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CORRELATION AND PATH ANALYESES OF YIELD AND YIELD ASSOCIATED TRAITS IN GRAIN SORGHUM (*Sorghum bicolor L.*) GENOTYPES

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ABSTRACT

An investigation was carried out on 24 restorer lines of grain sorghum and Dorado as a check variety to asses associations among grain yield and some of its components and to find out their direct and indirect effects on grain yield/panicle during 2020 and 2021 at two locations (Shandaweel Agric. Res. Station, Sohag Governorate and Arab El-Awamer Agric. Res. Station, Assuit Governorate). The combined analysis of variance for 25 genotypes across two years under two locations reveled highly significant differences among genotypes and locations for all studied traits. Moreover, the genotypes × locations interaction variance was also highly significant for all the studied traits. The highest value for 1000-kernel weight across two years under two locations (37.69 g) was given by R-sh-36 genotype and for grain yield/panicle (72.65 g) by R-sh-64. At Shandaweel a positive and significant or highly significant correlation was found between grain yield and each of panicle width, 1000-kernel weight and grain yield (0.276, 0.543, respectively). On the other hand there are negative and highly significant correlation (-0.334) between panicle length and grain yield. At Arab El-Awamer, positive and significant or highly significant correlation was found between panicle width, panicle length, 1000-kernel weight (0.343, 0.385, 0.484, respectively). The path analysis at Shandaweel Station showed that 1000-kernel weight had high positive direct effect on grain yield (0.477), In addition, panicle length had a positive direct effect on grain yield (0.299). Morever, at Arab El-Awamer location, the path analysis showed also that 1000-kernel weight had high positive direct effect on grain yield (0.347), also, panicle length had positive direct effect on grain yield (0.205).

Key words: ***Sorghum, Grain yield, Correlation, Path analysis.***

INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) is one of the important food crops in the world. It is cultivated in many parts of Asia and Africa, where its grains are used to make flat breads that form the staple food of many cultures. The species can be used as a source for making ethanol fuel and in some environments may be better than maize or sugarcane, as it can grow under harsh conditions. In Egypt it is the fourth most important cereal after wheat, rice and maize. The estimates of correlations alone may be often misleading due to mutual cancellation of component traits. So, it becomes necessary to study path coefficient analysis, which takes into account the casual relationship in addition to degree of relationship Mahajan *et al* (2011). The path coefficient analysis initially suggested by Wright (1921) and described by Dewey and Lu (1959) allows partitioning of correlation coefficient into direct and indirect contributions (effects) of various traits towards dependent variable and thus helps in assessing the cause-effect relationship as well as effective selection. Path analysis is necessary for better understanding of correlations among traits, which is a pathway for knowledge on specificity of the genetic material being studied. Ikanovic, (2010) concluded that even if correlation values are similar for certain pairs of traits, direct effects for some of them and especially indirect effects *via* other traits, can differ for some traits. Mahajan *et al* (2011), Wankhede *et al* (1985), Mallinath *et al* (2004) and Ambekar *et al* (2000) stated that panicle length, panicle width, plant height, number of primary branches/panicle, number of grains/panicle, test weight, harvest index and grain yield/panicle had showed a positive and significant association at both levels with all characters except days to 50%flowering and days to maturity. Therefore, this study aims to analyze and determine the traits having greater interrelationship with grain yield utilizing the correlation and path analysis.

MATERIALS AND METHODS

Twenty four local and international restorer grain sorghum lines and Dorado obtained from Shandweel Research Station were used for this study. The experiments were carried out at Arab El-Awamer Research Station, Assuit and Shandaweel Research Station during 2020 and 2021 growing seasons in a Randomized Complete Block Design (RCBD) with three replications. Each genotype was planted in one row plot, 4 meter long, 0.6 m wide and hill to hill distance of 0.20 m apart with two plants/hill after thinning. All other cultural practices were carried out as recommended for grain sorghum production in both seasons. The studied traits were: plant height (cm), days to 50% flowering, panicle length (cm), panicle width (cm), 1000-kernel weight (g), and grain yield/plant (g).

