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Effect of various organic manures and systems of planting on growth, yield attributes and yield of scented rice

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Abstract
A field investigation was performed at crop research farm at the Maya College of Agriculture and Technology in Selaqui, Dehradun (Uttarakhand), during the 2016 *kharif* season. Combinations of six various organic manure treatments were used in the experiment. Green manuring with *Sesbania aculeata* + foliar spray of *Panchgavya* (3%), green manuring with *Sesbania aculeata* + foliar spray of fish amino acid (FAA 3%), green manuring with *Crotalaria juncea* + foliar spray of *Panchgavya* (3%), green manuring with *Crotalaria juncea* + foliar spray of fish amino acid (FAA 3%), basal application of FYM (12 t ha^{-1}) + foliar spray of *Panchgavya* (3%) and basal application of FYM (12 t ha^{-1}) + foliar spray of fish amino acid (FAA 3%)) in main plots and three systems of planting (System of Rice Intensification (SRI), Conventional Transplanted Rice (CTR) and Direct Seeded Rice (DSR)) in sub plots, taken in split plot design with three replications. The maximum growth (dry weight), yield attributes (panicle length and number of grains panicle^{-1}) and yield was recorded with the basal application of FYM (12 t ha^{-1}) + foliar spray of *Panchgavya* (3%). Rice planted under SRI system of planting found higher growth (dry weight, crop growth rate and relative growth rate) at all the growth stages, yield attributes (effective tillers, panicle length, number of grains panicle^{-1} and test weight) and yield as compared to rest of the planting systems.

Keywords: Rice, systems of planting, organic manure, yield attributes

Introduction

The tribe Oryzeae, family Poaceae (Gramineae), and genus Oryza all refer to rice. The tropics and subtropics of the planet are home to the genus Oryza. The rice crop is the most extensive in India, followed by China and Indonesia, with China producing the most. In terms of production, consumption, and area, it is among the most significant staple foods in India. With an annual productivity and production of 3105 kg ha^{-1} and 509.87 million tonnes, respectively, rice is grown on around 164.19 million ha worldwide. The yearly production and productivity of rice in India are 118.87 million tonnes and 2641.5 kg ha^{-1}, respectively, over a land area of around 45 million ha. West Bengal, Bihar, Maharashtra, Uttar Pradesh, Panjab, Haryana, *etc*. are the top states in India for rice production (FAO STAT 2020) [2]. The endosperm, germ, and bran—the three edible parts of the grain—are what make cereals a member of the grass family Poaceae. Compared to other types of crops, cereal grains are cultivated more widely and produce the most food energy. They include a lot of vitamins, minerals, lipids, proteins, and carbohydrates in their natural state. According to Singh and Singh (2011) [11], rice is responsible for 40% of India's total production of food grains.

India's major limits to rice production are land, water, labour and other inputs such as fertilisers, herbicides, and insecticides (all of which are significant pollutants) without negatively impacting the agricultural environment. The rapid adoption of agricultural systems centred on rice in India has had a negative impact on soil productivity in the long run as well as sustainability and profitability. It has become more necessary to reconsider current agricultural practises, particularly nitrogen management, due to growing concerns about human health, soil quality, and environmental safety. A higher level of crop output that can be sustained, particularly in developing nations like India, is urgently needed to meet the population's demand for food grains. The long-term rice trials' findings indicate a reduction or stagnation in this system's productivity. It is also clear that the amount of organic matter has decreased, and that this has changed the availability of nutrients and the physical characteristics of the soil. The efficiency of rice production is also being hampered by secondary nutritional deficits (Yadav *et al*., 2009) [18].

Agronomists and soil scientists have been searching for other potential alternate sources of nutrients while their focus has been diverted by the rising costs of artificial fertilisers and the global energy crisis. By combining inorganic fertilisers with organic fertilisers like FYM, green manure, and crop residues, Khan *et al*. (2006) [6] stated that it has become crucial to use the available organic manures efficiently through suitable application methods, time of application, and integrated nutrient management practises.

In addition to being a significant source of secondary and micronutrients, FYM is dense organic manure that is a repository of important nutrients. Usually, farmyard manure is made from cow and goat waste. This manure contains trace amounts of all the nutrients needed by plants. They produce good effects and stay in the soil for longer periods of time. Due to its production in-situ, fast decomposition in the soil, mobilization of nutrients, and improvement in soil physical condition, green manure has been determined to be the most suitable. The rice plant absorbs various nutrients from the soil from the day of seeding till harvest. In order to maintain soil fertility and prepare the soil for the harvest of the following season, it is crucial to replenish the nutrients that have been utilized.

