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COVARIABILITY OF YIELD AND QUALITY OF TWENTY SUGAR BEET GENOTYPES

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ABSTRACT

Twenty mono and multigerm sugar beet genotypes namely Demapoly, Carola (KWS 9421), Tteri, Kawemira, Desprez poly N, B2001, FD 9902, FD 9901,FD 0405, FD4901, Meridio, Mahara (6S86), Despreez mono N, Anema, LP 11, LP 12, LP 13, LP 14, LP, 15 and LP 16 were evaluated.

Results showed that LP 15 genotype was superior in root length cm, root diameter cm, root fresh weight kg/plant, root and sugar yields ton/fed in both seasons while LP 12 genotype had superiority in sucrose, purity and extractability %. Values mean square show highly significant differences due to genotypes for all characters under study. Whereas, variances due to differences among genotypes were higher than those due to the interaction. These results indicated that most of variability for these traits was mainly controlled by genetic factors with less influence by environmental.

Straw weight exhibited significant and positive phenotypic and genotypic correlation with sugar yield ton/fed and each of root length cm, root diameter cm, root fresh weight kg/plant and root yield ton/fed.

Under conditions of this study we suggest that varieties Lp 12 and Lp 15 are suitable for Fayoum governorate, also we can used the characters of yield compound to evaluated and selection of sugar beet genotype.

Key words: ***Sugar beet, Phenotypic and genotypic coefficients, Yield, Quality, Mono and multigerm varieties***

INTRODUCTION

Genetic variation among traits is important for breeding and in selecting desirable types. On the other hand, an analysis of the correlation between yield and yield components is essential in determining selection criteria however, estimates of genetic variance can be done. (EL-Attar 1983 and EL-Rassas *et al* 1987) These analyses yield techniques showed or identify the contribution of some independent variables on a dependent variable. Walton (1972) criticized these techniques and explained that false conclusion could be obtained. He concluded that biologists must seek right assistance from statistical methodology. He suggested factor analysis as a new technique to identify growth and plant characters related to yield in spring wheat. Inayatullah (1999) found that variety "1E 0148" showed best performance for fresh root weight, root girth, pol percent, root yield and sugar yield followed by Kawe Terma which showed best performance for fresh root weight, root leaves ratio, root length, brix reading, pol percent, root yield and sugar yield. The maximum coefficient of correlation was

recorded for pol percent and brix reading, while the least was for fresh leaves weight and sugar yield. It is evident from the data that sugar yield showed positive correlation with root girth, leaves number per plant, and fresh root weight, while negative one with the rest of the characters studied. The results indicated that most prominent characters, which affect the yield of sugar in sugar beet are root girth, root yield and pol percent which should be directly involved in the improvement programmes of sugar beet. Inayatullah *et al* (2001) Studied correlation and path analyses for some quality parameters in 10 sugar beet varieties grown under Peshawar valley conditions during the 1997-98 season. Varieties were Kawe Terma, 3A0107, Prestibel, 1E0148, Trebyx, SM1390 (Atomium), 4A0120, Marzaka, Eureka and 2E0136. Results indicated that. Kawe Terma gave the highest sugar yield (8.54 t/ha). Sugar yield showed positive correlations with Brix value and root yield, but negative correlations with purity percentage and pol percentage. Path analysis showed that Brix had the highest positive direct effect on sugar yield. Geidel *et al* (2000) compared several indices to select for root yield and sugar content which affected sugar yield. The indices differ in the amount of information necessary for the calculation of their weights. Three different series of each eight sites gave similar results. Sugar content with its higher heritability must have a larger weight than root yield. Heritabilities as index weights performed best, but two other indices using heritabilities and phenotypic but no genetic covariances also performed well. El-Bakry (2006) found significant different effects between varieties on root and top fresh weight/plant, and yields of root, sugar and tops tons/fed and purity percentage. Azzazy *et al* (2007) evaluated four sugar beet varieties (Gloria, Sofie, Sumba and Sultan), under two planting densities (40000 and 56000 plants/fed.) and two durations to harvest (180 and 210 days from sowing). The obtained results indicated that the tested sugar beet varieties differed significantly in root and sugar yields as well as sucrose and purity percentages. Sultan sugar beet variety recorded the highest values of the studied traits. Sugar yield showed significant and positive correlation coefficient with root yield, root length, and sucrose %. Regression analysis showed that root yield and sucrose % were the most effective traits affecting sugar yield..Ismail *et al* (2007) evaluated some sugar beet varieties viz. (Gloria, Monte bianco, Carolla, Desprezpoly, LP13, Pleno, Baraca, Shems, Farida, and Samba) under different combinations of NPK fertilizers. They found that varieties differed significantly in root length, root diameter, root yield, sugar yield, sucrose % and purity % in both seasons. Monte bianco variety surpassed the other varieties in growth, yield and quality traits.

