars had at par averages. Regarding grain number / ear, S.C. 10 had the largest number whereas T. W.C. 310 had the smallest one. The rest two of the other three single cross (S.C 123 , S.C 124) had a second rank in this respect whereas the third one (S.C. 129) had a third rank. This was not true regarding the test weight where T.W.C. 310 had the heaviest 100-grain weight followed by S.C. 10 with significant differences and the other three single cross (S.C. 123 S.C. 124, S.C. 129) had at par intermediate averages. Therefore significant differences could be detected in grain weight/ear among the tested cvs where S.C. 10 had the hightest weight whereas T.W.C 310 and S.C 129 had at par the lowest averages whereas S.C. 123, S.C 124 had intermediate averages.

It seems evident that the superiority of S.C. 10 in grain weight/ear could be attributed to its superiority in grain number /ear. The superiority of T.W.C 310 in either row number /ear (combined) or the test weight in the two seasons was not reflected in grain weight /ear. These results are in harmony with those obtained by Basha (1994), EL – Bana (2000) and EL-Bana (2001).

C.2- Nitrogen splitting effect:

The different N splitting treatments affected significantly grain number/ear and hence grain weight /ear but were without significant effect on either number of rows/ear or the test weight. It is evident from Table (3) that addition of N in four splits increased grain number and weight/ear compared with the other treatments where the lowest averages were recorded by T_2 which received three N splits without N addition at 20 DAP.

These results followed the same trend of growth attributes (Table 1) and also both of ear length and diameter (Table 2) where splitting of N in four equal splits recorded the highest averages and its splitting as in T2 recorded the lowest ones.

These data are interesting as they show that improvement of maize plant growth due to splitting of N in four equal splits since, the time of planting up to 60 DAP, which coincides with silking, could afford these plants their N requirements throughout the most active growth and yield determining period. Duncan (1978) indicated that row number/ear and hence grain number/ear are defined during the two weeks prior and post silking. These results are in accordance with those reported by Gouda (1989), Shalaby *et al.*, (1990), EL-Bana and Gomaa (1994) and Mahgoub *et al.*, (1994). They reported that splitting N increased significantly grain yield and some yield attributes. But these results are not in agreement with those obtained by Zeidan *et al.*, (1998) who reported that grain yield/fad and its attributes were not affected by time of N application under clay soil conditions.

C.3-Interaction effect:

No significant interaction effect could be detected in all yield attributes except grain weight/ear in the first season.

It is obvious from (Table 3-a) that S.C.10 was more sensitive than the rest of the tested cultivars, to varying the number of N splits, this was observed also, in the main ear leaf area (Table 1-a).

Table (3-a): Grain weight / ear (gm) as affected by the interaction between maize cultivars and N splitting treatments (first season).

N splitting treatments	Cultivars				
	S.C. 10	S.C. 123	S.C. 124	S.C. 129	T.W.C. 310
T_1	A 132.1a	B 119.8ab	B 119.4ab	C 114.9a	C 114.9a
T_2	A 123.9c	B 115.4c	B 115.5c	C 102.4c	C 101.8b
T_3	A 129.5b	B 120.1a	B 119.8a	C 113.7ab	C 112.1a
T_4	A 130.1b	B 118.5b	B 117.8b	C 112.9b	C 114.4a

D.Grain yield /fad.

D.1- Cultivar differences:

It is evident from Table (4) that hybrids under study differed significantly regarding grain yield/fad in both seasons and their combined where S.C. 10 recorded the highest average where S.C. 129 and T.W.C. 310 recorded at par the lowest ones. The other two single crosses i.e S.C. 123, S.C. 124 had at par intermediate averages. It seems evident that superiority of S.C. 10 in grain yield/fad could be attributed to its superiority in grain weight/ ear (Table 3). These data ascertain the superiority of S.C 10 in grain yield /fad as reported by EL-Bana (2000) and EL-Bana (2001). Also, Graish *et al.*, (2001) found S.C. 124 and S.C.

Table (4) : Grain yield (ardab/fad), grain protein and oil content (%) and protein and oil yields (kg/fad) as affected by cultivars and different N splitting treatments in the two seasons and their combined.

