The Bioscan 10(2): 935-938, 2015 (Supplement on Genetics and Plant Breeding)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

GENETIC VARIABILITY AND HERITABILITY ESTIMATES FOR YIELD ATTRIBUTES AND LEAF RUST RESISTANCE IN F_3 POPULATION OF WHEAT (*TRITICUM AESTIVUM* L.)

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KEYWORDS
Wheat
Genetic variability
Heritability
Genetic advance
Leaf rust

Received on :
10.02.2015

Accepted on :
21.05.2015

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ABSTRACT
Fifty nine F_3 lines of cross DWR162 X PBW343 subjected to study the genetic variability for grain yield, its attributing traits and leaf rust resistance along with their parents and checks indicated that genetic material in the present investigation possessed sufficient variability which provides basis for selection by breeder. Moderate to high estimates of PCV and GCV obtained for yield per plant, yield per meter row and leaf rust resistance indicated a good deal of variability for these characters signifying the effectiveness of selection of desirable types for improvement of these traits. High heritability assisted with high genetic advance as per cent of mean was observed for plant height, days to fifty percent flowering, yield per plant, yield per meter row and leaf rust resistance. Hence, simple selection based on phenotypic performance of these traits would be more effective. Present investigation suggests that selection for the traits like days to fifty percent flowering, plant height and leaf rust resistance will be beneficial for improvement of yield parameters and leaf rust resistance in evolving potential genotypes in wheat.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the main staple food of the people of India and world. Wheat attains unique prominent position in agriculture and economic perspective of our country because of being second most important food crop after rice. In India wheat is grown over an area of 31.2 million hectare, with production of 96 million tonnes with an average productivity of 3140 kg per hectare (Anon., 2014). There is a need to increase the productivity of this crop by developing high yielding varieties through appropriate breeding work to meet the demand of domestic and export markets.

The development of an effective plant breeding programme is depending upon the assessment of polygenic variation, selection of elite genotypes, choice of parents and breeding procedures. Crop improvement depends upon the magnitude of genetic variability and the extent to which desirable characters are heritable. Genetic variability for yield and yield components is essential in the base population for successful crop improvement (Allard, 1960). Yield and yield components are quantitative characters and are poly genetically inherited which are greatly influenced by environment. The phenotype of a character is the resultant of interaction between genotype and environment. Partitioning of observed variability into heritable and non-heritable components is essential to get a true indication of the genetic variation of the trait. Genetic parameters such as Genotypic, Phenotypic coefficient of variation (PCV and GCV) are useful in detecting the amount of variability present in the available genotypes. Heritability and genetic advance help in determining the influence of environment in expression of the characters and the extent to which improvement is possible after selection (Robinson *et al.,* 1949). The total variability can be partitioned into heritable and non heritable components with the help of genetic parameters like phenotypic and genotypic coefficient of variation, heritability and genetic advance. Heritable variation can be effectively studied in conjunction with genetic advance. High heritability alone is not enough to make efficient selection in segregation, unless the information is accompanied for substantial amount of genetic advance (Johnson *et al.*, 1955). Wheat, being self pollinated crop, we can create genetic variability through hybridization which could be favorably utilized in developing a genotype with all desirable characters.

Genetic variability for bread wheat genotypes has been studied by Abinasa *et al.* (2011), Awale *et al.* (2013), Bhushan *et al.* (2013), Binod Kumar *et al.* (2013), Said Salman (2014) and Shahid *et al.* (2013). Genetic variability study in segregating population of wheat is also reported by several co-workers (Vijayakumar *et al.*, 2013, and Shoukat Ali et al., 2007). But still there is much effort is needed to study the genetic variability for leaf rust resistance in segregating populations of wheat. Hence, the present investigation was undertaken to elucidate the genetic variability, heritability and genetic advance for grain yield and yield contributing traits along with leaf rust resistance in F_3 population of wheat.

MATERIAL AND METHODS

The present investigation was undertaken at the experimental area of Dr. Sanjay Rajaram Wheat Laboratory, All India Coordinated Wheat Improvement Project (AICWIP), Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad. An experimental material comprising of fifty nine segregating F_3 lines of cross DWR162 X PBW343, two parents DWR162, PBW343 and five checks HI977, GW322, UAS304, MACS6222 and HS240 were sown in randomized complete block design (RCBD) with two replications in a row length of three meter with the help of a dibble, keeping plant to plant distance of 20cm and row to row distance of 23 cm during rabi 2012-13. Data was recorded on grain yield per plant, days to fifty percent flowering, number of productive tillers per plant, plant height, spike length, number of spikelets per spike, TGW, protein content and yield per meter row.

