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Stability Analysis for Yield and Yield Attributing Traits in Rice (*Oryza sativa* L.)

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A B S T R A C T

The present investigation was carried out during *kharif* 2016 at the Agricultural and Horticultural Research Station, Kathalagere and other five locations under University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, to know the stability of the Twenty three advanced genotypes including three checks of paddy. Highly significant differences among genotypes were observed for all the characters except number of number of tillers, panicles fertility percent. The variance due to Genotype x Environment found significant for the characters like days to maturity, Plant height, Panicle length (cm) and number of spikelets per plant. Environment (linear) interaction component was significant for all the traits. The variance due to pooled deviation (non- linear) was highly significant for all the characters except for harvest index which reflect considerable genetic diversity in the material. Out of 23 genotypes studied six entries viz., JT-2-16-1, JT-2-22-5, JA-4-3, JT-2-15-1, JB-1-20-2 and JK-1-7-5 were consistent and high yielding compared to local checks, from the present study genotype JA-6-2 was found to be a stable across the environments.

Introduction

Rice (*Oryza sativa* L.), belongs to the family Graminae, recognized as “Millennium Crop” expected to contribute towards food security in the world, as it is one of the staple cereal crops of the world and a primary source of food for more than half the world’s population. With an alarming increase in the population throughout the world, the demand for rice will continue to increase in near future. Therefore, rice breeders across the world aim at increasing the grain yield of rice (Song *et al.,* 2007). Worldwide, rice is cultivated in an area of about 161.4 million hectares, production of about 506.3 million tonnes and productivity of 3.14 tonnes per hectare. In India area under rice cultivation is 44.11 million hectare and production of about 105.48 million tonnes with 2.39 tonnes per hectare productivity. In Karnataka, it is grown in an area of 13.26 lakh hectares with production of 3541 thousand tons and productivity of 2.67 tonnes per ha (Annon, 2016). Yield is a complex quantitative character and is greatly influenced by environmental fluctuations; hence, the selection for superior genotypes based on yield *per se* at a single location in a year may not be very effective (Shrestha *et al.*, 2012). The assessment of stability of a genotype under different environments is useful for recommending cultivars for known conditions of cultivation. The stability of varieties over wide range of environments with high yield potential is desirable. It has always been emphasized by breeders as base before releasing an ideal variety for commercial cultivation (Singh and Shukla, 2001). For a genotype to be commercially successful, it must perform well across the range of environment likely to be encountered in a target region over the entire array of years in which the genotype could be in use. Beyond seasonal and location differences, however, cultivation conditions within season do transit from one condition to the other, as dictated by variability in moisture and other environmental indices.

The presence of G x E interaction is naturally makes it difficult to fully realise the potential of a genotype for a region in which weather varies from year to year. When the G x E interaction is significant, the plant and environmental factors that play a major role in causing differential performance, and their significance in determining desirable breeding strategies, must be carefully considered (Kang and Martin, 1987 and Yan and Hunt, 2000). Understanding the genotype x environment interaction has long been a key issue for plant breeders and geneticists. In crop performance, the observed phenotype is a function of genotype (G), environment (E) and genotype × environment interaction (GEI). GEI is said to occur when different cultivars or genotypes respond differently to diverse environments. Researchers agree that GEI is important only when it is significant and causes considerable changes in genotype ranks in different environments. If this interaction is more, then the stable performance of the variety is less and vice versa. Hence, testing of newly developed genotypes for their stable performance is vital across the different environments.

Materials and Methods

The experimental material for the contemporary study comprises of twenty advanced breeding lines of F_6 generation (Table 1.) with three checks Jyothi, KHP-2 and Tunga collected from Department of Genetics and Plant breeding, College of Agriculture Shivamogga. The research was carried out during *kharif* 2016. The experiment was laid out in Randomized Complete Block Design (RCBD) with two replications in puddle field at all locations (Table 2). Five plants in all the advanced breeding lines were selected at random from each replication for recording of observations on metric characters of these advanced breeding lines were used for recording all the below cited characters. The average of observations recorded on these five plants was considered for statistical analysis. Similarly plant morphological characters of each genotype were recorded by selecting single or group of plants depending on all characters at different stages of crop growth. Days to fifty per cent flowering, Days to maturity, Plant height (cm), Panicle length (cm), Number of tillers, Number of productive tillers per plant, Number of spikelets per plant, Number of grains per panicle, Panicle fertility (per cent), Test weight (g), Grain yield (kg/ha), Straw yield (kg/ha) and Harvest Index (%).To analyze the data over six environments the stability model proposed by Eberhart and Russel (1966) have proposed a dynamic approach for studying and interaction phenotypic stability from regression analysis. It enables selection of genotypes that may reasonably show stable performance over a range of environment was adopted.

