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Genotypic and Phenotypic Path Coefficient Analysis for Yield and Yield-Related Traits in Bread Wheat (*Triticum aestivum* L.)

Ajeet Singh[1], Sachin Kumar[1], Vipin Kumar Dwivedi[1], Shubham Mishra[1] and Ajeet Kumar[2*]

[1]Department of Genetics and Plant Breeding, Janta Vedic College, Baraut, Baghpat, CCS University Meerut, India
[2]Department of Genetics and Plant Breeding, SVPUA&T, Meerut, India

**Corresponding author*

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A B S T R A C T

A study was genotypic and phenotypic path coefficient analysis for yield and yield-related traits in 13 parents and line × tester mating design in bread wheat (*Triticum aestivum* L.) grown in randomized block design with three replications under at Research Farm, Department of Genetics and Plant Breeding, J.V College, Baraut, U.P. during the *rabi* season 2019-20, 2020- 21 and 2021-22. The critical evaluation of path coefficient for highest positive direct effect on grain yield per plant was observed for biological yield per plant (G 0.8856 and P 0.8817) followed by harvest index (G 0.6169 and P 0.6344), peduncle length (G 0.0130 and P 0.0095), spike length (G 0.0106 and P 0.0145) and days of anthesis (G 0.0089). The residual effects observed in present study was (G 0.0971 and P 0.1145) for genotypic and phenotypic path coefficient analysis.

Introduction

Wheat (2n=6x=42) belongs to family Poaceae and *Triticum genera*. Spring wheat or bread wheat (*Triticum aestivum* L. em Thell), which comes under aestivum species, is the most common and widely grown wheat at global level as well as in India. Other wheat like *Triticum durum, Triticum dicoccum* are also grown in a limited area for their some special significance in developing products for human consumption (Khokhar, *et al.,* 2010).

Wheat flour is the main product of wheat produce, by which various kinds of human foods are being developed. Wheat straw is a major source of animal feed in the country like India. Gluten which is a major part of wheat protein (about 75% of the total protein present in the wheat grain), has a unique quality for making the processed food puffly, with increase in perforated volume. Because of its versatility in adaption and utility in various ways, wheat is grown in more 44 countries at global level. The total area, production and productivity of wheat are 30.47 million hectare, 106.84 million tonnes and 3507 Kg per hectare in India and in Uttar Pradesh the total area, production and productivity are 9.42 million hectare, 33.95 million tonnes and 3604 Kg per hectare, respectively (Agriculture Statistics at a glance, Ministry of Agriculture, 2022). The major increase in the productivity of wheat has been observed in the states of Haryana, Punjab and Uttar Pradesh (Subhani, 2000; Kushwah, *et al.,* 2021).

Materials and Methods

Thirteen parents and their line × tester mating design in bread wheat were evaluated for grain yield and its related traits in randomized block design with three replications during *rabi* season 2019-20, 2020- 21 and 2021-22 at Research Farm, J.V College, Baraut (U.P.). Each plot consisted of two rows of five meter length with row to row and plant to plant spacing of 22.5 and 5 cm, respectively.

Observations were recorded on 15 traits i.e., Days to booting, Day to heading, Day to anthesis, plant height, Number of productive tillers per plant, Days to maturity, spike length, Peduncle length (cm), Number of spikelets per spike, number of grains per spike, Number of grains per plant, Harvest index, 1000 grain weight (g), Biological yield per plant (g) and Grain yield per plant (g). The concept of partitioning of correlation into direct and indirect effects through path analysis was originally developed by Wright (1921), Sharma, A. and Singh, (2009), but the technique was first used for plant selection by Dewey and Lu (1959).

Results and Discussion

The genotypic and phenotypic correlation coefficients of grain yield with its contributing characters were partitioned into direct and indirect effect through path coefficient analysis is presented in table 1 and table 2. The correlation coefficient indicates the absolute total association with different characters while path coefficient revealed the relative importance of different component characters on grain yield. At genotypic level, highest positive direct effect on grain yield per plant was observed for biological yield per plant (0.8856) followed by harvest index (0.6169), peduncle length (0.0130), spike length (0.0106) and days of anthesis (0.0089); whereas, the highest negative direct effect was observed for number of spikelets per spike (-0.0516) followed by plant height (-0.0327), number of grains per spike (-0.0111), days of heading (-0.0111), test weight (-0.0094), number of grains per plant (-0.0067), days of booting (-0.0059), number of productive tillers per plant (-0.0038) and days of maturity (-0.0011). The residual effects observed in present study was 0.0971 for genotypic path coefficient analysis.

