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***Full Length Article***

# Studies on heritability and genetic advance estimates in timely sown bread wheat (*Triticum aestivum* L.)

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**ABSTRACT**

The present experiment was conducted and estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) revealed that phenotypic coefficient of variation were higher than genotypic coefficient of variation, which indicates less effect of environment on the expression of characters studied. Highest estimates of GCV and PCV were observed for grain yield per plant followed by biological yield and harvest index (GCV 22.87 and PCV 23.03). Heritability estimates revealed that characters like biological yield per plant exhibited highest heritability followed by test weight and flag leaf length. Genetic advance revealed that it was high for plant height, biological yield per plant and moderate estimates were exhibited by harvest index, test weight and low genetic advance was observed for flag leaf width, days to 50% flowering, spike length and flag leaf length. Characters like plant height, 1000 seed weight and harvest index showed high heritability coupled with high genetic advance therefore, these characters should be given top priority during selection breeding in wheat.

**Key word:** GCV,PCV, Heritability, Genetic advance, Wheat

## INTRODUCTION

Wheat (*Triticum aestivum* L.) is the world's leading cereal grain and most important food crop, occupying commanding position in Indian Agriculture, which occupies 28% area under cereals and contributing 33% of the total food grain production in the country. Wheat offers a great wealth of material for genetical studies due to its wide ecological distribution and enormous variation encountered for various morphological and physiological characters (Rangare *et al.,* 2010).

In India wheat is mainly grown under three production conditions, *viz*., timely sown; medium to good fertility, irrigated; late sown, medium fertility; irrigated and timely sown; low fertility and in rainfed conditions (Datta *et al.,* 2009). In recent years, a new situation of timely sown, restricted/limited irrigation has emerged in some of the areas of the central and peninsular parts where water for irrigation is not available in sufficient quantity and thus, the wheat crop is grown with one to two irrigations only. The growing period of wheat is variable from one agro-climaic zone to another that affect the vegetative and grain filling duration leading to differences in attainable yield (Datta *et al*., 2009).

The ultimate aim of any plant breeding programme is to develop cultivars with high potential and consistent performance over diverse environments. Hybridization is an important source for creation of variation. The study of genetic variability is the pre-requisite for any crop improvement programme. Success in recombination breeding depend on suitable exploitation of genotypes as parent of obtaining high heterotic crosses and transgressive sergeants or the presence of genetic variability in base population is essential (Allarad, 1960). The modern wheat breeding programmes focus on the improvement of agronomic and grain quality traits.

The manipulation of wheat genetics has led to ever increasing gains in yield and grain quality, while decreasing the ability of wheat to survive in the wild or in varying climate especially with adverse conditions. In self pollinated crops, the assessment of quantitative variable for genotypic variance, estimates of heritability and genetic advance of yield contributing characters are important for successful hybridization programme to evaluate new cultivars (Amin *et al*., 1992). Selection on the basis of phenotypic variation is not efficient and selection therefore, based on evaluation and utilization of genetic variability in a desired direction is extremely important in wheat improvement programme. The present study was conducted in Middle Gangetic Plains region or Vindhyan Zone of Uttar Pradesh with timely sown bread wheat lines with objectives to find out the extent of variability, heritability, genetic advance and environmental effect on timely sown advanced lines developed at our centre for twelve quantitative characters.

**MATERIALS AND METHODS**

The present investigation was carried out in the field experimentation centre of department of Genetics and Plant Breeding, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences- Deemed to be University, Allahabad (U.P.), during *rabi* 2009-10. Experimental materials for the present study consist of 50 advanced wheat lines *(Triticum aestivum* L*.)* generated through systematic crossing in 2004 with continuous selection and selfing in subsequent years along with four checks (Table1). The experimental material in $F_5$ generation comprising of 50 wheat genotypes and 4 checks, which were grown under randomized block design (RBD) with three replications, during *Rabi* 2009-10 with timely sown condition. Each genotype was growing a plot size 2x1 square meters. The observations were recorded on five randomly selected competitive plants in each entry of each replication for all the characters except for days to 50% flowering and days to maturity, which were recorded on plot basis. Analysis of variance was done for partitioning the total variation into variation due to treatments and replications according to procedure given by Panse and Sukhatme (1967). In the present investigation three types of coefficient of variations were estimated viz., phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) and error/environmental coefficient of variation (ECV). It was calculated by the formula given by Burton and Devane (1953). The estimates of genetic advance were obtained by the formula given by Johnson *et al*., (1955).

