**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 germplasm/varieties from Completely Randomized Design (CRD) with three replications during 2024-25. The magnitude of genotypic and phenotypic coefficient of variation 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 and high estimate of heritability with high genetic advance in percent of 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 were 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) general mean performance was observed 12631.55. The above results show that some information will be used in the future for improving wheat genotypes/varieties and developing new varieties.

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

**INTRODUCTION**

Wheat, belonging to the family of Gramineae (Poaceae) and the *Triticum*, genus is the world’s most prominent cereal crop. The bulk of the cultivated wheat varieties belong to 3 main species of the monocotyledons: the hexaploidy- *T. aestivum* L. (bread wheat), the tetraploid- *T. durum* desi and the diploid- *T. dicoccum* and *T. monococcum*, common wheat Triticum aestivum L. wheat is the most lively species which covers 90 per cent of the land. The Second most popular wheat is Triticum durum which covers about 9 per cent of the total area while T. dicoccum and T. monococcum wheat, the minor species, cover 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 scheme of production and offer of seed to formers. Seed quality within the sum of these qualities which differentiate the seed from the grain. The important seed quality attributes are: genetic purity, physical purity, germination, moisture, wellbeing and vigour. In addition quality seed should be of unchanging size and will own good. 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 sphere establishment or stand and thus the yields will be dropped. Seed germination is rested low with a range of things which are compulsory to the seed during its formation, maturing, ripening, like infection with the paste and pathogen.

Using seeds of low vigour will reduce the sphere establishment or stand and thus the yields are lowered. An estimated five out of one hundred crop loss occurs every year due to low seed vigour. The fullest genetic possible of an improved variety and hence, forth the benefit is grasped only if highly vigorous seed is employed for sowing. Link wise seed vigour is incorporated in an exceeding high yielding variety, the low seed germ powerlessness problem in tropical area are greatly minimized. 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. The recital potential (hidden stamina) of the seeds makes it suited to perform well upon sowing.

**MATERIALS AND METHODS**

In the present study, twenty germplasm of wheat wide spectrum of variation for various seed quality characters, were evaluated in laboratory during 2024-25. The experiment was presented following Completely Randomized Design (CRD) with three replications in the Department of Seed Science and Technology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (Uttar Pradesh) India.

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.

**RESULTS AND DISCUSSIONS**

The analysis of variance of the experiment designated highly significant differences among the twenty germplasm of wheat (Triticum aestivum L.) for all the thirteenstudied seed quality characters. 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 1st and 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 the stated characters in wheat is similar to the results found earlier by Kumar, et al. (2004), Gautam, et al. (2012), Hosseini, et al. (2012), Wani, et al. (2013).

Wide spectrum of distinction was observed for seed quality characters 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. 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 (%). These charactershaving high values of heritability and genetic advanced 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 germination percentage indicating medium range of heritability and genetic advance studies earlier workers 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 | 1000  Seed Weight (g) | Seed Length (mm) | | Seed Width (mm) | | | Shoot Length (cm) | Root Length (cm) | | Seedlin g Length (cm) | | | Speed of germi nation | Seedlin g Dry Weight (mg) | | | First Count (No.) | Final Count (No.) | | | Germina tion Percenta ge (%) | | 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 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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