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Effect of fertility, genotypes and spacing on yield and soil properties of rice under SRI during dry season in coastal Odisha

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ABSTRACT : A study was carried out at the Agronomy Main Research Station, Orissa University of Agriculture and Technology, Bhubaneswar during the *Rabi* seasons of 2012-2013 and 2013-2014 in split plot design with three replications. The six main plots consisted of the combinations of three fertility levels and two genotypes; while the subplots had four different methods of planting. The pooled data for both the years revealed that the fertility level with 3 splits of N @ 50% at sowing + 25% top dressing at 30 DAS+25 per cent top dressing at 60 DAS (F_2) recorded the significantly highest grain yield (6424 kg ha^{-1}) while HI (0.44) of highest value was recorded with F_3 (organics). The hybrid 'Arise gold' produced significantly higher (6606 kg ha^{-1}) grain yield as compared to that of conventional variety Lalat (5214 kg ha^{-1}). The treatment of S_2 - 25 cm square planting with two spaced (5cm) seedlings $hill^{-1}$ recorded significantly highest grain yield (6811 kg ha^{-1}) which was at par with the treatment S_4 - 30 cm with three seedlings $hill^{-1}$ in a traingular method (6642 kg ha^{-1}). In case of grain nutrient uptake F_3, V_1 (hybrid 'Arise gold') and S_2 recorded the highest value whereas in straw F_2, V_1 (Lalat) and S_3 (30 cm with two seedlings with a gap of 5cm between 2 seedlings $hill^{-1)}$ recorded the highest uptake.The highest pH was recorded with F_3. F_2, V_2 and S_1 (25 cm with one seedling $hill^{-1}$) recorded the highest EC while the highest organic carbon percentage was recorded in F_2, V_2 and S_4 (30 cm with three seedlings with a gap of 5cm between 2 seedlings in a triangular method $hill^{-1}$).The highest available soil N, P and K was recorded with F_3, V_2 and S_1. F_3 recorded the highest value in microbiological properties.

KEY WORDS : SRI, Fertility levels, Organic, Genotypes, Planting geometry, Microbial property

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Rice (*Oryza sativa*) is one of the most ancient crops being cultivated in 117 countries, hence, called as "global grain". It is the staple cereal food grain of majority of India's over one billion population, contributing nearly 44 per cent of total food grain production. In India, it is grown over an area of 44.1 mha with a total production of 105 m t and a productivity of 2393 kg ha^{-1}. India has to produce 114 mt of rice by the year 2030 to meet the food grain requirement of burgeoning population. Irrigated rice in particular, is a heavy consumer of water. It takes 5000 litres of water to produce 1 kg of rice and consumes 7650 m^2ha^{-1} (CMIE, 2012). As water for irrigation is becoming limited producing more rice with less water, as well as with less

land and minimum fertilizer if possible, is important for sustainability of rice production systems. The possible way to increase the productivity is through formulating better production technologies with improved cultivars and efficient nutrient management practices. The system of rice intensification (SRI) was introduced in India during the year 2000 as a viable alternative of rice cultivation that enhances the productivity while minimizing the inputs. However, while highlighting SRI (Uphoff *et al.*, 2002) stated that the best SRI yields can be achieved with HYV's or hybrids. Some farmers' experiences indicate that, only long and medium duration rice varieties perform better than short duration varieties. Hence, it is necessary to evaluate and harness the potential of different duration rice varieties developed at research stations for their suitability to SRI method. Our farmers are using more and more chemical fertilizers, excessive irrigation and more pesticides that have adverse impacts on soil health and crop productivity. The use of organic manures such as farm yard manure (FYM) and vermicompost has proved to be a viable component for rice across the globe. At the same time the plant geometry and spatial configuration exploit the initial vigour of the genotypes, enhances soil aeration and provides congenial condition for better establishment also need to be evaluated. Keeping the above considerations in view, an investigation was planned to evaluate rice cultivars in relation to various fertility levels in SRI.

