SHORT COMMUNICAITON

Oryza Vol. 53 No.2, 2016 (187-195)

Stability analysis for grain yield and its component traits in rice

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Received : Accepted : 11 February 2016 Published : 20 July 2016

ABSTRACT

Twenty nine genotypes of rice were evaluated for the stability of yield and yield components by growing them under three different environments. Significant differences among the genotypes and environments for the twelve traits studied, suggested the presence of wide variability. Both the components of G × E interaction were significant, indicating that the major portion of interaction was linear in nature and prediction over the environments could be possible. Significant pooled deviations observed for all the traits, suggested that there is a considerable genotypic differences. Based on the stability parameters, none of the genotype could be identified as stable for higher grain yield over three environments but, the genotypes PRR-78, Ketaki Joha, Swarna Sub-1 and Nagina-22 showed stability for low grain yield in all three environments. Whereas, the genotypes NDR-3026-3-1R, Pusa Basmati-1, IDR-763, Karahani, Kanak Jeer and Pant Dhan-12 for high grain yield per plant were considered as suitable under improved environment.

Key words: *Rice, stability, yield component, interaction.*

Rice is the most important cereal crop of India. It is grown, particularly in India with a wide range of agro climatic situations, from high altitude of Himalayan valleys to the tropical coastal areas of Kerala. There is a wide spectrum of varieties cultivated with differential response to climatic factors such as highlands, valleys and lowlands. Identification of genotypes that show minimum interaction with the environment or possess greater yield stability is an important consideration in areas where environmental fluctuations are considerable. Murphy and Jones (2007) opined that the most effective way to improve productivity of crops in target environment is to use locally adopted germplasms and selection in the target environment itself. Similarly, Venuprasad *et al*. (2003) also emphasized the thrust on development of habitat specific varieties to boost rice production and productivity by classifying the rice production system into several target habitats.

Food security programme depends on high yielding varieties by increasing yield potential and yield stability (Puji Lestari *et al*. 2010). The development of cultivars, which can be adapted to a wide range of diversified environments, is the ultimate goal of plant breeders in a crop improvement program. The adaptation of cultivar over different environments is usually tested by the level of its interactions with different environments under which it is cultivated. A variety or genotype is considered to be more adaptive or stable one, if it has a high mean yield but a low degree of variations in yield capacity when grown over varied environments (Ashraf *et al*. 2003). Eberhart & Russell (1966) suggested a model to test the stability of genotypes under different environments. They differentate the stable as having unit regression over the environments (b_i=1.00) and minimum variation from regression (S^2d_i =0). Consequently, a variety with a high mean yield over the environments, unit regression coefficient (b_i=1) and variation from regression as small as possible (S^2d_i =0), will be a superior choice as a stable variety.Grain yield, being a complex entity, is subjected to environmental fluctuations and is largely dependent on inter relationships of various components.

The knowledge of genotype x environment interaction is very important to identify the stable genotypes in varying environments. Therefore, the present study was carried out to estimate phenotypic stability for yield and yield components under different environmental conditions.

The present investigation was carried out at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Twenty nine genotypes were sown in the nursery on 21st June 2011 and on two dates in wet season 2012 *i.e*. 15th and 30th June to create three different environments. Twenty five days old seedlings were used for transplanting in the field. All entries were grown in a Randomized Block Design in three replications with spacing of 20 x 15 cm between row to row and plant to plant respectively, with a row length of 5.0 m. Standard agronomic practices were followed to raise a good crop. Five competitive plants were selected randomly from the center row of each genotype in each replication and observations were recorded for characters *viz.*, days to 50 per cent flowering, days to maturity, total number of tillers per plant, number of effective tillers per plant, plant height (cm), panicle length (cm), number of spikelets per panicle, number of grains per panicle, spikelets fertility (%), grain weight per panicle (g), grain yield per plant (g) and 1000-grain weight (g). The mean values for all the traits across the environments were subjected to stability analysis (Eberhart and Russell, 1966) after testing for homogeneity of error variance.

