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RESEARCH PAPER

Screening of rice (*Oryza sativa* L.) genotypes for shattering resistance

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Abstract : The present investigation on screening rice genotypes for shattering resistance was done involving twenty five rice genotypes. Among these lines Aiswarya and Aathira were taken as susceptible and resistant checks, respectively. Seeds were collected from Rice Research Stations of Kerala Agricultural University (KAU). Selected lines comprising both traditional and high yielding varieties were evaluated in augmented design and shattering was measured by Induced Random Impact (IRI) method using a force gauge apparatus. Fourteen characters were evaluated along with seed shattering and yield. Wide variability was found to exist among the tested genotypes for yield and most yield attributes. High phenotypic and genotypic co-efficient of variance (PCV and GCV) estimates were recorded for seed yield and shattering per cent indicating wide variability among genotypes for these traits and the possibility of improvement through selection. High heritability coupled with high genetic advance which indicate the influence of additive gene action in trait expression were observed for characters *viz.,* days to fifty per cent flowering, length and width of flag leaf, number of panicles per plant, seed yield and shattering per cent. Substantial improvement in the expression of these characters over base population can be expected through simple selection.

Key Words : Seed shattering, Genotypic co-efficient of variation (GCV), Phenotypic co-efficient of variation (PCV), Heritability, Genetic advance

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INTRODUCTION

Rice is the staple food for more than half of the world population. In addition to calories, rice is considered as a source of minerals. High yielding rice varieties were always a concern for plant breeders all around the world. Apart from having a stable high yielding variety, it was more challenging for maintaining the stability during harvesting, storage and upto the hand of consumer.

Like all present day cultivated crops, rice is also domesticated from its wild relatives. During the process of domestication ancient humans noted several important agronomical characters such as high seed yield, seed size, shape, crop duration, adaptation, reduced seed shattering etc., in the wild plant species and selected favourable plants knowingly or unknowingly. But the narrow genetic base and frequent occurrence of disease

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and pest incidence forced man to breed plants tolerant to biotic and abiotic stresses. Most of the times the donor parents were wild relatives, however, along with desirable characters some undesirable ones also were incorporated in cultivated crops such as early shattering of grains. In domesticated and cultivating crops the reduction of shatter is a desirable trait, as keeping the seeds on the mother plants facilitates efficient harvesting and prevent yield loss. In early shattering varieties, harvest loss occurs in the process of reaping and conveying the plant to the threshing section of combine apart from field loss. There are reports that, at some point farmers were experiencing more than 50 per cent yield loss due to delayed harvesting. On the other hand, in hardy shattering varieties the grain may not be removed completely from the panicle. In this situation even though we are having a number of high yielding varieties in rice, the post-harvest loss is still a major factor in reducing production.

As far as Kerala the humid tropical climate of Kerala is highly suited for the cultivation of rice and traditionally rice occupied a prime position in Kerala's agriculture. Since the Indian population continues to grow steadily food grain production is becoming a matter of concern for India as a whole and Kerala in particular. At present rice occupies 7.46 per cent of the total cropped area in Kerala. However, the area under rice has been falling at an alarming rate. The paddy area has come down from 8.82 lakh hectares in 1974-75 to 1.96 lakh hectares in 2015-16 (SPB, 2016).

Jyothi, the most popular rice variety of Kerala which contributed more than 60 per cent of the rice production in the state was replaced mainly due to its it's highly shattering nature by another important variety Uma. The knowledge of heritability and genetic variability is a prerequisite for carrying out selection based on shattering nature for crop improvement. It was in this background the present investigation was taken up.

MATERIAL AND METHODS

The research was conducted in the Department of Plant Breeding and Genetics in Kerala Agricultural University (KAU) Vellanikkara, Kerala.The experimental materials included twenty-five rice genotypes comprising traditional as well as high yielding verities (HYVs). These rice genotypes were procured from three different research centers in Kerala *viz.,* Regional Agricultural Research Station (RARS), Pattambi, Rice Research Station (RRS), Moncompu and Agricultural Research Station (ARS), Mannuthy.

The genotypes were raised in ARS, Mannuthy in augmented design. The seedlings were raised in nursery and transplanted to the main field with variety Aathira as resistant check and Aiswarya as susceptible check. The seedlings were planted at 20 x 20 cm spacing with an alley row of 40 cm. after every ten lines. Shattering was measured by Induced Random Impact (IRI) method, by using a force gauge apparatus. For this purpose, ten panicles from each genotype were harvested separately at physiological maturity of each crop and dried under shade in a paper bag for two to three days. After shade-drying the panicles were placed in a force gauge apparatus along with 100 steel balls of 1 cm. and rotated at 30 rpm for 20 seconds and the number of shattered kernels was counted. Per cent shattering was calculated using eq.

