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Stability analysis of yield and its components in rice (*Oryza sativa* L.)

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Abstract
The present investigation was carried out at Agriculture Research Station, Palghar with seven rice varieties released by DBSKKV, Dapoli during four consecutive *kharif* seasons *viz*., 2015, 2016, 2017 and 2018 for five yield and yield contributing traits. The experiment was laid out in Randomized Block Design (RBD) with three replications. The analysis of variance of stability for variety, environment, Var. x Env., Env.+Var. x Env., Env. (Linear), Env. x Var. (Lin) and pooled deviation was highly significant for all the yield contributing traits under study. Based on observed results, all the varieties are stable for grain yield over the seasons. Among these, Karjat 7 and Karjat 184 reported high stability for days to 50 per cent flowering, panicle length, spikelets per panicle and grain yield, where the regression coefficient (bi) was near unity with low deviation from regression (S^2di). Palghar 1 performed highly stable for panicle length, spikelets per panicle and grain yield, while the regression coefficient (bi) was near unity with low deviation from regression (S^2di). Thus, Karjat 7, Karjat 184 and Palghar 1 are ideally adaptable, stable and may be recommended for cultivation for *kharif* season in north konkan region of Maharashtra state.

Keywords: Rice, stability, genotypes x environment

Introduction

Rice (*Oryza sativa* L.) is the staple food of about more than one third population of the world. Its demand is increasing day by day as per the increase in the population, hence varietal adaptability to environmental fluctuations is important for the stabilization of crop production over both the regions and years. Food security programme depends on high yielding varieties by increasing yield potential and yield stability (Puji Lestari *et al.*, 2010) [8]. 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 programme.

Rice has unique position in Indian economy. India ranks second in rice followed by China. In India, rice occupies an area of 43.38 million hectares with annual production of 104.32 million tones and productivity is 2.4 tones/ha (Anonymous, 2015-16). In Maharashtra, the total area occupied by this crop is about 15.33 lakh hectares with annual production of 26.27 lakh tones and productivity is about 1.71 tones/ha (Anonymous, 2015-16). The major rice growing districts in Maharashtra are Palghar, Thane, Raigad, Ratnagiri, Sindhudurg and some part of Nashik, Bhandara and Chandrapur in the eastern parts of the states and minor areas are Tuljapur, Prabhani, Western ghat of Pune, Satara, Kolhapur, parts of Nanded. Maximum productivity is observed in Konkan region and it contributes 42.25% of total rice production in state.

The adaptation of a cultivar over different environments is usually tested by the level of its interaction 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 variation in yielding capacity when grown over varied environments (Ashraf *et al.*, 2003) [2]. The model of stability analysis suggested by Eberhart & Russell (1966) [5] to test the stability of genotypes under different environments. A variety with a high mean yield over the environments, unit regression coefficient (bi=1) and variation from regression as minimum as possible ($S^2di = 0$), will be a superior choice as a stable variety.

One of the effective factors to study of stability is to determine interaction between genotype and environment and it was studied by many researcher on the various genotypes of rice (Aslam and Anhar, 2007 [3], Blanche and linscombe, 2009 [4], Kumar *et al.*, 2010 [7] and

Puji Lestari *et al.*, 2010) [8]. The stability of yield in cultivars in different places can be due to cultivar performance that derived from a specific collection of genes (G), the characteristic that associated factors of the environment in which it is grown (E) and the interaction between genotype and environment which are usually conducted in various years and locations to satisfactorily stand for spatiotemporal variation. In the presence of large numbers of interaction (G×E), the selection of perfect cultivar will be hard because of the explanation of data is difficult for breeders (Blanche and linscombe 2009) [4]. The aim of this research work to identify the most stable rice variety for north konkan region of Maharashtra state.

Materials and methods

The experimental material comprised of seven released rice varieties *viz*., Karjat-3, Karjat-7, Palghar 1, Palghar 2, Ratnagiri 5, Ratnagiri 24 and Karjat 184 developed by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The pedigree and the physical grain quality characters of the genotypes were given in Table 1. The verities were evaluated during four consecutive *kharif* seasons from *kharif* 2015 to *kharif* 2018 at Agriculture Research Station, Palghar (19º 45' N and 72º 41' E) on an elevation of 6 m above sea level. The meteorological data on the farm showed that the experimental field had mean annual rainfall of 2824.70 mm, 3700.40 mm, 2629.40 mm and 2351.60 mm in 2015, 2016, 2017 and 2018 cropping seasons, respectively.