Organic materials, such as farmyard manure, green manure, green leaf manure, and liquid formulations of organics, such as cattle urine, botanicals, etc., can provide the nutrients needed by plants. These manures enhance the soil's ability to infiltrate water and help stop soil erosion. They might also help improve the biological qualities of the soil. Organic farming and recycling would have the combined benefits of reducing pollution and using waste-derived manures to boost soil production. Food produced organically is anticipated to sell for more money, which can help make up for any losses caused by reduced yields and create lucrative commercial opportunities on the global market.

According to the opinion of Yadav and Lourduraj (2006) [17], organic farming can save a significant amount of money (23%) by using *Panchgavya* foliar treatment method, which is efficient and inexpensive.

In the past 20 years or so, a novel strategy known as the System of Rice Intensification (SRI) has gained popularity due to its apparent success in raising rice productivity. The system of rice intensification (SRI), a practical rice growing option that increases yield while reducing inputs, was launched in India in the year 2000. Utilising organic manures like FYM and GM has been shown to be a successful INM for SRI component. However, there is a need for us to transition to organic farming wherever there is a chance of increasing productivity potential through this method (Uphoff *et al*., 2002) [15].

Materials and Methods

A study was conducted at plot number 16 B of the crop research farm at the Maya College of Agriculture and Technology in Selaqui, Dehradun (Uttarakhand), during the 2016 *kharif* season. Selaqui receives 1040.4 mm of rainfall on average throughout the course of the experimental period. Selaqui is located at 25.28° N Latitude, 81.54° E Longitude, and 410 m above mean sea level. The average temperature for the maximum and minimum is 35.34 °C and 12.94 °C, respectively. The experimental site's soil had a sandy-loam with adequate drainage qualities and a reaction pH of 8.34. The soil was found to have low organic carbon (0.36%) and low levels of available nitrogen (0.028%) and medium in available phosphorus (13.05 kg ha^{-1}) and potassium (156.44 kg ha^{-1}). The treatments involved combinations of six organic manure treatments (M_1: green manuring with *Sesbania aculeata* + foliar spray of *Panchgavya* (3%), M_2: green manuring with *Sesbania aculeata* + foliar spray of fish amino acid (FAA 3%), M_3: green manuring with *Crotalaria juncea* + foliar spray of *Panchgavya* (3%), M_4: green manuring with *Crotalaria juncea* + foliar spray of fish amino acid (FAA 3%), M_5: basal application of FYM (12 t ha^{-1}) + foliar spray of *Panchgavya* (3%) and M_6: basal application of FYM (12 t ha^{-1}) + foliar spray of fish amino acid (FAA 3%)) in main plots and three systems of planting (S_1: System of Rice Intensification (SRI), S_2: Conventional Transplanted Rice (CTR) and S_3: Direct Seeded Rice (DSR)) in sub plots, taken in split plot design with three replications. Rice seedling transplanted of 13 days old in SRI treatment and 22 days old in conventional method treatment. In DSR, drum seedling of sprouted seed of rice was done. Due to non availability of tractor with puddler, manual puddling was done.

Green manure crops (*Sesbania aculeata* and *Crotalaria juncea*) were grown in the field up to 55 days and buried in the field with tractor drawn disc plough on June 30, 2016. Well decomposed FYM was applied at the rate of 12 t ha^{-1}, 7 days before transplanting/sowing. *Panchgavya* was prepared with mixtures of five components in the ratio of 5:4:3:2:1, *viz*., cow dung, cow urine, milk, curd and ghee respectively and six ripe bananas, which was fermented for 15 days. *Panchgavya* 3% solution was prepared by adding 300ml prepared and filtered solution in 10 liters of water, and applied as foliar spray at 15, 30, 45 and 60 DAS/DAT as per the treatments. Fish amino acid was prepared with fish waste (2.5 kg) and jaggy (2.5 kg), which was fermented for 15 days. Fish amino acid 3% solution was prepared by adding 300 prepared and filtered solution is 10 liters of water and applied as foliar spray a 15, 30, 45 and 60 DAS/DAT as per the treatments. Rice 'Pusa Basmati 1' was taken as test crop.