Results and Discussion

In the present study stability parameters such as mean (μ), regression coefficient (bi) and deviation from regression (S^2di), as suggested by Eberhart and Russel (1966) were considered to explain and discuss the stability of different advanced breeding lines for various characters under consideration. From the pooled analysis of variance, it was evident that the significant mean squares due to environment (linear) for grain yield revealed differential response of the genotypes and environment, mean square for pooled deviation were significant for all most all the characters studied (Table 3). The results supported with the reports of Vanave *et al.,* 2014.

Table 4 shows that the advanced breeding lines JB-1-22-2 and JA-4-3 had less mean value for days to fifty per cent flowering than the population mean had regression coefficient unity and least deviation from regression, indicating that with respect to days to fifty per cent flowering, these advanced breeding lines show stable performance across the environments.

So, by using these advanced breeding lines in breeding programme can develop medium duration or short duration cultivars. JK-1-11-8, JA-4-2, JB-1-22-2, JA-6-3, JA-6-4 and JA-6-2 are identified as stable lines for specific locations these results were in associated with Basavaraj (1994) and Subramanya (1996). In other hand Koli *et al.,* (2015) reported that days to fifty per cent flowering is a stable character across the environment. The advanced breeding line JB-1-20-2 had less mean value for days to maturity than population mean, also had regression coefficient value is around unity and less deviation from regression. So, it is indicated that this advanced breeding line had stable performance across the environments and less sensitive to environment it can adapt to the diverse environments. These findings are agreement with those of Sawant *et al.,* (2006) and Praveen *et al.,* (2013). JA-4-2 and JA-6-2, JA-4-3, JA-6-2, JA-4-2, JA-6-2 and JA-4-2 identified as stable lines for specific locations. The advanced breeding line JT-2-16-1 had more mean value for plant height than the population mean also had regression coefficient value is around unity and less deviation from regression. Significant regression co-efficient was observed for JT15-3 and JK2 15-2 indicate that they were highly sensitive to environmental changes and rest of the advanced breeding lines had average stability. Basavaraj (1994) also identified advanced breeding lines with average responsiveness and also advanced breeding lines with higher environmental sensitivity.

Subramanya (1996) noted unpredictability of the genotypes for this trait. Similar results were also reported by Koli *et al.,* (2015). JT-2-16-1, JT-2-16-1, JT-2-22-5, JT-2-16-1, JT-2-22-5 and JT-2-16-1 are identified as stable lines for specific locations. The advanced breeding line JK-1-12-1 had more mean value than the population mean and also had regression coefficient value is around unity and less deviation from regression.

Similar results were reported Mahapatra and Sujathadas (1999). JT-2-16-1, JT-2-16-1, JB-1-11-7, JA-6-4, JA-6-2 and JA-6-4 identified as stable lines for specific locations. High mean values than the population mean, regression coefficient around unity and least deviation from regression were recorded for number of tillers per plant in the advanced breeding lines JB-1-11-7 and JA-6-3 indicating that their stability over wide range of environments. These findings are agreement with those of Umadevi *et al.,* (2008). JA-6-2, JK-1-7-5, JT-2-15-1, JT-2-16-1, JK-1-13-2 and JT-2-16-1 are identified as stable lines for specific locations.

