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IMPROVEMENT OF THE NEW SYNTHETIC MAIZE CULTIVAR, SAKHA-6, VIA THREE CYCLES OF MODIFIED EAR TO ROW SELECTION

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ABSTRACT

The synthetic Sakha-6,which is a new white maize cultivar, was used to utilize its genetic variability to improve yielding potentiality through out three cycles C-0, C-1 and C-2 of modified ear-to row ,METR ,selection method .The research was made ,during 2001,2002 and 2003 growing seasons at Sakha Research Station under two nitrogen levels. The mean values for all traits, except silking date were higher at the high nitrogen level of 120 Kg N/Fad than the low nitrogen level of 70 Kg N/Fad in the three cycles of selection. Over the two nitrogen levels, the mean of cycle-2 was higher than cycle-0 for grain yield, ear length and ear diameter, while it was the reverse for silking date, plant and ear heights. These results indicated that the modified ear-to-row selection method were effective for increasing grain yield and yield components and in decreasing silking date and plant and ear heights. Genetic variance was significant at the two nitrogen levels and their combined for all traits in most three cycles of METR selection methods. The interactions between genetic variance and nitrogen levels were not significant for all traits in the three cycles. Moreover, the phenotypic and genotypic variances, over the two nitrogen levels, were low at C-2 than C-0 for all traits except phenotypic variance for silking date. Broad sense hertiability H^2_b% values were higher under the high nitrogen level than the low nitrogen level for all traits at the three cycles. However, the heritability estimates, over the two nitrogen levels , decreased from C-0 to C2 in METR selection method for all traits. H^2_b% for grain yield was 75.5%, 48.3% and 18.9% at C-0,C-1 and C-2, respectively. This indicated that genetic variability was decreased with the advances of cycles of selection. The expected gain from selection was higher under high nitrogen level than low nitrogen level for silking date, plant height and grain yield in two out of the three cycles. The expected genetic advance from selection ΔG% for all traits were low at C-2 than C-0 over the two nitrogen levels. ΔG% for grain yield were 13.9%, 10.01% and 3.14% at C-0,C-1 and C-2, respectively. Moreover, the highest values for expected gain from selection at the two nitrogen levels and when combined were obtained for grain yield compared with other traits in each cycle.

INTRODUCTION

The success of any breeding program depends on the amount and type of genetic variability available in the germplasm pool and on choosing the best selection scheme for the utilization of this genetic variability. The ear-to-row selection is a method for improving populations through increasing the frequency of favorable genes in the populations without considerable decrease in the amount of the non-additive genetic variance (Hopkins, 1896). Lonnquist (1964) outlined a new technique for improving the ear-to-row selection method initiated by Hopkins, the new method has been known as modified ear-to-row selection method. El-Rouby *et al.*, (1971) compared the relative efficiency of selection based on modified mass selection and ear-to-row selection in the variety American Early. They found that both methods of selection were effective in increasing grain yield by 8.9 ± 1.2% per cycle relative to the original population. The genetic variability was dropped as selection advances from cycle 0 to cycle 1, however, it was not affected in cycle-2. Deleon and Pondey (1989) found that the modified ear-to-row selection was effective in increasing grain yield, stalk-rot resistance and ear-rot resistance, and in reducing number of days to 50% silking and plant height in maize. Nawar *et al.*, (1991) revealed that highest estimates of heritability on variety Cairo-1 were obtained from the high plant density ,especially, for grain yield and some of its components. Expected genetic advance values of different selection methods i.e. mass selection, modified ear-to-row, half and full sib family selection were higher under the high plant density. The predicted genetic advances per cycle (ΔG%) for these methods were 7.99%, 7.56%, 13.06% and 9.77%, respectively. Galal *et al.*, (1996) found that the heritability were 57.99, 44.67 and 35.84% for modified ear-to-row cycle-0, cycle-1, cycle-2 families, respectively. The actual advance from selection was 26.96, 15.69 and 20.66 for modified ear-to-row through the three cycles ,respectively, for improving the yield of the composite Giza-2 variety. Weyhrich *et al.*, (1998) tested seven methods of recurrent selection in the BS_{II} maize population. They found that all selection methods were successful and significantly improved each population for grain yield .They added that S_2 progeny selection had the greatest response of 4.5% for grain yield in cycle-1 and mass selection had the lowest response of 0.6% in cycle-1. All selection programs in which index selection was practiced, except for modified ear-to-row, were successful in Improving the population *per se* for all four traits tested simultaneously.Amer *et al.*,(1999) found that the genetic parameters σ^2p,σ^2 g , P.C.V,G.C.V, H^2_b% and ΔG% which were used as function of genetic variability , decreased from one cycle to another of METR .The mean of 200 families were increased from one cycle to another . The actual yield of cycle-7 showed an increase of about 39% over that of cycle-0. The present study was conducted to improve the new cultivar synthetic Sakha-6, utilizing the diverse genetic variability for grain yield.

