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SEED SIZE OF MAIZE HYBRIDS: II- EFFECTS ON AGRONOMIC TRAITS UNDER NEW SANDY SOIL CONDITIONS.

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ABSTRACT

Many previous studies showed that grading hybrid seed based on size, had a little effect on grain yield. However, farmers are still concerned about using small seeds that may result from seed position on the ear or poor growing conditions. This study was carried out to clarify the effect of seeding the commercial maize hybrids, Single Cross 2010 (SC2010), Three-Way Cross 310 (TWC310) and Three-Way Cross 321(TWC321) with different seed sizes (large, medium and small) on some agronomic traits and yield and its components under newly reclaimed sandy soil conditions. Two field experiments were conducted in a split-split plot, in a complete block design, with three replicates, in El-Bostan Experimental Farm of College of Agriculture, Alexandria University during the two summer seasons of 2003 and 2004.

The results indicated significant differences among the three hybrids in plant height, stem diameter and ear length in 2004 season, and kernel weight in 2003 season. The TWC310 had the highest plants, the longest ear and the thickest stem in 2004 season. Furthermore, the same hybrid had the heaviest kernels in 2003 season. Seed size had a significant effect on ear weight, where the large seed size resulted in the heaviest ears in both seasons. Other significant effects of seed size were observed on ear length, kernel weight and grain yield, where large seed size had the longest ears and the heaviest kernels and

the highest grain yield in 2003 season. In 2004 season, the small seed size had significantly less stem diameter, shortest plants, shortest ears, lightest ears and lowest grain yield among the other seed sizes. Furthermore, there was a significant effect of hybrids by seed size interaction on kernel weight in 2003 season, and on plant height and grain yield in 2004 season.

Accordingly, it could be concluded that sowing hybrid maize with graded large seed size might be more productive under newly reclaimed sandy soil conditions.

INTRODUCTION

Maize is the first summer crop, considering acreage and total production in Egypt. It occupies almost one-third of the total cultivated area in summer season (0.84 million hectares). Recently, most of such maize area is sown with hybrids. Increasing productivity of the hybrids is an essential target to fill the gap between maize consumption and production in Egypt.

Seeds of three-way and double-way maize hybrids are, generally, larger than those of single-cross hybrid. Several scientific publications on graded seeds within hybrids indicated that seed size had affected grain yield and its components, such as Fontes and Ohlryge (1972), Singh and Kailasanathan (1976), Hoy and Gamble (1987) and Atta (1994). Others, such as Srivastava and Nigram (1973), Kalita and Choudhury (1984), Odhiambo and Compton (1987), Graven and Carter (1990), Nafziger (1992), Sexton *et al* (1994) and Choudhry and Ikram Ullah (2001) reported non-significant effect of seed sizes on yield and its components.

In general, there is a lack of information concerning the response of different maize hybrids to seeding with different sizes of seeds, especially at the newly reclaimed areas in Egypt. Therefore, the present study was carried out to clarify the effect of seeding three different hybrids with three different seed sizes in newly reclaimed sandy soil.

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MATERIALS AND METHODS

The present investigation was carried out during the two successive summer seasons of 2003 and 2004 in newly reclaimed sandy soil at the Experimental Farm of College of Agriculture, El-Bostan, Alexandria University, Egypt. Soil characterization was performed for the two experimental field sites at El-Bostan in 2003 and 2004 seasons. Table (1) illustrates the physical and chemical properties of the two sites before sowing, according to Black (1965).

Three different commercial maize hybrids, namely, single cross 2010 (SC2010), three-way cross 310 (TWC310) and three-way cross 321 (TWC321) were used in the present study. Seeds of the three hybrids were sorted to three sizes; i.e., large, medium and small, according to the number of seeds/100g, as shown in Table (2).

A split-plot arrangement, in a randomized complete block design, with three replicates was used, where the commercial hybrids were assigned to the main plots, while the different seed sizes were allocated to the sub-plots. Sowing date was June 22nd in the two successive seasons. Grains were sown on ridges, in hills (30-cm apart), and plants were thinned to one plant/hill after three weeks from sowing. Each experimental unit (14.4 m^2) was composed of six ridges (each 4 m long and 0.6 wide). All other cultural practices, except for the selected hybrids and classified seed size, were applied as recommended for the experimental site.

At harvest time, five random plants were tagged from each sub-plot to determine the following agronomic traits, grain yield, and grain yield components:

1- Plant height (cm): Measured from soil surface to the top of plant.
2- Stem diameter (cm): Measured on the node carrying the ear.
3- Ear length (cm): Measured as complete ear length excluding ear shank.
4- Ear weight (g): measured as dry weight of the ear.

