Correlation and Path Coefficient Analysis in Wheat

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To understand the association of yield and yield attributes and their contribution to each other, 179 genotypes including four check varieties were evaluated in an Augmented Block Design with 18 blocks. Each block (excepting one block) contained 10 test genotypes and 4 check genotypes. The data on five random selected plants of each genotype were recorded on 14 quantitative characters, including grain yield and its component characters. The phenotypic coefficient of variation was high for most of the characters, especially, the biological yield per plant, tillers per plant, plant height and grain yield. Correlation coefficient analysis revealed that nine characters namely, biological yield per plant, tiller number per plant, grain weight per ear, grains per ear, harvest index, spikelets per spike, plant height, flag leaf area and flag leaf sheath length showed significant and positive correlation with grain yield. Path coefficient analyses revealed that biological yield followed by harvest index and grains per ear were the only traits that showed highest positive direct effects towards grain yield.

Key Words: Character association, Path coefficient analysis, Grain yield, Wheat

Introduction

Among the cereals which have played a significant role in the evolution of human civilization, wheat (*Triticum aestivum*) is an important food crop and a source of almost 20 per cent of total calories of the world population. Grain yield in wheat is a complex character affected directly or indirectly by every gene present in plant (Waqas *et al*., 2005). Genotypic and phenotypic correlations indicate the degree to which various morpho-physiological characters are associated with economic productivity (Alam *et al*., 1992). Expression of complex trait yield is dependent upon the inter-relationship of its component traits. The selection programme for high yield requires not only the understanding and knowledge of the variability present in the germplasm of the crop, but also the association and contribution of various plant attributes towards grain yield. Therefore, in the present investigation we have shortlisted important traits which have strong association with grain yield. Grafius (1969) and Singh *et al*. (1997) emphasized the need to base the selection for yield on principal components which have a very strong association. Most of the traits of economic importance were quantitative characters whose expression is conditioned by the polygenes. Such traits are analyzed and studied using the biometrical approaches. In view of this, correlation and path coefficient analyses on a large number of wheat genotypes representing considerable genetic variability was done.

Materials and Methods

One-hundred-seventy-nine wheat genotypes of Indian and exotic origin including four check varieties namely, UP 2425, PBW343, HD 2687 and PBW435 were evaluated in an Augmented Block Design at Ch. Charan Singh University, Meerut during rabi season. Each genotype was planted in a row plot of 3 m each. Recommended cultural practices were followed to raise a good crop of wheat. Five randomly selected plants were used to record. The material was evaluated in an Augmented Block Design with 18 blocks, each block (excepting one block) was assigned 10 test genotypes selected randomly and four check varieties. Each genotype in a block, whether test or check, was assigned at random to a single row plot of 2 m length. Line to line and plant distance was kept at 30 cm and 10 cm, respectively.

Results and Discussion

The analysis of variance for fourteen quantitative characters is presented in Table 1. The mean squares due to checks for all the 14 characters studied were highly significant except biological yield per plant and grain yield per plant. Suggesting the presence of considerable variability for different characters among the wheat accessions under investigation. However, the mean squares due to block were non-significant for most of the traits except the four traits. Nevertheless, the genotype means were adjusted for block effects to remove to effect of soil heterogeneity. The estimates of phenotypic coefficients of correlation among the 14 characters are presented in Table 2. The correlation coefficient were calculated for all possible pairs of 14 characters giving rise to a total 91 pairs of characters. Of the total 91 pairs of characters,

Table 1. Analysis of variance for 14 quantitative characters of four check varieties evaluated in eighteen blocks in an Augmented Block Design

		Characters													
Source	d.f.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Checks	3	429.74**	35.32**	470.15**	279.69	24.74**	29.74**	10.12**	14.64**	119.14	3.07	157.52*	0.37	3.06**	356.63
Block	17	16.92	0.73	61.03	7.47	1.14	1.78	4.23*	3.59	70.54	13.81	93.95**	0.21	0.43*	252.64*
Error	51	14.58	0.60	90.51	6.49	0.71	1.23	2.11	2.66	49.23	14.34	39.45	0.73	0.23	117.98

*,** : Significant at 5% and 1% levels, respectively.