Statistical Analysis: Data for all these attributes were subjected to analysis of variance according to Steel and Torrie (1980) to evaluate the significant differences among genotypes. Estimation of variation components and phenotypic correlations were calculated as suggested by Burton (1952), Wright (1960) and Narasimharao and Rachie (1964). The correlation coefficient was partitioned into direct and indirect causes according to Dewey and Lu (1959) and Turner and Stevens [(1959). Test of significance was carried out with (n-2) degrees of freedom for phenotypic correlation by referring to the table given by Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Data presented in Table (1) are mean squares in the combined analysis of variance of analyzed traits of 25 genotypes of sorghum. The analysis of variance for yield and its attributes revealed that the differences among genotypes were highly significant (P<0.01) for all the studied traits. The data regarding means of grain yield and other characters of 25 genotypes of grain sorghum across two years are presented in Table 2. The presented data in Table (2) reveled the highly significant (P<0.01) variation between sorghum genotypes in all studied traits. Thus, the highest range of individual character was registered with regard to plant height (from 126.7 to 189.6 cm), days to 50% flowering (number of days to flowering) from 74.08 to 81.25 day), panicle length (from 24.73 to 31.68 cm), panicle width (from 6.422 to 7.683cm), 1000-kernels weight (from 24.25 to 37.69 g), and grain yield/ plant (from 47.22 to 72.65g). These variation between genotypes in all studied traits may be due to the genetic behavior combination with environment factors, which were suitable for one genotype than other.

Table 1. Combined analysis of variance for 25 genotypes of grain sorghum across two years and across two locations.

SOV	df	Mean squares					
		Plant height (cm)	Days to 50% flowering	Panicle length(cm)	Panicle width (cm)	1000-kernel weight	Grain yield per plant (g)
Year	1	24.65	16.33**	1.703	0.113	8.300*	5.333
Location (L)	1	2826.2**	10920.3**	882.7**	15.04**	2283.6**	14233.4**
Y x L	1	17.67	5.880*	1.129	0.162	19.92**	48.16**
R(LY) (Ea)	8	20.16**	3.750**	1.615	0.038	1.091	20.59**
Genotypes (G)	24	4145.3**	36.03**	58.10**	4.193**	93.81**	429.8**
YxG	24	4.528	1.125	1.411	0.079	3.630**	4.214
L x G	24	30.43**	18.86**	6.246**	0.342**	61.12**	32.44**
YxLxG	24	4.189	1.297	0.841	0.077	2.470*	7.422
Error	192	7.338	1.330	1.044	0.091	1.418	5.569

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

Table 2. Means of grain yield and other traits of 25 genotypes of grain sorghum across two years under two locations.