Table.1 List of advanced breeding lines (F_6) used under present investigation including checks

Cross combinations	Code	Advanced breeding lines	Grain shape	Grain color
JYOTI x BILIYA	G1	JB-1-11-7	Medium slender	Light red
	G2	JB-1-20-2	Medium slender	Light red
	G3	JB-1-22-1	Medium slender	Light red
	G4	JB-1-22-2	Medium slender	Light red
	G5	JB-1-22-3	Medium slender	Light red
JYOTI x KESARI	G6	JK-1-7-5	Medium bold	Dark red
	G7	JK-1-11-8	Medium bold	Light red
	G8	JK-1-12-1	Medium bold	Light red
	G9	JK-1-13-1	Medium bold	Light red
	G10	JK2-2-1-8-1	Medium bold	Light red
	G11	JK2-1-12-1	Medium bold	Light red
JYOTI x AKKALU	G12	JA-4-1	Medium slender	Light red
	G13	JA-4-2	Medium slender	Light red
	G14	JA-4-3	Medium slender	Light red
	G15	JA-6-2	Medium slender	Light red
	G16	JA-6-3	Medium slender	Light red
	G17	JA-6-4	Medium slender	Light red
JYOTI x TUNGA	G18	JT-2-15-1	Medium slender	Light red
	G19	JT-2-16-1	Medium slender	Light red
	G20	JT-2-22-5	Medium slender	white
JYOTHI	G21		Bold	Red
KHP-2	G22		Slender	Red
TUNGA	G23		Bold	white

Table.2 Location of experiments conducted to evaluate rice genotypes for stability analysis

SL. NO.	Particulars	Environments					
1	**Locations**	AHRS, Kattalagere	UAHS, Shivamogga	AHRS, Honnavile	ZAHRS, Mudigere	AHRS, Bhavikere	AHRS, Ponnampet
2	**Latitude**	16°12' N	13.054° N,	13.9299° N,	13°8'3"N	12.50° N,	12.14907°N
3	**Longitude**	74°54' E	75.03930° E	75.5681° E	75°38'30" E	77.35° E	75.94052 °E
4	**Elevation**	598 meters	569 meters	570 meters	915 meters	566.7met	851 meters
5	**Average temperature**	25.5 °C	24.8 °C	24.6 °C	23.2 °C	36 °C	22.6 °C
6	**Average rainfall**	567 mm	909 mm	863 mm	610 mm	1104.2 mm	2173 mm

Table.3 Pooled ANOVA values for thirteen quantitative traits over six environments

Source of Variations	DF	X1	X2	X3	X4	X5	X6	X7
Rep within Evn.	6	0.82	13.52	4.62	0.53	1..67	0.51	57.53
Varieties	22	168.92**	868.42**	512.17**	2.48**	4.67*	5.29**	522.81**
Env.+(Var.x Env.)	115	51.62**	8.71	74.93**	1.66**	4.42*	1.71	184.72
Environments	5	868.06**	15.24	1293.62**	25.77**	35.45**	8.56**	845.53**
Var.x Env.	110	14.51	8.41	19.53	0.57	3.01	1.40	154.68
Environments(Lin.)	1	4340.31**	76.20	6468.11**	128.86**	177.27**	42.81**	4227.68**
Var.x Env.(Lin.)	22	18.42	4012	3.40	0.72	3.46	1.24	152.29
Pooled Deviation	92	12.94	9.07	22.54**	0.50**	2.77**	1.38**	148.53**
Pooled error	132	0.66	3.39	8.69	0.23	0.96	0.87	65.71
Total	137	70.45	146.77	145.14	1.79	4.46	2.29	23.01

Source of Variations	DF	X8	X9	X10	X11	X12	X13
Rep within Evn.	6	60.46	1.15	0.33	57622.57	139889.49	1.05
Varieties	22	563.92**	11.93*	10.48**	3332866.56**	2807513.59*	42.77**
Env.+(Var.x Env.)	115	157.35	7.37	1.92	296132.08*	479592.10	4.89
Environments	5	694.63**	23.30**	4.67*	1437879.31**	1873335.65**	3.32
Var.x Env.	110	132.93	6.65	1.79	244234.48	416240.12	4.96
Environments(Lin.)	1	3473.16**	116.52**	23.49**	7189396.54**	9366678.25**	16.61
Var.x Env.(Lin.)	22	106.99	7.82	2.55*	435198.69**	631680.12*	4.66
Pooled Deviation	92	133.35**	6.08**	1.53**	18750.23*	346624.47**	4.82**
Pooled error	132	66.17	0.50	0.26	124084.59	187533.05	2.39
Total	137	222.64	8.11	3.29	783782.87	853418.90	10.97

