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Character Association and Path Analysis of Vigor Index with some Important Seed Vigor Contributing Traits in Barley (*H. vulgare* L.)

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Abstract

Sixty barley (*H. vulgare* L.) genotypes were assessed to work out the association of different seed vigor traits, direct and indirect effects of these different traits on vigor index, to evaluate the eleven seed vigor contributing traits in completely randomized design at room temperature in germination for germination based on ISTA method during 2009-2010 over three replications. Standard statistical techniques such as correlation between different characters and path coefficient analysis were analyzed, in which vigor Index was kept as dependant character. Highly significant and positive phenotypic and genotypic correlations were recorded in seedling length followed by shoot length, root length and germination percentage while, remaining traits was non-significant. Path-coefficient analysis on both genotypic and phenotypic level revealed that seedling length has high order of direct positive effect followed by germination percentage and seed width while other traits exhibited low or negative direct effect on vigor index. Shoot length, root length, seed width, decorticated seed length and seed length as most important indirect contributors to vigor index. The characters identified above merit due consideration in formulating effective selection strategy in barley for improving overall seed quality.

Key words : Barley (*H. vulgare* L.), Character association, Path coefficient, Seed vigor.

Barley, a crop of ancient origin, have been cultivated in rain fed condition and neglected areas that are characterized by poor soil fertility and moisture stress. Though this crop is nutritionally superior, energy rich, highly digestible and having improved grain yield under limited resources of fertilizer and irrigation i.e. grown largely under starvation condition. Barley is a widely adaptable crop. It is currently popular in temperate areas where it is grown as a summer crop and tropical areas where it is sown as a winter crop. Barley is not as cold tolerant as the winter wheat but has a short growing season and is also relatively drought tolerant. Recently it was strongly advocated for hormonal balance and the treatment of many acute illnesses like blood pressure, osteoarthritis, gastric, ulcer and kidney stone. In addition barley is indispensable in virtually every Hindu ritual ceremony as a sacred grain. Due to its hardy and versatile nature, superior nutritional qualities have multifarious uses in industries. Barley has beta-glucan and cholesterol substance, acetylcholine which energizes the nervous system and recovers memory losses, easy digestibility due to low gluten, soluble dietary fibers, high lysine, thiamine and riboflavin which provide anti inflammatory effect i.e. cooling and soothering effects after use of barley food products. It also contain high levels of chlorophyll, a substance said to inhibit cancer and several anti-oxidants to prevent many degenerative diseases such as cancer, heart disease, stroke and premature ageing. Its potential alternative use in malt and bear industry and health tonic proved that barley is an important crop of present era. Considering the advantages of this crop, need the development of high yielding varieties that are better adapted to wide range of environment. Both genotype and the environment affect vigor index and vigor components of barley. For that purpose, effective plant selection characters that are associated with vigor are obligatory. Thus, study of correlation and direct and indirect effects of seed traits provides the basis for

Table 1. Estimates of genotypic and phenotypic correlation coefficient between different characters in barley genotypes. * and **significant at 5 and 1% level of probability, respectively.

Characters		Seed length (mm)	Seed width (mm)	Decorti-cated seed length (mm)	Decorti-cated seed width (mm)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Germi-nation (%)	Food reserve (g)	Vigor index
1000-seed weight (g)	r_g	0.424**	0.728**	0.517**	0.567**	-0.029	0.179	0.039	0.050	0.732**	0.050
	r_p	0.390**	0.539**	0.485**	0.421**	-0.020	0.163	0.029	0.047	0.702**	0.040
Seed lenght (mm)	r_g	1.000	0.472**	0.543**	0.497**	0.116	0.155	0.134	0.212	0.320*	0.201
	r_p	1.000	0.363**	0.527**	0.379**	0.107	0.141	0.101	0.206	0.314*	0.155
Seed width (mm)	r_g		1.000	0.570**	0.915**	0.119	0.327**	0.158	0.031	0.623**	0.146
	r_p		1.000	0.427**	0.577**	0.040	0.294*	0.260	0.021	0.488**	0.254
Decorticated seed	r_g			1.000	0.564**	0.211	0.245	0.176	0.101	0.520**	0.200
length (mm)	r_p			1.000	0.427**	0.182	0.215	0.115	0.094	0.508**	0.137
Decorticated seed width	r_g				1.000	0.198	0.284	0.147	0.052	0.609**	0.144
(mm)	r_p				1.000	0.114	0.207	0.063	-0.001	0.482**	0.051
Root length (cm)	r_g					1.000	0.581**	0.929**	-0.004	0.047	0.852**
	r_p					1.000	0.537**	0.640**	0.003	0.041	0.595**
Shoot length (cm)	r_g						1.000	0.920**	0.161	0.164	0.897**
	r_p						1.000	0.687**	0.140	0.156	0.681**
Seedling length (cm)	r_g							1.000	0.012	0.033	0.914**
	r_p							1.000	0.047	0.023	0.943**
Germination (%)	r_g								1.000	0.074	0.414**
	r_p								1.000	0.067	0.372**
Food reserve (g)	r_g									1.000	0.053
	r_p									1.000	0.050
Vigor index	r_g										1.000
	r_p										1.000

