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PATH –COEFFICIENT ANALYSIS AND CORRELATION STUDIES ON GRAIN YIELD AND YIELD COMPONENTS OF TWO WHEAT CROSSES

A. A. Hamada[1] , A. M. El-Zanaty[2] and S. M. Abdel-Daym[1]
[1] Wheat Research Department, Field Crops Research Institute, ARC,Giza, Egypt
[2] Agronomy Department, Faculty Of Agriculture, Minufiya University, Egypt
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ABSTRACT: ***This study was carried out at El-Gemmeiza Agric. Res. Station, during the three seasons from 2004/2005 to 2006/2007 to estimate the relationships between grain yield and its components ; number of spikes/ plant , number of kernels/ spike and 100 kernel weight for F_2, F_3 and F_4 generations of two bread wheat crosses ; Gemmeiza 3 x Attila and Sids1 x Gemmeiza 5 . Results showed a positive and significant genotypic and phenotypic correlation between yield and its components . Moreover, genotypic and phenotypic correlations among each two of the yield components were mostly significant positive or significant negative in the most of correlations for the two crosses studied in their three generations F1,F2 and F3.***

Path coefficient analysis showed that grain yield was directly affected by number of kernel / spike ,100 kernel weight and number of spike/ plant , in both genotypic and phenotypic correlation . Also coefficient of determination for grain yield showed that the total direct effects for yield components was larger than the total indirect effect of its components ; number of spike/ plant , number of kernel/spike and 100 kernel weight .

Keywords: **Wheat, Path coefficient, Correlation.**

INTRODUTION

Conventional breeding methods to improve self pollinated crops could not be extensively used in wheat *(Triticum aestivum L.)* because of its narrow gene pool. Wheat breeders try to explain the relations between grain yield, agronomic and morphological traits using simple correlation coefficient. Although, correlation coefficient is very important to determine traits that directly affect grain yield ,they are insufficient to determine indirect effects of these traits on grain yield. They study the correlation that helps plant breeders to select important characters on the basis of genotypic association of the paired traits which are highly correlated .Direct selection for wheat grain yield seems to be rather complex , it might be more desirable to select for some easily identified characteristics proved to be closely correlated with grain yield . Several investigators performed path coefficient analysis for wheat yield and yield components . Fonsela and Patterson (1968); Sidwell *et al* (1976) and Asif *et al* (2004) reported that number of

kernels/ spike had the largest direct phenotypic effect, while genotypic estimates were intermediate and nearly equal to those of kernel weight. Many investigators studied phenotypic and genotypic correlations and path analysis (kampoj and Mani (1983) ; Hamada (1988) ; El-Sayed (1990) ; Abd El-Rahman (1991);Khattab (1994) and Zaied (1995).This investigation which involved three different generations i.e. F2, F3 and F4 aimed to study the correlation coefficients among yield and its components, i.e. number of spikes/ plant, number of kernels/ spike and 1000- kernel weight .Also to estimate the direct and indirect effects for each trait on yield .

MATERIALS AND METHODS

This investigation was carried out at Gemmeiza Agricultural Research Station, during the three growing seasons , 2004/2005 , 2005 /2006, and 2006/2007 .The genetic behaviour of yield and its components in F_2 ,F_3 and F_4 generation of two wheat crosses i.e, Gemmeiza 3 x Attila and Gemmeiza 5 x Sids 1 were studied to determine the most likely character which could be used to help the plant breeder to select for other characters on the basis of genotypic and phenotypic association of the paired traits .In 2004/2005 season, the F_2 population seeds for each cross as well as the seeds of the parents involved were sown by single plant in 6 rows 20 m long ,30 cm. apart and 10 cm.between plants. Data were recorded on 150 plants of F_2 and 20 plants of each parents.The grains of 100 plants for each cross were randomly chosen to produce F3 families .

In 2005 /2006 season, 100 families of each cross were sown. Each family represented a single row 5.0 m long in addition to the two parents involved in the cross .The parental genotypes were used as check varieties and were sown every 20 F3 families the system of sowing and agronomic practices were the same as used for the F_2 experiment .Data were recorded on 5 plants which were chosen randomly from every row .Fifteen F3 families from each cross were chosen randomly and approximately 900 grains from each family was used to produce F4 families .