Main effects and interaction	Grain yield (ardab/fad)			Grain protein content (%)			Grain oil content (%)			Protein yield (kg/fad)			Oil yield (kg/fad)		
	2001	2002	Comb.	2001	2002	Comb.	2001	2002	Comb.	2001	2002	Comb.	2001	2002	Comb.
Cultivars (C)															
S.C. 10	17.41a	18.99a	18.20a	7.721	7.110	7.415	3.025	2.935	2.980	188.2	189.0	188.6	73.64bc	77.96b	75.80c
S.C. 123	16.49b	18.05b	17.27b	7.787	7.686	7.736	3.124	3.212	3.168	179.7	194.2	186.9	71.94c	81.01b	76.48c
S.C. 124	16.47b	18.02b	17.25b	7.789	7.700	7.745	3.486	3.235	3.361	179.5	194.3	186.9	79.97b	81.48b	80.73b
S.C. 129	15.20c	16.23c	15.71c	8.952	8.288	8.620	4.466	4.217	4.342	190.4	188.2	189.3	94.89a	95.16a	95.02a
T.W.C. 310	15.21c	16.29c	15.75c	8.957	8.307	8.632	4.387	4.166	4.276	190.6	189.5	190.1	93.29a	94.63a	93.96a
F. test	**	**	**	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	*	*	*
N splitting treatments (N):															
T1	16.89a	18.73a	17.80a	8.236	7.831	8.034	3.436	3.320	3.378	193.8a	204.5a	199.2a	80.37c	86.09a	83.23b
T2	15.29c	16.93c	16.11c	8.283	7.771	8.027	3.933	3.781	3.857	176.8d	183.4c	180.1c	83.59b	88.73a	86.16a
T3	16.50a	17.61b	17.05b	8.205	7.837	8.021	3.409	3.319	3.364	188.7b	192.6b	190.6b	78.08c	81.22b	79.65c
T4	15.95b	16.81c	16.38c	8.241	7.835	8.038	4.013	3.792	3.903	183.4c	183.7c	183.5c	88.94a	88.14a	88.54a
F. test	**	**	**	N.S	N.S	N.S	N.S	N.S	N.S	*	*	*	*	*	*
Interaction :															
CXN	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

*, ** and N.S indicate significant at 0.05, 0.01 and insignificant, respectively.

155 outyielded S.C. Sultan by 19.2% and 14.4% for grain yield/fad, in respective order.

D.2- Nitrogen splitting effect:

In both seasons and their combined, grain yield/fad was significantly affected by varying N splitting treatments where addition of N in four equal splits recorded the highest yield whereas its addition in three splits as in either T_2 or T_4 recorded the lowest averages (Table 4).

These data clearly indicate that missing the addition of N either at 20 DAP as in T_2 or missing its addition at 40 DAP as in T_4 caused significant reduction in grain yield compared with its addition in three splits as in T_3 where 1/3 of N was given at planting, 20 DAP and 40 DAP. The data further indicate that the best of these treatments was as in T_1 where four equal splits were given since time of planting and up to 60 DAP.

According to these data and under sandy soil conditions N should be applied since the time of planting up to 60 DAP as missing one of these splits particularly at 20 DAP caused significant reduction in grain yield and almost all growth and yield attributes. These results strengthen the importance of providing maize plants with N at 20 DAP and also at 40 DAP which seemed to be the most critical period for N as missing its addition during either of these periods was followed by noticeable reduction in grain yield and its attributes.

The soil of the experimental field was sandy and of a very low content from organic matter and all plant nutrients and in particular N. Addition of N at time of planting was indispensable to activate maize root growth, and hence plants were in need for a further addition at 20 DAP to improve shoot growth. These plants with their improved root and shoot growth, were in need for a third N addition at 40 DAP where the number of rows per ear was about to be defined two weeks before silking (Hanway, 1962). Comparison of the three N splitting treatments where three split were given, showed that the best of them was the T_4 where N was added at planting, 20 DAP and 40 DAP. Missing the 60 DAP (T_3) was not as detrimental as its missing at 20 DAP (T_2) indicates that maize plants were in more bad need for N at early than late vegetative growth stages. Under sandy soil conditions, root ramification, as induced herein by the 20 DAP N addition, afforded maize plants more efficient use of added N and as well all plant nutrients in addition to more efficient use of water. Certainly four splits were superior to any of the three N splitting treatments as the 4^{th} addition at 60 DAP (T_1) covered N requirements during the period where the number of grains/row and the grain sink size are determined (Duncan, 1978).

These results are in harmony with those obtained by Basha (1994) and El Bana and Gomaa (1994).

E- Grain quality:

E-1- Cultivar differences:

It is evident from Table (4) that maize hybrids did not vary significantly, as far as, their grain contents from protein or oil, as well as, protein yield /fad. However, significant differences could be detected in oil yield/fad. It was evident that both the T.W.C. 310 and S.C. 129 had at par higher oil yields/fad than the rest of tested hybrids where S.C.10 and S.C. 123 recorded the lowest oil yield averages. This was true in the two seasons and their combined.

These data indicate that though differences in grain protein contents did not reach the level of significance, however, a dilution effect took place in this content. The insignificancy of differences in protein yield/fad among the studied hybrids strengthens this views as it was expected that S.C.10 which recorded the highest grain yield /fad should have had produced the highest protein yield/ fad. This dilution effect was more obvious in grain oil content where S.C.10 had grains with the lowest oil content and hence had the lowest oil yield /fad. among the tested hybrids.

