Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(6): 437-441
Received: 12-09-2017
Accepted: 14-10-2017

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Changes in soil physiological and chemical properties due to adoption of organic farming practice in scented rice

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Abstract
A field study was conducted during *Kharif*, 2016-17 in Instructional cum Research farm, IGKV, Raipur (Chhattisgarh) in Inceptisols with rainy season rice to evaluate the effect of different combinations of organic manures along with biofertilizers on physico-chemical, chemical, biochemical properties of soil and crop yield. Different chemical and non –chemical weed management techniques were also evaluated to find out their suitability. Three different types of organic manures i.e. FYM, Poultry manure and Vermicompost were mixed in different combinations and applied in field to fulfill the nitrogen requirement of the crop. The results of the investigation revealed that the 50% nitrogen management through FYM, 50% nitrogen management by poultry manure along with application of biofertilizers *Azospirillum* and PSB was found most effective to improve the physico-chemical, chemical, biochemical properties of soil and crop yield. Under this system the pH of the soil tended towards nutrality. Soil organic carbon was also found at maximum level due to above combination of organic manures. In this experiment a minute increase in soil pH was observed before application of organic manures (initial observation) and harvest of crop. It was also observed a minute increase in soil EC from initial observation i.e. before application of organic manures and at harvest stage of the crop. Comparatively higher soil organic carbon content (SOC) was found in soil at 30 and 50 DAS of crop.
A field study was conducted during *Kharif*, 2016-17 in Instructional cum Research farm, IGKV, Raipur (Chhattisgarh) in an Inceptisols with rainy season rice to evaluate the effect of different combinations of organic manures along with biofertilizers on physico-chemical and chemical properties of soil and crop yield. Different chemical and non –chemical weed management techniques were also evaluated to find out the suitability. Three different types of organic manures i.e. FYM, Poultry manure and Vermicompost were mixed in different combinations. The experiment was laid Split Plot Design with three replications and twelve treatments involving organic manures *Azotobacter* and along with PSB. The results revealed that significantly highest soil physiological and chemical properties was obtained under FYM (50% N) + Poultry Manure (50%N) + *Azospirillum* + PSB as compared to FYM (50% N) + Vermicompost (25% N) + Poultry Manure (25% N) +*Azospirillum* + PSB and FYM (50% N) +Vermicompost (50% N) + *Azospirillum* + PSB treatments. In this treatments FYM (50% N) + Poultry Manure (50%N) + *Azospirillum* + PSB is produced significantly maximum soil pH (6.38), soil EC (0.24) and Organic carbon content (0.51) over other treatments. No significant difference in grain yield of scented rice was found among different nutrient management practices. However, highest grain yield of rice (1.48 t/h) was recorded in FYM (50% N) + Poultry Manure (50%N) combination of organic manure application along with treatment of *Azospirillum* and PSB. Residual nitrogen in soil also found significantly higher in treatment FYM (50%N) + Poultry Manure (50%N) +*Azospirillum* + PSB. Thus it is concluded that management of nitrogen through FYM (50% N), Poultry Manure (50%N) and application of biofertilizers like *Azospirillum* and PSB improved the soil properties of during organic scented rice cultivation.

Keywords: Organic farming system, soil pH, soil EC, Organic Carbon content, Residual NPK, Grain Yield

1. Introduction

The global production of rice has been estimated to be at the level of 744.4 million tons (FAOSTAT, 2014) [3] and the area of production is estimated as 164.3 million hectares (FAO, 2014). India ranks first in area (42.5 million ha) and second in production (106.29million tons) in the year of 2014 (WWW.ICAR.ORG). Annual population growth rate of the country is nearly 3.5 % and if per capita consumption of rice is expected to be 400 gm of rice per day then the demand for rice in 2025 will be 130 m. tones. In Chhattisgarh, rice occupies average of 38.02 lakh.ha. With production of 67.16 lakh MT (C.G. Govt., 2013-14) [1].
Organic farming system emphasis on the use of organic matter for enhancing soil properties,