In 2006/2007 season, the selected 15 F_4 grain families and the two parents of each cross , were sown using the Randomized Complete Block Design with three replications .Each plot consisted of 6 rows of 5 m long 20 cm. apart and seeded with 50 seeds per row .At harvest data were recorded on twenty guarded individual plants for each plot.

Statistical analysis and statistical procodures :

The phenotypic (r_{ph}) and genotypic (r_g) correlation coefficients among the studied characters for each of F2 , F3 and F4 generations were estimated according to Dewey and Lu (1959) using the covariance analysis.The relative importance of number of spikes /plant , number of kernels per /plant and 100- kernel weight to the phenotypic and genotypic variations of grain yield

were calculated using path analysis according to Li (1956) and Steel and Torie (1960) .

RESULTS AND DISCUSSION

1- Correlation coefficients study :-

The phenotypic and genotypic correlations for the yield and its components of the two studied crosses for F2,F3 and F4 generations are presented in (Table 1). Generally, phenotypic correlation estimates were higher than the respective genetic ones in most cases. The significant results among yield and its components indicate their genetic effect, Yunus and Paroda(1982), Asif, *et al* (2004) and Hendawy ,*et al* (2005).

Table (1): Correlation coefficient for two crosses studied in F_2 ,F_3 and F_4 generations.

Traits	Gemmeiza 3 x Attila			Sids1 x Gemmeiza 5		
	F_2	F_3	F_4	F_2	F_3	F_4
G.y x No. S/ P r_{ph}	0.832**	0.823**	0.894**	0.823**	0.569**	0.702**
r_g	0.636**	0.771**	0.823**	0.782**	0.789**	0.856**
G.y x No K/S r_{ph}	0.863**	0.787**	0.335	0.815**	0.816**	0.718**
r_g	0.652**	0.613**	0.329	0.856**	0.834**	0.783**
Gy x 100 K wt r_{ph}	0.851**	0.517**	0.956**	0.781**	0.815**	0.865**
r_g	0.806**	0.506**	0.898**	0.892**	0.918**	0.823**
No. S/P X No K/S r_{ph}	0.616**	-0.083	0.320	0.663**	0.294	0.256
r_g	0.511**	0.226	0.226	0.423	0.401	0.506**
No. S/P X100 K wt r_{ph}	0.632**	0.632**	-0.318	0.326	0.561**	0.367
r_g	-0.130	0.401	-0.225	0.529**	0.727**	0.621**
No K/S x 100 K wt r_{ph}	0.151	0.014	-0.642**	-0.416	0.227	-0.467
r_g	-0.161	-0.163	-0.713**	-0.516**	-0.506**	-0.615**

Genotypic and phenotypic correlation (r_{ph} and r_g) between grain yield per plant (G.y) and each of number /spikes per plant (No. S/P) ,number of kernels/spike (No K/S) and 100-kernel weight (100 K wt) of the two crosses studied for F2, F3 and F4 were positive and highly significant . These results are agreed with those obtained by Kampoj and Mani (1983), El-Sayed (1990), Khattab (1994), Zaied (1995), Asif, *et al* (2004) and Hendawy, *et al* (2005).

The phenotypic and genotypic correlations between number of spikes per plant and number of kernels per spike were positive and significant in the

two crosses except phenotypic correlation in the F3 generation of cross Gemmeiza 3 x Attila which was negative and non significant. Same results were obtained by Rovandranth and Pand(1978) ; Sinha and Sharma (1979) ; Zaied (1995) ; Rebetzke, *et al* (2004) and Seleem and Hendawy (2007).

