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Effect of Varieties and Methods of Planting on Performance of Rice under Organic Farming

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A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during late *Samba* season (2017-18) to study the effect of varieties and methods of planting on productivity of organic rice. The experiment was laid out in split plot design with three replications. Four varieties (V_1 - Rice CO-52, V_2 - *Jeeraga samba*, V_3 - *Kitchili samba* and V_4 - Improved white ponni) were grown in main plot and three planting methods (P_1 - Random planting, P_2 - Line planting and P_3 - SRI method) were allotted to sub-plots. The experimental results revealed that Rice CO-52 registered lesser plant height (113.2 cm), higher drymatter (10330 kg/ha), LAI (4.70), total number of tillers (441/m^2), number of productive tillers (394/m^2), total number of grains and filled grains, grain yield (3780 kg/ha) and harvesting index. Among methods of planting, SRI method of planting registered higher growth characters, yield attributes and yield of rice than other methods of planting. Hence, it is inferred that SRI method enhanced productivity of rice under organic farming.

Key words: Organic farming, Traditional rice, Planting methods, Performance of rice.

Rice is the foremost cultivated crop all over the Globe and India. India ranks the second globally with production of 109.68 m.t. followed by China. In India, Tamil Nadu ranks the eleventh in position with production of 2.36 m.t. (Indiastat, 2017). It is estimated that by 2020, at least 170 to 180 m.t. (115 to 120 m.t. milled rice) of rice is to be produced at a productivity of 4.03 t/ha to feed the expected population of India (Mishra *et al.*, 2006). Due to green revolution in mid-1960's, short statured rice varieties, pesticides and fertilizers were introduced. Exorbitant use of pesticides and fertilizers, the soil environment got polluted. Organic farming is a unique option to recover the hostile effects of soil environment that being polluted. In organic farming, synthetic fertilizers and pesticides are not used for farming operations. Organic farming which depend upon the practices of organic manures such as FYM, poultry manures, goat manures, vermi-compost, crop residues and mulching which are naturally available in the farm (Pretson *et al.,* 1996). Among different methods of crop establishment of rice in India, transplanting is major method in spite of the fact that it requires more labour (Ali *et al.,* 2006). Manual transplanting is the most common practice of rice cultivation in South and South East Asia. Before 1980s, the rice seedlings are transplanted at random without any specified spacing. Later on, the rice seedlings are transplanted in line with wider row spacing with narrow plant to plant spacing. For the past two decades, the system of rice intensification (SRI) is gaining momentum all over globe especially in India.

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There are different traditional as well as high yielding rice varieties cultivated in India in general and Tamil Nadu in particular. These varieties are gaining awareness now-a-days because of easy adaption to organic farming. Under organic farming, the farmers of Tamil Nadu practising all three transplanting methods (random planting, line planting and SRI) and they are using most of the traditional varieties. However, there is no such research evidence on the impact of varieties under different methods of planting under organic farming. Hence, the present study was formulated.

Material and Methods

A field experiment was conducted at Wetland farms of the Department of Farm Management, Tamil Nadu Agricultural University, Coimbatore during late samba (September to February) season of 2017-18. Experiment was conducted at 11°N latitude, 77°E longitude with an altitude of 427 m above Mean Sea Level (MSL). The soil of the experimental field was clay loam in texture with the pH, EC and organic carbon (%) of 8.3, 0.3 and 0.6, respectively. The available nitrogen, phosphorous and potassium of the soil before experimentation was 296, 9.7, 285 kg/ha, respectively. The study was conducted in split plot design with three replications. Four varieties namely, Rice CO-52, *Jeearga samba, Kitchili samba* and Improved White Ponni were grown in main plot and planting methods (Random planting, Line planting - 20 x 10 cm and SRI - 25 x 25 cm) were allotted in sub plot. Nursery was raised by using the different varieties of rice in the organic field. The

