Sustainability Index as an Aid for Determination of Genotypic Stability in Aromatic Rice (*Oryza Sativa L.*) under Transplanted Condition in South-Eastern Plain Zone of Rajasthan

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Abstract

An experiment was conducted during *kharif* (2006-2010) season to determine the sustainability index and genotypic stability of seven released rice varieties under transplanted condition of South-Humid plane Zone of Rajasthan. The highest sustainability index (%) and high mean yield was recorded in variety P-1121 (91.28 % and 4.65 t/ha) followed by P-2511 (89.88 % and 4.56 t/ha.), P-1460 (85.58 % and 4.38 t/ha) and Pusa Basmati-1 (86.55% and 4.11 t/ha), whereas moderate sustainability index was observed in Mahi Sugandha (73.92 %) and Taraori Basmati (73.53%). Based on high yield performance and sustainability index, varieties *viz.*, P-1121 (Pusa Sugandh-4)), P-2511 (Pusa sugandha-5) and P-1460 (Improved Pusa basmati-1) can be used as parent in future breeding programme.

Key words: Sustainability index, genotypic stability, aromatic rice, best performance and standard deviation.

Rice, *Oryza sativa* (2n=24) is the second most important cereal and stable food for more than one third of the world's population. Varietal adaptability to environmental fluctuations is important for the stabilization of crop production over both the region and years. An information on genotype x environment interaction leads to successful evaluation of stable genotype, which could be used for general cultivation. Yield is a complex quantitative character and is greatly influenced by environmental fluctuation; hence selection for superior genotype based on yield per se at a single location in a year may not be very effective. Thus, varietal stability is of paramount importance for stabilizing the production over region and seasons especially in decreased farm holdings and resource poor farmer conditions. This lays a heavy emphasis on developing technologies while keeping sustainability of small farmer and his resources as the top priority. In subsistence agricultural system, yield *per se* may be less important than reaching a certain yield level (Fox *et al*., 1997). Therefore, development of varieties and hybrids with stable performance is gaining ground to help achieve sustainability in agricultural production. To achieve this, first concept is to select the genotype with the smallest deviation from its production potential. The use of sustainability

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index in terms of varietal stability gives an indication about the stability of a variety across the location and over the years. In rice, phenotypic stability has been studied by various workers (Nurmalina 2008 and Baber *et al.*, 2009). However, the information on the use of sustainability index for assessment of varietal stability is lacking in rice. Hence the present investigation was undertaken to determine the sustainability index of seven aromatic rice genotypes evaluated for five consecutive years (2006-2010).

Materials and Methods

The experimental material consisted of six aromatic rice varieties namely, Pusa Basmati-1, Pusa Sugandh-3, Pusa Sugandh-4, Pusa Sugandh-5, Mahi Sugandh and Taraori Basmati (Pusa Basmati-1 and Taraori used as checks) were evaluated at Agricultiral Research Station, Ummedganj, Kota, Rajasthan in completely randomized block design with three replications with row to row spacing of 20 cm. and plant to plant spacing of 10 cm. The grain yield was recorded on plot basis and was estimated in tonnes/ha. The four year data on each variety were used for estimation of sustainability index. The sustainability index was estimated according to following formula used by other workers (Singh and Agarawal, 2003; Gangwar *et al*., 2004 and Tuteja, 2006).

$$\textbf{Sustainability index} = \frac{\text{Average performance} - \text{Standard Deviation}}{\text{Best performance}} \times 100$$

The value of sustainability index were arbitrarily divided in to five group *viz*. very low (up to 45%), low (46– 60 %), moderate (61-75%), high (76-90) and very high (above 90%).

Results and Discussion

The yield differences were found to be significant over the years, indicating genetic difference among the varieties studied. For drawing meaningful interference, the yield (best performance) and sustainability index could be divided into four groups as follows;

Yield (Best Performance)	Sustainability index	Remarks
High	High	Desirable
High	Low	Location specific
Low	High	Undesirable
Low	Low	Undesirable