The experiment was laid out in Randomized Block Design with three replications. The seedlings were transplanted at the age of 21-25 days maintaining a spacing of 20 x 15 cm between and within the rows, respectively. The plot size was 10 m^2. All the recommended cultural practices were adopted to raise the crop. Observations on days to 50 % flowering, plant height, panicle length, spikelets per panicle and grain yield per plot were recorded.

The analysis of variance for each season was conducted the mean genotypic values for each season was taken for analysing the data over the seasons. The characters which recorded significant G x E were used for stability analysis of Eberhart and Russell model (1966) [5]. A genotype with unit regression coefficient (bi=1) and deviation not significantly different from zero (S^2di=0) was taken to be a stable genotype with unit response.

Table 1: Pedigree and grain type of rice varieties

Variety	Pedigree	Grain type
Karjat 3	IR36 / KJT 35-3	Short Bold
Karjat 7	Patel 3 / KJT 9-333	Long Slender
Palghar 1	IR 22 x Palghar 141-1	Medium Slender
Palghar 2	IR-5 x Zinia –63	Short Slender
Ratnagiri 5	Zinia 63 x TN 1	Short Slender
Ratnagiri 24	Zinia 63 x IR 64	Short Slender
Karjat 184	T(N)-1 x K-540	Medium Slender

Table 2: Analysis of variance for stability performance for grain yield and its components in rice

Source	DF	Days to 50 per cent flowering	Plant height (cm)	Panicle length (cm)	Spikelets per panicle	Grain yield (t/ha)
Variety	6	6.82**	20.35**	4.01**	161.17**	0.05
Environment	3	184.18**	14.55**	18.17**	1513.40**	0.99
Var. X Env.	18	18.07**	32.34**	4.65**	153.54**	0.04
Env.+Var. X Env.	21	41.80**	29.79**	6.58**	347.81**	0.18
Env. (Linear)	1	552.52**	43.64**	54.52**	4540.20**	2.97
Env. X Var. (Linear)	6	23.64**	21.66**	8.44**	359.80**	0.03
Pooled Deviation	14	13.10**	32.29**	2.36*	43.21**	0.04
Pooled Error	48	4.81	9.13	2.20	63.50	0.03

* & ** Significant at P=0.05 and P=0.01 respectively when tested against pooled error.

Table 3: Stability parameters of yield and yield contributing traits in rice

Genotype	Days to 50 % flowering			Plant height (cm)			Panicle length (cm)			Spikelets per panicle			Grain yield (t/ha)		
	Xi	Bi	S^2di	Xi	Bi	S^2di	Xi	Bi	S^2di	Xi	Bi	S^2di	Xi	Bi	S^2di
Karjat-3	91.25	-0.09	49.25**	98.04	2.21	35.98**	24.83	1.76	1.18	190.67	1.52	51.84**	3.89	1.27	0.07
Karjat-7	94.00	1.16	9.15**	99.99	2.00	20.86**	24.49	2.02	0.61	194.83	1.41	-12.56**	3.75	0.94	0.00
Palghar-1	90.50	1.13	10.55**	97.58	2.26	46.87**	23.54	1.87	0.83	189.00	1.83	2.09	3.80	1.07	0.00
Palghar-2	91.83	1.53	6.30**	94.41	1.47	30.70**	23.21	1.67	1.08	191.00	1.57	42.38**	3.62	1.41	-0.02
Ratnagiri-5	91.33	1.50	3.66*	96.70	2.35	27.85**	24.56	0.01	2.14	180.25	0.34	75.88**	3.69	0.81	0.02
Ratnagiri-24	89.33	0.78	-0.42	93.78	-1.02	5.51**	24.89	-0.12	3.36*	180.33	0.33	13.89**	3.59	0.72	0.08
Karjat 184	90.25	0.99	1.97	98.72	-2.27	36.97**	22.28	-0.20	0.56	179.33	0.01	-19.19**	3.61	0.78	0.05