RESEARCH PROCEDURE

A field experiment was carried out in the *Rabi* seasons of 2012-2013 and 2013-2014 at the Agronomic Main Research Station, Orissa University of Agriculture and Technology, Bhubaneswar located at a latitude and a longitude of $20^0$15' N and $85^0$52'E, respectively, with an altitude of 25.9m above the mean sea level. The station comes under the East and South Eastern Coastal Plain Agro-climatic Zone of Odisha. The texture of the soil was sandy loam with an average pH of 5.83, EC 0.0125 dSm^{-1}, 0.54 per cent of organic carbon, 159.74 kg ha^{-1} of available nitrogen, 51.83 kg ha^{-1} of available phosphorus and 332.38 kg ha^{-1} of potash. The experiment was conducted in Split Plot Design with three replications with the following treatments. For the main plot the combinations of fertility levels of F_1, F_2 and F_3(100-50-50 N-P_2O_5-K_2O kg ha^{-1}-N splitted as 50% at planting + 50% top dressing at 30 DAS; 100-50-50 N-P_2O_5-K_2O kg ha^{-1} -N splitted as 50% at planting + 25% top dressing at 30 DAS+25% top dressing at 60 DAS and organic-FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}) with variety of V_1 (Hybrid -OFD 6444 gold or 'Arise gold') and V_2 (Lalat) were taken. For the subplot four spacing of S_1, S_2, S_3 and S_4(25 cm with one seedling $hill^{-1}$; 25 cm with two seedlings with a gap of 5cm between 2 seedlings $hill^{-1}$; 30 cm with two seedlings with a gap of 5cm between 2 seedlings $hill^{-1}$ and 30 cm with three seedlings with a gap of 5cm between 2 seedlings in a triangular method $hill^{-1}$) were taken. Sprouted seeds were sown in wet nursery beds with the practices recommended for SRI nursery. Fourteen day old seedlings were transplanted on the main field. Crop was weeded twice *i.e.*, at 30 and 60 days after transplanting with cono weeder in a crisscross manner. Experimental plots were kept at saturation upto panicle initiation stage by suitably maintaining the water level in the side channels of each bed. Thereafter, a thin film of water was allowed over the beds till 10 days before the harvest of the crop.

RESEARCH ANALYSIS AND REASONING

The treatment of F_2 reported the highest grain and straw yield in the first year whereas in the second year F_3 recorded highest grain yield which may be attributed to cumulative application of organics in later (Table 1). Chemical fertilizers have been reported to give higher yield in SRI during *Rabi* by Surekha *et al.* (2012). It was seen that both F_2 and F_3 recorded the same HI for both the years. The hybrid rice Arise gold (V_1) was found to be significantly higher (23.77% in first year and 30.14 % in the second year) in grain yield as compared to that of V_2 for both the years. Hybrid rice giving higher yield over conventional rice which is accordance to the findings of Islam *et al.* (2010). As far as the spacing goes, the treatment S_2 recorded the highest grain yield which was at par with the treatment of S_4. The above two planting geometry had higher plant population (100 and 106.25 %, respectively) and yield attributing characters over S_1 planting geometry which may be the reason for their grain yield to remain statistically at par. Simillar trend was noticed for the dimension of HI. However, the treatment of S_3 recorded significantly highest straw yield (8.77 t ha^{-1} in the first year and 8.60 t ha^{-1} in the second year).

Organics had more uptake and reduced loss of N from soil (Table 2 and 3). Increased potassium uptake with organic source of FYM was due to priming effect

Table 1 : Grain yield (t ha^{-1}), straw yield (t ha^{-1}) and HI for the year 2012-2013 and 2013-2014

Treatments	Grain yield (t ha^{-1})		Straw yield (t ha^{-1})		HI	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility levels						
F_1	5.40	4.41	8.06	7.13	0.39	0.37
F_2	6.60	6.25	8.87	8.19	0.44	0.43
F_3	6.50	6.30	8.27	8.01	0.44	0.44
S.E. ±	0.24	0.06	0.15	0.20	0.01	0.01
C.D. (P=0.05)	0.75	0.18	0.47	0.64	0.04	0.02
Variety						
V_1	6.82	6.39	8.62	8.39	0.44	0.43
V_2	5.51	4.91	8.18	7.17	0.40	0.40
S.E. ±	0.19	0.05	0.12	0.16	0.01	0.01
C.D. (P=0.05)	0.61	0.15	0.38	0.52	0.03	0.02
Spacing						
S_1	4.64	4.43	7.82	6.81	0.37	0.39
S_2	7.12	6.51	8.42	7.67	0.45	0.45
S_3	5.95	5.36	8.77	8.60	0.40	0.38
S_4	6.96	6.32	8.59	8.02	0.45	0.43
S.E. ±	0.18	0.15	0.12	0.22	0.01	0.01
C.D. (P=0.05)	0.53	0.42	0.36	0.62	0.03	0.03

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling hill^{-1}, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) hill^{-1}, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) hill^{-1}, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method hill^{-1}

Table 2 : Grain uptake of nitrogen, phosphorus and potash (kg/ha) for the year 2012-2012 and 2013-2014