seedlings of 14 days and 30 days old were used for planting SRI and other methods respectively. Prior to experimentation, the green manure crop Daincha (*Sesbania aculeata*) was raised and incorporated at 50 per cent flowering. The land was brought to well pudulled by repeated puddling using tractor operated puddler and land was leveled by using roto-puddler cum leveler. Furthur, vermi-compost was applied to the field by broadcasting as a basal application @ 5.0 t/ha. The experiment as conducted in organic block which is maintained with organic practices for past one decade. All other packages of practices were made as per Crop Production Guide, 2012. Five plants were selected at random from the net plot area and tagged. From the tagged plants, plant height was measured from ground level to the tip of the longest leaf stretched at maturity stage and expressed in centimetre. LAI at flowering stage was worked out using leaf length and breadth for 0.75 as correction factor. The total leaf area to the ground area was expressed as leaf area index. Five plants/ plot at random from outside the net area of the plot were pulled out at maturity stage. The samples were initially air dried in shade and then oven dried at 70ºC ± 5ºC till the samples attained a constant weight and then weighed. The DMP was computed to kg/ha. The total number of tillers/m^2, productive tillers/m^2 was counted at maturity stage from five randomly marked hills in the net plot area. Panicle length was measured from base to the tip of the panicle obtained from the marked five hills. The panicles were collected from the five tagged plants at maturity stage and counted to total number of grains and filled grains/panicle. Data subjected to statistical scrutiny (Gomez and Gomez, 2010).

Results and Discussion

Plant height

The mean data on plant height (cm) at maturity stage were significant with varieties and their interaction effects (Table 1). Plants grew taller (128.8 cm) when variety Jeeraga samba was transplanted under puddled condition in organic farming, but, the rice variety Rice CO-52 and Improved white ponni had produced shorter plants. Methods of planting did not have any marked influence on plant height at maturity stage. Interaction effect between varieties and planting method on plant height was significant at maturity stage. Jeeraga samba variety planted in SRI (V2P3) recorded higher plant height (132.9 cm) compared to others. But, it maintained statistical parity with *Jeeraga samba* planted either randomly (V_2P_1) or in lines (V_2P_2) and Kitchili samba planted randomly (V_3P_1). Significantly shorter plants were recorded when Rice CO-52 was planted in any of the methods of planting (V_1P_1, V_1P_2 and V_1P_3). This way mainly due to the genetic nature of the varieties besides more resources available in SRI. Yoshida *et al*. (1981) and Sharma (2005) also confirmed the direct relationship of varietal characters on plant height of crops.

Table 1. Effect of varieties and methods of planting on growth characters in organic rice

Treatments	Plant height (cm) at maturity stage				Drymatter production (kg/ha) at maturity stage				LAI at flowering stage				Total number of tillers/m^2 at maturity stage			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
V1	113.4	110.3	116.0	113.2	9860	10166	10965	10330	4.30	4.70	5.10	4.70	440	428	456	441
V2	128.8	124.6	132.9	128.8	9218	9533	10613	9638	3.93	4.20	4.16	4.10	416	418	459	431
V3	124.1	119.6	113.2	119.0	9680	9166	10400	9749	4.30	4.70	4.70	4.56	440	416	460	439
V4	117.8	117.7	118.1	117.9	9684	9233	10042	9653	4.43	4.23	4.23	4.30	423	446	440	436
Mean	120.0	118.1	120.1	9618	9525	10393	4.24	4.45	4.55	430	427	454				
V	P	V at P	P at V	V	P	V at P	P at V	V	P	V at P	P at V	V	P	V at P	P at V	
SEd	0.59	2.53	4.18	5.06	250	185	394	372	0.07	0.08	0.16	0.17	22	28	40	44
CD (P=0.05)	1.45	NS	8.88	10.74	500	393	788	744	0.17	0.18	0.35	0.37	NS	NS	NS	NS

Main plot – Varieties: V_1 – Rice CO-52; V_2 – *Jeeraga samba*; V_3 – *Kitchili samba*; V_4 – Improved white ponni

Sub plot – Planting methods: P_1 – Random planting; P_2 – Line planting (20 x 10 cm); P_3 – SRI (25 x 25 cm)