The experimental plot was ploughed with the help of tractor drawn plough followed by two harrowing and planking. After that flooding and puddling operations were done manually in experimental blocks. The field was maintained in a moist condition and provides eight irrigations as per recommendation during the crop growing period. Weed management was done two time with the help of cono weeder @ 22 and 36 DAS/DAT. The crop was harvested separately from each plot according to transplanting date. The produce from net plot was tied in bundles separately and then tagged.

Three plants were selected at random from border rows in each plot. The plants cut, air dried initially and then oven dried at 65$\pm$5 °C for till constant weight was obtained and their weights were recorded. Dry weight was recorded at 15, 30, 45, 60, 75 and 90 DAS and expressed as g $hill^{-1}$. The crop growth rate (CGR) of a plant is measured as the increase in dry weight of plant material from a unit area per unit of time. Mean crop growth rate (CGR) was calculated with the following formula (Watson, 1952) [16] from periodic dry matter recorded at different stages:

$$CGR\ (gm^{-2}day^{-1}) = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{P}$$

Where,
W_1 = Total dry weight of plant at time t_1
W_2 = Total dry weight of plant at time t_2
t_1 = Time at first observation
t_2 = Time at second observation
P = Total ground area (m^2)

The relative growth rate (RGR) of a plant is also measured as the increase in dry weight of plant material per unit of material present per unit of time (Watson, 1952) [16]. The mean relative growth rate (RGR) of the crop was calculated by the following formula:

$$RGR\ (g\ g^{-1} day^{-1}) = \frac{\log_e w_2 - \log_e w_1}{t_2 - t_1}$$

Where,
W_1 = Total dry weight of plant at time t_1
W_2 = Total dry weight of plant at time t_2
Log_e = Natural logarithm
t_1 = Time at first observation
t_2 = Time at second observation

The number of effective tillers hill^{-1} was recorded from five tagged hills in each plot at 90 DAS/DAT. Panicles length (cm) was observed at the time of harvest from each tagged hills. Grains from the five panicles were counted separately which were obtained randomly five tagged hills and their averages were recorded. Five seed samples of 1000 grains were drawn from net plot yield of each treatment and 1000 grains weight was recorded and mean was expressed in grams.
The marked bundles were left to sun dry in the field before being weighed on the threshing floor to calculate biological yield. Rice was manually threshed by hitting panicles on the sheaf with a wooden baton, and the seeds were then separated by winnowing. The grain yield was then recorded treatment-by-treatment and expressed as t ha^{-1}. By deducting the grain yield from the corresponding biological yield of each plot, straw yield was estimated and expressed as t ha^{-1}.
In order to statistically analyse the data, Panse and Sukhatme's (1985) [9] method of analysis of variance was used. Every time a "F test" was judged to be significant at a 5% probability level and values were provided, a critical difference was calculated. Non-significant treatment differences were recorded with a 'NS'.

Results and Discussion

Organic manure

Application of organic manures increased dry weight of scented rice. The maximum dry weight was recorded under basal application of FYM (12 t ha^{-1}) + foliar spray of *Panchgavya* (3%) at 75 DAS/ DAT. Dry weight of rest of growth stages, crop growth rate and relative growth rate at all the growing stages found increased non-significantly.
The maximum yield attributes *viz*. panicle length and number of grains panicle^{-1} was observed with application of organic manure - FYM (12 t ha^{-1}) as basal application + foliar spray of *Panchgavya* (3%). Organic manures increased length of the panicle which may have caused on increased and continuous supply of photosynthates to the sink, due to slow release of nutrients from organic sources (Deshpande and Devasenapathy, 2011) [1]. The application of organic sources was showed significant effect on the number of grains panicle^{-1}, which may be due to the positive influence on growth and yield parameters of the crop. This may be ascribed to the better macro and micronutrient availability as well as physical condition of the soil (Mankotia *et al*., 2008) [7]. Synergetic effect of deeper root system foliar feeding of organic liquid manure may have caused bigger panicles. The application of organic sources significantly affected the individual grain weight. This may be ascribed to the micro and macronutrient availability as well as physical condition of the soil (Parihar, 2004) [10].
The grain yield was significantly influenced by the organic manure application (Table 1). The maximum grain yield and biological yield was recorded with basal application of FYM (12 t ha^{-1}) + foliar spray of *Panchgavya* (3%). The corresponding increases in term of per cent 85.32 and 43.39 as compared to green manuring with *Sesbania aculeata* + foliar spray of fish amino acid (FAA 3%). This might due to increased plant height and leaf area index may have helped in increasing the photosynthetic area for photosynthesis in plant. Foliar spray of *Panchgavya* showed beneficial effect on yield parameters. The easy transfer of nutrients through foliar spray of Panchgavya might be the reason for enhancement of yield attributes, and then increased yield ultimately (Yadav and Lourduraj, 2006) [17]. Better supply of micro and macro nutrients by organic manure might have helped for more enzymatic activity and physiological process of plant, which resulted into better translocation of the photosynthates and production of dry matter of the sink (grain). This might have helped in increasing the number of filled grains panicle^{-1} and increased 1000- grain weight (Deshpande and Devasenapathy, 2011) [1]. The current and residual contribution of organic sources, *viz*., FYM and green manure may have carry-over effect, which in turn increased the availability of nutrients to plants, resulting in higher productivity of rice (Munda *et al*., 2008).

