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Study of genetic diversity for grain yield and other agronomic traits of bread wheat (*Triticum aestivum* l.) in acid soils of West Bengal

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Abstract
Soil acidity is a major yield limiting factor for wheat production in terai agro-climatic region of West Bengal. Recent findings showed that the impact of soil acidity can be significantly reduced by choosing suitable varieties. To assess the performance of wheat genotypes and to estimate genetic variability among them, the present experiment was conducted with sixty-seven potential wheat genotypes which were evaluated for a number of morpho-physiological traits along with yield under acid soil condition of terai region of West Bengal. Significant variation was found among the genotypes for yield/ plant which showed 10-fold range in the mean performance. Plants were grouped into six clusters and the constitution of clusters revealed that clusters VI had the largest number of genotypes (31) followed by clusters I (28) and other clusters II, III, IV and V were all made of only two genotypes each. Among the genotypes, some like PBW 617, PHS 1102, HPW 347 were found promising for grain yield/plant and they can be selected as suitable genotypes for growing such condition.
Key words: Acid soil, D^2analysis, Heritability, Genetic divergence

Introduction

Soil acidity is a major yield limiting factor for wheat production in terai agro-climatic region of West Bengal. The bread wheat (*Triticum aestivum* L.) prefers 6.0-7.5 pH as a favorable soil environment (Das, 2008). But, terai soils are mostly sandy and light in texture. The average annual rainfall is 3000 mm, most of which is received during June to September. Due to severe leaching by rain and presence of good amount of organic matter, the soils are acidic and are poor in bases and available plant nutrients. Low soil pH (< 5.5) in the topsoil affects nutrient availability while aluminium (Al) toxicity in subsurface (pH< 4.8) restricts root growth and access to moisture and nutrients. Recent findings showed that the impact of soil acidity can be significantly reduced by combining the strategy of liming treatments in conjunction with choosing and managing acidity tolerant crop varieties (Tang *et al.*, 2003). Recent research has found significant genetic variation in the performance of wheat genotypes when grown in acid soils (Delhaize, *et al.*, 2012). To assess the genetic variability of wheat genotypes under such condition, the present experiment was planned with sixty-seven potential genotypes of bread wheat which were evaluated for a number of morpho-physiological traits along with yield.

Materials and methods

The present investigation was conducted during rabi season of 2012-2013 and 2013- 2014 at the University Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar. The farm is situated at 26°19′ 86″ N latitude, 89°23′ 53″ E longitude with an altitude of 43 m above the mean sea level. The soil of the experimental field was from testa alluvial plain group, which is sandy loam in texture (Sand-65.9%; Slit-18%; Clay-16.1%) with field capacity (44.04%) and moderate fertility status. The pH value was acidic in nature (pH 5.3).

The experimental genotypes were selected from National Genetic Stock Nursery of All India Co-ordinated Wheat and Barley Improvement Project. The experiment was laid out in a randomized block design with two replications. The genotypes were sown in two rows each of 2 m length with row to row spacing 20 cm. Five competitive plants of each genotypes were randomly selected from each replication during appropriate physiological growth stage and data were recorded on eight quantitative characters namely, days to heading, days to maturity, tillers/meter, plant height (cm), spike length (cm), no of grains /spike, 1000-grain weight (g), grain yield/plant (g).

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Genetic diversity among sixty-seven genotypes was worked out following D^2 cluster analysis given by Mahalanobis (1936). Statistical software GENRES (Version 3.11) was used for analyzing the genetic diversity of genotypes.

Results and discussion

The analysis of variance revealed significant variation among sixty-seven genotypes for all the quantitative traits studied. Among them yield varied maximum and there was near about a 10- fold range in grain yield per plant (Table1). The similar result was observed by Verma P.N. *et al*. 2014. Genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV) revealed high variability for traits like tillers/meter, spike length, yield/ plant while it was low for traits like days to heading and maturity, grains/spike, plant height etc. The results were in conformity with earlier studies of Nayeem *et al.* (2003), Bahadur *et al.* (1994), Jag Shoran (1995).

High heritability (with more than 80%) was observed for 1000-grain weight (1.00), days to heading (0.99), days to maturity (0.87), tillers per meter (0.83), and spike length in cm (0.80) characters. Similar results were found by Pawar *et al.* (2002), Gupta *et al.* (2004) who also reported high heritability for days to heading, plant height, and spike length. High heritability coupled with high genetic advance was observed for tillers per meter, grain yield per plant, plant height and 1000 grain weight. So, these traits can be used as selection parameter for selecting promising genotypes under acid soil conditions.