E.2- Nitrogen splitting effect:

Addition of nitrogen either in four or three splits did not affect the grain content from either protein or oil (Table 4). However, both the protein and oil yields were significantly affected by N splitting treatments. Addition of N in four splits produced the highest protein yield /fad whereas its addition in three splits as in T_4, where the last N split was missed, produced the highest oil yield /fad. These results clear that protein accumulation in maize grain was to a certain extent on the expense of oil accumulation. The data further indicate that addition of N in four splits produced the highest grain yield / fad. and in turn the highest protein yield. This indicates that starch deposition in maize grain was in favour of protein accumulation but on the other hand was against oil accumulation.

REFERENCES

Abd El-Haleem, A.K (1994): Growth and yield response of some maize cultivars to irrigation intervals. Egypt. J. Appl. Sci. 9 (11) : 1-16.

Anonymous (2000): Second Annual Maize workshop. A. R. C. Giza. April, 2000.

Atta Allah, S.A. (1996); Effect of irrigation intervals and plant densities on growth, yield and its components of some maize Varieties. Proc. 7th Conf. Agron., Mansoura Univ. 1 : 59-70.

Atta-Allah, S.A.A. (1998): Response of maize to nitrogen and biofertilizer. Assiut J. of Agric. Sci., 29 (1) : 59-73.

A. O. A. C. (1980): Association of Official agricultural Chemical : Official Methods of Analysis. 13th Ed. Washington, D.C.

Basha, H.A. (1994): Effect of nitrogen fertilizer application time on growth and yield of some maize Varieties. Zagazig J. Agric. Res. 21 (2) : 329-344.

Castelli, F. ; R. Contillo and F. Miceli (1996): Non-destructive determination of leaf chlorophyll content in four crop species. J. Agronomy and Crop Science 188, 275-283.

Duncan, B.D (1955): Multiple range and Multiple F. Tests. Biometrics, 11 : 1-24.

Duncan, D.B. (1978): Maize Crop Physiology "some case histories". By L. T. Evans. Cambridge Univ. Press : 23-49.

Eagles, H.A. and J.E. Lothrop (1994) : Highland maize from central Mexico – its origin, characteristics, and Use in breeding programs. Crop Sci. 34 : 11-19

EL- Bana ; A.Y and M.A Gomaa (1994) : Response of maize to time of nitrogen application and some micronutrients under Sandy soils conditions. Zagazig J. Agric. Res. 21 (4) : 1029-1040.

EL- Bana, A.Y. (2000) : Response of some single cross hybrids to planting density under drip irrigation conditions in newly cultivated lands. Egypt. J. Appl. Sci. 15 (4) 102-117.

EL- Bana, A.Y.A. (2001) : Effect of nitrogen fertilization and stripping leaves on yield and yield attributes of two maize hybrids. Zagazig J. Agric. Res. , 28 (3) : 579-596.

EL-sheikh, F.T.Z. (1998) : Effect of soil application of nitrogen and foliar application with manganese on grain yield and quality of maize (*Zea Mays*, L.) Proc. 8th Conf. Agron., Suez. Canal Univ., Ismailia, Egypt, 28-29 Nov. : 182-189.

Gouda, A.S. (1989) : Agronomic studies on maize. Ph. D. Thesis. Fac. Agric., Zagazig Univ., Egypt.

Graish, M.H. ; K.I. Khalifa and G.M. Yakout (2001) : Yield and growth characters of some maize hybrids as affected by nitrogen fertilization and row spacing Under drip irrigation system in sandy soil. Egypt. J. Appl. Sci. ; 16 (5) : 136-150.

Hanway, J.J. (1962) : Corn growth and composition in relation to soil fertility : II. Uptake of N, P, and K and their distribution in different plant parts during the growing season, Agron. J. 54 : 217-222.

Hassan, A.A. (1995): Agronomic characteristics of eight maize varieties as affected by nitrogen fertilization 1-plant characteristics. Zagazig J. Agric. Res. 22 (2) : 377-385.

Ibrahim, A.A. and M.F.Abd El-Maksoud (2001): Leaf defoliation and hill spacing effects on maize productivity. Zagazig J. Agric. Res. 28(2): 261-274.

Mabrouk, S.S. and A.A.Aly (1998): Maize growth and production on a sandy soil treated with organic and mineral N sources. Proc. 8th conf. Agron., Suez canal Univ., Ismailia, Egypt, 28-29 Nov. : 222-229.

Mahgoub, G.M. ; M.A. Younis and M.A. Younis (1994) Effect of nitrogen sources and time of nitrogen application on maize growth and grain yield. Zagazig J. Agric. Res. 21 (5) : 1399-1409.