**RESULTS AND DISCUSSION**

The mean sums of squares for the characters studied are presented in table 2. The mean sums of squares due to genotypes were significant for all the twelve characters studied. The mean sum of squares suggesting that the genotypes selected were genetically variable and considerable amount of variability existed among them. Thus, indicates selection for different quantitative characters for wheat improvement. These findings of mean sum of squares are in accordance with the findings of Bergale *et al.,* (2001), Dwivedi *et. al.,* (2004) and Asif *et al*., (2004) who also observed significant variability in wheat germplasm. Hence, it can be noted that systematic crossing among selected genotypes in self pollinated like wheat generates variability in subsequent generation.

The variability exploited in breeding programme is desired from the naturally occurring variants and wild relative of main crop species as well as from strains and genetic stocks artificially developed by human efforts. Through this study an attempt was made to assess the mean performance and extent of variability in wheat germplasm. On the basis of mean performance, the highest seed yield per plant was observed for genotype Raj1972/K8962 (23.49 g) followed by HUW234/HD1982 (21.15g), Kalyansona /Raj3737 (20.17g), Sonalika / HUW234 (19.9g) and HD2236/PBW524 (19.66g). The Raj 1972 / K8962 are the best genotype among 54 genotypes on the basis of grain yield per plant and for few other characters (Table3). A wide range recorded for maximum characters also indicated that there are differences among the genotypes in terms of performance for yield and component traits. The superior genotypes in the population may be attributed to the possible accumulation of favorable genes reservoir of variability for different characters of plant species resulting from available natural or artificially synthesized variants or strains constitute its germplasm. Germplasm bearing high intensity of economic traits is extremely useful in engineering superior genotypes.

The quantitative measurement of individual character provides the basis for an interpretation of different variability parameters. The phenotypic variability which is observable includes both genotypic and environmental variation. It changes under different environmental conditions. Estimation of phenotypic and genotypic coefficient of variation for the twelve characters studied is presented in table 4. The highest variability (VP or $\sigma^2_P$ and VG or $\sigma^2_g$) was recorded for plant height (120.167 and 119.413) followed by biological yield per plant (114.457and114.229). The low values were observed for flag leaf width (0.0197 and 0.0194). Gupta and Verma (2000) reported that phenotypic coefficient of variation (PCV) is much higher than the genotypic coefficient of variation (GCV) for number of tillers per plant, grain yield per plant and harvest index indicating that apparent variation for the characters was not only due to genotypes but also due to influence of wide range of phenotypic (VP or $\sigma^2_P$) and genotypic variance (VG or $\sigma^2_g$) observed in the experimental material for all the traits studied.

In the present investigation, in general, estimates of phenotypic coefficient of variation was found higher than their corresponding genotypic coefficient of variation, indicating that the little influence of environment on the expression of these characters. Also it can be interpreted as less difference in the estimates of genotypic and phenotypic variance and higher genotypic values compared to environmental variances for all the characters suggested that the variability present among the advanced material were mainly due to genetic reason with minimum influence of environment and hence heritable. However, good correspondence was observed between genotypic coefficient of variation and phenotypic coefficient of variation in all the characters. A wide range of phenotypic coefficient of variation (PCV) was observed for all the traits ranged from 1.71 (days to50% flowering) to 28.43 (grain yield per plant). Higher magnitude of PCV was recorded for grain yield per plant (28.43), tillers per plant (25.027), biological yield per plant (23.038), harvest index (23.03), test weight (18.64). Genotypic coefficient of variation (GCV) ranged from 1.50 (days to 50% flowering) to 28.31(grain yield per plant). Grain yield/ plant had maximum estimate of both the coefficient of variation in present study. Low value of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) observed for characters like days to 50% flowering and days to maturity. Shoran (1995) also indicated little variability and scope for selection for days to 50% flowering and days to maturity in his study. These findings of genotypic and phenotypic variance for different quantitative characters in wheat are in accordance with the findings of Sharma *et al.* (2006). On an average, the higher magnitude of GCV and PCV were recorded for grain yield per plant harvest index, tillers per plant, spike length and test weight suggesting sufficient variability and thus scope for genetic improvement through selection for these traits. These findings were in agreement with those of Amin *et. al.,* (1992), Panwar and Singh (2000), Bergale *et al.,* (2001) and Dwivedi *et al.,* (2004). They also observed the PCV values higher than GCV values for different quantitative characters in wheat.

