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INTER-RELATIONSHIPS AND PATH ANALYSIS FOR YIELD ATTRIBUTES IN WHEAT (*TRITICUM AESTIVIUM* L.)

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Abstract

Correlation and path analysis studies were conducted on a population including 48 F_1's + 48 F_2's + 16 parents in RBD with three replications in a single row (F_1's), 2 rows (parents) and 4 rows (F_2's) in plot of 3 m length with inter and intra-row spacing of 23 cm and 10 cm, respectively. Correlation and path coefficient analysis for yield attributes in wheat (*Tetricum aestivium* L.) on ten quantitative traits. Results revealed that the grain yield per plant exhibited positive and highly significant association with biological yield per plant (0.9818 and 0.9153) and days to maturity (0.4422 and 0.3488) in both F_1 and F_2 generations, respectively and number of spikelets per spike (0.6117), number of grains per spike (0.6023), plant height (0.3285), number of effective tillers per plant (0.3861) only in F_1, generation whereas, positive significant association was noted with days to 50 per cent flowering (0.3215) in F_1 and plant height (0.2737), number of spikelets per spike (0.2557) in F_2 generation. The highest positive direct effect on grain yield per plant were exerted by biological yield per plant (0.9297 and 0.9083) followed by harvest index (0.1690 and 0.2505) in both F_1 and F_2 generations, respectively. The inter-relationship among the characters identified above may be utilized in the breeding programme to exploit the yield potential and to develop high yielding varieties with target oriented research.

Key words : Wheat, correlation coefficient, path analysis, yield.

Introduction

Wheat (*Triticum aestivum* L.) is most important cereal among crops belonging to family *Poaceae.* It is cultivated more widely around the world than rice and consumed in variety of ways such as bread, chapatti, porridge, flour and suji etc. Wheat has relatively high content of niacin and thiamin which are principally concerned in providing the special protein called 'Glutin'. Wheat proteins are of special significance because Glutin provides the framework of spongy cellular texture of bread and baked products. In India, total wheat was grown on an area of 31.2 m ha with production of 95.9 million tones and productivity 3.08 tonnes per hectare (William Baker, 2016). Therefore, Grafius (1956) and Singh *et al.* (1997) emphasized the need to base the selection for yield on principal component with very strong association. The correlation coefficient analysis is useful in the identification of such characters and elimination of those with undesirable correlated changes. The path coefficient analysis is a partial regression technique to partition the correlated response into direct and indirect influence of each character. It also provides the direction and extent of such influence on yield.

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Materials and Methods

The experiment was conducted at Main Experiment Station of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.), India; during *rabi*, 2014-15 on 112 population including (48 F_1's + 48 F_2's + 16 parents) in Randomized Block Design with three replications in a single row (F_1's), 2 rows (parents) and 4 rows (F_2's) in plot of 3 m length with inter and intra-row spacing of 23 cm and 10 cm, respectively. On the basis of 15 randomly selected plants, data were recorded on days to 50 percent flowering, days to maturity, plant height (cm), number of effective tillers per plant, number of spikelets per spike, number of grains per spike, 1000-grain weight (test weight) (g), biological yield per plant (g), harvest index (%) and grain yield per plant (g).

Data recorded on ten quantitative traits of wheat genotypes were subjected to statistical analyses where correlation coefficients worked out as per Johanson *et al*. (1955) and path analysis as suggested by Dewey and Lu (1959) were used to partition the correlation coefficient in to direct and indirect effects.

Results and Discussion

The progress in plant breeding depends upon effective selection scheme based on the correlated and non-correlated response. The grain yield or economic yield in almost all the crops is referred as super character which results from the multiplicative interactions of several other characters, which are termed as yield components. Thus, identification of important yield components and information about their association with grain yield and also with each other is very useful for selecting efficient genotypes for evolving high yielding varieties. In this respect, the correlation coefficient which provides symmetrical measurement of degree of association between two variables or characters, help us in understanding the nature and magnitude of association among yield and yield components. The phenotypic correlation coefficients are presented in table 1. The result showed that grain yield per plant exhibited positive and highly significant association with biological yield per plant (0.9818 and 0.9153) and days to maturity (0.4422 and 0.3488) in both F_1 and F_2 generations, respectively and number of spikelets per spike (0.6117), number of grains per spike (0.6023), plant height (0.3285), number of effective tillers per plant (0.3861) only in F_1; whereas, its positive significant association was noted with days to 50 per cent flowering (0.3215) in F_1 and plant height (0.2737), number of spikelets per spike (0.2557) in F_2. Therefore, these characters emerged as most important factors influencing grain yield in wheat. The strong positive correlations among of grain yield with the characters mentioned above has also been reported earlier in wheat, Saxena *et al.* (2007), Yousaf *et al*. (2008), Nagireddy and Jyothula (2009), Tripathi *et al.* (2011) and El-Mohsen *et al.* (2012). Biological yield per plant displayed positive and highly significant associated with grain yield per plant (0.9818 and 0.9135), days to maturity (0.4180 and 0.3282) in both F_1 and F_2, generations respectively and with days to 50 per cent flowering (0.3291), number of effective tillers per plant (0.3598), number of spikelets per spike (0.5955), number of grains per spike (0.5833) in F_1 only, Whereas, positive significant correlation exhibited with plant height (0.3122) in F_1 generation. 1000-grain weight and harvest index were either very less or negatively correlated with all the characters under study in both the generations. Furthermore, the remaining characters were found correlated with each other and these traits add towards higher biomass. These findings are broadly in agreement with some of the earlier reports of Sherif *et al.* (2005) and Tripathi *et al.* (2011).