minimizing food chain associated health hazards and attaining closed nutrient cycles, the key factors for sustainable agriculture (Cardelli *et al.*, 2004). According to the International Federation of Organic Agriculture Movement (Willer *et al.*, 2008) [13] the major objectives of organic farming include, production of high quality food in sufficient quantity in harmony with natural systems and cycles, enhancing biological cycles within the farming system involving microorganisms, soil flora and fauna, plants and animals, maintaining long-term soil fertility and genetic diversity of the production system and minimizing all forms of pollution. The key component of organic farming is organic manures such as farm yard manure, compost, green manure, and bone meal. Biological pest control, mixed cropping and the fostering of insect predators are also encouraged. Organic matter is an important soil component influencing the physical, chemical and microbiological properties of soil to a great extent. All physical properties of soil are affected by changes in organic matter levels of soil. Rice (*Oryza sativa* L.) is the most important cereal crop and staple food for two –thirds of the worlds's population. Rice production currently depends on the large –scale use of chemical fertilizers which pose an environmental hazards for rice –producing areas. Organic manure have the capacity to fulfill nutrient demand of crops adequately and promotes the activity of macro and micro flora in the soil. The area under scented rice varieties is increasing day by day with the opening of the world market as well as increased domestic consumption due to their premium quality. Under this situation organic cultivation of scented is a good option for earning more money by the marginal rice growers of Chhattisgarh by narrowing the cost of cultivation simultaneously with production of high value scented organic rice. In cultivation of scented rice under organic farming system, weeds are one of the hindrance for getting profitable yield. Under this system the chemicals are banned for controlling weeds. Hence we have to opt for mechanical weed control measures.

Keeping this in view, the present investigation was undertaken to find out the suitable combination of organic manures and biofertilizers which can give better yield of scented rice, also to search the impact of organic rice cultivation on the soil properties.

2. Materials & Methods

The experiment was conducted during *kharif* season of 2016-17 with rice (*Oryza sativa* L.) at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment was laid out in split plot design (SPD). Three organic treatments were (i) FYM (50% N) +Vermicompost (50% N) + *Azospirillum* + PSB, (ii) FYM (50% N) + Poultry Manure (50%N) +*Azospirillum* + PSB and (iii) FYM (50% N) + Vermicompost (25% N) + Poultry Manure (25% N) +*Azospirillum* + PSB practices which were put in main plots. In sub plots weed control treatments were applied i.e. (i) Hand weeding (ii) motorized weeding and (iii) application of recommended herbicides. A weedy check plot was also maintained as control (Table-1). As recommended herbicide for *kharif* rice oxadiargyl 80g/ha was sprayed in pre emergence of rice and fb bispyribac 25g/ha was sprayed in post emergence stage of the crop respectively. The pre emergence and post emergence herbicides were applied at 6 and 29 days after sowing of the crop.

The experiment was conducted on *kharif* rice with test variety Dubraj. The soil was Inceptisol (pH 6.38, EC 0.23 dSm^{-1}, Organic Carbon 0.51%, N 225.7 kg/ha, P 14.77 kg/ha, K 343.2 kg/ha). Soil samples from field were collected from 7.5-15cm from the soil surface at different stages of crop growth. The pooled soil samples were subjected to analysis for soil physico chemical and chemical analysis. A 10 g air dried soil was taken in a clean 50 ml. beaker and 25 ml. of distilled water was added to it. The suspension was stirred intermittent for 30 minutes. The pH of soil water suspension was recorded using pH meter (Piper, 1967) [10]. The EC was determined by Conductivity Bridge as described by Jackson (1973) [7]. For this determination 10 g of soil was weighed and taken in a 50 ml. beaker, 25 ml. distilled water was added and suspension was stirred intermittently for 30 minutes and allowed the suspension to settle for about one hour. The measure of EC in supernatant solution was done by using EC Bridge. Organic carbon content in soil was determined by the rapid dichromate oxidation technique given by Schollenberber *et al*. (1927) [11]. One g air dried soil sample was taken in dry 500 ml conical flask and added 10 ml of 1N $K_2Cr_2O_7$ with the help of volumetric pipette and swirled a little. To this 20 ml of H_2SO_4 was then added and swirl again 2-3 times and kept the flask on an asbestos sheet for 30 min. Then 200 ml of distilled water, 10 ml of H_3PO_4, 0.5 gm Sodium Fluoride and 1 ml Diphenylamine indicator were added. Titrated the content against 0.5N Fe $(NH_4)_2(SO_4)_2$ till the colour flashed from blue-violet to green. Crop yield was recorded at harvest of the crop. After harvest of rice soil analysis was done for quantification of residual NPK. In this regard available N was determined by alkaline $KMnO_4$ method of Subbiah and Asija (1965) [12], Soil phosphorus was extracted by 0.5M $NaHCO_3$ as described by Olsen *et al*. (1954) [9], Potassium was estimated by flame photometer (Muhr *et al.*, 1965) [8]. All the pre and post harvest observations were recorded and tabulated in a systematic manner. The final observations were statistically analyzed by Split Plot Design (Gomez & Gomez, 1984).

