

CHARACTER ASSOCIATION ANALYSIS FOR QUALITY AND YIELD RELATED TRAITS IN BARLEY (*HORDEUM VULGARE* L.)

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Abstract: Thirty five genotypes of barley were studied for the character association among quality and yield related. Grain yield per plant showed highly significant and positive correlation with biological yield per plant and harvest index. Similarly, positive and significant correlations of grain yield per plant were also observed for number of spikelets per ear, number of seeds per spike and tiller number per plant. Path coefficient analysis revealed that the traits biological yield per plant and harvest index consistently showed high positive direct effect on grain yield per plant. Whereas, the traits, number of tillers per plant, number of spikelets per ear, number of seeds per spike, had low direct but contributed towards grain yield per plant mainly through biological yield per plant.

Therefore, it is concluded that the traits biological yield per plant and harvest index exhibiting positive and significant correlation with grain yield per plant and it also had high positive direct effects on grain yield per plant, which reveals that true relationship between yield and both traits therefore, direct selection for these traits will be rewarding for yield improvement.

Keywords: Character association, correlation coefficient, path analysis, barley

INTRODUCTION

Barely forms a basic food in region of India where the growing seasons is too short or the rainfall inadequate particularly among cereals. Besides, its consumption as a main food, the barley grains are primarily used as a feed for livestock and in the manufacturing of beverages. The grain yield of a crop is a complex character and is the ultimate product of actions and interactions of various component characters. Further, it is well known that no independent gene system is present for grain yield *per se* but genes are available only for component characters (Grafius, 1964). Therefore, a successful breeding programme should depend not only on the information on association of various yield component characters with grain yield but also on the information of their inter-association. Sometimes the selection merely on the basis of component characters of yield may not be effective due to low heritability. To make the selection effective for higher grain yield it is important to understand the yield contributing characters and the interrelationship among themselves and with yield is necessary (Carpici and Celik 2012, Drikvand *et al.* 2011, Jabbari *et al.* 2012 and Zaefizadeh *et al.* 2011). With the more number of traits in correlation studies, indirect association becomes more complex and important. In such circumstances, the partition of correlation coefficients of grain yield components into direct and indirect effects can be used to understand the exact association. The present investigation therefore, was undertaken to estimate the phenotypic and genotypic correlations and their direct and indirect effects on grain yield in barley.

MATERIAL AND METHOD

The experimental material for present investigation consisted of 35 indigenous genotypes of six rowed barley. These were procured from National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi. The experiment was conducted during 1997-98 and 1998-99 in *rabi* season at experimental farm of Kisan Post Graduate College, Simbhaoli, Ghaziabad (U.P.), India. The material was grown in 2 row plots of 2 meter long at 25 cm spacing, with three replications in randomized Block Design, under two levels of fertilizer and irrigations considered eight environments (table -1). All the recommended agronomical practices were adopted during experiments to raise the normal and healthy crop. The data were recorded on 3 randomly selected plants in each plot for 11 morphological traits viz., days to 50% flowering, days to maturity, plant height, number of tillers per plant, ear length, number of spikelets per ear, number of seeds per spikelets, grain yield per plant, 1000 grain weight, biological yield per plant and harvest index and two quality traits namely malt percentage and starch percentage. The mean values were used in the estimation of correlation coefficients among the traits and their direct and indirect effects on grain yield per plant.

Correlated characters are of interest to find out the genetic causes of correlation through the pleiotropic action of genes, to know how selection for one character will cause simultaneous change in other characters and to find out correlation between character and fitness.

Phenotypic $r(p)$ correlation coefficients for all possible pairs of characters were calculated from the already obtained variance and covariances according to Johnson *et al.* (1995).

Phenotypic $r(p)$ correlation coefficients were tested against standardized tabulated significant values of ' r ' with $(g-2)$ degrees of freedom as described by the Fisher and Yates (1963). The correlation coefficients were used to work out the path-coefficient analysis. The estimates of direct and indirect effects of various traits were calculated through path coefficient analysis as suggested by Dewey and Lu (1959).

RESULT AND DISCUSSION

The estimates of genotypic and phenotypic correlation coefficients among grain yield per plant and yield components on the basis of pooled analysis are presented in Table 2. The magnitude of genotypic correlation coefficient is higher than corresponding phenotypic correlation coefficient as earlier observed by Singh (1987) and Ram Kishor *et al.* (2000).