A stable genotype is one which performs well when it is grown under a wide range of environments. Unfortunately, the genetic effects are not independent of non-genetic environmental effects.This interplay between genotype and environment resulting into a phenotype is known as genotype x environment interaction,*i.e*., the failure of a genotype to express the same phenotypic performance when grown under different environments (Comstock and Moll 1963). It is equally important to consider differences in cultural practices as a result of change in date and method of planting, fertilizer application etc. (Mahapatra 1993). Though number of models have been developed to measure phenotypic stability on the basis of mean performance of test material by several researchers, the model suggested by Eberhart and Russel (1966) has been widely used by several plant breeders *viz.*, Vidhu Francis and Kanakamany (2008); Panwar (2008); and Krishnappa *et al.* (2009). Hence in the present study also the stability model suggested by Eberhart and Russel (1966) was applied.

Environmental indices (Table 1) for the characters *viz.*, number of grains per panicle, panicle length, plant height, number of spikelets per panicle and spikelets fertility percent were high in the first environment. Similarly, higher environmental index values were recorded for the characters *viz.*, number of grains per panicle, grain yield per plant, spikelets fertility percent, number of spikelets per panicle, plant height, number of tillers per plant, number of effective tillers per plant, 1000grain weight, panicle length and grain weight per panicle in the second environment except days to 50% flowering and days to maturity. Whereas, the environmental index values were low in third environment for all the characters except for days to maturity, days to 50% flowering and 1000 grain weight. The range in environmental values indicated that the selected environments were quite varied, contrasting and appropriate to carry out the present experimentation.

The analysis of variance for stability (Table 2) revealed that there was significant genotype x environment interactions for all most all characters studied. Eberhart and Russell (1966) defined a stable genotype as the one which show high mean yield, regression co-efficient (b_i) around unity and deviation from regression near to zero. Accordingly, the mean

Table 1. Environment index values (I_j) for different characters (Eberhart and Russell, 1966) in rice (*Oryza sativa* L.)

Character	Environmental indices		
	E1	E2	E3
Days to 50% Flowering	-1.130	-1.992	3.123
Days to Maturity	-1.625	-2.004	3.628
Plant Height(cm)	1.169	2.331	-3.501
Tillers/ Plant	-1.559	1.995	-0.437
Effective Tillers/ Plant	-1.512	1.607	-0.095
Panicle Length(cm)	1.475	1.148	-2.623
Spikelets/ Panicle	0.237	3.384	-3.621
Grains/ Panicle	1.503	13.639	-15.141
Spikelets Fertility %	0.061	4.912	-4.973
Grain Weight/ Panicle	-0.265	0.317	-0.052
Grain Yield/ Plant	-6.459	8.007	-1.549
1000 Seed Weight	-2.046	1.568	0.478

Table 2. Stability analysis of variance for yield contributing characters in 29 rice genotypes

Source of variation	df	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	Tillers/ Plant	Effective Tillers/ Plant	Panicle Length (cm)	Spikelets/ Panicle	Grains/ Panicle	Spikelets Fertility (%)	Grain Weight/ Panicle (g)	Grain Yield/ Plant (g)	1000 grain Weight (g)
Environments	2	217.5***	287.4***	276.3**	95.7*	70.7***	150.4***	357.0	6054.2***	709.0***	2.5***	1569.3***	99.6***
Varieties	28	410.0***	388.0***	2410.2***	28.7***	23.3***	23.8***	16858.1***	10995.1***	81.0**	4.4***	238.0***	59.4***
Env+(Var* Env.)	58	27.6	23.2	72.1	6.4**	5.5***	6.8***	243.6	500.0	42.7	0.29	102.3**	8.99***
Var.* Env.	56	20.90	13.83	64.81	3.27	3.17***	1.68	239.58	301.69	18.93	0.21	49.97	5.75***
Environments (Lin.)	1	435.0***	574.7***	552.6*	191.4***	141.4*	300.8***	714.0	12108.3***	1417.1***	5.04***	3138.6***	200.0***
Var.* Env.(Lin.)	28	16.47**	7.14*	13.99**	3.95***	4.99***	1.06*	25.16**	108.89***	9.51*	0.19**	63.35*	10.38***
Pooled Deviation	29	24.4***	19.8***	111.6***	2.51***	1.30	2.22***	438.4***	477.4***	27.4***	0.21***	35.3***	1.08***
Pooled Error	168	0.37	0.40	6.60	1.05	0.98	0.32	60.46	38.53	2.83	0.03	8.78	0.12
Total	86	152.13	142.02	833.00	13.72	11.30	12.36	5653.00	3917.06	55.12	1.65	146.51	25.42