Treatment details

Nutrient management (Main Plot)

Treatment	Organic Inputs
1	50% N (FYM) + 50% N (Vermicompost) + *Azospirilium* + PSB
2	50% N (FYM) + 50% N (Poultry Manure) + *Azospirilium* + PSB
3	50% N (FYM) + 25% N (Vermicompost) + 25% N (Poultry Manure) + *Azospirilium* + PSB

Diluted cow urine @ 500 litre/ ha was applied as foliar spray twice in all plots uniformly.

Weed Management (Sub-Plot)

1. Hand weeding twice (at 20 & 40 DAS)
2. Motorized weeder (at 20 & 40 DAS)
3. Recommended herbicides (oxadiargyl 80 g /ha PE *fb* bispyribac 25 g/ha PoE)
4. Control (weedy check)

3. Result and Discussion

Effect of different organic manures and weed control practices on soil pH

It was revealed from the data that there was a minute increase in soil pH before application of organic manures (initial observation) and harvest of crop. The results given in the Table 1 indicated that there was no significant difference between different combinations of organic manures. The pH

value of all the four treatments (main plot) lies between 6.38-6.29. The enhancement of pH value under the treatment might be due release of different salts which acts buffering agent to enhance the soil pH towards neutrality. The result is in accordance with Grewal *et al*. (1981) [5]. Who found that FYM recorded maximum pH at all the stages of crop growth compared to green leaf manure and vermin compost probably due to complexing of exchangeable and free Al- ion by aliphatic and aromatic hydroxyl acids produced during decomposition. It is apparent from the data that pH of the hand weeded, motorized weeded, recommended herbicide applied and control (weedy check) plots did not vary significantly from each other at initial growth stage and also at harvest stage of the crop. At harvest stage of the crop the soil pH under recommended herbicide applied plots found to be maximum (6.91) followed by motorized weeded plots (6.85), hand weeded (6.87), and control (weedy check) plots (6.84).

Effect of different organic manures and weed control practices on soil EC

It was revealed from the data that there was a minute increase in soil EC from initial observation Table 1 i.e. before application of organic manures and after application (at harvest stage of the crop). Maximum soil EC was recorded in FYM (50% N) +Vermicompost (50% N) + *Azospirillum* + PSB followed by FYM (50% N) + Vermicompost (25% N) + Poultry Manure (25% N) +*Azospirillum* + PSB, and FYM (50%) + Poultry Manure 50% +*Azospirillum* + PSB at harvest stage. However, these values were found at par. The higher EC under different treatment organic manures and biofertilizers might be due release of different salts. These finding is in dose confirmity with the results of Goutami *et al*. (2015) [4], who found that EC values of the soil were not significantly influenced by bio-fertilizers and FYM either alone or in combination at different levels of nitrogen. It was apparent from the data that EC of the hand weeded, motorized weeded recommended herbicide applied and control (weedy check) plots did not vary significantly from each other at both initial and harvest stage of the crop. At harvest stage of the crop the soil EC under control (weedy check) plots was found maximum (0.26) followed by hand weeded plots (0.25), recommended herbicide plots (0.24), and motorized weeded plots (0.23).