Shattering percentage = (Number of shattered grains/ Total number of grains) x 100

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed significant difference existing among the genotypes for most of the characters studied except number of tillers per plant. A significant difference at 1 per cent level was observed among genotypes for plant height, days to 50 per cent flowering, days to maturity, panicle per plant and kernel length, whereas significant difference at 5 per cent level was observed for flag leaf width, flag leaf length, panicle length, seeds per panicle, test weight, seed yield per plant, kernel width and shattering per cent. It indicates the presence of a substantial amount of genetic variability and scope for selection to crop improvement. Variability and genetic parameters estimated for fourteen plant characters among 25 genotypes of rice are enlisted in Table 2 and he results are explained below.

Phenotypic and genotypic co-efficient of variation:

Co-efficient of variation provides a relative measure of variance among different traits under study. In general, the estimates phenotypic co-efficient of variation (PCV) were higher than the genotypic co-efficient of variation (GCV) indicating the effect of environment on expression of genotype.

Phenotypic co-efficient of variation ranged from 3.86 per cent (test weight) to 39.64 per cent (seed shattering). According to Sivasubramanian and Madhavamenon

(1973) classification for PCV and GCV, seven characters recorded low PCV (test weight (3.86%), seeds per panicle (6.86%), kernel width (7.19%), panicle length (7.55%), days to maturity (9.03%), kernel length (9.73 %) and plant height (9.91%), while three characters recorded moderate PCV [(flag leaf width (12.01%), flag leaf length (12.52%) and days to fifty per cent flowering (12.61%)] and four characters recorded high level of PCV [(Tillers per plant (21.16%), panicles per plant (23.13%), seed yield per plant (23.87%) and shattering per cent (39.64%)].

Genotypic co-efficient of variation also ranged from 3.85 per cent in case of test weight to 37.47 per cent in case of shattering per cent. Among the fourteen characters studied seven recorded a low GCV [(test weight (3.85%), panicle length (5.78%), seeds per panicle (6.54 %), kernel width (7.02%), kernel length (8.72%), days to maturity (8.99%) and plant height (9.74%)]. Low PCV and GCV estimates in plant height were also reported by Borkakati *et al*. (2005). Akhtar *et al*. (2011) reported low GCV and PCV for test weight in rice. Five characters recorded moderate response [(flag leaf width

Table 1 : Analysis of variance calculated for different vegetative and panicle and seed character among rice genotypes

Sr. No.	Character	Treatments	Check	Germplasm	C v/s G	Error
1.	Plant height (cm)	338.800	102.300**	363.100**	41.700**	4.135
2.	Number of tillers per plant (no.)	9.132	0.667	7.683	49.482*	2.050
3.	Days to 50 per cent flowering	355.600	170.700**	350.800**	646.100**	2.197
4.	Days to maturity	332.600	0	361.800**	23.400**	1.000
5.	Flag leaf width (cm)	0.108	0.18375*	0.108*	0.029	0.003
6.	Flag leaf length (cm)	85.590	2.090	86.450*	150.180*	4.496
7.	Number of panicle per plant (no.)	7.652	12.907**	4.894**	63.070**	1.081
8.	Panicle length (cm)	3.931	4.034*	3.826*	6.150*	1.406
9.	Seeds per panicle (no.)	272.000	54.000	139.800*	3399.400**	4.499
10.	Test weight (g)	3.234	0.735	3.177*	6.994*	0.001
11.	Seed yield per plant (g)	104.780	114.41**	60.380*	1072.060**	1.865
12.	Kernel width (mm)	0.119	0.167**	0.104*	0.39145**	0.002
13.	Kernel length (mm)	2.098	0.084	1.421**	19.017**	0.112
14.	Shattering (%)	64.140	694.170**	34.070*	95.660**	1.290

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Variability and genetic parameters for fourteen characters estimated from 25 rice genotypes