* Significant at 5% level, ** significant at 1% level and *** significant at 0.1% level against pooled error

and deviation from regression of each genotype were considered for stability and linear regression was used for testing the varietal response.(1) Genotypes with high mean,b_i =1 with non significant S^2d_i are suitable for general adaptation, *i e.*,suitable over all environmental conditions and they are considered as stable genotypes. (2) Genotypes with high mean,b_i>1 with non significant S^2d_i are considered as below average in stability. Such genotypes tend to respond favourably to better environments but give poor yield in unfavourable environments. Hence, they are suitable for favourable environments.(3) Genotypes with high mean, b_i< 1 with non significant S^2d_i do not respond favourably to improved environmental conditions. Hence, it could be regarded as specifically adapted to poor environments. (4) Genotypes with any b_i value with significant S^2d_i are unstable.The estimates on the three stability parameters, mean performance (X_i), regression coefficient (b_i) and deviation from regression (S^2d_i) for the different traits are presented in Table 3. Based on high mean values, unit b_i and non-significant S^2d_i values, none of the genotypes could be identified as stable for higher grain yield over three environments but the genotypes PRR-78, Ketaki Joha, Swarna Sub-1 and Nagina-22 with low mean, regression coefficient around unity with non-significant deviation from regression showed stability over all the three environments with low grain yield. The genotypes IR-79156B, HUR-2-1, GR-32, CR-2496 and GR-32 improved showed low grain yield were not suitable to improved environmental conditions based on low mean, low b_i values and non-significant S^2d_i values along with NDR-3026-3-1R for high grain yield with high mean, regression coefficient less than unity with non-significant deviation from regression. Whereas, the genotypes Pusa Basmati-1, IDR-763, Karahani, Kanak Jeer and Pant Dhan-12 for high grain yield per plant were considered as suitable under improved environment as they showed high means, higher b_i values and non-significant deviations from regression. The genotype Anjali was considered as stable for early flowering. The genotypes IDR-763 and Type-3 were found suitable for early flowering under favourable environment whereas the genotype HUR-2-1, NDR-3026-3-1R and Karahani were considered as suitable for early flowering under poor environmental conditions.

The genotype, Type-3, IR-80555B and Pani Dhan showed high mean, unit regression co-efficient

Table 3. Stability parameters for different characters over three environments for 29 genotypes of rice