Drymatter production

During maturity stage, varieties, methods of planting and their interaction had significant influence on drymatter production of rice (Table 1). Among varieties, Rice CO-52 observed to be superior by recording higher drymatter production (10330 kg/ha). Among planting methods, SRI method of planting significantly recorded higher drymatter production (10393 kg/ha). Among interaction effect, Rice CO-52 planted in SRI method (V_1P_3) produced higher dry biomass (10965 kg/ha) compared to others. Minimum drymatter production (9166 kg/ha) was noted in Kitchili samba planted in lines (V_3P_2). Increase in drymatter was mainly due to increase in tiller production and increase in leaf area of the plant. Findings are in accordance with the reports of Ying *et al*. (1998).

LAI at flowering stage

At flowering stage, varieties and methods of planting had significant influence on LAI of rice (Table 1). Among varieties, Rice CO-52 recorded superior LAI (4.70) compared to Jeeraga samba and Improved white ponni. Whereas, Kitchili samba variety was on par with Rice CO- 52. With respect to planting methods of rice, SRI produced more leaf surface (4.55) compared to random planting but, was on par with line planting. The results of interaction between

variety and planting method shown that Rice CO-52 planted under SRI (V_1P_3) produced significantly more LAI (5.10) compared to all other combinations. This was mainly due to the increased in tillers production in latest rice variety Rice CO-52 besides, SRI method known to provide chance for vigorous growth and in turn might have produced more LAI. However, Jeeraga samba planted in random (V_2P_1) produced minimum LAI. This was mainly due to the varietal character and leaf blade was narrower in this variety. The present result was agreed with the reports of Chandrasekhar *et al.* (2001).

Tillering behaviour

Neither varieties nor planting methods and their interaction did have significant influence total number of tillers/m^2 at maturity stage (Table 1).

The varieties, planting methods and their interactions had significant influence on productive tillers/m^2 (Table 2). Rice CO-52 variety produced more number of productive tillers (394/m^2) compared to other varieties with the least in Jeeraga samba (348/m^2). Among planting methods, SRI method produced more number of productive tillers/m^2 (377/m^2) but, it maintained its statistical parity with line planting. With regard to interaction effect, Rice CO-52 planted under SRI method recorded significantly more number of productive tillers (404/m^2) compared to others. However, it was on par with Rice CO-52 planted either in lines (V_1P_2) or randomly (V_1P_1), Kitchili samba planted in either in lines (V_3P_2) or SRI (V_3P_3) and Improved white ponni planted under SRI method (V_4P_3). The least number of productive tillers (320/m^2) was recorded in Jeeraga samba planted randomly (V_2P_1). In general, any varieties planted under SRI method did produce more tillers than others. Also, Rice CO-52 was better in terms of productive tillers than others. Though total number of tillers were not varied, due to the better resources (light, space, nutrient, water, etc.) availability in SRI method might have converted more tillers into productive tillers. Similarly, Rice CO-52 variety is an improved released variety its conversion efficiency of tillers to productive tillers was better than other local cultivars. Local cultivars had a habit of producing more tillers but, poor conversion from tiller to productive tiller. The results are in line with the findings of Jabran *et al.* (2015).

Table 2. Effect of varieties and methods of planting on yield attributes in organic rice

Treatments	Number of productive tillers/m^2				Panicle length (cm)				Total number of grains/panicle				Number of filled grains/panicle			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
V_1	386	391	404	394	25.60	25.10	25.50	25.40	164.0	158.3	165.7	162.7	141.2	146.4	146.0	144.5
V_2	320	336	354	337	27.70	26.97	26.70	27.12	139.0	139.0	144.0	140.7	127.4	132.2	136.1	131.9
V_3	340	364	370	358	26.90	26.83	23.90	25.88	139.3	146.0	144.7	143.3	130.5	132.8	137.1	133.5
V_4	326	339	380	348	26.20	25.77	26.37	26.11	146.7	144.3	160.7	150.6	137.3	135.3	146.4	139.6
Mean	343	358	377	26.60	26.17	25.62	147.5	146.9	153.3	134.1	136.7	141.4				
V	P	V at P	P at V	V	P	V at P	P at V	V	P	V at P	P at V	V	P	V at P	P at V	
SEd	14	13	22	23	0.22	0.50	0.62	0.45	1.11	1.47	2.65	2.95	2.60	2.47	4.83	4.96
CD (P=0.05)	34	28	47	49	0.48	NS	1.44	0.95	2.71	3.12	5.77	6.24	6.46	5.26	NS	NS