*& ** Significant at 5% and 1% respectively

Where,

X1 Days to 50% flowering	X5 Number of Tillers per plant	X9 Panicles fertility (%)	X13 Harvest index (%)
X2 Days to maturity	X6 Number of Productive tillers	X10 Test weight	
X3 Plant Height	X7 No. Of spikelets tillers	X11 Grain Yield (kg/ha)	
X4 Panicle Length	X8 No. Of grains per panicle	X12 Straw yield	

Table.4 Mean and stability parameters in 23 advanced genotypes of Rice

		Days to fifty per cent flowering			Days to maturity			Plant height (cm)			Panicle length (cm)			Number of tillers per plant			Number of productive tillers per plant			Number of spikelets per panicle		
Sl. No.	**Advanced breeding lines**	**Mean**	**S²di**	**Bi**	**Mean**	**S²di**	**bi**	**Mean**	**S²di**	**bi**	**Mean**	**S²di**	**bi**	**Mean**	**S²di**	**bi**	**Mean**	**S²di**	**bi**	**Mean**	**S²di**	**bi**
1	JB-1-11-7	96.83	1.61*	1.14	125.58	-1.74	0.31	67.08	19.20*	0.77	19.28	0.24	0.15*	19.21	-0.62	0.91	19.21	-0.62	0.91	161.92	864.08**	-0.90
2	JB-1-20-2	97.33	10.99**	1.14	128.33	2.73	0.96	77.66	12.65*	1.00	19.58	-0.08	0.83	18.67	-0.61	1.20	18.67	-0.61	1.20	169.58	17.25	0.80
3	JB-1-22-1	96.83	27.02**	1.07	127.08	4.84	0.78	82.44	6.05	1.06	19.59	-0.18	1.06	18.24	-0.16	2.17	18.24	-0.16	2.17	162.25	-31.93	0.86
4	JB-1-22-2	93.92	41.45**	1.00	125.92	-1.53	-0.87	82.67	2.45	0.90	19.38	-0.20	0.79	18.08	-0.21	1.79	18.08	-0.21	1.79	163.17	-38.36	0.55
5	JB-1-22-3	96.25	8.15**	1.14	126.75	8.60*	3.19	83.91	0.91	1.06	20.32	0.65**	1.03	18.78	1.22	0.99	18.78	1.22	0.99	174.67	45.20	1.15
6	JK-1-7-5	95.50	0.65	1.40*	126.92	14.01**	2.15	80.89	-3.71	1.15	19.37	0.14	1.01	19.33	-0.79	1.54*	19.33	-0.79	1.54*	163.50	-37.32	1.17
7	JK-1-11-8	94.75	13.74**	1.37	125.92	0.80	1.75	81.68	-4.17	1.11	19.00	-0.02	0.87	18.73	-0.17	1.55	18.73	-0.17	1.55	171.00	94.29*	-0.35
8	JK-1-12-1	95.00	7.75**	1.30	126.67	3.18	1.48	81.29	3.51	1.04	19.72	-0.10	0.98	18.98	-0.51	0.93	18.98	-0.51	0.93	165.50	-20.01	1.77
9	JK-1-13-1	96.67	11.30**	1.28	127.67	7.61*	2.58	79.91	4.02	0.98	19.37	0.20	1.26	19.13	1.66*	1.79	19.13	1.66*	1.79	170.33	112.46*	1.05
