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Comparative studies on genetic variability of rice (*Oriza sativa* L.) strains for certain physiological traits in NEP zone under two different Sodicity levels

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Abstract
Genetic variability, heritability and genetic advance were studied in seventy three diverse rice genotypes including three checks at two different farm with different Sodicity levels i,e.pH-8.6 (Student instructional farm) and 9.5 (Main experiment station) during *kharif* 2019-20 following randomized complete block design. A collection of diverse genotypes were evaluated for certain physiological traits *viz*. days to 50% flowering, plant height (cm), flag leaf area (cm), biological yield per plant(g), harvest index%, chlorophyll content, leaf nitrogen, leaf temperature and grain yield per plant (g.). The analysis of variance revealed highly significant differences among all the genotypes for all the traits. The estimates of genetic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) indicated the presence of considerable amount variability for all the traits at both the Sodicity levels. In general the estimate of phenotypic coefficient of variability were higher than genotypic coefficient of variability. A perusal of coefficient of variability indicated that quit high for, Biological yield per plant, chlorophyll content and grain yield per plant while Moderate for plant height, harvest index and leaf nitrogen and lowest value noted for days to 50% flowering and leaf temperature at student instructional farm (pH-8.6) on other hand, PCV and GCV was quiet high for flag leaf area, chlorophyll content, biological yield per plant and grains yield per plant, moderate for plant height, harvest index and leaf nitrogen while lowest for days to 50% flowering and leaf temperature at main experiment station farm (E2). A high estimate of heritability was found for all parameter forE1 pH-8.6 while at E2 pH -9.6 high estimate heritability for all parameter except leaf nitrogen. The presence of high heritability coupled with high genetic advance in majority of the traits indicated the preponderance of additive gene action. So, these traits can be improved through direct selection. The moderate broad sense heritability with low genetic advance in percent of mean were observed for leaf temperature indicating presence of non-additive gene action suggesting heterosis breeding may be useful for rice improvement in sodic soil. The overall result indicates the presence of enough variability for development of improved rice varieties and these traits can be used for selection further the experiment should be repeated by integrating more number of important traits in representative sodic areas of the country.

Keywords: Genotype, rice, variability, heritability, genetic advance

Introduction

Rice *(Oryza sativa* L.) is a golden crop of paramount importance to Indian economy. Rice is the major source of calories of more than half of the global population. More than 90 per cent of the world's rice is grown and consumed in Asia, known as rice bowl of the world, where 60 per cent of the earth's people and two third of world's poor live. Rice is therefore, on the frontline in the fight against world's hunger and poverty. It's being the staple food for more than 70 per cent of our national population and source of livelihood for 120 to 150 million rural households, is backbone of the Indian Agriculture. Rice which is belongs to the family Poaceae (Gramineae) having the diploid chromosome 2n= 24. The cultivated rice belongs to genus *Oryza* and there are about 24 species of rice distributed in tropical, sub-tropical and warm temperate regions of the world. Out of these, most commonly cultivated species are *Oryza sativa* and *Oryza glaberrima*. The *Oryza sativa* is divided into three sub-species, namely, *Indica*, *Japonica* and *Javanica*. Its needs a hot and humid climate. At the time of tillering the crop requires a high temperature for growth. Temperature requirement for blooming ranges from 26.5 to 29.^{0}C. At the time of ripening the temperature should be between 20 to 25 ^{0}C. The irrigated area is over 13.43 m ha. About 6.5% (831 million ha) of the world's total area (12.78 billion ha) is affected by salt in soils (FAO). Rice area with salt problem in state is estimated to be ≤2%.

