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Assessment of Heritability and Genetic Advance for Yield and Yield Related Traits under Different Dates of Sowing of Bread Wheat (*Triticum aestivum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Wheat (*Triticum aestivum* L.) is a self-pollinating annual plant extensively grown as staple food source in the world. Information on the extent of heritability and genetic advance among different traits of bread wheat genotypes is essential to designing breeding strategies with the objective to estimate heritability and genetic advance for different characters of bread wheat genotypes. A total of 10 bread wheat genotypes were evaluated for 15 traits sown, three at different dates in 10 days interval The first on 30 November 2022, second on 10 December 2022, and third 20 December 2022 in a Randomized Block Design with three replications at Student Instruction Farm, C.S. Azad University of Agriculture and Technology, Kanpur-208002 (U.P.) during *Rabi*, 2022-23. in Randomized Block Design. High PCV and GCV were observed from biological yield, grain yield, plant height and productive tiller per plant high heritability estimate were recorded for grain yield per plant followed by biological yield per plant, plant height, days to 50% heading, days to maturity, number of productive tillers per plant, 1000-grain weight and number of grains per ear in both generations on individual and grain yield per plant followed by biological yield, number of productive tillers per plant, plant height, seed hardness, days to maturity in both generations on pooled basis. High genetic advance was observed for grain yield per plant and biological yield per plant in both the generation; seed hardness, number of productive tillers per plant in F_1 generation and grain yield per plant and biological yield per plant in both the generation on pooled basis. Consequently, since additive gene action controls the phenotypic manifestation of certain features, those traits should receive special attention in wheat breeding programs. Grain yield will therefore be increased by direct selection for these features.

Keywords: Genetic advance; wheat; heritability; grain yield.

1. INTRODUCTION

“Wheat (*Triticum aestivum* L.), is a self-pollinating annual plant, it is in the true grass family, *Gramineae*, is extensively grown as staple food source in the world [1]. And it is one of the most important crops among the prime cereals at the global level [2]. Bread Wheat evolved through years of cultivation in the southern Caspian plains [3]. Wheat is the second important food crop after rice worldwide” [4] and it provides 20% of the calories and protein and feeding about 40% of the world population [5].

One of Africa's top producers of wheat is Ethiopia (Yasin, 2015, Regasa, 2019). “Two current kinds of wheat are grown in Ethiopia: durum or tetraploid wheat (T. turgidum subsp. durum, 2n=4x=28, AABB) and hexaploid wheat (*Triticum aestivum* L, 2n=6x=42, AABBDD). By international standards, however, wheat productivity and production are rather low. The primary cause is that small-scale farmers primarily use rain feed production systems with less irrigated production for subsistence farming of wheat” [6]. “These farmers are also limited by a number of infectious diseases, such as Septoria leaf blotch and rust, which are the main issues with wheat production in Ethiopia” [7,8].

“Accurate understanding of genetic advancement, heritability, and germplasm variability is essential for crop improvement initiatives since it facilitates the creation of superior recombinants for all desired traits” [9,10]. “To meet the problems of crop breeding, both current and future, genetic variety is crucial” [7]. These challenges include breeding for increased yield, wider adaptation, desirable quality, drought tolerance, and resistance to insects and diseases [11].

2. MATERIALS AND METHODS

The experimental material comprised of 45 F_1s developed by crossing 10 lines *viz*., DBW-187, HD-3249, K-1006, PBW-723, PBW-757, HD-3271, HD-3298, K-8434, KRL-350, K - 9107 following half diallel mating design. The experimental materials consisted of 55 genotype (45 F1s +10 Parents) were sown in Randomized Block Design with three replications at the Student Instruction Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during the rabi season of 2022-23. Each cultivar was grown in a single row plot measuring 3 meters in length, with a distance of 22.5 centimetres between rows. “The plants within each plot were spaced 10 centimetres apart. Various quantitative characteristics of the wheat plants were recorded as observations. These characteristics included the number of days to reach 50% heading, the number of days to maturity, plant height, flag leaf area in square centimetres, number of leaves on the main tiller, number of productive tillers per plant, ear length in centimetres, number of spikelet's per ear, number of grains per ear, biological yield per plant in grams, grain yield per plant in grams, harvest index as a percentage, 1000-grain weight in grams, seed hardness, and protein content as a percentage. For each replication and for all characteristics except for the number of days to 50% heading and days to maturity, five randomly selected competitive plants were recorded. The heritability in broad sense (h^2) was determined using the method" described by Burton and DeVane [12]. The genetic advance was calculated based on the formula provided by Johnson et al*.* [13].