10	JK2-2-1-8-1	97.58	16.72**	0.87	124.25	5.13	1.69	81.11	1.25	0.99	20.03	-0.09	1.03	18.72	-0.35	1.88	18.72	-0.35	1.88	153.08	75.66	2.07
11	JK2-1-12-1	98.58	-0.47	0.94	126.33	14.17**	3.10	78.59	-3.55	1.17	19.62	0.68**	0.63	20.00	0.04	-0.70	20.00	0.04	-0.70	154.67	58.46	1.19
12	JA-4-1	99.83	7.46**	0.81	120.42	0.73	1.50	84.12	5.95	0.86	19.95	0.02	1.05	18.95	-0.23	1.31	18.95	-0.23	1.31	159.67	13.48	0.20
13	JA-4-2	93.25	22.77**	1.33	118.42	2.52	0.49	81.18	-5.31	0.90	20.12	0.66**	1.46	19.88	0.09	0.70	19.88	0.09	0.70	162.92	-6.79	1.73
14	JA-4-3	95.67	9.55**	1.00	118.75	-0.08	1.08	80.87	-2.02	0.94	19.70	-0.17	1.36*	19.58	1.50*	0.55	19.58	1.50*	0.55	162.83	17.08	2.16
15	JA-6-2	92.58	4.91**	0.47*	118.58	-2.68	-0.89*	82.58	0.08	0.84	20.45	0.74**	0.61	21.10	1.99*	-1.03	21.10	1.99*	-1.03	178.33	28.69	0.89
16	JA-6-3	95.17	7.29**	0.68	119.17	-2.11	0.53	80.38	-5.70	1.01	19.34	0.50*	0.99	19.40	0.61	0.64	19.40	0.61	0.64	163.50	271.68**	0.67
17	JA-6-4	96.92	19.00**	0.05*	120.17	-2.56	0.72	82.15	-0.27	1.01	20.59	0.62**	1.62	18.84	0.04	2.05	18.84	0.04	2.05	165.08	-13.86	1.48
18	JT-2-15-1	102.75	11.46**	1.22	149.67	14.60**	0.18	100.85	36.12**	1.08	20.16	-0.08	1.06	19.88	3.63**	1.42	19.88	3.63**	1.42	162.58	-30.54	0.12
19	JT-2-16-1	100.92	9.70**	0.84	149.08	22.75**	-0.64	107.89	71.88**	0.95	20.69	1.75**	1.85	19.23	1.06	0.15	19.23	1.06	0.15	155.67	-52.95	-0.26**
20	JT-2-22-5	98.83	6.71**	0.87	149.67	18.33**	0.23	102.12	102.80**	1.07	19.77	-0.05	0.96	20.31	3.21**	0.26	20.31	3.21**	0.26	166.58	302.55**	1.26
21	Jyothi	96.83	8.63**	1.21	132.17	-3.16	0.19	78.16	19.08*	0.94	17.62	0.33	0.97	16.50	0.86	0.78	16.50	0.86	0.78	135.67	103.70*	2.98
22	KHP-2	109.92	9.67**	0.81	153.25	3.17	1.33	82.84	35.39**	1.22	19.14	0.26	0.52	17.58	0.56	0.53	17.58	0.56	0.53	148.00	39.32	2.05
23	Tunga	116.00	26.21**	1.06	155.67	11.29**	1.14	98.78	26.14**	0.97				18.35	-0.75	1.62	18.35	-0.75	1.62	149.17	100.86*	0.38
	Mean	**98.17**			**130.28**			**84.31**			**19.66**			**19.04**			**19.04**			**161.72**		