The phenotypic and genotypic correlation between number of spikes /plant and 100 kernel weight were positive and significant for the cross sids1xGemmeiza5 .The cross Gemmeiza 3 x Attila, had positive and significant phenotypic correlation for F2 and F3 but it was negative and significant for F4 . The genotypic correlation were negative and non-significant for F2, positive and significant for F2and negative and significant in F4 . These results are in harmony with the result obtained by Ravandranath and pand (1978); Sinha and sharma(1979) ; Mohiudin and Croy(1980) ; Singh *et al*. (1982) Contrail and Haro(1986), and Seleem (2006). The genotypic correlation between number of kernels / spike and 100-kernel weight was negative and significant in F2,F3 and F4 for Sids1x Gemmeiza5 , and it was insignificant negative values for F2 and F3 and significant negative for F4 with cross Gemmeiza 3 x Attila . Same results were obtained by Karrar(1980). However, the phenotypic correlation between number of kernels per spike and 100-kernel weight was insignificant and positive in F2 and F3 and found to be significantly negative in F4 for cross Gemmeiza 3 x Attila. On the other hand, cross number 2, Sids1 x Gemmeiza 5 showed significantly negative correlation in F2 and F4 and significantly positive in F3 for the same trait. Rachinski(1971) ; Sirvistava and Singh(1971) ; Karrar (1980) Sing *et al* .(1982) Esmail (2001) and Seleem (2006) found the same results.

2- Path coefficient analysis :-

Further information regarding yield and its components interrelationships could be investigated by conducting path coefficients which are included by Dewey and Hu(1959) and Durat and Adams (1971). A summarry of direct and indirect phenotypic and genotypic effects are given in (Tables 2 and 3), respectively. Results on path coefficient analysis of the phenotypic correlation (Table 2) , showed that, the greatest direct effect on grain yield were found with number kernels /spike and 100-kernel weight for the two crosses studied in F2,F3 and F4 generations except in F3 for cross Gemmeiza 3 x Attila for number of spikes/ plant and number of kernels/spike. the significantly positive correlation with grain yield per plant revealed that the importance of the two components i.e. number of kernels/spike and 100 kernel weight .The indirect effect of number spikes / plant had the more influence on grain yield than number of kernels/ spike and 100 kernel weight (Table 2) .

Table (2): Partitioning of phenotypic correlation coefficients into direct and indirect effects for the two crosses studied .

Level of estimation	Gemmeiza 3 x Attila			Sids x Gemmeiza 5		
	F_2	F_3	F_4	F_2	F_3	F_4
No. of spikes /plant						
Direct effect P1	-0.3004	0.8780	1.1528	-4.3478	0.0014	-0.3621
Indirect effect	1.1324	-0.0550	-0.2588	5.1708	0.5676	1.0641
Via No.K/S r_{12} P_2	0.5616	-0.0670	0.4445	3.6978	0.1955	0.4180
Via 100 K.wt r_{13} P_3	0.5708	0.0120	-0.7033	1.4730	0.3721	0.6461
Total correlation r_1	0.832	0.823	0.8940	0.8230	0.5690	0.7020
No. of kernels/spike						
Direct effect P2	0.9117	0.8072	1.3848	5.5773	0.6650	1.6328
Indirect effect	-0.0487	-0.0202	-1.0498	-4.7623	0.1510	-0.9148
Via No.S/P r_{21} P_1	-0.1851	-0.0729	0.3700	-2.8826	0.0004	-0.0927
Via 100 K.wt r_{23} P_3	0.1364	0.0527	-1.4198	-1.8797	0.1506	-0.8221
Total correlation r_2	0.8630	0.7870	0.3350	0.8150	0.8160	0.7180
100 kernel weight						
Direct effect P3	0.9032	0.3759	2.2116	4.5185	0.6633	1.7604
Indirect effect	-0.0522	0.1411	-1.2556	-3.7375	0.1517	-0.8954
Via No.S/P r_{31} P_1	-0.1899	0.0281	-0.3665	-1.4174	0.0007	-0.1329
Via No.K/S r_{32} P_2	0.1377	0.1130	-0.8891	-2.3201	0.1510	-0.7625
Total correlation r_3	0.8510	0.5170	0.9560	0.7810	0.8150	0.8650

These results indicated that selection for lines which have high yielding ability should be characterized by great number of kernels/ spike , heavy kernels and high tillers /plant (Ehadaie and Waines (1989) . These results were confirmed by Fonsela and Patterson (1968) ; Yunus and Paroda(1982); Kampoj Mani (1983); El-Sayed (1990); Khattab (1994); Zaied (1995), Esmail,(2001) and Seleem (2006) .

