Plant Archives Vol. 19 No. 2, 2019 pp. 4360-4364 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

VARIABILITY ANALYSIS IN F_2 POPULATION OF RICE (*ORYZA SATIVA* L.)

Karthikeyan. P., Venkatesan. M.* and Yuvarani. M.

Department of Genetics and Plant Breeding, Faculty of Agriculture,
Annamalai University, Annamalai Nagar, Tamil Nadu, India-608 002

Abstract

Rice (*Oryza sativa* L.) (2n=2x=24) is the important cereal crop belonging to the family Poaceae. Rice is a life for thousands of millions of people. In Asia alone, more than 2000 million people obtain 60 to 70 percent of their calories from rice and its products. Hence the slogan "rice for life" would be appropriate. Thirty F_1 were evolved using six genotypes as lines which were selected based on diversity analysis and five varieties of Tamil Nadu as testers in a line × tester mating design. Among them, ten F_1 crosses were forwarded to F_2 based on their *per se* and *sca* effects. All the hybrids were recorded additive type of gene action. All the ten crosses were evaluated for their mean and variability parameters such as in F_2 generation. Based on the *per se* performance, variability, skewness, kurtosis and desirable segregants, the crosses ADT 45 × Vandana, TKM 11 × Nootripathu and TKM 11 × MDU 5 were considered as superior for almost all characters such as plant height, number of productive tillers per plant, boot leaf length, panicle length, grain weight per panicle.

Key words: F_2 population, variability, skewness, kurtosis, desirable segregants.

Introduction

Rice is a life for thousands of millions of people. In Asia alone, more than 2000 million people obtain 60 to 70 percent of their calories from rice and its products. Hence the slogan "rice for life" would be appropriate. India has the largest acreage under rice at 43.38 M. ha. with annual production of 104.32 MT in the year 2015-16 as per Agricultural Statistics Division, Directorate of Economics & Statistics, Department of Agriculture & Cooperation. Considering the importance of rice, the United Nation designated, year 2004 as the "International year of rice". Crop improvement depends on the efficiency of selecting the parents properly. Among the methods available for identifying the parents, selection based on the F_1 performance is more useful and reliable. Based on the combining ability effects ten crosses were selected. Vavilov (1926) ascertained that greater variability is essential for crop improvement. So assessment of the extent of genetic variation available for yield attributes will be of immense help to plant breeders. Hence the segregating populations in F_2 have to be studied for their mean and variability parameters to assess the superiority. The mean, variance, coefficient of variation, skewness and kurtosis are the important parameters, which help in the assessment of worthiness of the segregating populations.

***Author for correspondence :** E-mail: pkes2003@yahoo.co.in

Materials and Methods

Evaluation of F_1 generation for the selected ten crosses

Ten crosses were selected based on the combining ability analysis. These crosses are namely, ADT 45 × Vandana, ADT 45 × Nootripathu, ADT 45 × Norungan, ADT 45 × MDU 5, ADT 45 × PMK 2, TKM 11 × Vandana, TKM 11 × Nootripathu, TKM 11 × Norungan, TKM 11 × MDU 5 and TKM 11 × PMK 2. All the crosses were evaluated in their F_2 generation during January - April, 2017 under coastal salinecondition. Normal cultural practices and plant protection measures were followed. Observations were recorded on 200 plants per replication. Mean performance and variability parameters such as coefficient of variation was categorized as per Sivasubramaniam and Madhavamenon (1973). Skewness and Kurtosis of the characters were calculated using the frequency distribution (Kapur, 1981).

Results and Discussion

Table 1: Mean performance of all characters in F2 population in rice.