Path analysis emerged as a powerful and widely used technique for understanding the direct and indirect contribution of yield contributing traits. In this study, the path coefficient analysis was carried out using estimates of simple correlation coefficients among ten characters (table 2). Highest positive direct effect on grain yield per plant were exerted by biological yield per plant (0.9297 and 0.9083) followed by harvest index (0.1690 and 0.2505) in both F_1 and F_2 generations respectively; while number of grains per spike (-0.0317), days to 50 percent flowering (0.0112) in F_1 also exhibited moderate estimate of direct effects. The negative direct effect towards expression of grain yield per plant were exerted by number of spikelets per spike (-0.0155), plant height (-0.0110) in F_1 and days to 50 per cent flowering (-0.0111), number of effective tillers per plant (-0.0219), number of grains per spike (-0.0237), plant height (-0.0037) and 1000-seed weight (-0.0490) in F_2 generation. Direct effects of rest of characters were positive but too low to be considered. The available literatures have also identified these characters as major direct contributors to grain yield per plant in wheat Esmail (2001), Asif *et al.* (2004), Tripathi *et al.* (2011), EI- Mohsen *et al*. (2012) and Singh *et al.* (2012).

The substantial high order positive indirect effect on grain yield per plant were exerted by days to 50 percent flowering (0.2308 and 0.2234), days to maturity (0.3200 and 0.3139), plant height (0.2138 and 0.2036), number of effective tillers per plant (0.0115 and 0.0239), number of spikelets per spike (0.2284 and 0.2070), number of grains per spike (0.1661 and 0.1541) via biological yield per plant in both F_1 and F_2 generations, respectively. Whereas, days to 50 percent flowering (0.0145), days to maturity (0.0146), number of effective tillers per plant (0.0068), number of grains per spike (0.0317) and biological yield per plant (0.0185) via grains per spike were also exerted of moderate estimates in F_1 generation only and in F_2 all the above mentioned characters were exerted with negative indirect effects. Days to 50 percent flowering (0.0152), days to maturity (0.0155), plant height (0.0192), number of effective tillers per plant (0.0138), number of spikelets per spike (0.0510) and biological yield per plant (0.0110) via number of spikelets per spike in F_2 generation and in F_1 all these characters were exerted with negative indirect effects and indirect effects of the remaining characters were too low to be considered. These findings are broadly

Table 1 : The estimates of phenotypic correlation coefficient among ten characters in wheat (F_1 & F_2).

Characters / Generations		Days to 50% flowering	Days to maturity	Plant height (cm)	Effective tillers/ plant	Spikelet's/ spike	Grains/ spike	1000 seed weight (g)	Biological yield/plant (g)	Harvest index (%)	Grain yield/ plant (g)
Days to 50% flowering	F_1	**1.0000**	0.5295**	0.0758	0.2833*	0.4727**	0.4580**	-0.0632	0.3291**	-0.1908	0.3215*
	F_2	**1.0000**	0.6823**	0.2063	0.1745	0.2971*	0.2417	-0.0790	0.2336	-0.2173	0.2095
Days to maturity	F_1		**1.0000**	0.3496**	0.2771*	0.4756**	0.4618**	0.0483	0.4180**	0.0242	0.4422**
	F_2		**1.0000**	0.3720**	0.2631*	0.3036*	0.2690*	0.1392	0.3282**	-0.0627	0.3488**
Plant height (cm)	F_1			**1.0000**	0.1138	0.1497	0.2134	0.0873	0.3122*	0.1023	0.3285**
	F_2			**1.0000**	0.0277	0.3760**	0.3249**	-0.0257	0.2129	0.1616	0.2737*
Effective tillers/ plant	F_1				**1.0000**	0.4084**	0.3764**	-0.0298	0.3598**	0.0529	0.3861**
	F_2				**1.0000**	0.2706*	0.2462*	0.0123	0.0250	0.1053	0.0503
Spikelets/ spike	F_1					**1.0000**	0.9529**	-0.0030	0.5955**	-0.0643	0.6117**
	F_2					**1.0000**	0.9318**	-0.1314	0.2164	0.0193	0.2557*
Grains/ spike	F_1						**1.0000**	0.0216	0.5833**	-0.0537	0.6023**
	F_2						**1.0000**	-0.0781	0.1611	0.0195	0.1943
1000-Seed seight (g)	F_1							**1.0000**	-0.1441	-0.0658	-0.1568
	F_2							**1.0000**	-0.3177*	0.0299	-0.3407
Biological yield/plant (g)	F_1								**1.0000**	-0.2238	0.9818**
	F_2								**1.0000**	-0.3221*	0.9153**
Harvest index (%)	F_1									**1.0000**	-0.0593
	F_2									**1.0000**	-0.0628
Grain yield/ plant (g)											**1.0000**
											1.0000

