Electronic Journal of Plant Breeding, 4(4): 1313-1318 (Dec 2013)
ISSN 0975-928X

Research Note

Correlation and path coefficient studies in barley (*Hordeum vulgare* L.) under dual purpose condition

Mahender Kumar and S. S. Shekhawat
AICRP on Forage Crops, Centre for Forage Management, Agricultural Research Station, S. K. Rajasthan Agricultural University, Bikaner 334 006, Rajasthan
E-mail : srn_shekhawat@yahoo.co.in

(Received: 17 Oct 2013; Accepted: 28 Oct 2013)

Abstract
Twenty two barley genotypes were evaluated for green fodder yield, grain yield and related morphological characters. Plant height, spike length, number of spikelets per spike, number of grains per spike, number of tillers per meter row length and test weight had positive and significant correlation with green fodder yield. Spike length, number of spikelets per spike, number of grains per spike, number of tillers per meter row length, test weight and green fodder yield showed positive and significant association with grain yield. Number of tillers per meter row length and leaf length were having the highest positive direct effects on green fodder yield. Spike length, number of spikelets per spike, number of grains per spike, number of tillers per meter row length, leaf width, test weight, peduncle length and leaf length showed positive direct effects on grain yield. Hence these traits may be considered as selection indices for green fodder and grain yield.

Key words: Barley, correlation, path coefficient, direct effect, grain yield

Barley [*Hordeum vulgare* L.] is the world's fourth most important cereal crop after wheat, maize and rice. Barley is one of the most widely distributed *rabi* cereals cultivated throughout the temperate and tropical regions of the world. The major barley producing countries of the world are Canada, U.S.A., Germany, France, Spain, Turkey, U.K., Denmark, Russia, Central Asian State (CAS) and Australia. By virtue of its nature, lower cost of cultivation, superior nutritional qualities, barley is favoured in neglected agricultural areas, particularly in problematic soils like rainfed, dry land, salinity, alkalinity and flood prone marginal/coastal areas. The major barley growing states are U.P., Rajasthan, M.P., Bihar, Punjab, H.P., Haryana, Jammu & Kashmir and Gujarat. Rajasthan ranks second after Uttar Pradesh, both in area and production in India. In Rajasthan, it is an important *rabi* cereal next to wheat in acreage and production.

The correlation coefficient analysis measures the mutual relationship between various plant characters and determines the characters on which selection can be based for improvement in yield. Path analysis simply splits the correlation coefficient into the measures of direct and indirect effect of a set of independent variables on the dependent variables. Therefore, the present study was conducted to get information for character association for grain yield, green fodder yield and related characters in 22 improved genotypes of barley.

The investigation was carried out during *rabi* season 2009-10 at Agricultural Research Station (SKRAU), Bikaner. The experimental farm is situated between 27^0 11' N latitude and 71^0 54' E longitude at an altitude of 228.5 meters above sea level. The experimental material consisted of 22 genotypes of barley. Genotypes differing in growth and morphological characters were obtained from AICRP on Forage crops, Agricultural Research Station (SKRAU), Bikaner. The experiment was laid out in randomized block design with three replications. Each plot consisted of six rows of five meter length, the spacing between rows was 23 cm. Normal and uniform cultural operations were followed during the crop to raise a good crop. The sample size consisted of five plants, selected randomly from each plot. The observations on different characters were recorded on the basis of five selected plants and mean was obtained. Days to 50 per cent flowering, number of tillers per meter row length, days to maturity, test weight, green fodder yield and grain yield were based on whole plot basis. Green fodder yield was recorded by cutting the crop after 55 days of sowing. After that, crop was allowed to grow and grain yield was obtained.

Genotypic and phenotypic correlation coefficients of green fodder yield and grain yield and contributing characters were estimated as described by Singh and Choudhary (1985). The direct and indirect effects were estimated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

In general, the estimates of genotypic correlation were higher than the corresponding phenotypic correlation coefficients with similar trend of association (Table 1). Hence genotypic correlation was further discussed and also used for path analysis. Higher magnitude of genotypic correlation might be resulted from the modifying effect of environment on the association of characters at genotypic level. The character green fodder yield (q/ha) had positive and significant correlation with plant height, spike length, number of spikelets per spike, number of grains per spike, number of tillers per meter row length and test weight. The character grain yield (q/ha) had positive and significant correlation at with spike length, number of spikelets per spike, number of grains per spike, number of tillers per meter row length, test weight and green fodder yield. This association indicated that improvement in green fodder yield and grain yield can be achieved by increasing above characters.