At the genetic level , it was obvious that the important direct effects on grain yield for the two crosses were 100-kernel weight and number of kernels/spike in F2 generation .(Table 3).On the other hand, in F3 families number of kernels/spike and number of spikes/ plant had the effective direct effect on grain yield for the two crosses,100-kernel weight and number of kernels/ spike in F4 for Gem 3x Attila and number of spike/ plant and number of kernels/spike in F4 for cross Sids1 xGem.5. The indirect effect value at phenotypic level showed that the greatest effect for number of spike/ plant in F2 with cross SidsxGem.5 followed by the value of indirect effect of number

of spikes / plant in F3 for cross Gim. 3 x Attila. However , the indirect effect for number of kernels /spike showed the highest value effect in F2 for Sids 1 x Gem.5 followed by the value of the indirect effect in F3 and F4 for cross Gem.3x Attila. Also , the highest indirect effect value of 100 kernel weight was obtained in F2 for cross Sids1 xGem .5 , the highest value for the same trait in F2 and F3 were obvious in the cross Gem.3 xAttila. These results were confirmed by those obtained by Assey *et al* (1979) ; Sinha and Sharm (1979) ; Mitkees *et al* . (1992) ; El-Bana and Basha(1994) Tammam *et al*.(2000) ; Asif (2004) and Seleem and Hendawy (2007).

Table (3): Partitioning of genotypic correlation coefficients into direct and indirect effects for two crosses studied.

Level of estimation	Gemmeiza 3 x Attila			Sids1 x Gemmeiza 5		
	F_2	F_3	F_4	F_2	F_3	F_4
No. of spikes /plant						
Direct effect P1	0.4718	0.4786	0.9523	-15.6317	3.8741	2.2889
Indirect effect	0.1642	0.2924	-0.1293	16.4137	-3.0851	-1.4329
Via No.K/S r_{12} P_2	0.2888	0.1291	0.4169	7.0306	-0.9014	-0.6048
Via 100 K.wt r_{13} P_3	-0.1246	0.1633	-0.5462	9.3831	-2.1837	-0.8281
Total correlation r_1	0.6360	0.7710	0.8230	0.7820	0.7890	0.8560
No. of kernels/spike						
Direct effect P2	0.5652	0.5712	1.8445	16.6207	-2.2478	-1.1952
Indirect effect	0.0868	0.0418	-1.5155	-15.7697	3.0818	1.9782
Via No.S/P r_{21} P_1	0.2411	0.1082	0.2152	-6.6122	1.5535	1.1582
Via 100 K.wt r_{23} P_3	-0.1543	-0.0664	-1.7307	-9.1525	1.5283	0.8200
Total correlation r_2	0.6520	0.6130	0.3290	0.8560	0.8340	0.7830
100 kernel weight						
Direct effect P3	0.9583	0.4072	2.4274	17.7375	-3.0204	-1.3334
Indirect effect	-0.1523	0.0988	1.5294	-16.8455	3.9384	2.1564
Via No.S/P r_{31} P_1	-0.0613	0.1919	-0.2143	-8.2692	2.8010	1.4213
Via No.K/S r_{32} P_2	-0.0910	-0.0931	-1.3161	-8.5763	1.1374	0.7351
Total correlation r_3	0.8060	0.5060	0.8980	0.8920	0.9180	0.8230

2- Coefficient of determination :-

From the results in Table 4 and at the genetic and phenotypic levels, it was obvious that, the total direct effect for the three components of grain yield , i.e. number of Spikes/plant, number of kernels/spike and 100- kernel weight were larger than the indirect effect for the same traits in F2,F3 and F4 for the two crosses studied. These outcomes may assess the important role of genotype x environment interaction . On the other hand the residual values for the two crosses showed negative values in most generation at phenotypic and genotypic correlations .These results in agreement with Gafius (1956) ; Asif (2004) and Seleem and Hendawy (2007). It could be easier to increase grain yield by selecting for yield components (No .spikes/ plant, No. kernels/ spike and 100 kernel weight) .The most important two components from the present study are, number of kernel / spike and 100 kernel weight and followed by no. of spikes/ plant . So ,we can bread for increasing grain yield by selecting for kernel /spike and 100 kernel weight while using optimum agronomic and cultural practices such seeding rate nitrogen fertilization, etc .