Treatments	Nitrogen		Phosphorus		Potash	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility						
F_1	62.34	50.56	10.10	7.32	14.47	11.57
F_2	76.81	72.37	12.48	12.63	18.18	16.65
F_3	75.07	74.09	12.78	13.35	18.05	18.68
S.E. ±	2.99	1.53	0.50	0.44	0.571	0.503
C.D. (P=0.05)	9.43	4.83	1.57	1.37	1.8	1.59
Variety						
V_1	79.25	75.15	13.61	13.15	19.01	17.21
V_2	63.57	56.20	9.96	9.06	14.79	14.05
S.E. ±	2.44	1.25	0.41	0.36	0.466	0.411
C.D. (P=0.05)	7.70	3.94	1.28	1.12	1.47	1.3
Spacing						
S_1	53.43	50.10	8.72	8.01	12.48	12.83
S_2	83.12	76.82	13.95	13.42	20.28	17.2
S_3	68.62	61.67	11.21	10.37	15.98	14.63
S_4	80.45	74.10	13.26	12.60	18.86	17.86
S.E. ±	2.15	1.73	0.56	0.46	0.648	0.465
C.D. (P=0.05)	6.16	4.97	1.60	1.33	1.86	1.33

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling hill^{-1}, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) hill^{-1}, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) hill^{-1}, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method hill^{-1}

Table 3 : Straw uptake of nitrogen, phosphorus and potash (kg/ha) for the year 2012-2013 and 2013-2014

Treatments	Nitrogen		Phosphorus		Potash	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility						
F_1	31.69	28.84	4.78	4.197	137.87	122.51
F_2	36.00	35.22	5.72	5.053	157.4	144.80
F_3	35.38	34.13	4.66	4.71	149.52	143.38
S.E. ±	1.09	1.34	0.19	0.19	3.29	4.91
C.D. (P=0.05)	3.44	4.21	0.60	0.61	10.37	15.48
Variety						
V_1	36.12	36.03	5.58	5.15	153.41	149.07
V_2	32.60	29.43	4.53	4.15	143.12	124.73
S.E. ±	0.89	1.09	0.16	0.16	2.69	4.01
C.D. (P=0.05)	2.81	3.43	0.49	0.50	8.47	12.64
Spacing						
S_1	31.17	27.58	4.69	4.02	135.9	118.44
S_2	33.83	31.85	4.82	4.49	148.27	134.82
S_3	37.18	37.09	5.77	4.98	156.42	153.29
S_4	35.25	34.39	4.93	5.10	152.46	141.05
S.E. ±	1.11	1.27	0.22	0.17	3.51	3.77
C.D. (P=0.05)	3.17	3.65	0.63	0.48	10.07	10.81

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling $hill^{-1}$, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method $hill^{-1}$

Table 4 : Soil Ph, organic carbon (%) and EC (dS/m) for the year 2013-2014 and 2014-2015

Treatments	pH		EC (dS/m)		Organic carbon (%)	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility						
F_1	5.42	5.38	0.18	0.19	0.97	0.97
F_2	5.25	5.31	0.32	0.33	0.93	0.94
F_3	5.77	5.73	0.18	0.18	0.74	0.77
S.E. ±						
C.D. (P=0.05)						
Variety						
V_1	5.42	5.41	0.18	0.19	0.82	0.84
V_2	5.54	5.54	0.27	0.27	0.94	0.95
S.E. ±						
C.D. (P=0.05)						
Spacing						
S_1	5.33	5.37	0.25	0.25	0.87	0.9
S_2	5.56	5.6	0.20	0.21	0.80	0.77
S_3	5.44	5.4	0.23	0.24	0.90	0.92
S_4	5.59	5.54	0.23	0.23	0.95	0.98
S.E. ±						
C.D. (P=0.05)						

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling $hill^{-1}$, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method $hill^{-1}$

Table 5 : Soil available N, P and K (kg/ha) for the year 2013-2014 and 2014-2015

Treatments	N		P		K	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility						
F_1	184.22	181.82	84.44	80.84	228.06	234.17
F_2	165.43	153.63	81.12	74.99	204.82	206.8
F_3	214.40	188.59	138.47	142.52	233.43	237.19
S.E. ±	3.55	2.79	0.85	0.596	3.323	5.004
C.D. (P=0.05)	11.18	8.79	2.67	1.88	10.47	15.77
Variety						
V_1	178.41	161.91	99.00	96.9	214.85	212.31
V_2	197.62	187.46	103.69	102	229.36	239.8
S.E. ±	2.90	2.28	0.69	0.486	2.713	4.086
C.D. (P=0.05)	9.13	7.18	2.18	1.53	8.55	12.87
Spacing						
S_1	209.18	195.40	104.77	103.18	238.88	247.31
S_2	176.83	164.41	99.42	97.3	218.71	226.56
S_3	187.98	174.32	101.20	99.83	214.87	210.66
S_4	178.08	164.59	99.99	97.48	215.95	219.68
S.E. ±	2.12	1.74	0.37	0.443	3.636	3.721
C.D. (P=0.05)	6.06	4.98	1.05	1.27	10.43	10.67

