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MAIZE PRODUCTIVITY AS INFLUENCED BY GENOTYPES, SOWING DATES, NITROGEN DOSES AND APPLICATION TIMES AND THEIR INTERACTIONS

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ABSTRACT

Due to climatic, agricultural and irrigation conditions of Fayoum region, some of maize growers coerced to plant it with their own seeds of local type on dates spread from March to July. The early and late maize sowings are far from the optimum date. For these reasons and may be other constrains, maize average yield (3.06) is still lower than the national average, i.e. 3.33 t/faddan (Agric. Stat., part2, July 2000). Therefore, the present investigation was conducted, through splitspiltsplit-plot design, during 2000 and 2001 seasons in the Farm of Fac. of Agric. at Fayoum, to study the effect of four sowing dates (main plots), three N application times (sub-plots) and three N doses (subsub-plots) on the productivity of three maize hybrids and varieties (subsubsub- plot). The objectives of this work were; to study the responses of the different genotypes to the other tested variables, to determine the relative importance of all variables under experimentation, to specify the optimum combination among these variables, and calculate the reduction in yield due to change in one or more of these variables.

The obtained results revealed that the most important factors affecting yield was genotypes followed by sowing date, N doses and then N application times. Genotypes had the highest correlation and direct effect on grain yield followed by sowing date in favour to early sowing. The best combination for producing the highest yield was; early sowing on May or late of April using single cross “Watania 4" and fertilized by 150 kg N/fad applied into two halves (before: 1st & 2nd irrigation). Sowing on April or June reduced yield by 2.46 & 6.21% in the first season and by 2.35 & 6.20% in the second one, as compared with sowing on May, while the late sowing on July reduced yield by 49.94 & 50.36% in the two respective seasons. Reductions in yield due to changes of the other three tested variables (genotypes, N dose & N application times) were discussed depending upon the interaction effects.

Key words: Maize genotypes, sowing dates, N doses, N applications and their interactions.

In fact, maize (*Zea mays* L.) as the third international cereal crops, is one of the important national food and feed crops. In Egypt, during last two decades, actual and significant improvement of maize productivity have been achieved by using high yielding varieties and hybrids suited to summer environmental conditions at different governorates planting during the period from mid May to mid June under recommended improved cultural practices.

This was not exactly true at Fayoum governorate which characterized with specific environmental conditions make it unique compared to other governorates.

It located within depressed area declined from 26m upmarine to 45m submarine (affecting water irrigation management) surround by desert and including about 360-km^2 water surface (Karoun & Rayan lakes). These conditions sharply affected its climate and then the national cultural recommendations are not completely suited. In addition, there is a wide crops diversification due to planting various winter and summer vegetables. Due to these conditions , many of maize growers coerced to plant it using their own seeds of local type on dates expanded from March to July. The early and late sowings of maize, as the available succeeded crop in vacant fields after some vegetable crops or when irrigation water become profuse, are common in wide (scuttered) areas of the total maize area at Fayoum governorate. For these reasons and may be other constrains, maize average yield (3.06) at Fayoum is still lower than the national average, i.e. , 3.33 t / faddan (Agric. Stat. , part 2 , July 2001).

It is well known that sowing date of maize is depending upon the climatic conditions prevailing in the crop growing area. Allison and Daynard (1979) suggested that silking and tasseling of maize were advanced by increasing temperature and decreasing photoperiod. Several preliminary Egyptian maize studies (Bishr and Shalaby, 1976; Osman *et al*., 1980; Eweis, 1981 and El-Ashmoony , 1983) showed that the highest values of growth , most yield attributes and grain yield were obtained from late of May to early of June plantings. Other recent studies (Abdel-Gawad, 1986; Abdel-Aziz, 1987; Abo El-Zahab and Rady, 1990 and Salem, 1993) emphasized that planting maize early on mid May was preferred to latter plantings.