Hybrids		ADT 45 × Vandana	ADT 45 × Nootripathu	ADT 45 × Norungan	ADT 45 × MDU 5	ADT 45 × PMK 2	TMK 11 × Vandana	TKM 11 × Nootripathu	TKM 11 × Norungan	TKM 11 × MDU 5	TKM 11 × PMK 2
Plant height	Mean (cm)	115.98	124.98	116.34	122.66	124.62	120.57	153.69	131.86	120.16	136.74
	SE	1.20	0.72	0.77	1.30	0.54	2.05	0.67	0.76	1.34	0.75
No of productive tillers per plant	Mean (cm)	24.72	21.65	37.56	37.64	40.10	33.46	38.99	30.70	26.96	29.97
	SE	0.77	0.46	0.49	0.65	0.71	0.69	0.47	0.63	0.71	0.69
Boot leaf length	Mean (cm)	30.45	29.63	32.11	32.88	32.43	43.08	54.49	30.09	37.34	36.87
	SE	0.78	0.55	0.46	0.54	0.82	1.26	0.68	0.48	0.83	0.70
Panicle length	Mean (cm)	28.72	30.34	30.48	29.36	29.83	29.36	32.27	27.78	28.24	28.47
	SE	0.78	0.40	0.43	0.53	0.68	0.54	0.58	0.46	0.59	0.47
Grain weight per panicle	Mean (cm)	2.20	2.57	2.39	2.25	2.01	2.21	2.39	2.33	2.52	2.81
	SE	0.05	0.04	0.03	0.05	0.06	0.05	0.03	0.03	0.04	0.02
100 grain weight	Mean (cm)	2.10	2.27	2.19	2.14	2.04	2.10	2.22	2.17	2.23	2.27
	SE	0.04	0.02	0.01	0.03	0.05	0.04	0.01	0.01	0.01	0.01
Grain yield per plant	Mean (cm)	34.86	31.55	33.10	29.86	32.70	32.16	34.08	33.25	34.79	32.86
	SE	0.61	0.61	0.53	0.45	0.65	0.55	0.46	0.44	0.50	0.48

The mean value for plant height ranged from 115.98 cm (ADT 45 × Vandana) to 153.69 cm (TKM 11 × Nootripathu). The cross ADT 45 × Norungan was significantly on-par with ADT 45 × Vandana. The variance ranged from 36.66 (ADT 45 × PMK 2) to 481.16 (TKM 11 × Vandana) and medium coefficient of variation (CV) was recorded for ADT 45 × Vandana, ADT 45 × MDU 5, TKM 11 × Vandana and TKM 11 × MDU 5 while others showed low CV. Similar results were reported earlier by Govintharaj *et al*., (2016). With regard to Skewness, the crosses ADT 45 × Vandana, ADT 45 × Norungan, TKM 11 × MDU 5 and TKM 11 × PMK 2 recorded significant negative values. In case of Kurtosis, the crosses ADT 45 × Nootripathu, ADT 45 × MDU 5, ADT 45 × PMK 2, TKM 11 × Vandana, TKM 11 × Nootripathu recorded significant negative values. Above 50 percent of desirable segregants were recorded for crosses such as ADT 45 × Norungan, ADT 45 × MDU 5, TKM 11 × Vandana and TKM 11 × MDU 5.

The mean value ranged from 21.65 (ADT 45 × Nootripathu) to 40.10 (ADT 45 × PMK 2) for the character number of productive tillers per plant. The cross TKM 11 × Nootripathu was significantly on-par with ADT 45 × PKM 2. The variance for this character ranged from 26.39 (ADT 45 × Nootripathu) to 71.62 (ADT 45 × Vandana). High CV recorded for crosses ADT 45 × Vandana, ADT 45 × Nootripathu, TKM 11 × Vandana, TKM 11 × Norungan, TKM 11 × MDU 5 and TKM 11 × PMK 2 and others with low CV. High CV for this character was reported by Govintharaj *et al*., (2016). Skewness and kurtosis values were non-significant for all the crosses. Among the crosses, ADT 45 × Nootripathu, TKM 11 × Vandana, TKM 11 × Nootripathu, TKM 11 × Norungan showed above 45 percent of desirable segregants.

For boot leaf length, the mean value ranged from 29.63cm (ADT 45 × Nootripathu) to 54.59cm (TKM 11 × Nootripathu). Here no crosses showed on-par with TKM 11 × Nootripathu. The variance ranged from 24.58 (ADT 45 × Norungan) to 181.47 (TKM 11 × Vandana). The crosses ADT 45 × Vandana, ADT 45 × Nootripathu, ADT 45 × PMK 2, TKM 11 × Vandana, TKM 11 × MDU 5 and TKM 11 × PMK 2 recorded high CV values. For skewness the cross ADT 45 × Nootripathu showed significant positive value where as for kurtosis was found in the cross ADT 45 × Nootripathu. 45 percent of desirable segregants was reported in crosses ADT 45 × Nootripathu, ADT 45 × MDU 5, TKM 11 × Vandana, TKM 11 × Nootripathu for this character.

Regarding the panicle length the mean performance ranged from 27.78 cm (TKM 11 × Norungan) to 32.27 cm (TKM 11 × Nootripathu). The cross TKM 11 × Nootripathu recorded significantly higher mean than other crosses. The variance for this character ranged from 19.9 (ADT 45 × Nootripathu) to 73.47 (ADT 45 × Vandana). The crosses ADT 45 × Vandana, ADT 45 × PMK 2 and TKM 11 × MDU 5 recorded high range of CV while other crosses recorded medium value of CV where as low CV was reported by Ponnaiah *et al,*. None of the crosses showed positive significant value for skewness. TKM 11 × PKM 2 alone showed positive significant value for kurtosis. Among the 10 crosses, TKM 11 × Norungan, TKM 11 × PMK 2 had more than 45

Table 2: Variability parameters-variance, CV (%) for all characters in F2 population of rice.

