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**Research Paper**

# Evaluation of varieties and local manurial sources for organic rice (*Oryza sativa*) production

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## ABSTRACT

Field experiments conducted at ICAR Research Complex for Goa, for two years during 2009 to 2011 to standardize locally available nutrient sources for different rice (*Oryza sativa* L.) varieties indicated that high yielding rice 'Karjat-3' and red kernelled rice 'Revathy' recorded significantly more productive tillers (8.99 and 8.94/hill, respectively) and panicles per unit area (276 and 262 per $m^2$, respectively) over scented rice 'Pusa Sugandh-5'. Rice variety 'Karjat-3' recorded significantly higher grain yield (3.13 t/ha) over 'Revathy' (2.50 t/ha) and 'Pusa Sugandh-5' (1.80 t/ha). Application of recommended fertilizers recorded significantly higher productive tillers (9.3/hill), total dry matter (26.1 g/hill), panicles per unit area (268/$m^2$) and higher grain yield of rice during first year of experimentation and the pooled mean (3.15 t/ha and 3.09 t/ha, respectively). Use of *Glyricidia* + Eupatorium each at 5 t/ha yielded 87% of the yield (2.69 t/ha) recorded with recommended fertilizers indicating its feasibility for use as nutrient source for rice production. Higher increase in organic carbon was observed with FYM @ 10 t/ha (1.44% O.C.) and paddy straw + water hyacinth each at 5 t/ha (1.36% O.C.). Application of *Sesbania rostrata* @10 t/ha resulted in higher microbial growth in soil in terms of fungi (10.39 $\times 10^3$ CFU/g), bacteria (17.5$\times 10^5$ CFU/g) and actinomycetes (10.28 $\times 10^4$ CFU/g) and yield of rice.

***Key words :*** Microbial population, Organic carbon, Organic sources, Problematic weed, Rice

The market for organic food is on the rise despite a dialogue on organic v/s modern agriculture (Prasad, 2005). Organic farming provides a way for continued rice production by resource poor farmers. Further the low yields obtained in the organic farming are well compensated by the higher price for organic foods. Organic farming also permits the recycling of organic wastes, the disposal of which could be difficult and expensive.

Proper selection of a variety and appropriate nutrient management are important in organic rice production (Manjunath *et al.,* 2009). A number of organic waste materials are available, which can supply a good amount of plant nutrients, NPK to produce comparable yield (Ghosh, 2005). Further, organic sources offer more balanced nutrition to the plants especially secondary and micro nutrients (Rakshit *et al.,* 2008).

Problematic weeds like Eupatorium, water hyacinth, etc., pose a serious menace for crop production. If managed properly, weed biomass could be a potential source of plant nutrients (Rajkhowa *et al.,* 2002). Use of the weeds as a source of plant nutrients not only reduces the dependence on external inputs but also limits the damage caused by them in crop production. In organic rice, the price premium varies with varieties. Keeping this in view, a field experiment was conducted to evaluate locally available manures including weeds for different rice varieties under West coast situations.

## MATERIALS AND METHODS

Field experiment was conducted at ICAR Research Complex for Goa, Old Goa ($15^0$ 30'N, $73^0$55'E and 16 m above mean sea level) for two rice seasons (2009-10 and 2010-11) in a split-plot design with three replications. Three rice varieties (red kernelled variety 'Revathy', scented variety 'Pusa Sugandh-5' and high yielding medium duration variety 'Karjat-3') were the main plot treatments, while seven manurial sources (Table 2) were the sub-plot treatments. The experiment was conducted on the same site during both the years of study. The soil of the experimental site was lateritic with a pH of 6.0, organic carbon 0.58%, available N 154.9 kg/ha, available P 21.1 kg/ha and K 188 kg/ha. The crop was managed with recommended package of practices. A dose of 100-50-50 kg NPK/ha was applied in recommended fertilizer plot. The manurial resources were selected based on the local avail-