Maize as one of grain crop belonging to grasses, is highly responding to nutrients fertilization especially with nitrogen which is considered as limiting factor for maize production. Application of nitrogen fertilizer had great attention of many maize workers. But, they differed in determining the optimum N dose due to different genotypes and environmental conditions. The highest means of growth, grain yield and most of yield components were obtained by applying N rate up to 80 kg N / fad. (Leilah and El-Kassaby , 1987) ; 90 kg N / fad (Khalifa *et al.*, 1983; Kamel *et al.*, 1986 and Badawy *et al.*, 1988) ; 120 kg N / fad (El-Kassaby and El-Kalla, 1981; Ahmed, 1989; Matta *et al.* , 1990 ; El-Ashmoony and El-Hefnawy, 1990 ; Mokadem and Salem, 1994; Ashoub *et al.*, 1996; Zeidan *et al.*, 1998 and El-Absawy, 2000); 135 kg N/fad (El-Rassas *et al.*, 1988 and Gouda *et al.*, 1993), and 140 kg N/fad (El-Marsafawy, 1991 and Abo Bakr, 1994). However, Salem *et al.* (1983), El-Hosary and Salwau (1989) and Salwau and Shams El-Din (1992) found that plant height, ear height, yield and yield components were not significantly increased by increasing N levels.

In regard to the time of N application, Ali (1985), Ahmed (1989), Shalaby *et al.* (1990) and Basha (1994) obtained the highest grain yield when N was splited into two equal portions, i.e. before 1st and 2nd irrigations. El-Bana and Gomaa (1994) in sandy soil found that adding of N into four equal splits (at sowing, at 25, 40 and 55 days age) resulted in marked increases for ear length and diameter, as well as, grains weight/ear and grain yield/fad. However, Zeidan *et al.*, (1998) reported that N application at three or four equal splits significantly decreased grain weight but increased grain–oil content percentage compared with its application at two equal halves. They did not find any significant effects of N application time on the other studied grain yield attributes and grain yield/faddan.

Significant differences among maize genotypes in yield and its components were frequently detected by many investigators (Osman *et al.*, 1980; Eweis, 1981; El-Deep, 1990; Aly *et al.*, 1996; El-Sheikh, 1998 and El-kalla *et al.*, 2001). Several maize authors suggested that hybrids produced more ear/plant, better ear characteristics, heavier weight of grains/plant and higher grain yield/fad compared with the open pollinated varieties. (El-Agamy *et al.*, 1987; Abdul-Galil *et al.*, 1990 Gouda *et al.*, 1992; El-Sheikh, 1998 and Radwan *et al.*, 2001). Significant interactions between maize genotypes and N application were detected by various authers (Khaifa *et al.*, 1983; Ahmed, 1989; El-Deep, 1999; El-Kalla *et al.*, 2001 and Radwan *et al.*, 2001).

The objectives of the present investigation were; to study the productivity of three maize genotypes under different combinations of sowing dates, nitrogen dose and N application times, to assess the relative importance of these four tested variables, and to determine the optimum combination (and alternative ones) suitable for improving crop production at Fayoum region.

MATERIALS AND METHODS

Two field experiments were carried out in the experimental farm of the Faculty of Agriculture at Fayoum, during 2000 and 2001 seasons, to study the performance and productivity of maize genotypes (as one variable) under other three agricultural variables. In both seasons, the used statistical design was split split split-plot, with three replications. The plot area was of 3.5 x 4 m. The preceding crop was Egyptian clover in both seasons. The field soil, in the two seasons, was calyey in texture with pH of 7.5 and contained organic matter of about 2.1% and $CaCo_3$ of 6.5%. It possessed N and P as available nutrients of 409 and 10.8 in the first season and 420 and 10.6 ppm in the second season one. Monthly mean temperatures from April to Oct. were 28.6, 29.5, 30.2, 31.7, 30.4, 28.7 and 28.0 in the first season and 28.2, 29.0, 30.4, 31.5, 30.6, 29.0 and 28.1˚C (Fayoum Metreorological Station at Itsa). The studied four variables and their arrangement within the design was as follows:

1. Four sowing dates (in main plot), i.e.; (S_1): April 15; (S_2): May 15; (S_3): June 15 and (S_4): July 15.
2. Three nitrogen application times; i.e. (C_1): addition in three portions: 1/5 at sowing and 2/5 before each of 1st and 2nd irrigation; (C_2): addition in three portions: 1/5 before 1st , 2/5 before each of 2nd and 3rd irrigation, and (C_3): addition in two halves , i.e. , ½ before each of 1st and 2nd irrigation.
3. Three nitrogen doses , as ammoniom nitrate 33.5 N % , i.e. 90 (D_1), 120 (D_2) and 150 (D_3) kg/faddan.
4. Three maize genotypes, i.e. (G_1) Balady, is a local type frequently handled by many farmers and may be originated to Giza 2 variety propagated by farmers for long time; (G_2) Three-way cross (T.W.C.310), and (G_3) Single cross "Watania 4" (S.C.Wat. 4). The sources of seeds were; a farmer for balady type and ARC, at Giza, Min. Agric. for the two hybrids.

