**Genetic variability, Heritability and Genetic advance in Analysis of Seed Quality Parameters in Wheat (*Triticum aestivum* L.) Germplasm**

**ABSTRACT**

The present investigation was carried out for wheat (Triticum aestivum) in the ~~laboratory~~ Department of Seed Science and Technology, Institute of Agricultural Sciences, Bundelkhand University Jhansi (U.P.). ~~The~~ Twenty wheat germplasms were sown in ~~from~~ Completely Randomized Design (CRD) with three replications during 2024-25 to assess the ~~The~~ magnitude of genotypic and phenotypic coefficient of variation for various seed quality parameters. The data revealed that CV for GC and PC were detected for vigour index-I, shoot length (cm), seed width (mm), root length (cm), seedling length (cm) indicating there by substantial scope for improvement in seed quality and subsequent selection. Similarly ~~and~~ high estimate of heritability with higher ~~high~~ genetic advance in percent mean were detected for seed width (mm), shoot length (cm), root length(cm), seedling length(cm), 1000-seed weight(g), seed length (mm), speed of germination, seedling dry weight(mg). The lowest and highest mean performance for vigour index-I detected in WH-1402 (2349.60) and JK-7254 (1540), respectively. The general mean for this character was found 2106.44. the highest and lowest mean performance of vigour index-II observed for PBW-502 (14378) and JK-7254 (10824) with a general mean performance of ~~was observed~~ 12631.55. The above results apparently indicate that some information considered here will be of use in future for improving wheat genotypes/varieties and developing new varieties.

**Keywords:** Wheat, Heritability, Germination and Vigour index.

**INTRODUCTION**

Wheat, belonging to the family of Gramineae (Poaceae) and the genus Triticum, is that world’s most prominent cereal crop. The bulk of the cultivated wheat varieties belong to 3 main species of the monocotyledon genus. These are the hexaploidy- T. aestivum L. (bread wheat), the tetraploid- T. durum (desi) and therefore the diploid- T. dicoccum and T. monococcum. Common wheat ‘Triticum aestivum L.’ ~~wheat~~ is most cultivated ~~lively~~ species covering ~~which covers~~ 90 per cent of the land. Second popular wheat in existence is Triticum durum which occupies ~~protections~~ about 9 per cent of the total area while T. dicoccum and T. monococcum wheat cover balance ~~however~~ one per cent ~~of the full area~~ (Prasad et al. 2020).

 Constant increase in agriculture production and productivity essentially requires continuous expansion of recent and improved types of crops and efficient seed production scheme to convey the latest technology to farmers. ~~scheme of production and offer of seed to formers~~. Seed quality is ~~within~~ the sum of these qualities which differentiates the seed from the grain. The important seed quality attributes with relevance to farm productivity are: genetic purity, physical purity, germination, moisture, seed health ~~wellbeing~~ and vigour. In addition, ~~additionally~~ to above qualities, seed should be ~~of~~ robust ~~unchanging~~ ~~size~~ and evenly sized. ~~will own good.~~ Seed germination capability must be superior enough to provide high field stand for gaining supremacy in cultivation. ~~Germination capacity of superiority seed portion should be high for gaining the specified crop supernumerary this sector~~. Using seed of low germination will diminish the crop ~~sphere~~ establishment or stand and thus the yields will ~~be~~ drop~~ped~~. Seed germination is however dependant of factors like ~~Seed germination is rested low with a range of things which are compulsory to the seed during~~ its formation, maturing, ripening, pest and pathogen infection.  ~~like infection with the paste and pathogen.~~

 Using seeds of low vigour will reduce crop establishment ~~the sphere establishment~~ or stand and thus lowering yields. ~~the yields are lowered.~~ An estimated five out of a hundred crop losses occur every year due to low seed vigour. The fullest genetic potential ~~possible~~ of an improved variety and henceforth the benefit is realized ~~grasped~~ only if highly vigorous seed is employed for sowing. Likewise ~~Link wise~~ when seed vigour is incorporated in an exceptionally well performing variety, the germination problem and thus it’s failure in field performance is highly minimized in tropical zones. ~~in an exceeding high yielding variety, the low seed germ powerlessness problem in tropical area are greatly minimized.~~ Seed vigour is also linked to field establishment even under suboptimal conditions. ~~The performance potential of a seed lot with esteem to field establishment is extremely much dependent to the capacity of the seed to germinate and establish underneath suboptimal field conditions.~~ Thus, the residual potential (hidden stamina) ~~The recital potential (hidden stamina)~~ of the seeds makes it suited to perform well upon sowing.

