معامل الارتباط المظهري وتحليل المسار للغلة ومكوناتها في هجن فردية من الذرة الصفراء (*Zea mays* L.) مطورة في سورية

Phenotypic Correlation and Path Coefficient Analysis for Yield and its Contributors in Single Crosses of Maize (*Zea mays* L.) Developed in Syria

Received 29 May 2011 / Accepted 25 October 2011

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المُلَخَّص

نُفذت هذه الدراسة في مركز بحوث حمص/سورية، خلال الموسمين 2008 و2009 لتقدير درجة التوريث بالمعنى الضيق Narrow sense heritability ومعامل الارتباط المظهري Phenotypic correlation، وكذلك تحليل المسار Path analysis لصفات الغلة الحبية ومكوناتها ومحتوى الحبوب من البروتين والزيت والنشاء. أظهرت الدراسة أن تباين الفعل الوراثي الإضافي (VA) كان معنوياً لكل الصفات عدا صفة محتوى الحبوب من النشاء، وأظهر الفعل الوراثي اللاإضافي (VD) تبايناً معنوياً في صفات طول العرنوس، وقطر العرنوس ووزن 100 حبة، وكانت قيم تباين الفعل الوراثي الإضافي (VA)، أعلى من مثيلاتها للفعل الوراثي اللاإضافي (VD) باستثناء صفة غلة النبات الفردي من الحبوب. كما كانت قيم درجة التوريث بالمعنى الضيق عاليةً في صفات محتوى الحبوب من البروتين (78 %) والزيت (78 %) وقطر العرنوس (69 %) ووزن 100 حبة (63 %). أبدت الغلة الحبية ارتباطاً موجباً ومعنوياً بكل من صفة قطر العرنوس ، وزن 100 حبة، وطول العرنوس ومحتوى الحبوب من الزيت وأظهر تحليل المسار أن صفات قطر العرنوس، محتوى الحبوب من الزيت ووزن 100 حبة كانت أكثر الصفات مساهمةً في تباين الغلة الحبية، ويمكن لمربي الذرة اعتمادها كمعايير انتخابية لتحسين غلة محصول الذرة الصفراء.

الكلمات المفتاحية: الذرة الصفراء، درجة التوريث، الارتباط المظهري، تحليل المسار.

Abstract

This study was conducted at the Agricultural research Center, Homs, during the two seasons 2008 and 2009, to estimate the narrow sense heritability, correlation and path coefficient analysis for grain yield/plant (GY), ear length (EL), ear diameter (ED), 100- kernel weight, grain protein (Pro.), oil and starch (Sta.)

content of grains. Results showed that all Additive Variance (VA) estimates were significant for all traits except starch content of grain. Also, Domimance Variance (VD) estimates were significant for ear length, ear diameter, 100- kernel weight. However, the magnitude of VA was consistently larger than that of VD for all traits except starch content of grain. High narrow sense heritability estimates were obtained for protein (78%) and oil (78%) content of grains, ear diameter (69%) and 100- kernel weight (63%), emphasizing that environmental influence was low on these traits. Results also indicated that grain yield correlated positively and significantly associated with ear diameter, 100- kernel weight, ear length and oil content of grains. The path coefficient analysis estimates indicated that ear diameter, oil content of grains and 100- kernel weight can be considered as the most important sources of plant grain yield variation. It has been concluded that ear diameter had high positive direct effects on grain yield and the breeder may consider this trait as the main selection criteria.

Keywords: Maize, Heritability, Correlation and path coefficient analysis.

Introduction

Plant breeder is concerned with the amount of genetic variance in his material rather than its productivity levels. However to carry out a successful breeding program, the breeder should have enough knowledge about the inheritance of the important traits associated with grain yield. Estimation of simple correlation between various agronomic characters may provide good information necessary for maize breeder, when selection is based on two or more traits simultaneously. Information obtained from correlation coefficient for these characters could be also useful as indicators for the most important ones under consideration. Direct selection for grain yield per may not be the most efficient method for its improvement, but indirect selection for other yield related characters, which are closely associated with yield and high heritability estimates will be more effective. Yassien (1993) reported that narrow sense heritability estimates ranged from 27% to 65% for plant height, ear length, ear diameter, number of rows per ear, number of kernel per row, 100- kernel weight and grain yield. Amer and Mosa, (2004) found that narrow sense heritability estimates were 27% for ear length, 31% for ear diameter, and 36% for grain yield. (AL- Ahmad, 2004; Aydin et *al.*, 2007; Najeeb et *al.*, 2009) indicated that the correlation values were significantly positive between grain yield and each of ear diameter and ear length. Path coefficient analysis has been used by cereal breeders to determine the nature of relationships between grain yield and its components, and to identify those components with significant effects on yield for potential use as selection criteria. The direct effect of ear diameter, ear length and number of kernels per row had the highest effect on yield variation (AL- Ahmad, 2004; Sadek et *al.*, 2006). Amin et al., (2003) also, indicated that number of kernels per row and 100- kernel weight were the highest contributors to variation in grain yield directly or indirectly.