Continued…

		Number of grains per panicle			Panicle fertility (per cent)			Test weight (g)			Grain yield (kg/ha)			Straw yield (kg/ha)			Harvest index		
Sl. No.	**Advanced breeding lines**	**Mean**	**S²di**	**Bi**	**Mean**	**S²di**	**bi**	**Mean**	**S²di**	**bi**	**Mean**	**S²di**	**bi**	**Mean**	**S²di**	**bi**	**Mean**	**S²di**	**bi**
1	JB-1-11-7	144.83	455.18**	-0.60	89.90	9.23**	2.87	30.74	0.29	-0.05	6026.63	-92232.61	0.83	7942.50	128655.11	2.46	43.24	0.82	2.50
2	JB-1-20-2	153.95	46.69	0.38	90.78	8.69**	1.42	30.06	5.85**	-0.28	6466.69	277102.89*	0.44	8093.33	117713.20	1.96	44.44	10.26**	3.89
3	JB-1-22-1	145.16	-42.84	0.65	89.51	12.11**	0.29	31.52	0.62*	-0.55	6490.38	-102165.83	0.30*	8119.17	40851.44	1.31	44.48	1.34	0.14
4	JB-1-22-2	147.37	1.08	0.10	90.27	6.78**	-0.29	29.61	0.80**	-0.15	6530.04	175040.21*	0.22	8337.50	39571.17	1.97	43.95	8.49**	4.90
5	JB-1-22-3	156.19	124.66*	1.36	89.28	10.81**	0.50	29.81	-0.08	2.64*	6459.36	303364.99**	-0.43	8346.67	35105.38	-0.06	43.60	2.95	5.66
6	JK-1-7-5	147.33	-31.59	0.87	90.13	6.05**	2.15	29.62	0.20	2.66	6875.67	176756.09*	-0.43	8728.33	-41520.19	0.57	44.04	1.63	1.98
7	JK-1-11-8	152.93	240.29**	0.09	89.24	9.04**	1.56	29.75	-0.11	1.68	6397.34	-12557.51	1.24	8105.83	361806.04*	2.23	44.24	1.83	2.38
8	JK-1-12-1	144.50	-54.80	1.35	87.41	6.65**	-0.99	30.64	0.04	1.35	6575.67	95776.87	1.26	8006.67	3470.32	0.70	45.11	1.76	-0.25
9	JK-1-13-1	155.08	80.27	0.96	91.02	0.07	-0.48*	29.69	0.16	2.68	6549.13	244994.25*	1.54	8340.83	-4518.89	0.70	43.90	0.95	-0.81
10	JK2-2-1-8-1	138.13	82.61	1.96	90.21	5.04**	2.56	30.11	1.62**	2.80	6352.49	-26221.86	1.29	8435.00	135465.77	-0.78	42.90	3.88*	2.21
11	JK2-1-12-1	140.82	10.61	1.02	91.10	3.63**	1.93	29.88	0.26	0.24	6177.71	54428.55	0.61	7824.17	-11295.77	0.23	44.09	-0.49	1.27
12	JA-4-1	145.70	-6.66	-0.02	91.23	1.23*	0.87	28.42	0.05	-1.32*	6634.93	-11067.75	0.46	8472.50	-34684.04	-0.12	43.91	1.10	0.85
13	JA-4-2	146.95	-32.34	2.22	90.11	1.77**	1.46	30.27	2.23**	1.42	6584.93	-45167.91	0.63	8474.17	-106266.60	-0.35*	43.73	0.51	2.29
14	JA-4-3	148.17	19.85	2.21	90.94	0.46	1.76	30.93	1.24**	0.79	6696.80	66107.04	0.21	8395.83	-152853.91	0.34	44.36	-0.30	1.81
15	JA-6-2	167.83	-4.39	1.12	94.12	-0.18	-0.09*	30.76	0.05	0.08	6865.83	-344.27	0.94	8599.17	-143760.05	0.30	44.38	-0.87	2.26
16	JA-6-3	146.17	163.47**	0.95	89.50	6.30**	2.62	29.89	1.68**	2.39	6477.90	-69897.93	1.36	8460.00	276175.59*	0.90	43.44	1.17	0.51
17	JA-6-4	149.10	-0.05	2.10	90.19	3.84**	1.56	30.40	2.07**	2.27	6456.39	-2367.73	2.27	8963.33	9808.13	1.67	41.83	2.12	1.06
18	JT-2-15-1	146.47	5.54	0.78	90.01	4.54**	2.05	30.09	0.31	1.02	7059.60	242504.26*	3.78	9891.67	848675.82**	3.98	41.51	3.65*	1.14
19	JT-2-16-1	142.33	-63.61	-0.29**	91.43	2.28**	-0.76	29.32	1.48**	-0.55	6827.72	248044.72*	3.41	9737.50	547211.51**	2.87	41.19	1.24	0.13
20	JT-2-22-5	152.17	341.57**	1.45	91.25	9.03**	2.16	30.51	3.02**	-0.25	7177.53	110844.45	2.81	10135.83	651461.76**	2.56	41.46	0.43	-1.15
21	Jyothi	118.42	181.04**	2.39	87.22	4.80**	0.95	25.09	-0.07	-1.97**	4093.06	52475.53	0.91	6994.17	50195.35	0.08	36.90	11.32**	0.34
22	KHP-2	132.73	-49.05	1.55	89.94	12.96**	-1.42	27.37	6.20**	1.56	4881.40	-81675.58	0.53	8443.33	471340.13**	-0.06	36.72	2.48	4.27
23	Tunga	132.10	83.43	0.41	88.53	2.60**	0.33	29.93	1.22**	4.56*	4788.67	-68369.08	-1.15**	8680.83	484138.77**	-0.44	35.57	0.83	-5.83*
	Mean	**145.84**			**90.14**			**29.76**			**6323.73**			**8501.23**			**42.69**		

