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SUPERIMPOSITION OF ORGANIC SOURCES OF MANURES TO ENHANCE GROWTH, YIELD ATTRIBUTES AND YIELD OF SCENTED RICE (*ORYZA SATIVA* L.) AND ITS IMPACT ON SOIL HEALTH

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Abstract

An experiment was conducted during *kharif* 2012 and 2013 at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), India; in scented rice (*Oryza sativa* L.). Data revealed that superimposition of organic sources on RDF significantly increased growth and yield attributing characters *viz*., plant height, number of tillers per plant, dry weight per plant and leaf area and length of panicle, panicle weight, number of grains per panicle and 1000 grain weight of scented rice than control (RDF). Superimposition of organic sources of neem cake @ 3 t ha^{-1} over RDF produced significantly higher grain (53.60 and 54.76 q ha^{-1}) and straw (83.33 and 84.20 q ha^{-1}) yield than all other treatments except $\mathbf{T_8}$ (RDF + FYM @ 12 t ha^{-1}) and $\mathbf{T_9}$ (RDF + Vermicompost @ 6 t ha^{-1}) where it showed at par with each others during both the years. The magnitude of increase in yield an average as assess to 53 percent over the control. The superimposition of organic sources of manures significantly enhanced organic corbon content and available NPK in soil after harvest of crop. The significant higher organic corbon (OC) and available NPK in soil after harvest of crop was recorded by RDF + neem cake @ 3 t ha^{-1} which followed by $\mathbf{T_8}$ (RDF + FYM @ 12 t ha^{-1}) and $\mathbf{T_9}$ (RDF + Vermicompost @ 6 t ha^{-1}). However, significantly lowest OC and available NPK in soil after harvest of crop was recorded by RDF only ($\mathbf{T_1}$).

Key words : Scented rice, superimposition, FYM, vermicompost neem cake, yield, grain and soil health.

Introduction

Rice export from India constitutes the major share of Basmati rice. Nearly two-third of Basmati rice produced in India is exported. Basmati rice is the leading aromatic fine quality rice of the world trade and it fetches good export price in the international markets. Infact, Basmati rice is a gift from "Mother Nature" to the Indian sub-continent and grown an area about 1.6 million hectares and production about 6.6 million tonnes. The production of aromatic rice is declining fast even in the native areas of adaptation due to poor yield and quality traits including aroma. As regards to enhance rice yield, different crop management practices are important to enhance target yield.

During the last one decade the practices of substituting 25-50% fertilizers through organic manures did not achieve sustainability in rice production because rice is heavy feeders of macro as well as micro nutrients. Due to continuous use of recommended dose of fertilizers without application of organic sources would lead to gradual decline of macro as well as micro nutrients status of soil, which resulted in lower rice production (Murthy, 2012). In European countries, application of organic sources as substituting inorganic fertilizers gives better response due to temperate climatic condition. Hence, organic sources are sustained longer times in soil, but in tropical countries like India application of organic sources as substituting inorganic fertilizers are not sufficient to better responses for longer times in soil due to high temperature prevailed during summer season which caused rapid mineralization, leaching losses and humus burning.

The superimposed quantizes of organic sources along with 100% recommended dose of fertilizers catching attention of scientific communities, now a days because superimposition of organic sources we add the organic sources without consideration of substituting of RDF for enhancing the productivity and maintaining soil health

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(Singh *et al*., 2006). More recently, attention is focused on the global environmental problems; utilization of organic sources like, FYM, vermicompost, neem cake and green manure as the most effective measure for the purposes. The superimposition of organic sources along with recommended doses of fertilizers are also positively correlated with soil porosity, enzymatic activity and CO_2 production. Organic fertilizer enhances soil porosity by increasing regular and irregular pores and causes a 'priming effect' of native soil organic matter (Marinari *et al*., 2000). Keeping theses views, present investigation was carried out to effect of superimposition of organic sources of manures to enhance growth, yield attributes and yield of scented rice (*Oryza sativa* L.) and its impact on soil health.