In present investigation, grain yield per plant was found consistently associated positively and significantly with biological yield per plant and harvest index in all the environments as well as in pooled analysis. These results are in conformity with Theoulakis *et al.* (1994) and El-Hennawy (1997). In pooled analysis, grain yield per plant was found significantly and positively correlated with number of spikelets per ear, tiller number per plant and number of seeds per spike.

The same pattern was observed by Yadav (1993), Irfan-ul-haq (1997), Singh *et al.* (1998), Subhash *et al.* (1998) and Ram Kishor *et al.* (2000).

It may be emphasized that the characters biological yield per plant, harvest index, number of spikelets per ear, tiller number per plant and number of seeds per spike important attributes in determining grain yield in barley. Their importance in yield improvement is further substantiated with the fact that they had significant positive association with other component characters. Some more characters like, ear length and 1000 grain weight were observed to have positive significant correlation with grain yield per plant showing their relative importance. Similar results were observed by El-Hennawy (1997), Irfan-ul-haq (1997), Singh *et al.* (1998) and Ram Kishor *et al.* (2000). Harvest index exhibited positive and highly significant correlation with malt percentage. While, plant height showed significant but negative correlation with grain yield per plant. Singh (1987) was also observed that grain yield negatively associated with plant height.

The traits biological yield per plant, tiller number per plant, harvest index, number of spikelets per ear and number of seeds per spike have high correlation with grain yield and are thus appeared as the main contributors for improving grain yield. These traits may form the basis of selection for better genotypes in barley over a range of given environments. Therefore, the simultaneous selection for these traits would ensure the improvement of yield potential in barley.

Correlation coefficient analysis provides only the direction and degree of association between various characters but, do not clearly bring out the traits on which breeders showed concentrate to improve the productivity or yield potential of a crop. Therefore, path coefficient analysis was also carried out to meet the desired objective. This analysis estimates the direct and indirect effects via alternate characters towards grain yield per plant. Hence, path analysis was also attempted as suggested by Dewey and Lu (1959).

Path Coefficient analysis

Direct and indirect effects of metric traits on grain yield per plant are presented in Table 3. It would be interesting to note the traits recommended earlier on the basis of correlation studies, showed consistent high direct effects and indirect effects through each other towards dependable variable. The traits biological yield per plant and harvest index exhibited high direct contribution towards grain yield. The other important yield contributing characters namely number of spikelets per ear and number of seeds per spike although have positive and significant correlation with grain yield per plant. But these characters did not exhibit considerable direct influence on grain yield, instead, they contributed towards grain yield via biological yield per plant whereas, Singh (1987), Garcia *et al.* (1991), Ganeshwa *et al.* (1997), Mandal and Dana (1993), Naik *et al.* (1998), Verma *et al.* (1998) and Fathi and Rezacimoghdam (2000) reported that the number of seeds per spike had greatest effect on grain yield. It is pertinent to mention that trait tiller number per plant had positive and significant correlation with grain yield but it had negative and low direct effects on grain yield, however, it contributes towards grain yield via biological yield per plant, indicating the significant correlation of these two variables was mainly due to the high direct effect via biological yield per plant. While Kumar *et al.* (1986), Jadav and Jadon (1987), Singh (1987), Sarker *et al.* (1988), Singh (1990), Garcia *et al.* (1991), Yadav (1993), Kudla (1995), Maled and Hanchinal (1997), Naik *et al.* (1998), Verma *et al.* (1998) and Fathi and Rezaeimoghddam (2000) reported that the tiller number per plant had positive and direct effect on grain yield per plant.

It is apparent from the presence of direct effect and high positive correlation with grain yield that biological yield per plant and harvest index have true relationship with grain yield. Therefore, direct selection for high biological yield per plant and high harvest index will result in improvement of grain yield. Because other component characters had indirect effect on grain yield via these two characters. The important yield contributing trait 1000 grain weight has positive and significant correlation with grain yield in only two environments (V & VIII) and simultaneously shows positive direct effect on grain

yield in same environments. However, pooled analysis of correlation and path coefficient revealed that it does not have any influence on grain yield directly or indirectly. On the contrary Singh (1987), Ganeshwa *et al.* (1992), Mandal and Dana (1993), Kudla and Kudla (1995), Verma *et al.* (1998) reported that 1000 grain weight had positive direct effects on grain yield per plant. Therefore, it may be suggested that 1000 grain weight is not a stable selection criteria for yield improvement in barley.

In addition to agronomic traits, quality traits like malt and starch percentage have important role to stabilize the barley as a row product for different industrial purposes. In the present investigation malt percentage has positive and significant correlation with harvest index in pooled analysis, whereas, it shows negligible direct and indirect effects on most of the characters conserved. Therefore, it may be concluded that selection for harvest index can also improve the malt percentage along with grain yield

in barley. However, starch percentage does not have any correlation, direct and indirect effects in the direction of yield improvement. Therefore, it necessitates formulating the breeding procedures for starch percentages improvement.