Genotypes	Days to 50% Flowering			Days to Maturity			Plant Height(cm)		
	μ Mean	βi	σ^2di	μ Mean	βi	σ^2di	μ Mean	βi	σ^2di
HUR-5-1	92.67	-0.15	45.46***	129.22	0.11	34.01***	97.09	0.29	14.60
NDR-3026-3-1 R	88.89	0.57	-0.41	127.44	0.89	-0.27	95.54	0.20	1.00
PRR-78	88.22	0.10	2.16*	116.89	1.04	-0.45	109.81	0.89	2.36
Pusa Basmati-1	102.33	0.59	1.30*	136.67	0.54	-0.10	112.34	1.02	-2.34
IDR -763	95.89	3.60	0.82	134.67	1.73	63.85***	95.49	0.45	-1.07
HUR-3022	89.22	0.89	5.63***	120.22	1.58	59.49***	88.56	0.30	40.20**
Karahani	87.89	0.78	-0.43	121.00	0.49	5.59***	113.47	0.91	5.55
Sonachur	96.11	0.03	17.85***	129.00	1.48	-0.19	142.27	1.64	95.01***
KetakiJoha	112.56	3.12	159.21***	147.22	2.47	103.54***	141.21	0.67	2.75
Type-3	97.00	2.29	1.04	135.89	0.94	-0.25	143.42	0.44	15.19
Anjali	77.89	1.14	0.50	108.78	1.24	1.80*	93.84	0.78	-3.83
Pusa 6B	98.89	1.93	69.36***	137.44	1.37	23.09***	95.86	0.91	-2.04
IR-58025B	100.22	3.03	57.33***	137.22	1.46	8.45***	94.54	1.05	-2.45
IR-80555B	101.56	1.21	58.42***	138.00	0.90	0.92	84.98	1.19	1.03
IR-68897B	97.89	-0.07	6.69***	127.22	1.15	29.81***	91.52	1.02	-4.16
IR-79156B	92.11	-0.12	98.52***	130.78	1.63	42.76***	81.94	1.57	46.48**
BPT-5204	111.22	0.59	9.89***	149.00	0.67	3.30**	112.42	0.91	2.97
HUR-105	104.00	0.95	4.77***	134.78	0.69	0.31	104.26	1.10	-6.13
HUR-2-1	91.56	0.37	-0.37	126.00	0.73	-0.04	98.11	0.42	48.09**
Kala Namak	109.22	1.41	55.56***	145.67	0.67	3.30**	167.54	1.16	-5.55
GR-32	118.78	1.75	33.85***	150.78	1.93	20.06***	172.71	1.05	-5.17
CR-2496	114.44	1.43	10.26***	145.56	1.59	-0.48	130.30	1.01	79.14***
PaniDhan	113.78	1.47	8.04***	150.78	1.17	-0.09	148.98	0.69	44.51**
Swarna Sub-1	116.22	0.22	2.73**	141.78	-0.36	90.57***	93.68	-0.09	-6.48
Nagina-22	81.33	1.32	1.92*	115.56	0.88	2.25*	125.38	0.59	154.82***
GR-32 Improved	86.11	0.26	3.52**	128.78	0.52	-0.34	112.98	4.81	2436.92***
LohaChhad	107.44	0.13	15.40***	141.33	0.11	63.50***	172.60	1.82	28.03*
Kanak Jeer	118.22	0.89	5.63***	149.44	0.79	-0.44	160.46	1.48	52.89**
Pant Dhan-12	83.78	-0.77	22.40***	123.00	0.59	6.67***	85.83	0.74	12.73
Population Mean	99.15			133.80			116.11		