Among the various interrelationships among different characters, leaf length and width exhibited positive and significant correlations with leaf area; leaf area exhibited positive and significant association with peduncle length; plant height exhibited positive and significant correlation with spike length, number of grains per spike, peduncle length, number of tillers per meter row length, test weight and green fodder yield; spike length was having positive and significant correlation with number of spikelets per spike, number of grains per spike, number of tillers per meter row length, test weight, green fodder yield and grain yield; number of spikelets per spike had positive and significant association with number of grains per spike, number of tillers per meter row length, test weight, green fodder yield and grain yield; number of grains per spike showed positive and significant association with number of tillers per meter row length, test weight, green fodder yield and grain yield; number of tillers per meter row length exhibited positive and significant association with test weight, green fodder yield and grain yield; test weight had positive and significant association with green fodder yield and grain yield and green fodder yield had positive and significant association with grain yield. Similar findings of positive and significant correlation with grain yield have been reported by Singh *et* al. (1983); Rajbir and Kaul (1989); Singh *et* al. (1998); Verma *et* al. (1998); Kishor *et* al. (2000); Kumar and Prasad (2002); Najeeb and Wani (2004) and Singh *et al*. (2006).

The residual effects of path analyses indicated that the traits chosen for path analysis were appropriate. Path coefficient analysis revealed that the character number of tillers per meter row length showed high positive direct effect on green fodder yield (q/ha) (Table 2). Other traits recorded negligible direct effects on green fodder yield. Therefore, this character is the important green fodder yield determining character. With regard to indirect effects, plant height had high positive indirect effect via no. of tillers per meter row length. Path coefficient analysis on grain yield revealed that the characters like spike length and number of tillers per meter row length showed positive and high direct effect on grain yield (q/ha) (Table 3). The traits, plant height had high negative direct effect on grain yield. With regard to indirect effect, days to maturity and no. of grains per spike had negative and positive effects on grain yield. Therefore these are the important yield determining characters. In similar findings, Solanki and Bakhshi (1973) observed that number of tillers/plant had the greatest direct and indirect effects of yield variation. Tewari (1975) observed that ear length, grain number and 1000-grain weight had a direct positive effect on yield. Kirtok and Colkesen (1985) observed that the components contributing directly to yield differed according to year, but 1000-grain weight, ear length and number of grains/ear generally had marked direct effects. El-Hennawy (1997) observed that grains/spike and 100-grain weight had the most marked effects on grain yield. Fathi and Rezaeimoghddam (2000) studied that spike number per m^2 and number of grains per spike had the largest direct effect on grain yield. Najeeb and Wani (2004) reported high and positive direct effects of effective tillers per plant, effective tillers running per meter, plant height, grains per ear, days to heading, awn length and 1000-grain weight on grain yield. Mittal *et al.* (2009) reported that grains per spike had maximum positive direct effect followed by 100 grain weight and plant height upon grain yield.

From the foregoing discussion, it may be concluded that no. of tillers per meter row length is an important selection index for green fodder yield. In case of grain yield, no. of tillers per meter row length, spike length, no. of grains per splike, plant height, days to maturity are the selection indices for grain yield improvement.

Acknowledgement: The authors are thankful to the Zonal Director Research, Agricultural Research Station, Bikaner and the Dean, College of Agriculture, Bikaner for the necessary facilities provided.

References

Dewey, D.R. and Lu, K.H. 1959. Corelation and path coefficient analysis of components of created wheat grain seed production. *Agron. J*., **51**:515-518.

El-Hennawy, M. 1997**.** Genetic variability and path coefficient analysis of some agronomic characters in barley (*Hordeum vulgare* L.)**.** *Annals Agril.Sci.,-Moshtohor*, **35**: 773-783.