MATERIALS AND METHODS

Sakha-6 which is a new synthetic cultivar of maize was used in this study.It was originally formed at Sakha Research Station during 1997 through 2000 seasons. In 2000 season, 200 ears were selected from this cultivar to be used as a base population to start the improvement via the modified ear-to-row selection method. Each ear was divided into 6 parts such as: two for each two nitrogen levels trials, one for an isolated plot females and one for the bulk of pollen parent. In 2001 season, 200 selected ears from cycle-0 were evaluated in two experiments under two nitrogen levels:70(N1) and 120(N2) Kg nitrogen .The design used was a randomized complete block design with two replications. The plot size was one row, 6 m long and 80 cm apart with 25 cm between hills. Data were recorded on plots on the following traits; Silking date (days to 50% emergence silking) plant and ear heights cm, grain yield (Ard/Fad) adjusted based on 15.5% grain moisture content, ear length (cm) and ear diameter (cm.) At the same time, the 200 families were planted in an isolated crossing block at the rate: 4 females: 1 male. Upon the combined yield trials, 20% selected families were taken from the isolated plot i.e., 5 ears per each row. Equal number of seeds from each of the 200 selected ears were mixed to obtain the following cycle-1 (C1) of selection. Subsequently, in seasons 2002 and 2003, the same procedures were made for cycle-1 and cycle-2 to produce cycle-2 and cycle-3, respectively.

The analysis of variance for each experiment and the combined analysis was computed as outlined by Snedecor and Cochram (1980).Estimates of heritability and expected gain from selection were done as outlined by Falconer (1981).

RESULTS AND DISCUSSION

The means ($\bar{x}$), the errors ($\sigma^2 e$), coefficients of variability (C.V%) for the six studied traits at the two nitrogen levels and their combined in three cycles of modified ear-to-row are presented in Table 1. Results indicated that the mean values for grain yield, ear length, ear diameter, plant and ear heights were higher at high nitrogen level (120 KgN/Fad) than of low nitrogen level (70KgN/Fad) at each of the three cycles of METR selection expect of cycle-2 for plant and ear heights. The reverse was obtained for silking date where the means of 200 families were lower at the high nitrogen level for the three cycles, these results would indicate that the high nitrogen level was not a cause at environment stress while, the low nitrogen level would cause environmental stress Frey and Moldonado (1967) defined the environmental stress as the one in which mean performance for certain attribute is low. Omar *et al.*, (1990) found that the nitrogen level of 120 Kg N/Fad led to an increase in grain yield , ear height and earliness. The results, over the two nitrogen levels, indicated that the mean of cycle-2 was higher than these of cycle-0 for grain yield, ear length, and ear diameter, while the reverse was obtained for silking date, plant and ear heights, indicating that the modified ear-to-row was effective as a selection method for increasing grain yield and yield components and decreasing days to silking (toward earliness), as well as plant and ear heights. Deleon and Pondey (1989) found that the METR selection was effective in increasing grain yield and reducing number of days to 50% silking and plant height in maize. Amer (1995) found that the means of the three cycles i.e. cycle-1, cycle-2 and cycle-3 of METR gradually increased for grain yield. Weyhrich *et al.*, (1998) found that METR was significantly successful in improving the performance of the population *per se* for grain yield. The results showed that the errors ($\sigma^2 e$) and coefficients of variability (C.V%) were higher at the low nitrogen level than at high nitrogen level for all traits in all three cycles except $\sigma^2 e$ of cycle-0 for grain yield , plant and ear heights, $\sigma^2 e$ of cycle-1 for ear length and ear height and C.V% of cycle-0 for plant and ear heights. These results mean that accuracy of the experiment was higher at the high nitrogen level or non-environmental stress than at the low nitrogen level or environmental stress. These results are in common agreement with the results obtained by Amer *et al.*, (2003).