System of planting

Different systems of planting significantly affected the growth parameters of scented rice. The maximum dry weight at 15, 30, 45, 60, 75 and 90 DAS/DAT was recorded under sowing of scented rice with SRI method. The crop growth rate and relative growth rate also increased under this treatment as compared to rest of the systems of planting. The accelerated growth and development of the crop under SRI at successive stages particularly at advanced phases resulted in higher dry matter accumulation (Sowmya *et al*., 2011) [13]. The dry matter accumulation depends upon the photosynthesis and respiration rate, which finally increase the plant growth with respect to increased growth parameters. The treatments which attained the maximum growth also accumulated higher dry matter at different growth stages (Jha *et al*., 2004) [5]. The factor responsible for increased weight of individual hills dry matter at wider spacing was greater tiller number with a large number of leaves (Thakur *et. al*. 2010) [14]. More dry matter accumulation might be due to increase in plant height. LAI and number of tillers plant. It was also observed by Deshpande and Devasenapathy (2011) [1].
The maximum yield attributes *viz*. effective tillers hill^{-1}, panicle length, number of grains panicle^{-1} and test weight were recorded in rice planting of SRI method as compared to rest of systems of planting. Increased number of effective tillers during peak vegetative stages might due to better

growth and development of crop indicated by more plant height and dry matter accumulation and improvement in soil physico-chemical properties due to de addition of organic manures (Deshpande and Devasenapathy, 2011) [1]. The higher effective tillers realized with SRI method may be due to the use of younger seedlings and wide spacing, which provided more room for more canopy and met growth. More canopies utilize higher light radiation; which increase more effective tiller. It corroborates with the findings of Hugar *et al*. (2009) [3]. Synergetic effect of deeper root system with SRI method may have caused bigger panicles. The increase in the test weight due to SRI method may be attributed to the larger root volume, profuse and stronger tillers and well filled spikelets with higher gain weight (Sowmya *et al*., 2011) [13].

The grain yield was significantly influenced by the organic manure application (Table 2). The maximum grain yield, biological yield and harvest index was recorded with S1. The corresponding increases in term of per cent 85.32 and 43.39 as compared to DSR method of planting. SRI recorded an additional grain yield over CTR and DSR method which may be due more yield attributes and better partitioning. The increase in the test weight due to SRI method may be attributed to the larger root volume, profuse and stronger tillers and well filled spikelets with higher grain weight (Sowmya *et al*., 2011) [13]. Similar results were recorded by Sowmya *et al*. (2007) [12]. Higher grain yield realized with SRI method might be due to large root volume, strong tillers with big panicles as well as higher fertility of spikelet. Harvest index was considerably higher in plants grown at the spacing of 25 x 25 cm than in plants grown in other spacings. This indicates that differences in grain yield at the various spacing were attributable to differences in harvest index (Thakur *et al*., 2010) [14].

