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Comparative study of system of rice intensification and conventional method of rice cultivation in Madurai district of Tamil Nadu

J. PONNI PRIYA*, R.VEERAPUTHIRAN, V.GANESARAJA, T.PANDISELVI AND B.J.PANDIAN[1]
Department of Agronomy, Agricultural College and Research Institute, Madurai, (T.N.) INDIA

ABSTRACT

Twenty two on farm demonstrations on System of Rice cultivation (SRI) were carried out in 12 hectares of farmers fields in Alangampatti and Karungalagudi village, Manimuthar sub basin, Madurai district of Tamil Nadu during November 2008 – February 2009 under Tamil Nadu-Irrigated Agriculture Modernization and Water Bodies Restoration and Management (TN – IAMWARM) Project. Two methods of rice cultivation *viz.*, SRI and conventional were compared. The results revealed that adoption of SRI favorably influenced all the yield attributes of rice *viz.*, number of productive tillers m^{-2}, length of panicle and numbers of grains $panicle^{-1}$. Significant superiority of SRI in terms of grain yield was also evident due to 17.0 per cent yield increment by SRI than conventional method of rice cultivation. Higher grain yield coupled with substantial water saving (24.1 per cent) resulted in higher Water Use Efficiency of rice under SRI method. Higher gross income, net profit and benefit cost ratio were also associated with SRI than conventional method of rice cultivation. The cost of cultivation was comparatively lesser in SRI which resulted in gaining an additional net profit of Rs.11,000 ha^{-1} in SRI as compared to conventional method of rice cultivation.

Key words : SRI, Yield attributes, Grain yield, Water use, Economics

INTRODUCTION

Rice is the most water consuming food crop of India and Tamil Nadu. In Tamil Nadu rice crop alone consumes about 80 per cent of the total water available in the state. The present water status demands for the scientific management of available water efficiently to achieve the twin objectives of higher productivity and better water use efficiency. At present non- availability of labour, escalating input cost coupled with water shortage leads to non economic of rice cultivation. System of Rice cultivation (SRI) is the modern and alternative method of rice cultivation for reduced usage of water and other inputs. The concept of SRI includes transplanting young seedlings early, carefully, singly and widely spaced with soil kept well aerated. The Manimuthar sub basin is one of the sub basins in Tamil Nadu with a drainage area of 16751 ha. This basin comprises of four minor-basins *viz.*, Manimuthar, Virisuliyar, Thirumanimuthar and Palar and spreads over in six taluks in three districts of Tamil Nadu namely Madurai, Sivagangai and Ramanathapuram. The major focus of this basin is to promote water saving technologies, to enhance crop and water productivity and to increase the cropped area by diversification. Therefore, an attempt was made to study the performance of SRI in comparison with the conventional method of rice cultivation in the Manimuthar sub basin area.

MATERIALS AND METHODS

Twenty two on farm demonstrations on System of Rice Intensification (SRI) were carried out in farmer's fields of Alangampatti and Karungalagudi village covering an area of 12 hectares in Manimuthar sub basin of Madurai district during November 2008 – February 2009 under Tamil Nadu-Irrigated Agriculture Modernization and Water Bodies Restoration and Management (TN – IAMWARM) Project. The available soil fertility status of the study area was low in Nitrogen, high in Phosphorus and medium in Potash and sandy clay loam in nature. Two methods of rice cultivation *viz.*, SRI and conventional were compared by using the variety ADT 39. In SRI, the concepts *viz.*, lesser seed rate of 7.5 kg ha^{-1} raised in 100 m^{-2} mat nursery, transplanting of 14 days old seedlings at 25 x 25 cm spacing, irrigating 2.5 cm depth of water after hair line crack formation up to panicle initiation and after that one day after disappearance of ponded water and weeding using rotary weeder at 10, 20, 30 and 40 Days After Transplanting (DAT) were followed. In conventional method of rice cultivation, use of a seed rate of 30-60 kg ha^{-1} in 800 m^{-2} nursery area, seedling age 21-30 days with 15 x 10 to 20 x 15 cm, irrigation 5 cm depth one day after disappearance of ponded water and manual weeding twice at 15 and 30 DAT were practiced. The total water use was calculated by adding irrigation water applied and effective rainfall. The biometric observation on yield attributes and grain yield were recorded. Water use and economics were also analyzed.

