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Research Article

Genetic analysis for economic traits in wheat under salt affected soil

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Abstract

A study was conducted to estimate the genetic variability, correlation and path coefficient analysis of economic traits in 27 wheat genotypes grown in randomized block design with three replications during *rabi* season 2012-13 at CCS HAU, Regional Research Station, Bawal (Haryana) under sodic soil condition. Significant differences were observed among the genotypes for all the 10 economic traits studied *viz.*, plant height (cm), ear length (cm), number of tillers per meter row, number of grains per spike, days to heading, days to maturity, 1000-grain weight (g), harvest index (%), biological yield (kg/plot) and grain yield (kg/plot). High phenotypic coefficients of variation was observed for grain yield (18.57) followed by number of tillers per meter row (18.44) and harvest index (17.30) while, genotypic coefficients of variation was highest in number of tillers per meter row (16.27) followed by grain yield (13.31) and number of grains per spike (13.26). The estimates of heritability varied from 41 per cent for biological yield to 95 per cent for days to heading whereas grain yield showed 51 per cent heritability. High heritability coupled with high genetic advance as per cent of mean was observed for number of tillers per meter row, number of grains per spike, 1000-grain weight and ear length indicating the importance of these traits in selection and crop improvement. The genotypic correlation estimates showed significant positive association of grain yield with harvest index, biological yield and number of tillers per meter row. Days to heading, harvest index and biological yield exhibited the highest positive direct effect on grain yield. Hence, these traits could be considered as suitable selection criteria for the development of high yielding wheat varieties under salt stress conditions.

Keywords: Genetic variability, correlation coefficient, path analysis, economic traits, wheat

1. Introduction

Wheat (*Triticum aestivum* L.) is the second most important cereal crop after rice in the context to its antiquity and use as a major crop for food and nutritional security in India and also at global level. In India, the area under wheat is around 29.65 million hectares with the production and productivity of 92.46 million tons and 3119 kg/ ha, respectively. Haryana state on the whole has achieved a productivity level of 4.45 tons ha^{-1} on 2.50 million hectares (Anonymous, 2013). Salt affected soils are problem for agriculture as almost all the crops show decline in growth and yield to various extent depending upon the level of stress and the potential of the crops or their cultivars to tolerate these stresses. About 6.73 million hectares of land is affected by salinity (2.96 million ha) and sodicity (3.77 million ha) stresses in India.

In spite of poor salt tolerance of our crops, there are considerable variations among the different crops and their cultivars to tolerate salt stress (Singh *et al.*, 2009). For a tolerant line of bread wheat, one must be aware of crop genetics and physiology and develop an efficient screening system based on stable selection criteria. Grain yield is a complex trait and highly influenced by many genetic factors and environmental fluctuations. In plant breeding programme, direct selection for yield as such could be misleading. Efficiency of selection for higher yield depends upon the knowledge of trait components and their interaction with grain yield. This requires information about nature and magnitude of variability in base population and association of yield components with grain yield. There are many reports on genetic variability and characters association analysis in wheat but quite deficient on study under sodicity stress. This study was therefore, conducted to estimate the genetic variability, correlation and path coefficients among wheat genotypes to determine criteria for selection that could be effectively used to identify the desirable genotypes with high yield potential under sodic soil condition.

2. Materials and methods

The experimental material consisted 27 wheat genotypes *viz*, P 7762, P 9006, KRL 210, P 9008, P 9005, P 7682, P 7972, P 7975, P 7758, KH 65, P 9007, P 7968, P 7973, P 9009, P 7743, P 7966, P 7978, P 7749, KRL 19, P 9003, P 9002, P 9001, P 7967, P 9010, P 9004, WH 157 and P 7974 evaluated in randomized block design with three replications at CCS HAU, Regional Research Station, Bawal (Haryana) during *rabi* 2012-13 under sodic soil condition. The pH and EC of the sodicity plot was 9.42 (1:2) and 0.35 dsm^{-1} (1:2), respectively. Each genotype was grown in four rows with a plot size of 5 x 1.20 m^2. Recommended agronomic practices were followed to raise a good crop. The observations on ten economic traits *viz*, plant height (cm), ear length (cm), number of tillers per meter row, number of grains per spike, days to heading, days to maturity, 1000-grain weight (g), harvest index (%), biological yield (kg/plot) and grain yield (kg/plot) were recorded at appropriate crop growth stage. Five randomly selected competitive plants in each replication were recorded for all the traits under study except of days to heading, days to maturity, biological yield and grain yield which were recorded on plot basis. Harvest index was calculated as per formula given by Donald and Humblin (1976).

The mean performance of each genotype was subjected for statistical analysis. Analysis of variance (ANOVA) to test the significance for each character was carried out as per methodology given by Panse and Sukhatme (1967). Genotypic and phenotype coefficients of variation (GCV and PCV) were calculated by formula given by Burton (1952), heritability in broad sense (h^2) by Burton and Vane (1953) and genetic advance given by Johnson *et al.* (1955). Correlation and path coefficients were worked out as per method suggested by Al-Jibouri *et al.* (1958) and Dewey and Lu (1959), respectively.