The objectives of this study were to quantitatively assessing the pattern of genotype variation and the nature of association between key traits of yield and quality.

MATERIALS AND METHODS

Two field experiments were carried out in Kom Osheem district, Fayoum Governorate during 2005/2006 and 2006/2007 seasons. Twenty mono and multigerm sugar beet genotypes were used were used: Demapoly, Carola (KWS 9421), Tteri, Kawemira, Desprez poly N, B2001, FD 9902, FD 9901,FD 0405, FD4901, Meridio, Mahara (6S86), Desprez mono N, Anema, LP 11, LP 12, LP 13, LP 14, LP, 15 and LP16. Genotypes were arranged in a randomized complete block design with three replications. Other agricultural practices were applied as usual for growing sugar beet in the region. Plot area was 21 m^2 (1/200 fad.), which consisted of 6 ridges 7 meters in length and 50 cm in width and spacing between hills was 20 cm. Sugar beet plants were cultivated at 15 Oct. in both seasons. Agronomic cultural practices were carried out as usual to assure optimum production. Sugar beet was harvested after 210 days after sowing date.

Recorded data

At harvest, a random sample of ten roots was taken from each plot to determine root length (cm), root diameter (cm), root fresh weight (kg/plant).
- root yields (ton/fed.).

At harvest, four guarded rows in each plot were up-rooted, topped, weighed and root yield in tons per feddan was calculated on plot basis.

-Theoretical sugar yields (ton/fed.)

Sugar yield was calculated according to the following equation

Sugar yield = Root yield x sucrose %.

-Sucrose % (Pol %) was estimated in fresh samples of sugar beet roots, using saccharemeter according to the method described in A.O.A.C. (1995).

- Purity % (Sucrose % x 100 / TSS%).

-Extractable sugar (Ex %) and Extractability (Exb %) were calculated as proposed by Dexter *et al* (1967):

Extractable sugar % = sucrose % - (sugar loss to molasses % + 0.6)

Extractability % = (extractable sugar % / sucrose %) x100

Statistical analysis

All the recorded data were statistically analyzed according to Snedecor and Cochran (1981).Least significant difference test (LSD) at 5% level of significance was used to compare means.

The form of the variance analysis and the mean square expectations from which estimates of variance components were obtained is presented in Table (1). Separate estimates of the components of variation in each mean square expectation were calculated to evaluate the magnitude of the different effects .The estimates of these variance components and the expected composition of the mean squares were determined by the procedures described by Miller *et al* (1959), where g is number of genotypes, y = number of years, σ^2e = error variance; σ^2g, σ^2gy are the variance attributed to genotypes and genotypes x years, respectively. Such estimates of variance components were obtained from the mean squares of the analysis of variance by using the following formula:

Genotypes (σ^2g) = M3-M2/ry
Genotypes x Years (σ^2gy) = M2-M1/r
Pooled error (σ^2e) = M1

Table 1. Form of variance analysis and mean square expectations

S.V		D.F	E.M.S
Years	**(Y)**	**y-1**	
Reps in years	**(R)**	**y(r-1)**	
Genotypes	**(G)**	**g-1**	**M3: $\sigma^2e + r\sigma^2_{yg} + ry\sigma^2_g$**
	Y x G	**(y-1)(g-1)**	**M2: $\sigma^2e + r\sigma^2_{yg}$**
Pooled Error		**Y(g-1)(r-1)**	**M1: σ^2e**

The phenotypic variance was estimated by the formula as outlined by Miller *et al* 1959 and Comstock and Mull 1963.
- Genotypic correlation (rg).
- Phenotypic correlation between characters (rp).