Table 1: Effect of different combination of organic manures and weed control measures on soil pH and EC.

Treatment	Initial			At Harvest	
	pH	EC (dSm^{-1})		pH	EC (dSm^{-1})
Main Plot (Nutrient Management)					
FYM(50%N) + Vermi Comp.(50%N)+*Azo*.+PSB.	6.39	0.24		6.88	0.25
FYM (50% N) + Poultry Manure(50%N)+*Azo*.+PSB.	6.38	0.23		6.87	0.24
FYM (50%N)+ Vermi Comp. (25% N)+ Poultry Manure(25%N) + *Azo*. +PSB.	6.39	0.23		6.88	0.24
CD (5%)	NS	NS		NS	NS
Sub –Plot (Weed Management)					
Hand Weeding	6.38	0.24		6.87	0.25
Motorized Weeder	6.39	0.22		6.85	0.23
Recommended Herbicide	6.39	0.23		6.91	0.24
Control	6.39	0.25		6.84	0.26
CD (5%)	NS	NS		NS	NS
Interaction NM x WM					
CD (5%)	NS	NS		NS	NS

FYM. = Farm Yard Manure
Vermi Comp. = Vermi Compost
Azo. = *Azospirillum*
PSB. = Phosphorus Solublizing Bacteria

Effect of different organic manures and weed control practices on soil organic carbon content

Data showed that there was a little increase in the organic carbon content in soil during the crop growth stages Fig.1. Comparatively higher soil organic carbon content (SOC) was found at 30 and 50 DAS. At 50 DAS significantly higher SOC was quantified in FYM (50%N) + Poultry Manure (50%N) +*Azospirillum* + PSB over other. However, other two treatments i.e. FYM (50% N) +Vermicompost (50% N) + *Azospirillum* + PSB and FYM (50% N) + Vermicompost (25% N) + Poultry Manure (25% N) +*Azospirillum* + PSB, were found at par with each other with respect to SOC. Zhao *et al.* (2009) [14] also mentioned that the level of organic matter tends to be enhanced in soils amended with organic fertilizers (manure and straw). Significant increase in organic carbon due to application of FYM may be attribute to excessive microbial activity of soil. An increasing trend in organic carbon content was observed in all the sub-plots treatments in all growth stages. There was no significant difference found among different weed control practices at all the growth stages of the crop including weedy check. However the SOC was found higher in weedy check plots followed by hand weeded plots in all the growth stages of crop which might be due to higher crop- weed density in control plots and hand weeded plots in comparison to herbicide treated plots which contributed higher organic matter in soil.

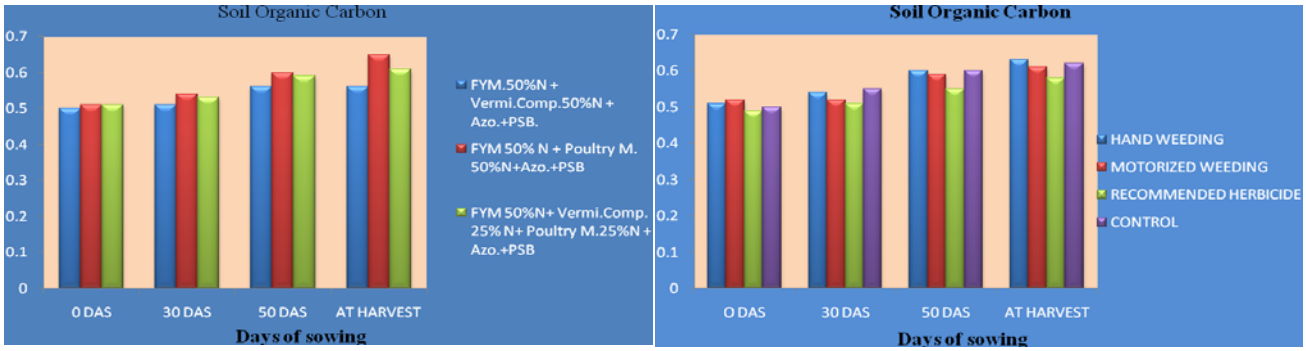

Fig 1: Effect of different combination of organic manures and weed control measures on Organic Carbon Content in soil.