* and ** significant at p- 0.05 and p-0.01 respectively, Xi- mean, bi-regression coefficient and S^2di-deviation from the regression

Results and discussion

The analysis of variance for stability showed that the genotype (G) and environment (E) differences were highly significant to days to flowering; plant height, panicle length, spikelets per panicle except grain yield per ha (Table 2) which indicated a wide range of variability among the genotypes performance. The G x E interaction when tested by collective error it was significant for all the factors, indicating that the majority of interaction was linear in nature and forecast over the environments was possible (Satit *et al.*, 2000 and Sarawgi *et al.*, 2000) [11, 10]. The variation in both linear trend and non-linear trend relative to all the traits were significant, where it was corroborated by Kulkarni *et al.*, (2000) [6]. Eberhart and Russell (1966) [5] confirmed that a need for considering both the linear and non-linear trend in order to evaluate yield and other parameters of stability of genotypes as well as both the linear regression coefficient and deviation from regression for phenotypic stability. Similar results reported by Kumar *et al.*

(2010) [7], Reddy and Choudhary (1991) [9], Singh *et al.* (1995) [12] and Vijaya Lakshmi (2014) [13].

The data on the three stability parameters including mean performance (xi), regression coefficient (bi) and deviation from regression (S^2di) have been shown in the table 3 and figure 1 relative to various factors.