Fathi, G.H. and Rezaeimoghddam, K. 2000. Path analysis of grain yield and yield components

for some barley cultivars in Ahvaz region. *Agrl. Sci. And Tech.*, **14**:39-48.

Kirtok,Y. and Colkesen, M. 1985. Path coefficient analysis of some important yield components of barley varieties in trials in the Cukurova region. *Doga Bilim Dergisi,D2 Tarim-ve-Ormancilik*, **9**: 40-50.

Kishor,R., Pandey, D. D. and Verma, S. K. 2000. Genetic variability and character association in hull-less barley (*Hordeum vulgare* L.). *Crop Res. (Hisar)*, **19**: 241-244.

Kumar, S. and Prasad, L. C. 2002. Variability and correlation studies in barley (*Hordeum vulgare* L.). *Research on Crops*, **3**: 432-436.

Mittal, V. P., Brar, K. S. and Singh, P. 2009. Interrelationships and path coefficient analysis for yield and component characters in barley (*Hordeum vulgare* L.). *J. Agrl. Sci.*, **5**:151-153.

Najeeb, S. and Wani, S.A. 2004. Correlation and path analysis studies in barley (*Hordeum vulgare* L.). *Nat. J. Plant Improve.*, **6**: 124-125.

Rajbir, S and Kaul. M. L. H. 1989. Agronomic performance and correlations in elite barley. *Archiv fur Zuchtungsforschung*, **19**: 119-132.

Singh, A.K., Singh, S.B. and Yadava, H.S. 1998. Correlation and path analysis in early generation of hull-less barley (*Hordeum vulgare* L.). *Annals Agrl. Res.*, **19**: 260-264.

Singh, H. L., Singh, S. K., Singh, P. and Singh, B. C. 2006. Genetic variability and characters association in barley (*Hordeum vulgare* L.). *Internat. J. Plant Sci. (Muzaffarnagar)*, **1**: 2, 256-258.

Singh, R. R., Singh, R. V. and Pandey, R. A. 1983. Path coefficient analysis in barley. *Madras Agric. J.*, **70**: 123-124.

Singh, R.K. and Choudhary, B.D. 1985. *Biometrical Methods in Quantitative Genetic Analysi.* Kalyani Publishers (Rev. Ed., 1985), Ludhiana, pp : 39-68.

Solanki, K. R. and Bakhshi, J.S. 1973. Component characters of grain yield in barley. *Indian Journal of Genetics and Plant Breeding*, **33**: 201-203.

Tewari, S. N. (1975). Path coefficient analysis for grain yield and its components in a collection of barley (*Hordeum vulgare* L.) germplasm. *Third Internat. Barley Genet. Symp., Authors T-Z*, 118.

Verma, S.K., Kumar, N. And Lamba, R.A.S. 1998. Study of direct and indirect influences of contributing traits on grain yield in barley (*Hordeum vulgare* L.). *Crop Res.(Hisar)*, 16: 3, 333-336.

Wright, S. 1921. Correlation and causation. *J. Agrl. Res.*, **20**: 557-585.

Table 1. Phenotypic (upper diagonal) and genotypic (lower diagonal) correlation coefficients among grain yield, green fodder yield and its component characters in barley