RESULTS AND DISCUSSION

The results obtained from the present investigation

*** Author for correspondence** [1]TN-IAWARM Cell, WTC, Tamil Nadu Agricultural University, COIMBATORE (T.N.) INDIA

as well as relevant discussion have been presented under following sub heads :

Yield attributes :

The results on yield attributes (Table 1) revealed that SRI showed a favorable influence on all the yield attributes of rice. Adoption of SRI recorded 638 number of productive tillers m^{-2} which was significantly higher than that of conventional method of rice cultivation (507). The length of panicle and numbers of grains $panicle^{-1}$ were also significantly higher under SRI than farmer's practice of rice cultivation. SRI registered 218 grains $panicle^{-1}$ and 22.6 cm length of panicle. Similar results of higher yield attributes with SRI than conventional method were reported by Senthil Kumar (2002).

Grain yield :

The grain yield of rice was substantially increased due to adoption of SRI (Table 1). SRI registered a mean grain yield of 6082 kg ha^{-1} which was significantly higher than conventional method of rice cultivation (5223 kg ha^{-1}). Thus significant superiority of SRI in terms of grain yield was evident due to 17.0 per cent yield increment by SRI. Veeraputhiran *et al* (2008) also obtained 23.1 per cent yield improvement by SRI than farmers practice in Tamirabarani Command areas of Southern Tamil Nadu. Higher yield attributes like number of productive tillers m^{-2}, length of panicle and numbers of grains $panicle^{-1}$ attributed the higher grain yield of SRI. These results of higher grain yield with SRI corroborate with the findings of Makarim *et al.* (2002) and Ganeshraja *et al.* (2008). Rajendran *et al.* (2003) also registered 48 and 35 per cent higher yield under SRI than traditional method of rice cultivation at TRRI, Aduthurai and SWMRI, Thanjavur, respectively. Similarly Bommaiasamy (2005) reported that planting 14 days old seedlings at 20 x 20 cm spacing with single seedling was a viable establishment technique for SRI method of rice cultivation which recorded 7.2 per cent higher yield than 21 days old seedlings.

Water use studies :

The water use studies of both the rice cultivation methods (Table 1) clearly indicate the beneficial effect of SRI in terms of water saving and higher Water Use Efficiency (WUE). The total water use of rice including effective rainfall was drastically reduced (1185 mm) due to intermittent and alternate wetting and drying type of irrigation under SRI which was lesser than that of farmers practice (1471 mm).Thus, there was a substantial quantity of water saving by 24.1 per cent was evident due to the adoption of SRI. The higher grain yield coupled with enormous water saving under SRI method resulted in higher WUE of rice in the study area. The mean WUE of SRI was 5.15 kg ha mm^{-1} and it was only 3.54 kg ha^{-1} mm^{-1} in conventional method. Similar water saving and higher water use efficiency under SRI was also observed by Veeraputhiran *et al.* (2008) in Thirunelveli District of Southern Tamil Nadu.

Economic analysis :

The economic feasibility of both the method of rice cultivation (Table 1) revealed that the cost of cultivation was comparatively lesser in SRI than that of conventional method. The mean cost of cultivation for SRI and conventional method was Rs. 20,944 ha^{-1} and Rs. 23,111

Table 1 : Comparision of SRI and conventional method on Grain yield, water use and economics of Rice cultivation (Mean of 22 demonstrations)