Heritability in broad sense is the ratio of genotypic variance to the total variance. It is that portion of total variability or phenotypic variability which is heritable and due to the genotype. It is a measure of the extent of phenotypic variation caused by the action of genes. Heritability plays an important role in deciding the suitability and strategy for selection of a character. In the present study heritability estimated ranged from 76.76 to 99.80 percent indicating that all the characters exhibited high heritability table 4. High estimates of heritability (above 80%) in broad sense were recorded for eleven characters studied. The highest heritability values indicate that heritability may be due to higher contribution of genotypic component. High heritability estimates were also reported by Amin *et al.,* (1992) for 1000 grain weight, Panwar and Singh. (2000) and Asif *et al.,* (2004) for plant height, Rasal *et al.,* (2008) who also observed high value of heritability for most of the characters studied. Heritability alone provides no indication of amount of genetic improvement that would result from selection of individual genotype; hence knowledge about genetic advance coupled with heritability is most useful (Vashistha *et al*., 2013). Genetic advance is the improvement in the mean of selection family over the base population (Lush, 1949 and Johnson *et al*., 1955). Characters exhibiting high heritability may not be necessarily give high genetic advance. Johnson *et al.,* (1955) showed that high heritability should be accompanied by high genetic advance to arrive at more reliable conclusion. The breeder should

**Tabe:1 List of genotypes with pedigree used in present investigation**

| S. No | Name of Genotypes | S.No | Name of Genotypes |
|---|---|---|---|
| 01. | HD2236 / PBW524 | 28. | HD2236 / Raj3077 |
| 02. | Sonalika /HUW12 | 29. | Kalyansona / Raj4037 |
| 03. | Raj 1972 / HD2009 | 30. | Kalyansona / HD2385 |
| 04. | Sonalika / HUW 234 | 31. | Kalyansona / AA12 |
| 05. | PBW373 /Kalyansona | 32. | Kalyansona / PBW343 |
| 06. | Kalyansona / K8962 | 33. | HD2733 / Veeri |
| 07. | HUW510 / Sonalika | 34. | Sonalika / Raj4037 |
| 08. | HD2236 / Raj3077 | 35. | HUW510 /HUW12 |
| 09. | HUW510 / K8962 | 36. | HD2733 / PBW343 |
| 10. | Kalyansona / Veeri | 37. | Raj6566 / RD1008 |
| 11. | HD2428 / HD2009 | 38. | Raj30799 /K-9423 |
| 12. | HD2236 / HD2009 | 39. | Sonalika / K-9423 |
| 13. | Raj1972 / HD2385 | 40. | HD1982 / K9423 |
| 14. | HUW12 / K9423 | 41. | HUW510 / PBW373 |
| 15. | Raj1972 / HD2428 | 42 | HUW510 / HD1982 |
| 16. | K8962 / HD2501 | 43. | Kalyansona /Raj4026 |
| 17. | HUW234 / HD1982 | 44. | HD2236 / HD2385 |
| 18. | Raj1972 / HD2236 | 45. | Kalyansona / PBW343 |
| 19. | Raj1972 / HD2881 | 46. | Raj6566 / K8963 |
| 20. | Raj1972 /K8962 | 47. | HD2385 / HD2881 |
| 21. | HUW12 / Kalyansona | 48. | HD2428 /K8962 |
| 22. | Kalyansona / Raj3737 | 49 | HD2009 / Raj3077 |
| 23. | HD2428 / HD2501 | 50. | K8962 / PBW524 |
| 24. | HD2236 / HD2501 | 51 | ND1014 (check1) |
| 25. | K8962 / HD2009 | 52. | Halna (check2) |
| 26. | HD2428 / HD2881 | 53. | K 8962 (check3) |
| 27. | HD2236 / HD2428 | 54. | PBW 373(check4) |

**Table 2. Analysis of variance for different quantitative characters in wheat**

| S.N. | Characters | Mean sum of square | | |
|---|---|---|---|---|
| | | Replications (df=2) | Treatments (df=53) | Error (df= 106) |
| 1. | Days to50%heading | 1.56 | 1513.8* | 37.09 |
| 2. | Days to 50%flowering | 2.92 | 234.94* | 43.07 |
| 3. | Flag leaf length | 0.33 | 1289.55* | 4.96 |
| 4. | Flag leaf width | 0.09 | 3.10 | 0.03 |
| 5. | No. of tillers/plant | 1.21 | 1954.40* | 20.61 |
| 6. | Plant height | 1.06 | 19026.73* | 79.86 |
| 7. | Spike length | 0.01 | 181.48* | 1.18 |
| 8. | Days to maturity | 7.56 | 1601.95* | 80.43 |
| 9. | Grain yield/plant | 1.78 | 2371.79* | 13.47 |
| 10. | Biological yield | 0.80 | 18174.54* | 24.17 |
| 11. | Test weight | 0.07 | 4733.56* | 14.49 |
| 12 | Harvest index | 5.52 | 7316.18* | 65.65 |