The recommended cultural practices for growing maize were followed. Harvest was done on Aug. 8 and 5; Sept. 10 and 7; Oct. 5 and 3, and Oct. 29 and 28 for the four sowings in the first and second season, respectively. At harvest time, ten guarded plants were choosen to measure plant height (cm), ear length (cm), ear diameter (cm) number of rows/ear, grains weight (g) and 100 grain weight (g). Grain yield (t)/faddan was calculated on the plot bases. The collected data were subjected to factorial analysis of variance according to Gomez and Gomez (1984). Simple correlation among all studied variables and grain yield, as well as, direct and indirect effects of these variables on grain yield were recorded using the procedures described by Dewey and Lu, 1959.

RESULTS AND DISCUSSION

Effect of sowing date (S):

The four monthly dates of sowing, between mid of April to mid of July, significantly affected all of the studied characters in 2000 and 2001 seasons except plant height in the second seasons and 100 grain weight in both seasons (Tables 1 & 2). These results indicated that most characters were greatly influenced by climatic conditions. Whereas, 100 grain weight was the most constant one over dates. It was observed, generally, that delaying sowing date decreased the yield component means, but in slightly different manner in the two successive seasons. Where in the first season, April sowing showed some highest means followed by May, June and July sowings. While in the second season, May sowing had the best character means followed by April, June and then July. Consequently, in both seasons, grain yields of May sowing (3.368 and 3.322) were insignificantly different from those of April sowing (3.285 and 3.244 t/fad.). April sowing produced yields similar to those of June sowings (3.159 and 3.117 t/fad.) which significantly decreased than those of May sowing in the first and the second season, respectively. Superiority of May planting was in agreement with those reported by Abdel-Gawad (1986) Abdel-Aziz (1987); Abo El-Zahab and Rady (1990) and Salem (1993). But, none of the maize authors indicated the superiority of April planting detected herein at Fayoum region which characterized with its own specific environmental conditions. However, sowing maize on July induced considerable reduction in grain yield, i.e., 1.686 and 1.649 t/faddan in the two respective seasons, indicating that late sowing on July is not economic and should be refused.

These results revealed that sowing maize crop at Fayoum on May or April is beneficial and recommended. But under compeled circumstances, maize sowing may be done on June with some supportable yield reduction. Whereas, expansion sowing to July not expected to produce satisfied yield but done in order to cover the vacant fields. Drastic yield reductions in July sowings may be due to short growing season and small heat unit sum associated to the period from July planting dates to harvest dates on the end of October. These results interpreted why maize crop is sown at Fayoum during the period from April to July. It is interest to note that the present results slightly deviate from the national recommendation concerning maize sowing date, which promotes sowing on mid May to mid June. The results also confirmed the view that Fayoum governorate should be have specific crop-production recommendations, due to its specific edaphic and climatic conditions.

<u>Effect of N application times (C):</u>

Analysis of variance showed significant differences due to different three times of N application for all studied characters in the first season and for number of rows/ear, 100 grain weight, and grain yield/faddan in the second one (Tables 1

& 3). It was noticed, in almost all cases, that the third treatment (C_3), i.e. addition N fertilizer in two equal portions; before each of 1st and 2nd irrigation, was the best

Table (1): Significant (*) and highly significant (**) difference for yield attributes and grain yield / fad due to the effect of main sources of variation and their interactions, in 2000 and 2001 seasons.

