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Association and Path coefficient Analysis Among Grain Yield and it's component Traits in Barley (*Hordeum vulgare* L.)

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ABSTRACT: A study was undertaken to estimate character association and path coefficient analysis for grain yield and its contributing traits in 36 novel barley genotypes grown in Randomized Block Design with three replications during *Rabi*, 2022-23. The grain yield per plant had a positive and significant correlation with number of effective tillers per plant, number of grains per spike, 1000-grain weight and biological yield per plant at both genotypic and phenotypic levels while with harvest index at genotypic level only. The characters namely biological yield per plant, 1000-grain weight, number of effective tillers per plant, days to 75 percent heading and grain protein content had high positive direct effect on grain yield per plant. Thus, these traits are to be considered as the most important yield contributors and due emphasis should be given while attempting yield improvement in barley.

Keywords: Barley, correlation coefficient, path analysis.

INTRODUCTION

Barley (*Hordeum vulgare* L.; 2n=2x=14), a self-pollinated crop, belongs to the family Poaceae and is one of the most important food grains since historic times. *Hordeum vulgare* is solely cultivated species that has two distinct phenotype forms, *viz*., two-rowed and six-rowed types based totally on ear morphology. It is the most widely grown cereal crop over wide environmental situations and the world's fourth most important cereal crop after wheat, maize and rice. It is hardy crop more tolerant to drought, heat and can be grown in salt affected soil (Baik and Ullrich 2008; FAO, 2002 and Sharma *et al*., 2016). It has played an important role throughout human history and is grown predominantly for animal feed and malt for the brewing industry. Only 6% of barley is used as human food, while nearly 21% of the produce is consumed by malting industry and more than 70% is used for livestock purposes and the remaining percentage is used for medicinal purposes, brewing child ingredients etc. (Caterina *et al*., 2018). Barley, renowned as the world's most nutritious crop, boasts a rich composition with 12.50 % water, 11.50 % protein, 1.30 % fat, 69.6 % carbohydrate, 3.9 % fiber, and 1.2 % minerals. It is also abundant in vitamin B, vitamin E, folic acid and other essential minerals.

Path coefficient and correlation analyses are used widely in plenty of crop species by plant breeders to define the nature of complex inter-relationships among yield components and to find out the reasons for occurrence of variations in yield. Correlation studies simply measures the association of yield and yield attributes and does not give the actual dependence of yield on the correlated characters. Correlation provides an incomplete representation of the relative importance of direct and indirect influences on the individual factors involved (Garcia del Moral *et al*., 1991). Path coefficients analysis is an effective method to determine the direct and indirect causes of association an also permits to examine the specific forces acting to produce to a given correlation.

Therefore, in the present study, an effort has been made to generate information on the association of yield with its different components measures through correlation and path analysis so that appropriate selection strategy can be formulated for evolving suitable genotypes.

MATERIALS AND METHODS

The present investigation was conducted at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur. The experiment was carried out with thirty-six diverse genotypes of barley during *Rabi*, 2022-23 in Randomized Complete Block Design with

three replications. In each replication, genotypes were sown in a plot of 4.0 m × 0.75 m size accommodating 03 rows of 4.0 meters length spaced 25 cm apart with an intra-row spacing of 10 cm. All the recommended packages of practices were followed to raise a good and healthy crop. The observations were recorded on five randomly selected competitive plants from each plot in each replication for plant height (cm), number of effective tillers per plant, spike length (cm), number of grains per spike, grains weight per spike (g), 1000-grain weight (g), biological yield per plant (g), grain yield per plant (g), harvest index (%) and grain protein content (%) while for days to 75 per cent heading and days to maturity, the data was recorded on whole plot basis. The genotypic and phenotypic correlation coefficients were calculated by using method suggested by Al-Jibouri *et al*. (1958) and path coefficients were obtained by following the method of Dewey and Lu (1959). The seed protein content was estimated by using Micro Kjeldhal's method (1883).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the genotypes for all the traits under study that indicating presence of significant variability in the materials thereby justifying the selection of the experimental materials. Information regarding the nature and extent of association of morphological character would be helpful in developing suitable plant type, in addition to the improvement of yield a complex character for which direct selection is not effective.

The genotypic and phenotypic correlation coefficients among 12 characters using 36 barley genotypes are presented in Table 1 (Fig. 1). Significant correlation of characters suggested that there is much scope for direct and indirect selection for further improvement. In general, the estimates of genotypic correlation coefficient were higher than their corresponding phenotypic ones thereby suggesting inherent association among the characters studied. Lower degree of associations between two variables at phenotypic level might be due to the masking or modifying effect of environment on the association of traits.