Characters	Range		Mean	Co-efficient of variation (%)		Heritability broad sense (%)	Genetic gain (%)
	Minimum	Maximum		GCV	PCV		
Plant height (cm)	82.80	151.40	112.31	9.74	9.91	96.66	19.73
Number of tillers per plant (no.)	5.00	14.00	9.37	14.63	21.16	47.81	20.84
Days to 50 per cent flowering	32.00	126.00	86.28	12.49	12.61	98.15	25.49
Days to maturity	78.00	163.00	119.04	8.99	9.03	99.18	18.45
Flag leaf width (cm)	1.02	2.23	1.63	11.47	12.01	91.26	22.58
Flag leaf length (cm)	27.84	60.30	42.16	11.47	12.52	83.88	21.64
Number of panicle per plant (no.)	3.00	11.93	7.12	17.93	23.13	60.11	28.64
Panicle length (cm)	20.98	28.90	24.40	5.78	7.55	58.61	9.12
Seeds per panicle (no.)	82.00	130.67	103.08	6.54	6.86	90.99	12.85
Test weight (g)	22.40	29.00	26.10	3.85	3.86	99.86	7.94
Seed yield per plant (g)	10.04	37.71	19.53	22.82	23.87	91.42	44.95
Kernel width (mm)	2.19	3.20	2.63	7.02	7.19	95.34	14.13
Kernel length (mm)	5.83	9.50	7.75	8.72	9.73	80.32	16.10
Shattering per cent	1.73	26.20	8.78	37.47	39.64	89.34	72.96

(11.47%), flag leaf length (11.47%), days to fifty per cent flowering (12.49%), number of tillers per plant (14.63%) and number of panicles per plant (17.93%)], Karthikeyan *et al*. (2010) reported moderate level of PCV and GCV for days to fifty per cent flowering and low PCV and GCV for panicle length. Only two characters recorded high GCV [(seed yield per plant (22.82%) and shattering per cent (37.47%)]. Borkakati *et al*. (2005); Karim *et al*. (2007); Sabesan *et al*. (2009); Karthikeyan *et al*. (2010); Jayasudha and Sharma (2010) and Fiyaz *et al*. (2011) also reported high level of GCV and PCV for grain yield per plant. High GCV and PCV estimates in seed yield per plant and shattering per cent, indicating presence of ample variability among the genotypes for these traits and the possibility of improvement through selection. Similar findings in case of shattering per cent were reported by Perera *et al.* (2014). Jiang *et al.* (2019) identified a genetic factor regulating seed shattering in rice.

A comparison between PCV and GCV is depicted in Fig.1. In general the estimated PCV will be higher than the GCV indicating the influence of environment in gene expression among the fourteen character studied, the estimated difference between PCV and GCV were highest for number of tillers per plant (6.53%) followed by number of panicles per plant (5.20%) and it is least for test weight (0.02%). For other characters the difference was less than five per cent indicating comparatively less influence of environment on character expression. Those characters with least difference between PCV and GCV can be considered for selection.

Heritability and genetic gain:

The amount of genetic variation in a population alone will not be of much use to the breeder unless it is supplemented with the information on heritability estimate which is a measure of the heritable portion of the total variation. Heritability plays an important role in deciding the strategy for selection of a character since high heritability indicates high scope of genetic improvement of the character through selection.

According to Johnson *et al*. (1955) classification, out of fourteen characters measured from the 25 rice genotypes, twelve characters showed high heritability and it ranged from 41.87 per cent in number of tillers per plant to 99.86 per cent in test weight. Findings of Jayasudha and Sharma (2010) and Quatadah *et al*. (2012) also reported high heritability for grain yield per plant. High heritability in case of 50 per cent flowering was reported by Fiyaz *et al*. (2011); Singh *et al*. (2011). Akhtar *et al*. (2011); Fiyaz *et al*. (2011) and Quatadeh *et al*. (2012) reported high heritability for plant height in rice. Kumar *et al*. (2012) also reported high heritability value for panicle length and grains per panicle similar to the findings of present study. High heritability in broad sense was noted for plant height followed by days to 50 per cent flowering, biological yield per plant, days to maturity, grain yield per plant 1000-grain weight and

