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Heritability of Yield and Its Components in Wheat under Boron Deficient and Supplemented Conditions.

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ABSTRACT

The study was conducted to identify the important characters under boron deficient and supplemented conditions that may be used as selection criteria in a wheat breeding program. Experiment was carried out in a randomized complete block in a split-plot arrangement with twenty one wheat genotypes. Data were recorded on different parameters like, Days to 50% flowering, Plant height (cm), Tillers/ plant, Spike length (cm), Spikelets/ spike, Grains/ spike, Chaffy grains (%), 1000 Grain weight (g), Harvest Index and Yield/ plant (g). The PCV were always higher than GCV for all the ten characters studied under both boron deficient and boron supplemented condition. This indicated environmental influence on the expression of characters under study. In the present investigation, high genetic advance associated with high heritability and with comparable genotypic coefficient of variation were evident for the characters viz., chaffy grain %, harvest index under both conditions and number of seeds per spike and grain yield per plant under boron deficient condition. Therefore, these traits deserve more attention in further breeding programs for evolving better wheat for stress environments.

Key words: Heritability, yield and its components, boron, wheat

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INTRODUCTION

The natural advantages for wheat cultivation in *terai* region of West Bengal are prolonged winter, bright sunshine hour and high residual moisture content in the soil at initial phase of crop growth. Despite of the natural advantages of the, it is characterized by low crop productivity. The major constraint is the widespread deficiency of micronutrients, particularly boron. In some boron-deficient soils, boron concentration is ≤0.27 ppm under this region which cause severe yield reduction in wheat [1]. Among the micronutrients, boron has been reported to influence the grain setting and yield in wheat [2]. Soils containing extractable boron, less than 1.0 mg kg^{-1} are deficient according to the critical levels indicated by Reisenauer *et al*. In this region, the general practice is the application of boron (@ 10kg/ha) to sustain high yield. However, yield loss can also prevented by identifying cultivars tolerant or resistant to boron deficiency. Genotypic variation offers a solution to boron deficiency through selection and breeding for the efficient cultivars [3]. Genetic resistance is the cheapest and best method to overcome the barriers against floret fertility and helps to sustain productivity more efficiently. To achieve this objective, an experiment was intensified to improve solving power of the genetic system to isolate high yielding stress resistant varieties.

MATERIALS AND METHODS

The field experiment was conducted at the experimental farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal, which is representative of highly leached acid soil and low in available boron. Soil of experimental plot was sandy loam to loam in texture, highly leached, low water retention capacity and boron deficient (≤0.21 ppm).

The study was conducted in a split plot design with three replications keeping doses of boron in main plots. Each genotype was accommodated in subplots of 2.5m x 1.5m size maintaining a distance of 30 cm between rows and 10 cm between plants. Wheat genotypes were grown without boron application (B_0) as well as with boron application (B_1). The boron was applied in the form of borax, which was applied @10kg/ha during the land preparation. Recommended doses of major nutrients (N:P:K;120:60:60) and other micronutrients were applied. Normal cultural practices were followed. Ten plants were selected randomly from each plots and data were recorded on different parameters like, Days to 50% flowering, Plant height (cm), Tillers/ plant, Spike length (cm), Spikelets/ spike, Grains/ spike, Chaffy grains (%), 1000 Grain weight (g), Harvest Index and Yield/ plant (g).

The general statistical procedure was followed according to standard method given by [4]. The analysis of variance (ANOVA) and broad sense heritability (h^2_b) were estimated by using the formula suggested by [5]. The phenotypic coefficients of variance (PCV %) and genotypic coefficients of variance (GCV %) were computed according to [6]. The expected genetic advance from selection was computed according to [7].

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RESULTS AND DISCUSSION

The mean, range, phenotypic and genotypic coefficients of variation, heritability % (broad sense) and expected genetic advance for the ten characters in wheat grown under both boron deficient and supplemented conditions were presented in Table 1. The values of phenotypic coefficient of variation (PCV) were higher compared to those of genotypic coefficient of variation (GCV) for all the characters studied, both under boron deficient and supplemented conditions.