At phenotypic level, highest positive direct effect on grain yield per plant was observed for biological yield per plant (0.8817) followed by harvest index (0.6344), spike length (0.0145) and peduncle length (0.0095); whereas, the highest negative direct effect was observed for plant height (-0.0310) followed by number of spikelets per spike (-0.0307), number of grains per plant (-0.0119), test weight (-0.0092), number of grains per spike (-0.0078), days of heading (-0.0051), days to anthesis (-0.0042), number of productive tillers per plant (-0.0039), days of booting (-0.0008) and days of maturity (-0.0005). The residual effects observed in present study was 0.1145 for phenotypic path coefficient analysis.

The correlation study showed that grain yield per plant showed a positive and significant correlation with number of productive tillers per plant, spike length, peduncle length, plant height, number of spikelets per spike, number of grains per spike, number of grains per plant, test weight, biological yield per plant and harvest index at genotypic and phenotypic levels. These associations indicated that improvement in grain yield can be achieved by improving above characters.

Table.1 Genotypic path coefficient analysis showing direct (diagonal) and indirect (non-diagonal) effect of different characters on grain yield per plant in wheat

Characters	DB	DH	DA	DM	NPT	SL	PL	PH	NSS	NGS	NGP	TW	BY	HI	Correlation with grain yield per plant (gm)
DB	**-0.0059**	-0.0052	-0.0054	-0.0030	-0.0002	0.0002	0.0008	0.0010	0.0022	0.0005	-0.0009	0.0027	0.0009	0.0032	**-0.465****
DH	-0.0098	**-0.0111**	-0.0100	-0.0047	-0.0014	-0.0009	0.0013	0.0013	0.0036	0.0007	-0.0020	0.0037	0.0008	0.0059	**-0.379****
DA	0.0082	0.0080	**0.0089**	0.0043	0.0011	0.0004	-0.0013	-0.0015	-0.0023	-0.0004	0.0021	-0.0038	-0.0002	-0.0056	**-0.411****
DM	-0.0006	-0.0005	-0.0005	**-0.0011**	0.0001	0.0001	0.0002	0.0000	0.0003	0.0002	0.0000	0.0002	0.0001	0.0004	**-0.303****
NPT	-0.0001	-0.0005	-0.0004	0.0003	**-0.0038**	-0.0016	-0.0010	-0.0010	-0.0016	-0.0012	-0.0022	-0.0005	-0.0022	0.0004	**0.421****
SL	-0.0004	0.0008	0.0004	-0.0012	0.0046	**0.0106**	0.0036	0.0023	0.0038	0.0050	0.0055	0.0008	0.0057	0.0001	**0.458****
PL	-0.0018	-0.0015	-0.0020	-0.0023	0.0035	0.0043	**0.0130**	0.0076	0.0049	0.0029	0.0046	0.0007	0.0039	0.0021	**0.341****
PH	0.0059	0.0039	0.0057	0.0008	-0.0089	-0.0070	-0.0192	**-0.0327**	-0.0113	-0.0018	-0.0119	-0.0074	-0.0134	0.0025	**0.269****
NSS	0.0195	0.0169	0.0134	0.0123	-0.0219	-0.0186	-0.0195	-0.0179	**-0.0516**	-0.0117	-0.0182	-0.0197	-0.0317	-0.0227	**0.754****
NGS	0.0010	0.0007	0.0006	0.0018	-0.0034	-0.0052	-0.0025	-0.0006	-0.0025	**-0.0111**	-0.0064	-0.0005	-0.0024	-0.0018	**0.276****
NGP	-0.0011	-0.0012	-0.0016	-0.0002	-0.0040	-0.0035	-0.0024	-0.0024	-0.0024	-0.0039	**-0.0067**	0.0004	-0.0039	0.0017	**0.325****
TW	0.0044	0.0032	0.0040	0.0015	-0.0012	-0.0007	-0.0005	-0.0021	-0.0036	-0.0004	0.0006	**-0.0094**	-0.0021	-0.0040	**0.429****
BY	-0.1426	-0.0616	-0.0239	-0.0653	0.5162	0.4730	0.2688	0.3627	0.5439	0.1952	0.5127	0.2011	**0.8856**	-0.0634	**0.797****
HI	**-0.3420**	**-0.3306**	**-0.3874**	**-0.2457**	**-0.0598**	**0.0070**	**0.0993**	**-0.0477**	**0.2709**	**0.1024**	**-0.1525**	**0.2610**	**-0.0442**	**0.6169**	**0.536****

*Significant at P = 0.05 and ** significant at P = 0.01

DB=Days of booting, DH=Days of heading, DA=Days of anthesis, DM=Days to maturity, NPT=No of productive tillers/plant, SL=Spike length (cm), PL=Peduncle length (cm), PH=Plant height (cm), NSS=No of spikelets/spike, NGS=No of grains/spike, NGP=No of grains/plant, GY=Grain yield/plant (gm), TW=Test weight, BY=Biological yield/plant (gm) and HI=Harvest index (%).