The main objective of the present investigation was to estimate heritability, phenotypic correlations and path coefficients for yield and its components of 28 F1 hybrids of yellow maize, expecting that the results of the present investigation will be of value for maize breeders in Syria.

Materials and methods

Twenty-eight single crosses were developed by 8×8 half diallel cross in 2008 season at the

Agriculture Scientific Research Center, Homs, Syria. Eight yellow maize inbred lines i.e. IL.256-06 (P1), IL.136-06 (P2), IL.840-06 (P3), IL.291-06 (P4), IL.322-06 (P5), IL.233-06 (P6), IL.767-06 (P7) IL.257-06 (P8) were the source material of this investigation. The parents were chosen based on the presence of wide differences between them with respect to certain plant characteristics. F1 hybrids were planted in 2009 season in an experiment was designed in Randomized Complete Blocks Design (R.C.B.D) with three replications. Each, plot consisted of four ridges, 6m long and 70 cm wide. Plants were spaced at 25 cm within ridge and thinned to one plant per hill after about 21 days of planting. Other recommended cultural practices for maize production were applied during the growing season.

Observations and measurements were recorded on 10 guarded plants chosen at random from each plot for the following characteristics: grain yield/plant (GY) g, ear length (EL) cm, ear diameter (ED) cm, 100- kernel weight (100- KW) g, protein (Pro.), oil and starch (Sta.) content of grain. Griffing, (1956) approach was used to estimate genetic variance components (additive variance VA, dominance variance VD and residual variance VE). Estimates of VA/VP resulted in an estimate of narrow- sense heritability (h2). Phenotypic correlation coefficients were calculated as described by Snedecor and Cochran (1981) for all possible pairs of the studied characters including grain yield to obtain more information about the relative contribution of specific characters to grain yield and remaining characters, the path coefficient analysis was performed for all crosses. Partitioning correlation coefficients into direct and indirect effects at phenotypic level was made by determining path coefficients using the method proposed by Wright, (1934) and utilized by Dewey and Lu (1959).

Results and Discussion

Variability and heritability estimates

Variance components for general (V_{GCA}) and specific (V_{SCA}) combining abilities calculated for each trait were translated in terms of additive (VA) and dominance (VD) genetic variances according to Griffing, (1956) and they are summarized in Table (1). Results showed that all estimates of VAwere significant for all traits except VA for starch content of grains. Also, VD estimates were significant for all traits except for grain yield/plant, protein, oil and starch content of grains. The insignificance of these traits may be attributed to large magnitude of error variance of these traits. However, the magnitude of VA was consistently larger than that of VD for all traits except starch content of grain where, VD value was larger than VA. These results, indicate the clear predominance of additive genetic variance in the inheritance of most studied traits. High narrow sense heritability estimates were obtained for protein (78%) and oil (78%) content of grain, ear diameter (69%) and 100- kernel weight (63%), emphasizing that the additive genetic variation was the major component of genetic variation in the inheritance of these traits and the effectiveness of selection in the early segregating generations of the studied hybrids for improving these traits. Yasien (2000) ; El Hifny et *al.*, (2003) reported high estimates of heritability in narrow sense for ear diameter and 100- kernel weight, protein and oil content of grain. However, moderate narrow sense heritability estimates were obtained for grain yield/plant (59%), which is in agreement with that reported by Khalil (1999). Low narrow sense heritability estimates were obtained for, ear length (28%) and starch content of grain (24%).

Table 1. Heritability (h2) and Variance of additive (VA), dominance (VD), environment (VE) and phenotypic (VP) for studied traits.

S.O.V	GYP	EL	ED	100-KW	Pro. %	Oil %	Sta.%
V_A	1639.26**	0.52**	0.08**	15.00**	0.81**	0.12**	0.28NS
V_D	625.82NS	1.17**	0.03**	7.07**	0.11NS	0.02NS	0.56NS
V_E	514.03	0.15	0.01	1.74	0.12	0.01	0.35
V_P	2779.11**	1.84**	0.12**	23.81**	1.04**	0.15**	1.19**
h^2	0.59	0.28	0.69	0.63	0.78	0.78	0.24

NS non- significant * and ** refer to Significant at *P*= 0.05 and *P*= 0.01 respectively.

These results are in harmony with those obtained by (Younis et *al.*, 1994, Mohamed et *al.*, 2002; Amer and Mosa, 2004). Narrow sense heritability estimates emphasized the importance of choosing suitable segregating generations for exhibiting the best expression of genes of different characters in the studied hybrids for improving such traits.

