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Study of variability parameters of rice under high temperature tolerance conditions

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Abstract

Forty six rice varieties were evaluated at IGKV, Raipur under heat stress condition. Analysis of variance revealed presence of high variability among the genotypes forall the traits. The analysis of variance showed that the mean sum of squares due to replication were significant for plant height, panicle length, leaf length, filled grain panicle^{-1}, spikelet fertility percentage, spikelet sterility percentage. The results showed that PCV (Phenotypic Coefficient of Variation) in general was higher than GCV (Genotypic Coefficient of Variation) for maximum of the characters. The highest phenotypic and genotypic coefficient of variation was found for number of unfilled grains per panicle (56.73%, 54.53%) followed by total number of grain per panicle (35.33%, 34.25%). High heritability was found for days to 50% flowering (0.990) followed by leaf length (0.967) and yield/plant (0.941). High genetic advance was obtained for total number of grains/panicle (107.08) followed by number of filled grains/panicle (73.69). Those characters which have high PCV and GCV have high heritability and genetic advance and can be considered for direct selection.

Keywords: Heat stress, variability, heritability, genetic advance

Introduction

Rice is considered as one of the most important crop in the world and is the main nutritional staple food of the world's population. Rice can be grown under all agro climatic conditions. Due to this wide adaptation, it has led to the evolution of thousand of varieties of rice having diverse cooking, eating and product-making characteristics. The knowledge on the nature and magnitude of genetic variation governing the inheritance of quantitative characters like yield and its components is essential for effecting genetic improvement.

Genetic variability studies are important in selection of parents for hybridization (Chaudhary and Singh, 1982) [5] because crop improvement depends upon magnitude of genetic variability in base population (Adebisi *et al.*, 2011) [1]. Phenotypic and genotypic coefficient of variation helps us to study association between two or more characters.

The main objective for the development of high yielding varieties with good quality the information on variability and genetic parameters of grain quality attributes and their association with each other including grain yield is necessary to formulate suitable breeding strategies for grainquality improvement. The broad sense heritability is the relative magnitude of genotypic and phenotypic variances for the traits and it is used to predictive role in selection procedures (Allard, 1999) [2]. Heritability is essential for selection based improvement as it indicates the extent of transmissibility of a character into future generations (Sabesan *et al.*, 2009) [20].

Keeping in view the above facts, the present investigation was undertaken to know the mean, range and variability parameters among yield and its contributing traits under heat stress conditions.

Materials and Methods

Forty six rice genotypes were grown in a randomized block design with three replications at the Research Farm, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G., to assess the mean, range and other variability parameters. The traits studied were days to 50 per cent flowering, plant height, effective tiller/plant, panicle length, leaf length, leaf width, total number of grains/panicle, filled grains/panicle, unfilled grains/panicle, spikelet fertility percentage, spikelet sterility percentage, 100 grain weight, panicle/square meter and yield/plant were evaluated on the basis of ten randomly selected plants in each replication.

Statistical analysis

Statistical analysis was done for traits to estimate the genetic parameters. Genotypic and phenotypic coefficients of variability were calculated by following method of Burton and De Vane (1953) [4]. Broad sense heritability and genetic advance were estimated as suggested by Hanson *et al.*, (1956) [10] and Johnson *et al.* (1955) [11] respectively.

The coefficient of variation for different characters was estimated by formula as suggested by Burton and De Vane (1953) [4].

(1) Phenotypic coefficient of variation (PCV)

$\sigma^2 p = \sigma^2 g + \sigma^2 e$

$P\,C\,V\,(\%) = (\sqrt{\sigma^2 p} / \overline{X}) \times 100$

(2) Genotypic coefficient of variation (GCV)

$G\,C\,V\,(\%) = (\sqrt{\sigma^2 g} / \overline{X}) \times 100$

Where,

$\sigma^2 p$ = Phenotypic variance

$\sigma^2 g$ = Genotypic variance

$\sigma^2 e$ = Environment variance

$\overline{X}$ = General Mean

The estimates of PCV and GCV were classified as low, moderate and high according to Sivasubramanian and Madhavamenon (1973) [25] as; < 10% = Low, 10 to 20% = Moderate,>20% = High.

(3) Heritability (broad sense)

It is the ratio of genotypic variance to the phenotypic variance (total variance). Heritability for the present study was calculated in a broad sense by adopting the formula as suggested by Hanson *et al.*, (1956) [10].

$h^2_{(bs)} = (\sigma^2 g / \sigma^2 p) \times 100$

Where,

h^2 (bs) = Heritability in broad sense,

$\sigma^2 g$ = Genotypic variance,

$\sigma^2 p$ = Phenotypic variance

The estimates of heritability broad sense were classified as low, moderate and high according to Robinson (1966) [19] as,-

< 50% = Low heritability, 50 to 70% = Moderate heritability, > 70% = High heritability.

(4) Genetic advance

Improvement in the mean genotypic value of selected plants over the parental population is known as genetic advance. Expected genetic advance (GA) was calculated as per the method suggested by Johnson *et al.*, (1955) [11].