Genotypes	Number of tillers/plant			Effective tillers/ plant			Panicle Length(cm)		
	μ Mean	β i	σ^2di	μ Mean	β i	σ^2di	μ Mean	β i	σ^2di
HUR-5-1	16.02	1.34	-0.67	12.30	1.35	-0.98	26.17	0.94	2.12**
NDR-3026-3-1 R	15.67	1.16	-0.54	12.22	0.83	-0.97	26.13	1.00	-0.33
PRR-78	10.49	0.25	2.54	7.84	-0.05	1.33	27.08	0.62	5.72***
Pusa Basmati-1	17.44	1.96	8.08**	14.11	1.85	0.68	30.87	0.74	1.70*
IDR -763	16.18	1.82	0.79	13.07	1.59	-0.45	25.74	0.86	-0.20
HUR-3022	17.24	0.87	-0.88	13.93	0.86	-0.32	22.01	0.88	0.68
Karahani	20.91	1.82	2.39	17.84	2.60	0.30	20.42	0.70	1.67*
Sonachur	15.93	1.85	1.77	12.58	2.20	2.66	29.73	1.28	-0.28
KetakiJoha	15.76	1.76	1.52	12.98	1.81	0.27	22.44	0.90	-0.32
Type-3	17.20	2.40	4.30*	13.93	3.03	2.31	27.13	0.54	1.56*
Anjali	15.96	1.85	3.24*	12.73	2.07	2.81	23.76	1.32	3.16**
Pusa 6B	10.31	0.64	0.22	7.72	0.19	-1.01	25.36	1.37	3.11**
IR-58025B	11.27	-0.28	6.46**	8.68	-0.79	2.15	23.84	1.20	0.71
IR-80555B	13.82	0.30	1.31	11.11	0.25	0.77	21.89	1.40	4.22***
IR-68897B	13.69	1.20	-0.97	11.00	1.68	0.36	24.52	1.21	0.52
IR-79156B	10.31	-0.19	4.78*	7.11	-1.04	0.72	24.01	0.79	2.54**
BPT-5204	13.98	0.39	1.24	10.78	-0.09	1.87	23.99	0.46	3.20**
HUR-105	14.98	1.32	-0.36	11.80	1.61	-0.97	21.44	0.99	-0.32
HUR-2-1	11.76	0.35	0.73	8.51	0.97	-0.76	25.00	1.02	-0.28
Kala Namak	10.96	0.73	-1.01	8.29	0.82	0.14	26.29	1.18	1.70*
GR-32	9.66	-0.01	1.06	7.40	-0.23	0.35	31.28	1.32	3.80***
CR-2496	11.73	0.62	-0.88	8.98	0.52	-0.92	22.82	1.15	0.04
PaniDhan	16.81	0.55	-0.88	13.87	0.68	0.28	23.87	0.89	0.92
Swarna Sub-1	13.33	1.13	-0.96	10.51	1.09	-0.99	22.87	0.95	-0.24
Nagina-22	16.53	0.27	5.74*	13.20	0.50	0.54	22.42	0.55	6.97***
GR-32 Improved	12.24	0.08	2.37	9.89	0.21	-0.59	23.88	1.28	1.71*
LohaChhad	8.62	0.77	-0.86	6.87	0.35	0.03	29.94	1.23	-0.24
Kanak Jeer	19.33	2.26	1.96	15.60	2.46	-0.42	27.43	1.76	6.52***
Pant Dhan-12	16.60	1.82	-0.22	13.16	1.67	-0.96	25.46	0.44	4.22***
Population Mean	14.30			11.31			25.10		

Genotypes	Spikelets/ Panicle			Grains/ Panicle			Spikelets Fertility %		
	µ Mean	β i	σ^2di	µ Mean	β i	σ^2di	µ Mean	β i	σ^2di
HUR-5-1	187.18	1.15	22.50	155.07	0.61	-41.15	82.89	0.63	16.31
NDR-3026-3-1 R	185.87	0.92	-47.25	157.75	0.67	-42.71	84.93	0.76	*1.02
PRR-78	176.02	1.33	2139.63***	151.37	0.21	2868.82***	85.15	0.04	72.40***
Pusa Basmati-1	194.98	0.95	-51.86	163.61	1.16	-41.05	83.84	1.44	0.41
IDR -763	183.96	1.22	857.52***	152.16	1.16	547.03***	82.59	1.51	-2.58
HUR-3022	188.27	-0.80	311.52*	153.59	0.62	305.35**	83.09	0.80	4.85
Karahani	106.09	1.69	65.69	90.81	0.61	60.16	85.57	0.71	-2.00
Sonachur	292.22	1.20	220.68*	234.84	1.81	-36.21	80.39	1.52	20.74**
KetakiJoha	142.36	1.40	95.29	122.28	0.50	81.93	85.83	0.41	-2.47
Type-3	138.91	1.29	326.15*	114.20	0.92	397.74**	81.88	1.40	15.32*
Anjali	140.87	1.27	61.60	94.89	0.17	-9.67	67.31	-0.10	-1.73
Pusa 6B	223.04	1.29	183.72	174.94	0.89	-32.98	78.50	0.91	35.07***
IR-58025B	214.31	1.72	142.91	176.02	1.40	6.52	82.52	1.34	0.11
IR-80555B	144.38	1.06	-56.43	117.57	0.92	11.47	81.33	1.47	3.14
IR-68897B	285.93	-3.67	-50.69	234.29	0.99	769.57***	78.40	0.75	11.11*
IR-79156B	134.58	0.96	181.93	100.45	0.71	1014.63***	75.95	1.27	93.13***
BPT-5204	332.51	1.01	872.12***	269.00	1.88	500.09***	80.87	1.45	-0.76
HUR-105	193.36	1.20	-62.75	169.52	0.76	-36.81	87.66	0.74	3.39
HUR-2-1	180.33	1.48	1306.31***	145.50	0.73	715.41***	80.84	0.72	-2.04
Kala Namak	297.13	1.22	-29.51	249.54	1.68	-3.40	83.91	1.40	-1.05
GR-32	338.38	0.83	1336.09***	266.53	1.68	-20.41	79.43	1.21	120.92***
CR-2496	304.67	0.85	456.00**	202.60	1.26	440.72**	66.29	1.07	-0.80
PaniDhan	118.56	1.26	-56.25	98.73	0.87	-18.67	83.16	1.45	53.07***
Swarna Sub-1	186.67	1.63	953.72***	155.36	1.15	1304.29***	82.95	1.23	30.75***
Nagina-22	105.07	0.87	89.91	87.02	0.43	344.28**	82.39	0.80	72.44***
GR-32 Improved	225.87	1.83	729.16***	196.50	0.99	975.54***	86.89	0.73	9.86*
LohaChhad	346.76	1.49	222.82*	297.37	2.20	977.86***	85.60	1.55	31.97***
Kanak Jeer	329.87	1.38	-55.12	260.37	1.51	478.02***	78.82	1.04	44.93***
Pant Dhan-12	151.62	0.96	666.87***	109.69	0.50	1073.83***	71.68	0.74	83.23***
Population Mean	208.61			169.02			81.06		