successful breeding plan. The objective of this study was to determine the correlation and path analysis of yield and yield contributing characters in barley and to assess their suitability in a breeding plant.

Methods

The study was designed to work out the status of association of different vigor traits and direct and indirect effects of these different traits on vigor index among 60 barley genotypes at Seed Testing Laboratory (STL) of Seed Technology Section, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (UP) during 2009-2010, sourced from genetic stock available in wheat and barley section, Department of Genetics and Plant Breeding, of this university. The Experiment was done in completely randomized design for all other laboratory tests with three replications. The observations were recorded on eleven different seed vigor traits viz. 1000-seed weight (g), seed length (mm), seed breadth (mm), decorticated seed length (mm), decorticated seed breadth (mm), germination (%), root length (cm), shoot length (cm), seedling length (cm), food reserve (depletion), and seed vigor index. Standard statistical techniques such as correlation between different characters (1) and path coefficient analysis (2) using MASTA-C computer program in which vigor Index was kept as dependant character. Seed germination percentage was investigated under laboratory condition and germination was estimated on the basis of 100 randomly selected seed kept for germination in germination papers at room temperature in germinator. In test 25 seeds were kept in four replications of two layer of moist germination paper and rolled. The samples were kept in seed germinator maintained at 20 C ± 1. Ten seedlings were randomly taken from each replication. On day 8 shoot length were measured the unit of length was in cm. The vigor index was calculated following the method prescribed by Abdul-Bali and Anderson (3) and expressed in whole number. The 20 seeds are randomly selected and

Table 2. Direct and indirect effects of different characters on vigor index at genotypic and phenotypic level in barley genotypes. Genotypic residual effect = 0.085. Phenotypic residual effect = 0.106.

Characters		1000-seed weight (g)	Seed length (mm)	Seed width (mm)	Decorticated seed length (mm)	Decorticated seed width (mm)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Germination (%)	Food reserve (g)
1000-seed weight (g)	G	**-0.113**	0.002	0.088	0.006	-0.054	0.001	-0.009	0.084	0.007	0.038
	P	**-0.024**	-0.002	0.013	0.003	-0.006	0.000	0.000	0.047	0.006	0.001
Seed length (mm)	G	-0.046	**0.005**	0.059	0.007	-0.048	0.002	-0.007	0.125	0.087	0.017
	P	-0.008	**-0.006**	0.010	0.004	-0.006	0.001	0.000	0.095	0.068	0.001
Seed width (mm)	G	-0.080	0.002	**0.125**	0.007	-0.089	0.002	-0.015	0.150	0.014	0.033
	P	-0.011	-0.002	**0.027**	0.003	-0.009	0.000	0.000	0.236	0.006	0.001
Decorticated seed length (mm)	G	-0.057	0.003	0.071	**0.013**	-0.055	0.003	-0.012	0.164	0.041	0.028
	P	-0.010	-0.003	0.011	**0.007**	-0.006	0.002	0.000	0.107	0.031	0.001
Decorticated seed width (mm)	G	-0.063	0.003	0.114	0.007	**-0.097**	0.003	-0.014	0.138	0.021	0.032
	P	-0.009	-0.002	0.015	0.003	**-0.015**	0.001	0.000	0.058	0.000	0.001
Root length (cm)	G	-0.007	0.001	0.015	0.003	-0.019	**0.015**	-0.028	0.870	-0.003	0.002
	P	-0.001	-0.001	0.001	0.001	-0.002	**0.009**	-0.001	0.594	0.002	0.000
Shoot length (cm)	G	-0.020	0.001	0.041	0.003	-0.028	0.009	**-0.048**	0.864	0.066	0.009
	P	-0.003	-0.001	0.007	0.002	-0.003	0.005	**-0.001**	0.633	0.046	0.000
Seedling length (cm)	G	-0.010	0.001	0.020	0.002	-0.014	0.014	-0.044	**0.939**	0.004	0.001
	P	-0.001	-0.001	0.007	0.001	-0.001	0.006	-0.001	**0.917**	0.016	0.000
Germination (%)	G	-0.002	0.001	0.004	0.001	-0.005	0.000	-0.008	0.009	**0.409**	0.004
	P	-0.000	-0.001	0.000	0.001	0.000	0.000	0.000	0.046	**0.327**	0.000
Food reserve (g)	G	-0.080	0.002	0.078	0.007	-0.059	0.001	-0.008	0.025	0.030	**0.053**
	P	-0.015	-0.002	0.013	0.004	-0.007	0.000	0.000	0.030	0.022	**0.002**

