Original Research Article

Assessment of Yield Criteria in Bread Wheat through Correlation and Path Analysis.

ABSTRACT

Path coefficient analysis was used by plant breeders to help identify traits that could be useful as a selection criterion for improving crop yield. The path coefficient divides correlation coefficients into direct and indirect effects within the correlation system of traits. When there is a genetic correlation between two traits, the selection for one of them will produce a change in the other trait. In other words, the response of the correlation to the act of selection will take place. The present investigation was conducted during*rabi*seasonof2022-23atChameltiAgricultureFarm,MSSwaminathanSchoolofAgriculture, Shoolini University, Solan, Himachal Pradesh. The experiment consisted of 75genotypes of wheat with three check varieties viz., RAJ 3765, PBW 343 and HP 1633. Theexperimental field was divided into three blocks of equal size. Twenty-four entries includingchecks were accommodated in each block. Results indicated that grain yield per plant(g) havea positive and highly significant correlation with biological yield per plant (g), number ofproductive tillers per plant, harvest index (%), number of grains per spike. Path analysisidentified biological yield per plant and number of productive tillers per plant as importantdirect components for grain yield per plant (g). As per the analysis of variance, variations dueto blocks and checks were found to be significant for all the traits. Ten clusters were formedaccording to Non- hierarchical Euclidean cluster analysis and the maximum inter cluster wasrecorded between cluster 6 and 8 (86.478), followed by cluster 4 and 8 (83.180). Earlymaturing genotypes were contained in cluster 1 whereas cluster 4 contained the genotypeswhichgavethemaximusgrainyieldperplant.Highyieldinggenotypes identified were:DBW-187, DBW-303, DBW-222, HD-3226 and HS-240. The identified superior can be furtherutilizedinwheatimprovement breedingprograms.

Keywords:Bread Wheat, Path analysis, correlation coefficient, Yield

INTRODUCTION

The wheat crop (*Triticum aestivum* L.) is unique among all cereal crops in terms of importance and is considered one of the most important strategic grain crops in reducing the food gap, which has become the problem of the world (Khan *et al.,*2013) as it supplies the world's population with more than 20% of Energy. The improvement of cereal crops depends on the continuous processing of new genetic materials that carry different genes, granting many of the desired agricultural characteristics. To meet the growing demand for wheat, it is necessary to work to increase the yield using new genetic resources in the genetic improvement programs for wheat on the one hand and to improve the yield components of the wheat on the other hand, and since the yield is the result of interaction with a large number of its components (Khan *et al.,*2013). To determine the best genotypes with desirable traits and use those later in breeding programs and to choose an appropriate selection index that can help in the success breeding programs. Here it is necessary to conduct studies to analyze the variance, find the relationships between the different characteristics, by analysis correlation coefficient and path analysis between yield and its components. Wheat is one of the most important cereal crop grown indifferent environments due to its versatile nature over the world. At global level, it wascultivatedover 221.18millionhaandproductionof774.74milliontoneswithanaverageproductivity of 35 quintals per hectare. In India, it is grown in area of 31.36 million hectareswithaproductionof 107.86 million tones and productivity of 34.4 quintals per hectare (Kumar *et al*.,2022).InHimachalPradesh,itisgrowninareaof3.30hectareswithaproductionof 6.17metrictonsandproductivity of1869.70kgperhectare. Wheat holds a prominent position as the primary *rabi* crop in Himachal Pradesh, particularlyin Kangra district, where it is cultivated on a large scale.

Correlationcoefficientsprovideinsightsintotheassociationsbetweendifferentyieldcomponents.Conducting correlation studies allows us to gauge the strength of these associations betweenanytwotraits.Thus,understandingcharacterassociationsisvitalfortheconcurrentimprovementofbothyieldanditscomponents. Path coefficient analysis was used by plant breeders to help identify traits that could be useful as a selection criterion for improving crop yield. The path coefficient divides correlation coefficients into direct and indirect effects within the correlation system of traits.