Phenotypic correlation

The phenotypic correlation coefficient provides importantinformationaboutinterrelationshipsbetween two or more of yield attributes by which the breeder can design a successful program to improve the yield capacity of maize. Phenotypic correlation coefficients estimated between all pairs of studied characters including grain yield, obtained results are recorded in Table (2). The data showed that significant and positive correlation coefficients were found between grain yield and each of ear diameter (0.664**), 100-kernel weight (0.428**), ear length (0.324**) and oil content of grain (0.263*), such results could help the breeder to select high grain yield through selection for one or more of these characters. This result indicates that selection for length or thickness of ears, heavy 100-kernels weight and high oil content of grain may be accompanied by increasing grain yield of maize. However, non- significant correlations were observed between grain yield and any of the other characters. Similar results were reported by (Aydin et *al.*, 2007; Najeeb et *al.*, 2009, Fabijianac et al., 2006 and Saleem et *al.*, 2007). Other inter- character correlations revealed that protein content of grain, gives significant and positive correlation with ear length (0.264*) and negative correlations with starch content of grain (-0.459**) and ear diameter (-0.310**). Ear length exhibited significant and positive correlation

Table 2. Phenotypic correlation between all studied traits.

Traits	GYP	Pro.	EL	ED	100-KW	Oil
Pro.	-0.014 NS					
EL	0.324**	0.264*				
ED	0.664**	-0.310**	0.263*			
100-KW	0.428**	0.127 NS	0.486**	0.312**		
Oil	0.263*	0.204 NS	-0.125 NS	0.07 NS	-0.118 NS	
Sta.	0.189 NS	-0.459**	0.045 NS	0.340**	0.334**	-0.303**

(GYP) grain yield/plant, (Pro.) protein content of grain, (EL) ear length, (ED) ear diameter, (100-KW) 100- kernel weight and (Oil) oil content of grain. NS non- significant * and ** indicated to significant at P= 0.05 and P= 0.01, respectively.

with 100- kernel weight (0.486**) and ear diameter (0.263*). Previous studies (Yasien, et *al.*, 1987; Saleh et *al.*, 2002) confirmed the positive association between Ear length and each of 100- kernel weight and ear diameter. Ear diameter showed significant and positive correlation with starch content of grain (0.340**) and 100-kernels weight (0.312**). Such results are in accordance with the finding of Parvez and Rather, (2006). Regarding oil content of grain significant and negative association with starch content of grain (-0.303**).

Path coefficient analysis

Path coefficient analysis was estimated to study the direct and indirect effects of various yield components on grain yield per plant as well as the relative importance of these components as selection criteria. The traits taken into consideration as yield contributors in this investigation were ear diameter, oil content of grain and 100- kernel weight (Table 3). The data showed that the direct effect of ear diameter on grain yield was 0.570. The indirect effects of this trait through both oil content of grain and 100- kernel weight were 0.018 and 0.070, respectively (Table 3). These results indicated that the relative importance of ear diameter on grain yield was 42.44% (Table 4). Oil content of grains proved to have moderate direct effect on grain yield 0.253. The indirect effects of this character through the other traits were low (0.040 and -0.026) (Table 3). However, the relative importance of direct and indirect effects for oil content of grains was 5.07% (Table 4). The direct influence of 100- kernel weight on grain yield moderate 0.223. The indirect effects of this trait through ear diameter and oil content of grains were moderate 0.178 and low -0.030, respectively (Table 3). On the other hand, relative importance of 100- kernel weight was 4.97%. These results coincide with those obtained by (Sadek et *al.*, 2006; Amin *et al.*, 2003). Also, indicated that number of kernels per row and 100- kernel weight were the highest contributors to variation in grain yield directly or indirectly.

Table 3. Direct and indirect effects of Ear diameter, Oil content of grain and 100 - kernel weight vs. grain yield/plant.

	Source of variation	Effects
1	Ear diameter vs. grain yield/plant	
	Direct effect	0.570
	Indirect effect via oil content of grain	0.018
	Indirect effect via 100- kernel weight	0.070
	Total	0.658
2	Oil content of grain vs. grain yield/plant	
	Direct effect	0.253
	Indirect effect via ear diameter	0.040
	Indirect effect via 100- kernel weight	-0.026
	Total	0.267
3	100 - kernel weight vs. grain yield/plant	
	Direct effect	0.223
	Indirect effect via ear diameter	0.178
	Indirect effect via oil content of grain	-0.030
	Total	0.371

Table 4. Relative importance (direct and joint effects) in percent of grain yield variation.

Source of variation			CD	RI%
1	Ear diameter	(X_1)	0.3249	32.49
2	Oil content of grain	(X_2)	0.0640	6.40
3	100- kernel weight	(X_3)	0.0497	4.97
6	$(X_1) \times (X_2)$		0.0202	2.02
7	$(X_1) \times (X_3)$		0.0793	7.93
10	$(X_2) \times (X_3)$		-0.0133	-1.33
	Residual		0.4752	47.52
	Total relative importance			52.48%

CD denote coefficient of determination

RI% denote relative Importance

Finally, it can be concluded that, the contribution of ear diameter, oil content of grain and 100- kernel weight for grain yield variation account for 52.48%. Therefore, such results could help the breeder to improve grain yield through selection for one or more of these traits as the main selection criteria.

Conclusion

Ear diameter, oil content of grains and 100- kernel weight of maize had high narrow sense heritability and positive correlations with grain yield. Also, its total contribution was 52.48% of the total grain yield variation therefore, it seemed to be the most important sources affecting grain yield variation and consequently may be considered as important characters in selection programs aiming to maize yield improvement and the breeder may consider these traits as the main selection criteria.

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