$G\,A = K.\, h^2.\, \sigma_p$

Where,

GA = Genetic advance

K = Constant (Standardized selection differential) having the value of 2.06 at 5 per cent level of selection intensity.

h^2 = Heritability of the character

σ_p = Phenotypic standard deviation

(5) Genetic advance as percentage of mean

It was calculated by the following formula:

GA as percentage of mean = (Genetic Advance/General mean) x 100

The estimation of genetic advance categories as;< 10% = Low, 10 to 20% = Moderate,>

20% = High.

Results and Discussion

The estimation of mean, range, phenotypic coefficient of variation, genotypic coefficient of variation, heritability, genetic advance and genetic advance as percentage of mean are presented in Table 1.

Table 1: Mean, Range and other variability parameters of different quantitative characters of 46 selected rice genotypes

			Range						
S.N.	Characters	Mean	Min	Max	GCV%	PCV%	h^2(bs)%	GA	GA as% of mean
1	Days to 50% flowering	83.427	65	104	13.84	13.91	0.990	23.67	28.37
2	Plant Height(cm)	84.7	63.48	100.01	7.5	7.39	0.903	12.44	14.68
3	Effective Tiller/plant	7.17	5.8	9.9	10.13	11.38	0.792	1.33	18.54
4	Panicle Length(cm)	26.28	22.3	30.62	6.27	6.51	0.926	3.27	12.44
5	Leaf Length(cm)	29.79	22.5	33.9	9.91	10.07	0.967	5.98	20.07
6	Leaf Width(cm)	1.17	0.8	2.0	17.11	18.57	0.849	0.38	32.47
7	Total number of grain/Panicle	156.55	57.20	284.20	34.25	35.33	0.94	107.08	68.39
8	Filled grain/Panicle	117.14	46.60	220.30	31.51	32.51	0.939	73.69	62.90
9	Unfilled grain/Panicle	39.35	10.90	109.30	54.53	56.73	0.924	42.49	107.97
10	Spikelet Fertility (%)	75.82	59.82	90.46	9.87	10.38	0.904	14.66	19.33
11	Spikelet Sterility (%)	24.172	9.537	40.500	30.75	32.31	0.906	14.57	60.27
12	100 GRAIN WT. (g)	2.31	1.8	2.8	9.68	10.63	0.831	0.42	18.18
13	Panicle/Sq Meter	259.41	212	332	8.98	9.95	0.814	43.31	16.69
14	Yield/Plant	19.96	12.4	33.5	18.32	18.88	0.941	7.31	36.62

1. Days to 50% flowering

The days to 50% flowering was observed between ranges of 65 days (IR 10C136) to 104 days (IGKV R1 and Maheshwari) with a mean of 83.42 days.

2. Plant height (cm)

The plant height ranged from 63.48 cm (HHZ 8-SAL6-SAL-3-S) to 100.01 cm (DULAR (ACC32561)) with an average height of 84.7 cm.

3. Effective tillers per plant

The effective tillers per plant varied from 6 (IR 10C108) to 10 (IR 10C153) with a mean of 7.17.

4. Panicle length (cm)

The panicle length ranged from 22.3 cm (N22) to 30.62 cm (HHZ 12-Y4-DT1-Y3) with an average of 26.28 cm.

5. Leaf length (cm)

The leaf length ranged from 22.5 cm (IR 10C179) to 33.9 cm (HHZ 12-Y4-DT1-Y3) with a mean of 29.79 cm.

6. Leaf width (cm)

The leaf width ranged from 0.8 cm (IR 10C114) to 2.0 cm (IR 10C173) with an average of 1.17 cm.

7. Number of grains (spikelets) per panicle

Number of grains per panicle ranged from 57.20 (N22) to 284.20 (Maheshwari) with an average of 156.55.

8. Number of filled grains (spikelets) per panicle

The number of filled grains per panicle is an important yield contributing trait, as it directly affects grain yield, it ranged from 46.60 (N22) to 220.30 (17-DT16-Y3-Y1) with a mean of 117.14.

9. Number of un-filled grains (chaffy spikelets) per panicle

The number of unfilled grains per panicle ranged from 10.90 (DULAR (ACC32561)) to 109.30 (Maheshwari) with a mean of 39.35.

10. Spikelet fertility per cent

The spikelet fertility per cent ranged from 59.81% (Maheshwari) to 90.46% (IR 10C114) with a mean of 75.82%.

11. Spikelet sterility per cent

The spikelet sterility per cent ranged from 9.53% (IR 10C114) to 40.50% (IR 10C174) with a mean of 24.17%.

12. 100-grain weight (g)

The average 100-grain weight was 2.31 g, this trait ranged from 1.8 g (HHZ 8-SAL 6-SAL 3-Y1) to 2.8 g (IR 10C137, IR 83143-B-51-B and IR 10C172).

13. Number of panicles per square meter

Number of panicles per square meter ranged from 212 (IR 10C108) to 332 (IR 10C153) with an average of 259.41.