In the present investigation, the grain yield per plant had a positive and significant correlation with number of effective tillers per plant, number of grains per spike, 1000-grain weight and biological yield per plant at both genotypic and phenotypic levels while with harvest index at genotypic level only. Similar results are also in consonance with Aklilu *et al*. (2020); Singh *et al.* (2014); Madakemohekar *et al*. (2015); Tofiq *et al*. (2015). Days to 75 percent heading expressed a positive and significant correlation with plant height at both genotypic and phenotypic levels, while it exhibited a negative and significant correlation with harvest index. Days to maturity displayed a negative and significant correlation with spike length at genotypic level only. Plant height expressed a negative and significant correlation with grain yield per plant at both genotypic and phenotypic levels and with harvest index at phenotypic level only. Number of effective tillers per plant exhibited a positive and significant correlation with 1000-grain weight, harvest index and grain yield per plant at genotypic and phenotypic levels while it showed a positive and significant correlation with biological yield per plant at genotypic level only. Number of grains per spike expressed a positive and significant correlation with grain weight per spike, biological yield per and grain yield per at both genotypic and phenotypic levels. Grain weight per spike expressed a positive and significant correlation with biological yield per plant at genotypic and phenotypic levels. 1000-grain weight showed a positive and significant correlation with biological yield per plant, harvest index and grain yield per plant at both genotypic and phenotypic levels. Biological yield per plant exhibited a positive and significant correlation with grain yield per plant at both genotypic and phenotypic levels. Harvest index showed a positive and significant correlation with grain yield per plant at genotypic level only. Similar results of positive association of grain yield per plant with biological yield per plant and harvest index by Aklilu *et al*. (2020); Singh *et al*. (2014); Madakemohekar *et al*. (2015); Tofiq *et al*. (2015); with days to 75% heading and maturity by Shiferaw *et al*. (2020). Thus, these characters emerged as important traits associated with grain yield. An improvement in above characters followed by effective selection is expected to affect the grain yield positively.

Path coefficient analysis is an important tool for partitioning the correlation coefficients into the direct and indirect effects of independent variables on a dependent variable. It is also important to understand the relative importance of different parameters as selection criteria. It helps to better understand the inter-relationship among the traits. Grain yield is complex character and for its improvement multiple traits needed to be considered. The result of present investigation on path coefficient analysis is presented in Table 2 revealed that biological yield per plant, 1000-grain weight, number of effective tillers per plant, days to 75 % heading and grain protein content had a positive direct effect on grain yield per plant while negative direct effect on grain yield per plant was observed by plant height followed by number of grains per spike, days to maturity, spike length and grain weight per spike. These characters could be considered as main components of selection in a breeding program for obtaining higher grain yield in barley. These traits had also been identified as major direct contributors towards grain yield by Aklilu *et al*. (2020); Nagesh *et al*. (2019); Kumar *et al*. (2017); Madakemohekar *et al*. (2015); Solemani *et al*. (2017).

Table 1: Estimation of genotypic (rg) and phenotypic (rp) correlation coefficient for different characters in barley.

Character		Days to 75 % Heading	Days to maturity	Plant height	Number of effective tillers per plant	Spike length	Number of grains per spike	Grains weight per spike	1000-grain weight	Biological yield per plant	Harvest Index	Grain protein content	Grain yield per plant
Days to 75 % Heading	rg		0.28	**0.52****	-0.21	0.18	0.15	0.02	-0.18	0.07	**-0.33***	-0.02	-0.15
	rp		0.18	**0.43****	-0.15	0.16	0.12	0.01	-0.15	0.02	**-0.28***	-0.02	-0.14
Days to maturity	rg			-0.27	0.21	**-0.39***	0.11	-0.01	0.11	0.23	0.06	-0.22	0.21
	rp			-0.23	0.09	-0.22	0.10	0.01	0.06	0.10	0.05	-0.24	0.11
Plant height	rg				-0.15	0.13	-0.26	-0.25	-0.28	-0.22	-0.32	0.29	**-0.37***
	rp				-0.14	0.15	-0.20	-0.18	-0.22	-0.13	**-0.26***	0.21	**-0.26***
Number of effective tillers per plant	rg					-0.28	0.28	0.16	**0.46****	**0.40***	**0.50****	-0.02	**0.62****
	rp					-0.18	0.24	0.11	**0.41****	0.35	**0.42****	-0.01	**0.54****
Spike length	rg						-0.30	-0.19	0.21	0.01	-0.02	0.17	0.01
	rp						-0.22	-0.12	0.19	0.08	0.09	0.08	0.11
Number of grains per spike	rg							**0.72****	0.09	**0.59****	-0.15	-0.20	**0.39***
	rp							**0.72****	0.09	**0.41****	-0.13	-0.18	**0.30***
Grains weight per spike	rg								0.21	**0.39***	-0.02	-0.09	0.29
	rp								0.2	**0.26***	0.00	-0.08	0.22
1000-grain weight	rg									**0.45****	**0.56****	-0.13	**0.69****
	rp									**0.33****	**0.51****	-0.12	**0.57****
Biological yield per plant	rg										-0.05	-0.22	**0.79****
	rp										-0.05	-0.13	**0.83****
Harvest Index	rg											-0.03	**0.51****
	rp											-0.01	-0.13
Grain protein content	rg												-0.19
	rp												-0.13
Grain yield per plant	rg												
	rp												

Table 2: Estimate of direct effect (bold face and diagonal) and indirect effects (off diagonal) at phenotypic level in 36 barley genotypes.