weighed. The seeds were kept for germinate following ISTA method. The normal seedling were counted after seven days for germination before unfolding of cotyledon into normal leaves to ensure no photosynthesis occurred. The seedlings were measured for shoot and roots length and dried at 70 C overnight (complete drying till seedling tissue become brittle) to obtain seedling dry weight. The unit of food reserve in gram (g) was calculated.

Results and Discussion

Seed is a basic input in agriculture and plays a vital role in boosting up the productivity and economy of the country. Without the use of good quality seed, the investments, incurred on fertilizers, pesticides and water will not dividend which ought to be realized. The genotypic and phenotypic correlation coefficients in the experiment (Table 1) were generally similar in sign, magnitude and nature to the corresponding characters. However, genotype correlations were higher in magnitude than the corresponding phenotypic values (4, 5). A strong positive association of vigor index was observed with seedling length, shoot length, root length and germination percentage at phenotypic and genotypic level. Thus, seedling length, shoot length, root length and germination percentage were identified as most important associates of vogor (4, 6—11). thousand-seed weight showed strong positive association as genotypic as well as phenotypic level with food reserve (0.732 and 0.702), seed width (0.728 and 0.539), decorticated seed length (0.517 and 0.485), decorticated seed width (0.567 and 0.421) and seed length (0.424 and 0.390). Seed length exhibited highly significant and positive genotypic and phenotypic correlation with seed width (0.472 and 0.363), decorticated seed length (0.543 and 0.527), decorticated seed width (0.497 and 0.379) and food reserve (0.320 and 0.314). Seed width had strong positive association at genotypic and phenotypic level with decorticated seed length (0.570 and 0.427) and width (0.915 and 0.577), shoot length (0.327 and 0.249) and food reserve (0.623 and 0.488). Decorticated seed length was positively correlated at both genotypic and phenotypic level with decorticated seed width (0.564 and 0.427) and food reserve (0.520

and 0.508). Decorticated seed width was positively correlated both genotypic and phenotypic level only for food reserve (0.609 and 0.482). Root length showed very strong positive association with seedling length (0.929 and 0.640), shoot length (0.581 and 0.537) and vigor index (0.852 and 0.595). Highly significant and positive correlation at both the level was observed in shoot length for seedling length (0.920 and 0.687). Seedling length exhibit significant and positive correlation at genotypic and phenotypic level only for vigor index (0.914 and 0.943). Seed vigor index showed positive genotypic and phenotypic correlation in all the characters except for root length (0.852 and 0.595), shoot length (0.897 and 0.681), seedling length (0.914 and 0.943) and germination percentage (0.414 and 0.372) respectively (Table 1). The results exhibited mostly positive genotypic and phenotypic correlations of substantial nature between different seed characters which represented a highly favorable situation from breeding point of view. The strong positive association between seed characters may lead to rapid and high improvement during selection owing correlated response because of improvement in one character may bring improvement in other character.