RESULTS AND DISCUSSION

Root characters

Results in Table (2) indicated that the tested genotypes differed significantly in root length, diameter and fresh weight in both seasons. Mahara (6S86) and LP 15 genotype gave highest values of root length; diameter and fresh weight in both seasons. The highest values were (50.0, 19.50 cm and 2.275 kg/plant) in the first season, while in the second season they were (47.0, 22.50 cm and 1.850 kg/plant) respectively.

On the other hand, LP 12 and LP 14 genotype recorded the lowest values of root length and diameter. The differences among the tested sugar beet varieties might be principally due to the genetic variation. These findings are in agreement with those obtained by El-Bakry (2006) and Ismail *et al* (2007).

Root and sugar yields (tons/fed)

Results presented in Table (2) illustrated that genotypes differed significantly in root and sugar yields in both seasons. LP 15 and Demapoly genotypes were superior in these traits where it recorded 35.50 and 5.86 tons/fed), respectively in first season, corresponding to, 31.30 and 5.90 tons/fed., respectively, in the second season, followed by FD 4901 and Demapoly genotypes.

Table 2. Average values of root characters and yields of different sugar beet varieties in 2005-2006 and 2006-2007 seasons.

Genotypes	2005-2006 season					2006- 2007 season				
	RL	*RD*	*RFW*	*RY*	*SY*	*RL*	*R/D*	*RFW*	*RY*	*SY*
Demapoly	46.0	17.0	1.450	30.6	5.86	43.0	18.5	1.675	30.4	5.9
Carola (KWS9421)	30.0	14.5	1.435	29.2	5.04	28.5	14.5	1.175	27.8	5.1
Tteri	32.5	13.5	0.880	22.9	4.20	32.5	16.5	1.000	19.6	3.8
Kawemira	48.0	17.5	0.760	27.3	4.76	43.5	18.0	1.150	23.5	4.2
Desprez poly N	37.0	13.5	1.400	26.3	4.33	41.5	21.5	1.050	26.3	4.1
B2001	35.0	14.5	1.825	20.2	3.44	30.5	11.5	1.200	12.9	2.1
FD 9902	44.0	18.5	2.270	24.0	4.36	42.5	19.0	1.050	24.0	4.4
FD 9901	34.0	16.0	2.000	25.7	4.93	28.5	15.5	1.150	23.0	4.5
Meridio	39.5	15.5	1.725	30.4	5.44	30.0	18.0	1.125	25.5	4.5
Mahara (6S86)	46.5	19.5	2.250	29.5	4.81	43.5	22.5	1.100	22.5	3.9
FD 0405	32.5	18.0	1.050	31.4	5.62	22.0	14.5	1.050	21.1	3.8
FD 4901	44.0	14.0	1.425	31.9	5.63	46.5	13.5	1.700	31.3	5.5
Despreez mono N	35.0	13.5	0.950	25.9	4.67	33.5	15.5	1.100	26.9	5.0
Anema	42.0	18.0	1.350	23.2	4.35	42.5	18.5	1.200	22.5	4.2
LP 11	33.0	13.5	1.450	23.4	4.28	24.0	12.0	0.925	16.3	3.0
LP 12	25.0	18.5	1.350	25.9	5.00	18.5	18.0	1.025	24.0	4.6
LP 13	36.0	16.0	1.325	28.0	5.28	27.5	12.5	0.875	13.7	2.5
LP 14	36.5	11.0	1.150	25.2	4.59	25.5	10.5	1.150	24.0	4.5
LP 15	50.0	18.5	2.275	35.5	5.68	47.0	19.0	1.850	30.5	5.0
LP 16	33.5	11.5	1.300	20.7	3.47	30.0	11.5	0.925	14.0	2.3
Average	**38.0**	**15.6**	**1.5**	**26.9**	**4.8**	**34.1**	**16.1**	**1.2**	**23.0**	**4.1**
L.S.D at 0.05	9.17	4.56	0.83	5.91	1.04	10.29	6.64	0.31	5.48	0.98