The contribution of residual factor in pooled analysis (0.0563) at phenotypically. It indicates that these thirteen traits contributes 99.68 per cent variability is explained toward grain yield per plant.

From these studies it appears that, the traits biological yield per plant and harvest index consistently showed high positive direct effect on grain yield per plant. Whereas, the traits, number of tillers per plant, number of spikelets per ear, number of seeds per spike had low direct effect and contributed towards grain yield per plant mainly through biological yield per plant. Therefore, direct selection for these traits will be rewarding for yield improvement.

Table 1. Details of environments in the years 1997-98 and 1998-99

Fertilizer levels	Irrigations	Environments
1997-98		
40 kg N ₂	One	I
20 kg P ₂ O ₅		
20 kg K ₂ O		
40 kg N ₂	Three	II
20 kg P ₂ O ₅		
20 kg K ₂ O		
20 kg N ₂	One	III
20 kg P ₂ O ₅		
20 kg K ₂ O		
20 kg N ₂	Three	IV
20 kg P ₂ O ₅		
20 kg K ₂ O		
1998-99		
40 kg N ₂	One	V
20 kg P ₂ O ₅		
20 kg K ₂ O		
40 kg N ₂	Three	VI
20 kg P ₂ O ₅		
20 kg K ₂ O		
20 kg N ₂	One	VII
20 kg P ₂ O ₅		
20 kg K ₂ O		
20 kg N ₂	Three	VIII
20 kg P ₂ O ₅		
20 kg K ₂ O		

Table 2. Phenotypic and genotypic correlation coefficient analysis among different characters of barley (*Hordeum vulgare* L.) in pooled basis

[illegible]

	G												-	0.803**
Starch (%)	P													-
	G													-

*Significant at 5% level ** Significant at 1% level

Table 3. Phenotypic and genotypic correlation coefficient analysis among different characters of barley (*Hordeum vulgare* L.) in pooled basis

Characters	Days to flowering	Days to maturity	Plant height (cm)	Tiller No./plant	Ear length (cm)	No. of spikelets/ear	No. of seeds/spike	1000 grain wt. (g)	Biological yield/plant	Harvest index (%)	Malt (%)	Starch (%)	'r' values with grain yield
Days to flowering	0.022	0.002	0.001	0.002	0.019	-0.006	-0.046	0.011	-0.105	-0.087	-0.002	0.002	-0.186
Days to maturity	-0.004	-0.011	-0.002	-0.011	-0.018	0.021	0.002	-0.013	0.294	-0.057	0.002	0.011	0.215
Plant height	0.006	0.006	0.003	0.002	0.021	-0.011	-0.005	-0.002	-0.388	-0.001	-0.003	-0.003	-0.373*
Tiller No./plant	0.010	-0.002	-0.011	-0.007	0.043	0.012	0.018	0.044	0.382	-0.137	0.001	0.002	0.356*
Ear length (cm)	0.009	-0.004	0.002	0.006	0.047	-0.017	-0.019	0.002	-0.262	-0.017	0.004	0.007	-0.240
No. of spikelets/ear	-0.002	-0.004	-0.001	0.002	-0.014	0.055	0.054	0.032	0.475	-0.237	0.019	-0.001	0.378*
No. of seeds/spike	0.008	0.188	0.076	0.034	0.036	0.024	-0.125	0.030	0.439	-0.363	0.006	0.001	0.354*
1000 grain wt (g)	0.004	0.002	-0.100	-0.001	0.001	0.002	-0.012	0.060	-0.137	0.081	-0.002	-0.003	-0.103
Biological yield/plant	-0.002	-0.003	-0.001	-0.003	-0.011	0.026	-0.049	-0.007	1.113	-0.525	0.004	0.001	-0.544**
Harvest index (%)	-0.022	0.001	0.018	0.001	0.009	-0.014	0.070	0.005	-0.628	0.931	-0.009	-0.008	0.354*
Malt (%)	-0.012	0.001	0.001	0.021	0.010	-0.089	0.035	0.007	-0.236	0.412	-0.030	-0.013	0.188
Starch (%)	-0.004	0.012	0.001	0.001	0.001	0.004	0.014	0.016	-0.069	0.083	-0.016	-0.003	0.031

*Significant at 5% level ** Significant at 1% level

Residual effects = 0.0563

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