Genetic diversity study of sixty-seven genotypes based on Mahalanobis D^2statistics values revealed six non-hierarchial clusters (Table 2). The composition of clusters showed that clusters VI had the largest number of genotypes (31) followed by cluster I (28), and other cluster II, III, IV, and V all are constitute only two genotypes each. All the genotypes were belong to same geographical region, India. But the clustering pattern revealed that genotypes belong to same geographical region got scattered into several clusters. This pattern of clustering indicated that there was no association between geographical distribution of genotypes and genetic divergence. Related results were reported by Yousaf *et al.* (2008).

The clusters, which are separated by the greatest statistical distance, show the maximum divergence for variability. For hybridization programme, genotypes can be selected from those inter-clusters, which are separated by more statistical distance. The inter-cluster distance was higher than the intra-cluster, indicating wide genetic diversity among the genotypes .The highest inter cluster distance was observed clusters IV and cluster VI (56.00) (Table 3). D^2 value between cluster IV and cluster VI was 3135.99 (Table 4). Another notable inter cluster distances (46.25) were recorded between clusters III and IV (D^2 value=2139.15).The maximum intra-cluster distance was observed for clusters VI (48.73) followed by cluster I (35.86). While, minimum intra-cluster distance (5.26) was observed for cluster II. It was reported that genotypes within the cluster with high degree of divergence would produce more desirable breeding materials for achieving maximum genetic advance (Singh *et al.* 2010).

The comparison of cluster means for the different characters indicated considerable differences between clusters for all the characters (Table 5). Cluster I was the highest yielder per plant (7.99 g) followed by cluster II (6.93) and VI (6.32). However, regarding 1000-grain weight (in g) cluster VI was the higher value (49.45) followed by cluster II, V, III, IV, and I. Regarding number of grains per spike, cluster I was higher value followed by cluster VI, V, III, IV and II. Similar result was found by Verma *et al.* (2014).

The characters, which contributed most towards the genetic divergence, were 1000-grain weight (79.47%), days to heading (12.08%), and spike length (5.61%) (Table 6). While, grain yield per plant, days to maturity, plant height, number of grains per spike, and tillers per meter contributed very poorly, respectively, 0.32%, 0.50%, 0.54 %, 072%, and 0.77%. It has similarity with finding of Kumar *et al.* (2011).

Conclusion

Finally, it can be conclude that all the sixty seven genotypes were found highly divergent under the present soil conditions. Genotypes which performed well for various traits where listed in Table 7. Among them genotypes like PBW 617 (17.38 g/ plant), PHS 1102 (11.76 g/ plant), HPW 347 (11.25 g/ plant) can be selected as suitable genotypes for growing under acid soil condition of West Bengal.

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Table 1. Descriptive statistics of the 8 quantitative characters of 67 genotypes of bread wheat

Characters	Parameter						
	Range	Mean	GCV	PCV	ECV	h^2	GA
Days to heading	58.00- 93.00	75.98	10.80	10.85	1.01	0.99	22.16
Days to maturity	114.00-138.00	123.94	3.05	3.26	1.17	0.87	5.86
Tillers/ meter	41.00-192.00	92.21	33.18	36.26	14.63	0.83	62.55
Plant height(cm)	61.80- 130.40	90.12	11.26	12.63	5.73	0.79	20.67
Spike length (cm)	5.72- 14.10	9.62	18.26	20.38	9.04	0.80	33.72
No. of grains/ spike	41.00- 76.00	54.71	8.83	10.18	5.07	0.75	15.76
1000-grain weight (g)	30.83- 70.19	46.27	16.42	16.43	0.10	1.00	33.83
Grain yield/ plant (g)	2.60- 22.56	6.89	30.33	35.32	18.10	0.74	53.65

Where, GCV= Genotypic coefficient of variation; PCV= Phenotypic coefficient of variation; ECV= Environmental coefficient of variation; h^2= Broad sense heritability; GA= Genetic advance.