Hybrids		ADT 45 × Vandana	ADT 45 × Nootripathu	ADT 45 × Norungan	ADT 45 × MDU 5	ADT 45 × PMK 2	TMK 11 × Vandana	TKM 11 × Nootripathu	TKM 11 × Norungan	TKM 11 × MDU 5	TKM 11 × PMK 2
Plant height	variance	175.02	64.72	69.61	201.43	36.66	481.16	55.12	67.44	209.08	68.66
	CV (%)	11.41	6.41	7.17	11.57	4.86	18.19	4.83	6.23	12.03	6.06
No of productive tillers per plant	variance	71.62	26.39	28.04	49.57	62.46	55.23	26.66	46.26	58.93	57.17
	CV (%)	34.24	23.73	14.10	18.71	19.71	22.21	13.24	22.15	28.48	25.23
Boot leaf length	variance	73.67	37.83	24.58	35.04	83.36	181.47	57.36	27.05	80.77	59.25
	CV (%)	28.19	20.76	15.44	18.00	28.15	31.27	13.87	16.83	24.07	20.88
Panicle length	variance	73.47	19.79	21.72	33.28	57.71	33.62	40.74	24.98	40.34	27.29
	CV (%)	29.84	14.66	15.29	19.65	25.46	19.75	19.78	17.99	22.49	18.35
Grain weight per panicle	variance	0.29	0.15	0.11	0.28	0.38	0.32	0.12	0.13	0.22	0.06
	CV (%)	24.43	15.61	13.80	23.44	30.89	25.50	14.56	15.56	18.61	8.80
100 grain weight	variance	0.22	0.03	0.00	0.12	0.33	0.22	0.00	0.00	0.00	0.01
	CV (%)	22.46	7.61	2.94	16.32	28.10	22.07	2.60	2.95	3.15	3.36
Grain yield per plant	variance	45.13	45.47	32.98	24.57	53.28	35.19	25.91	23.04	28.64	27.53
	CV (%)	19.27	21.37	17.35	16.60	22.32	18.44	14.94	14.43	15.38	15.97

percent of desirable segregants.

The mean value of grain weight per panicle ranged from 2.01g (ADT 45 × PMK 2) to 2.81 g (TKM 11 × PMK 2). Significantly higher mean was recorded for cross the TKM 11 × PMK 2. The variance ranged from 0.06 (TKM 11 × PMK 2) to 0.38 (ADT 45 × PMK 2). High CV reported in ADT 45 × Vandana, ADT 45 × MDU 5, ADT 45 × PMK 2, TKM 11 × Vandana. For skewness, ADT 45 × Nootripathu and TKM 11 × MDU 5 showed significant positive value. Regarding kurtosis, the crosses ADT 45 × Nootripathu and TKM 11 × PMK 2 had positive significant value. Only ADT 45 × Vandana showed above 50 percent of desirable segregants.

The mean value for character 100 grain weight ranged from 2.10 g (ADT 45 × Vandana and TKM 11 × PMK 2) to 2.27 g (ADT 45 × Nootripathu and TKM 11 × PMK 2). The cross TKM 11 × MDU 5 was significantly on-par with TKM 11 × PMK 2 and ADT 45 × Nootripathu. The variance ranged from 0.00 (ADT 45 × Norungan, TKM 11 × Nootripathu, TKM 11 × Norungan, TKM 11 × MDU 5) to 0.33 (ADT 45 × PMK 2) where as high mean variation was reported by Ponnaiah Govintharaj *et al.,* 2016. The crosses ADT 45 × Vandana, ADT 45 × PMK 2 and TKM 11 × Vandana reported high CV while the cross ADT 45 × MDU 5 had medium CV where as low CV was reported by Ponnaiah, Manonmani and Robin (2016) for 1000 grain weight. ADT 45 × Nootripathu showed positive significant value for skewness while the cross ADT 45 × Nootripathu and ADT 45 × MDU 5 had positive significant for kurtosis. The cross ADT 45 × Vandana and ADT 45 × PMK 2 showed 50 percent of desirable segregants.