Statistical analysis

Statistical analysis was done on the mean values of five randomly selected plants in each progeny rows. The statistical software (WINDOSTAT version 8.0) was used to work out ANOVA, genetic parameters and the statistical methods adopted were as follows.

Genotypic coefficient of variability (GCV)

$$GCV\,(\%) = \frac{\sigma_g}{\bar{X}} \times 100$$

Where, σ_g = Genotypic standard deviation and $\bar{X}$ = General mean of the characters

Phenotypic coefficient of variability (PCV)

$$PCV\,(\%) = \frac{\sigma_g}{\bar{X}} \times 100$$

Where, σ_p = Phenotypic standard deviation

$\bar{X}$ = General mean of the characters

GCV and PCV values were categorized as low, moderate and high as indicated by Sivasubramanian and Menon (1973).

0-10%	:	Low
10-20%	:	Moderate
20% and above	:	High

Heritability (broad sense)

Heritability in broad sense was estimated as the ratio of genotypic to the phenotypic variance and was expressed in percentage.

$$\text{Heritability } (h^2)\,(\%) = \frac{\sigma^2_g}{\sigma^2_p} \times 100$$

The heritability was categorized as low, moderate and high as given by Robinson *et al.* (1951).

0-30%	:	Low
30-60%	:	Moderate
60% and above	:	High

Genetic advance (GA)

The extent of genetic advance to be expected from selecting five per cent of the superior progeny was calculated by using the following formula

Genetic advance (GA) = $ih^2 \sigma_p$

i	=	Intensity of selection
h^2	=	Heritability in broadsense
σ_p	=	Phenotypic standard deviation

The value of i was taken as 2.06 assuming 5 per cent selection intensity.

Genetic Advance over Mean (GAM)

Genetic advance over mean was estimated using the following formula

$$GAM = \frac{GA}{\bar{X}} \times 100$$

Where,

GA = Genetic advance

$\bar{X}$ = General mean of the character

Genetic advance as per cent mean was categorized as low, moderate and high as given by Johnson *et al.* (1955).

0-10%	:	Low
10-20%	:	Moderate
20% and above	:	High

Leaf rust resistance screening

The F3 segregating progenies rows were sown in rust screening nursery to screen for leaf rust resistance at seedling stage with leaf rust pathotype 77-5. Screening at the seedling stage was done in controlled conditions (Nayar *et al.*, 1997). Rust epidemic was generated using the susceptible spreader rows of var. Lal bahadur, Agra local, Amrut. Spraying and dusting of rust inoculums to spreader rows was done three times during the months of December and January, 2012-2013. Fourteen days after inoculations the infection types were recorded using 0-4 scale (Stakman et al., 1962). Leaf rust severity (percentage) and response of the plants to disease were also assessed using a modified Cobb's scale (Peterson et al., 1948). The final disease severity data for the leaf rust was converted into a Average Coefficient of Infection (ACI) by multiplying severity with a constant value for field response given in Table 1.

RESULTS AND DISCUSSION

The amount of genotypic and phenotypic variability that exist in a species is of utmost importance in breeding better varieties and in initiating a breeding program. Genotypic and phenotypic coefficients of variation are used to measure the variability that exists in a given population. Estimated genotypic coefficient of variability (GCV) and phenotypic coefficient of variability (PCV), broad sense heritability (h^2) and genetic advance as percent of mean (GA) of the traits studied are presented in Table 2.

Results revealed high mean and wide range of expression of different characters indicating sufficient variability existed in the present material selected for the study and indicating the scope for selection of suitable initial breeding material for crop

Table1: Leaf rust reaction, code for field response and response value

Reaction	code	Field response	Responsevalue
No disease	0	No visible infection	0.0
Resistant	R	Necrotic areas with or withoutminute uredia	0.2
Moderately resistant	MR	Small uredia present surrounded bynecrotic area	0.4
Moderately resistant, Moderately susceptible	MRMS	Small uredia present surrounded by necrotic areas as well as medium uredia with no necrosis but possible some distinct chlorosis.	0.6
Moderately susceptible	MS	Medium uredia with no necrosis butpossible some distinct chlorosis	0.8
Moderately susceptible susceptible	MSS	Medium uredia with no necrosis but possible some distinct chlorosis as well as large uredia with little or chlorosis present	0.9
Susceptible	S	Large uredia and little or nochlorosis present	1.0

Cobb's scale (Peterson *et al.*, 1948) was used only to record the rust severity data.