Genotypes	Plant height (cm)			Days to 50% flowering			Panicle length (cm)		
	A	S	Com.	A	S	Com.	A	S	Com.
R-sh-11	166.1	172.5	169.3	84.33	66.83	75.58	23.90	29.34	26.62
R-sh-12	165.6	175.1	170.3	81.33	69.33	75.33	29.67	31.83	30.75
R-sh-13	174.2	175.9	175.0	83.33	71.00	77.17	25.53	30.12	27.83
R-sh-14	160.9	166.0	163.4	83.50	70.50	77.00	27.98	32.00	29.99
R_sh_17	188.6	195.6	192.1	84.17	72.33	78.25	23.58	28.30	25.94
R_sh_18	137.1	143.2	140.1	85.33	71.33	78.33	22.48	28.14	25.31
R_sh_19	139.4	143.0	141.2	85.33	72.67	79.00	21.75	27.70	24.73
R_sh-27	149.4	157.0	153.2	81.67	71.33	76.50	23.52	28.01	25.77
R_sh-28	161.9	167.3	164.6	84.83	71.83	78.33	29.43	33.03	31.23
R_sh-30	157.2	165.7	161.4	85.50	71.17	78.33	25.95	32.94	29.44
R_sh-31	165.3	173.0	169.1	84.00	72.17	78.08	21.62	32.36	26.99
R_sh-36	175.5	186.2	180.8	83.83	72.33	78.08	31.20	32.35	31.78
R_sh-56	176.9	181.7	179.3	83.17	73.33	78.25	22.58	28.85	25.72
R_sh-57	172.1	174.7	173.4	84.83	76.17	80.50	26.08	30.85	28.47
R_sh-58	185.7	193.5	189.6	84.50	77.00	80.75	28.17	31.62	29.89
R_sh-59	165.3	166.0	165.7	83.33	75.33	79.33	27.80	30.60	29.20
R_sh-60	155.2	156.1	155.7	82.67	72.67	77.67	27.27	31.75	29.51
R_sh-61	136.0	141.6	138.8	83.33	68.50	75.92	27.73	30.25	28.99
R_sh-62	132.5	137.4	134.9	85.83	69.50	77.67	25.42	28.58	27.00
R_sh-63	152.2	155.7	154.0	82.17	70.33	76.25	24.18	29.48	26.83
R_sh-64	124.0	129.5	126.7	85.00	71.67	78.33	30.30	33.05	31.68
R_sh-65	125.4	131.7	128.5	78.17	70.00	74.08	28.58	31.78	30.18
R_sh-67	127.5	141.6	134.5	86.00	71.83	78.92	22.83	26.98	24.91
R_sh-68	153.4	159.6	156.5	87.83	74.67	81.25	26.38	27.78	27.08
Dorado	140.4	151.4	145.9	85.67	74.17	79.92	24.93	27.60	26.27
LS.D.05	2.18	3.14	2.66	1.06	1.20	1.13	1.00	1.01	1.00

Table 2. Cont.

Genotypes	Panicle width (cm)			1000-grain weight (g)			Grain yield per plant (g)		
	A	S	Com.	A	S	Com.	A	S	Com.
R-sh-11	6.750	6.883	6.817	33.85	40.20	37.03	51.95	66.23	59.09
R-sh-12	6.583	7.200	6.892	29.08	35.45	32.27	50.58	65.60	58.09
R-sh-13	6.783	6.817	6.800	25.83	28.08	26.96	44.93	59.58	52.26
R-sh-14	7.550	7.800	7.675	29.62	40.35	34.98	58.78	70.75	64.77
R_sh_17	7.217	7.417	7.317	27.20	31.33	29.27	42.02	52.42	47.22
R_sh_18	6.517	7.100	6.808	28.27	32.15	30.21	51.05	61.98	56.52
R_sh_19	6.400	6.800	6.600	27.05	35.62	31.33	50.28	65.37	57.83
R_sh-27	7.067	7.433	7.250	23.70	35.73	29.72	45.65	67.50	56.58
R_sh-28	7.238	7.667	7.453	32.25	34.78	33.52	52.55	70.62	61.58
R_sh-30	7.250	7.650	7.450	23.88	35.00	29.44	55.67	71.55	63.61
R_sh-31	7.383	7.750	7.567	24.60	35.92	30.26	50.97	70.80	60.88
R_sh-36	7.700	7.533	7.617	36.23	39.15	37.69	63.88	74.03	68.96
R_sh-56	6.733	6.933	6.833	27.88	29.33	28.61	55.50	68.73	62.12
R_sh-57	6.600	6.967	6.783	21.92	26.58	24.25	44.87	55.68	50.28
R_sh-58	6.460	6.967	6.713	25.58	28.33	26.96	52.45	64.67	58.56
R_sh-59	6.933	7.650	7.292	26.50	28.90	27.70	45.98	57.05	51.52
R_sh-60	7.417	7.783	7.600	26.48	35.32	30.90	50.58	70.68	60.63
R_sh-61	6.217	6.700	6.458	25.87	30.25	28.06	46.10	59.23	52.67
R_sh-62	7.567	7.800	7.683	25.43	28.25	26.84	48.38	58.92	53.65
R_sh-63	7.300	6.780	7.040	24.85	26.17	25.51	57.60	69.30	63.45
R_sh-64	7.430	7.560	7.495	31.48	37.60	34.54	68.20	77.10	72.65
R_sh-65	6.583	6.700	6.642	25.08	27.48	26.28	52.45	64.85	58.65
R_sh-67	6.332	6.805	6.568	24.02	26.85	25.43	52.08	67.32	59.70
R_sh-68	6.417	6.427	6.422	24.13	25.48	24.81	54.22	64.53	59.38
Dorado	6.472	7.385	6.928	29.68	32.12	30.90	54.72	66.35	60.53
LS.D.05	0.262	0.329	0.296	1.05	1.29	1.17	2.05	2.58	2.32