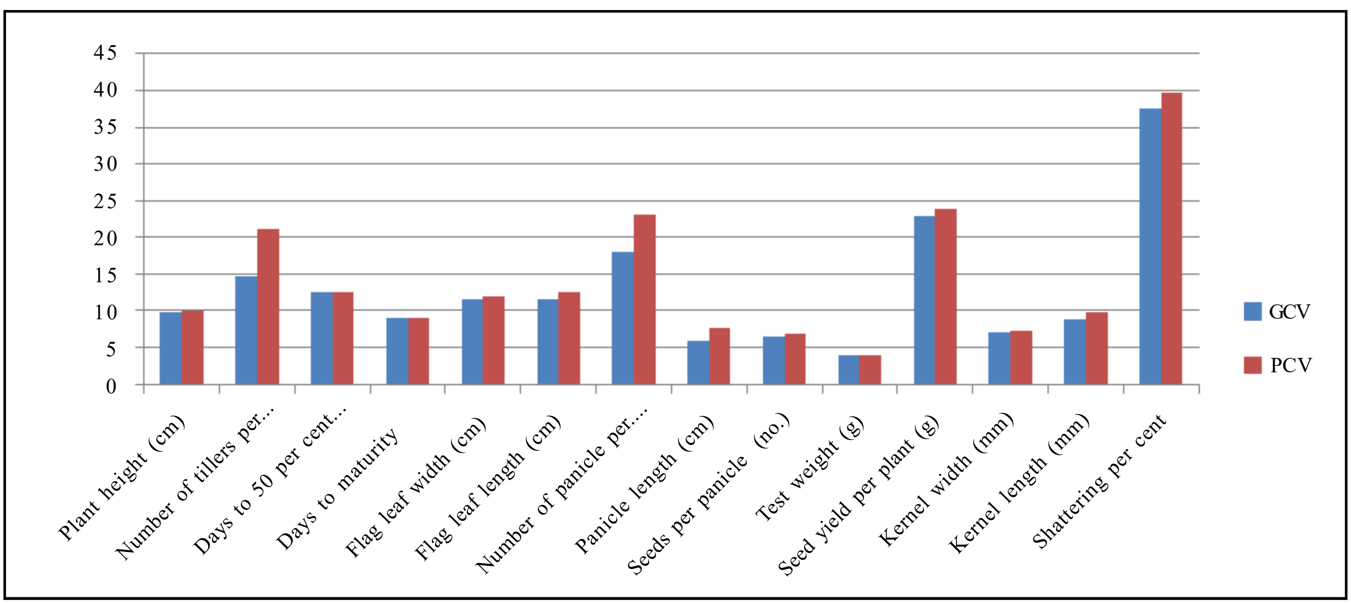

Fig. 1 : Comparison of PCV and GCV for vegetative and panicle and seed characters among 25 rice genotypes

spikelet per panicle by Yadav *et al*. (2011). Moderate heritability was observed for number of tillers per plant (47.806%) and panicle length (54.039%).

Though high heritability for a character indicates the effectiveness of selection on the basis of phenotypic performance, it cannot be considered as the amount of genetic progress that can be made from selecting the best individual among the population. Panse and Sukatme (1954) reported that a high heritability value for character does not necessarily lead to a high genetic gain. If the heritability is mainly due to non-additive genetic effects (dominance and epistasis) the expected genetic gain would be low and when it is chiefly due to additive effects, a high genetic gain would be expected. Hence, estimation of genetic advance as percentage mean can serve as an indication in this regard. According to Johnson *et al*. (1955) for more effective selection heritability estimates should be considered along with genetic gain since genetic advance depends on phenotypic variability, heritability and to the selection intensity.

The genetic advance as per cent of mean estimates varied between 7.94 per cent (test weight) to 72.96 per cent (shattering %). As per Johnson *et al*. (1955) classification, low genetic gain was recorded for two characters [(test weight (7.94 %) and panicle length (9.12 %)], moderate estimates were recorded for five characters [(seeds per panicle (12.85%), kernel width (14.13%), kernel length (16.10%), days to maturity (18.45%) and plant height (19.73%)], whereas high estimates were recorded for remaining seven characters [(number of tillers per plant (20.84%), flag leaf length (21.64%), flag leaf width (22.58%), days to fifty per cent flowering (25.49%) number of panicles per plant (28.64%), seed yield per plant (44.95%) and shattering per cent (72.96%)].

It is interpreted that characters with high heritability combined with high genetic gain will be controlled by additive genes which can improve through pure line selection. Seed yield per plant and shattering per cent which showed high genetic gain along with high heritability indicate that, judicious selection for these characters will be effective for further improvement. A high genetic gain for grain yield per plant was also reported by Fiyaz *et al*. (2011).

Conclusion:

The present study identified the presence of adequate variability among rice genotypes for most of the characters studied. The differences between PCV and GCV were least for twelve characters indicating chances in character improvement through selection. High heritability combined with high genetic gain for seed yield and shattering per cent reveals that these characters can be achieved through selection.