Ragheb, M.M.A. ; Beddeer, A.A. and Gouda, A. Sh. A. (1993): Effect of row spacing and plant population density on grain yield of some maize hybrids. Zagazig J. Agric. Res. 20 (2) : 581-594.

Shalaby, M.A. ; S.E.Matta ; E.A. Khedr and B.N. Ayad (1990) Effect of time of nitrogen fertilizer application on the performance of some maize varieties. Egypt. J. Appl. Sci., 5 (8) : 508-518.

Snedecor, G.W. and W.G. Cochran (1981) Statistical methods applied to experiments in agriculture and biology 7th Ed. Lowa state, Univ. Press, Ames., Lowa, U.S.A.

Zaki, Nabila, M. ; M.M. El-Gazzar ; Karima M. Gamal and M.M. Ahmed (1999): Partition and migration of photosynthates in some maize hybrids. Egypt. J. Appl. Sci. 14 (6) : 117-139.

Zeidan, E.M. ; R.M. Aly ; H.A. Basha and I.M. Abd El-Hameed (1998): Effect of nitrogen and farm yard manure fertilization on yield attributes, yield and quality of maize. Proc. 8th Conf. Agron., Suez Canal Univ., Ismailia, Egypt, 28-29 Nov. : 211-221.

استجابة بعض هجن الذرة الشامية لتجزئ السماد الأزوتى تحت نظام الرى بالتنقيط فى الأراضى الرملية

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أجريت هذه الدراسة بمزرعة كلية الزراعة بالخطارة – جامعة الزقازيق – محافظة الشرقية خلال موسمى ٢٠٠١ ، ٢٠٠٢ وذلك لدراسة استجابة بعض هجن الذرة الشامية (هجين فردى ١٠ ، هجين فردى ١٢٣ ، هجين فردى ١٢٤ ، هجين فردى ١٢٩ وهجين ثلاثى ٣١٠) لتجزئ إضافة السماد الأزوتى بمعدل ١٢٠ كجم ن / فدان كالتالى :

المعاملة الأولى : ٤ دفعات متساوية عند الزراعة و ٢٠ و ٤٠ و ٦٠ يوم من الزراعة .

المعاملة الثانية : ٣ دفعات متساوية كما فى المعاملة الأولى مع استبعاد الإضافة عند ٢٠ يوم من الزراعة .

المعاملة الثالثة : ٣ دفعات متساوية كما فى المعاملة الأولى مع استبعاد الإضافة عند ٤٠ يوم من الزراعة .

المعاملة الرابعة : ٣ دفعات متساوية كما فى المعاملة الأولى مع استبعاد الإضافة عند ٦٠ يوم من الزراعة .

استخدم تصميم القطع المنشقة فى ثلاث مكررات حيث شغلت الأصناف القطع الرئيسية ومعاملات تجزئ السماد الأزوتى القطع الشقية ويمكن إيجاز أهم النتائج كما يلى :

١ – تفوق الصنف هجين فردى ١٠ فى محصول الفدان من الحبوب عن باقى الهجن وذلك لتفوقه فى صفات ارتفاع النبات ، مساحة ورقة الكوز الرئيسى ومحتواها من الكلوروفيل ، دليل مساحة الأوراق ، طول الكوز ، عدد ووزن حبوب الكوز بينما تفوق الصنف هجين ثلاثى ٣١٠ فى كل من قطر الكوز ، عدد سطور الكوز ووزن ١٠٠ حبة دون مردود على محصول الحبوب / فدان .

٢ – لم تختلف الهجن معنويا فى نسبتى البروتين والزيت بالحبوب وكذلك محصول البروتين كجم/فدان فى حين تفوقا الصنفان هجين فردى ١٢٩ وهجين ثلاثى ٣١٠ فى محصول الزيت كجم/فدان .

٣ – تفوقت المعاملة الأولى حيث تم إضافة السماد الأزوتى على أربع دفعات متساوية فى كل من ارتفاع النبات ، مساحة ورقة الكوز الرئيسى ومحتواها من الكلوروفيل ، دليل مساحة الأوراق ، طول الكوز ، قطر الكوز ، عدد ووزن حبوب الكوز ، محصول الحبوب أردب / فدان ومحصول البروتين كجم / فدان بينما تفوقت المعاملة الرابعة فى محصول الزيت كجم / فدان فى حين لم تؤثر معاملات تجزئ إضافة السماد الأزوتى معنويا على كل من عدد الكيزان / نبات ، عدد السطور بالكوز ، وزن ١٠٠ حبة ونسبة البروتين والزيت بالحبوب.

٤ – وجد تداخل فعل معنوى بين هجن الذرة الشامية ومعاملات تجزئ إضافة السماد الأزوتى على كل من مساحة ورقة الكوز الرئيسى ووزن حبوب النورة المؤنثة فقط ولم تلاحظ استجابة صنفية لمعاملات تجزئ النيتروجين على بقية الصفات .