Table (1): Mean ($\bar{x}$), error variance (σ^2e) and coefficient of variability (C.V%) for the six studied traits at the two nitrogen levels and their combined in three cycles of modified ear- to –row.

Trait	Statistical measures	cycle	Nitrogen levels		
			70KgN/Fad(N1)	120KgN/Fad(N2)	Combined
Grain yield	$\bar{x}$ Ard/Fad	C0	22.80	29.51	26.15
		C1	18.34	23.11	20.73
		C2	23.80	30.20	27.00
	σ^2e	C0	10.08	13.26	11.67
		C1	13.76	12.73	12.90
		C2	8.47	5.17	6.82
	C.V%	C0	13.93	12.34	13.06
		C1	19.71	15.44	17.33
		C2	12.23	7.52	9.70
Ear length	$\bar{x}$ cm	C0	20.33	21.65	20.99
		C1	19.45	20.82	20.13
		C2	20.89	23.30	21.9
	σ^2e	C0	1.84	1.23	1.53
		C1	1.19	1.30	1.24
		C2	1.809	1.74	1.77
	C.V%	C0	6.67	5.12	5.9
		C1	5.61	5.49	5.55
		C2	6.44	5.69	6.05
Ear diameter	$\bar{x}$ cm	C0	4.73	4.97	4.85
		C1	4.53	4.79	4.66
		C2	4.74	5.01	4.87
	σ^2e	C0	0.027	0.027	0.027
		C1	0.03	0.023	0.027
		C2	0.052	0.028	0.040
	C.V%	C0	3.46	3.32	3.39
		C1	3.89	3.18	3.54
		C2	4.79	3.33	4.09
Silking date	$\bar{x}$ days	C0	69.00	66.89	67.94
		C1	62.53	61.2	61.86
		C2	63.64	62.53	63.08
	σ^2e	C0	2.58	1.04	1.81
		C1	3.75	1.08	2.41
		C2	4.25	2.82	3.536
	C.V%	C0	2.33	1.63	1.98
		C1	3.10	1.70	2.51
		C2	3.24	2.69	2.98
Plant height	$\bar{x}$ cm	C0	288.15	303.6	295.86
		C1	261.43	277.14	269.27
		C2	277.32	272.33	274.83
	σ^2e	C0	303.83	550.43	427.134
		C1	152.75	128.37	140.56
		C2	284.86	254.45	269.65
	C.V%	C0	6.05	7.73	6.99
		C1	4.73	4.090	4.40
		C2	6.09	5.86	5.98
Ear height	$\bar{x}$ cm	C0	163.35	170.64	166.99
		C1	145.92	156.53	151.23
		C2	160.60	158.79	159.69
	σ^2e	C0	177.87	217.97	197.92
		C1	90.66	101.83	96.25
		C2	137.74	119.88	128.81
	C.V%	C0	8.16	8.65	8.42
		C1	6.53	6.45	6.49
		C2	7.31	6.9	7.11

Estimates of phenotypic (σ^2p), genotypic (σ^2g) and interaction (σ^2gN) variances for the six studied traits at the two nitrogen levels and their combined in the three cycles of METR are shown in Table 2. Genetic variance (σ^2g) was significant at the two nitrogen levels and their combined for all traits in most cycles of METR selection method, while the interaction between genetic variance and nitrogen levels (σ^2gN) was not significant for all traits in the three cycles except cycle-1 and cycle-2 for grain yield and cycle-1 for ear length and ear diameter. The results across the two nitrogen levels exhibited that the phenotypic variances (σ^2p) and genotypic variances (σ^2g) were low for cycle-2 than cycle-0 as expected for all traits except (σ^2p) for silking date. These results are in agreement with the findings of Amer (1995) who found that (σ^2p) and (σ^2 g) ,over two plant denities, were decreased from cycle-1 to cycle-3.

Table (2): Phenotypic (σ^2p) and genotypic (σ^2g) variances and interaction (σ^2gN) for the six studied traits at the two nitrogen levels and their combined in three cycles of modified ear-to-row.