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ability and the quantity was determined based on feasibility of application. The amount of organic manures applied were FYM @10 t/ha, vermicompost@ 5 t/ha, *Glyricidia* @ 5 t/ha + Eupatorium@ 5 t/ha, paddy straw @ 5 t/ha+ water hyacinth @ 5 t/ha and *Sesbania* @ 10 t fresh matter/ha. NPK content of organic manurial sources is given in Table 1. During 2009, the crop was sown on 12th June for nursery and was transplanted on 17th July, while during 2010, the crop was sown on 8th June for nursery and was transplanted on 11th July. During both the years, the crop was harvested during last week of October. All the manures were applied before planting and incorporated into the soil. All the relevant growth and yield parameters were recorded in rice and the data analyzed as per standard statistical procedures during both the years. The soil samples were collected after each harvest both for soil fertility parameters and the microbial count. Soils were analysed by using standard procedures as described for organic carbon (Walkley and Black, 1934), available nitrogen (Subbiah and Asija, 1956), available phosphorus (Bray and Kurtz, 1945) and available potassium (Jackson, 1973). The microbial population in soil sample was determined by serial dilution petri plate method by using Kingh's B agar for bacteria, potato dextrose agar for fungi and Walkmen's agar for actinomycetes (Joneps and Mollisonj, 1948).

**Table 1.** Nutrient composition of organic manurial resources

| Organic sources | N (%) | P (%) | K (%) |
|---|---|---|---|
| FYM | 1.10 | 0.85 | 0.33 |
| Vermicompost | 1.59 | 1.01 | 0.25 |
| Glyricidia | 4.13 | 0.45 | 1.85 |
| Eupatorium | 2.52 | 0.05 | 1.58 |
| Paddy straw | 1.68 | 0.05 | 0.45 |
| Water hyacinth | 3.51 | 0.23 | 3.33 |
| Sesbania rostrata | 3.79 | 0.04 | 0.90 |

## RESULTS AND DISCUSSION

### *Growth and yield attributes*

Rice variety 'Pusa Sugandh-5' recorded significantly taller plants than 'Revathy' and 'Karjat-3'. However, high yielding rice variety 'Karjat-3' and red kernelled rice variety, 'Revathy' recorded significantly more productive tillers (9.0 and 8.9/hill, respectively) and panicles/$m^2$ (276 and 261, respectively) over scented variety 'Pusa Sugandh-5'(216 panicles/$m^2$). Although 'Pusa Sugandh-5' recorded longer panicles (25cm), significantly more spikelets were observed in the panicles of 'Revathy' (135 per panicle). However, the variety, 'Revathy' also recorded higher sterility (34%).

The order of plant growth among the manurial resources was chemical fertilizer > *Glyricidia* + Eupatorium > *Sesbania* > paddy straw + water hyacinth > vermicompost > farmyard manure > untreated control. Plants of untreated control remained generally well below all other treatments. Application of recommended fertilizer dose recorded significantly more productive tillers (9.3/hill) and total dry matter (26.1 g/hill). The treatment also recorded significantly more panicles per unit area (268/$m^2$) but was on par with rest of the treatments except FYM and the control. The variation in plant growth due to organic manures was considered to be due to variation in the availability of major nutrients. All the parameters were significantly lower with the control.

Among the organic sources of nutrients, growth and yield attributes were in general better with application of *Glyricidia* + Eupatorium followed by application of *Sesbania rostrata*. Further, application of *Sesbania rostrata* was statistically on par with that of recommended fertilizers in respect of spikelets/panicle. Sarwar *et al.*, (2008) also observed that addition of organic materials appreciably increased the height of rice plants and differences among various treatments for number of fertile tillers/plant were significant. Further, it is pertinent to note that application of recommended fertilizers (inorganic) resulted in significantly higher sterility (41%) clearly suggesting the imbalance in source-sink relation and scope for its improvement.

Although, the harvest index did not differ due to manurial resources, a significant variation was observed among the rice varieties. 'Karjat-3' recorded a significantly higher harvest index (0.42) over other two varieties indicating its superiority (Table 2).

### *Grain and straw yield*

Rice variety 'Karjat-3' recorded significantly higher grain yield (3.06 t/ha) over 'Revathy' (2.52 t/ha) and 'Pusa Sugandh-5' (1.77 t/ha). The straw yield record was significantly higher with rice variety 'Pusa Sugandh-5' (5.3 t/ha) followed by 'Revathy' (4.9 t/ha).

Application of recommended fertilizer dose recorded highest grain yield of rice, significantly more than organic manures (Table 2). Among the organic manurial resources, application of *Glyricidia* + Eupatorium each @ 5 t/ha recorded relatively better grain yield (2.69 t/ha) than other organic manures; it was 87% of the yield recorded with recommended fertilizers. Higher nutrient content of *Glyricidia* loppings (4.13% N, 0.45% P and 1.85% K) along with the additional biomass of Eupatorium having 2.52% N, 0.05% P and 1.58% K contributed for the increased yield in this treatment. Tripathi and Verma (2008) also observed that inorganic fertilizer treatment resulted in the higher grain and straw yields as compared to farm yard manure and vermicompost.

