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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(10): 217-221

www.thepharmajournal.com
Received: 20-07-2023
Accepted: 24-08-2023

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Effect of different forms of organic manures and systems of planting on productivity, profitability of scented rice and soil parameter

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Abstract
A field trial conducted at crop research farm at the Maya College of Agriculture and Technology in Selaqui, Dehradun (Uttarakhand), during the 2016 *kharif* season. Six different organic manure treatments were combined 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 significantly higher gross returns (₹ 143990 ha^{-1}), net returns (₹ 89571 ha^{-1}) and B-C ratio (2.65) were fetched by growing of rice under basal application of FYM + *Panchgavya* + SRI (T_{13}).

Keywords: Rice, systems of planting, organic manure, returns

Introduction
Cereals are grasses that are members of the poaceae family and are grown for the endosperm, germ, and bran, which are edible parts of the grain. More than any other type of crop, cereal grains are grown in bigger quantities and offer more food energy. They are a good source of carbohydrates, protein, vitamins, minerals, and lipids in their natural state. In India, rice cultivation makes over 40% of all food grain production (Singh and Singh, 2011) [7]. China produces the most rice, although India has the most area dedicated to the crop. Indonesia and China follow. In terms of production, consumption, and area, it is one of India's most significant staple food crops. Around the world, 164.19 million ha are used to grow rice, with yearly yields of 3105 kg ha^{-1} and 509.87 million tonnes, respectively. With an annual yield and productivity of 118.87 million tonnes and 2641.5 kg ha^{-1}, respectively, rice is produced on around 45 million ha in India. West Bengal, Bihar, Maharashtra, Uttar Pradesh, Panjab, Haryana, and other states produce the majority of India's rice (FAO STAT 2020) [3].
Land, water, manpower, and other inputs like fertilisers, pesticides, and insecticides (which are significant pollutants) are the main obstacles to rice production in India, without damaging the agricultural environment. The rapid development of India's rice-based cropping system has had an adverse effect on the soil's long-term viability and profitability as well as crop productivity. The need to reconsider current agricultural practises, particularly nitrogen management, has been felt due to growing concerns about human health, soil quality, and environmental safety. Furthermore, crop yield must be sustained at a greater level, particularly in developing nations like India, in order to meet the population's demand for food grains. The productivity of this system is declining or stagnating, according to the findings of long-term trials done on rice. It is also clear that the amount of organic matter in the soil is declining, and that this has an impact on how readily available nutrients are and how the soil behaves physically. Secondary nutritional deficits are also having an impact on how well rice is produced (Yadav *et al*., 2009) [12].
Researchers studying soil and agronomy have been focusing on finding alternative potential alternate sources of nutrients due to the rising costs of artificial fertilisers and the global energy crisis.

According to Khan *et al*. (2006) [4], it is now crucial to use the organic manures that are currently available as effectively as possible by using the right application techniques, timing, and practises, and by combining inorganic fertilisers with organics like FYM, green manure, and crop residues.

A significant number of secondary and micronutrients are also present in FYM, bulky organic manure that is a repository of key nutrients. Cattle and goat waste is typically utilised as farmyard manure. Small amounts of each nutrient that plants need are found in this manure. They stay in the soil longer and yield positive outcomes. Given that it is produced in-situ, decomposes quickly in the soil, mobilises nutrients, and improves the physical state of the soil, green manure has been determined to be the most suitable. The rice plant absorbs a number of soil nutrients from the day of seeding till harvest. Soil fertility must be maintained and used nutrients must be replaced in order to prepare the soil for the crop that will be planted the following season.

Organic substances like farmyard manure, green manure, green leaf manure, and liquid formulations of organics like calf urine, botanicals, etc. can provide the nutrients needed by plants. These manures also increase the soil's capacity for infiltration while assisting in the prevention of soil erosion. Additionally, they might be helpful in improving the biological qualities of the soil. Organic farming and recycling would have the added benefit of using waste-derived manures to improve soil productivity while reducing pollution. Food produced organically is anticipated to fetch a higher price, which can offset any losses resulting from reduced yields and generate lucrative business on the global market.

Organic farming, according to Yadav and Lourduraj (2006) [12], could save a significant amount of money (23%) with foliar spraying of *Panchgavya*.

A novel strategy known as the System of Rice Intensification (SRI) has gained popularity over the past 20 years or so due to its apparent success in raising rice yield. As a practical alternative to rice cultivation that increases output while reducing inputs, the system of rice intensification (SRI) was implemented in India in the year 2000. It has been demonstrated that using organic manures like FYM and GM is a viable INM for SRI component. Wherever there is a chance to increase productivity potential through an organic farming strategy, we must transition to organic farming, according to Uphoff *et al*. (2002) [11].