S = Shandaweel, A = Arab El-Awamer

These finding are in agreement with those obtained by House (1985), Mahdy *et al* (2011), Tag El-Din *et al* (2012) and Abd El-Raheem *et al* (2020). Furthermore, data in Table (1) showed highly significant interaction between years and genotypes for 1000-kernel weight, while the plant height, days to 50% flowering, panicle length, panicle width and grain yield/plant, did not show significant interaction.

At Shandaweel Station, Phenotypic correlations presented in Table (3). They showed highly significant ($p<0.01$) and positive association between 1000-kernel weight and grain yield (0.543), whereas highly significant ($P<0.01$) and negative association was found between grain yield and panicle length (-0.334) .Panicle width showed a positive and significant correlation with grain yield (0.276). The correlation of 1000-kernel weight was positive and highly significant ($P<0.01$) with panicle length and panicle width (0.392, 0.506), respectively, whereas significant ($P<0.05$) and negative association was found with days to 50% flowering (-0.334).While in Assuit Station, grain yield showed highly significant correlation ($P<0.01$) with 1000- Kernel weight and panicle length (0.484, 0.385), respectively. Panicle width showed a positive and significant correlation with grain yield (0.343). 1000- Kernel weight had a positive and highly significant ($P<0.01$) correlation with panicle length (0.392) and a significant ($P<0.05$) with panicle width (0.288).

Table 3. Phenotypic correlation among the studied traits for yield and yield contributing characters in grain sorghum at Shandaweel (above diagonal) and Assuit (below diagonal).

Trait	Plant height	50% flowering	Panicle length	Panicle width	1000-Kernel weight	Grain yield/plant
Plant height	**---**	**0.316***	**0.183**	**0.099**	**0.100**	**-0.151**
50% flowering	**-0.026**	**---**	**-0.019**	**-0.018**	**-0.334***	**-0.128**
Panicle length	**0.046**	**-0.229**	**---**	**0.453****	**0.392****	**-0.334****
Panicle width	**0.166**	**-0.089**	**0.225**	**---**	**0.506****	**0.276***
1000- Kernel weight	**0.122**	**-0.011**	**0.392****	**0.288***	**---**	**0.543****
Grain yield/plant	**-0.222**	**0.105**	**0.385****	**0.343***	**0.484****	**--**

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

The path analysis Table (4) in Shandaweel, showed that panicle length had a positive direct effect on grain yield (0.299). Its positive indirect effect was through 1000-kernel weight (0.187), whereas its indirect effect was negative through panicle width (-0.046). Panicle width had a negative direct effect was grain yield (-0.101), whereas its indirect effect was through panicle length and 1000- kernel weight (0.135, 0.241), respectively. Its positive direct was through 1000- kernel weight and grain weight yield (0.477), whereas its indirect effect was through panicle length (0.117) and a negative indirect effect was through panicle width (-0.051).

Table 4. Partitioning of phenotypic correlation coefficients into direct and indirect effects by path coefficient analysis for grain yield/plant under two locations across two years.