Table 1: Estimate of genetic parameters for different characters of wheat under boron Deficient (B_0) and boron supplemented (B_1) condition

Characters	Env.	Mean	Range	GCV (%)	PCV (%)	Heritability (%) Broadsense	GA	GA (in % of mean)
Days to 50% Flowering	B_0	80.27 ± 1.08	75.66-86.00	3.18	3.46	84.08	4.82	6.00
	B_1	81.22 ± 0.91	78.33-85.00	1.81	2.14	71.08	2.55	3.14
Plant height (cm)	B_0	79.24 ± 1.66	76.18-82.25	0.76	2.28	11.13	0.42	0.52
	B_1	80.32 ± 1.41	76.26-83.95	1.26	2.20	32.71	1.89	1.48
Tillers/ plant	B_0	3.94 ± 0.16	3.58-4.22	2.31	4.72	24.00	0.09	2.32
	B_1	4.04 ± 0.17	3.58-4.62	4.66	6.33	54.07	0.29	7.05
Spike length (cm)	B_0	8.35 ± 0.17	7.86-9.50	5.82	6.20	88.47	0.94	11.30
	B_1	8.63 ± 0.23	7.96-9.53	3.92	4.73	69.83	0.59	6.80
Spikelets/ spike	B_0	18.45 ± 0.28	16.25-21.72	6.91	7.08	95.00	2.56	13.88
	B_1	18.59 ± 0.26	16.76-20.00	4.90	5.11	92.09	1.80	9.69
Grains/ spike	B_0	20.10 ± 0.71	10.27-34.78	34.97	35.16	98.40	14.40	71.66
	B_1	34.99 ± 0.70	30.45-38.94	5.27	5.65	86.88	3.54	10.13
Chaffy grains (%)	B_0	30.55 ± 0.51	12.03-40.98	23.95	24.01	99.00	15.04	49.21
	B_1	4.24 ± 0.12	1.60-5.80	22.80	22.98	98.40	1.98	46.61
1000 Grain weight (g)	B_0	37.71 ± 1.18	35.30-41.67	4.02	5.16	60.70	2.43	6.45
	B_1	38.73 ± 0.64	34.77-41.90	3.95	4.30	84.47	2.90	7.48
Harvest Index	B_0	18.99 ± 0.85	13.55-26.47	17.57	18.16	93.68	6.65	35.04
	B_1	25.65 ± 1.22	21.43-29.79	10.70	11.80	82.88	5.17	20.14
Yield/ plant (g)	B_0	2.99 ± 0.13	1.36-5.95	36.09	36.37	98.50	2.48	73.79
	B_1	6.33 ± 0.14	5.51-7.17	6.01	6.39	88.45	0.74	11.65

GCV= genotypic coefficient of variation; PCV= Phenotypic coefficient of variation; GA= Genetic advance

Under boron deficient condition, the highest GCV and PCV values were obtained for grain yield/plant (36.09% and 36.37% respectively) and the lowest GCV and PCV values were obtained for the character plant height (0.76% and 2.28% respectively). Grain yield/ plant, grains /spike, chaffy grain % and harvest index showed high PCV and GCV. Except plant height and tillers/ plant, all the traits exhibited high heritability estimates. However, 1000 grain weight showed moderate heritability estimates. High to moderate values of genetic advance (GA) as percent of mean were recorded for grain yield/ plant, grains/ spike, chaffy grain % and harvest index. Whereas, lowest value for this trait was recorded for plant height (0.52%).

Under boron supplemented condition, genotypic coefficient of variation (GCV) varied from 1.26% for plant height to 22.80 % for chaffy grain percentage, whereas, the phenotypic coefficient of variation (PCV) ranged from 2.14% for days to 50 percent flowering to 22.98 % chaffy grain percentage. Except plant height and tillers/ plant, all the traits exhibited high heritability estimates. However, days to 50% flowering and spike length showed moderate heritability estimates. The highest expected genetic advance (GA), expressed as percent of mean, recorded for chaffy grain percentage (46.61%) followed by harvest index (20.14%) and grain yield/ plant (11.65%).