MMain plot – Varieties: V_1 – Rice CO-52; V_2 – *Jeeraga samba*; V_3 – *Kitchili samba*; V_4 – Improved white ponni

Sub plot – Planting methods: P_1 – Random planting; P_2 – Line planting (20 x 10 cm); P_3 – SRI (25 x 25 cm)

Panicle length

Barring planting methods, other treatments had significant influence on panicle length (cm) of rice (Table 2). Among varieties, significantly longer panicles (27.12 cm) were recorded with Jeeraga samba than others, but shorter panicles were recorded Rice CO-52 variety. With respect to treatment combinations, Jeeraga samba planted randomly (V_2P_1) produced longer panicle (27.70 cm) and was comparable with Jeeraga samba planted either in lines (V_2P_2) or in SRI (V_2P_3), Kitchili samba planted either randomly (V_3P_1) or in lines (V_3P_2) and Improved white ponni planted in SRI method (V_4P_3). Remaining all other combinations recorded shorter panicles. The length of panicle is more influenced by genetic characters and less influenced by the environmental factors. Traditional types of varieties comparatively have loose panicles than the dense compact panicles with released varieties. Jeeraga samba and Kitchili samba are traditional types which had longer panicle irrespective of planting methods than Rice CO-52 which had shorter panicle. Similarity of the findings was reported by Bisne *et al.* (2009).

Number of grains and filled grains per panicle

There existed a significant influence on total number of grains/panicle due to varieties and planting methods; and their interaction (Table 2). Between varieties, Rice CO-52 produced significant higher number of grains (162.7) and filled grains/panicle (144.5) compared to all other varieties. Lesser number of grains (140.7) were observed in Jeeraga samba variety. Similarly, among planting methods, total number of grains and filled grains/panicle were higher under SRI method (P3) compared to line and random planted rice. With regard to interaction effect, Rice CO-52 transplanted in SRI method (V_1P_3) recorded significantly higher total number of grains/panicle (165.7) compared to other combinations except, random planted Rice CO-52 (V_1P_1) and SRI planted Improved white ponni (V_4P_3). Lesser number

of grains/panicle were noted with Jeeraga samba planted either randomly (V_2P_1) or lines (V_1P_2).

Generally, total number of grains and filled grains panicle-1 were higher when any of varieties planted under SRI method. This was because of higher biomass production as contributed by more leaf area and better source sink relationship under SRI method of planting as evidenced in the present study that maintained positive in producing more number of grains and filled grains. With respect to varieties, in general, Rice CO-52 counted more number of grains and filled grains panicle^{-1} than others. The released varieties usually have compact panicle which means more number of grains at shorter interval of panicles in turn produce more grains. Similar findings were reported by Baloch *et al*. (2006).

Table 3. Effect of varieties and methods of planting on grain yield, straw yield and harvest index in organic rice

Treatments	Grain yield (kg/ha)				Straw yield (kg/ha)				Harvest Index			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
V_1	3624	3710	4007	3780	5423	5103	5850	5459	0.413	0.408	0.407	0.409
V_2	3180	3057	3343	3193	5353	5756	5876	5662	0.373	0.347	0.363	0.361
V_3	3210	3273	3350	3278	5586	6953	6463	6334	0.365	0.320	0.341	0.341
V_4	3328	3339	3473	3380	6063	6363	6460	6295	0.354	0.344	0.350	0.349
Mean	3336	3345	3543	5606	6044	6162	0.376	0.353	0.365			
V	P	V at P	P at V	V	P	V at P	P at V	V	P	V at P	P at V	
SEd	103	85	172	169	205	74	238	149	0.003	0.003	0.007	0.007
CD (P=0.05)	252	179	386	359	502	157	562	314	0.007	0.007	0.015	0.016