14. Yield per plant (g)

The maximum yield per plant was recorded 33.5 g (Poornima) and the minimum 12.4 g (HHZ 12-Y4-Y1-DT1) with a mean of 19.96 g.

Coefficient of variation

The coefficient of variation is a useful tool for obtaining comparisons of variability in different characters. A wide range of variation was observed for most of the characters in rice genotypes.

The highest coefficient of variation was observed for number of unfilled grains per panicle (GCV = 54.53, PCV= 56.73) followed by total number of grains (spikelets) per panicle (PCV = 34.25, GCV = 35.33). Medhi *et al.* (2004) [14] also reported high coefficient of variation for number of grains per panicle.

In addition to this the other characters which showed high magnitude of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) (more than 20%) were total number of grain per panicle (GCV = 34.25, PCV = 35.33), number of filled grain per panicle (GCV = 31.51, PCV = 32.51). Bisne *et al.* (2006) [3] and Patil *et al.* (2009) [17] also reported high coefficient of variation for number of filled grain per panicle.Other characters which show high PCV and GCV are number of unfilled grain per panicle (GCV = 54.53, PCV = 56.73) and spikelet sterility percentage (GCV = 30.75, PCV = 32.31). Chaudhary and Motiramani (2003) [6] also reported high PCV and GCV for spikelet sterility percentage.

The moderate estimation of GCV and PCV (10-20%) was observed for days to 50% flowering (GCV = 13.84, PCV = 13.9), effective tillers per plant (GCV = 10.13, PCV = 11.38), leaf width (GCV = 17.11, PCV = 18.57), yield per plant (GCV = 18.32, PCV = 18.88).

The low estimation of GCV and PCV (less than10%) were observed for plant height (GCV = 7.5, PCV = 7.39), panicle length (GCV = 6.27, PCV = 6.51), panicle per square meter (GCV = 8.98, PCV = 9.95). Similar finding was reported by Singh *et al.* (2002) [24] for low estimation of GCV and PCV for panicle length.

Heritability

In all genotypes, heritability in broad sense was highest for days to 50% flowering (99.0). Satyanarayana *et al.* (2005) [21] and Dhanwani *et al.* (2013) [7] also reported high heritability in broad sense for 50% flowering.

The other characters which follow 50% flowering are leaf length (96.7), yield per plant (94.1), total number of grains per panicle (94.0), number of filled grains per panicle (93.9), panicle length (92.6), number of unfilled grains per panicle (92.4), spikelet sterility percentage (90.6), spikelet fertility percentage (90.4) and plant height (90.3). The high estimation of heritability was also observed for plant height, which is accordance to finding of Mishra and Verma (2002) [15], Bisne *et al.* (2009), Sedeek *et al.* (2009) [22], Yadav *et al.* (2010) [26], Fukrei *et al.* (2011) [8], Prasad *et al.* (2013) [18] and Dhanwani *et al.* (2013) [7]. Other characters like leaf width (84.9), 100 grain weight (83.1), panicle per square meter (81.4) and effective tiller/plant (79.2) also show high heritability.

Genetic Advance

The highest genetic advance was observed for total number of grains per panicle (107.08). Singh *et al.* (2002), Shukla *et al.* (2004), Satyanarayana *et al.* (2005) [21], Padmaja *et al.* (2008) [16] and Gangashetty *et al.* (2013) [9], they all reported similar finding for total number of grains per panicle.

The other characters which also show high genetic advance are number of filled grains per panicle (73.69), panicle per square meter (43.31), number of unfilled grains per panicle (42.49) and days to 50% flowering (23.67).Satyanarayana *et al.* (2005) [21] also reported similar finding for days to 50% flowering.

The moderate estimation of genetic advance was observed for spikelet fertility percentage (14.66), spikelet sterility percentage (14.57) and plant height (12.44).

The low estimation of genetic advance was observed for yield per plant (7.31), leaf length (5.98), panicle length (3.27), effective tiller per plant (1.33), 100 grain weight (0.42) and leaf width (0.38).

Genetic advance as percentage of mean

The highest genetic advance as percentage of mean was observed for number of unfilled grains per panicle (107.97). Markam (2013) [13] also reported similar finding for number of unfilled grains per panicle.

The other characters which show high genetic advance as percentage of mean are total number of grains per panicle (68.39), filled grains per panicle (62.90), spikelet sterility percentage (60.27), yield plant^{-1} (36.62), leaf width (32.47), days to 50% flowering (28.37) and leaf length (20.07). Kumar *et al.* (2013) [12] also reported high genetic advance as percentage of mean for grain yield/plant.

The moderate estimation of genetic advance as percentage of mean was found for spikelet fertility percentage (19.33), effective tiller per plant (18.54), 100 grain weight (18.18), panicle/square meter (16.69), plant height (14.68) and panicle length (12.44).

Conclusion

It is concluded that the characters,days to 50% flowering, total no. of grain/panicle, filled grain/panicle and spikelet sterility (%) which showed high genotypic value coupled with high heritability and genetic advance should be considered for direct selection.

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