Table 2. Distribution pattern of 67 genotypes of bread wheat into six clusters based on Mahalanobis D^2 statistics values

Sl. No.	Cluster	Total genotypes	Name of genotypes of clusters
1	**I**	28	DBW 62, HPW 338 ,HS 522, HUW 629, KRL 250, NW 4091, PBW 635 ,UAS 327 ,HD 3002 ,HPW 289, VL 931, VL 943, VL 944, HPW 347, HS 525 ,HI 1569, HUW 635, PBW 617, DBW 60, HD 2982, PBW 640, NW 4081, PBW 628 ,RAJ 4201, RAJ 4205, PHS 1101, DBPY 08-3, DBPY 08-7
2	**II**	2	DSP4/ RAJ 1555, BAJAJI/PDW 233
3	**III**	2	RAJ 4238 , K 0906
4	**IV**	2	NIAW 1594, NIAW 1689
5	**V**	2	DBPY 08-1, DBPY 08-9
6	**VI**	31	PHS 1102, PHS 1103, PHS 1104 ,PHS 1105, PHS 1106, PHS 1107, PHS 1108, PHS 1109, AKDW 4537, DBPY 08-2, DBPY 08-4, DBPY 08-6, DBPY 08-8, DL 1014 ,DL 1038, DL-1015, HPW 324 ,HPW 327, LBPY-08-6, LBPY-08-7,LBPY-08-9, RAJ 4215, MP 3336, WH 1097, HS 490 ,HI 1563, C 306, DBP 11-4, IDSN 129/UPD 52, DBP11-14, DWR-TS 33.

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Table 3. Inter and intra cluster distances among six clusters of sixty-seven genotypes

Cluster	I	II	III	IV	V	VI
I	35.86	28.99	28.86	38.00	27.43	45.92
II		5.26	23.10	39.71	15.19	40.20
III			5.78	21.52	16.74	46.25
IV				5.88	31.12	56.00
V					6.05	40.78
VI						48.73

Table 4. Inter and intra cluster D-square values among six clusters of sixty-seven genotypes

Cluster	I	II	III	IV	V	VI
I	1286.02	840.53	832.99	1444.42	752.69	2108.96
II		27.63	533.58	1576.99	230.76	1616.27
III			33.37	462.93	280.23	2139.15
IV				34.53	968.32	3135.99
V					36.61	1663.06
VI						2374.51

Table 5. Mean values of six clusters of 67 genotypes of wheat for eight quantitative characters

	Characters							
Clusters	**DH**	**DM**	**T/M**	**PH**	**SPL**	**GPS**	**1000 GW**	**Y/P**
I	78.08	125.12	100.50	90.45	9.83	55.71	45.15	7.99
II	83.87	131.37	65.87	85.50	7.10	50.87	47.92	6.93
III	81.50	124.50	154.50	107.22	10.1	51.27	42.70	5.5
IV	76.37	122.75	117.00	97.40	10.02	51.20	36.78	4.35
V	81.87	121.37	80.37	83.47	6.79	51.30	44.98	4.52
VI	72.73	122.34	82.79	92.90	9.90	54.23	49.45	6.32

Where, DH = Days to heading; DM = Days to maturity; T/M = Tillers per meter; PH = Plant height (cm); SPL= Spike length (cm); GPS =No of grains per spike; 1000 GW = Thousand grain weight (g); Y/P = Grain Yield per plant (g)

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Table 6. Contribution of each character towards genetic divergence in sixty-seven genotypes

Sl. No.	Character	No. of first rank	Percentage of Contribution
1.	**Days to heading**	267	12.08
2.	**Days to maturity**	11	0.50
3.	**Tillers/ meter**	17	0.77
4.	**Plant height (cm)**	12	0.54
5.	**Spike length (cm)**	124	5.61
6.	**No of grains / spike**	16	0.72
7.	**1000 grain weight (g)**	1757	79.47
8.	**Grain yield / plant (g)**	7	0.32
9.	**Total**	2211	100%

Table 7. Promising genotypes of bread wheat selected from diverse clusters for different biometrical characters for acid soils

Character	Genotypes
Days to heading	PHS 1102 (61.50), PHS 1109 (62.75), PHS 1108 (58.25)
Days to maturity	PHS 1106 (115.75), PHS 1108 (116.50), HPW 324 (117.25)
Tillers/ meter	VL 943 (184.50), RAJ 4238 (164.00), VL 944 (155.50)
Plant height (cm)	PHS 1104(74.25), RAJ 4201 (74.55), PBW-640 (75.10)
Spike length (cm)	PHS 1103(13.25), PHS 1104 (13.23), PHS 1106 (13.23), PHS 1102 (12.89)
No of grains / spike	PHS 1102 (70.67), HUW 629 (67.67), C 306 (63.17)
1000 grain weight (g)	PHS 1102 (70.99), HPW 324 (66.03), AKDW 4537 (63.39)
Grain yield per plant (g)	PBW 617 (17.38), PHS 1102 (11.76), HPW 347 (11.25), DBW 60 (10.34), DBW 62 (10.10)

Where, figures in parenthesis indicate mean values.