REFERENCES

Akhtar, N., Nazir, M. F., Rabnawaz, A., Mahmood, T., Safdar, M. E., Asif, M. and Rehman, A. (2011). Estimation of heritability, correlation and path co-efficient analysis in fine grain rice (*Oryza sativa* L.). *J. Anim. Plant Sci.,* **21**(4): 660-664.

Borkakati, R. P., Chawdhry, R. K. and Kurmi, K. (2005). Studies on genetic variability and correlation in some rice genotypes. *Natl. J. Plant Improv.,* **7**(2): 119-121.

Fiyaz, A. R., Ramya, K. T., Chikkalingaiahl, Ajay, B. C., Gireesh, C. and Kulkarnil, R. S. (2011). Genetic variability, correlation and path co-efficient analysis studies in rice (*Oryza sativa* L.) under alkaline soil condition. *Electr. J. Plant Breed.,* **2**(4): 531-537.

Jayasudha, S. and Sharma, D. (2010). Genetic parameters of variability, correlation and path-coefficient for grain yield and physiological traits in rice (*Oryza sativa* L.) under shallow lowland situation. *Electr. J. Plant Breed.,* **1**(5): 1332-1338.

Jiang, L., Ma, X., Zhao, S.,Tang, Y., Liu, F., Gu, P., Zhu, Z., Fu, Y,. Cai, H., Sun, C. and Tan, L. (2019). The APETALA2-Like Transcription Factor SUPERNUMERARY BRACT Controls Rice Seed Shattering and Seed Size. *The Plant Cell,* **31**: 17–36. DOI:https:// doi org/10.1105/tpc.18.00304.

Johnson, H.W. and Robinson, H.F. and Comstock, R.E. (1955). Genotypic and phenotypic correlations in soybeans and their implications in selection. *Agronomy J.,* **47** (10): 477-483.

Karim, D., Sarkar, U., Siddique, M. N. A., Miah, M. A. K. and Hasnat, M. Z. (2007). Variability and genetic parameter analysis in aromatic rice. *Int. J. Sustain.,* **15** (3): 75-78.

Karthikeyan, P., Anbuselvam, Y., Elangaimannan, R. and Venkatesan, M. (2010). Variability and heritability studies in rice (*Oryza sativa* L.) under coastal salinity. *Electr. J. Plant Breed.,* **1**(2): 196-198.

Kumar, S., Singh, D., Satyendra, Sirohi, A., Kant, S., Kumar, A., Pal, K. and Kumar, M. (2012). Variability, heritability and genetic advance in rice (*Oryza sativa* L.) under aerobic condition. *Environ. Ecol.,* **30** (4): 1374-1377.

Panse, V. G. and Sukatme, P. V. (1954). *Statistical methods for agricultural workers,* ICAR, New Delhi, 58pp.

Perera, U.I.P., Ratnasekera, D., Senanayake, S.G.J.N. and de Z. Abeysiriwardena, D.S. (2014). Genetic parameters and correlations of yield attributing characteristics of weedy rice in Sri Lanka. *J. Natl. Sci. Foundation of Sri Lanka*, **42** (4): 59-63.

Quatadah, S. D. M., Singh, C. M., Babu, G. S. and Lavanya, G. R. (2012). Genetic variability studies in rice (*Oryza sativa* L.). *Environ. Ecol.,* **30** (3A): 664-667.

Sabesan, T., Suresh, R. and Saravanan, K. (2009). Genetic variability and correlation for yield and grain quality characters of rice grown in coastal saline low land of Tamil Nadu. *Electr. J. Plant Breed.,* **1**: 56-59.

Singh, S. K., Singh, C. M. and Lal, G. M. (2011). Assessment of genetic variability for yield and its component characters in rice (*Oryza sativa* L.). *Res. Plant Biol.,* **1**(4): 73-76.

Sivasubramanian, V. and Madhavamenon, P. (1973). Path analysis for yield and yield components in rice. *Madras Agric. J.,* **60** : 1217-1221.

Yadav, S.K., Pandey, P., Kumar, B. and Suresh, B.G. (2011). Genetic architecture, interrelationship and selection criteria for yield improvement in rice. *Pakistan J. Biol. Sci.,* **14**(9): 540-545.

WEBLIOGRAPHY

SPB (State Planning Board) (2016). Economic Review [on line]. Available*: http://spb.kerala.gov.in/EconomicReview2016/web/index.php [07 Aug. 2018].*