5- One-hundred kernel weight (g): Determined as the average of two random samples of each sub-plot.
6- Grain yield (tons/hectare): All maize plants in the four inner guarded ridges (3-m long) for each sub-plot were harvested to determine grain yield.

All collected data were subjected to the statistical analysis, according to Little and Hills (1988).

Analyses of variance were performed on the studied traits following the split-plot model, using the GLM procedures of SAS (SAS Institute Inc. 2000). Least significant difference was used for mean separation of different hybrids and different seed sizes and their interactions, as outlined by Steel and Torrie (1980).

Table (1): Physical and chemical proprieties of the experimental field sites at El-Bostan in 2003 and 2004 seasons.

Soil properties	2003 Season	2004 Season
Sand (%)	90.62	89.37
Silt (%)	1.25	2.50
Clay (%)	8.13	8.13
Soil texture	Sand	Sand
Ca^{+2} meq/L	6.10	5.90
Mg^{+2} meq/L	3.00	3.60
Na^{+1} meq/L	9.50	9.20
K^{+1} meq/L	0.24	0.32
Co_3^{-2} meq/L	0.00	0.00
Hco_3^{-1} meq/L	1.80	2.30
Cl^{-1} meq/L	9.40	9.60
So_4^{-2} meq/L	7.10	5.20
EC ds/m	1.85	2.10
N %	0.020	0.012
Available phosphorus (ppm)	6.00	5.80

Table (2): Average number of seeds/100g for different size of three maize hybrids.

Seed size	Maize hybrids		
	SC2010	TWC310	TWC321
Large	270	217	223
Medium	327	245	249
Small	425	302	297

RESULTS AND DISCUSSION

Differences among maize hybrids:

Analysis of variance (Table 3) indicates significant or highly significant differences among the three hybrids for plant height, stem diameters, ear length only in 2004 seasons. TWC310 had the highest plants (186 cm), followed by TWC321 (183 cm) and SC2010 (166 cm). Furthermore, TWC310 had the thickest stems (61.0 mm) and the longest ears (19.6 cm). However, TWC310 was not significantly different from TW321 in stem diameter and plant height and not significantly different from SC2010 in ear length (Table 5). In 2003 season, all hybrids were similar in their traits, except for kernel weight (Table 4). Table (6) shows that TWC310 had the superior kernel weight (37.2g), while TWC321 had the lowest kernel weight (32.9g).

In respect to ear weight and grain yield traits, the three hybrids were statistically similar in both traits in both seasons (Table 4). These results might be due to the environment of the newly reclaimed sandy soil, where the poor content of nutrients of such soil (Table 1) could result in depressed genetic behavior of the different hybrids leading to a similar performance among hybrids under such conditions (Swamy *et al*., 1998). Considering the non-significant yield performance among hybrids, the low seed cost of the three-way hybrids (TWH), comparing to that of single hybrids (SH), would suggest using TWH for seeding maize rather than SH especially under unfavorable conditions as the case of present study. This could be an evidence that growing maize hybrids in new poor sandy soils might require specific cultural practices, differing from those applied to the old planted fertile soils.

Seed size of hybrids:

Effects of hybrid seed size on the studied agronomic traits and grain yield and its components during the two studied seasons (2003 and 2004) are presented in Tables (3 and 4). Plant height and stem diameter were not significantly affected by seed size in the first season (2003). Whereas, the differences turned to be significant for these traits in the second season (2004). Medium seed size was superior for both plant height (181cm) and stem diameter (58.6mm) in the second season (Table 5). However, the large and medium seed sizes were similar in 2004 season.

All other traits of grain yield and its components were significantly affected by hybrid seed size (Tables 3 and 4), except for kernel weight in 2004 (Table 4). Large seed size produced the longest ears (17.8cm) in 2003 season, followed by medium seed size (16.3) and small seed size (15.8). While, in the second season, the medium seed size produced the highest mean ear length (20.1cm), followed by the large seed size (18.8), then, the small seed size (17.9).

Similarly, large seed size resulted in heavier ears (196, and 227g in 2003 and 2004, respectively) than both medium and small seed sizes (Table 6). Furthermore, large seed size produced the heaviest 100-kernel weights (35.9g) in 2003 season. Overall, the highest grain yield was an end product of large seed size in 2003 season (11.09 tons/hectare). But, the medium seed size produced the lightest grain yield (8.5 tons/hectare)in 2004. This emphasizes the predominant effects of either large or medium seed size on the previous yield components and, finally, on grain yield (Table 6) under such growth environment of new poor sandy soil.

Generally, graded hybrid seed size significantly affected grain yield and its components, beside other agronomic traits; i.e., plant height and stem diameter. Furthermore, the small seed sizes, in general, produced the lowest grain yield and its components.