Genotypes	Grain Weight/ Panicle(g)			Grain Yield/ Plant(g)			1000 Grain Weight(g)		
	μ Mean	β i	σ²di	μ Mean	β i	σ²di	μ Mean	β i	σ²di
HUR-5-1	2.74	2.85	0.28**	34.94	2.15	43.32*	19.65	1.57	0.20
NDR-3026-3-1 R	2.99	0.85	-0.03	34.29	0.07	-1.29	20.50	-0.62	1.71***
PRR-78	3.50	3.26	0.84***	27.03	1.12	-4.22	24.39	0.80	0.19
Pusa Basmati-1	2.87	0.43	0.04	40.52	1.39	-6.63	19.08	0.46	-0.10
IDR -763	2.88	0.91	0.02	37.86	1.43	-8.98	19.65	1.12	-0.16
HUR-3022	1.98	2.16	0.48***	28.20	1.42	127.43***	12.40	1.56	0.24
Karahani	1.78	0.71	-0.02	32.31	1.44	6.85	19.99	1.92	1.00**
Sonachur	2.10	2.30	0.00	28.20	2.00	20.99	9.81	1.28	0.53*
KetakiJoha	1.86	0.73	-0.02	24.31	1.01	4.70	14.40	1.76	1.04**
Type-3	1.99	1.29	-0.01	28.98	1.92	24.28	16.91	1.75	0.61*
Anjali	1.86	0.96	0.14*	24.59	1.14	81.46**	23.30	2.23	0.26
Pusa 6B	3.51	-0.93	1.02***	27.14	-0.10	54.91**	20.42	-1.77	6.01***
IR-58025B	3.50	-0.85	0.18**	30.78	-0.86	115.76***	19.62	-1.50	0.07
IR-80555B	2.08	2.13	0.16*	24.51	1.43	-7.91	18.45	1.17	0.03
IR-68897B	4.09	1.60	0.05	45.97	2.05	73.20**	20.61	-0.83	2.17***
IR-79156B	2.14	2.48	0.62***	12.57	0.42	-9.08	19.51	1.38	0.58*
BPT-5204	4.38	1.14	-0.02	47.19	0.54	33.51*	13.81	0.73	0.26
HUR-105	3.05	1.12	0.35***	36.60	1.73	35.87*	19.06	1.47	0.50*
HUR-2-1	2.51	0.29	-0.02	21.54	0.65	-7.66	18.13	1.29	-0.15
Kala Namak	3.84	0.18	0.12*	31.97	0.81	28.08*	11.88	1.37	-0.10
GR-32	3.16	-0.09	0.05	23.53	-0.13	25.53	10.34	0.40	0.07
CR-2496	2.26	-0.88	0.19**	20.16	-0.05	10.01	12.31	-1.62	3.74***
PaniDhan	2.53	-0.20	0.53***	34.64	0.28	41.97*	22.25	1.48	-0.12
Swarna Sub-1	2.61	0.79	0.00	27.39	0.87	-4.00	14.78	1.33	0.02
Nagina-22	2.07	1.45	0.01	27.58	1.05	-8.96	20.54	3.00	1.52**
GR-32 Improved	3.02	1.36	0.06	29.72	0.65	-6.77	13.21	3.14	4.03***
LohaChhad	8.13	0.69	0.28**	56.07	0.92	110.58***	23.55	1.04	1.62***
Kanak Jeer	2.53	0.72	0.10*	39.64	1.80	-4.75	8.07	1.07	0.62*
Pant Dhan-12	2.69	1.55	-0.03	35.54	1.86	-6.68	21.34	2.03	0.42
Population Mean	2.92			31.51			17.52		