Sr .No.	Particulars	System of Rice cultivation	Conventional method of rice intensification	S.E. ±	C.D. (P=0.05)
1.	No. of productive tillers m^{-2}	638	507	37.3	77.5
2.	Panicle length (cm)	22.6	19.8	0.73	1.52
3.	No. of grains $panicle^{-1}$	218	184	15.4	33.2
4.	Yield (kg ha^{-1})	6082	5223	49.1	102.1
5.	Percent yield increase	17.0	-	-	-
6.	Total water use (mm)	1185	1471	-	-
7.	Percent water saving by SRI	24.1	-	-	-
8.	Water use efficiency (kg $ha^{-1}mm^{-1}$)	5.15	3.54	-	-
9.	Cost of cultivation (Rs ha^{-1})	20,944	23,111	-	-
10.	Gross income (Rs ha^{-1})	61,000	52,167	-	-
11.	Net income (Rs ha^{-1})	40,056	29,056	-	-
12.	Additional net income by SRI (Rs ha^{-1})	11,000	-	-	-
13.	Benefit - Cost ratio	2.91	2.26	-	-

ha^{-1}, respectively. Thus it is evident that adoption of SRI was found to reduce the cost of cultivation by Rs.2167 ha^{-1}. In addition, higher gross income, net profit and benefit cost ratio were also associated with SRI than conventional method of rice cultivation. SRI registered a total income of Rs.61, 000 ha^{-1}and net profit of Rs.40,056 ha^{-1} as compared to Rs.52,167 ha^{-1} and Rs. 29,056 ha^{-1}, respectively under conventional method. Regarding Benefit-Cost ratio (BC ratio), higher BC ratio was also associated with SRI (2.91) than conventional method (2.26). Lesser cost of cultivation coupled with higher gross and net income under SRI resulted additional economic benefit. Adoption of SRI gained an additional net profit of Rs.11, 000 ha^{-1} as compared to conventional method of rice cultivation.

Thus the results of the demonstration on SRI clearly indicated that adoption of SRI leads to 17.0 per cent higher yield, substantial water saving (24.1 %), higher water use efficiency and better economic benefits which will pave way for sustainable rice production and higher standard of living of the farming community of the Manimuthar sub basin study area.

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Genetic divergence studies in rice

DEBORA GANTA AND D.P.B. JYOTHULA*
Department of Genetics and Plant Breeding, Allahabad Agricultural Institute- Deemed University, ALLAHABAD (U.P.) INDIA

ABSTRACT

Genetic diversity among twenty five genotypes of rice of different geographic origin was studied by considering twelve quantitative characters. Analysis of variability revealed the presence of considerable amount of variability among the genotypes for all the twelve quantitative characters. The multivariate analysis following Mahalanobis D^2 statistics, revealed considerable genetic diversity in the material and led to their grouping into six clusters. The three characters, *viz.*, plant height, biological yield and flag leaf width appeared as the major source of divergence. On the basis of genetic distance, cluster means and per se performance a crossing programme involving diverse genotypes like RNR 196, SKL-61-14-15-10, BGL-11694 is suggested to obtain superior segregants for yield improvement.

Key words : Variability, Heritability, Genetic divergence, Clusters, Rice

INTRODUCTION

Parental diversity plays a vital role in the success of any hybridization programme. Improvement in any character primarily depends on the genetic variability of the parents. The more diverse the parents, the greater the chances of obtaining heterotic progeny and broad spectrum of variability in the segregating generations (Arunachalam, 1981). Therefore, in the present study an attempt was made to classify the parents in to different clusters by multivariate D^2 analysis (Mahalonobis, 1936).

MATERIALS AND METHODS

The 25 genotypes were used for this work and seeds of each of these genotypes were sown in nursery beds in June 2006 and transplanted in July . The row to row distance was maintained 20 cm and the plant to plant distance was maintained 15 cm. Genotypes were sown in a Randomized Block Design with three replications. Observations on plant height, days to 50% flowering, number of tillers plant^{-1}, number of effective tillers plant^{-1}, panicle length, flag leaf length, flag leaf width, number of spikelets panicle^{-1}, biological yield, harvest index, test weight and grain yield plant^{-1} were recorded, using five random plants excluding the border plants. Analysis of variance and covariance of means were carried out for all the twelve traits by the method advocated by Panse and Sukhatme (1967) and by Burton (1952), respectively. Further, the analysis of genetic divergence using Mahalanobis's D^2 statistic was carried out as described by Rao (1952). On the basis of the magnitude of the D^2 values the genotypes were grouped into number of clusters. The genotypes were grouped into various clustrers by Tochers method (Rao, 1952). After formation of clusters, the average inter and intra cluster distances were calculated.