Main plot – Varieties: V_1 – Rice CO-52; V_2 – *Jeeraga samba*; V_3 – *Kitchili samba*; V_4 – Improved white ponni

Sub plot – Planting methods: P_1 – Random planting; P_2 – Line planting (20 x 10 cm); P_3 – SRI (25 x 25 cm)

Grain yield

There existed a marked variation on grain yield of rice due to varieties and method of planting. The interaction effect between the varieties and methods of planting had significant influence on grain yield of rice under organic farming (Table 3). Between different varieties grown under organic cultivation, significantly higher grain yield (3780 kg/ha) was recorded with Rice CO-52 variety compared to all other varieties. Notably, lesser grain yield was recorded with Jeeraga samba variety (3193 kg/ha). With respect to planting methods, SRI planted rice produced more grain yield (3543 kg/ha) compared to randomly and line planted rice. With regard to interaction effect, the latest variety Rice CO-52 planted under SRI (V1P3) produced more grain yield (4007 kg/ha) compared to other combinations. However, it was statistically on par with Rice CO-52 planted either randomly (V1P1) or in SRI (V_1P_2). Rice CO-52 planted any of the methods especially under SRI method recorded better growth characters (LAI and DMP) which

have provided sufficient source and converted more tillers to productive tillers, also produced more grains and filled grains/panicle which eventually increased the grain yield of rice. Whereas, all other varieties planted in any of the methods did produce lesser number of yield attributes such as productive tillers, grains and filled grains/panicle though it had higher source (LAI and DMP) which ultimately resulted with poor grain yields. Fageria (2007) also reported similar results.

Straw yield

The effect of varieties, planting methods and their interaction on straw yield (kg/ha) of rice was significant (Table 3). Among varieties, Kitchili samba produced more straw yield (6334 kg/ha) compared to Rice CO-52 and Jeeraga samba varieties, but was on par with Improved white ponni. With respect to planting methods, SRI method recorded significantly higher straw yield (6162 kg/ha) but was on par with line planting. With regard to interaction effect, Kitchili samba planted in lines (V_3P_2) did register significantly higher straw yield compared to other combinations. However, it was on par with SRI planted with either Kitchili samba (V_3P_3) or Improved white ponni (V_4P_3). Lesser straw yield was noted when Rice CO-52 was planted in line (V_1P_2) but was on par with random planting of Rice CO-52, Jeeraga samba and Kitchili samba (V_1P_1, V_1P_2 and V_3P_1). Kitchili samba variety is known to produce more biomass due to its traditional growth nature with any of the planting method by genetic character. This was mainly due more drymatter production in Kitchili samba variety due to its varietal character and more availability of resources in SRI combined together contributed straw yield. However, lesser straw yield was obtained when Rice CO-52 planted in lines and random was mainly due to lesser plant height. The results are concomitant with the findings of Parameswari and Srinivas (2014).

Harvesting index

All the treatments had significant influence on harvest index (HI) of rice (Table 3). Among varieties, significantly superior HI values (0.409) were recorded with Rice CO-52 than all other varieties under study. With respect to planting methods, random planting recorded higher HI (0.376) than other methods. Due to the interaction effect, Rice CO-52 planted randomly

calculated significantly higher HI (0.413) compared to other combinations except Rice CO-52 planted either in lines (V_1P_2) or in SRI (V1P3). Lower HI (0.321) was noted in Kitchili samba planted in lines (V_3P_2). Higher harvest index was obtained in Rice CO-52 planted in any of the methods was mainly due to more ratio of grain production. Findings are accordance with Prasad *et al.* (2006).

Conclusion

From the experimental results, it could be concluded that growth characters, yield attributing characters such as productive tillers/m^2, total number of grains and filled grains/ panicle were higher in SRI method under organic farming. However, the method of planting may also be considered for enhancing the growth and productivity of rice under organic farming.

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