In the present study (Fig-1), Pusa Sugandh-4 recorded highest grain yield and has highest sustainability index (4.89 t/ha and 91% respectively), indicating the best performance of this variety. The high level of best performance coupled with high value of sustainability index could be taken as the indication of close proximity between the best performance and the average performance over the years. This explains the good stable performance of Pusa Sugandh-4 over the years. The second best genotype was Pusa Sugandh-5 which recorded best performance of 4.81 t/ha and sustainability index of 90 percent. The variety Mahi Sugandh although recorded high

yield of 4.43 t/ha, however its sustainability index was moderate indicating its inconsistent performance over the years. This variety gave the highest performance during the year 2010, thus it was adaptable to specific situation only. The yield performance and sustainability index of remaining genotypes were poor to average indicating their unstable performance over the years. From the present investigation, it's concluded that the variety Pusa Sugandh-4 was the most suitable followed by Pusa Sugandh-5, Improved Pusa Basmati-1 and Pusa Basmati-1. It is suggested that variety Pusa Sugandh-4, Pusa Sugandh-5 and Improved Pusa Basmati-1 can be used as a parents in future breeding programme for evolving genotypes with high sustainability of grain yield.

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.Table 1: Estimation of sustainability index (%) for seven genotypes of aromatic rice

Particulars / Year	Grain Yield performance in different years (t/ha)						
	Pusa Sugandh-4	Pusa Sugandh-5	Pusa sugandh-2	Improved Pusa Basmati-1	Mahi Sugandha	Pusa Basmati-1	Taraori basmati
2006	4.41	4.18	3.24	3.86	3.13	3.94	2.72
2007	4.65	4.53	3.46	4.15	3.54	3.86	3.05
2008	4.56	4.69	3.82	4.52	3.85	3.98	2.93
2009	4.72	4.81	3.59	4.65	3.78	4.45	3.36
2010	4.89	4.56	3.99	4.69	4.43	4.27	3.75
Mean yield (q/ha) over years	4.65	4.55	3.62	4.37	3.75	4.10	3.16
Standard deviation	0.18	0.23	0.29	0.35	0.47	0.24	0.40
Best performance (q/ha)	4.89	4.81	3.99	4.69	4.43	4.45	3.75
Sustainability index (%)	9.12	8.98	8.33	8.55	7.39	8.65	7.35

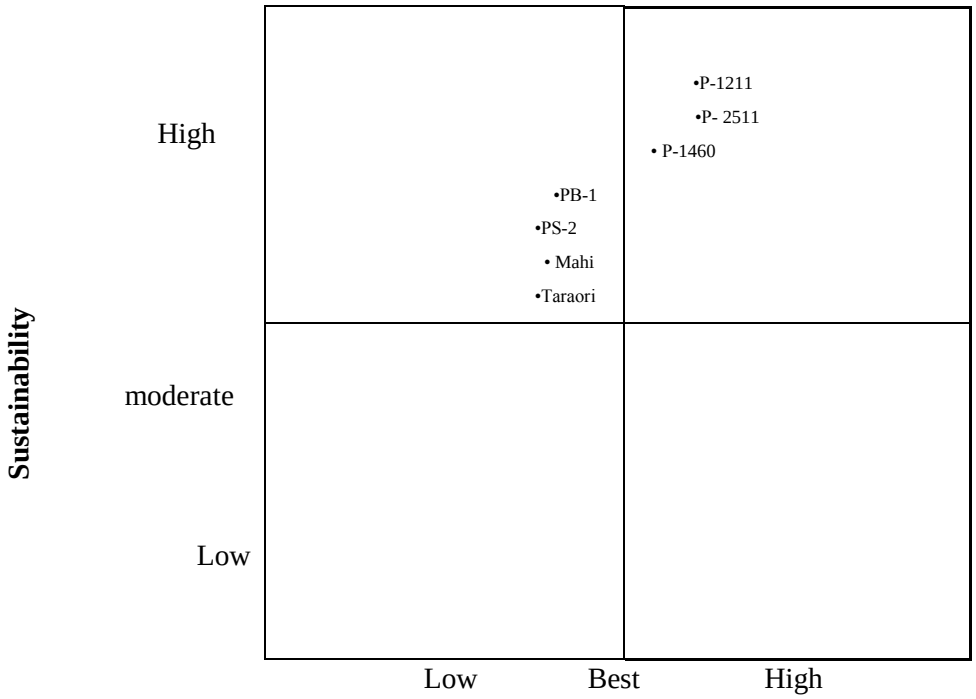

Figure 1: Grouping of genotypes as per their best performance and sustainability indices