MATERIALS AND METHODS

The present investigationwas conducted during *rabi*seasonof2022-23atChameltiAgricultureFarm,MSSwaminathanSchoolofAgriculture, Shoolini University, Solan, Himachal Pradesh. The experimental research farm is located at Chamelti. Geographically, this place issituatedat alatitudeof$30^0$85‟67.30‟Nand$77^0$13‟20.38‟Elongitudewithaltitudeof1284mabove sea level. The soil texture is characterized as sandy loam. The weather conditions of*rabi*, 2022-23 (November to April) during the evaluation period were almost normal. The experiment consisted of 75genotypes of wheat with three check varieties viz., RAJ 3765, PBW 343 and HP 1633. Theexperimental field was divided into three blocks of equal size. Twenty-four entries includingchecks were accommodated in each block. Results indicated that grain yield per plant(g) havea positive and highly significant correlation with biological yield per plant (g), number ofproductive tillers per plant, harvest index (%), number of grains per spike. Path analysisidentified biological yield per plant and number of productive tillers per plant as importantdirect components for grain yield per plant (g). Analysis of variance for design of experiment was carried out according to Panse andSukhatme (1967). An estimate of experimental error variance, which was used to computestandard error and least significant difference, was obtained using following format for analysis of variance of thechecksyield.The correlation coefficients were worked out using the following formula given by Pearson(1904).Path coefficient analysis was calculated according to the given formula by Dewey and Lu(1959).

RESULTS AND DISCUSSION

CorrelationCoefficient

Theestimateofsimplecorrelationcoefficientamong11charactersunderstudyispresentedin Table1.

Biological yield per plant had highest significant positive correlation with grain yield perplant followed by number of productive tillers per plant, harvest index, number of grains perspike, number of spikelets per spike, plant height and test weight. Plant height, days of 75%floweringand spikelengthhad significantnegativecorrelationwithgrainyieldperplant.

Days to 75% flowering had high significant positive correlation with days to maturity andit had non-significant correlation with the number of productive tillers per plant, spike length,number of spikelets per spike, number of grains per spike, biological yield per plant, test weight,harvest index, grain yield per plant and plant height. Plant height had highly significant positivecorrelation with spike length, biological yield per plant and grain yield per plant and it had non-significant correlation with days to maturity, number of productive tillers per plant, number ofspikelets per spike, number of grains per spike, biological yield per plant, test weight and harvestindex. Days to maturity had significant negative correlation with number of spikelets per spike,number of grains per spike, number of productive tillers per plant, spike length, biological yieldper plant, test weight, harvest index and grain yield per plant. Number of productive tillers perplant had significant positive correlation with number of spikelets per spike, number of grains perspike,biologicalyieldperplant,harvestindexandgrainyieldperplant.Ithadnon-significantcorrelationwithspikelengthandtestweight.Spikelengthhadnon-significantcorrelation with number of spikelets per spike, number of grains per spike, biological yield perplant, test weight, harvest index and grain yield per plant. Number of spikelets per spike hadsignificantpositivecorrelationwithnumberofgrainsperspike,biologicalyieldperplant,harvest index and grain yield per plant and it had non-significant correlation with test weight.Number of grains per spike had significant positive correlation with biological yield per plant,harvestindex,grainyieldper plantandithadnon-significantcorrelationwith test weight.Biological yield per plant had significant positive correlation with harvest index, grain yield perplant and it had non-significant correlation with test weight. Test weight had significant positivecorrelationwithgrainyieldperplant.Ithadnon-significantcorrelationwithharvestindex.

The grain yield in almost all the crops is a complex character, which manifests frommultiplicative interaction of several other characters that are termed as yield components. Thegenetic architecture of grain yield in wheat as well as other crops is based on the balance oroverall net effect produced by various yield components directly or indirectly by interactingwith one another. Therefore, selection for yield per cent alone would not matter much as suchunlessaccompaniedbytheselectionforvariouscomponentcharactersresponsibleforconditioning it. Thus, identification of important component characters and information abouttheir association with yield and also with each other are very useful for developing efficientbreedingstrategyforevolvinghighyieldingvarieties.Thecorrelation coefficientisthemeasure of degree of linear association between two variables or characters and helps us inunderstanding the nature and magnitude of association among yield and yield component. Inthe present investigation, simple correlation coefficients were computed among 11 charactersgivenin Table2.

In previous studies the grain yield per plant showed positive and highly significantcorrelation with biologicalyield per plant, number of productive tiller per plant, harvestindex, number of spikelets per spike, number of grains per spike, plant height and test weightexcept days to maturity, days to 75% flowering, spike length negative correlation with grainyield.Thestrongpositiveassociationofgrainyieldwithoneormoreoftheabovetraitshasalsobeen observed by previous worker. (Ali *et al*., 2008; Chaitali and Bini, 2007; Singh *et al.* 2010).

The strong positive association of grain yield with above mentioned components,which were also highly correlated with each other, indicated highly favourable situation forobtaining high response through selection. Thus, selection practiced for improving these traitsindividually orsimultaneously is likely to bring improvementin otherdueto correlatedresponse.