Character	Days to 50% flowering	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Plant height (cm)	Days to maturity	Spike length (cm)	Number of spikelets/ spike	Number of grains / spike	Peduncle length (cm)	Number of tillers/ meter row length	Test weight (gm)	Green fodder yield (q/ha)	Grain yield (q/ha)
Days to 50% flowering	**1.000**	0.276	-0.095	0.024	-0.170	0.097	-0.172	-0.300	-0.234	-0.161	-0.260	-0.401	-0.158	-0.198
Leaf length (cm)	0.477*	**1.000**	0.139	0.486*	0.258	0.160	0.102	0.163	0.228	0.362	0.002	0.062	0.111	0.103
Leaf width (cm)	-0.055	0.006	**1.000**	0.433*	0.125	0.144	-0.005	0.004	0.140	0.294	0.090	0.033	0.069	0.128
Leaf area (cm^2)	0.074	0.513*	0.535*	**1.000**	0.159	0.021	0.170	0.267	0.000	0.554**	0.060	0.031	0.059	0.152
Plant height (cm)	-0.175	0.372	0.128	0.179	**1.000**	0.202	0.448*	0.378	0.569**	0.444*	0.595**	0.599**	0.587**	0.293
Days to maturity	0.120	0.265	0.199	0.048	0.247	**1.000**	0.038	-0.246	0.059	0.019	-0.073	0.024	-0.078	-0.269
Spike length (cm)	-0.188	0.135	0.051	0.208	0.471	0.045	**1.000**	0.764**	0.535*	0.026	0.838**	0.869**	0.790**	0.826**
Number of spikelet's/ spike	-0.314	0.291	0.006	0.302	0.423	-0.289	0.821**	**1.000**	0.514*	0.189	0.786**	0.777**	0.796**	0.805**
Number of grains / spike	-0.237	0.288	0.186	0.014	0.621**	0.078	0.592**	0.556**	**1.000**	0.193	0.694**	0.695**	0.705**	0.623**
Peduncle length (cm)	-0.193	0.542**	0.465*	0.652**	0.458*	-0.010	0.020	0.224	0.232	**1.000**	0.108	0.131	0.142	0.101
Number of tillers/ meter row length	-0.283	0.031	0.111	0.054	0.615**	-0.081	0.870**	0.828**	0.745**	0.118	**1.000**	0.888**	0.960**	0.815**
Test weight	-0.434*	0.093	0.028	0.054	0.624**	0.025	0.891**	0.829**	0.750**	0.129	0.909**	**1.000**	0.859**	0.790**
Green fodder yield q/ha)	-0.167	0.190	0.088	0.051	0.605**	-0.102	0.829**	0.834**	0.755**	0.146	0.970**	0.883**	**1.000**	0.792**
Grain yield (q/ha)	-0.231	0.164	0.196	0.178	0.313	-0.309	0.845**	0.867**	0.671**	0.113	0.834**	0.805**	0.821**	**1.000**

*Significant at 5% level of significance ** Significant at 1% level of significance

Table 2 Direct and Indirect effects of different characters on green fodder yield in barley at phenotypic and genotypic levels

Character		Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Plant height (cm)	No. of tillers/m row length	Correlation with green fodder yield (q/ha)
Leaf	P	**0.077**	0.000	-0.035	-0.009	0.002	0.111
length (cm)	G	**-0.057**	0.000	-0.067	-0.017	0.023	0.190
Leaf width	P	0.011	**0.003**	-0.031	-0.004	0.081	0.069
(cm)	G	0.000	**0.026**	-0.070	-0.006	0.081	0.088
Leaf area	P	0.037	0.001	**-0.073**	-0.005	0.054	0.059
(cm^2)	G	-0.029	0.014	**-0.131**	-0.008	0.040	0.051
Plant height	P	0.020	0.000	-0.012	**-0.033**	0.532	0.587**
(cm)	G	-0.021	0.003	-0.023	**-0.045**	0.451	0.605**
No. of tillers	P	0.000	0.000	-0.004	-0.020	**0.895**	0.960**
/m row length	G	-0.002	0.003	-0.007	-0.028	**0.733**	0.970**

Residual effect: Phenotypic = 0.0455 Genotypic= 0.0221

Table 3 Direct and Indirect effects of different characters on grain yield in barley at phenotypic and genotypic levels