Estimates		Cycle	Grain yield Ard/Fad	Ear length cm	Ear diameter cm	Silking date days	Plant height cm	Ear height cm
σ^2p	N1	C0	12.008	1.520	0.029	3.069	285.36	187.45
		C1	24.588	0.960	0.021	2.964	189.69	99.28
		C2	23.29	1.120	0.038	4.35	161.76	90.69
	N2	C0	17.500	1.464	0.029	2.174	477.3	273.10
		C1	16.165	0.954	0.021	1.718	165.48	125.037
		C2	18.655	1.044	0.021	4.33	104.40	50.134
	Comb	C0	11.840	1.072	0.0232	2.166	282.00	181.060
		C1	9.384	0.519	0.011	1.708	133.60	88.32
		C2	11.58	0.665	0.018	2.72	79.411	41.160
σ^2g	N1	C0	6.966*	0.6015*	0.016*	1.778*	133.44*	98.500*
		C1	5.759*	0.365*	0.006	1.086*	113.30*	53.95*
		C2	19.005*	0.216*	0.012	2.227*	19.33	21.82
	N2	C0	10.867*	0.849**	0.016*	1.651*	202.13*	164.124*
		C1	9.797*	0.302*	0.0092	1.176*	101.29*	50.92*
		C2	16.07*	0.171	0.008*	2.924*	22.800*	9.809
	Comb	C0	8.941*	0.652*	0.017*	1.711*	182.70*	131.82*
		C1	4.540*	0.080	0.0017	1.075*	89.615*	64.470*
		C2	2.19	0.25*	0.006*	1.105*	25.728*	11.905*
σ^2gN	Comb	C0	0.045	0.073	-0.001	0.009	-14.948	0.477
		C1	3.237*	0.253*	0.003*	0.056	17.689	-0.443
		C2	15.37*	-0.055	0.004	1.4705*	-13.73	-5.897

Table 3 shows the estimates of heritability (H^2_b %) and the expected genetic advance ΔG% for the six studied traits, under two nitrogen levels and their combined performance in the three cycles . Broad sense hertiability values were higher under high nitrogen level than low nitrogen level for all traits in most three cycles. However the hertiability estimates over two nitrogen levels were decreased from cycle-0 to cycle-2 for all traits. H^2_b % for grain yield was C-0 75.5%, C-1 48.3% and C-2 18.9%, indicating that the genetic variability was decreased with the advanced cycles of selection. These results are in agreement with that of Galal *et al.*, (1996) who found that the heritability estimates were decreased sequently from cycle-0 to cycle-2 in M.E.T.R. selection method. Amer *et al.*, (2003) found that heritability was higher under high nitrogen levels for grain yield, ear length, ear diameter, plant and ear heights. These results are in disagreements with these of Diab (1979) and Omar *et al.*, (1990) they found that heritability estimates were higher under the low nitrogen level.

The expected gain from selection was higher under high nitrogen level than low nitrogen level for grain yield, silking date and plant height in two out of the three cycles, indicating that more gain from selection would be expected for these traits when selection is practiced under 120 Kg N/fad. On the other hand, the reverse was obtained for ear height, ear length and ear diameter in two out of the three cycles. The results over the two nitrogen levels showed that the expected genetic advance from selection for all traits were low for cycle-2 than cycle-0. It was for grain yield in C-0 13.90%, C-1 10.01% and C-2 3.34%. Moreover, grain yield showed the highest trait for expected gain from selection at the two nitrogen levels and their combined compared with other traits in each selection cycle .Consequently, the modified ear- to- row selection method was effective an improving grain yield for synthetic cultivar i.e. Sakha-6 .

Table (3): Heritability estimates (H^2_b%) and expected genetic advance (ΔG%) for the six studied traits at the two nitrogen levels and their combined in three cycles of modified ear-to-row.

Estimates		Cycle	Grain yield Ard/Fad	Ear length cm	Ear diameter cm	Silking date days	Plant height cm	Ear height cm
H^2_b%	N1	C0	58.0	39.5	54.2	57.9	46.7	25.7
		C1	23.4	38.0	2.7	36.6	59.7	54.3
		C2	81.6	19.2	31.5	51.1	11.9	24.0
	N2	C0	62.1	57.9	54.2	75.9	42.3	60.0
		C1	60.6	31.6	45.2	68.4	61.2	40.7
		C2	86.14	87.3	36.0	67.4	21.8	20.0
	Comb	C0	75.5	60.8	73.1	78.0	64.7	72.0
		C1	48.3	15.5	15.2	62.9	64.0	72.0
		C2	18.9	37.5	33.3	40.5	32.3	28.9
ΔG%	N1	C0	12.34	3.36	7.756	2.057	3.84	6.169
		C1	8.860	2.68	6.16	1.41	4.400	5.190
		C2	23.16	1.367	1.242	2.347	0.767	1.997
	N2	C0	12.35	4.540	2.624	2.344	4.266	8.150
		C1	14.76	2.078	1.910	1.405	3.977	4.070
		C2	17.25	1.054	11.40	3.144	1.147	1.220
	Comb	C0	13.90	4.20	3.216	2.395	5.147	8.12
		C1	10.01	7.768	0.489	1.86	4.030	6.35
		C2	3.34	2.032	1.530	1.485	1.470	1.626