**MATERIALS AND METHODS**

 In the present study, twenty wheat germplasms of with wide spectrum of variation for various seed quality characters, were evaluated in laboratory during 2024-25. The experiment was conducted ~~presented~~ following Completely Randomized Design (CRD) with three replications in Department of Seed Science and Technology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (Uttar Pradesh) India during 2024-25. The Seed quality parameters were studied namely, 1000-seed weight (g), Seed length (mm), Seed breadth (mm), Shoot length (cm), Root length (cm), Seedling length (cm), Seedling Dry Weight (mg), Speed of germination, Germination (%), Vigour index-I, Vigour Index–II, First count (%), Final count (%). The data on thirteen seed quality characters from the experiments were utilized for estimation of coefficient of variation at genotypic and phenotypic levels, heritability in broad sense and genetic advance in per cent of mean. Percentage values were calculated into their respective angular values before analysis. Standard Error (SE) and Critical Difference (CD) were calculated for comparison.

HI8751, RAJ 3077 ARE FOUND BOTH IN VI I & VI II

**RESULTS AND DISCUSSIONS**

 The analysis of variance of the experiment brought out ~~designated~~ highly significant differences among the twenty germplasms of wheat (Triticum aestivum L.) for all the thirteen seed quality characters under studied. Among the twenty varieties of wheat, WH-1402, HI-8751, HI-1628, HD-3086, PBW-550, PBW-343, RAJ-3077, RAJ-4220 and HD-3086 produced highest vigour index (I) and germplasms PBW-502, HI-8751, RAJ-4220, HI-8751, HI-1628, HD-3086, PBW-550, PBW-343, RAJ-3077, RAJ-4220 and HD-3086 produced highest in vigour index -II. The existence of high variability for above characters in wheat were also reported earlier by ~~similar result found earlier by~~ Kumar, et al. (2004), Gautam, et al. (2012), Hosseini, et al. (2012) and Wani, et al. (2013).

HI8751, RAJ 4220 HD 3086 ARE REPEATED TWICE

 Wide spectrum of distinction was observed for seed quality characters among ~~of~~ twenty Wheat varieties. High magnitude of genotypic and phenotypic coefficients of variation were observed for vigour index-I indicating thereby, substantial scope for improvement in this parameter after seed quality improvement and subsequent selection. Moderate estimates of GCV and PCV were observed for seed length, seed width, root length, seedling length, 1000- seed weight, seedling length, which suggested possibility of obtaining reasonable improvement through selection as also observed by ~~The result of the present study in respect of genotypic and phenotypic coefficient of variation similar result found earlier workers~~ Singh, et al. (2017), Geleta, T. (2017), Prasad, et. al. (2020).

 The high estimates of heritability with high genetic advance in per cent of mean were recorded for vigour index-I, seed width (mm), shoot length (cm), root length (cm), seedling length (cm), germination percentage (%). The characters, mentioned above, having high values of heritability and genetic advance in per cent of mean emerged as ideal traits for improvements through selection. 1000-seed weight (g), seed length (mm), first count, vigour index, seedling length (cm), seedling dry weight (mg), speed of germination, final count showed high to moderate heritability coupled with high to moderate genetic advance in per cent of mean which indicated possibility of obtaining reasonable response to selection in these owing to their moderate transmissibility but moderate to high variability. The result obtained under present investigation are in accordance with earlier reports that by Akshitha, et al. (2020), Lakshmi, et al. (2016), Moshatati, et al. (2012).

The estimate medium heritability and genetic advance in first count, final count and percent germination indicated a ~~percentage indicating~~ medium range of heritability and genetic advance as reported by ~~studies~~ earlier workers viz., Moshatati, et al. (2012), Lakshmi, et al. (2016), Singh, et al. (2017), Sudeepthi, et al. (2020).

**Table 1: Analysis of variance of completely randomized design for 13 characters of wheat genotypes**

|  |  |
| --- | --- |
| **Characters** | **Source of variation** |
| **Treatments** | **Error** | **Total** |
| **19****(Degree of freedom)** | **40****(Degree of freedom)** | **59****(Degree of freedom)** |
| 1000 Seed Weight (g) | 36.30\*\* | 0.74 | 12.35 |
| Seed Length (mm) | 00.88\*\* | 0.03 | 0.30 |
| Seed Width (mm) | 00.82\*\* | 0.01 | 0.27 |
| Shoot Length (cm) | 7.10\*\* | 0.06 | 2.36 |
| Root Length (cm) | 9.26\*\* | 0.08 | 3.08 |
| Seedling Length (cm) | 22.05\*\* | 0.21 | 7.34 |
| Speed of germination | 5.24\*\* | 0.18 | 1.83 |
| Seedling Dry Weight (mg) | 287.15\*\* | 10.12 | 100.58 |
| First Count (No.) | 37.75\*\* | 3.07 | 14.39 |
| Final Count (No.) | 28.15\*\* | 3.70 | 11.68 |
| Germination Percentage (%) | 20.57\*\* | 3.05 | 8.77 |
| Vigour Index - I | 397376.22\*\* | 1836.00 | 130991.99 |
| Vigour Index – II | 2498481.95\*\* | 86019.27 | 873762.19 |