Characters S.V	DF	Plant height		Ear length		Ear diameter		Rows no./ear		Grains wt./ear		100 grain weight (g)		Gr. Yield/fad	
		2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Reps	2														
Sow. Dates (S)	3	**	-	**	**	**	*	**	*	**	**	-	-	*	*
Err.	6														
N. appl. (C)	2	**	-	**	-	**	-	**	*	**	-	**	**	**	**
SC	6	-	-	**	-	-	-	-	**	**	-	-	-	**	**
Err.	16														
N.dose (D)	2	**	**	**	**	**	-	**	-	**	**	**	**	**	**
SD	6	-	-	**	**	-	-	-	**	**	**	**	**	**	**
CD	4	-	-	-	**	**	-	**	-	**	-	-	-	-	-
SCD	12	-	-	**	-	-	-	-	**	**	-	-	-	-	-
Err.	48														
Genotypes (G)	2	**	**	**	**	**	**	**	**	**	**	**	**	**	**
SG	6	**	-	**	**	-	**	-	**	**	-	**	**	**	**
CG	4	**	-	**	-	**	-	**	**	**	-	*	-	**	**
SCG	12	**	-	**	-	-	-	**	**	**	**	**	-	**	**
DG	4	-	-	-	-	**	-	**	**	**	-	**	**	-	-
SDG	12	**	-	-	-	-	-	-	-	**	-	-	-	-	-
CDG	8	-	-	**	-	**	-	**	-	**	**	-	-	-	-
SCDG	24	-	-	-	-	-	-	-	**	**	-	-	-	**	**
Err.	144														

- : Denotes insignificant

Table (2): Maize characters as affected by sowing dates (S_{1-4}) in 2000 &2001 seasons

Characters	season	S_1	S_2	S_3	S_4	$LSD_{.05}$
Plant height (cm)	2000	241.91	232.61	210.00	180.61	1.82
	2001	220.51	227.21	219.30	219.30	NS
Ear length (cm)	2000	21.14	21.18	18.65	17.31	0.29
	2001	18.90	20.22	18.84	15.97	0.43
Ear diameter (cm)	2000	4.52	4.44	4.42	4.12	0.03
	2001	4.33	4.41	4.28	4.09	0.15
Rows number / ear	2000	11.53	11.40	11.29	11.19	0.03
	2001	11.84	11.96	11.51	11.25	0.61
Grains weight (g) / ear	2000	180.05	183.98	149.31	135.87	1.10
	2001	142.95	145.14	133.99	96.39	4.98
100 grain weight (g)	2000	31.55	31.91	31.84	31.71	NS
	2001	31.48	31.91	31.79	31.63	NS
Grain yield (t/fad)	2000	3.285	3.368	3.159	1.686	0.137
	2001	3.244	3.322	3.117	1.649	0.163

Table (3): Maize characters as affected by nitrogen application times (C_{1-3}) in 2000 &2001 seasons

Characters	season	C_1	C_2	C_3	$LSD_{.05}$
Plant height (cm)	2000	213.34	215.87	218.69	1.91
	2001	219.62	222.20	222.91	NS
Ear length (cm)	2000	19.22	19.14	20.35	0.28
	2001	18.33	18.64	18.48	NS
Ear diameter (cm)	2000	4.34	4.23	4.25	0.02
	2001	4.28	4.28	4.27	NS
Rows number / ear	2000	11.30	11.29	11.46	0.06
	2001	11.55	11.85	11.52	0.32
Grains weight (g) / ear	2000	165.50	134.79	186.62	1.68
	2001	129.64	127.98	131.23	NS
100 grain weight (g)	2000	31.85	31.38	32.02	0.07
	2001	31.80	31.33	31.99	0.12
Grain yield (t/fad)	2000	2.955	2.587	3.082	0.071
	2001	2.915	2.541	3.043	0.056

application times and surpassed the second one (C_2), i.e. addition N fertilizer in three portions, at sowing and before each of 1st and 2nd irrigation, for all characters in both seasons. These results are in agreement with those reported by Ali (1985); Ahmed (1989); Shalaby *et al.* (1990) and Basha (1994). However, Zeidan *et al.* (1998) reported that splitting N dose into three or four portions did not affect grain yield/faddan and yield attributes but decreased 100 grain weight. Superiority of C_3 treatment may be due to splitting the fertilizer into only two portions and the plants received fertilizer at proper stages of growth, while in C_1 treatment the plants received some fertilizer early at sowing which reduced the two portions added before 1st and 2nd irrigation which become relatively smaller than those corresponding ones in C_3. However C_2 produced the lowest character means due to delaying of fertilization which splitted in three portions (before each 1st, 2nd and 3rd irrigation).