Path coefficient analysis was carried out at genotypic as well as phenotypic level (Table 2). Seedling length (0.939 and 0.917) followed by germination percentage (0.409 and 0.327) exerted very high order positive direct effect on vigor index at genotypic and phenotypic level. Seed width (0.125 and 0.027) exhibited considerable positive direct effect on vigor index at genotypic level. Thus, seedling length and germination percentage emerged as most important direct seed vigor influencing characters followed by seed width (5, 12—17). Considerable positive indirect effect at both levels of all the characters was observed except for germination percent and food reserve. Root length (0.870 and 0.0594) followed by shoot length (0.864 and 0.633), decorticated seed length (0.164 and 0.107), seed width (0.150 and 0.236), decorticated seed width (0.138 and 0.058) and seed length (0.125 and 0.095) exhibited high order positive indirect effects at phenotypic and genotypic level on vigor index via seedling length. Thus, root shoot length, decorticated seed length and seed width emerged as most important indirect components of seed vigor index while decorticated seed width and seed length may be considered as indirect seed vigor component of secondary importance. On the basis of results of path coefficient analysis at phenotypic and genotypic level it can be concluded that characters identified as important direct components like seedling length, germination percentage and seed width and important indirect components like root length, shoot length, decorticated seed length and seed width should be given due consideration at the time of devising selection strategy for improving vigor index in regarding to seed quality in barley.

References

1. Searle S. R. 1961. Phenotypic, genotypic and environmental correlations. *Biometrics* 17 : 474—480.
2. Dewey D. R. and K. H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.* 51 : 515—518.
3. Abdul-Bali A. A. and J. D. Anderson. 1973. Vigor determination in soybean seed by multiple criteria. *Crop Sci.* 630—633.
4. Mahajan A. R. and K. A. Nayeem. 1989. Character associated and path analysis for seedling vigor index in wheat species and tricale under different temperatures. *Seed Res.* 17 : 31—35.
5. Mandal N. and I. Dana. 1993. Correlation and path coefficient analysis in two rowed barley (*Hordeum distiahum* L.). *Environ. Ecol.* 11 : 233—234.
6. Jagdish G. V. and H. G. Sambulingappa. 1973. Relationship between seed size and seed quality attributes in sunflower (*Helianthus annus* L.). *Seed Res.* 11 : 172—176.
7. Singh V. P., I. D. Tripathi and P. K. Chaudhary. 1975. Effect of seed size on seedling growth and mature plant Characters in barley (*Hordeum vulgare* L.). *Haryana Agric. Uni. J. Res.* 5 : 48—51.
8. Evans L. E. and G. M. Bhatt. 1977. Influence of seed size. Protein content and cultivars on early seedling vigor in wheat. *Can. J. Plant Sci.* 57 : 929—936.
9. Chinna B. S. and Paul P. S. 1982. Association of seed size and seedling vigor with various morphological traits pearl millet. *Seed Sci. and Technol.* 10 : 541—545.
10. Rajamony L., B. J. Naik and N. N. Potty. 1984. Seed biometrics seedling vigor in cocoa. *Ind. Coco, Arecanut and Sopices J.* 8 : 29—31.
11. Kher D. and R. G. Satpate. 1999. Influence of days to maturity and seed size on germination and seedling vigor in pigeonpea. *Seed Res.* 2 : 170—173.
12. Malhotra R. S. and R. P. Jain. 1972. Path and regression analysis in barley (*Hardeum vugari* L.). *Ind. J. Agri. Sci.* 42 : 404—406.
13. Kirtok Y. and M. Colkesen. 1985. Path coefficient analysis of some important components of barley varieties in traits in the Cukurova region. *Doga-Bilim.*

Dergisi, D2-Tarim-Ve-Orman-Cilik 9 : 40—50.

14. Nayeem K. A. and S. V. Deshpande. 1987. Genetic variability and correlation coefficient relating to seed size seedling vigor some physiochemical properties in wheat. *Seed Sci. and Tech.* 15 : 690—705.
15. Richards R. A. and Z. Lukacs. 2002. seedling vigor in wheat-sources of variation for genetic and agronomic improvement. *Aust. J. Agric. Res.* 53 : 41—50.
16. Peighambari Samadi. B. Y., C. Abd-Mishara, A. Sarrafi, A. Teleei and M. R. Ghannadha. 2005. An evaluation of drought tolerance and yield attributes of double haploid barley (*H. vulgare* L.) lines. *Iran. J. Agric. Sci.* 36 : 955—967.
17. Singh H. L., S. K. Singh, P. Singh and B. C. Singh. 2006. Genetic variability and characters association barley. *Int. J. Pl. Sci.* 1 : 256—258.