The above discussion revealed that all the highly significant estimates of correlationcoefficient observed among the important yield components.Thus,selectionpracticed forimproving these traits individually or simultaneously is likely to bring improvement in othersdue to correlated response. This suggests that selection would be quite efficient in improvingyield and these three yield components in wheat, especially in context of the germplasmcollectionsevaluated.Positiveassociationwasreportedbetweenplantheightwithspikelength, number of productive tillers per plant and grainyield per plant, number of spikeletsperspikeandnumberofgrainperspikeandbetweennumberofgrainsperspikeandgrainyieldper plant. (Ali *et al.*, 2008;Muhammad Mohibullh*et al.,* 2011; Singh*et al.,* 2019).

Table1:Estimatesofsimplecorrelationcoefficientsbetweenelevencharactersinwheatgenotypes

Character	Days to75% Flowering	Plant height(cm)	Days tomaturity	Number ofproductivetillers/plant	Spikelength(cm)	Number ofspikelets/spike	Number ofgrains/spike	Biologicalyield /plant(gm)	Testweight(gm)	Harvest index(%)	Grainyield /plant(gm)
Days to 75%Flowering	**1.000**	0.010	0.271*	-0.056	-0.026	-0.086	-0.082	-0.010	-0.079	-0.124	-0.024
Plant height(cm)		**1.000**	-0.199	0.131	0.352*	0.056	0.067	0.225*	0.025	0.142	0.223*
Days tomaturity			**1.000**	-0.190	-0.199	-0.261*	-0.250*	-0.044	0.010	-0.134	-0.063
Number ofproductivee tillers/plant				**1.000**	-0.002	0.825*	0.819*	0.898*	0.158	0.764*	0.902*
Spike length(cm)					**1.000**	0.083	0.067	-0.040	0.047	0.027	-0.029

Number ofspikelets /spike						**1.000**	0.986*	0.769*	0.165	0.736*	0.784*
Number ofgrains/spike							**1.000**	0.774*	0.145	0.736*	0.788*
Biological yield /plant(gm)								**1.000**	0.174	0.792*	0.995*
Test weight(gm)									**1.000**	-0.012	0.149*
Harvestindex(%)										**1.000**	0.843*
Grain yield /plant(gm)											**1.000**

PathCoefficientAnalysis

Estimates of direct and indirect effects of different traits on seed yield per plant in pathcoefficientanalysisusing simplecorrelations are given inTable 2

According to Table 2, revealed that the highest positive direct effects on grain yield perplant were exerted by biological yield per plant (0.8767) followed by harvest index (0.1471).However,othercharacterscontributingsignificantpositive directeffecton seedyieldwerenumber of spikelets per spike (0.0138), number of productive tillers per plant (0.0029), plantheight (0.0038) and days to 75% flowering (0.0042). The non- significant direct effects on seedyield per plant were exerted by test weight (-0.0020), number of grain per spike (-0.0157), spikelength (-0.0001) and days to maturity (-0.0048). Low direct effect recorded for the charactersindicating that direct contribution of these characters was too low to be considered for anyconsequences.

Plant height showed positive correlation with grain per plant via high indirect effects ofbiologicalyieldperplantfollowedbyharvestindex.Numberofproductivetillersper plant showedpositive correlation with grain per plant via high indirect effects of biological yield per plantfollowed by harvest index. Number of spikelets per spike showed positive correlation with grainperplantviahighindirecteffectsofbiologicalyieldperplantfollowedby harvestindex.Number of grains per spike showed positive correlation with grain per plant via high indirecteffects of biological yield per plant followed by harvest index. Biological yield per plant showedpositive correlation with grain per plant via high indirect effects of harvest index. Test weightshowed positive correlation with grain per plant via high indirect effects of biological yield perplant. Harvest index showed positive correlation with grain per plant via high indirect effects ofbiologicalyield per plant.

Thecorrelationcoefficientisdividedintodirectandindirecteffectsusingthecommon partial regression technique known as the path coefficient (Falconer and Mackay,1996).AlthoughWrightfirstdevelopedtheideain1921,DeweyandLuapplieditforthefirsttimeinplants electionin1959.Ithasbecomeapotentandpopulartoolfordeterminingtherelative weights of several yield-determining characteristics (Maurya et al., 2020; Upadhyay,2020). Since grain yield is a complicated quantitative property, several traits must be takenintoaccounttoimproveit.Pathcoefficientanalysisisa key toolforcreating effectiveselectionstrategiesbecausecorrelationstudiesalonedoesnotprovideacomprehensivepictureofth e relationship betweenfeatures.