Consequently, C_3 treatment produced the highest grain yields (3.082 and 3.043) significantly increased those of C_1 (2.955 and 2.915 t/fad.) in the first and second seasons, respectively. Whereas, C_2 application treatment gave marked decreased yields reduced by 16.06 and 16.50 % compared to those of C_3 in the two respective seasons.

Effect of nitrogen doses (D):

Except ear diameter and number of rows/ear in the second season, all of the studied characters exhibited significant differences due to fertilization by different N doses in the two seasons of experimentation (Tables 1 & 4). For all characters, it was found that fertilization with 150 kg N/fad. (D_3) resulted in the highest means in both seasons. D_3 treatment possessed character means significantly increased those of D_2 (120 kg N/fad.) and both surpassed those of D_1 (90 kg N/fad.). The obtained results may be in line with those detected by El-Marsafawy (1991) and Abo-Bakr (1994) whereas it contradicted with other maize investigators who obtained yield increases by increasing N doses up to 120 kg/faddan (Ahmed, 1989; Matta *et al.*, 1990; El-Ashmoony and El-Hefnawy, 1990, Ashoub *et al.*, 1996; Zeidan *et al.*, 1998 and El-Absawy, 2000). On the other hand, Salem *et al.*, (1983); El-Hosary and Salwau (1989) and Salwau and Shams El-Din (1992) recorded insignificant increases in yield and its attributes by increasing N levels. These contradicted results may be due to different soil fertility, soil N availability and maize genotypes, as well as, most of them applied N dose up to only 120 kg N/faddan.

As shown in Table (4) fertilization with 150 kg N/fad (D_3) produced the highest grain yield/fad (2.983 and 2.944) and significantly increased those of D_2 (2.884 and 2.849 t/fad.) in 2000 and 2001 seasons, respectively. However, D_1 produced the lowest yields reduced by 7.57 and 8.08 % compared to those of D_3 in the two respective seasons.

Table (4): Maize characters as affected by nitrogen doses (D_{1-3}) in 2000 &2001 seasons

Characters	season	D_1	D_2	D_3	$LSD_{.05}$
Plant height (cm)	2000	214.07	215.74	218.10	0.65
	2001	218.26	222.40	224.07	4.55
Ear length (cm)	2000	19.09	19.57	20.06	0.11
	2001	18.28	18.12	19.04	0.35
Ear diameter (cm)	2000	4.20	4.39	4.53	0.02
	2001	4.28	4.26	4.29	NS
Rows number / ear	2000	11.11	11.31	11.64	0.06
	2001	11.58	11.63	11.71	NS
Grains weight (g) / ear	2000	137.26	152.60	197.06	1.83
	2001	125.36	128.08	135.41	4.07
100 grain weight (g)	2000	31.55	31.55	31.96	0.07
	2001	31.48	31.71	31.93	0.09
Grain yield (t/fad)	2000	2.757	2.884	2.983	0.023
	2001	2.706	2.849	2.944	0.029

Effect of genotypes (G):

As expected, the cultivars showed significant differences , due to usage of different bred genotypes and to the presence of Balady type among them (Tables 1 & 5). These significant genotypic differences were previously detected by several authors (Osman *et al.*, 1980; Eweis, 1981; El-Deep, 1990; Aly *et al.*, 1996; El-Sheikh, 1998 and El-Kalla *et al.*, 2001). The S.C. Watania 4 (G_3) was the best genotype followed by the T.W.C. 310 (G_2) whereas the local type (G_1) was the worst, reflecting the importance of recommendation concerning with planting improved varieties and hybrids. Superiority of maize hybrids over the open pollinated varieties was indicated by various investigators (El-Agamy *et al.*, 1987; Abdul-Galil *et al.*, 1990; Gouda *et al.*, 1992; El-Sheikh, 1998 and Radwan *et al.*, 2001). It was noticed, in both seasons, that S.C. Watania 4 was significantly higher than T.W.C. 310 for all studied characters (Table 5). Both hybrids surpassed Balady stock for all characters except 100 grain weight in the two seasons. In this concern, Salem (1993) reported that D.C. 215 gave the highest values of yield and its components, except 100 grain weight, compared to Giza 2 variety. But, superiority of Balady in 100 grain weight could not compensate its inferiority in other characters, as compared to those of hybrids, and then produced the lowest grain yield (1.941 and 1.904 t/fad.) in 2000 and 2001 seasons, respectively. On the other hand, the highest grain yield (3.408 and 3.366 t/fad) was produced by S.C. watania 4 due to its superior yield components, which significantly increased those of T.W.C. 310 by 3.93 and 4.10 % and the respective values were 43.05 and 43.43 % as compared with Balady in the first and second season, respectively.

