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Genotypic correlation and path coefficient analysis for yield and yield contributing traits in released varieties of barley (*Hordeum vulgare* L.) under partially reclaimed saline sodic soil

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Abstract: This research sought to determine the correlations between grain yield and its contributing traits and to measure the direct and indirect effects on grain yield in barley. Sixty four released varieties were grown under partially reclaimed saline- sodic soil, under irrigated conditions during *rabi* 2010-11. The grain yield per plant showed highly significant and positive correlation with 1000 grain weight (0.517), plant height (0.460), length of main spike (0.459), fertile tillers per plant (0.385), and grains per main spike (0.366). On the basis of relationship of grain yield with yield contributing traits, we can select the best genotype and can be utilised in breeding program.

Keywords: Barley, Correlation coefficient, Path coefficient analysis, Quantitative characters

INTRODUCTION

Barley (*Hordeum vulgare*; 2n = 14, family Poaceae) is an important *rabi* cereal rank fourth after maize, rice and wheat. Barley has a long history of use as human and animal food, health benefits and malting and brewing in many countries around the world (Malcolmson, *et al*., 2005). Since pre-historic times, barley was consumed primarily, as human food in the form of *Chapatti* and *Sattu* but due to alternate use of barley in field of brewing and medicine industry, it is considered as highly needed crop of present era. From nutritional point of view, barley grain is considered as superior grain over other cereals due to its higher biological value and rich source of β-glucon, acetylcholine, thiamin, riboflavin, total dietary and water soluble digestible fiber. Barley is also used in breakfast as soup. It is beneficial in treating hyper cholesteremia (Anderson *et al.,* 1990). Its bran and bran oil have medicinal value, which considerably reduce the serum cholesterol level in the blood. β-glucon and water soluble digestible fiber fraction present in barley decreases the blood plasma cholesterol (Newman and Newman, 1991). Superior nutritional qualities, water soluble fiber, higher malt extract, low gluten, easy digestibility, cooling and soothering effect of its products are desirable features of barley. Barley based diet reduces the risk of coronary heart diseases by lowering down undesirable level of cholesterol.

Ozturk *et at.* (2007) studied six barley cultivars in turkey and observed a significant and positive correlation between grain yield and days to maturity and 1000-grain weight. The magnitude of correlations between yield and its component and their utilization in the selection had been stated by a number of researchers (Prasad *et al.,* 1980; Al- Tabbal and Al-Fraihat, 2012). Correlations is helpful in determining the principal components influencing final grain yield, they provide an incomplete representation of the relative importance of direct and indirect influences on the individual factors involved (Garcia del Moral *et al.,* 1991). In plant breeding path-coefficient analysis has been used to explain clearly the relations among yield components and assist identification of traits that are useful as selection criteria to improve crop yield (Ahmed *et al.,* 2003; Milomirka *et al.,* 2005, Drikvand *et al.,* 2011; Zaefizadeh *et al.,* 2011). The main objective of this was to determine the relationship between yield and yield contributing traits and on the basis of this relationship we can select best genotype for breeding program.

MATERIALS AND METHODS

The experiment was conducted during *rabi* 2010-11 under partially reclaimed saline- sodic soil (pH 8.6-8.9, EC = 4-4.2 dSm^{-1}, ESP = > 15). The experimental materials for investigation was comprised of sixty four released varieties of barley collected from Directorate of Wheat Research, Karnal. The said varieties were evaluated in a Simple Lattice Design with two replications. Each plot consists of three rows, each of three meter long with spacing of 23 cm. The plants within a row were spaced approximately 10 cm apart. The eight contiguous plots collectively constituted one tier. Thus there were eight tiers each of eight plots in a replication. The varieties were allocated randomly in each replication. The recommended cultural practices were adopted to grow a good crop. Data were recorded on five randomly selected competitive plants from each plot on 7 quantitative characters namely, plant height (cm), days to maturity, number of fertile tillers per plant, length of main spike (cm), grains per main spike, 1000-grain weight (g), grain yield plant per plant (g). Data recorded on the above characters were subjected to estimation of correlation coefficients (Searle, 1961) and path-coefficient analysis (Dewey and Lu, 1959). Genotypic correlations were estimated using the standard procedure suggested by Miller *et al*. (1958) and Kashiani and Saleh (2010) Path coefficient analysis was carried out according to Dewey and Lu (1959) and grain yield was assumed to be dependent variable (effect).

RESULTS AND DISCUSSION

Descriptive statistics of 7 traits in 64 released varieties of barley under partially reclaimed saline sodic soil traits given in the Table 1. Path coefficient and correlation analyses are used widely in many crop species by plant breeders to define the nature of complex interrelationships among yield components and to identify the sources of variation in yield. Knowledge derived in this way can be used to develop selection criteria to improve grain yield in relation to agricultural practices (Board *et al*., 1997; Finne *et al*., 2000; Gravois and Mc New, 1993; Samonte *et al*., 1998; Sinebo, 2002).

Genetic correlation coefficient analysis for seven characters: The estimates of genotypic correlation coefficients between seven characters of released varieties of barley are given in (Table 2). The grain yield per plant exhibited highly significant and positive correlation with 1000 grain weight (0.517), plant height (0.460), length of main spike (0.459), fertile tillers per plant (0.385) and grains per main spike (0.366). The 1000 grain weight showed highly significant and positive correlation with length of main spike (0.525), plant height (0.476) grains per main spike (0.414) , while non-significant positive correlation with fertile tiller per plant (0.180) and days to maturity (0.170). Grains per main spike showed highly significant and positive correlation with length of main spike (0.519), and plant height (0.473). Length of main spike possessed highly significant and positive correlation with plant height (0.491) and days to maturity (0.304), while tillers per plant exhibited highly significant positive correlation with plant height (0.340).