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تحسين الصنف التركيبي الجديد سخا-٦ باستخدام ثلاث دورات من الانتخاب بطريقة الكوز للخط المعدلة

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أجريت هذه الدراسة لتحسين القدرة المحصولية للصنف التركيبي الأبيض الجديد(سخا-٦) باستخدام ثلاث دورات من الانتخاب بطريقة الكوز للخط المعدلة خلال ثلاث مواسم زراعية: ٢٠٠١، ٢٠٠٢ ، ٢٠٠٣ بمحطة البحوث الزراعية بسخا تحت معدلين من التسميد النيتروجيني .
وقد أوضحت النتائج ما يلي:

كانت متوسطات جميع الصفات تحت معدل التسميد العالى (١٢٠ وحدة ازوت للفدان) أعلى من متوسطات معدل التسميد المنخفض (٧٠ وحدة ازوت للفدان) ماعدا صفة تاريخ ظهور ٥٠% من النورات المؤنثة للثلاث دورات من الانتخاب بطريقة الكوز للخط المعدلة.كذلك أوضح التحليل المشترك لمعدلى التسميد أن متوسط الدورة الثانية يزيد عن متوسط دورة الأساس لصفة محصول الحبوب ،طول وقطر الكوز بينما العكس تحصل عليه لصفة تاريخ ظهور ٥٠% من النورات المؤنثة(فى اتجاة التبكير) وارتفاع النبات والكوز وهذا يعنى فاعلية طريقة الكوز للخط المعدلة في تحسين محصول الحبوب ومكوناته وللتبكير وقصر النباتات.

كان التباين الوراثي معنويا لجميع الصفات تحت كلا من معدلي التسميد والتحليل المشترك لهما فى معظم دورات الانتخاب بطريقة الكوز للخط المعدلة ، بينما التفاعل بين التباين الوراثى والتسميد لم يكن معنوياً لجميع الصفات فى دورات الانتخاب. كان التباين المظهري والوراثى للتحليل المشترك منخفض فى الدورة الثانية من الانتخاب بالمقارنة بدورة الأساس لجميع الصفات ماعدا التباين المظهرى لصفة تاريخ ظهور ٥٠% من النورات المؤنثة

تنخفض تتدرجاً قيم درجة التوريث للتحليل المشرك من دورة الأساس الى الدورة الثانية بالانتخاب بطريقة الكوز للخط المعدلة فى جميع الصفات المدروسة. كانت درجة التوريث لصفة المحصول ٧٥,٥% لدورة الأساس ، ٤٨,٣% للدورة الأولى و١٨,٩% للدورة الثانية وهذا يعنى أن التباين الوراثى يقل مع التقدم فى الدورات الانتخابية

كان التحسين الوراثى المتوقع عالياً تحت معدل التسميد العالى بالمقارنة بمعدل التسميد المنخفض لصفة تاريخ ظهور ٥٠% من النورات المؤنثة ، ارتفاع النبات ومحصول الحبوب لمعظم دورات الانتخاب. كما اظهر التحسين الوراثى انخفاضاً فى الدورة الثانية بالمقارنة بدورة الأساس لجميع الصفات للتحليل المشترك لمعدل التسميد . درجة التحسين الوراثي لصفة المحصول كانت ١٣,٩% لدورة الأساس ،١٠,٠١% للدورة الأولى و٣,١٤% للدورة الثانية من الانتخاب .
كانت صفة المحصول هى الأعلى فى نسبة التحسين الوراثي تحت كلا من التسميد العالي والمنخفض والتحليل المشترك في كل دورة من دورات الانتخاب بالمقارنة بقيم التحسين الوراثي للصفات الأخرى.