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling $hill^{-1}$, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method $hill^{-1}$ NS=Non-significant

Table 6 : Actinomycetes population (CFU per gram) of rice grown soil for the year 2013-2014 and 2014-2015

Treatments	Active tillering		Panicle initiation		Post harvest	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility						
F_1	2.22	1.82	4.80	5.08	6.71	7.18
F_2	5.24	5.12	8.97	8.12	12.60	13.00
F_3	10.63	10.51	13.11	13.16	17.48	17.45
S.E. ±	0.20	0.23	0.22	0.28	0.23	0.32
C.D. (P=0.05)	0.63	0.72	0.70	0.87	0.72	1.02
Variety						
V_1	5.85	5.58	8.74	8.72	12.17	12.53
V_2	6.20	6.06	9.18	8.86	12.36	12.55
S.E. ±	0.16	0.19	0.18	0.23	0.19	0.27
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Spacing						
S_1	5.89	5.50	9.07	8.52	12.13	12.47
S_2	5.79	5.72	8.81	8.67	12.26	12.57
S_3	6.18	5.95	8.62	8.91	12.34	12.64
S_4	6.25	6.11	9.34	9.06	12.33	12.48
S.E. ±	0.22	0.21	0.22	0.22	0.23	0.16
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling $hill^{-1}$, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method $hill^{-1}$ NS=Non-significant

Table 7 : *Azotobacter* population (CFU per gram) of rice grown soil for the year 2012-2013 and 2013-2014

Treatments	Active tillering		Panicle initiation		Post harvest	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility						
F_1	5.90	5.88	15.96	15.80	26.52	25.90
F_2	9.58	9.69	23.29	23.78	34.87	35.25
F_3	12.67	13.13	34.18	32.44	44.39	40.83
S.E. ±	0.26	0.25	0.34	0.42	0.42	0.43
C.D. (P=0.05)	0.81	0.77	1.06	1.31	1.32	1.35
Variety						
V_1	9.01	9.48	24.91	23.51	35.16	34.70
V_2	9.76	9.64	24.04	24.50	35.36	33.28
S.E. ±	0.21	0.20	0.27	0.34	0.34	0.35
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Spacing						
S_1	9.07	9.47	24.51	23.93	34.82	33.86
S_2	9.12	9.13	24.36	23.67	34.84	33.83
S_3	9.78	9.63	24.34	24.14	35.06	34.74
S_4	9.56	10.02	24.68	24.28	36.32	33.53
S.E. ±	0.23	0.20	0.18	0.11	0.08	0.14
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling $hill^{-1}$, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method $hill^{-1}$ NS=Non-significant

Table 8 : Bacteria population (CFU per gram) of rice grown soil for the year 2013-2014 and 2014-2015

Treatments	Active tillering		Panicle initiation		Post harvest	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility						
F_1	4.97	5.53	22.86	21.40	24.04	25.32
F_2	7.31	8.36	24.32	27.83	34.02	32.54
F_3	13.05	15.56	32.44	41.20	40.26	41.98
S.E. ±	0.30	0.30	0.49	0.44	0.53	0.42
C.D. (P=0.05)	0.93	0.93	1.53	1.40	1.68	1.32
Variety						
V_1	8.69	9.70	26.51	30.01	32.32	33.39
V_2	8.20	9.94	26.58	30.28	33.23	33.16
S.E. ±	0.24	0.24	0.40	0.36	0.44	0.343
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Spacing						
S_1	8.77	9.59	26.74	29.98	33.11	32.47
S_2	8.34	10.10	27.11	29.77	32.26	33.83
S_3	7.87	9.80	26.51	30.56	32.59	33.83
S_4	8.79	9.77	25.81	30.27	33.15	32.98
S.E. ±	0.29	0.23	0.19	0.05	0.16	0.063
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling $hill^{-1}$, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method $hill^{-1}$ NS=Non-significant

Table 9 : Fungi population (CFU per gram) of rice grown soil for the year 2013-2014 and 2014-2015