The three advanced breeding lines JB-1-11-7 and JA-4-2 had more mean value for number of productive tillers per plant than population mean, also had regression coefficient value is around unity and very less deviation from regression. So, it is indicated that the genotype had stable performance across the environments. These findings are agreement with those of Vishnuvardhan *et al.*, (2015). JA-6-2 and JT-2-22-5, JA-6-2 and JT-2-22-5, JT-2-15-1, JB-1-22-3 and JK-1-7-5, JK2-1-12-1 and JK2-1-12-1 are identified as stable lines The advanced breeding line JA-6-2 had more mean value for test weight than population mean also had regression coefficient value is around unity and less deviation from regression. So, it is indicated that this advanced breeding line had stable performance across the environments and less sensitive to environment it can adapt to the diverse environments. JA-6-4, JA-6-4, JA-4-2, JA-4-2, JB-1-20-2 and JA-4-2 are identified as stable lines for specific locations. This is on par with results of Deshphande *et al.,* (2003), Arumugam *et al.,* (2007), Panwar *et al.,* (2008), Ramya and Senthilkumar (2008) and Krishnappa *et al.,* (2009). Among twenty advanced breeding lines including checks line JA-6-2 had more mean value than population mean also had regression coefficient value is around unity and less deviation from regression. Therefore, it is indicated that this advanced breeding line had stable performance across the environments and it can adapt to the diverse environments. Hence, it can be used as stable line adopted across the environments and could be released for large scale trials. JT-2-16-1, JT-2-22-5, JA-4-3, JT-2-15-1, JB-1-20-2 and JK-1-7-5 are identified as suitable lines for specific locations. These results are also reported by Mall *et al.,* (2013). The advanced breeding line JK-1-7-5 had more mean value for straw yield per hectare than population mean also had regression coefficient value is around unity and less deviation from regression. So, it is indicated that the advanced breeding line had stable performance across the environments and less sensitive to environment it can adapt to the diverse environments. JT-2-22-5, JT-2-15-1, Tunga, JT-2-15-1, JT-2-15-1 and JT-2-22-5 are identified as stable lines for specific locations. These findings are in conformity with Patil *et al.,* (2013). High mean value than the population mean, regression coefficient around unity and least deviation from regression were recorded for harvest index in the advanced breeding line JA-4-1 indicating that their stability over wide range of environment.JK2-2-1-8-1, JK-1-12-1, JA-6-3, JB-1-22-2, JA-4-1 and JB-1-20-2 are identified as stable lines for specific locations.(Gourishankar *et al.,* (2008), Ramya and Senthilkumar (2008) and Krishnappa *et al.,* (2009)).

Different measures of stability have been used by various workers earlier, Finlay and Wilkinson (1963) considered linear regression slopes as a measure of stability. Eberhart and Russel (1966) emphasized the need of considering both linear and nonlinear component of Genotype x Environment interaction in judging the stability of genotypes. Later Breese (1969); Samuel *et al.,* (1970); Paroda and Hayes (1971) and Jatasra and Paroda (1978) emphasized that the linear regression could simply be regarded as a measure of response of a particular genotype whereas deviation around the regression line was the most suitable measure of stability. In the present study the stability was assessed by the parameters suggested by Eberhart and Russel (1966).

The term stable genotype has been used for the average performance in all environments. Hence, such a stable variety has a high mean, unit regression and a minimum deviation from regression. From the present study it is concluded that genotypes JA-6-2 was found to be a stable across the environments and this genotype can also be used as a donor parent for generating new breeding material for development of variety with good stability for irrigated conditions. However, this needs to be verified by testing the breeding lines over the season and over the locations for one more year under rain fed condition.

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