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the genotypes for all the traits (Table 1) indicating the presence of variation among the genotypes used in the present study. From the Table 2, it is evident that the maximum genotypic variance, high heritability (B.S) along with genetic advance as per cent

Table 1 : Analysis of variance and coefficient of variability (CV%) for 12 characterS

Sr. No.	Characters	Source of variation		
		Genotypes d.f.=24	Error d.f.=48	CV %
1.	Plant height	119.75**	0.452	6.22
2.	Days to 50% flowering	29.27**	0.302	3.01
3.	Number tillers per plant	8.20*	1.097	10.04
4.	Number of effective tillers per plant	3.94*	2.034	5.51
5.	Panicle length	13.40**	0.248	8.25
6.	Flag leaf length	24.62**	0.584	10.15
7.	Flag leaf width	0.12**	0.002	18.81
8.	Number of spikelets per panicle	4561.66**	205.961	21.30
9.	Biological yield	449.71**	6.434	15.47
10.	Harvest index	421.83**	13.465	29.63
11.	Test weight (1000 grain weight)	7.11**	2.009	4.88
12.	Grain yield per plant	138.84**	3.023	22.08

* and ** indicate of significance of values at P = 0.05 and 0.01, respectively,

*** Author for correspondence** Present Address : Agricultural Research Station, Ragolu SRIKAKULAM (A.P.) INDIA

Table 2 : Estimates of genetic parameters for 12 quantitative characters in 25 genotypes of rice

Character	Phenotypic variance (σ^2p)	Genotypic variance (σ^2g)	Environmental variance (σ^2e)	Coefficient of variance		Heritability (BS) %	Genetic advance as per cent of mean
				Phenotypic	Genotypic		
Plant height	40.22	39.76	0.45	6.26	6.22	98.9	12.75
Days to 50% flowering	10.04	9.61	0.43	3.14	3.07	95.1	6.19
Number tillers per plant	3.46	2.36	1.09	12.15	10.04	68.3	17.11
Number of effective tillers per plant	2.47	0.43	2.03	13.12	5.51	17.6	4.76
Panicle length	4.63	4.38	0.24	8.48	8.25	94.6	16.54
Flag leaf length	8.59	8.01	0.58	10.51	10.15	93.2	20.19
Flag leaf width	0.04	0.04	0.002	19.32	18.81	94.8	37.74
Number of spikelets per panicle	1657.86	1451.90	205.96	22.76	21.30	87.6	41.07
Biological yield	154.19	147.76	6.43	15.80	15.47	95.8	31.2
Harvest index	149.58	136.12	13.46	31.06	29.63	91.0	58.23
Test weight (1000 grain weight)	3.71	1.70	2.00	7.21	4.88	45.9	6.82
Grain yield per plant	48.29	45.27	3.02	22.81	22.08	93.7	44.05

of mean was recorded for the character, number of spikelets per panicle, suggesting preponderance of additive gene action in the expression of this character. The same result was also reported by Datke *et al*.(1997), Yadav (2000),Nayak *et al*.(2004) and Madhavilatha *et al*.(2005).This type of character could be improved by mass selection and other breeding methods based on progeny testing. Whereas low genetic variance, low heritability and low genetic advance as per cent of mean was noticed in number of effective tillers per plant. This result is in contrast to the findings of Patil *et al*. (2003), where they have reported high heritability associated with high genetic advance for ear bearing tillers. The characters plant height, days to 50% flowering, panicle length, flag leaf length and flag leaf width showed high heritability with low genetic advance as per cent of mean indicating equal emphasis of both the additive and non-additive gene effects in the inheritance of these traits. In such cases selection should be delayed for advanced generations. Das *et al*.(2005) in their investigation reported the same finding for the character panicle length.

Based on genetic distance, the 25 genotypes of rice were grouped into 6 clusters (Table 3). Cluster I was the largest comprising 9 genotypes, followed by cluster III with 8 genotypes, cluster IV with 3 genotypes, cluster V and VI with 2 genotypes, cluster II was monogenotypic. The clustering pattern of the genotypes showed that genetic diversity was not related to geographic distribution. Many genotypes from different regions were grouped into one cluster like I, III and IV indicating the possible ancestral relationship while developing genotypes. The results are in consonance with the findings of Mokate *et al*. (1998), Bansal *et al*.(1999), Naik *et al*.(2006) and Yugandhar Reddy *et al*.(2006).