Table (5): Maize characters as affected by genotypes (G_{1-3}) in 2000 &2001 seasons

Characters	Season	G_1	G_2	G_3	$LSD_{.05}$
Plant height (cm)	2000	199.93	221.73	226.25	0.53
	2001	215.16	221.88	227.69	3.07
Ear length (cm)	2000	17.38	19.87	21.46	0.11
	2001	17.28	18.72	19.45	0.42
Ear diameter (cm)	2000	4.25	4.38	4.50	0.02
	2001	4.20	4.27	4.35	0.06
Rows number / ear	2000	9.43	12.22	12.39	0.05
	2001	9.94	12.12	12.86	0.32
Grains weight (g) / ear	2000	141.30	162.34	183.26	1.73
	2001	109.25	131.06	148.54	4.71
100 grain weight (g)	2000	32.38	31.27	31.60	0.06
	2001	32.34	31.20	31.59	0.06
Grain yield (t/fad)	2000	1.941	3.274	3.408	0.025
	2001	1.904	3.228	3.366	0.029

Interaction effects on yield attributes and grain yield:

The data listed in Table (1) reveal that significant interactions detected in the first season were greater than those of the second one, due to the environmental fluctuations. SC interaction had significant effects on ear length, grain weight/ear (in 1st season) and rows no./ear (in 2nd season) and grain yield/fad (in both seasons). SD interaction was of marked effects on rows no./ear (in 2nd season) and ear length, grain weight/ear, 100 grain weight and grain yield/fad (in both seasons). SCD interaction significantly affected ear length and grain weight/ear (in 1st season) and rows no./ear (in 2nd season). SG (sowing date x genotype) interaction was significant for all characters in both seasons, except ear diameter and rows no./ear (in 1st season) and plant height and grains weight/ear (in 2nd season), indicating the relative importance of both variables (S&G) affecting yield and yield attributes.

CG interaction was significant for all characters (in 1st season) and rows no./ear and grain yield/fad. in both seasons. SCG interaction affected plant height, ear diameter and 100 grain weight (in 1st season) and grains weight/ear and grain yield/fad in both seasons. DG interaction affected ear length and grains weight/ear (in 1st season) and rows no./ear and 100 grain weight in both seasons. SDG interaction was significant for only plant height and grains weight/ear (in 1st season). CDG interaction had marked effects on ear length, ear diameter and rows no./ear (in 1st season) and grains weight/ear in both seasons.

It was noticed, in general, that ear length, rows no./ear and grains weight/ear were the most yield attributes affected by most first, second, or third order interactions especially in the first season. Also, in the most cases, there was great similarly of the significant interactions affected grain yield/fad (in one side) and 100 grain weight, grains weight/ear, rows no./ear and ear length (in other side) indicating their tight relations. Each 100 grain weight and grain yield/fad showed full similarity for significant interactions in both seasons. The interactions affected grain yield, as ultimate goal of the crop production, will be discuss in details.