Incorporation of water hyacinth + paddy straw yielded

78% of grain and 83.5% straw, respectively in comparison to recommended fertilizer dose. Further, the treatment recorded 34.2% higher grain and 14% higher straw yield, respectively over the absolute control (no manure/fertilizer) and was on par with rest of the organic manures.

The interaction effects between the varieties and the manurial resources for the pooled mean grain yield indicated that application of recommended fertilizers (100-50-50 kg NPK/ha) in rice variety Karjat-3 recorded significantly highest grain yield (3.65 t/ha). *Glyricidia* + Eupatorium green leaf manuring resulted in 90% of the yield obtained with the recommended fertilizer dose in 'Karjat-3' (3.30 t/ha). Higher straw yield (5.75 t/ha) was also recorded with the application of recommended fertilizers, significantly more than the organic manurial treatments except vermicompost which was at par (5.59 t/ha). Among the other organic manurial resources, application of *Glyricidia* + Eupatorium recorded better pooled mean straw yield (5.20 t/ha); about 90% of the yield recorded with recommended fertilizer dose.

### *Changes in soil fertility*

A significant increase in organic C content in soil after two rice seasons over control was obtained with FYM (1.44% O.C.) and paddy straw + water hyacinth (1.36% O.C.), which were at par. Prasad and Mishra (2001) and Sharma and Prasad (2002) also reported a significant increase in soil organic C in rice-wheat cropping system due to addition of FYM and crop residues. A significant increase in available nitrogen in soil was observed only with the application of *Sesbania rostrata* green manure. This was due to higher N content in *Sesbania* residue. The highest available phosphorus content (35.5 kg/ha) was observed with FYM application and the highest available potassium content (164 kg/ha) was recorded with paddy straw along with water hyacinth. This was due to higher P content in FYM and the highest K content in water hyacinth (Table 1). These results are in accord with those of Prasad and Mishra (2001).

### *Influence on soil microbial population*

Application of *Sesbania rostrata* significantly increased microbial growth in soil in terms of bacteria ($17.5\times10^5$ CFU/g), actinomycetes ($10.28\times10^4$ CFU/g) and fungi ($10.39\times10^3$ CFU/g). The higher microbial growth in the treatment may be attributed to the free living nitrogen fixers both in stem and root nodules of *Sesbania* coupled with addition of sufficient quantities of easily decomposable organic matter that might have served as a substrate for the microbial growth. Singh *et al.,* (2007) also observed that soil microbial population viz. actinomycetes, bacteria, fungi and BGA increased due to the application of organic amendments. Although recommended fertilizer application recorded highest actinomycetes population ($11.33\times10^4$ CFU/g), application of FYM resulted in relatively higher fungal population.

**Table 2.** Pooled mean growth, yield attributes and the yield in different varieties of rice as influenced by addition of different manurial resources over two years