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

Table 2 : Phenotypic direct and indirect effect of yield components on grain yield in wheat (F_1 & F_2).

Characters / Generations		Days to 50% flowering	Days to maturity	Plant height (cm)	Effective tillers/ plant	Spikelet's/ spike	Grains/ spike	1000 seed weight (g)	Biological yield/plant (g)	Harvest index (%)	Grain yield/ plant (g)
Days to 50% flowering	F_1	**0.0112**	0.0059	0.0008	0.0032	0.0053	0.0051	-0.0007	0.0037	-0.0021	0.3215
	F_2	**-0.0111**	-0.0076	-0.0023	-0.0019	-0.0033	-0.0027	0.0009	-0.0026	0.0024	0.2095
Days to maturity	F_1	0.0037	**0.0070**	0.0025	0.0019	0.0033	0.0032	0.0003	0.0029	0.0002	0.4422
	F_2	0.0429	**0.0629**	0.0234	0.0166	0.0191	0.0169	0.0088	0.0207	-0.0039	0.3488
Plant height (cm)	F_1	-0.0008	-0.0038	**-0.0110**	-0.0013	-0.0016	-0.0023	-0.0010	-0.0034	-0.0011	0.3285
	F_2	-0.0008	-0.0014	**-0.0037**	-0.0001	-0.0014	-0.0012	0.0001	-0.0008	-0.0006	0.2737
Effective tillers/ plant	F_1	0.0018	0.0017	0.0007	**0.0062**	0.0025	0.0023	-0.0002	0.0022	0.0003	0.3861
	F_2	-0.0038	-0.0058	-0.0006	**-0.0219**	-0.0059	-0.0054	-0.0003	-0.0005	-0.0023	0.0503
Spikelets/ spike	F_1	-0.0073	-0.0074	-0.0023	-0.0063	**-0.0155**	-0.0147	0.0000	-0.0092	0.0010	0.6117
	F_2	0.0152	0.0155	0.0192	0.0138	**0.0510**	0.0475	-0.0067	0.0110	0.0010	0.2557
Grains/ spike	F_1	0.0145	0.0146	0.0068	0.0119	0.0302	**0.0317**	0.0007	0.0185	-0.0017	0.6023
	F_2	-0.0057	-0.0064	-0.0077	-0.0058	-0.0221	**-0.0237**	0.0018	-0.0038	-0.0005	0.1943
1000 Seed weight (g)	F_1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**	0.0000	0.0000	-0.1568
	F_2	0.0039	-0.0068	0.0013	-0.0006	0.0064	0.0038	**-0.0490**	0.0156	-0.0015	-0.3407
Biological yield/plant (g)	F_1	0.2308	0.3200	0.2138	0.0115	0.2284	0.1661	-0.2448	**0.9247**	-0.2549	0.9818
	F_2	0.2234	0.3139	0.2036	0.0239	0.2070	0.1541	-0.3038	**0.9083**	-0.3080	0.9153
Harvest index (%)	F_1	-0.0323	0.0041	0.0173	0.0089	-0.0109	-0.0091	-0.0111	-0.0378	**0.1690**	-0.0593
	F_2	-0.0544	-0.0157	0.0405	0.0264	0.0048	0.0049	0.0075	-0.0807	**0.2505**	-0.0628
Grain yield per plant (g)	F_1										**1.0000**
	F_2										**1.0000**

Residual effects = 0.0914 (F_1) and 0.3126 (F_2).

in agreement with some of the earlier reports of Bergale *et al.* (2002), Saxena *et al.* (2007), Yousaf *et al*. (2008), Nagireddy and Jyothula (2009), Tripathi *et al.* (2011) and El-Mohsen *et al.* (2012). The estimate of residual effect 0.0914 in F_1 and 0.3126 in F_2 was negligible which reflects that majority of the yield contributing traits have been included in the study. In the present study, path analysis identified biological yield per plant and harvest index as important direct yield contributing characters, which were also found to be useful indirect contributors via each other. The characters mentioned above, merit due consideration at the time of devising selection strategy aimed at developing high yielding varieties in wheat.

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