Regarding grain yield per plant, the mean values ranged from 29.86 g (ADT 45 × MDU 5) to 34.86 g (ADT 45 × Vandana). The crosses ADT 45 × PMK 2, TKM 11 × Nootripathu, TKM 11 × MDU 5 were significantly on-par with ADT 45 × Vandana. The variance ranged from 23.04 (TKM 11 × Norungan) to 53.28 (ADT 45 × PMK 2). High CV was recorded in ADT 45 × Nootripathu and ADT 45 × PMK 2. Similar results were reported for grain yield by Govintharaj *et al*., (2016). None of the crosses showed significant positive value for skewness and kurtosis. ADT 45 × Nootripathu alone showed 50 per cent desirable segregants while the crosses ADT 45 × Vandana, ADT 45 × PMK 2, TKM 11 × Nootripathu. TKM 11 × Norungan and TKM 11 × PMK 2 reported 40 percent desirable segregants.

The estimates of mean serves as a basis for eliminating undesirable crosses whereas, genetic variability (Allard, 1960). Thus based on the mean performance, ADT 45 × Vandanahad shorter plant stature, TKM 11 × Nootripathu had high mean boot leaf length, panicle length and number of productive tillers per plant. Population of the cross TKM 11 × MDU 5 had high 100 grain weight in addition to superior grain yield per plant. The crosses ADT 45 × Vandana, TKM 11 × Nootripathu and TKM 11 × MDU 5 recorded significantly higher mean grain yield per plant. Variability existed in the segregating material is the important criterion in the choice of crosses (Allard, 1960). The high amount of variability in addition to the superior mean performance is a prerequisite for the effective genetic advance for yield and yield component characters. ADT 45 × Vandana recorded high variability for number

Table 3: Variability parameters –Skewness, kurtosis, desirable segregants for all characters in F2 population of rice.

Hybrids		ADT 45 × Vandana	ADT 45 × Nootripathu	ADT 45 × Norungan	ADT 45 × MDU 5	ADT 45 × PMK 2	TMK 11 × Vandana	TKM 11 × Nootripathu	TKM 11 × Norungan	TKM 11 × MDU 5	TKM 11 × PMK 2
Plant height	Skewness	-0.72**	0.39	-0.50**	-0.29	-0.09	-0.07	-0.02	0.41	-0.8**	-0.44*
	kurtosis	0.30	-0.93*	-0.45	-1.02*	-1.08*	-1.48**	-0.91*	-0.23	-0.28	-0.61
	desirable segregants	40.49	41.49	51.69	50.42	48.00	51.30	43.09	38.98	51.72	47.11
No of productive tillers per plant	Skewness	0.25	-0.38	-0.16	-0.04	-0.24	-0.18	0.13	-0.17	0.30	0.20
	kurtosis	-0.68	-0.63	-0.19	-0.81	-0.52	-0.68	-0.77	-0.48	-0.40	-0.47
	desirable segregants	42.15	47.58	43.22	22.88	44.00	46.96	46.34	46.61	39.66	37.19
Boot leaf length	Skewness	0.30	-1.09**	0.45*	-0.14	-0.23	0.13	0.07	0.01	-0.05	0.00
	kurtosis	-0.45	2.76**	-0.27	-0.35	-0.26	-0.95*	-0.67	-0.51	-0.73	-0.75
	desirable segregants	15.33	49.19	37.29	47.89	44.00	46.96	45.53	42.37	40.52	40.50
Panicle length	Skewness	0.04	-0.07	-0.06	-0.30	-0.16	-0.02	0.31	-0.02	0.21	1.11**
	kurtosis	-0.85	-0.16	-0.66	-0.63	-0.93*	-0.07	-0.64	-0.49	-0.62	4.07**
	desirable segregants	43.80	38.71	41.53	43.69	43.20	41.74	39.02	45.76	41.38	45.00
Grain weight per panicle	Skewness	-0.56*	2.64**	0.15	-0.36	-0.05	-0.58*	0.21	0.19	0.61**	0.38
	kurtosis	-0.78	18.03**	-1.12*	0.77	-1.34**	-0.51	-1.08*	-1.11*	0.22	1.64**
	desirable segregants	51.24	43.55	44.92	47.06	47.20	47.83	28.46	49.15	37.93	33.88
100 grain weight	Skewness	-0.45*	1.84**	-0.06	-0.47*	0.04	-0.56*	-0.32	0.20	0.11	0.19
	kurtosis	-0.20	3.02**	-0.90*	1.59**	-1.17**	0.15	-0.42	-0.88*	0.00	1.17**
	desirable segregants	57.85	17.74	31.36	43.69	50.40	24.54	33.33	3.39	37.07	33.88
Grain yield per plant	Skewness	0.27	-0.46*	0.34	0.08	-0.26	-0.45*	-0.11	0.11	0.30	-0.17
	kurtosis	-0.13	-1.08*	-0.79	-0.84	-0.78	0.04	-0.67	-0.65	-0.20	-0.63
	desirable segregants	43.80	54.84	38.14	43.69	39.20	10.45	46.34	41.25	16.38	42.98