The highest and lowest grain yield/fad for all kinds of interactions among the four tested variables are presented in Tables (6 & 7) in the two respective seasons. It is interest to note that all the highest yields were obtained from the first, second or third order interactions between S_2, C_3, D_3 or G_3, whereas, the lowest yields were obtained from the interactions between S_4, C_2, D_1 or G_1 in both seasons. These results indicated the advantage of early sowing of S.C. wat.4 on May and fertilized by 150 kg N/feddan added in two equal portions at 1st and 2nd irrigation (S_2 C_3 D_3 G_3). In both seasons by calculation the differences between the highest and lowest means at the significant interactions, the third-order one (S C D G) which showed the greatest differences ranked as the first followed by SCG, CG, SC, SD and CG reflecting the considerable effect of the third order interaction (including the four variables) followed by the second order (three variables) and then the first order (two variables) which showed the least differences. These results indicated that most of these significant interactions included S, G, C or all reflecting the relative importance of sowing date, genotypes, N application times for maize productivity.

Table (6): The highest and lowest grain yield (t/fad) under all different levels of interactions, in 2000 season.

Interact	Highest Mean					$LSD_{.05}$	Lowest Mean					Difference	Rank
	Value	S	C	D	G		value	S	C	D	G		
SC	3.662	2	3	.	.	0.142	1.543	4	2	.	.	2.119	4
SD	3.486	2	.	3	.	0.054	1.588	4	.	1	.	1.998	5
CD	3.047	.	3	3	.	NS	2.485	.	2	1	.		
SCD	3.771	2	3	3	.	NS	1.436	4	2	1	.		
SG	4.088	2	.	.	3	0.050	1.369	4	.	.	1	2.718	3
CG	3.519	.	3	.	3	0.043	1.772	.	2	.	1	1.746	6
SCG	4.484	2	3	.	3	0.086	1.222	4	2	.	1	3.261	2
DG	3.381	.	.	3	3	NS	1.825	.	.	1	1		
SDG	4.213	2	.	3	3	NS	1.289	4	.	1	1		
CDG	3.612	.	3	3	3	NS	1.658	.	2	1	1		
SCDG	4.554	2	3	3	3	0.211	1.116	4	2	1	1	3.438	1

To calculate the effect of change in the levels of S, C, D and G, the highest and second highest yield means of the significant SC, SD, SG, SCG and SCDG were recorded under each sowing date and presented in Tables 8 & 9 for the two successive seasons.

Change in sowing date from B_2 to B_1, B_3 and B_4 induced yield reductions of 3.97, 11.15 and 51.67 % in the first season and of 3.64, 11.17 and 51.94 % in the second season, as measured from the third order interaction, indicating again the importance of early sowing on May and April (Table 8). Insignificant differences between the highest and second highest yield means represent (as in third order interaction, SCDG, in both seasons) by C_1 D_3 G_3 and C_1 D_2 G_3 for April (S_1) sowings and by C_3 D_3 G_3 and C_3 D_2 G_3 for May (S_2) , June (S_3)and July (S_4)

Table (7): The highest and lowest grain yield (t/fad) under all different levels of interactions, in 2001 season.

Interact	Highest Mean					$LSD_{.05}$	Lowest Mean					Difference	Rank
	Value	S	C	D	G		Value	S	C	D	G		
SC	3.617	2	3	.	.	0.112	1.513	4	2	.	.	2.104	4
SD	3.459	2	.	3	.	0.038	1.544	4	.	1	.	1.915	5
CD	3.007	.	3	3	.	NS	2.417	.	2	1	.		
SCD	3.745	2	3	3	.	NS	1.400	4	2	2	.		
SG	4.053	2	.	.	3	0.039	1.328	4	.	.	1	2.725	3
CG	3.476	.	3	.	3	0.033	1.742	.	2	.	1	1.734	6
SCG	4.445	2	3	.	3	0.067	1.129	4	2	.	1	3.316	2
DG	3.347	.	.	3	3	NS	1.795	.	.	1	1		
SDG	4.192	2	.	3	3	NS	1.247	4	.	1	1		
CDG	3.575	.	3	3	3	NS	1.639	.	2	1	1		
SCDG	4.520	2	3	3	3	0.218	1.100	4	2	1	1	3.419	1

sowings (Tables 8 & 9) indicated that there were insignificant differences between 120 and 150 kg N doses (change of D_3 to D_2) under all sowing dates but with the presence of high levels of the other two variables. Change in D may be differ if the four variables were not considered where the results of the first order (SD) interactions showed that change N dose from D_3 to D_2 significantly reduced yield under all sowing dates in both seasons. From SC, SCG and SCDG interactions, it was noticed that, at early sowing on April , C_1 (addition N at sowing before each of 1^{st} and 2^{nd} irrigation) was preferable whereas in May-July sowings C_3 was preferable. This observation was confirmed in both seasons (Table 8 & 9). This effect may be due to the cold rihzosphere at April needs some N dose early (at sowing) to make it worm.