* Significant at 5% level, ** significant at 1% level and *** significant at 0.1% level against pooled error

and non-significant deviation from regression, so considered as stable for long duration.The genotype Pusa Basmati-1, HUR-105 and Kanak Jeer were found suitable for long duration under poor environmental condition as they possessed high mean performance, b_i value less than unity and non-significant deviation from regression, whereas the genotype CR-2496 was found suitable for long duration under improved environmental condition. The genotype Sonachur was considered as suitable for short duration under favourable environmental condition based on low mean values, regression coefficient greater than unity and non-significant deviations from regression, whereas the genotypes HUR-5-1, HUR-2-1 and GR-32 improved found suitable for short duration under poor environmental condition as they have low mean values, regression coefficient less than unity with non-significant deviation from regression. Stability parameters identified PRR-78, Pusa Basmati-1, Karahani, Pusa 6B, IR-58025B, IR-80555B, IR-68897B, BPT-5204 and HUR-105 with low mean value, non-significant deviation from regression and regression coefficient around unity as the most stable for short plant height of the plant over the three environments whereas the genotypes Kala Namak and GR-32 found stable for tall plant height over the three environments.

The genotypes HUR-5-1, NDR-3026-3-1R, HUR-3022 and HUR-105 were considered stable for higher number of tillers over all the three environments. The genotypes IDR-763, Karahani, Sonachur, Ketaki Joha, Kanak jeer and Pant Dhan-12 were found suitable with higher tillers per plant for high yielding environment as they possessed high mean values, regression coefficient greater than unity, whereas the genotypes PRR-78, Pusa 6B, IR-80555B, BPT-5204, HUR-2-1, Kala Namak, GR-32, CR-2496, GR-32 improved and Loha Chhad were found suitable with less number of tillers for low yielding environment. The genotypes NDR-3026-3-1R and HUR-3022 identified as stable for high number of effective tillers per plant under all three environments. The genotypes HUR-5-1, Pusa Basmati-1, IDR-763, Karahani, Sonachur, Ketaki Joha, Type-3, Anjali, HUR-105, Kanak Jeer and Pant Dhan-12 were found to be suitable for higher number of tillers per plant under high yielding environment based on high mean values, high b_i values and non-significant S^2d_i values. The genotype Pani Dhan for higher number of effective tillers as possessed high mean, regression coefficient less than unity with non-significant deviation from regression.The genotypes NDR-3026-3-1R and IDR-763 found to be stable for long panicle. The genotypes Sonachur and Loha Chhad were identified to be suitable for long panicle under high yielding environment.

The genotypes HUR-5-1, NDR-3026-3-1R, Pusa Basmati-1, IR-80555B, IR-79156B, HUR-105 and Nagina-22 were found stable for more number of spikelets per panicle over all the three environments. The genotypes Pusa 6B, IR-58025B, Kala Namak and Kanak Jeer found suitable with more number of spikelets per panicle for high yielding environments as appeared with high mean value, regression coefficient greater than unity with non-significant deviation from regression. The genotypes Pusa 6B and HUR-105 were regarded as stable genotype for more number of grains per panicle over all three environments considering stability requirements of high mean performance, regression coefficient around unity, least deviation from regression. The genotypes Sonachur, IR-58025B, Kala Namak and GR-32 were found to be suitable for more number of grains per panicle over high yielding environment. The genotype HUR-105 was found suitable over low yielding environment.