* Significant at 5% level of significance

**Table3: Five best advanced lines identified on the basis of mean performance for grain yield per plant and few more traits**

| Genotype | Days to 50% flowering | Days to maturity | Spike length (cm) | Tillers/ plant | Biological yield (g) | Grain yield/ plant (g) |
|---|---|---|---|---|---|---|
| 1.Raj 1972/ K8962 | 77.00 | 116.33 | 11.20 | 21.31 | 44.26 | 23.49 |
| 2.Sonalika / HUW 234 | 76.00 | 115.33 | 10.67 | 13.46 | 68.00 | 19.90 |
| 3.HUW 234 / HD1982 | 78.00 | 93.10 | 10.30 | 20.46 | 44.10 | 21.15 |
| 4.Kalyansona / Raj 3737 | 76.33 | 109.00 | 11.36 | 12.80 | 60.10 | 20.17 |
| 5.HD2236 / PBW524 | 76.33 | 110.00 | 11.07 | 14.30 | 62.66 | 19.26 |

**Table 4. Estimates of variance and genetic parameters for twelve quantitative characters in 54 wheat genotypes**

| S. No. | Characters | $\sigma^2 g$ | $\sigma^2 g$ | GCV % | PCV % | $h^2$ (bs)% | GA | GA as % of mean |
|---|---|---|---|---|---|---|---|---|
| 1. | Days to 50% heading | 9.40 | 9.75 | 4.22 | 4.3071 | 96.41 | 6.20 | 8.55 |
| 2. | Days to 50% flowering | 1.34 | 1.74 | 1.50 | 1.7169 | 76.76 | 2.09 | 2.71 |
| 3. | Tillers/plant | 12.22 | 12.42 | 24.83 | 25.02 | 98.43 | 7.14 | 50.74 |
| 4. | Flag leaf length | 8.094 | 8.14 | 10.95 | 10.98 | 99.42 | 5.84 | 22.49 |
| 5. | Flag leaf width | 0.019 | 0.019 | 9.94 | 10.03 | 98.32 | 0.28 | 20.31 |
| 6. | Plant height | 119.41 | 120.16 | 12.38 | 12.42 | 99.37 | 22.44 | 25.42 |
| 7. | Spike length | 1.13 | 1.14 | 10.04 | 10.09 | 99.03 | 2.18 | 20.60 |
| 8. | Days to maturity | 9.82 | 10.58 | 2.75 | 2.85 | 92.83 | 6.22 | 5.46 |
| 9. | Biological yield | 114.22 | 114.45 | 23.01 | 23.03 | 99.80 | 21.99 | 47.36 |
| 10. | Test weight | 29.72 | 29.86 | 18.60 | 18.64 | 99.54 | 11.20 | 38.24 |
| 11. | Harvest index | 45.80 | 46.42 | 22.87 | 23.03 | 98.67 | 13.84 | 46.81 |
| 12. | Grain yield/plant | 14.87 | 15.00 | 28.31 | 28.43 | 99.15 | 7.91 | 58.07 |

cautious in making selection based on heritability as it includes both additive and non-additive gene effect. A perusal of genetic advance revealed that it was high for plant height (22.44), biological yield per plant (21.99) and moderate estimates were exhibited by harvest index (13.84), test weight (11.20) and low genetic advance was observed for flag leaf width (0.28). High heritability accompanied with high genetic advance was found for biological yield per plant (99.8%, 21.99), it indicates that most likely the heritability is due to additive gene effect and selection may be effective. Gupta and Verma (2000) also reported high values of heritability and high genetic advance for number of grain per spike. High heritability and high genetic advance indicates that preponderance of additive gene effect (Panse, 1967) therefore, characters can be better exploited through selection. The same was suggested through the finding of Mandal *et al.,* (2008). High heritability associated with low genetic advance was exhibited by flag leaf width (98.32, 0.28). This may be because of predominance of non additive gene action in the expression of this character. The high heritability of these traits was due to favorable influence of environment rather than genotypic and selection for these traits may not be rewarding. Similar results were reported by Pawar *et al.,* (2002) for plant height, number of tillers exhibited higher heritability.

Hence, from the present finding it is concluded that the advanced wheat material generated and used in the present study has adequate variability for most of the traits which need to be used in future wheat breeding programme. Characters like plant height, 1000 seed weight and harvest index showed high heritability coupled with high genetic advance therefore, these characters should be given top priority during selection breeding in wheat. Since, these findings are based on one year trial; further testing is needed to substantiate the results.

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