only 45 combinations of characters, the correlation coefficients were not statistically significant, suggesting that such characters are not associated and selection for one trait will not effect the performance of other traits. Therefore, only the correlation coefficients among 46 paired combinations of characters are important to be interpreted. Out of the significant correlation coefficients, only two combinations biological yield and harvest index, and tiller number and harvest index showed significant negative correlation coefficients. This suggested that there was no corresponding increase in grain yield with increase in biomass and tiller number. All the characters except peduncle length, spike length (excluding and including awns) and 100-grain weight showed significant positive correlation with grain yield. This suggests that increase in the intensity of these characters may bring about increase in grain yield. Similar relationship with grain yield was also reported earlier by Dhonde *et al.* (2000) and Bergale *et al.* (2001). Biological yield per plant, which showed the maximum degree of correlation with grain yield and seems to be the most important trait for improving grain yield, also showed significant positive correlation with tillers per plant, spikelets per spike, plant height, flag leaf sheath length, flag leaf area, grain weight per ear and spike length. This suggested that increase in such characters was responsible for increase in biological yield. Positive association of these characters with biological yield was also reported by Gupta *et al*. (1977), Sharma *et al.* (1998), Singh *et al.* (1998) and Khumkar *et al*. (2001). It may also be important to mention that the phenomenal increase in wheat yield potential during the past few decades is attributed to increase of harvest index (Kulshrestha and Jain, 1982). The general consequence of this progression has been that the modern varieties are high yielding with

Table 2. Estimates of phenotypic correlation coefficient among 14 quantitative characters in wheat

S. No.	Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Flag leaf area	1.00	0.35**	0.29**	0.16*	0.08	0.20**	0.16*	0.04	0.19*	0.17*	0.10	0.31**	0.30**	0.03
2	Flag leaf sheath length		**1.00**	0.48**	0.31**	0.21**	0.26**	0.17*	0.05	0.22**	0.15*	0.01	0.10	0.21**	-0.08
3	Plant height			**1.00**	0.47**	0.29**	0.04	0.16*	0.15*	0.26**	0.20**	0.05	0.03	0.07	-0.06
4	Peduncle length				**1.00**	0.04	0.13	-0.10	-0.05	-0.06	-0.03	-0.11	0.00	0.30**	0.01
5	Spike length (excluding awns)					**1.00**	0.18*	0.42**	0.15*	0.16*	0.14	0.25**	0.05	-0.03	-0.09
6	Spike length (including awns)						**1.00**	0.24**	0.09	0.12	0.12	0.17*	0.14	0.11	-0.04
7	No. of spikelets/ spike							**1.00**	0.04	0.26**	0.20**	0.43**	0.27**	-0.06	-0.12
8	Effective tillers/plant								**1.00**	0.67**	0.59**	-0.01	-0.06	-0.11	-0.15*
9	Biological yield/ plant									**1.00**	0.80**	0.15*	0.17*	0.02	-0.32**
10	Grain yield/plant										**1.00**	0.24**	0.30**	0.11	0.24**
11	Grains/spike											**1.00**	0.58**	-0.12	0.04
12	Grain weight /spike												**1.00**	0.36**	0.23**
13	100-grain weight													**1.00**	0.12
14	Harvest index														1.00

*,** : Significant at 5% and 1% levels, respectively

Table 3. Estimates of direct and indirect effects of various quantitative characters on grain yield in wheat. Diagonal (bold) values represent direct effects and the remaining values are indirect effects of the characters

S. No.	characters	1	2	3	4	5	6	7	8	9	10	11	12	13	Correlation with grain yield
1	Flag leaf area	**-0.01**	-0.00	-0.00	0.00	0.00	0.00	-0.00	0.00	0.17	0.01	-0.03	0.02	0.01	0.17*
2	Flag leaf sheath length	-0.00	**-0.02**	-0.02	0.01	0.00	0.00	-0.00	0.00	0.21	0.00	-0.01	0.01	-0.04	0.15*
3	Plant height	-0.00	-0.01	**-0.04**	0.01	0.00	0.00	-0.00	0.00	0.25	0.00	-0.00	0.00	-0.03	0.20**
4	Peduncle length	-0.00	-0.00	-0.02	**0.03**	0.02	0.00	0.00	-0.00	-0.05	-0.01	0.00	0.02	0.00	-0.03
5	Spike length (excluding awns)	-0.00	-0.00	-0.01	0.00	**0.00**	0.00	-0.00	0.00	0.15	0.03	-0.00	-0.00	-0.04	0.14
6	Spike length (including awns)	-0.00	-0.00	-0.00	0.00	0.00	**0.00**	-0.00	0.00	0.11	0.02	-0.01	0.00	-0.02	0.12
7	Spikelets/spike	-0.00	-0.00	-0.00	-0.00	0.01	0.00	**-0.00**	0.00	0.25	0.06	-0.02	-0.00	-0.06	0.20**
8	Effective tillers/plant	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	**0.04**	0.64	-0.00	0.00	-0.00	-0.05	0.59**
9	Biological yield/plant	-0.00	-0.00	-0.01	-0.00	0.00	0.00	-0.00	0.03	**0.96**	0.02	-0.01	0.00	-0.17	0.80**
10	Grains/spike	-0.00	-0.00	-0.00	-0.00	0.00	0.00	-0.00	-0.00	0.14	**0.14**	-0.06	-0.01	0.02	0.24**
11	Grain weight/spike	-0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00	-0.00	0.16	0.08	**-0.10**	0.03	0.13	0.30**
12	100-grain weight	-0.00	-0.00	-0.00	0.01	-0.00	0.00	0.00	-0.00	0.02	-0.01	-0.03	**0.08**	0.06	0.11
13	Harvest index	-0.00	-0.00	0.00	0.00	-0.00	-0.00	0.00	-0.00	-0.30	0.00	-0.02	0.01	**0.55**	0.24**