Character		Days to 50% flowering	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Plant height (cm)	Days to maturity	Spike length (cm)	Spikelets per spike	Grain per spike	Peduncle length (cm)	No. of tillers/m row length	Test weight (gm)	Green fodder yield (q/ha)	Correlation with grain yield (q/ha)
Days to 50% flowering	P	**0.100**	0.016	-0.015	-0.003	0.052	-0.022	-0.084	-0.052	-0.051	-0.022	-0.089	-0.059	0.031	-0.198
	G	**0.298**	-0.100	-0.019	-0.036	0.013	-0.021	-0.148	-0.302	-0.100	-0.050	0.108	0.061	0.064	0.231
Leaf length (cm)	P	0.027	**0.058**	0.022	-0.054	-0.079	-0.037	0.050	0.028	0.050	0.049	0.001	0.009	-0.022	0.103
	G	0.142	**-0.210**	0.002	-0.248	-0.029	-0.046	0.106	0.280	0.122	0.141	-0.012	-0.013	-0.073	0.164
Leaf width (cm)	P	-0.009	0.008	**0.158**	-0.048	-0.039	-0.033	-0.003	0.001	0.031	0.040	0.031	0.005	-0.013	0.128
	G	-0.016	-0.001	**0.351**	-0.259	-0.010	-0.034	0.040	0.006	0.079	0.121	-0.042	-0.004	-0.034	0.196
Leaf area (cm^2)	P	0.002	0.028	0.069	**-0.112**	-0.049	-0.005	0.083	0.046	0.000	0.075	0.021	0.005	-0.011	0.152
	G	0.022	-0.107	0.188	**-0.484**	-0.014	-0.008	0.163	0.290	0.006	0.170	-0.021	-0.008	-0.020	0.178
Plant height (cm)	P	-0.017	0.015	0.020	-0.018	**-0.308**	-0.047	0.219	0.066	0.125	0.060	0.204	0.088	-0.114	0.293
	G	-0.052	-0.078	0.045	-0.087	**-0.077**	-0.042	0.371	0.407	0.263	0.119	-0.234	-0.088	-0.233	0.313
Days to Maturity	P	0.010	0.009	0.023	-0.002	-0.062	**-0.231**	0.018	-0.043	0.013	0.003	-0.025	0.004	0.015	-0.269
	G	0.036	-0.056	0.070	-0.023	-0.019	**-0.172**	0.035	-0.278	0.033	-0.003	0.031	-0.004	0.039	-0.309
Spike length (cm)	P	-0.017	0.006	-0.001	-0.019	-0.138	-0.009	**0.489**	0.133	0.118	0.004	0.287	0.127	-0.153	0.826**
	G	-0.056	-0.028	0.018	-0.100	-0.036	-0.008	**0.787**	0.790	0.251	0.005	-0.332	-0.126	-0.319	0.845**
Spikelets per Spike	P	-0.030	0.010	0.001	-0.030	-0.116	0.057	0.374	**0.174**	0.113	0.026	0.269	0.114	-0.155	0.805**
	G	-0.094	-0.061	0.002	-0.146	-0.032	0.050	0.646	**0.962**	0.236	0.058	-0.315	-0.117	-0.321	0.867**
Grain per spike	P	-0.023	0.013	0.022	0.000	-0.175	-0.014	0.262	0.089	**0.220**	0.026	0.238	0.102	-0.137	0.623**
	G	-0.071	-0.060	0.065	-0.007	-0.048	-0.013	0.466	0.535	**0.424**	0.060	-0.284	-0.106	-0.291	0.671**
Peduncle length (cm)	P	-0.016	0.021	0.047	-0.062	-0.137	-0.004	0.013	0.033	0.042	**0.135**	0.037	0.019	-0.028	0.101
	G	-0.057	-0.114	0.163	-0.315	-0.035	0.002	0.015	0.215	0.098	**0.260**	-0.045	-0.018	-0.056	0.113
No. of tillers/m row length	P	-0.026	0.000	0.014	-0.007	-0.183	0.017	0.410	0.136	0.153	0.015	**0.343**	0.130	-0.186	0.815**
	G	-0.084	-0.007	0.039	-0.026	-0.047	0.014	0.685	0.796	0.316	0.031	**-0.381**	-0.128	-0.374	0.834**
Test weight (gm)	P	-0.040	0.004	0.005	-0.003	-0.184	-0.006	0.425	0.135	0.153	0.018	0.304	**0.146**	-0.167	0.790**
	G	-0.130	-0.020	0.010	-0.026	-0.048	-0.004	0.701	0.798	0.317	0.034	-0.346	**-0.141**	-0.340	0.805**
Green fodder yield (q/ha)	P	-0.016	0.006	0.011	-0.007	-0.181	0.018	0.386	0.138	0.155	0.019	0.329	0.126	**-0.194**	0.792**
	G	-0.050	-0.040	0.031	-0.025	-0.046	0.018	0.652	0.803	0.320	0.038	-0.370	-0.125	**-0.385**	0.821**

Residual effect: Phenotypic = 0.1027 and Genotypic = 0.0254