3. Results and discussion

The results obtained under present study revealed that genotypes differed significantly for all the traits studied. The estimates of genetic variability parameters for all the traits were worked out and are presented in Table 1. The results revealed that in general the material under study had wide range of estimates for all the traits except for days to heading and maturity, thereby indicating presence of high genetic variability. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficients of variation (GCV) for all the characters indicating that the visible variation in the expression of traits was not only due to genotypes alone but also due to varying influence of environment. High PCV was observed for grain yield (18.57) followed by number of tillers per meter row (18.44) and harvest index (17.30) while, GCV was highest in number of tillers per meter row (16.27) followed by grain yield (13.31) and number of grains per spike (13.26). However, days to heading and maturity exhibited least genotypic and phenotypic coefficients of variation. Similar findings were also reported by Singh *et al.* (2012) in bread wheat.

The estimates of heritability varied from 41 per cent for biological yield to 95 per cent for days to heading, whereas grain yield showed 51 per cent heritability. Singh *et al.* (2012) reported high heritability for various traits while as in present study, low heritability was also reported for grain yield and biological yield (Abinasa *et al.,* 2011) and harvest index (Verma *et al.*, 2013). Genetic advance as per cent of mean was recorded maximum for number of tillers per meter row (29.59) followed by number of grains per spike (25.35) and grain yield (19.65). In general, number of tillers per meter row, number of grains per spike, 1000-grain weight and ear length revealed high estimates of heritability along with high genetic advance. The estimates of high heritability (broad sense) and high genetic advance (GA % of mean) indicate additive gene and hence improvement in these traits could be possible by direct selection (Panse, 1957). High heritability coupled with low genetic advance was observed for days to heading and maturity indicating predominance of non-additive gene action and presence of G x E interaction, simple selection may not be rewarding. In such cases hybridization followed by selecting desirable segregants will be better option. The intermediate estimates of heritability and relatively high estimates of genetic advance was observed in the present study for grain yield, harvest index, plant height and biological yield, slight improvement through direct selection could be possible. The present findings corroborate the earlier report of Singh *et al.* (2012) in wheat.

The estimates of genotypic correlation coefficients among ten traits are depicted in Table 2. The yield is the end product of contribution made by several component traits that are directly or indirectly associated with grain yield. If the association is positive, improvement in one character will simultaneously bring about improvement in other. However, the negative association between two economic traits is useful for characteristics, like plant height, days to heading and maturity. The grain yield was significant and positively correlated with harvest index, biological yield and number of tillers per meter row, while significant and negative correlation of plant height, days to heading and maturity was recorded with grain yield.

Table 1. Estimates of mean, coefficient of variation, heritability and genetic advance for different characters in wheat

Character	Mean ± SE (d)	Range	Coefficients of variation		Heritability (%)	Genetic advance
			PCV	GCV		
Plant height	96.90 ± 4.12	82.00-125.00	9.28	7.68	68	13.09
Ear length	10.30 ± 0.42	8.00-13.00	10.15	8.82	76	15.81
No. of tillers per meter row	122.17 ± 8.64	89.00-198.00	18.44	16.27	78	29.59
Days to heading	94.89 ± 0.66	89.00-102.00	3.77	3.67	95	7.37
Days to maturity	136.10 ± 0.67	133.00-139.00	1.45	1.31	83	2.46
1000-grain wt.	34.94 ± 0.74	28.20-41.10	7.68	7.23	88	14.01
No. of grains per spike	51.62 ± 2.24	35.50-65.00	14.29	13.26	86	25.35
Harvest index	34.79 ± 3.68	22.40-47.20	17.30	11.47	44	15.65
Biological yield	4.70 ± 0.43	2.90-6.80	14.45	9.28	41	12.26
Grain yield	1.62 ± 0.17	1.13-2.65	18.57	13.31	51	19.65

Table 2. The estimates of genotypic correlation coefficients among 10 characters in wheat

Character	Plant height	Ear length	No. of tillers per meter row	Days to heading	Days to maturity	1000-grain wt.	No. of grains per spike	Harvest index	Biological yield	Grain yield
Plant height	1.000									
Ear length	0.073	1.000								
No of tillers / meter row	0.375**	-0.169	1.000							
Days to heading	-0.066	0.188	-0.330**	1.000						
Days to maturity	0.011	0.205	-0.177	0.961**	1.000					
1000-grain wt.	0.048	-0.212	0.238*	-0.155	-0.081	1.000				
No. of grains per spike	-0.293**	0.331**	-0.700**	0.429**	0.230*	-0.350**	1.000			
Harvest index	-0.408**	-0.108	0.151	-0.492**	-0.569**	0.260*	-0.055	1.000		
Biological yield	0.016	0.276*	-0.155	-0.254*	-0.091	0.227*	0.012	-0.226*	1.000	
Grain yield	-0.388**	0.078	0.224*	-0.641**	-0.580**	0.069	0.096	0.712**	0.524**	1.000

**, ** Significant at 0.05 and 0.01 level, respectively.*

These results showed close resemblance with the report of Bhushan *et al.* (2013). Similarly, positive and significant correlation was found for plant height with number of tillers per meter row; ear length with number of grains per spike and biological yield; days to heading with maturity and number of grains per spike; 1000-grain weight with harvest index, biological yield and number of tillers per meter row, thereby indicating that these traits may be improved simultaneously. Significant negative relation was observed between biological yield and harvest index.