RL: Root length (cm) RD: Root diameter (cm) RFW: Root fresh weight (kg/plant) RY: Root yield (ton/fed) SY: Sugar yields (ton/fed)

Otherwise, B2001 genotype recorded the lowest values of root and sugar yields in both seasons. These results coincide with those reported by El-Bakry (2006) and Ismail *et al* (2007) who found that varieties differed significantly in root yield and sugar yield, in both seasons.

Juice quality (sucrose and purity percentages)

Data illustrated in Table (3) revealed that varieties significantly differed in sucrose and purity % in both seasons. LP 12 genotype produced the maximum values of sucrose and purity % (19.30 and 87.0 %) in first season. Meanwhile, in the second season, FD 9901 recorded similar trend and LP 14 genotype (19.80 and 86.40 %). Conversely, LP 15 and Carola genotypes gave the lowest values of sucrose and purity percentages This result may be due to the genetic differences of genotypes. These results are in agreement with those obtained by Ismail *et al* (2007) who found that varieties differed significantly in sucrose % and purity % in both seasons.

Table 3. Average values of quality characters of sugar beet genotypes in 2005-2006 and 2006-2007 seasons.

Genotypes	2005-2006 Season				20062007 Season			
	S	*P*	*Ex*	*Ey*	*S*	*P*	*Ex*	*Ey*
Demapoly	19.2	84.7	17.0	88.5	19.5	84.7	17.2	88.5
Carola (KWS9421)	17.3	84.0	15.0	87.2	18.3	84.6	16.1	88.1
Tteri	18.4	86.2	16.5	90.1	19.6	85.6	17.6	89.9
Kawemira	17.5	85.7	15.6	89.5	18.0	85.8	16.2	89.8
Desprez poly N	16.5	86.1	14.7	89.6	15.8	85.3	13.9	88.5
B2001	17.1	85.7	15.3	89.6	16.4	85.9	14.7	89.6
FD 9902	18.2	85.4	16.3	89.7	18.3	86.0	16.5	90.4
FD 9901	19.2	86.7	16.7	91.5	19.8	86.2	18.0	91.0
Meridio	17.9	86.4	16.2	90.7	17.8	85.8	15.9	89.8
Mahara (6S86)	16.3	86.0	14.6	89.5	17.5	85.2	15.6	89.2
FD 0405	17.9	85.4	16.0	89.5	18.2	86.2	16.4	90.3
FD 4901	17.7	86.8	16.1	90.9	17.5	85.8	15.7	89.7
Despreez mono N	18.1	85.8	16.3	90.1	18.6	86.3	16.9	90.7
Anema	18.8	85.7	17.2	91.5	18.8	85.5	16.8	89.6
LP 11	18.3	86.6	17.6	91.1	18.4	85.9	16.5	90.0
LP 12	19.3	87.0	17.4	90.1	19.3	86.3	17.5	91.0
LP 13	18.9	85.0	16.8	89.1	18.6	86.2	16.7	90.3
LP 14	18.2	86.6	16.5	90.6	19.0	86.4	17.2	90.8
LP 15	16.0	85.2	14.1	88.3	16.3	86.0	14.6	89.6
LP 16	16.8	85.3	14.8	88.6	16.4	85.6	14.6	89.2
Average	17.9	85.8	16.0	89.8	18.1	85.8	16.2	89.8
L.S.D at 0.05	1.74	1.52	1.80	2.00	0.97	1.00	1.02	1.33

S: Sucrose % P: Purity % Ey: Extractability % Ex: Extractable sugar %

Extractable sugar and extractability percentages

Results in Table (3) indicated that extractable sugar and extractability percentages significantly differed among the tested genotypes in both seasons. Varieties LP 11 and FD 9901 surpassed the other varieties for extractable sugar in both seasons by (17.6% and 18.0%). Meanwhile, varieties FD 9901 and Anema gave the highest values in extractability percentage by (91.5%) in the first season, while in the second season varieties FD 9901 and LP12 significantly surpassed the other varieties in this trait by 91.0 %.