Table 3 : Distribution of 25 genotypes of rice into different clusters

Cluster	Genotypes included	Number of Genotypes
I	CBO1-001 , RPHR635-1-9-4 , UPR 3199-464-1-2 , NDR-9930076 , NDR 3112-1 , HKR 2002-86 , RDR 898, CRAC 2224-1048 , NARENDRA 359	9
II	HKR 2002-85	1
III	HKR2002-87 , RPHR650-2-5 , R112-69-1-45-1 , CRK 22-1-2 , OR 1912-25 , CRK 26-1-2-1 , JAYA , JGL 7046	8
IV	RNR 196 , SKL-61-14-15-10 , BGL-11694	3
V	NP 36 , SYE 97-22	2
VI	KJT8-2-392-17-15 , CB02-081	2

The average intra cluster D values ranged from 0.00 (cluster II) to 326.85 (cluster IV) (Table 4). The maximum inter cluster distance was observed between cluster II and VI (6215.29) followed by Cluster II and V (3522.05), cluster II and IV (2132.05).

The cluster means for various traits (Table 5) showed that genotypes in cluster II showed highest biological yield, cluster IV showed medium tillering, highest number of effective tillers per plant, highest harvest index and highest

Table 4 : Intra (diagonal) and inter- cluster average distance for 25 genotypes of rice

Cluster	I	II	III	IV	V	VI
I	173.088	830.141	365.356	658.526	1263.912	2862.048
II		0.000	1797.807	2132.057	3522.052	6215.294
III			167.980	418.746	565.503	1658.825
IV				326.852	567.522	1818.887
V					153.623	829.312
VI						308.577

Table 5 : Cluster mean values for 12 quantitative characters of 25 rice genotypes

Cluster No.	Plant height (cm)	Days to 50% flowering	No. of tillers per plant	No. of effective tillers per plant	Panicle length (cm)	Flag leaf length (cm)	Flag leaf width (cm)	No. of spikelets per panicle	Biological yield per plant (g)	Harvest index (g)	Test weight (g)	Grain yield per plant (g)
I	97.64	98.93	15.01	11.83	24.21	25.85	0.96	156.15	79.50	33.32	26.65	26.54
II	88.68	93.75	14.70	10.81	24.12	28.52	0.96	145.32	88.46	28.80	26.50	25.48
III	102.63	102.10	15.29	12.19	25.63	26.88	0.96	164.90	80.45	35.00	26.84	27.37
IV	97.71	104.29	16.01	12.87	26.18	30.19	1.34	240.75	71.03	56.11	27.11	40.42
V	108.08	101.56	15.36	12.13	29.08	31.90	1.46	218.55	87.57	50.04	25.25	43.80
VI	116.71	102.38	15.98	12.11	25.05	33.21	1.34	220.66	64.12	53.53	25.18	34.65

Table 6 : Tentative crossing programme to obtain superior segregants

Sr. No.	Possible crosses	Cluster combinations	Characters to be improved
1.	RNR 196 X NP 36	IV X V	Grain yield and number of spikelets per panicle
2.	SKL-61-14-15-10 X SYE 97-22	IV X V	Grain yield and number of spikelets per panicle
3.	BGL-11694 X KJT 8-2-392-17-15	IV X VI	Number of spikelets per panicle and test weight
4.	NP 36 X BGL-11694	V X IV	Number of spikelets per panicle and plant height.

test weight, cluster V showed highest panicle length, highest flag leaf width, and highest grain yield per plant and cluster VI contain intermediate plant height and highest flag leaf length.

These observations suggest that inter crossing of genotypes from cluster IV, cluster V and cluster VI showing good mean performance may help in obtaining intermediate height with highest flag leaf length and highest grain yield per plant. Evaluation of such recombinants may be useful in identifying intermediate, high yielding rice varieties.

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