The genotype HUR-3022 was found stable with high spikelets fertility percent.The genotypes Pusa Basmati-1, IDR-763, IR-58025B, IR-80555B and Kala Namak with high spikelets fertility percent were found responsible to improved environments. The genotypes NDR-3026-3-1R, Karahani, Ketaki Joha and HUR-105 with high spikelets fertility percent as appeared with high mean, regression coefficient less than unity with non-significant deviation from regression. The genotypes NDR-3026-3-1R and BPT-5204 with high grain weight per panicle were found suitable for all the three environments. The genotypes IR-68897B and GR-32 improved with high grain weight found responsible for improved environmental condition. The genotypes PRR-78, IDR-763 and IR-80555B could be identified as stable for 1000-grain weight over all three environments. The genotypes HUR-5-1, Anjali, HUR-2-1, Pani Dhan and Pant Dhan-12 with high 1000grain weight were found suitable to improved environmental conditions based on high means, higher b_i values and non-significant S^2d_i values.

The present study provided the information of genotypic and environmental performance of twenty nine genotypes over three environments. Significant differences among the genotypes and environment for yield traits suggested the presence of wide variability. Both components of genotypes x environment interaction were significant, indicating that the major portion of interaction was linear in nature and prediction about the environments was possible. Significant pooled deviations observed for yield traits, suggested that there are considerable genotypic differences (Bose *et al.*, 2012). Based on the stability parameters none of the genotype could be identified as stable for higher grain yield over three environments but, the genotypes PRR-78, Ketaki Joha, Swarna Sub-1 and Nagina-22 showed stability for low grain yield in all three environments. Whereas the genotypes NDR-3026-3-1R, Pusa Basmati-1, IDR-763, Karahani, Kanak Jeer and Pant Dhan-12 were considered as suitable for higher grain yield under improved environment.

REFERENCES

Ashraf MA,Bakhh and Haqqani AM 2003. Genotype-environment interaction for grain yield in Chickpea (Cicer arientum L.). Pakistan J. Bot. 35(2): 181-186.

Bose L K,Nagaraju M. and Singh O N 2012. Genotype x Environment interaction and stability analysis of lowland rice genotypes. Journal of Agricultural Sciences 57(1):1-8.

Comstock R E and Mall R H 1963. Genotype x environment interactions. In Statistical Genetics and Plant Breeding NASNRC pp: 164-196.

Eberhart S. A. and Russel W A 1966. Stability parameters for comparing varieties. Crop Science 6: 36-40.

Krishnappa M R, Chandrappa H M and Shadakshari H G 2009. Stability analysis of medium duration hill zone rice genotypes of Karnataka. Crop Research (Hisar) 38 (1/3): 141-143.

Mahapatra KC 1993. Relative usefulness of stability parameters in assessing adaptability in rice.Indian Journal of Genetics and Plant Breeding 53(4): 435-441.

Murphy K and Jones SS 2007. Genetic assessment of the role of breeding wheat for organic systems. Wheat Production in Stressed Environments, Springer Netherlands 12: 217-222.

Panwar LL, Joshi VN and Mashiat Ali 2008. Genotype x environment interaction in scented rice. Oryza 45(1): 103-109.

Pugilestari A Buang A , Ahmad J, and Hajrial A 2010. Yield stability and adaptability of aromatic new plant type (NPT) rice lines. J. Agron. Indonesia 38(3) : 199-204.

Venuprasad R, Shashidhar HE and Shailaja H 2003. Evaluation of performance of rainfed lowland rice cultivars of south Karnataka in two diverse environments. Mysore Journal of Agricultural Sciences 37(4): 294-300.

Francis VP and Kanakamany M T 2008. Stability analysis of eco-geographically diverse rice (*Oryza sativa* L.) cultures. Indian Journal of Crop Science **3**(1): 179-181.