Treatments	Active tillering		Panicle initiation		Post harvest	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility						
F_1	3.96	3.35	5.39	3.80	7.62	4.06
F_2	5.73	5.66	8.66	7.66	10.58	10.73
F_3	9.78	9.29	11.40	11.19	12.43	12.39
S.E. ±	0.18	0.22	0.18	0.21	0.30	0.29
C.D. (P=0.05)	0.58	0.70	0.56	0.65	0.94	0.90
Variety						
V_1	6.61	6.21	8.65	7.56	10.02	9.06
V_2	6.37	5.99	8.32	7.53	10.40	9.06
S.E. ±	0.15	0.18	0.15	0.17	0.24	0.23
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Spacing						
S_1	6.61	6.28	8.55	7.60	10.21	9.17
S_2	6.62	5.79	8.55	7.48	9.87	9.11
S_3	6.27	6.28	8.61	7.73	9.71	8.93
S_4	6.46	6.04	8.23	7.38	11.05	9.03
S.E. ±	0.21	0.23	0.20	0.23	0.13	0.22
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling $hill^{-1}$, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method $hill^{-1}$ NS=Non-significant

Table 10 : Microbial biomass carbon (MBC) µ C per gram of soil for the year 2013-2014 and 2014-2015

Treatments	Active tillering		Panicle initiation		Post harvest	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Fertility						
F_1	23.74	30.48	47.96	36.93	82.25	88.33
F_2	39.00	41.04	56.95	55.72	113.83	107.81
F_3	53.74	53.63	75.05	84.43	152.68	152.66
S.E. ±	0.36	0.37	0.44	0.29	0.34	0.32
C.D. (P=0.05)	1.14	1.15	1.37	0.91	1.06	1.01
Variety						
V_1	38.68	42.36	60.56	58.81	115.88	114.63
V_2	38.98	41.07	59.42	59.24	116.63	117.91
S.E. ±	0.30	0.30	0.36	0.24	0.28	0.26
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Spacing						
S_1	39.34	41.59	60.27	59.54	115.97	115.49
S_2	38.34	42.23	59.66	59.07	116.55	116.34
S_3	39.47	41.30	59.24	58.91	115.81	117.05
S_4	38.15	41.74	60.79	58.58	116.68	116.19
S.E. ±	0.16	0.18	0.06	0.24	0.21	0.19
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

F_1-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 50% top dressing at 30 DAS), F_2-100-50-50 N-P_2O_5-K_2O kg ha^{-1} (N splitted as 50% at sowing + 25% top dressing at 30 DAS+25% top dressing at 60 DAS), F_3-Organic (FYM 20 t ha^{-1} and vermicompost 2 t ha^{-1}); V_1-Hybrid (OFD 6444 gold) or 'Arise gold', V_2-Lalat; S_1-25 cm with one seedling $hill^{-1}$, S_2-25 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_3-30 cm with two seedlings (with a gap of 5cm between 2 seedlings) $hill^{-1}$, S_4-30 cm with three seedlings (with a gap of 5cm between 2 seedlings) in a triangular method $hill^{-1}$ NS=Non-significant

such that organics on decomposition release organic acids which solubilises fixed and non-exchangable form of K (Rajithasri *et al*., 2013). Split application of nitrogen to rice under SRI could have maintained a constant supply of nutrients at different growth stages thereby improving the status of growth as well as yield attributes resulting in higher grain yield. Application of nitrogen upto the flowering stage could have attributed to the increased grain filling percentage by increasing nitrogen concentration. Ribulose biphosphate carboxylase (RUBISCO) content, photosynthetic rate of flag leaves and by delayed senescence due to continuous availability of nitrogen in sufficient quantities from sowing to ripening might have reduced the loss of nitrogen due to increase in number of splits of applied nitrogen. Nitrogen is known to be absorbed vigorously at early stages of growth due to greater cell division and accumulation of protein at panicle primordial stages and after flowering the rate of absorption decreases due to decreased root activity and increased dry weight. So, Nitrogen uptake was lower in F_1. Similar results were reported by Lal and Mohapatra (1975).

The organic treatment recorded the highest pH. The inorganic treatment with three splits recorded the highest EC and organic carbon percentage (Table 4). The highest soil available N, P and K was recorded with the treatment of organic along with the variety V_2 and S_1 (Table 5). As far as the microbial properties go, organic treatment recorded the highest number of bacteria, azotobacteria, fungi, actinomycetes and microbial biomass carbon (Table 6, 7, 8, 9 and 10). It has been reported that organic farming treatments maintain more microbial population than conventional farming (Wang and Chao,1995; Bolton *et al.*, 1982; Rangaswami and Venegatesan, 1966 and Krishnakumar *et al.*, 2005). The soil microbes continue to increase with the advancement of crop growth (Krishnakumar *et al.*, 2005).

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