Materials and Methods

A study was carried out 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. Throughout the length of the trial, Selaqui receives 1040.4 mm of rain on average. Selaqui is situated 410 metres above mean sea level at 25.28° N latitude, 81.54° E longitude. Maximum and minimum average temperatures are 35.34°C and 12.94°C, respectively. The soil at the test site was a sandy-loam with good drainage capabilities and a pH reaction of 8.34. The soil was found to have low amounts of accessible nitrogen (0.028%) and organic carbon (0.36%), as well as medium quantities of potassium (156.44 kg ha^{-1}) and phosphorus (13.05 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. Transplanted 13-day-old rice seedlings for the SRI treatment and 22-day-old seedlings for the traditional technique. Rice seeds that had sprouted were planted in drums in the DSR. Since there was no tractor with a puddler, manual puddling was used. On June 30, 2016, green manure crops (*Sesbania aculeata* and *Crotalaria juncea*) were grown in the field for up to 55 days before being buried there by a tractor-drawn disc plough. 7 days prior to transplanting or sowing, 12 t ha^{-1} of well-decomposed FYM was applied.

Six ripe bananas were used to make *Panchgavya*, which was fermented for 15 days using mixes of five ingredients in the ratios of 5:4:3:2:1: cow dung, cow urine, milk, curd, and ghee. 300ml of the prepared and filtered solution was added to 10 litres of water to create the *Panchgavya* 3% solution, which was then administered as a foliar spray at 15, 30, 45, and 60 DAS/DAT according to the treatments. Fish waste (2.5 kg) and jaggy (2.5 kg), which were fermented for 15 days, were used to make fish amino acid. A 15, 30, 45 and 60 DAS/DAT solution containing 3 percent of fish amino acid was created by mixing 300 prepared and filtered solutions with 10 litres of water. Rice 'Pusa Basmati 1' was taken as test crop.

Tractor-drawn ploughing, two harrowing passes, and planking were used to prepare the experimental plot for planting. Then, manual flooding and puddling operations were carried out in experimental blocks. For the duration of the crop-growing season, the field was kept moist and received eight irrigations as advised. Two times, at 22 and 36 DAS/DAT, weed control was performed with the use of a cono weeder. Depending on the transplanting date, the crop was collected separately from each plot. The net plot's harvest was tied in individual bundles before being labelled.

The tagged bundles were allowed for sun drying in field and after drying on the threshing floor, the weight of bundles was recorded for obtaining biological yield. Threshing of rice was done manually by beating panicles on the sheaf with wooden baton and then seeds were separated by winnowing and recorded grain yield as treatments wise and expressed as t ha^{-1}. Straw yield was calculated by subtracting grain yield from respective biological yield of each plot and expressed as t ha^{-1}. The gross returns (₹ ha^{-1}) occurred due to different treatments in the present study were worked out by considering market prices of economic product and by product during the experimental year. Net returns were calculated by subtracting the total cost of cultivation from gross returns and expressed as ₹ ha^{-1}. In order to evaluate the benefit accrued from the treatments applied, the economics of different treatments were worked out as follows in terms of net return (₹ ha^{-1}) and Benefit: Cost (B:C ratio), so that most remunerative treatment could be recommended. This was calculated on treatment yield basis and prevailing market rates of inputs and outputs.

$$\text{B: C ratio} = \frac{\text{Net Returns}}{\text{Cost of cultivation}}$$

Data were statistically analysed using the analysis of variance technique recommended by Panse and Sukhatme (1985) [6]. Where the "F test" was significant at a 5% probability level and the data were provided, the "critical difference" was determined. 'NS' was used to indicate non-significant treatment differences.

Results and Discussion

Organic manure

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, 26.81 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) [12]. 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) [11]. 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) [5].

System of planting

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 SRI system of planting. The corresponding increases in term of per cent 85.32, 61.33 and 43.39 as compared to DSR system 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. Similar results were recorded by Sowmya *et al*. (2007) [9]. 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) [10].

Economics

The significantly higher gross returns (₹ 143990 ha^{-1}), net returns (₹ 89571 ha^{-1}) and B-C ratio (2.65) were fetched by growing of rice under basal application of FYM + *Panchgavya* + SRI (T_{13}) and no other treatment was able to compete with this technique in this regard (Table 2). It might be due to direct influence of higher grain and stover yields and it's monetary value under this treatment. The higher returns under organic farming was mainly due to better soil health which resulted in better plant growth, yield components, yield and higher price of organic produce (Yadav *et al*., 2009) [12]. Net return and B:C ratios were more when cono-weeder was used. This was mainly because of the reduced labour requirement in cono-weeded plots compared to manually weeded treatments (Anitha and Chellappan, 2011) [1].

Organic carbon and total nitrogen were increased under the influenced of the GM (green manuring) with *Sesbania* + *Panchgavya*, GM with *Crotalaria* + *Panchgavya*, GM with *Crotalaria* + FAA, FYM + *Panchgavya* and FYM + FAA, respectively (14.89 and 12.00%), (229.41% and 66.66%) (27.02% and 35.71%), (270.59 and 35.71%) and (81.81% and 9.75%). Organic manuring practices with GM with *Sesbania* + *Panchgavya* (60.00%), GM with *Sesbania* + FAA (22.16%), GM with *Crotalaria* + *Panchgavya* (41.00%), FYM + *Panchgavya* (22.20%) and FYM + FAA (11.39%) increased the available phosphorus over the pre experimental stages. Available potassium was increased by 784.01%, 342.41%, 250.36%, 167.00%, 189.91% and 125.64% respectively with GM with *Sesbania* + *Panchgavya*, GM with *Sesbania* + FAA, GM with *Crotalaria* + *Panchgavya*, GM with *Crotalaria* + FAA, FYM + *Panchgavya* and FYM + FAA. The pH was decreased by approximately 4.21% under the influence of organic manuring, which is an indicator of the buffering properties as well as reclaiming potential of organic sources.