Materials and Methods

An experiment was conducted during the *kharif* seasons of 2012 and 2013 at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh. The soil was sandy loam, slightly alkaline (pH 8.2 and 7.9), low in available nitrogen (215 and 220 kg ha^{-1}), medium in available phosphorus (20.5 and 21.5 kg ha^{-1}) and available potassium (158 and 159 kg ha^{-1}), during 2012 and 2013, respectively. The experiment with ten treatments was laid out in Randomized Block Design with three replications with gross and net plot size of 5.00 x 3.60 m^2 and 4.20 x 3.0 m^2, respectively. The ten treatments consisted of i) recommended dose of fertilizer (RDF: 100: 40: 30 ha^{-1}), ii) RDF + FYM @ 6 t ha^{-1}, iii) RDF + vermicompost @ 2 t ha^{-1}, iv) RDF + neem cake @ 1 t ha^{-1}, v) RDF + FYM @ 9 t ha^{-1}, vi) RDF + vermicompost @ 4 t ha^{-1}, vii) RDF + neem cake @ 3 t ha^{-1} viii) RDF + FYM @ 12 t ha^{-1}, ix) RDF + vermicompost @ 6 t ha^{-1} and x) RDF + neem cake @ 3 t ha^{-1}. Scented rice variety Pusa Basmati 1121 was transplanted at spacing 20 × 10 cm^2 during both the years. As per treatments superimposition of organic sources (FYM, vermincompost and neem cake), phosphorus and potassium were applied as a basal application. The nitrogen was applied two in split doses, ¼ at transplanting, ¼ at 30 DAT and ¼ at 60 DAT. The observations on growth, yield attributes and yield were recorded. Among the soil analysis parameters like pH, EC, OC and available NPK were estimated as per standard procedure in laboratory after harvest of crop during both the years. All data were statistically analyzed (Panse and Sukhatme, 1978).

Results and Discussion

Growth parameters

Plant growth is dependent on the rate of accumulation of dry matter. The dry matter accumulation may reflect on the economic yield in view of the fact that vegetative part of the plant serves as source where, grains are the sink. The need for increased crop production is an outcome of a series of intermediate interaction of various biological events involving bio-chemical, physiological and morphological changes, which takes place during its development in accordance with the supply of light, water, temperature and nutrients. In general, there were

Table 1: Mean plant height, number of tillers, dry matter per hill and leaf area of scented rice as influenced by superimposition of organic sources of manures.

Treatment	At harvest				At harvest			
	Year-2012				Year-2013			
	Plant height (cm)	Number of tillers	Dry matter (g)	Leaf area (cm^{-2})	Plant height (cm)	Number of tillers	Dry matter (g)	Leaf area (cm^{-2})
T_1 RDF (100:40:30 NPK)	100.00	12.16	19.93	454.21	101.00	12.70	20.46	470.65
T_2 RDF + FYM @ 6 t ha^{-1}	103.66	15.93	24.26	500.25	105.00	17.00	25.00	511.68
T_3 RDF + VC @ 2 t ha^{-1}	104.33	17.03	25.03	508.01	104.66	16.23	24.43	507.82
T_4 RDF + NC @ 1 t ha^{-1}	105.00	17.30	25.83	516.65	105.33	17.46	26.23	520.32
T_5 RDF + FYM @ 9 t ha^{-1}	105.66	17.93	27.83	520.31	106.00	18.16	28.30	522.30
T_6 RDF + VC @ 4 t ha^{-1}	106.00	17.53	29.73	530.28	106.66	17.90	30.23	534.95
T_7 RDF + NC @ 2 t ha^{-1}	106.33	19.00	30.16	535.88	107.00	19.33	31.15	539.55
T_8 RDF + FYM@12 t ha^{-1}	107.00	19.20	31.43	545.55	108.66	20.13	31.76	548.88
T_9 RDF + VC @ 6 t ha^{-1}	108.33	20.00	31.86	547.91	109.66	20.83	32.70	554.58
T_{10} RDF + NC @ 3 t ha^{-1}	109.33	20.70	33.20	556.58	112.00	21.76	34.36	562.78
S.Em.±	0.90	0.54	0.99	6.48	1.22	0.59	1.05	6.34
CD (P=0.05)	2.68	1.60	2.95	19.25	3.63	1.77	3.14	18.84

Table 2 : Mean yield attributing characters of scented rice as influenced by superimposition of organic sources of manures.