In land salinity areas are mainly concentrated in Raibareilly, Azamgarh, Sultanpur, Ayodhya, Lucknow, Unnao and Pratapgarh district. With present scenario of increasing population global rice requirement by the year 2022 is estimated to be around 122 million tons as against the present production of about 100 million tons, thus leaving a gap of about 22 million tons rice. Salinity stress is one of the major abiotic constraints which limits rice production and it is estimated that 20% of all cultivated land and nearly half of irrigated land is affected by salt, greatly reducing the yield of crops to well below their genetic potential. Photo periodically rice is a short day plant, however, there are varieties which are non-sensitive to photo periodic condition. To date, genetic Engineering for salinity tolerance in plants has focused on genes that encode compatible organic solutes, antioxidants (detoxification of ROS), ion transport, heat-shock and late embryogenesis abundant proteins, programmed cell death, signal transduction and transcription factor. Example: 1.Gene OsNHX1 used in *Oryza sativa* for Improved salt tolerance, Transgenics had better growth, decrease osmotic potential under NaCl stress. [Fukuda, Biswas, Chen *et al* 2004, 2014, 2007] [15, 16], 2.Gene GlyII used in *Oryza sativa* Enhanced salt tolerance, Increase Glyoxalase activities, Increased shoot/root dry weight; accumulate less Na+, more K+. [Pareek *et al* 2008] [13] 3. Gene GS2 used in *Oryza sativa* Enhanced salt tolerance. Higher quantum yield of PSII, less Na+ accumulation. [Hoshinda *et al*. 2000] [14].

Protein contain of milled rice is 6-7 per cent, rice however, compares favourably with other cereals in amino acid content. The biological value of protein is high, the fat content of rice is low (2.0-2.5%) and much of the fat is lost during milling. Rice contains a low percentage of calcium (Ca). Rice grain contains as much B group vitamin as wheat. India's rice product is estimated at record 102.36 million tonnes in the kharif season of 2020-21 crop time on the reverse of appropriate thunderstorm rains and acreage, consistent with government facts. Rice product stood at101.98 million tonnes within the kharif season of the 2019-20 crop time. The Union Agriculture Ministry released the first strengthen estimates of made of important kharif crops for 2020-21. As in line with the facts, the entire food grains affair inside the kharif season of 2020-21 crop time is anticipated at record 144.52 million tonnes as against 143.38 million tonnes within the former time. The affair of nutri cereals is predicted to decline to 32. Eighty four million tonnes as against 33.69 million tonnes within the former time.it is crucial to enhance rice tolerance to salinity stress to enable this stable crop to provide enough food for rice consuming communities. although some success has been reported for enhanced salinity stress tolerance in rice, the achievement so far are quite modest. (Hoang *et al.* 2016) [12].

Material and Method

A field experiment was conducted during *Kharif season* 2019-20 at the Student Instructional Farm and Main Experiment Station Kumarganj, Ayodhya. All the genotypes were sown in Randomized Complete Block Design with three replications plot size is 5 m length (inter-and intra-row spacing 20 cm and 15 cm, respectively). The experimental materials of the study was comprised of seventy three diverse genotypes collected from different agro-climatic zones. These genotypes were procured from germplasm lines available in rice Section of the Department of Genetics and Plant Breeding, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya. The observations, *viz.*, days to 50% flowering, plant height (cm), flag leaf area (cm2), chlorophyll content, leaf nitrogen, leaf temperature (SPAD Value), biological yield per plant (g), harvest-index (%) and grain yield per plant (g), were recorded on the basis of five randomly selected competitive plants in each plot. The experiments were conducted in two different sodicity levels *viz.*, *p*H = 8.6 and 9.5, respectively at Student Instructional Farm and Main Experiment Station. The fertilizers were applied @120 kg nitrogen, 60 kg phosphorus and 60 kg potash per ha through urea, DAP and murate of potash, respectively. The full dose of phosphorus and potash and half dose of nitrogen were applied as basal and rest of nitrogen was applied in two split doses as top dressing at tillering and panicle initiation stage of crop growth. Biometrical analysis is done with Genetic variability parameter *viz.*, mean, variance, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) (Burton and De Vane, 1953) [1], heritability (h^2) (Hanson *et al*., 1956) [7] and Genetic advance (GA) (Johnson *et al*., 1955) [5, 8] among characters were calculated by following the standard procedures with the help of MSTATC, Statistica 2 and Genres software's.