Improvement in any crop largely depends on the wide range of variability present in that crop [8]. In the present study, the phenotypic coefficient of variations were always higher than those of genotypic coefficient of variation for all the ten characters studied under both boron deficient and boron supplemented condition. This indicated environmental influence on the expression of characters under study. Under boron deficient condition, on the basis of the values for genotypic coefficient of variation and phenotypic coefficient of variations, the characters can be classified into different groups. One with higher values for genotypic coefficient of variation and phenotypic coefficient of variations, such as grains per spike, chaffy grains %, harvest index and grain yield per plant indicating broader genetic base and wider adaptability thus greater scope for selection in these traits but in the remaining characters the values for genotypic coefficient of variation and phenotypic coefficient of variations were low. In case of rice, [9] also observed both high and low genotypic coefficient of variation and phenotypic coefficient of variations for different morphological traits. Grain yield is a very important trait in bread wheat. It is controlled by genetic factors but environmental conditions considerably affect their expression also [10]. Evaluation of germplasms aims ultimately at improving grain yield. However, grain yield is a complex trait and dependent upon number of yield attributing traits. So selection would be beneficial for the yield contributing traits, rather than grain yield as such. Variability, the most basic factor for selection of these characters is tested by genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). The trends of inheritance from generation to generation of these factors are tested by their heritability estimates which indicate the proportion of genotypic variance out of phenotypic variance, the sum total of genotypic and environmental variance. But heritability along with genetic advance provides a better tool than heritability alone for production of resultant effect by selection of best individual for a particular trait [7].

Gandhi *et al.,* reported that heritable portion of variation can be identified with the help of heritability estimates and genetic gain [11]. High heritability estimates generally enables the breeder to select plants on the basis of phenotypic expression [7]. Plant height and tillers per plant were found with low heritability estimates under both of the conditions. This suggests that less weightage should be given to those components possessing low heritability while fixing selection criteria. The character namely, number spikelets per spike, seed per spike, chaffy grain (%), harvest index and yield under both the condition whereas, days to 50% flowering and spike length under boron deficient condition were recorded with high heritability estimates. Selection for these characters may prove fruitful under boron deficient condition than under supplemented condition. Kheiralla reported moderate estimates of heritability for grain yield per plant and high heritability for number of grains per spikes while [12], Yadav and Mishra observed high heritability for characters number of tillers per plant and grain yield per plant [13]. However, Singh *et al.,* had observed high heritability for yield per plant but this was not reflected in offspring [14]. As this character is non reliable it should not be considered for direct selection and due weight age may be given for different yield components. So, considering the heritability it was observed that those were very high for most of the characters which could be exploited for further improvement through selection and breeding. Ghimiray and Sarkar observed high heritability coupled with high genetic advance for number of seeds per spike in boron deficient soil [15]. Ahmadi and Bajelan and Khan and Naqvi also reported the presence of high heritability and genetic advance in different yield related attributes in wheat [16,17]. This association would indicate that additive gene effects are probably more important in the inheritance of these characters and hence, selection for these characters would be highly effective under boron deficient condition [18].

CONCLUSION

The extent of genetic advance expected from selection can be obtained from a study of the genotypic coefficient of variation along with heritability estimates, as heritability estimates are often subjected to genotype-environment interactions. In the present investigation, high genetic advance associated with high heritability and with comparable genotypic coefficient of variation were evident for the characters viz., chaffy grain %, harvest index under both conditions and number of grains per spike and grain yield per plant under boron deficient condition. Selection for grain yield/ pants and the yield attributing characters such as grains/ spike, chaffy grain percent and harvest index would be highly effective under boron deficient condition as these characters exhibited high estimates of heritability and genetic advance.

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