Table.2 Phenotypic path coefficient analysis showing direct (diagonal) and indirect (non-diagonal) effect of different characters on grain yield per plant in wheat

Characters	DB	DH	DA	DM	NPT	SL	PL	PH	NSS	NGS	NGP	TW	BY	HI	Correlation with grain yield per plant (gm)
DB	**-0.0008**	-0.0007	-0.0006	-0.0004	0.0000	0.0000	0.0001	0.0001	0.0003	0.0001	-0.0001	0.0003	0.0001	0.0004	**-0.432****
DH	-0.0044	**-0.0051**	-0.0040	-0.0021	-0.0006	-0.0004	0.0005	0.0005	0.0015	0.0003	-0.0009	0.0016	0.0003	0.0026	**-0.357****
DA	-0.0034	-0.0033	**-0.0042**	-0.0018	-0.0004	-0.0002	0.0005	0.0005	0.0010	0.0002	-0.0009	0.0014	0.0001	0.0022	**-0.382****
DM	-0.0002	-0.0002	-0.0002	**-0.0005**	0.0000	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0001	0.0000	0.0002	**-0.277****
NPT	-0.0001	-0.0005	-0.0004	0.0003	**-0.0039**	-0.0016	-0.0010	-0.0010	-0.0015	-0.0011	-0.0023	-0.0005	-0.0022	0.0004	**0.396****
SL	-0.0005	0.0012	0.0006	-0.0016	0.0061	**0.0145**	0.0047	0.0028	0.0046	0.0064	0.0072	0.0011	0.0072	0.0002	**0.392****
PL	-0.0011	-0.0010	-0.0011	-0.0015	0.0025	0.0030	**0.0095**	0.0053	0.0032	0.0021	0.0033	0.0006	0.0028	0.0013	**0.304****
PH	0.0048	0.0030	0.0036	0.0003	-0.0076	-0.0060	-0.0175	**-0.0310**	-0.0093	-0.0023	-0.0104	-0.0073	-0.0119	0.0027	**0.209****
NSS	0.0106	0.0092	0.0071	0.0066	-0.0120	-0.0098	-0.0104	-0.0092	**-0.0307**	-0.0064	-0.0100	-0.0106	-0.0172	-0.0117	**0.612****
NGS	0.0007	0.0004	0.0003	0.0012	-0.0023	-0.0034	-0.0018	-0.0006	-0.0016	**-0.0078**	-0.0044	-0.0005	-0.0018	-0.0011	**0.266****
NGP	-0.0019	-0.0021	-0.0025	-0.0004	-0.0069	-0.0059	-0.0041	-0.0040	-0.0039	-0.0067	**-0.0119**	0.0007	-0.0068	0.0028	**0.321****
TW	0.0039	0.0029	0.0031	0.0013	-0.0011	-0.0007	-0.0006	-0.0022	-0.0032	-0.0005	0.0005	**-0.0092**	-0.0022	-0.0032	**0.374****
BY	-0.1301	-0.0562	-0.0148	-0.0587	0.4981	0.4361	0.2623	0.3391	0.4946	0.1992	0.5031	0.2079	**0.8817**	-0.1071	**0.730****
HI	**-0.3309**	**-0.3187**	**-0.3309**	**-0.2363**	**-0.0594**	**0.0076**	**0.0854**	**-0.0560**	**0.2412**	**0.0893**	**-0.1499**	**0.2227**	**-0.0771**	**0.6344**	**0.508****

Residual effect = 0.1145 **significant at P = 0.01

DB=Days of booting, DH=Days of heading, DA=Days of anthesis, DM=Days to maturity, NPT=Number of productive tillers per plant, SL=Spike length (cm), PL=Peduncle length (cm), PH=Plant height (cm), NSS=Number of spikelets per spike, NGS=Number of grains per spike, NGP=Number of grains per plant, TW=Test weight (gm), BY=Biological yield per plant (gm) and HI=Harvest index (%).

Author Contributions

Ajeet Singh: Investigation, formal analysis, writing—original draft. Sachin Kumar: Validation, methodology, writing—reviewing. Vipin Kumar Dwivedi:—Formal analysis, writing—review and editing. Shubham Mishra: Investigation, writing—reviewing. Ajeet Kumar: Resources, investigation writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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