Table 1: Effect of different forms of organic manures and systems of planting on dry weight and crop growth rate of scented rice

Treatments	Dry weight (g hill^{-1})						Crop growth rate (g m^{-2} day^{-1})					
	15 DAS/DAT	30 DAS/DAT	45 DAS/DAT	60 DAS/DAT	75 DAS/DAT	90 DAS/DAT	0-15 DAS/DAT	15-30 DAS/DAT	30-45 DAS/DAT	45-60 DAS/DAT	60-75 DAS/DAT	75-90 DAS/DAT
Organic manures												
M_1	0.11	1.24	2.07	9.04	11.62	13.92	0.87	4.13	2.18	20.32	7.43	6.15
M_2	0.15	0.85	2.68	8.00	10.94	13.24	0.41	2.79	6.13	15.13	7.36	4.77
M_3	0.18	1.00	2.42	10.69	12.98	15.40	0.41	2.62	5.18	22.96	7.82	6.73
M_4	0.16	1.01	2.28	9.34	14.30	16.48	0.42	3.95	3.23	20.20	14.17	9.92
M_5	0.21	0.66	2.18	11.65	16.04	18.49	0.56	2.06	5.29	25.56	7.77	7.78
M_6	0.36	0.70	2.32	12.28	13.84	17.13	0.82	1.06	4.46	20.17	12.60	5.29
SEd (±)	0.12	0.19	0.64	1.69	1.17	2.25	0.34	0.99	1.95	4.95	3.84	5.49
CD (P = 0.05)	NS	NS	NS	NS	2.61	NS	NS	NS	NS	NS	NS	NS
System of planting												
S_1	0.41	1.17	2.88	13.93	14.89	16.52	0.93	1.67	3.80	24.56	8.73	5.11
S_2	0.17	0.85	2.53	11.83	18.65	23.32	0.18	0.71	1.82	9.91	5.89	4.81
S_3	0.05	0.71	1.57	4.75	6.32	7.49	0.63	5.92	7.61	28.87	13.96	10.39
SEd (±)	0.07	0.19	0.32	1.36	0.71	1.16	0.22	0.66	1.91	2.80	5.51	4.40
CD (P = 0.05)	0.14	0.39	0.66	2.81	1.48	2.39	0.46	1.37	3.94	5.77	NS	NS

Table 2: Effect of different forms of organic manures and systems of planting on relative growth rate of scented rice

Treatments	Relative growth rate (g g^{-1} day^{-1})				
	15-30 DAS/DAT	30-45 DAS/DAT	45-60 DAS/DAT	60-75 DAS/DAT	75-90 DAS/DAT
Organic manures					
M_1	0.136	0.051	0.097	0.019	0.0103
M_2	0.137	0.075	0.073	0.020	0.0104
M_3	0.135	0.063	0.098	0.025	0.0108
M_4	0.154	0.053	0.087	0.030	0.0112
M_5	0.090	0.077	0.113	0.036	0.0123
M_6	0.087	0.067	0.101	0.025	0.0102
SEd (±)	0.024	0.018	0.026	0.009	0.008
CD (P = 0.05)	NS	NS	NS	NS	NS
System of planting					
S_1	0.117	0.067	0.105	0.048	0.0142
S_2	0.081	0.063	0.101	0.013	0.0080
S_3	0.171	0.062	0.079	0.020	0.0103
SEd (±)	0.013	0.014	0.009	0.007	0.005
CD (P = 0.05)	0.014	NS	0.018	0.015	NS

Table 3: Effect of different forms of organic manures and systems of planting on yield of scented rice

Treatments	Effective tiller hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Test weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index (%)
Organic manures							
M_1	4.33	25.07	124.06	20.84	3.38	6.92	37.17
M_2	4.42	24.31	127.17	21.10	2.99	8.05	71.06
M_3	5.11	24.68	125.55	21.63	3.25	9.55	29.29
M_4	5.64	25.41	133.33	21.17	3.06	7.48	33.92
M_5	5.86	26.93	161.20	22.30	4.79	6.67	43.37
M_6	5.6	26.69	159.77	22.09	3.99	10.51	27.54
SEd (±)	0.57	0.75	11.91	0.61	0.39	1.77	4.40
CD (P = 0.05)	NS	1.67	26.56	NS	0.88	NS	9.81
System of planting							
S_1	7.76	28.43	166.77	22.45	4.67	6.40	43.39
S_2	6.42	26.57	149.08	21.68	3.56	8.90	33.24
S_3	1.32	21.55	99.68	20.42	2.52	9.22	24.52
SEd (±)	0.46	0.60	6.65	0.26	0.37	1.57	5.64
CD (P = 0.05)	0.95	1.25	13.71	0.54	0.77	NS	11.63

Conclusion
Basis on our findings, it can be concluded that growing of scented rice with basal application of FYM + *Panchagavya* is most efficient preposition, when judged in term of growth, yield attributes and yield. Among systems of planting significantly and higher growth, yield attributes and yield of rice was recorded in SRI method over CTR and DSR methods.

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