Genetic Parameters

Mean values presented in Tables (2 and 3) showed, significant differences due to genotypes for growth, yield and quality traits viz: root length cm, root diameter cm, root fresh weight kg/plant, root and sugar yields ton/fed., sucrose, purity, extractability and extractable sugar % which, as illustrated differed in their genetic background.

Significant differences were also observed for growth, yield and quality due to genotype x year (gy) interaction indicating that genotypes had considerable different responses to environmental influences (Table 4). It appears, from these results, that the genotypes under study possess great genetic variability. The ratio between the two-variance (g and gy) interaction was greater for growth, yield and quality.

Estimates of the various variance components among twenty sugar beet genotypes for characters studied are shown in (Table 4). The genotypes x year variance (σ^2 gy) as less than the genotypic variance (σ^2 g) for all characters, supported the previously mentioned conclusion that biased introduced by year was small, concerning beneficial selection for yield and components.

Table 4. Variance components, genotypic and coefficient of variations for the studied characters.

Traits	σ^2_e	σ^2_g	σ^2_{yg}
Root length (cm)	6.281	2.25	0.449
Root diameter (cm)	3.025	0.566	0.208
Root firth weight (kg/plant)	0.089	0.018	0.043
Root yield (ton/fed.)	4.105	0.88	0.430
Sugar yield (ton/fed.)	0.232	0.561	0.018
Sucrose %	0.451	0.667	0.047
Purity %	0.371	0.109	0.049
Extractability %	0.483	0.636	0.060
Extractable sugar %	0.646	0.368	0.052

σ^2_e = Error variance σ^2_g = Genotypic variance
σ^2_{yg} = Genotype x year interaction variance

Covariability

Phenotypic (rp) and genotypic (rg) correlation among growth, yield and quality of 20 genotypes on data of two seasons are shown in (Table 5).

Table 5. Phenotyic (rp) and genotypic (rg) correlation coefficients among growth, yield and quality of 20 genotypes on data of two seasons.

Characters		RL	RD	RFW	RY	SY	S	P	EY
Root length (cm)	rp	-	-	-	-	-	-	-	-
	rg	-	-	-	-	-	-	-	-
Root diameter (cm)	rp	0.775**	-	-	-	-	-	-	-
	rg	0.653	-	-	-	-	-	-	-
Root firth weight (kg/plant)	rp	0.578**	0.371	-	-	-		-	-
	rg	0.586	0.325	-	-	-	-	-	-
Root yield (ton/fed.)	rp	0.746**	0.870**	0.490*	-	-	-	-	-
	rg	0.501	0.713	0.506	-	-	-	-	-
Sugar yield (ton/fed.)	rp	0.560**	0.482*	0.704**	0.686**	-	-		-
	rg	0.547	0.475	0.874	0.477	-	-	-	-
Sucrose %	rp	-0.480*	0.712**	0.998**	0.810**	0.490**	-	-	-
	rg	0.513	0.513	0.874	0.664	0.509	-	-	-
Purity %	rp	0.425	0.284	0.886**	0.415	0.513**	0.622**	-	-
	rg	0.460	0.345	0.972	0.316	0.416	0.489	-	-
Extractability %	rp	0.211	0.434	0.900**	0.403	0.612**	0.402	0.351	-
	rg	0.365	0.197	0.819	0.408	0.520	0.325	0.403	-
Extractable sugar %	rp	0.225	-0.120	0.412	0.213	0.489*	0.511**	0.554**	0.560*
	rg	0.297	0.348	0.365	0.396	0.499	0.478	0.481	0.498

*,**= Indicate significance at the 0.05 and 0.01 levels of probability respectively.