Abstract

Production potential of rice varieties under different nitrogen levels was studied for four consecutive seasons i.e., *kharif* 2007 and 2008 and *rabi* seasons of 2007 and 2008 at Jagtial. Results revealed that during *Kharif* 2007, varieties JGL-1798, JGL-11470 and JGL-3855 were equally superior in terms of grain and straw yields and nitrogen uptake. During *kharif* 2008, varieties JGL-11470 and JGL-3855 recorded significantly superior grain, straw yield and N uptake over other varieties tested. During *rabi* 2007-08, variety JGL-3855 recorded significantly superior grain yield and nitrogen uptake over other varieties. While during 2008-09 *rabi,* there were no significant differences in grain and straw yields and N uptake among varieties. The response to applied nitrogen was observed up to 100 % RDN (100 kg N ha^{-1}) during *Kharif* 2008 and up to 150% RDN (180 kg N ha^{-1}) during *rabi* seasons of 2007-08 and 2008-09, respectively. Soil available nitrogen status was significant only during *rabi* 2008-09. Lower soil nitrogen values were recorded in plots fertilized with 150% RDN.

Key words: Rice varieties, nitrogen levels, yield and nitrogen uptake.

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Rice (*Oryza sativa* L.) is the principal cereal crop of India and world. Andhra Pradesh is considered as rice granary and enjoys a pride place among rice growing states of India. With ever increasing population, demand for rice will continue to increase. In this endeavour, in addition to high yielding rice varieties, efficient use of nutrients play an important role. Among the major plant nutrients, nitrogen is most important for augmenting rice yield. Rice is the major consumer of fertilizer nitrogen and accounts for one third of the total nitrogen consumption in the country.

Application of optimum dose of nitrogen to rice is gaining importance because nitrogen is a key nutrient in crop production that it can never be ignored. It is crucial for individual farmer as well as to the country to get the maximum economic benefit out of a huge recurring expenditure.

Identification and use of high yielding potential cultivars, though ensures higher yields, the actual yield advantage depends on the agronomic management including that of nitrogen management. Yield potential of a cultivar could be exploited to a maximum extent by judicious management of applied nitrogen.

As nitrogen deficiency is universal, significant yield increase due to nitrogen use is common. In general, about 10-12 kg of rice is obtained per every kg of applied nitrogen. Magnitude of response varies with season, soil characteristics, variety and cultural practices (Pillai *et al*., 1976).

Identification of location specific cultivar and optimum nitrogen dose are essential for increasing the productivity of rice. Such information is lacking for the newly developed rice cultivars *viz;* JGL 1798, JGL 3844, JGL 3855 and JGL 11470 under Northern Telangana region during *kharif* and *rabi* seasons. Keeping these points in view, the present investigation was initiated during *kharif* and *rabi* seasons on sandy clay soils of Jagtial.

Material and Methods

Field experiments were carried out for four consecutive seasons of k*harif* 2007 and 2008 and *rabi* 2007 and 2008 at Regional Agricultural Research Station, Jagtial, Karimnagar, Acharya N.G. Ranga Agricultural University, Andhra Pradesh. The soil of the experimental site was sandy clay in texture, low in organic carbon (0.42%) and available nitrogen (198 kg ha^{-1}) medium in available phosphorus (18.6 kg ha^{-1}) and high in available potassium (384 kg ha^{-1}). The treatments consisted of four rice varieties *viz*., JGL 1798, JGL 3844, JGL 3855 and JGL 11470 and four nitrogen levels 100% RDN (RDN-100 kg N ha^{-1} during *kharif* and 120 kg N ha^{-1} during *rabi*) 125, 150 and 175% RDN, The experiment was laid out in randomized block design with factorial replicated thrice. Seedlings of 30 days old were transplanted at 15 cm x 15 cm spacing @ two seedlings per hill. Nitrogen (Urea) was applied as per treatments in three equal splits (1/3 as basal, 1/3 at maximum tillering and 1/3 at panicle initiation stage). Phosphorus (50 and 60 kg ha^{-1}) and potassium (40 kg ha^{-1}) were supplied through single super phosphate and muriate of potash and were uniformly applied to all plots as basal during *kharif* and *rabi* seasons. Recommended agronomic practices and plant protection measures were followed. Concentration (%) of N was estimated in plant samples as per Jackson (1973). The uptake of nitrogen (N) was calculated as a product of concentration and total biomass.

Results and Discussion

Grain Yield

Effect of varieties

It is evident from the data (Table 1) that during *kharif* 2007, among the rice varieties tested, JGL-1798 recorded significantly higher grain yield (7102 kg ha^{-1}) over JGL-3844 (6052 kg