At all sowing dates and in both seasons (Tables 8 & 9), based on the data of SC and SCG interactions, it could be recorded that change from C_1 to C_3 induced significant differences in grain yield. Also, change in genotypes from G_3 to G_2 (based on SCG interaction) significantly reduced grain yield/faddan.

Further evidence for the relative importance of the four tested variables was obtained by calculating the simple correlation, as well as, direct and indirect effects of these variables with grain yield (Table 10). The data of both seasons showed that, maize genotypes had the highest positive correlation coefficient, as well as, direct and total effects on grain yield. The second effective variable was sowing date, which had negative and significant correlation, in favour to early sowing date, as well as direct and total effects on grain yield. The other two variables (N dose and application time) showed insignificant and comparable values.

Tables 8,9

Table (10): Simple correlations (r) of the four tested variables and their direct and indirect effects on grain yield/faddan, in 2000 & 2001 seasons

Variables	2000				2001			
	r	Total effect	Direct effect	Indirect effect	r	Total effect	Direct effect	Indirect effect
S (X_1)	-0.506**	0.2559	0.2558	-0.0001	-0.506**	0.2563	0.2565	-0.0002
C (X_2)	0.050	0.0025	0.0025	0.0000	0.050	0.0025	0.0025	0.0000
D (X_3)	0.088	0.0078	0.0078	0.0000	0.093	0.0078	0.0078	0.0000
G (X_4)	0.573**	0.3285	0.3284	0.0001	0.574**	0.3295	0.3296	0.0001
R^2 for all	0.590				0.592			
$\hat{Y}$ =	$2236.00–0.0473X_1+0.636X_2+0.0113X_3+0.0734X_4$				$183.75–0.0471X_1+0.636X_2+0.0119X_3+0.0731X_4$			

ARABIC SUMMARY

إنتاجية الذرة الشامية وتأثرها بالتركيب الوراثي ومواعيد الزراعة
ومستويات التسميد الآزوتي ومواعيد إضافته وتفاعلاتها

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أقيمت تجربتان حقليتان بموسمي ٢٠٠٠ و ٢٠٠١ بمزرعة كلية الزراعة بالفيوم – جامعة القاهرة. لدراسة سلوك وإنتاجية بعض أصناف وهجن الذرة الشامية تحت تواليف من أربعة مواعيد للزراعة ، ثلاثة طرق لإضافة السماد الآزوتي وثلاثة معدلات من السماد النيتروجيني وثلاثة مواعيد لإضافته. وكانت أهم النتائج المتحصل عليها كما يلي :-

١- أهم العوامل تحت الدراسة المؤثرة على المحصول هي التراكيب الوراثية يليها مواعيد الزراعة ثم جرعات الأزوت وأخيرا مواعيد الإضافة.
٢- ارتبطت التراكيب الوراثية ارتباطا كبيرا بمحصول الحبوب وتبعها ميعاد الزراعة بتفضيل ملحوظ للمواعيد المبكرة.
٣- التوليفة المثلى لإنتاج أعلى محصول هي الزراعة المبكرة في مايو أو آخر أبريل باستخدام الهجين الفردي وطنية ٤ والتسميد بمعدل ١٥٠كجم ن/الفدان تضاف على دفعتين بالتساوي قبل ريه المحاياة والرية الثانية مباشرة.
٤- مقارنة الزراعة في أبريل ويونيو مع الزراعة في مايو وجد نقص في إنتاجية محصول الحبوب بمقدار ٢,٤٦ و ٦,٢١ % في الموسم الأول و٢,٣٥ و ٦,١٧ % في الموسم الثاني بينما الزراعة في يوليو وصل مقدار النقص في محصول الحبوب عن الزراعة في مايو إلى ٤٩,٩٤ و ٥٠,٣٥ % في الموسم الأول والثاني على التوالي.

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