Residual = 0.0699

shorter straw but have little or no increase in overall biological yield over their fore bearers and further efforts to increase yield potential have not been successful Gill (1979). In wheat, although the physiological limit for harvest index has been set to 60% (Austin *et al*., 1980) further improvement of present level of 50% harvest index has not been feasible. Therefore, the future improvement in grain yield of wheat can be attained by increasing the dry matter, *i.e.,* biomass or biological yield (Moss and Musgrave, 1971; Narsyrov, 1978) while maintaining the optimum level of harvest index.

The estimates of direct and indirect effects of various characters on grain yield are presented in Table 3. The path coefficient analysis appeared to provide a clue to the contribution of various components of yield to over all grain yield in the genotypes under study. It provides an effective way of finding out direct and indirect sources of correlation. In the present study, nine characters which showed significant and positive correlation with grain yield, only biological yield, harvest index and grains per ear exhibited direct contribution in increasing grain yield. However, the direct effect of biological yield on grain yield was maximum followed by harvest index. The remaining traits such as flag leaf area, flag leaf sheath length, plant height, spikelets per spike, tiller number etc. which had significant positive correlation with grain yield did not show considerable direct effect towards grain yield, instead, they contributed towards, grain yield indirectly via biological yield. In past also, high magnitudes of direct effects of biological yield have been reported by Sidhu *et al*., 1976 and Sharma *et al.*, 1998.

References

Alam K, G Shabbir, MA Chowdhry and I Khaliq (1992) Correlation of post emergence characters with yield in bread wheat. *Pak. J. Agri. Sci.* **29(4):** 449-452.

Austin RB, MJ Bingham, RD Blackwell, LT Evans, MA Forg, CL Morgan and M Taylor (1980) Genetic improvement in winter wheat yields since 1900 and associated physiological changes. *J. Agri. Sci. (Camb.)* **94:** 675 -689.

Bergale S, B Mridulla, AS Holka, KN Ruwali and SVS Prasad (2001) Genetic variability, diversity and association of quantitative traits with grain yield in bread wheat (*Triticum aestivum* L.) *Madras Agri. J.* **88(79):** 457-461.

Dhonde SR, NS Kute, DG Kenawade and ND Sarode (2000) Variability and characters association in wheat (*Triticum aestivum*). *Agri. Sci. Digest* **20(2):** 99-101.

Gill KS (1979) *Research on Dwarf Wheat*. Indian Council of Agricultural Research, New Delhi, 127p.

Graffius TE (1969). Components of yield in oats–geometrical interpretation. *Agron. J.* **48:** 419-423.

Gupta VP, AS Khera and KS Bains (1977) Concept in stability analysis. In: AK Gupta (ed.) Genetics of Wheat Improvement, Oxford and IBH Publishing Co., New Delhi.

Khumkar MS, MB Chaudhary and PS Deshmukh (2001) Genetic variability and association of morpho-physiological characters with grain yield in late sown wheat (*Triticum aestivum* L.) *Annals Agri. Res*. **22(2):** 217–220.

Kulshrestha VP and HK Jain (1982) Eight years of wheat breeding in India past selection pressure and future prospects. *Z. Pflanzenzuecht* **89:** 19-30.

Moss DN and RB Musgrave (1971) Photosynthesis and crop production. *Adv. Agron.* **23:** 317–336.

Nasyrov YS (1978) Genetic control of photosynthesis and crop productivity. *Ann. Rev. Plant Physiol.* **29:** 215-237.

Sharma PK, PK Gupta and HS Balyan (1998) Genetic diversity in a large collection of wheat (*Triticum* spp.) *Indian J. Genet.* **58:** 271–278.

Sidhu GS, KS Gill and BS Ghai (1976) Correlation and path analysis in wheat (*Triticum aestivum* L.) *PAU J. Res.* **13:** 235-237.

Singh D, PC Sharma and R Kumar (1997) Correlation and path coefficient analysis in chickpea. *Crop Res.* **13:** 625-629.

Singh RP, D Garg and PC Sharma (1998) Character association in wheat (*Triticum aestivum* L.) *Indian J. Genet*. **58(2):** 219–221.

Waqas MB, J Akhtar, M Anwar and M Ibrahim (2005) Cause and effect relations of yield components in spring wheat (*Triticum aestivum* L.) under normal conditions. *Caderno de Pesquisa série Biologia* **17(1):** 7-12 .