Character	Days to 75 percent heading	Days to maturity	Plant height	Number of effective tillers per plant	Spike length	Number of grains per spike	Grain weight per spike	1000-grain weight	Biological yield per plant	Grain protein content	r with grain yield per plant
Days to 75 percent heading	0.1341	-0.0396	-0.1299	-0.0587	-0.0153	-0.0249	-0.0004	-0.0533	0.0423	-0.0003	-0.146
Days to maturity	0.037	-0.1437	0.067	0.0597	0.0343	-0.0188	0.0003	0.0332	0.1438	-0.0027	0.21
Plant height	0.0695	0.0384	-0.2508	-0.0427	-0.0112	0.0439	0.0069	-0.0831	-0.1398	0.0036	-0.3653
Number of effective tillers per plant	-0.0277	-0.0302	0.0377	0.2842	0.0244	-0.0468	-0.0046	0.1356	0.2519	-0.0002	0.6243
Spike length	0.0235	0.0564	-0.0322	-0.0795	-0.0874	0.0495	0.0053	0.0611	0.0087	0.0021	0.0073
Number of grains per spike	0.0201	-0.0163	0.0662	0.08	0.026	-0.1661	-0.0201	0.0275	0.371	-0.0024	0.3859
Grain weight per spike	0.0021	0.0013	0.0616	0.0466	0.0165	-0.119	-0.0281	0.062	0.2441	-0.0012	0.286
1000-grain weight	-0.0242	-0.0162	0.0706	0.1307	-0.0181	-0.0155	-0.0059	0.2949	0.2798	-0.0016	0.6945
Biological yield per plant	0.009	-0.0329	0.0558	0.1139	-0.0012	-0.0981	-0.0109	0.1314	0.6282	-0.0027	0.7926
Grain protein content	-0.003	0.0321	-0.0732	-0.0054	-0.0146	0.0325	0.0027	-0.0392	-0.1354	0.0123	-0.1912
Residual = 0.3913; *, ** Significant correlation with dependent character at 5% and 1% respectively											

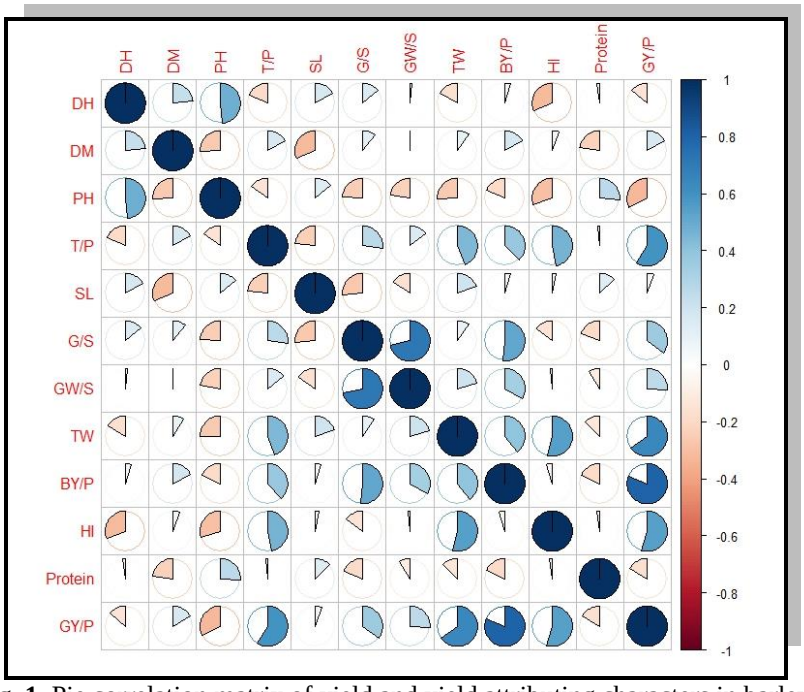

Fig. 1. Pie correlation matrix of yield and yield attributing characters in barley.

CONCLUSIONS

In the light of above findings, it may be concluded that improvement in the characters like biological yield per plant, 1000-grain weight, number of effective tillers per plant, number of grains per plant and plant height will help in improving the seed yield in barley both directly and indirectly. Therefore, these characters should be considered for yield improvement in barley breeding programme.

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Conflict of Interest. None.

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