Correlation		Shandaweel	Assuit
P.L *VS* G.Y	**r**	**0.440**	**0.385**
Direct effect	**P_{14}**	**0.299**	**0.205**
Indirect effects *via* P.W	**$r_{12}P_{24}$**	**-0.046**	**0.044**
Indirect effects *via* 1000-KW	**$r_{13}P_{34}$**	**0.187**	**0.136**
	Total	**0.440**	**0.385**
P.W *VS* G.Y	**r**	**0.276**	**0.343**
Direct effect	**P_{24}**	**-0.101**	**0.197**
Indirect effects *via* P.L	**$r_{12}P_{14}$**	**0.135**	**0.046**
Indirect effects *via* 1000- KW	**$r_{23}P_{34}$**	**0.241**	**0.100**
	Total	**0.276**	**0.343**
1000- KW *VS* G.Y	**r**	**0.543**	**0.484**
Direct effect	**P_{34}**	**0.477**	**0.347**
Indirect effects via P.L	**$r_{13}P_{14}$**	**0.117**	**-0.080**
Indirect effects via P.W	**$r_{23}P_{24}$**	**-0.051**	**0.057**
	Total	**0.543**	**0.484**
Residual factor		**0.798**	**0.828**

P.L = Panicle length, P.W= Panicle width, K.W= - Kernel weight, G.Y= Grain yield.

In Assuit, the path analysis showed that panicle length had a positive direct effect on grain yield (0.205). Its positive indirect effect was through 1000-kernel weight (0.136), whereas its indirect effect through panicle width (0.044). Panicle width had a direct effect with grain yield (0.197), whereas its indirect effect was through panicle length and 1000- kernel weight (0.046, 0.100), respectively. Its positive direct was through 1000-kernel weight and grain yield (0.347), whereas its negative indirect effect was through panicle length (-0.080) and a positive indirect effect was through panicle width (0.057).

Thus it is revealed from the present study that the traits like panicle length and 1000-kernel weight had the greatest importance. Hence, due consideration should be given to these characters, while planning a breeding strategy for increased grain yield/ panicle.

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قياس معامل المرورو الارتباط للمحصول والصفات المرتبطة به في بعض التراكيب الوراثية لمحصول الذرة الرفيعة للحبوب

اعتماد محمد حسين

قسم بحوث الذرة الرفيعة – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية

أجريت هذه الدراسة في كل من محطة بحوث عرب العوامر بأسيوط ومحطة بحوث شندويل بسوهاج حيث تم تقييم ٢٤ سلالة معيدة للخصوبة والصنف دورادو كصنف مقارنة لمعرفة مدي ارتباط صفة المحصول ومكوناته وتأثيرها بطريقة مباشرة أو غير مباشرة علي محصول الحبوب للنبات وذلك خلال موسمي ٢٠٢٠ و ٢٠٢١م. أظهرت النتائج وجود أختلافات عالية المعنوية بين النراكيب الوراثية بالنسبة لكل الصفات محل الدراسة في كلا الموقعين خلال موسمي الزراعة. كذلك أظهرت النتائج اختلافات عالية المعنوية للتفاعل ما بين التراكيب الوراثية والمواقع لكل الصفات المدروسة. أعلي قيمة كانت لصفة وزن الألف حبة (٣٧,٦٩ جم) وذلك للتركيب الوراثي R-sh-36 وأعلي قيمة لصفة المحصول كانت (72.65 جم) وذلك للتركيب الوراثي R-sh-6٤. أوضحت النتائج ايضا بالنسبة لمحطة شندويل وجود علاقة موجبة بين المحصول و كل من صفتي عرض القنديل ووزن الالف حبة بينما كانت العلاقة سالبة وعالية المعنوية بين صفتي طول القنديل ومحصول الحبوب. أما بالنسبة

لمحطة عرب العوامر بأسيوط فكانت هناك علاقة موجبة ومعنوية وعالية المعنوية بين صفة المحصول و كل من طول القنديل ووزن الألف حبة وعرض القنديل. ومن ناحية أخري أظهرمعامل المرور لمحطة شندويل وجود تأثير مباشر موجب بين صفتي وزن الألف حبة وصفة المحصول (0.477) كذلك وجود تأثير مباشر وموجب بين صفة طول القنديل وصفة المحصول (0.299). كذلك بالنسبة لمحطة عرب العوامر بأسيوط فأوضحت نتائج معامل المرور أيضا وجود تأثير مباشر وموجب بين صفتي وزن الألف حبة وصفة المحصول (0.347). كذلك وجود تأثير موجب ومباشر بين كل من صفتي طول القنديل و صفة المحصول (0.205) .

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