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Research Note

Studies on genetic variability for lodging related traits in rice (*Oryza sativa* L.)

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Abstract :
Genetic variability, heritability and genetic advance were estimated for various traits in relation to lodging in 80 genotypes of rice. Preliminary results indicate highly significant ($P<0.01$) differences for all traits studied thereby indicating the presence of genetic diversity among these accessions. The results revealed high range for plant height (19.49-66.8 cm), lodging percentage (1.74-62.66) and total tillers per meter length (54.5-180). The genotypic and phenotypic coefficient of variations (PCV and GCV) were maximum for lodging percentage (PCV=49.98, GCV=49.06) and minimum for days to maturity (PCV=3.17, GCV=2.91). The phenotypic coefficients of variations were higher than those of genotypic coefficients of variations, which indicate influence of environment for expression of the characters. High estimates of h^2 (bs) were obtained for all the character studied. The highest value of heritability h^2 was obtained for 1000 grain weight (97.45), plant height (96.49) and lodging percentage (96.33). In the present study, total tillers per meter length recorded maximum genetic gain (44.93). High heritability along with high genetic gain was observed for lodging percentage (h^2=96.33, GA=64.84), plant height (h^2=96.49, GA=22.4), productive tillers per meter (h^2=92.19, GA=42.91), non-productive tillers per meter (h^2=78.45, GA=10.35) and total tillers per meter length (h^2=90.57, GA=48.93). Therefore, improvement of these characters could be brought about by practicing phenotypic selection in desired direction.

Key words:
Lodging, silica content, internode length, plant height, rice.

Estimation of genetic variability present in the germplasm of a crop is pre-requisite for making any effective breeding program (Allard, 1960). Selection of parents to be included in the hybridization programme should be based on genetic distance. Most of the quantitative characters including yield are polygenically controlled and highly influenced by environment. Estimates of genetic advance together with heritability would be helpful in accessing the nature of the gene action. Selecting lodging resistant cultivars is difficult in rice because of the difficulty in screening for this trait under natural field conditions. Identification of easily measurable culm traits related to lodging resistance would help in the selection process. Therefore, the present investigation was carried out to evaluate the differences in culm morphology for lodging among the eighty modern and traditional rice genotypes under natural field conditions for estimating genetic variability, heritability and genetic advance for various yield contributing and lodging related characters.

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The experimental material comprised of 80 different rice varieties obtained from Up land Paddy Research Station and were studied under upland irrigated black soil of Parbhani, Marathwada Agricultural University. The genotypes were raised during *Kharif* season, 2005 on a well fertilized plot laid in randomized block design with two replications. Each treatment consisted of five rows of 3 meter length. A spacing of 20 x 30 cm was followed. Fertilizers were applied at the rate of 80 kg N+ 40 kg P_2O_5+ 40 kg K_2O/ha. Fifty per cent of nitrogen and whole of P_2O_5 and K_2O were applied as a basal dose at the time of sowing. Remaining 50 per cent of N was applied in two split doses i.e. 25 percentage on 30 and 60 DAT. One hoeing and four weedings were done and five irrigations were given as and when necessary depending upon rainfall.

Observations were taken on five randomly selected plants from the middle three rows for the traits *viz*., days to 50% flowering, plant height (cm), panicle length (cm), leaf sheath length of flag leaf (cm), leaf blade length of flag leaf (cm), total length of flag leaf (cm), number of leaves on main culm, length of first internode (cm), length of second inter node (cm), length of third inter node (cm), number of productive tillers per meter length, number of non productive tillers per meter length, number of total tillers per meter length, number of filled grains per panicle, number of unfilled grains per panicle, number of total grains per panicle, days to maturity, 1000 grain weight (g), silica content of paddy straw (boot stage) (%), silica content of paddy straw (maturity stage) (%) and lodging percentage per plot.

Silica content of the paddy straw at two stages (boot stage and the maturity stage) was estimated according to the method described by Piper (1944). Lodging percentage was recorded on the basis of visual counting of lodged tillers at the time of harvest. The middle three rows in each treatment were selected for counting the lodged and non lodged tillers and on the basis of average lodging percentage (LP) was calculated as LP = (Number of lodged tillers/Number of tillers) x100. The mean data were used for calculating the phenotypic and genotypic coefficients of variation following Burton and Devane (1953); heritability and genetic advance following Allard (1960).

Analysis of variance indicated a significant difference among the 80 genotypes for all the characters indicating the existence of high genetic diversity among the genotypes. In general, estimates of phenotypic coefficient of variability (PCV) were higher than those due to genotypic coefficient of variability for all characters (Table-1). Similar results were also reported by Majumdar *et al*. (1971), Das *et al*. (2001), Karthikeyan *et al.* (2010). High ranges for plant height (19.44 – 66.8 cm), total tillers per meter length (54.5 - 180) and lodging percentage (1.75 – 62.66) were observed. The higher phenotypic coefficient of variation when compared to respective genotypic coefficient of variation indicates the predominant role of environment in the expression of traits, which is in consonance with the results obtained by earlier workers (Singh *et al*., 2007, Anbanandan *et al.,* 2009 and Vange, 2009).