Table (4): Coefficient of determination relative to grain yield

Source of variation		Gemmeiza 3 x Attila			Sids1 x Gemmeiza 5		
		F_2	F_3	F_4	F_2	F_3	F_4
Phenotypic							
Direct effect		1.7372	1.5637	8.1381	70.4262	0.8822	5.896
No.S/P	$P1^2$	0.0903	0.7708	1.3289	18.9032	0.0000	0.1311
No.K/S	P_2^2	0.8311	0.6516	1.9178	31.1061	0.4423	2.6660
100 K.wt	P_3^2	0.8158	0.1413	4.8914	20.4171	0.4399	3.0990
Indirect effect		-0.4317	-0.0116	-4.5292	-65.9301	0.2018	-3.4551
No.S/P x No.K/S		-0.3374	-0.1177	1.0249	-32.1539	0.0005	-0.3027
No.S/P x100 K.wt		-0.3430	0.0211	-1.6215	-12.8089	0.0010	-0.4678
No.K/S x100 K.wt		0.2487	0.0850	-3.9326	-20.9673	0.2003	-2.6846
Residual value		-0.3055	-0.5521	-2.6089	-3.4961	0.0841	-1.4409
Total		1.000	1.000	1.000	1.000	1.000	1.000
Genotypic							
Direct effect		1.4604	0.7212	10.2016	835.2160	29.1836	8.4456
No.S/P	P_1	0.2225	0.2291	0.9069	244.3497	15.0085	5.2389
No.K/S	P_2	0.3195	0.3263	3.4023	276.2488	5.0526	1.4286
100 K.wt	P_3	0.9184	0.1658	5.8924	314.6175	9.1225	1.7781
Indirect effect		-0.0194	0.2041	-6.6310	-817.3910	-30.7743	-8.5195
No.S/P x No.K/S		0.2725	0.1236	0.7940	-219.7990	-60.9840	-2.7685
No.S/P x100 K.wt		-0.1175	0.1563	-1.0402	-293.244	-16.9197	-3.7907
No.K/S x100 K.wt		-0.1744	-0.0758	-6.3848	-304.244	-60.8706	-1.9603

Residual value	-0.441	0.0747	-2.5706	-16.825	2.5907	1.0739
Total	1.000	1.000	1.000	1.000	1.000	1.000

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دراسة الارتباط ومعامل المرور للمحصول ومكوناته فى هجينين من القمح

أسعد احمد حمادة [١] ، عبدالفتاح مندى الزناتى [٢] ، صبحى محمد عبد الدايم [١]
[١] قسم بحوث القمح – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية– الجيزة مصر
[٢] قسم المحاصيل– كلية الزراعة بشبين الكوم – جامعة المنوفية– مصر

الملخص العربي

أجرى هذا البحث بمحطة البحوث الزراعية بالجميزة خلال ثلاثة مواسم زراعية في الفترة من موسم ٢٠٠٥/٢٠٠٤ وحتى موسم ٢٠٠٧/٢٠٠٦ وذلك لتقدير الارتباط الوراثي والبيئي وكذلك معامل المرور بين محصول الحبوب ومكوناته ، عدد السنابل فى النبات ، وعدد حبوب السنبلة ووزن ١٠٠ حبة وذلك في الجيل الأول والثاني والثالث الإنعزالى لهجينين من هجن القمح هما جميزة٣× اتيلا وسدس١×جميزة٥ وقد أظهرت الدراسة ان الارتباط بين محصول الحبوب وكل من مكونات المحصول الثلاث موجبة ومعنوية على المستوى البيئي والوراثى. كما أظهرت الدراسة أن العلاقة بين مكونات المحصول الثلاث فيما بينها كانت في اغلب الحالات اما موجبة معنوية او موجبة سالبة وذلك في الأجيال الثلاثة وللهجينين محل الدراسة. كذلك أظهرت دراسة معامل المرور أن محصول الحبوب تأثر مباشرة بعدد الحبوب فى السنبلة ثم وزن ١٠٠حبة واخيرا عدد السنابل فى النبات على الترتيب وأظهرت دراسة معامل المرور أيضا أن مجموع التأثير المباشر لمكونات محصول الحبوب الثلاثة عدد السنابل فى النبات وعدد حبوب السنبلة ووزن ١٠٠حبة كان اكبر من تأثير نفس هذه المكونات الغير مباشر على محصول الحبوب وذلك في الهجينين محل الدراسة وفى الأجيال الثلاثة.