Result and Discussion

The analysis of variance for complete randomized block design for different characters in each environment is given in Table 1(a), 2(a) highly significant differences were observed among the genotypes for all the 9 characters in two different sodic levels.mean sum of squares due to treatments were highly significant for all the characters indicating the existence of sufficient variability in the materials at both research farm of different sodicity level. These findings are in conformity with Panwar *et al.* (2007) [10] and Konate *et al.* (2016) [9]. At sodicity levels Ph-8.6 the highest variability (genotypic and phenotypic) was exhibited in plant height (245.36 and 263.49). High variability plant height was also reported by Sumanth *et al*. (2017) [3] and at sodicity levels pH- 9.6 highest variability also found in plant height (230.67 and 246.63). According to Siva Subramanian and Menon (1973) [6]. GCV and PCV more than 20% considered as high, whereas values less than 10% are considered to be low and values between 10% and 20% being considered to be moderate. According to this, most the traits have high to intermediate GCV and PCV [Table 1(b) and 2(b)]. This indicated that these traits could be improved for breeding high yielding rice varieties through selection and hybridization. According to Johnson, Robinson and Comstock (1955) [5, 8], broad sense heritability classified as low (<30%), medium (30% to 60%) and high (>60%). This shows most of the traits studied can be easily improved through selection. At Student Instructional Farm (E1) has pH-8.6 all traits found high heritability value (>60%) and at Main Experiment Station (E2) pH-9.6 The medium heritability in leaf temperature (49.34%) showed the more influence of environment on this trait. Therefore, direct selection for this trait is not effective. Since heritability do not always indicate genetic gain, heritability coupled with genetic advance is more effective for selection. Genetic advance indicates the expected progress as the result of selection Pratap *et al*. (2014) [2]. It used to estimate the type of gene action in polygenetic traits. Genetic advance as percent of mean classified as low (<10%), moderate (10%-20%) and high (>20%). at pH-8.6 Sodicity level in, it ranges from 9.80 leaf temperature to 62.47% for flag leaf area and at pH-9.6 it ranges from 8.55% for leaf temperature to 65.77% for flag leaf area. At both sodicioty levels High heritability and high genetic advance were seen in most of the traits including grain yield (Table 2) which indicated these traits were less influenced by the environment, governed by additive gene action and can easily be selected through phenotypic selection. High heritability values indicate though the character is least influenced by environmental factors yet the selection for improvement of such characters may not be useful (Singh *et al.* 2018) [11]. At both sodicity levels Days to 50% flowering has high heritability and moderate genetic advance, indicating that this character is governed by both additive and non-additive gene action. This showed there is a possibility of direct selection for this character. So, heterosis breeding could be used for such kind of traits. The genetic variation result showed that phenotypic coefficient of variation (PCV) was relatively higher than genotypic efficient of variation (GCV). This result revealed that the influence of environment on phenotypic expression of each trait (North S.2013) [4]. But the difference between genotypic and phenotypic coefficient of variation is very little for all studied trait. The broad sense heritability in the studied traits ranged from 61.95% to 97.68% (Table 3).

Table 1(a): Analysis of variance (ANOVA) for nine characters in seventy three rice genotypes at Students Instructional Farm (pH-8.6)

Source of variation	DF	Days to 50% flowering	Plant height (cm)	Flag leaf area (cm2)	Biological yield /plant (g)	Harvest index%	Chlorophyll content	Leaf nitrogen	Leaf temperature	Grains yield per plant (g)
Repl.	2	11.84	44.04	1.55	10.22	12.55	0.31	0.006	0.16	0.37
Treatment	72	211.39**	754.21**	165.26**	304.56**	72.42**	25.65**	0.023**	14.36**	33.70**
Error	144	15.62	18.13	0.92	2.39	2.45	0.21	0.000	2.49	0.84

Table 1(b): Genetic variability- Student instructional farm (pH-8.6)