These results could be due to the positive effect of large seed size on the seed germination and seedling vigor (Morsy *et al*., 2007). More seedling vigor could be reflected on more productive maize plant (Joshi and Singh, 2005). such pervious conclusion could be more prominent

under poor growth environment, as proved in the present study on new sandy low-fertile soil (Table 2).

Analysis of variance (Tables 3 and 4) shows, furthermore, effects of seed size on the agronomic and grain yield traits through its interaction with hybrids, where significant effects were noticed on kernel weight in 2003 season, and on plant height and grain yield in 2004 season. The heaviest grains were those of large seed size of TWC310 but the lightest grains were associated with small seed size of CS2010 (Table 7). The tallest plants were those of medium seed size of TWC310, while, the shortest ones were those of large seed size of SC2010. The superior grain yield was for that of medium seed size of TWC321, while, the lowest grain yield was obtained from the large seed size of SC2010, which explained the significant interaction effects of Tables (3 and 4).

Similar positive effects of seed size on grain yield and its components were obtained by Fontes and Ohlrogge (1972) on soybean; Hunter and Kannenbery (1972) on corn; Burris *et al*. (1973) on soybean; Odhiambo and Compton (1987) on corn and Atta (1994) on wheat. While, others reported non-significant effects of seed size on grain yield and its components such as Major (1977) on rape seed, Silva and Marcos (1982) on maize; Sanchez and Carballo (1983) on maize; Hoy and Gamble (1987) on soybean; Reddy *et al*. (1989) on soybean; Graven and Carter (1990) on corn, Nafziger (1992) on corn; and Chaudhry and Ikram Ullah (2001) on maize.

In view of the present results, it could be concluded that sowing hybrid maize with graded large seed might be more productive under newly reclaimed sandy soil conditions under study.

Table (3): Mean squares of plant height, stem diameter and ear length as affected by seed size of three maize hybrids in 2003 and 2004 summer seasons.

Sources of variance	df	Traits					
		Plant height (cm)		Stem diameter (mm)		Ear length (cm)	
		2003	2004	2003	2004	2003	2004
Replications	2	284.3	55.4	34.5	3.3	2.88	3.37
Hybrids (H)	2	741.5	1092.9**	27.0	20.5*	3.82	7.37*
Error "a"	4	114.4	12.5	13.0	14.1	0.58	0.69
Seed size (Z)	2	96.5	68.4*	24.5	50.2*	9.64**	10.18**
H X Z	4	138.4	49.2*	16.0	10.0	0.89	2.03
Error "b"	12	71.0	11.6	11.0	11.3	0.30	0.62

*, ** Significant at 0.05 and 0,01 probability levels, respectively.

Table (4): Mean squares of ear weight, 100-kernel weight and grain yield as affected by seed size of three maize hybrids in 2003 and 2004 summer seasons.

Sources of variance	df	Trait					
		Ear weight (g)		100-Kernel weight (g)		Grain yield (t/ha)	
		2003	2004	2003	2004	2003	2004
Replications	2	3248.9	715.0	0.40	4.21	0.30	0.55
Hybrids (H)	2	125.8	1507.1	42.16**	4.45	0.55	4.52
Error "a"	4	578.0	506.2	1.17	5.73	0.22	1.77
Seed size (Z)	2	2149.6*	1075.9*	6.19**	2.37	21.1**	0.96*
H X Z	4	1177.9	422.1	4.24**	12.86	0.59	0.84*
Error "b"	12	489.3	211.1	0.73	5.06	0.21	0.24

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

Table 5: Means of plant height, stem diameter, and ear length as affected by seed size of three maize hybrids in 2003 and 2004 summer seasons.

	Trait					
	Plant height (cm)		Stem diameter (mm)		Ear length (cm)	
Hybrid:	2003	2004	2003	2004	2003	2004
SC2010	155a	166b	49.6a	51.8b	16.0a	19.3a(1)
TWC310	174a	186a	52.1a	61.0a	17.3a	19.6a
TWC321	166a	183a	53.0a	59.3a	16.5a	17.9b
Seed size:						
Large	169a	176b	50.4a	58.4a	17.8a	18.8b
Medium	163a	181a	53.5a	58.6a	16.3b	20.1a
Small	163a	178b	50.8a	54.7b	15.8c	17.9c

([1]) Means followed by the same letter within the same column are not significantly different at 0.05 probability level.

Table 6: Means of ear weight, 100-kernel weight, and grain yield as affected by seed size of three maize hybrids in 2003 and 2004 summer seasons.