\*\* Significant at 1% probability level

**Table 2. Adjusted means of twenty germplasm/varieties, range and least significant differences for 13 characters in wheat**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S.N. | Genotypes | 1000Seed Weight (g) | Seed Length (mm) | Seed Width (mm) | Shoot Length (cm) | Root Length (cm) | Seed-lin g Length (cm) | Speed of germi nation | Seedlin g Dry Weight (mg) | First Count (No.) | Final Count (No.) | Germina tion Percent (%) | Vigour Index -I | Vigour Index – II |
| 1 | JK-7254 | 35.83 | 5.86 | 2.78 | 5.60 | 11.70 | 17.50 | 20.42 | 123.00 | 83.00 | 88.00 | 88.37 | 1540.0 | 10824 |
| 2 | JK-5501 | 38.56 | 5.87 | 2.78 | 9.50 | 14.60 | 24.30 | 19.23 | 129.00 | 76.00 | 84.00 | 89.42 | 2041.2 | 10836 |
| 3 | JK-PITAMBAR | 42.89 | 5.76 | 2.69 | 9.40 | 13.80 | 23.40 | 18.67 | 132.00 | 86.00 | 89.00 | 89.68 | 2082.6 | 11748 |
| 4 | LOKWAN | 39.59 | 6.25 | 3.95 | 8.50 | 13.60 | 22.30 | 17.85 | 160.00 | 80.00 | 86.00 | 86.49 | 1917.8 | 13760 |
| 5 | RAJ-4037 | 38.25 | 6.69 | 3.84 | 8.40 | 14.70 | 23.40 | 17.58 | 147.00 | 81.00 | 85.00 | 85.31 | 1989.0 | 12495 |
| 6 | ATW RAJ- 2052 | 37.57 | 5.62 | 2.75 | 10.50 | 14.90 | 25.60 | 19.79 | 138.00 | 85.00 | 89.00 | 89.18 | 2278.4 | 12282 |
| 7 | BIO SEED- 3001 | 39.15 | 5.93 | 2.85 | 10.00 | 13.30 | 23.50 | 20.21 | 142.00 | 80.00 | 87.00 | 87.15 | 2044.5 | 12354 |
| 8 | RAJ-4238 | 40.54 | 5.78 | 3.17 | 8.20 | 16.50 | 25.00 | 21.53 | 150.00 | 81.00 | 83.00 | 86.27 | 2075.0 | 12450 |
| 9 | RAJ-4220 | 43.67 | 6.26 | 3.21 | 8.00 | 14.50 | 22.80 | 21.64 | 161.00 | 84.00 | 94.00 | 94.86 | 2143.2 | 12134 |
| 10 | RAJ-3077 | 42.16 | 6.18 | 2.83 | 9.00 | 14.50 | 23.80 | 22.32 | 137.00 | 83.00 | 92.00 | 92.78 | 2189.6 | 12604 |
| 11 | HD-2967 | 36.26 | 5.78 | 4.15 | 7.50 | 15.70 | 23.50 | 17.93 | 146.00 | 82.00 | 83.00 | 85.95 | 1950.5 | 12118 |
| 12 | PBW-343 | 42.11 | 6.05 | 3.86 | 7.60 | 15.00 | 22.90 | 18.07 | 153.00 | 80.00 | 86.00 | 86.29 | 1960.8 | 13158 |
| 13 | PBW-550 | 40.15 | 7.16 | 2.95 | 9.40 | 13.50 | 23.20 | 18.93 | 156.00 | 80.00 | 82.00 | 87.14 | 1902.4 | 12792 |
| 14 | PBW-502 | 43.16 | 6.23 | 2.84 | 10.10 | 13.30 | 23.60 | 20.21 | 158.00 | 77.00 | 91.00 | 91.23 | 2147.6 | 14378 |
| 15 | HD-3086 | 40.25 | 6.19 | 3.85 | 10.00 | 11.50 | 21.70 | 17.46 | 145.00 | 74.00 | 86.00 | 86.52 | 1866.2 | 12470 |
| 16 | WH-1402 | 28.52 | 5.87 | 3.98 | 11.70 | 14.50 | 26.40 | 19.35 | 134.00 | 83.00 | 89.00 | 89.63 | 2349.6 | 11926 |
| 17 | PB-826 | 44.85 | 6.21 | 3.83 | 9.50 | 11.10 | 20.80 | 18.57 | 136.00 | 81.00 | 86.00 | 86.79 | 1788.8 | 11696 |
| 18 | HI-1621 | 38.32 | 6.85 | 3.76 | 10.50 | 13.80 | 24.50 | 17.34 | 145.00 | 82.00 | 85.00 | 85.82 | 2082.5 | 12325 |
| 19 | HI-8751 | 44.29 | 7.23 | 4.18 | 12.10 | 15.60 | 27.90 | 20.52 | 149.00 | 85.00 | 93.00 | 93.67 | 2294.7 | 13857 |
|  20 | HI-1628 | 43.18 | 6.15 | 2.75 | 10.40 | 17.00 | 27.60 | 19.48 | 140.00 | 76.00 | 89.00 | 89.39 | 2263.2 | 11480 |
|  | **Mean** | 39.95 | 6.36 | 3.43 | 9.72 | 13.93 | 23.87 | 19.59 | 145.82 | 80.91 | 87.85 | 88.82 | 2106.44 | 12631.55 |
|  | **Min.** | 28.52 | 5.62 | 2.69 | 5.60 | 11.10 | 17.50 | 17.34 | 123.00 | 74.00 | 82.00 | 85.31 | 1540.00 | 10824.00 |
|  | **Max.** | 44.85 | 7.23 | 4.18 | 12.10 | 17.00 | 27.90 | 22.32 | 161.00 | 86.00 | 93.00 | 94.86 | 2349.60 | 14378.00 |
|  | **SE(d)** | 0.70 | 0.13 | 0.06 | 0.20 | 0.23 | 0.37 | 0.34 | 2.60 | 1.43 | 1.57 | 1.43 | 34.99 | 239.47 |
|  | **C.D. at 5%** | 1.41 | 0.26 | 0.12 | 0.39 | 0.47 | 0.74 | 0.69 | 5.20 | 2.86 | 3.14 | 2.85 | 70.01 | 479.21 |
|  | **C.V. (%)** | 2.16 | 2.52 | 2.16 | 2.46 | 2.05 | 1.90 | 2.14 | 2.18 | 2.17 | 2.19 | 1.97 | 2.03 | 2.32 |