| | Plant height (cm) | Productive tillers/ hill | Total dry matter (g/hill) | Panicles/m$^2$ | Panicle length (cm) | Spikelets/ panicle | Sterility (%) | Harvest Index | Grain yield (t/ha) | Straw yield (t/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| *Rice variety* | | | | | | | | | | |
| 'Karjat-3' | 79.7 | 9.0 | 29.5 | 275.7 | 21.0 | 127.5 | 23.9 | 0.42 | 3.06 | 4.08 |
| 'Revathy' | 93.5 | 8.9 | 38.5 | 261.4 | 20.5 | 134.6 | 33.8 | 0.39 | 2.52 | 4.94 |
| 'Pusa Sugandh-5' | 100.5 | 7.5 | 9.5 | 216.0 | 25.2 | 131.8 | 26.0 | 0.28 | 1.77 | 5.32 |
| SEm± | 0.8 | 0.2 | 2.6 | 7.1 | 0.2 | 2.1 | 0.7 | 0.04 | 0.18 | 0.90 |
| CD (P=0.05) | 3.3 | 1.0 | 10.3 | 27.8 | 0.7 | 8.1 | 2.8 | 0.05 | 0.73 | 1.54 |
| *Nutrient source* | | | | | | | | | | |
| FYM (10 t/ha) | 89.2 | 8.4 | 25.1 | 242.3 | 22.0 | 134.3 | 28.2 | 0.36 | 2.41 | 4.42 |
| Vermicompost (10 t/ha) | 89.7 | 8.1 | 26.1 | 252.0 | 22.1 | 134.0 | 27.2 | 0.35 | 2.24 | 5.59 |
| *Glyricidia* (10 t/ha) + Eupatorium (10 t/ha) | 94.0 | 8.8 | 23.6 | 260.8 | 22.2 | 132.2 | 27.5 | 0.38 | 2.69 | 5.20 |
| Paddy straw (10 t/ha) + water hyacinth (10 t/ha) | 90.8 | 8.3 | 24.8 | 252.8 | 22.3 | 135.0 | 28.3 | 0.38 | 2.40 | 4.80 |
| *Sesbania rostrata* (10 t/ha) | 92.2 | 8.7 | 23.6 | 256.2 | 22.1 | 137.3 | 28.9 | 0.35 | 2.41 | 4.63 |
| 100% NPK (100:50:50 kg/ha) | 97.4 | 9.3 | 26.1 | 267.8 | 23.0 | 139.1 | 40.6 | 0.35 | 3.09 | 5.75 |
| Control | 85.3 | 8.0 | 22.8 | 220.9 | 21.9 | 125.1 | 27.1 | 0.39 | 1.95 | 4.21 |
| SEm± | 0.8 | 0.1 | 1.7 | 6.4 | 0.2 | 8.3 | 1.2 | 0.03 | 0.11 | 0.13 |
| CD (P=0.05) | 2.3 | 0.4 | 4.9 | 18.3 | 0.7 | 2.9 | 3.6 | -- | 0.33 | 0.38 |

**Table 3.** Soil fertility parameters and microbial population in soil as influenced by addition of different manurial resources after two rice seasons.

| Manurial resources | Organic Carbon (%) | Available N (kg/ha) | Available P (kg/ha) | Available K (kg/ha) | Bacteria ($10^5$ CFU/g) | Fungi ($10^3$ CFU/g) | Actinomycetes ($10^4$ CFU/g) |
|---|---|---|---|---|---|---|---|
| *Rice variety* | | | | | | | |
| 'Karjat-3' | 1.26 | 189.2 | 39.1 | 114.8 | 11.64 | 6.83 | 9.31 |
| 'Revathy' | 1.30 | 190.3 | 30.2 | 86.3 | 11.62 | 5.31 | 9.98 |
| 'Pusa Sugandh-5' | 1.30 | 192.8 | 27.9 | 205.3 | 13.90 | 10.14 | 9.00 |
| SEm± | 0.14 | 17.87 | 4.10 | 34.04 | 1.85 | 2.65 | 2.64 |
| CD (P=0.05) | NS | NS | 6.09 | 50.52 | NS | NS | NS |
| *Nutrient source* | | | | | | | |
| FYM (10 t/ha) | 1.44 | 197.2 | 35.5 | 154.4 | 13.11 | 8.00 | 9.22 |
| Vermicompost (10 t/ha) | 1.21 | 185.4 | 34.1 | 122.2 | 13.83 | 6.94 | 9.67 |
| *Glyricidia* (10 t/ha) + Eupatorium (10 t/ha) | 1.24 | 189.2 | 31.1 | 140.2 | 7.94 | 6.39 | 7.72 |
| Paddy straw (10 t/ha) + water hyacinth (10 t/ha) | 1.36 | 191.3 | 32.6 | 164.0 | 10.83 | 7.33 | 9.33 |
| *Sesbania rostrata* (10 t/ha) | 1.31 | 203.5 | 29.4 | 123.3 | 17.50 | 10.39 | 10.28 |
| 100 % NPK | 1.25 | 178.6 | 31.8 | 107.3 | 9.83 | 5.61 | 11.33 |
| Control | 1.23 | 192.0 | 32.7 | 136.7 | 13.66 | 7.33 | 8.45 |
| SEm± | 0.04 | 4.96 | 1.34 | 10.90 | 5.34 | 4.01 | 1.91 |
| CD (P=0.05) | 0.11 | 13.70 | 3.70 | 30.10 | 9.31 | 6.65 | 3.17 |

*Soil had a initial content of Organic Carbon-0.58%, Available N-154.9 kg/ha, Available P-21.1 kg/ha and Available K-188 kg/ha

It is concluded that both the Eupatorium and water hyacinth can be a potential manurial source for organic rice production. These problematic weeds offer not only a good scope for addition of organic matter but also add nutrients to the soil. 'Karjat-3' was found to be the best rice variety for Goa.

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