The tent of enhancement of soil fertility status due to organic sources of both solid and liquid formulations indicates that nice cropping systems which currently showing a down-ward trent, has scope for sustainable management through organic farming.

Table 1: Effect of different forms of organic manures and systems of planting on yield of scented rice

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})
Organic manures			
M_1	3.38	6.92	10.3
M_2	2.99	8.05	11.04
M_3	3.25	9.55	12.8
M_4	3.06	7.48	10.54
M_5	4.79	6.67	11.46
M_6	3.99	10.51	14.5
SEd (±)	0.39	1.77	1.67
CD (P = 0.05)	0.88	NS	4.99
System of planting			
S_1	4.67	6.40	11.07
S_2	3.56	8.90	12.46
S_3	2.52	9.22	11.74
SEd (±)	0.37	1.57	1.94
CD (P = 0.05)	0.77	NS	5.78

Table 2: Effect of different forms of organic manures and systems of planting on economics of scented rice

Treatment	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1– GM with *Sesbenia* + Panchgavya + SRI	112050	47769	64281	2.35
T_2– GM with *Sesbenia* + Panchgavya + CTR	86520	50259	36261	1.72
T_3– GM with *Sesbenia* + Panchgavya + DSR	77320	50484	26836	1.53
T_4– GM with *Sesbenia* + FAA + SRI	105080	48489	56591	2.17
T_5– GM with *Sesbenia* + FAA + CTR	91090	50979	40111	1.79
T_6– GM with *Sesbenia* + FAA + DSR	71090	51204	19886	1.39
T_7– GM with *Crotalaria* + Panchgavya + SRI	91930	48419	43511	1.90
T_8– GM with *Crotalaria* + Panchgavya + CTR	103330	50909	52421	2.03
T_9– GM with *Crotalaria* + Panchgavya + DSR	104740	51134	53606	2.05
T_{10}– GM with *Crotalaria* + FAA + SRI	94580	49139	45441	1.92
T_{11}– GM with *Crotalaria* + FAA + CTR	90660	51629	39031	1.76
T_{12}– GM with *Crotalaria* + FAA +DSR	79170	51854	27316	1.53
T_{13} – Basal application of FYM + Panchgavya + SRI	143990	54419	89571	2.65
T_{14}– Basal application of FYM + Panchgavya + CTR	118400	56909	61491	2.08
T_{15} – Basal application of FYM + Panchgavya + DSR	91060	57134	33926	1.59
T_{16}– Basal application of FYM + FAA + SRI	137860	55139	82721	2.50
T_{17}– Basal application of FYM + FAA + CTR	129750	57629	72121	2.25
T_{18}– Basal application of FYM + FAA + DSR	85710	58679	27031	1.46

Table 3: Effect of different forms of organic manures and systems of planting on soil properties

Parameter	Before sowing of crop						After harvesting of crop					
	Available N (%)	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	Organic carbon (%)	pH	EC (dS m^{-1})	Available N (%)	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	Organic carbon (%)	pH	EC (dS m^{-1})
GM (*Sesbenia*) + *Panchgavya*	0.025	10.00	37.33	0.47	8.30	0.14	0.028	16.00	330.00	0.54	8.13	0.22
GM (*Sesbenia*) + FAA	0.027	12.00	44.00	0.37	8.40	0.15	0.024	14.66	194.66	0.56	8.13	0.21
GM (*Crotalaria*) + *Panchgavya*	0.015	13.00	45.00	0.17	8.30	0.16	0.025	18.33	157.66	0.56	8.16	0.21
GM (*Crotalaria*) + FAA	0.014	16.67	71.66	0.37	8.40	0.16	0.019	11.66	191.33	0.47	8.06	0.24
FYM + *Panchgavya*	0.047	15.00	62.66	0.17	8.30	0.19	0.049	18.33	181.66	0.63	8.10	0.22
FYM + FAA	0.041	11.67	78.00	0.33	8.36	0.17	0.045	13.00	176.00	0.60	8.13	0.23

Conclusion

Basis on our findings, it can be concluded that growing of scented rice with basal application of FYM + *Panchgavya* is most efficient preposition, when judged in term of production. Among systems of planting significantly and higher yield of rice was recorded in SRI method over CTR and DSR methods. All the treatments, T_{13} fetched maximum returns as compared to rest of the treatments.

Acknowledgement

The authors are highly thankful to the Department of Agronomy, Maya College of Agriculture and Technology in Selaqui, Dehradun (Uttarakhand) for providing all the necessary facilities and kind support.

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