Treatment	Yield attributes				Yield attributes			
	Year-2012				Year-2013			
	Panicle length (cm)	Panicle weight (g)	Number of grains	1000 grain weight (g)	Panicle length (cm)	Panicle weight (g)	Number of grains	1000 grain weight (g)
T_1 RDF (100:40:30 NPK)	20.13	3.05	149.66	19.23	20.33	3.13	151.00	10.48
T_2 RDF + FYM @ 6 t ha^{-1}	21.80	3.66	162.33	21.66	22.63	4.14	166.00	12.26
T_3 RDF + VC @ 2 t ha^{-1}	22.26	3.80	164.66	22.00	22.53	4.03	165.66	12.33
T_4 RDF + NC @ 1 t ha^{-1}	23.23	3.83	167.66	22.10	23.50	4.26	169.33	12.26
T_5 RDF + FYM @ 9 t ha^{-1}	22.50	4.50	172.00	22.13	22.96	4.73	174.00	12.76
T_6 RDF + VC @ 4 t ha^{-1}	23.43	4.56	174.00	22.06	23.63	4.90	175.00	13.62
T_7 RDF + NC @ 2 t ha^{-1}	23.63	4.93	176.66	22.96	23.43	5.30	177.66	13.93
T_8 RDF + FYM @ 12 t ha^{-}	24.73	5.23	178.00	23.26	25.00	5.86	179.66	14.81
T_9 RDF + VC @ 6 t ha^{-1}	25.03	5.36	178.66	23.76	25.46	6.00	180.00	15.52
T_{10} RDF + NC @ 3 t ha^{-1}	25.76	5.50	182.00	24.06	26.46	6.70	184.33	16.29
S.Em.±	0.48	0.18	2.12	0.41	0.53	0.29	1.57	0.49
CD (P= 0.05)	1.42	0.55	6.30	1.23	1.58	0.86	4.68	1.48

Table 3: Mean grain and straw yield (q ha^{-1}) of scented rice as influenced by superimposition of organic sources of manures.

Treatment	Year-2012		Year-2013	
	Grain (q ha^{-1})	Straw (q ha^{-1})	Grain (q ha^{-1})	Straw (q ha^{-1})
T_1 RDF (100:40:30 NPK)	35.18	58.76	35.72	59.48
T_2 RDF + FYM @ 6 t ha^{-1}	41.93	66.20	43.10	67.86
T_3 RDF + VC @ 2 t ha^{-1}	42.95	70.50	42.28	69.83
T_4 RDF + NC @ 1 t ha^{-1}	45.18	73.23	46.18	74.28
T_5 RDF + FYM @ 9 t ha^{-1}	45.98	75.80	46.98	76.70
T_6 RDF + VC @ 4 t ha^{-1}	47.93	78.56	48.60	79.63
T_7 RDF + NC @ 2 t ha^{-1}	48.42	80.63	49.07	81.16
T_8 RDF + FYM@12 t ha^{-1}	50.33	81.96	51.34	82.63
T_9 RDF + VC @ 6 t ha^{-1}	51.86	82.30	52.90	83.00
T_{10} RDF + NC @ 3 t ha^{-1}	53.60	83.33	54.76	84.20
S.Em.±	1.74	2.39	1.71	2.26
CD (P= 0.05)	5.18	7.12	5.10	6.72

significant differences in plant height number of tillers, dry matter per hill and leaf area among the treatments of crop growth (table 1). The treatment which received recommended dose of fertilizers in combination with neem cake @ 3 t ha^{-1} (**T_{10}**) recorded significantly highest plant height than all other treatment except **T_8** and **T_9**, it was found at par with each other during both the years at harvest stage. These suggest that the recommended dose of fertilizers along with neem cake was more advantageous than RDF alone. Application of organic manures improved the release pattern of nutrients by making it slowly available, synchronizing with the crop requirement at different phenophases. Several other workers also reported similar results in rice (Prakash *et al.*, 2002; Singh *et al.,* 2006 and Murthy, 2012).