of productive tillers per plant, boot leaf length, panicle length, grain weight per panicle and medium variability for plant height. The cross TKM 11 × Nootripathu recorded medium variability for number of productive tillers, boot leaf length, panicle length and grain weight per panicle. The cross TKM 11 × MDU 5 had high variability for number of productive tillers, boot leaf length, panicle length and medium variability for plant height and grain weight per panicle. ADT 45 × Vandana, TKM 11 × Nootripathu and TKM 11 × MDU 5 recorded average variability for grain yield per plant.

The third degree statistics namely skewness and kurtosis are the indicators of the direction and level of dispersion of individuals in the population. Significant and negative skewness was observed for plant height (ADT 45 × Vandana and TKM 11 × MDU 5) and grain weight per panicle (TKM 11 × MDU 5) but contradictory results have been reported for plant height by Ponnaiah *et al*., (2017). Thus these crosses had more proportion of individuals with positive deviants for both characters. With regard to kurtosis, the cross TKM 11 × Nootripathu recorded significantly negative kurtosis for plant height and grain weight per panicle. These results were in agreement with Nachimuthu *et al*., (2014). This cross had complete dispersion of individuals that resulted in high variability. Population with more positive deviants and high variability are important for the success of breeding programme.

Proportion of desirable segregants is important criteria in selection of crosses. The proportion of positive deviants from the general mean is expressed as desirable segregnts and the cross ADT45 × Vandana recorded above 40 percent desirable segregants for all characters except boot leaf length. The crosses TKM 11 × Nootripathu and TKM 11 × MDU 5 recorded above 40 desirable segregants for plant height, productive tillers, boot leaf

length and panicle length. High proportion of desirable segregants for grain yield per plant were recorded in the crosses ADT 45 × Vandana and TKM 11 × Nootripathu.

Thus based on the *per se* performance, variability, skewness, kurtosis and desirable segregants, the crosses ADT 45 × Vandana, TKM 11 × Nootripathu and TKM 11 × MDU 5 were considered as superior than other crosses and these crosses can be forwarded to next generation for further evaluation.

References

Kapur, S.K. (1981). Elements of practical statistics, Oxford and IBH Publishing co., New Delhi. 148-154.

Ponnaiah Gorintharaj, Shalini Tannidi, Swaminathan, Maninmani and Sabariappan Robin (2016). Genetic parameters studies on bacterial blight resistance genes introgressed segregating population in Rice. *World Scientific News.*, **59:** 85-96.

Ponnaiah Govintharaj, T. Shalini, S. Manonmani, S. Robin, V.N. Vishnu, G. Karthika and A. Balaji (2017). Genetic variability for yield and yield components characters in bacterial blight and blast resistance genes introgressed backcross populations in rice. *International Journal of current Microbiology and applied sciences.*, **6(2):** 100-103.

Ponnaiah Govintharaj, T. Shalini, S. Manonmani and S. Robin (2016). Estimates of genetic variability, heritability and genetic advance for blast resistance gene introgressed segrating population in rice. *International J. of current microbiology and applied sciences.*, **5(12):** 672-677.

Robert Wayne Allard (1960). Principles of plant breeding. John Wiley and sons Inc., New York.

Shalini, T., P, Govintharaj, M. Ameenal, S. Manonmani and S. Robin (2016). Improving blast resistance in parental line of rice hybrid through marker assisted selection. *International Journal of Agriculture science and Research (IJASR).*, **6(5):** 339-346.

Sivasubramaniam, S., and P. Madhavamenon (1973). Genotypic and phenotypic variability in rice. *Madras Agric. J.,* **60:** 1093-1094.

Vavilov, N.I. (1926). Studies on the origin of cultivated plants. Bulletin of applied Botany, Genetics and plant Breeding *(Trud.popnkl.hot.iseiek)*., **16(2):**1-248.

Vishnu varthini Nachimuthu, S. Robin, D. Sudhakar, M. Raveendran, S. Rajeshwari and S. Manonmani (2014). Evaluation of rice genetic diversity and variability in a population panel by principal component analysis. *Indian Journal of Science and Technolgy.*, **7(10):** 1555-1562.