Genetic path coefficient analysis for seven characters: The direct and indirect effects of a character on grain yield per plant computed in path coefficient analysis using genotypic correlation are presented in (Table 3). The highest positive direct effect on grain yield per plant was exerted by 1000 grain weight (0.303) followed by fertile tillers per plant (0.246) while lowest positive direct effect were exhibited by grains per main spike (0.061) and plant height (0.140). In contrast, days to maturity (-0.090) contributed considerable negative direct effect of grain yield per plant. Length of main spike (0.159), plant height (0.144), grains per main spike (0.126), fertile tillers per plant (0.055) and days to maturity (0.052) exerted substantial positive indirect effects on grain yield per plant via 1000-grains weight. Positive and significant correlations of grain yield with spike number per m^2 and 1000 -kernel weight were reported by Ataei (2006). In agreement with the results of this study, previously Fekadu *et al.* (2011) reported non-significant correlation between grain yield with plant height, spike length and number of grains per spike. The correlation coefficients between various traits could be partitioned into direct and indirect relationships by the path analysis method. Correlation coefficient and path coefficient analyses are used widely in many crop species by

Table 1. Descriptive statistics of 7 traits in 64 released varieties of barley under partially reclaimed saline sodic soil.

Characters	Parameters					
	Min.	Max.	Range	Mean	SE	SD
Plant height (cm)	50.40	78.70	28.30	65.29	0.93	7.49
Days to maturity	111.00	120.00	9.00	115.43	0.22	1.76
No. of fertile tillers per plant	3.00	6.00	3.00	4.40	0.11	0.94
Length of main spike (cm)	5.20	9.40	4.20	7.76	0.11	0.89
No. of grains per main spike	27.00	41.00	14.00	33.00	0.40	3.24
1000-grains weight (g)	32.52	42.92	10.40	37.58	0.34	2.77
Grain yield per plant (g)	4.96	9.48	4.52	6.87	0.13	1.11

Table 2. Estimate of genotypic correlation coefficient between different characters in released varieties of barley.

Characters	Plant height (cm)	Days to maturity	No. of fertile tillers per plant	Length of main spike (cm)	No. of grains per main spike	1000-grain weight (g)	Grain yield per plant (g)
Plant height (cm)	**1.000**	0.256*	0.340**	0.491**	0.473**	0.476**	0.460**
Days to maturity		**1.000**	0.078	0.304**	0.140	0.170	0.079
No. of fertile tillers per plant			**1.000**	0.203	0.140	0.180	0.385**
Length of main spike (cm)				**1.000**	0.519**	0.525**	0.459**
No. of grains per main spike					**1.000**	0.414**	0.366**
1000-grains weight (g)						**1.000**	0.517**
Grain yield per plant (g)							**1.000**

*Significant at 5 % level, r=0.2319, **Significant at 1 % level, r=0.3027

Table 3. Direct and indirect effects of various traits on grain yield per plant in released varieties of barley.

Characters	Plant height (cm)	Days to maturity	No. of fertile tillers per plant	Length of main spike (cm)	No. of grains per main spike	1000-grain weight (g)	Grain yield per plant (g)
Plant height (cm)	0.140	-0.023	0.084	0.087	0.029	0.144	0.461
Days to maturity	0.036	-0.090	0.019	0.054	0.009	0.052	0.080
No. of fertile tillers per plant	0.048	-0.007	0.246	0.036	0.009	0.055	0.386
Length of main spike (cm)	0.069	-0.027	0.050	0.176	0.032	0.159	0.459
No. of grains per main spike	0.066	-0.013	0.035	0.092	0.061	0.126	0.367
1000-grains weight (g)	0.066	-0.015	0.044	0.093	0.025	0.303	0.517

plant breeders to define the nature of complex interrationships among yield components (Hosin Babaiy *et al.,* 2011; Al-Tabbal and Al-Fraihat, 2012). Correlation coefficient is very important to determine the traits that directly affect the grain yield. The path coefficient analysis is one of the statistical tools which is used to determine the direct or indirect effects of any yield component on grain yield in relation to the other yield components. Correlation coefficient and path coefficient analysis assist to identify the traits that are useful as selection criteria to improve yield (Drikvand *et al.,* 2011; Khaiti, 2012). Plant height is an important trait directly linked with the productive potential of the plant and many researchers require correlation between plant height and yield. According to Jabbari *at al.* (2010), Drikvand *et al.* (2011) and Niazi-Fard *et al.* (2012) significant and positive correlation between grain yield and plant height was also observed. Direct positive effect on grain yield was observed by Budakli Carpici and Celik (2012). It was revealed that among different characters which showed positive significant association with grain yield plant per plant, and grains number per spike should be given more importance in selection criteria for superior varieties as these traits depicted high direct positive effect on grain yield.

Conclusion

From present investigation concluded that significant genotypic variation present among barley varieties to be subjected to selection for grain yield and its contributing traits. Plant height, fertile tillers per plant, length of main spike and grains per main spike, 1000 grain weight can be used as selection criteria to increase grain yield in barley. The highest positive direct effect on grain yield per plant was exerted by 1000 grain weight (0.303) and fertile tillers per plant (0.246). Length of main spike (0.159), plant height (0.144), grains per main spike (0.126), fertile tillers per plant (0.055) and days to maturity (0.052) exerted substantial positive indirect effects on grain yield per plant via 1000-grains weight. It is evident according to the results of this study, to evolve barley genotypes with ultimate higher grain yield, attention should be focused selecting plant traits which have positive direct effect on grain yield.

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