Phenotypic and genotypic coefficient of variations were higher for lodging percentage (PCV = 49.98, GCV = 49.06) followed by length of first internode (PCV = 38.70, GCV = 32.97), length of second internode (PCV = 29.38, GCV = 27.67) and plant height (PCV = 25.66, GCV = 25.21). Silica content of paddy straw recorded moderate PCV and GCV of 15.51 and 12.26 at boot stage and 17.58 and 16.69 at maturity stage respectively. However a close proximities between GCV and PCV, gave evidence that the variability existing in each genotype was mainly due to their genetic makeup.

High estimates of heritability in broad sense were obtained for all the characters. The magnitude of heritability is an important aspect of genetic constitution of breeding material, which has close bearing on the response to selection (Panse, 1957). High values for heritability were obtained for 1000 grain weight (97.45), plant height (96.49), lodging percentage (96.33), productive tillers per meter length (92.19), silica content of paddy straw at maturity stage (90.06), days to 50 % flowering (90.32) and length of second internode (88.68).

In the present study, total tillers per meter length showed maximum genetic gain (44.93) followed by productive tillers per meter length (42.91), lodging percentage (24.84) and plant height (22.4). High genetic advance for effective tillers per plant and total tillers per plant was also recorded by Kuldeep *et al.* (2004) and Karthikeyan *et al.* (2010).

Heritability along with genetic gain in per cent of mean is a more useful criterion in a predicting the resultant effect for selecting the best individual (Allard, 1960). The characters with high genetic advance would respond to selection better than those with high heritability and low genetic advance (Burton and Devane, 1953). High heritability along with high genetic gain in per cent mean could be recorded for plant height, first and second inter node lengths, productive tillers per meter length, non productive tillers per meter length, total number of tillers per meter and lodging resistance.

These results are in accordance with the findings of Patra *et al.* (2001). Therefore, phenotypic selection in the desired direction could bring about improvement in these characters. It is also suggested that variation for the above characters in the genotypes studied were due to high additive gene effect. Similar observations have been reported by Mishra and Verma (2002). The above results obtained from the present study clearly reveals that phenotypic selection for lodging resistance will be effective type was isolated and evaluated for its yield

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Table 1. Range, mean, coefficient of variation, heritability (broad sense) and genetic advance for yield contributing and lodging related traits in rice

Characters	Range	Mean ± S.E.	σ^2 g	σ^2 p	GCV (%)	PCV (%)	h^2 (%)	Genetic advance (%)	GA as (%) of mean
Days to 50 % flowering	76-114	94.257±1.737	55.69	61.731	7.91	8.33	90.21	14.59	15.48
Plant height (cm)	19.44-66.8	43.950 ±1.492	122.79	127.25	25.21	25.66	96.49	22.4	50.96
Length of panicle (cm)	11.81-20	16.360±1.026	2.11	4.22	8.88	12.55	50.07	2.11	12.94
Leaf sheath length of flag leaf (cm)	10.3-24.45	18.98±1.489	5.66	10.09	12.53	16.74	56.06	3.66	19.33
Leaf blade length of flag leaf (cm)	11.7-31.22	21.270±1.716	14.57	20.48	17.94	21.27	71.12	6.63	31.16
Total length of flag leaf (cm)	24.81-54.14	40.040±2.743	33.05	48.11	14.35	17.32	68.7	9.81	24.51
Number of leaves on main culm	3-6	3.970±0.373	0.392	0.67	15.76	20.61	58.5	0.98	24.84
First internode length (cm)	1.35-6.6	3.380±0.486	1.24	1.72	32.97	38.7	72.5	1.95	57.81
Second internode length(cm)	3.2-17.95	8.780±0.614	5.91	6.66	27.67	29.38	88.68	4.71	53.68
Third internode length (cm)	7.15-20.35	12.813±0.652	5.38	6.23	18.1	19.48	86.33	4.44	34.66
Productive tillers per meter length	43.52-155	84.2±4.462	470.73	510.61	25.76	26.83	92.19	42.91	50.96
Non productive tillers per meter length	7.5-37.5	15.69±2.102	32.2	41.04	36.16	40.82	78.45	10.35	65.97
Total tillers per meter length	54.5-180	99.99±5.694	622.59	687.85	24.96	26.22	90.57	48.93	48.93
Filled grains/panicle	32-71.5	47.18±2.950	76.48	93.98	18.53	20.54	81.38	16.25	34.44
Unfilled grains per panicle	9.3-32.3	17.31±2.442	10.94	22.87	19.10	27.62	47.84	4.71	27.22
Total grains per panicle	42-9.5	64.47±4.35	104.36	142.36	15.84	18.50	73.31	18.01	27.94
Days to maturity	137-157	147.98±1.325	18.61	22.12	2.91	3.17	84.11	8.14	5.50
1000 grain weight (g)	15.55-25.8	20.69±0.286	6.24	6.4	12.07	12.22	97.45	5.08	24.54
Silica percentage (boot stage)	4.25-8.4	6.43±0.432	0.622	0.996	12.26	15.51	62.44	1.28	19.96
Silica percentage (maturity Stage)	8.45-18.55	13.31±0.522	4.94	5.48	16.69	17.58	90.06	4.34	32.62
Lodging percentage	1.74-62.66	25.105±1.698	151.72	157.49	49.06	49.98	96.33	24.84	99.16