This finding is in agreement with the results of Tripathi *et al.* (2011). Some researchers reported positive correlation between plant height and number of tillers per plant (Dharmendra and Singh, 2010); ear length with number of grains per spike (Kotal *et al.*, 2010) and biological yield (Tripathi *et al.*, 2011); days to heading with maturity (Kotal *et al.*, 2010) and number of grains per spike (Singh *et al.*, 2012); 1000-grain weight with harvest index, biological yield (Ali and Shakor, 2012) and number of tillers per plant (Dharmendra and Singh, 2010). The negative association of grain yield with days to heading and maturity suggest that early heading and maturing genotypes may result in higher grain yield. Kotal *et al.* (2010) observed significant positive association between harvest index and grain yield.

The significant and negative association observed for plant height with number of grains per spike and harvest index; number of tillers per meter row with days to heading; harvest index and biological yield with days to heading and maturity; and 1000-grain weight with number of grains per spike and biological yield. Similar findings were also reported by Dharmendra and Singh (2010), Kotal *et al.* (2010), Abinasa *et al.* (2011), Tripathi *et al.* (2011), Iftikhar *et al.* (2012) and Hannachi *et al.* (2013). Path coefficient provides an effective way of finding direct and indirect sources of correlation. Direct and indirect effects of these components determined on grain yield are presented in Table 3. The results of path coefficient analysis revealed that days to heading (2.02) exerted the highest positive direct effect on grain yield followed by biological yield (1.15), harvest index (0.95), number of tillers per meter row (0.27) and 1000-grain weight (0.10), which support the findings of Bhushan *et al.* (2013).

Table 3. Direct (diagonal) and indirect effects of different characters on grain yield in wheat

Character	Plant height	Ear length	No. of tillers per meter row	Days to heading	Days to maturity	1000-grain wt.	No. of grains per spike	Harvest index	Biological yield	Grain yield
Plant height	**-0.031**	0.000	0.100	-0.133	-0.020	-0.005	0.073	-0.389	0.018	-0.388**
Ear length	-0.002	**-0.005**	-0.045	0.380	-0.361	-0.021	-0.083	-0.103	0.318	0.078
No. of tillers per meter row	-0.012	0.001	**0.266**	-0.668	0.312	0.024	0.176	-0.144	-0.179	0.224*
Days to heading	0.002	-0.001	-0.088	**2.022**	-1.692	-0.015	-0.107	-0.469	-0.293	-0.641**
Days to maturity	0.000	-0.001	-0.047	1.943	**-1.761**	-0.008	-0.058	-0.542	-0.105	-0.580**
1000-grain wt.	0.002	0.001	0.063	-0.313	0.143	**0.100**	0.088	0.248	-0.262	0.069
No. of grains per spike	0.009	-0.002	-0.186	0.867	-0.406	-0.035	**-0.251**	-0.052	-0.013	0.096
Harvest index	0.013	0.001	-0.040	-0.995	1.001	0.026	0.014	**0.954**	-0.261	0.712**
Biological yield	0.000	-0.001	-0.041	-0.513	0.161	-0.023	0.003	-0.215	**1.154**	0.524**

Residual effect: 0.015

Table 4. Important characteristics of the five top most high yielding genotypes

Genotype	Plant height	Ear Length	Tillers / meter	Days to heading	Days to maturity	1000-grain wt.	Grains / spike	Harvest Index	Biological Yield	Grain yield
P 9006	90.95	10.33	120.67	90.00	133.67	31.23	56.07	38.90	5.52	2.16
P 7682	89.28	10.50	110.33	91.67	134.67	38.53	55.70	39.10	5.10	2.00
WH 157	95.44	9.61	111.33	96.33	137.00	35.63	41.37	45.30	4.23	1.92
P 9003	100.40	12.89	122.33	96.00	136.67	31.67	57.20	32.70	5.87	1.91
P 7972	85.33	8.42	150.67	90.00	133.67	37.80	39.47	37.60	5.10	1.90

Therefore, these characters could be considered as main components for selection in a breeding program for higher grain yield. Perusal of data of Table 4 also depicts that among the five high yielding genotypes either tillers/meter, 1000-grain weight, grains/spike, harvest index and biological yield alone or in combination with one or two traits played significant role in having high grain yield. However, days to maturity, number of grains per spike, plant height and ear length had negative direct effect on grain yield. Similar findings were also reported for days to maturity, plant height and ear length (Dharmendra and Singh, 2010) and number of grains per spike (Tripathi *et al*., 2011). The highest direct contribution of biological yield and harvest index towards grain yield was also reported by Ali and Shakor (2012). The residual effect was 0.015 showing that most of the variability in the grain yield was contributed by the characters studied in path analysis. The present study thus suggests that selection for high grain yield can be based on biological yield, harvest index and days to heading in wheat under sodic soil conditions.

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