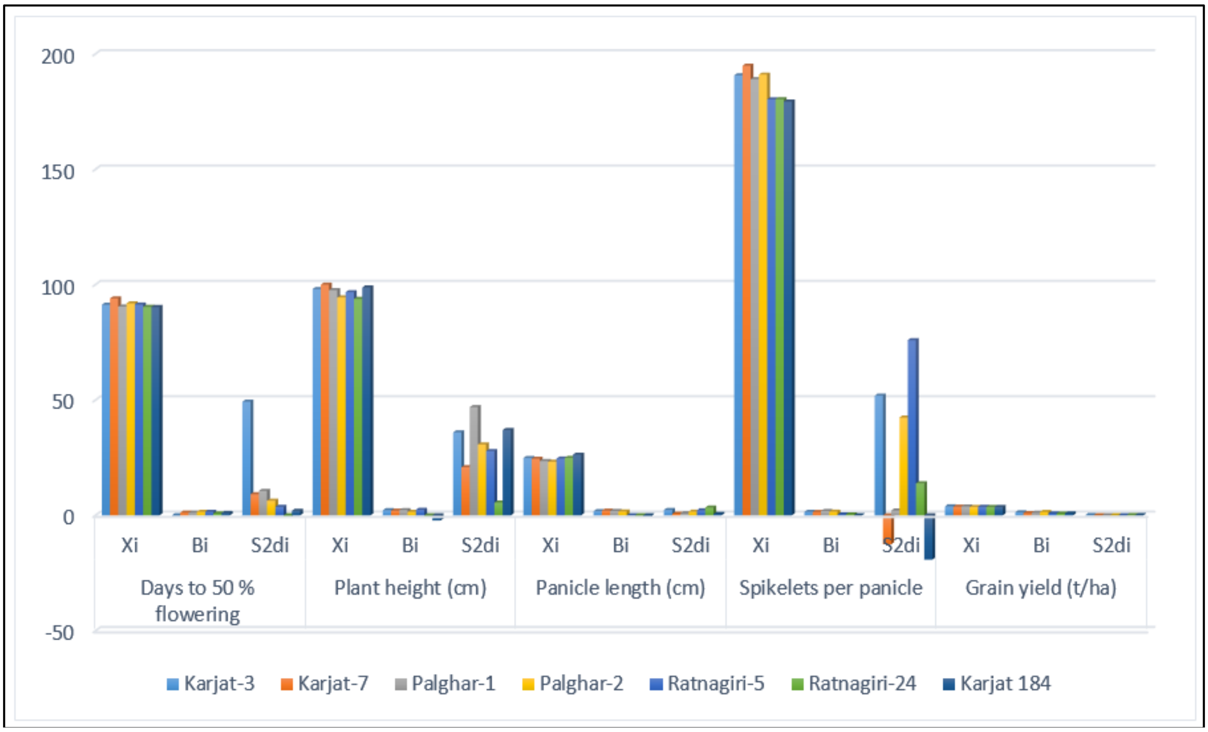

Fig 1: Stability parameters of yield and yield contributing traits in rice

The data revealed that, mean performance ranged for the traits, days to 50 per cent flowering 89.33 days (Ratnagiri 24) to 94.00 days (Karjat 7), plant height (cm) 93.78 (Ratnagiri 24) to 99.99 (Karjat 7), panicle length (cm) 22.28 (Karjat 184) to 24.89 (Ratnagiri 24), spikelets per panicle 179.33 (Karjat 184) to 194.83 (Karjat 7) and grain yield (t/ha) 3.59 (Ratnagiri 24) to 3.89 (Karjat 3). Similar results reported by Sarawgi *et al.* (2000) [10], Satit *et al.* (2000) [11], Aslam and Anhar (2007) [3] and Vijaya Lakshmi (2014) [13].

The divergence from regression for days to 50 per cent flowering was highly significant in all the varieties except Ratnagiri 24 and Karjat 184. Ratnagiri 24 was recorded approximately a unit regression coefficient (0.78) and low S^2di value (-0.42) and it required minimum days for 50 per cent flowering (89.33 days) over the seasons. It revealed that, Ratnagiri 24 is stable variety for earliness. For plant height, the divergence from regression was highly significant in all the varieties under study. Similar results reported by Sarawgi *et al.* (2000) [10], Satit *et al.* (2000) [11], Aslam and Anhar (2007) [3] and Vijaya Lakshmi (2014) [13].

The divergence from regression for panicle length was non-significant in all the varieties except Ratnagiri 24. The data showed that (Table 3), highest panicle length with regression coefficient near unity and low S^2di value for Palghar 1 (Xi-23.54, bi- 1.87 and S^2di-0.83) followed by Palghar 2 (Xi-23.21, bi- 1.67 and S^2di-1.08) and Karjat 3 (Xi-24.83, bi- 1.66 and S^2di-1.18). It revealed that, these three varieties considered to be stable for panicle length over the seasons. Similar results reported by Kumar *et al.* (2010) [7], Reddy and Choudhary (1991) [9], Singh *et al.* (1995) [12] and Vijaya Lakshmi (2014) [13].

For spikelets per panicle, the divergence from regression (S^2di value) was highly significant in all the varieties except Palghar 1. From Table 3, Karjat 7 exhibited highest number of spikelets per panicle (194.83) with regression coefficient near unity (1.41) and low deviation from regression (-12.56). Hence, Karjat 7 is presumed to be stable over the season for the same trait. Similar results reported by Kumar *et al.* (2010) [7], Reddy and Choudhary (1991) [9], Singh *et al.* (1995) [12] and Vijaya Lakshmi (2014) [13].

All the varieties showed non-significant deviation from regression for grain yield. The data of grain yield (t/ha) showed that (Table 3), the regression coefficient near unity and zero (approximately) S^2di value with highest grain yield (t/ha) for Karjat 3 (Xi-3.89, bi- 1.27 and S^2di-0.07) followed by Palghar 1 (Xi-3.80, bi- 1.07 and S^2di-0.00), Karjat 7 (Xi-3.75, bi- 0.94 and S^2di-0.00), Ratnagiri 5 (Xi-3.69, bi- 0.81 and S^2di-0.02), Palghar 2 (Xi-3.62, bi- 1.41 and S^2di- -0.02), Karjat 184 (Xi-3.61, bi- 0.78 and S^2di-0.05) and Ratnagiri 24 (Xi-3,59, bi- 0.72 and S^2di-0.08). It revealed that, these all the varieties opined to be stable for grain yield over the seasons. Similar results reported by Kumar *et al.* (2010) [7], Reddy and Choudhary (1991) [9], Singh *et al.* (1995) [12] and Vijaya Lakshmi (2014) [13].

Based on observed results, Karjat 7, Karjat 184 and Palghar 1 exhibited high stability for grain yield where the regression coefficient was near unity with low deviation from regression. The varieties Karjat 3 and Ratnagiri 24 indicated moderate stability. Thus, it is concluded that the rice varieties *viz.*, Karjat 7, Karjat 184 and Palghar 1 is ideally adaptable, stable and may be recommended for cultivation for *kharif* season in north konkan region of Maharashtra state.

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