3. RESULTS AND DISCUSSION

In the plant improvement initiative, heritability estimates have been used as a selection criterion. It is a commonly used method to calculate the potential character inheritance from parent to child. High heritability estimates revealed high values for the following traits in both generations: seed hardness and protein content in the F1 generation and flag leaf area, harvest index in the F2 generation; plant height, days to 50% heading, days to maturity, number of productive tillers per plant, 1000-grain weight, and number of grains per ear. The moderate magnitude of heritability estimates below 30 and above 10 per cent was observed for the characters, harvest index in F_1 generation and number of spikelet's per ear seed hardness and ear length in F_2 generation. The low magnitude of heritability observed in number of leaves/main tiller in both generations; number of spikelet's per ear, ear length and flag leaf area in F_1 generation on individual basis and The finding on heritability estimates showed high value for grain yield per plant, biological yield, number of productive tillers per plant, plant height, seed hardness, days to maturity in both generations; 1000-grain weight, protein content, number of grains per ear in F_1 generation and days to 50% heading in F_2 generation. Characters, harvest index, and number of leaves/main tiller in both generations; number of grains per ear, protein content, 1000-grain weight, number of spikelets per ear, and flag leaf area in the F2 generation all showed moderate magnitudes of heritability estimates below 30 and above 10 percent. The F1 generation's flag leaf area, number of spikelets per ear, and ear length all showed low levels of heritability. It showed that non-additive gene activity was more common, which accelerated the process of heredity selection so that these traits might be enhanced by selection in a subsequent generation. The environment has a significant impact on the associated traits, which decreased the degree of correspondence because of its phenotypic and breeding values on a pooled basis.

"The estimated value of genetic advance (GA) for all the characters as shown in Table 1 and Table 2 focused on direct selection in both the generations. High genetic advance in percentage over mean was estimated for grain yield per plant and biological yield per plant in both the generation; seed hardness, number of productive tillers per plant in F_1 generation Moderate values were also observed for number of productive tillers per plant and plant height F_2 generation. exhibited the similar performance. It indicated that these traits were governed grain weight, harvest index and protein content in both the generation and for plant height in by additive which are fixable and the desired selection will be rewarding for improvement of such traits in early generations" [13]. Singh et al*.,* [14], Singh et al*.,* [15] and Garg and Pal [16] also estimated "the high heritability and high genetic advance for the various characters in wheat. Lower values of genetic advance were recorded for 1000-grain weight, protein content, number of grains per ear, days to maturity, number of spikelet's per ear, days to 50% heading, ear length, harvest index, number of leaves/main tiller, flag leaf area in both generations; plant height in F_1 generation and seed hardness in F_2 generation on individual basis and high genetic advance in percentage over mean was estimated for grain yield per plant and biological yield per plant in both the generation; number of productive tillers per plant in F_2 generation Moderate values were also observed for seed hardness in both generations; number of productive tillers per plant in F_1 generation. Lower values of genetic advance were recorded for 1000-grain weight, protein content, number of grains per ear, days to maturity, number of spikelet's per ear, days to 50% heading, ear length, harvest index, number of leaves/main tiller, flag leaf area and plant height in both generations on pooled basis". indicated that these characters are governed by non-additive genes where heterosis breeding may be useful. As Rathwa et al*.* [17], Sateesh Chandra Gaur [18] and Malbhage et al*.* [19].

Table 1. Direct selection parameters for 15 characters of 10 parent diallel cross set of wheat (*Triticum aestivum* L.)