	Trait					
	Ear weight (g)		100-kernel weight (g)		Grain yield (t/ha)	
Hybrid:	2003	2004	2003	2004	2003	2004
SC2010	175.5a	223.3a	34.8b	39.42a	9.24a	7.46a(1)
TWC310	182.5a	205.5a	37.2a	40.61a	9.20a	8.05a
TWC321	176.7a	230.6a	32.9c	40.67a	9.64a	8.90a
Seed Size:						
Large	196.0a	227.0a	35.9a	39.8a	11.09a	7.94b
Medium	168.0b	225.2a	34.7ab	40.1a	8.82b	8.50a
Small	170.7b	207.2b	34.3b	40.8a	8.17c	7.93b

([1]) Means followed by the same letter within the same column are not significantly different at 0.05 probability level.

Table 7: Means of 100-kernel weight (2003 summer season), plant height and grain yield (2004 summer season) as affected by maize hybrids and seed size.

Trait	SC2010			TWC310			TWC321			*Lsd* $_{0.05}$	
	Large	Med.	Small	Large	Med.	Small	Large	Med.	Small	(1)	(2)
100-Kernel weight (g)	36.6	35.1	32.8	38.3	36.1	37.2	32.8	33.0	32.9	1.52	1.18
Plant height (cm)	164	165	167	186	190	181	177	188	184	6.1	4.3
Grain yield (t/ha)	6.91	8.10	7.40	7.84	8.00	8.30	9.10	9.44	8.10	1.71	1.09

(1) ***Lsd*** $_{0.05}$ **between two means of different seed size under the same hybrid.**

(2) ***Lsd*** $_{0.05}$ **between two means of different seed size under the same or different hybrids.**

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الملخص العربي

حجم الحبة لهجن الذرة الشامية: 2- تأثيرات على صفات محصولية تحت ظروف الأراضي الرملية الجديدة

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بالرغم من أن كثيرا من الدراسات السابقة قد أوضحت ضعف تأثير حجم الحبة لهجن الذرة الشامية على محصول الحبوب إلا إنه مازال هناك تخوف من المزارعين لاستخدام الحبوب صغيرة الحجم، والناجمة عن موضع الحبة على الكوز أو عن ظروف نمو غير موائمة. وقد أجريت هذه الدراسة لتوضيح تأثير استخدام أحجام مختلفة (كبيرة ومتوسطة وصغيرة) كتقاوى لزراعة ثلاثة هجن تجارية من الذرة الشامية (فردي 2010 وثلاثي 310 وثلاثي 321) على صفات محصولية وكمية محصول الحبوب ومكوناته فى الأراضى الرملية المستصلحة حديثا حيث نفذت تجربتان حقليتان فى قطع منشقة مرتان لتصميم قطاعات عشوائية كاملة مع ثلاثة مكررات بالمزرعة البحثية لكلية الزراعة بالبستان ـ جامعة الإسكندرية ـ خلال موسمي صيف2003 و 2004.

ولقد أوضحت النتائج اختلافات معنوية بين الهجن الثلاث فى ارتفاع النبات وسمك الساق وطول الكوز لموسم 2004 وفي وزن الحبة لموسم 2003، وكان للهجين الثلاثي " 310 " أعلي متوسط لارتفاع النبات وأعلي متوسط لطول الكوز وأعلى متوسط لسمك الساق في موسم 2004، وأيضا سجل نفس الهجين أعلى متوسط لوزن الحبة لموسم2003.

كما أظهرت النتائج تأثيراً معنوياً لحجم حبوب التقاوى علي وزن الكوز حيث نتج عن حبوب التقاوى كبيرة الحجم كيزانا أثقل وزنا فى كلا الموسمين، وكانت هناك أيضا تأثيرات معنوية لحجم حبوب التقاوى على طول الكوز ووزن الحبة ومحصول الحبوب حيث تفوقت الحبوب كبيرة الحجم فى طول الكوز ووزن الحبة والمحصول فى موسم 2003، بينما كان لحجم الحبوب صغيرة الحجم تأثير معنوى فى نقص سمك الساق وطول الكوز ووزن الكوز ومحصول الحبوب فى موسم 2004، وكان هناك أيضا تأثيرا معنويا للتفاعل بين الهجن وحجم حبوب التقاوى على وزن الحبة لموسم 2003 وعلى ارتفاع النبات ومحصول الحبوب لموسم2004.

ويمكن التوصية بناءا على نتائج هذه الدراسة باستخدام التقاوي كبيرة الحجم من هجن الذرة الشامية سواء كانت هذه الهجن أحادية أو ثلاثية وذلك لتحسين إنتاجية هذه الهجن حال زراعتها في الأراضي الرملية حديثة الاستصلاح تحت الدراسة.