Studies have shown a positive direct effect on grain yield for traits like plant height,flag leaf area, days to flowering, 50% heading, days to maturity, peduncle length,spikelength, spike per meter, number of spikelets per spike, grain-filling periods, grain weight perspike, biological yield and harvest index, indicating the relationship between these traits asgoodcontributorstograinyield(Dayem*etal*.,2021;Baye*etal*.,2020;SabiteGrainyield wasdirectly impacted most favorably by harvest index, then biomass yield (Dayem *et al*., 2021). The yield of breadwheatmaybeimproved through selection based on these qualities.

In previous studies, days to maturity and 1000 seed weight directly affected grainoutput in a negative way (Baye*et al*., 2020).TheseresultswereincontrasttothoseofMecha*etal*.(2017)andKhan*etal*.(2013),whofoundadirectrelationshipbetweendaystomaturityand100-seedweight andgrainyield thatwas positive.

This suggests that the environment may have an impact on how yield-related featuresaffect grain yield (Baye *et al*., 2020). Similar studies reported indirect effects of days tomaturity via plant height, number of spikes via number of seed/spike (Dayem *et al*. in 2021.) in contrast, reported a direct favorable influence of days to maturity.Similar results were obtained in previous studies. (Kumar *et al*., 2014; Dayem *et al*., 2021).

Table2:Directand indirecteffectsoftencharactersongrainyieldperplantinwheatgermplasm

Characters	Days to75 % Flowering	Plant heigh t(cm)	Days tomaturi ty	Number ofproducti vetillers/pl ant	Spike lengt h(cm)	Number ofspiikelet s/spike	Number ofgrain s/spike	Biological yield/Plant (gm)	Testw eight(gm)	Harvest index(%)	Grain yield/ plant (gm)
Daysto75%flo wering	**0.0042**	0.0001	-0.0013	-0.0002	0.0001	-0.0012	0.0013	-0.0088	0.0002	-0.0182	-0.024
Plant height(c m)	0.0001	**0.0038**	0.0010	0.0004	0.0001	0.0008	-0.0010	0.1973	0.0001	0.0209	0.223*
Days tomaturi ty	0.0011	-0.0008	**-0.0048**	-0.0005	0.0001	-0.0036	0.0039	-0.0386	0.0001	-0.0197	-0.063
Number ofproducti vetillers/pl ant	-0.0002	0.0005	0.0009	**0.0029**	0.0001	0.0114	-0.0128	0.7873	-0.0003	0.1124	0.902*

Spikelength(cm)	-0.0001	0.0013	0.0010	0.0001	**-0.0001**	0.0011	-0.0010	-0.0351	-0.0001	0.0040	-0.029
Number ofspikelets /spike	-0.0004	0.0002	0.0013	0.0024	0.0001	**0.0138**	-0.0154	0.6742	-0.0003	0.1083	0.784*
Number ofgrains/spike	-0.0003	0.0003	0.0012	0.0023	0.0001	0.0136	**-0.0157**	0.6786	-0.0003	0.1083	0.788*
Biological yield/plant (gm)	0.0001	0.0009	0.0002	0.0026	0.0001	0.0106	-0.0121	**0.8767**	-0.0003	0.1165	0.995*
Test weight(gm)	-0.0003	0.0001	0.0001	0.0005	0.0001	0.0023	-0.0023	0.1525	**-0.0020**	-0.0018	0.149*
Harvestindex(%)	-0.0005	0.0005	0.0006	0.0022	0.0001	0.0102	-0.0115	0.6943	0.0001	**0.1471**	0.843*

*Directeffectsonmaindiagonal(boldfigures)

CONCLUSION

Grain yield per plant have a positive and highly significant correlation with biologicalyield per plant, number of productive tillers per plant, harvest index, number of grainsper spike, number of spikelets per spike, plant height and test weight. It showed non-significantcorrelationwithdaysto75%flowering,spikelengthanddaystomaturity. Path analysis identified biological yield per plant and number of productive tillers perplant, number of grains per spike, number of spikelets per spike, plant height and testweight as important direct components for grain yield per plant. The aforementionedtraits were recognized as significant direct and indirect components that should betaken into account when formulating an efficient selection strategy for pea in order tocreatehighyieldingvarieties.

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