	Mean	Min	Max	var (g)	var (p)	GCV (%)	PCV (%)	Heritability (%)	GA	GA% mean
Days to 50% flowering	99.49	78.47	118.27	65.26	80.88	8.12	9.04	80.69	14.95	15.02
Plant height(cm)	100.98	65.26	143.10	245.36	263.49	15.51	16.07	93.12	31.14	30.84
Flag leaf area (cm2)	24.20	12.65	45.46	54.78	55.70	98.35	15.12	62.47	30.58	30.84
Biological yield /plant(g)	38.64	20.41	69.13	100.72	103.12	25.97	26.28	97.68	20.43	52.88
Chlrophyll content	10.82	6.25	16.84	8.48	8.69	97.58	5.93	54.74	26.90	27.23
Leaf nitrogen	0.51	0.32	0.75	0.01	0.01	94.70	0.17	34.22	17.07	17.54
Leaf temperature	32.75	29.56	38.65	3.96	6.45	61.40	3.21	9.80	6.07	7.75
Harvest index%	38.14	25.20	44.60	23.33	25.77	12.66	13.31	90.51	9.47	24.82
Grains yield per plant (g)	14.62	7.47	23.49	10.95	11.79	22.63	23.48	92.89	6.57	44.94

Table 2(a): Analysis of variance for nine characters in seventy three rice genotype at Main Experiment Station farm (pH-9.5)

Source of variation	DF	Days to 50% flowering	Plant height (cm)	Flag leaf area (cm2)	Biological yield /plant (g)	Harvest index%	Chlorophyll content	Leaf nitrogen	Leaf temperature	Grains yield per plant (g)
Repl.	2	106.03	50.48	2.85	9.44	0.90	1.02	0.000	14.75	0.31
Treatment	72	220.42**	707.98**	162.93**	323.53**	69.22**	19.77**	0.017**	15.18**	36.46**
Error	144	16.02	15.96	1.24	4.32	4.40	0.43	0.001	3.87	0.74

Table 2(b): Genetic variability- Main Experiment Station (pH-9.5)

	Mean	Min	Max	var (g)	var (p)	GCV (%)	PCV (%)	Heritability (%)	GA	GA% mean
Days to 50% flowering	97.38	76.21	115.72	68.13	84.15	8.48	9.42	80.97	15.30	15.71
Plant height(cm)	97.89	63.83	141.67	230.67	246.63	93.53	30.26	39.61	15.52	16.04
Biological yield /plant(g)	36.76	19.62	66.29	106.40	110.73	96.10	20.83	72.62	28.06	28.63
Harvest index%	36.60	24.36	43.14	21.61	26.01	83.08	8.73	30.56	12.70	13.93
Flag leaf area (cm2)	22.73	10.34	44.31	53.90	55.14	97.75	14.95	84.29	32.29	32.66
Chlrophyll content	10.14	5.38	15.15	6.44	6.88	93.73	5.06	64.00	25.04	25.86
Leaf nitrogen	0.50	0.38	0.69	0.01	0.01	83.66	0.14	35.00	14.50	15.85
Leaf temperature	32.87	27.36	37.25	3.77	7.64	49.34	2.81	10.96	5.91	8.41
Grains yield per plant (g)	13.36	6.32	22.31	11.90	12.65	25.82	26.61	94.12	6.90	51.60

Conclusion

In the present experiment, considering the evaluation of important variability parameters i.e. Coefficient of variation, heritability and genetic advance together, it was revealed that flag leaf area, chlorophyll content, biological yield per plant and plant height are most important characters at both Sodicity levels because they have high heritability coupled with high genetic advance. This indicates involvement of additive gene in controlling gene responsible for these traits. Therefore, these characters could be improved through selection in segregating generations. The overall result showed the presence of adequate variability in the genotypes studied. This variation could be effectively manipulated using appropriate breeding techniques and program to develop improved varieties. High estimate of heritability and genetic advance were observed in most of the traits at both farm of two different Sodicity levels indicating the predominance of additive gene action and the possibility of direct selection through these traits.

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