Regarding root length (cm) exhibited significant and positive correlation with each of its three components (growth, yield and quality) root diameter cm (rp= 0.775, rg = 0.653), root fresh weight kg/plant (rp = 0.578, rg = 0.586), root yield ton/fed. (rp = 0.746, rg = 0.501), sugar yield ton/fed. (rp = 0.560, rg = 0.0.547), and sucrose % (rp = 0.0.480, rg = 0.513) indicated that maximization of root length may be obtained via selection for these three component variables. Moreover, the significant association between root diameter (cm) and each root yield ton/fed. (rp = 0.870, rg = 0.0.713), sugar yield ton/fed. (rp = 0.482, rg = 0.475), and sucrose % (rp = 0.712, rg = 0.513). In respect to root fresh weight kg/plant exhibited highly significant and positive correlation with each of its for components, root yield ton/fed. (rp = 0.490, rg = 0.506), sugar yield ton/fed. (rp = 0.704, rg = 0.874), sucrose % (rp = 0.998, rg = 0.874) and extractability % (rp = 0.900, rg = 0.819). As well as, a highly positive correlation occurred between root yield ton/fed and each of sugar yield ton/fed. (rp = 0.686, rg = 0.477),and

sucrose % (rp = 0.810, rg = 0.664). Positive correlation between sugar yield each of sucrose % (rp = 0.490, rg = 0.509), purity % (rp = 0.513, rg = 0.461), extractability % (rp = 0.612, rg = 0.520) and extractable sugar % (rp = 0.489, rg = 0.499). Moreover, the significant association between the three components, sucrose % and each of purity % (rp = 0.622, rg = 0.489) and extractable sugar % (rp = 0.511, rg = 0.478) supports this view. These results are in harmony with that reported by Inayatullah (1999) and Geidel *et al* (2000).

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التغاير لصفات محصول وجودة عشرون صنفا من بنجر السكر

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معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية

أقيمت تجربتان حقليتان في منطقة كوم أوشيم بمحافظة الفيوم خلال موسمي ٢٠٠٥/٢٠٠٦، ٢٠٠٦/٢٠٠٧ لتقييم عشرون تركيب وراثي من بنجر السكر (***Demapoly, Carola (KWS 9421), Tteri, Kawemira, Desprez poly N, B2001, FD 9902, FD 9901,FD 0405, FD4901, Meridio, Mahara (6S86), Despreez mono N, Anema, LP 11, LP 12, LP 13, LP 14, LP, 15 LP 16***) فيما يتعلق بالمحصول وصفات الجودة

أوضحت النتائج تفوق الصنف إلـ بي ١٥ في طول الجذر ، والوزن الطازج للجذر كجم/نبات ومحصول الجذور والسكر طن /ف في كلا الموسمين بينما تفوق الصنف إل بي ١٢ في النسبة المئوية للسكروز والنقاوة وكفاء الاستخلاص % في كلا الموسمين .

أظهرت جميع التراكيب الوراثية اختلافات عالية المعنوية لكل الصفات تحت الدراسة ، كذلك التفاعل بين هذه التراكيب والبيئات(G x Y) كان معنويا. بينما المساهمة النسبية في التباين الكلي للأصناف كان أعلي من

مساهمة تباين التفاعل مما يدل على أن معظم التباين لهذه الصفات يتحكم في معظمه عوامل وراثية مع تأثر قليل بالعوامل البيئية.

أشارت أهم نتائج الارتباط الظاهري والوراثي أن محصول السكر طن/ف أظهر ارتباطا معنويا وموجبا مع كل من طول الجذر سم ، وقطر الجذر سم ، وزن الجدر الطازج كجم/بنات . محصول الجذور طن/ف .

تحت ظروف هذه الدراسة يمكن التوصية باستخدام الصفات المحصولية المذكورة في الدراسة في عملية انتخاب وتقييم أصناف بنجر السكر المنزرعة تحت ظروف محافظة الفيوم كما يوصي بزراعة الصنفين إلـــ بي ١٢ ، إلـــ بي ١٥ .