Grain Yield

No significant difference in grain yield of scented rice was found different nutrient management practices Table 2. However, highest grain yield of rice (1.48 t/h) was recorded in FYM (50% N) + Poultry Manure (50%N) combination of organic manure application along with treatment of *Azospirillum* and PSB. Among weed management practices maximum grain yield was found under application of herbicides which was significantly superior to rest of the treatments. Incase of other than chemical method of weed management, hand weeding twice and motorized weeding twice were equally effective and recorded comparable yield.

Table 2: Grain yield at harvest as influenced by nutrients and weed management in organically grow direct seeded scented rice.

Treatment Main Plot (Nutrient Management)	Grain yield, t/ha
FYM(50%N) + Vermi Compost (50%N)+*Azospirillum*.+PSB.	1.38
FYM (50% N) + Poultry Manure(50%N)+ *Azospirillum*.+PSB.	1.48
FYM (50%N)+ Vermi Compost (25% N)+ Poultry Manure(25%N) + *Azospirillum*.+PSB.	1.39
SEm+	0.03
LSD (P=0.05)	NS
Sub –Plot (Weed Management)	
Hand Weeding	1.66
Motorized Weeder	1.67
Recommended Herbicide	1.90
Control	0.43
SEm+	0.43
LSD (P=0.05)	0.18
Interaction NM x WM	NS
LSD (P=0.05)	NS

Effect of different organic manures and weed control practices on residual soil NPK

The observation on residual NPK content in soil as influenced by different combinations of organic manures Table 3. The data recorded that after application of different manures in different combinations did not increase the residual nutrient content in soil. However in treatment FYM (50%N) + Poultry Manure (50%N) +*Azospirillum* + PSB found better over treatment FYM (50% N) + Vermicompost (25% N) + Poultry Manure (25% N) +*Azospirillum* + PSB and FYM (50% N) +Vermicompost (50% N) + *Azospirillum* + PSB. Residual nitrogen in soil found significantly higher in treatment FYM (50%N) + Poultry Manure (50%N) + *Azospirillum* + PSB over treatment FYM (50% N) + Vermicompost (25% N) + Poultry Manure (25% N) + *Azospirillum* + PSB and FYM (50% N) + Vermicompost (50% N) + *Azospirillum* + PSB. The observation on the effect of different on residual soil nutrient content of different weed control practices. The observatios clearly decided that the residual soil NPK content was found lowest in weedy check plots. However the content was found maximum in recommended herbicides applied plots. The P content in herbicide treatment plots found at par with motorized weeded plots. However the residual K content in herbicide treatment plots found at par with all the non-chemical weed control methods.

Table 3: Effect of different combination of organic manures and weed control measures on Residual soil NPK Content.

Treatment	Initial			At Harvest		
	N	P	K	N	P	K
Main Plot (Nutrient Management)						
FYM(50%N) + Vermi Comp.(50%N)+*Azo*.+PSB.	224.5	15.0	344.4	183.6	9.9	314.2
FYM (50% N) + Poultry Manure(50%N)+*Azo*.+PSB.	225.7	14.7	343.2	199.5	10.8	323.0
FYM (50%N)+ Vermi Comp. (25% N)+ Poultry Manure(25%N) + *Azo*. +PSB.	225.5	14.7	342.5	186.3	10.3	317.4
CD (5%)	NS	NS	NS	12.51	NS	NS
Sub –Plot (Weed Management)						
Hand Weeding	226.1	14.2	343.2	191.0	10.4	316.2
Motorized Weeder	226.9	14.9	344.8	189.9	10.8	321.8
Recommended Herbicide	224.3	15.3	342.4	204.1	11.6	327.0
Control	223.7	15.0	343.1	174.3	8.5	307.9
CD (5%)	NS	NS	NS	6.9	1.0	14.4
Interaction NM x WM						
CD (5%)	NS	NS	NS	NS	NS	NS

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