Table 2: Estimates of components of variability, heritability, genetic advance and genetic advance over mean for morphological traits in F3 population of DWR162 X PBW343

Character	Mean	Range	PCV (%)	GCV (%)	h^2 %BS	GA	GAM (%)
Days to 50 per cent flowering	76.69	63.00-101.00	11.77	8.46	71.91	86.74	113.10
Plant height(cm)	75.30	46.67-90.67	11.13	8.88	79.77	92.12	122.33
Number of tillers per plant	14.01	5.00-29.00	31.74	3.77	11.88	0.57	4.10
Spike length (cm)	10.16	6.83-13.00	10.58	7.14	67.53	1.09	10.68
Number of spikelets	19.71	15.00-23.00	7.47	4.22	56.46	1.42	7.22
Grain yield per plant(g)	19.63	3.67-82.00	46.47	19.61	42.20	29.26	152.26
Yield per meter row(g)	96.08	27.78-180.00	46.47	19.61	42.20	731.44	761.30
Thousand grain weight(g)	34.59	23.00-47.50	13.81	5.88	42.56	8.51	24.61
Protein content (%)	13.72	11.50-17.00	8.12	6.59	81.12	1.68	12.27
Leaf Rust Incidence (ACI)	11.45	0.00-32.00	70.92	59.38	83.72	95.22	831.59

improvement (Bhushan Bharat *et al.,* 2013). For leaf rust resistance also wide range of variation was exhibited by the F_3 lines, suggesting that there is an ample scope for selection of superior and desired lines for further improvement of yield and leaf rust resistance (Arati yadawad *et al.,* 2015)

Wide range of phenotypic variability was observed for all the traits which could be exploited for initiating of breeding programs to develop new high yielding genotypes. Presence of narrow gap between PCV and GCV for all the characters except number of productive tillers per plant suggested low environmental influence in expression of these traits and greater effectiveness of selection and improvement to be expected for these characters in future breeding programme. Similar reports of high PCV and GCV in wheat for different quantitative traits has been reported in early segregating generations of wheat (Abinasa *et al.,* 2011, Arati yadawad *et al.,* 2015 and Vijaykumar *et al.,* 2013). For leaf rust incidence also high values of PCV and GCV were recorded indicating low environmental influence. Hence, simple selection can be relied upon and practiced for further improvement of resistance to leaf rust.

Perusal of results on heritability revealed high heritability estimates for days to fifty percent flowering, plant height, spike length, protein content and leaf rust resistance. This suggested most likely that heritability is due to additive genetic effects and selection could be effective in early segregating generations for these traits indicating the possibility of improving wheat grain yield through direct selection for grain yield related traits. Similar findings of high heritability for yield related traits like plant height, spike length, number of tillers per plant and grain yield have been reported by Binod Kumar *et al.* (2013), Dwivedi *et al.* (2002), Salman *et al.* (2014) and Yousaf *et al.* (2008)

Moderate heritability estimates were recorded for number of spikelets per spike, grain yield per plant, yield per meter row and thousand grain weight indicating the possibility of influence of the environment on the expression of these polygenic traits. Similar reports of moderate estimates of heritability for number of spikelets per spike have been reported by Awale *et al.* (2013) and Shahid *et al.* (2013). On the other hand, low heritability estimates were also recorded for number of tillers per plant, indicating the limited scope of improvement of this trait through selection.

Genetic advance is the measure of genetic gain under selection and expression in percentage of mean. Johnson *et al.* (1955) suggested that high heritability coupled with high genetic advance as percent of mean (GAM) is more useful than heritability alone in predicting the resultant effect during selection of best individual genotype. In the present experiment, high heritability coupled with high genetic advance as a per cent of mean was observed for days to fifty percent flowering, plant height, grain yield per plant yield per meter row and leaf rust resistance indicating predominance of additive gene action for these characters. Hence, Simple selection based on phenotypic performance of these characters would be more effective. This is in conformity with the earlier reports of high GAM for days to fifty percent flowering and plant height (Salman *et al.,* 2014).

Moderate heritability and high genetic advance as per cent of mean values were observed for the characters, grain yield per plant, yield per meter row and thousand grain weight. This indicates the influence of non-additive gene action and considerable influence of environment in the expression of these traits. These traits could be exploited through manifestation of dominance and epistatic components through heterosis. Number of productive tillers per plant and number of spikelets per spike recorded low GAM which indicated that selection is less meaning full for these traits.

Present investigation confirmed the presence of substantial genetic variability for yield and its component traits in the F_3 population of cross DWR 162 X PBW 343, which gives an opportunity to plant breeders for simple phenotypic selection that ensures improvement of these traits and simultaneously breeder should adopt suitable breeding methodology to utilize both additive and non additive gene effects. Priority should be given to the traits like DFF, grain yield per plant, yield per meter row and leaf rust incidence while deciding selection strategies in evolving high yielding and leaf rust resistant genotypes in wheat.

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