Characters	Grand mean		Heritability (%) (h^2)		GA		GA in% over mean	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Days to 50% heading	85.22	87.96	30.5	72.1	1.06	3.21	1.25	3.69
Days to maturity	125.19	124.41	67.7	70.6	3.64	3.11	2.91	2.50
Plant height (cm)	95.23	91.89	84.3	91.5	8.74	12.49	9.22	13.56
Flag leaf area (cm^2)	24.13	26.00	1.2	41.5	0.04	1.65	0.16	6.41
Number of leaves/main tiller	5.32	5.35	9.9	9.8	0.043	0.03	0.81	0.72
Number of productive tillers/plant	8.20	7.16	78.9	68.2	1.83	1.22	23.04	17.16
Ear length (cm)	10.06	9.25	3.7	14.9	0.12	0.51	1.18	5.35
Number of spikelet's/ear	20.03	19.13	8.5	25.2	0.27	0.83	1.36	4.30
Number of grains/ear	50.08	48.87	36.9	32.0	2.26	2.28	4.50	4.62
Biological yield/plant (g)	41.07	36.11	92.8	92.7	13.47	11.08	34.62	31.79
Grain yield/plant (g)	16.53	15.66	95.2	90.3	6.12	4.82	39.18	32.40
Harvest index (%)	40.32	43.62	13.9	41.1	0.43	1.21	1.03	2.85
1000-grain weight (g)	45.37	42.91	74.6	52.8	4.11	1.89	9.26	4.47
Seed hardness	8.39	8.74	81.2	18.8	2.01	0.59	23.16	6.25
Protein content (%)	12.50	11.78	42.5	39.1	0.97	0.83	7.84	7.04

Table 2. Direct selection parameters for 15 characters of 10 parent diallel cross set of wheat (*Triticum aestivum* L.)- Pooled

Characters	Grand mean		Heritability (%) (h^2)		GA		GA in % over mean	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Days to 50% heading	79.99	82.63	24.83	36.03	1.33	1.32	1.67	1.70
Days to maturity	118.66	117.56	79.98	59.05	2.51	2.48	2.12	2.09
Plant height (cm)	87.25	85.84	83.27	77.84	5.44	7.20	6.27	7.91
Flag leaf area (cm^2)	21.23	21.93	1.97	12.56	0.64	2.01	3.02	8.97
Number of leaves/main tiller	4.72	4.56	10.14	21.77	0.22	0.09	4.66	2.07
Number of productive tillers/plant	7.08	6.44	91.95	89.71	1.29	1.88	18.88	25.38
Ear length (cm)	8.86	8.61	3.32	8.37	0.38	0.29	4.24	3.07
Number of spikelet's/ear	18.21	17.95	8.16	15.05	0.52	0.25	2.87	1.30
Number of grains/ear	46.05	45.26	42.05	24.21	1.09	0.91	2.37	1.87
Biological yield/plant (g)	34.45	31.97	95.87	88.39	8.42	9.97	25.66	27.82
Grain yield/plant (g)	13.69	13.23	97.87	95.02	3.68	4.23	28.26	29.42
Harvest index (%)	39.63	41.40	29.72	26.08	3.05	2.40	7.72	5.98
1000-grain weight (g)	41.50	40.52	76.82	16.41	1.85	0.30	4.51	0.75
Seed hardness	7.61	8.05	81.32	56.07	1.12	1.04	14.46	13.24
Protein content (%)	11.74	11.51	64.08	22.45	1.03	1.13	8.85	9.82

4. CONCLUSION

High heritability estimates were found for both the individual and the pooled grain yield per plant, biological yield, number of productive tillers per plant, plant height, seed hardness, days to 50% heading, days to maturity, number of productive tillers per plant, 1000-grain weight, and number of grains per ear in both generations. High genetic advance was noted in the following areas: seed hardness, the number of fruitful tillers per plant in the F1 generation, and, on a pooled basis, the grain yield per plant and the biological yield per plant in both generations. Thus, attention should be given for those traits for breeding program.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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