**Table 3: Estimates of range, grand mean, phenotypic (PCV) and genotypic (GCV) coefficient of variation, heritability in broad sense [h2(bs)%] and genetic advance in per cent of mean (**Ga **%) for thirteen characters in wheat varieties**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Characters** | **Range (Min. – Max.)** |  **Mean (**x**)** | **PCV (%)** | **GCV (%)** | **Heritability****[h2(bs)%]** | **Genetic advance in****per cent of 5%****mean (Ga%)** |
| 1000 Seed Weight (g) | 28.52-44.85 | 39.95 | 8.88 | 8.62 | 94.11 | 17.22 |
| Seed Length (mm) | 5.62-7.25 | 6.36 | 8.74 | 8.37 | 91.71 | 16.51 |
| Seed Width (mm) | 2.69-4.18 | 3.43 | 15.35 | 15.19 | 98.02 | 30.99 |
| Shoot Length (cm) | 5.60-12.70 | 9.72 | 15.96 | 15.77 | 97.62 | 32.10 |
| Root Length (cm) | 10.00-17.00 | 13.93 | 12.72 | 12.56 | 97.41 | 25.53 |
| Seedling Length (cm) | 17.50-29.30 | 23.87 | 11.46 | 11.30 | 97.25 | 22.97 |
| Speed of germination | 17.34-22.32 | 19.59 | 6.97 | 6.63 | 90.55 | 13.00 |
| Seedling Dry Weight (mg) | 123.0-163.0 | 145.2 | 6.94 | 6.59 | 90.12 | 12.89 |
| First Count | 72.00-88.00 | 80.91 | 4.73 | 4.20 | 79.02 | 7.70 |
| Final Count | 82.00-94.00 | 87.85 | 3.92 | 3.25 | 68.75 | 5.55 |
| Germination Percentage | 85.31-94.86 | 88.82 | 3.36 | 2.72 | 65.71 | 4.54 |
| Vigour Index -I | 1540.0-3637 | 2106.4 | 17.36 | 17.24 | 98.63 | 35.27 |
| Vigour Index -II | 10824-14507 | 12631 | 7.47 | 7.10 | 90.34 | 13.90 |

**CONCLUSION**

The present study revealed significant genetic variability among the wheat genotypes for key seed quality parameters, indicating substantial scope for genetic improvement through selection. High heritability coupled with high genetic advance observed for traits such as germination percentage, seedling vigor index and seedling dry weight suggests the predominance of additive gene action, making them reliable selection criteria for quality enhancement. The findings emphasize ~~emphasis~~ the importance of identifying superior genotypes with desirable seed quality traits for developing high- performing and seed- efficient wheat varieties. These results can aid breeders in formulating effective selection strategies to improve seed quality and overall crop performance under diverse agro- climatic conditions.

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