The number of tillers per hill was greatly influenced by the application RDF + neem cake @ 7.5 t ha^{-1} (**T_{10}**) and all other treatments showed significant differences over RDF alone (**T_1**). The beneficial effect of the application of RDF + organic manures over other treatments was mainly due to combined application of organic and inorganic sources of nutrients and split application of fertilizer nitrogen as per crop growth stages which improved the available nitrogen status in soil for better uptake resulting in the increased number of tillers per plant. Mirja *et al*. (2010) reported that increase in number of tillers in rice plant due to influence of different fertilizer combination. According to them more number of tillers might be due to the more availability of nutrients which play vital role in cell division.

The dry matter production was significantly greater in treatment **T_{10}** (RDF + NC @ 3 t ha^{-1}) followed by **T_8** (RDF + FYM @ 12 t ha^{-1}) and **T_9** (RDF + VC @ 6 t ha^{-1}) at harvest stage. This may be attributed to higher availability of nutrients in neem cake vermicompost and FYM that increased the availability of both native and applied nutrients and better source and sink relationship which contributed to better dry matter production at all the stages of crop growth. Increased dry matter per plant was ascribed due to production of more number of tillers

Table 4 : Mean ph, EC, OC and available NPK (kg ha^{-1}) after harvest of scented rice as influenced by superimposition of organic sources.

Treatment	Year 2012						Year 2013					
	pH	EC (dSm^{-1})	OC (%)	Available N(kg ha^{-1})	Available P(kg ha^{-1})	Available K(kg ha^{-1})	pH	EC (dSm^{-1})	OC (%)	Available N(kg ha^{-1})	Available P(kg ha^{-1})	Available K(kg ha^{-1})
T_1 RDF (100:40:30 NPK)	8.38	0.18	0.37	213.66	17.51	181.00	8.35	0.20	0.35	211.66	17.18	178.00
T_2 RDF + FYM @ 6 t ha^{-1}	8.30	0.23	0.43	222.33	20.36	189.33	8.16	0.25	0.44	224.66	20.76	190.33
T_3 RDF + VC @ 2 t ha^{-1}	8.26	0.24	0.44	225.33	21.00	192.33	8.23	0.26	0.45	226.33	21.43	193.33
T_4 RDF + NC @ 1 t ha^{-1}	8.21	0.25	0.45	228.00	22.82	194.33	8.10	0.26	0.46	230.33	23.70	195.00
T_5 RDF + FYM @ 9 t ha^{-1}	8.16	0.25	0.45	231.33	23.30	198.00	7.95	0.25	0.46	233.66	23.75	199.33
T_6 RDF + VC @ 4 t ha^{-1}	8.10	0.26	0.46	235.66	23.81	201.00	8.00	0.27	0.47	236.33	24.27	202.33
T_7 RDF + NC @ 2 t ha^{-1}	8.00	0.27	0.46	239.00	24.20	201.33	7.90	0.28	0.47	242.33	24.92	203.66
T_8 RDF + FYM @ 12 t ha^{-1}	8.02	0.26	0.47	244.00	25.52	208.33	7.76	0.28	0.50	248.66	25.90	210.33
T_9 RDF + VC @ 6 t ha^{-1}	7.91	0.27	0.48	249.00	25.74	210.00	7.63	0.29	0.49	251.66	26.13	212.00
T_{10} RDF + NC @ 3 t ha^{-1}	7.81	0.29	0.49	253.33	26.13	212.00	7.53	0.32	0.52	254.66	26.50	214.66
S.Em.±	0.07	0.007	0.009	2.08	0.67	2.20	0.11	0.01	0.01	1.82	0.66	2.33
CD (P= 0.05)	0.22	0.021	0.027	6.18	2.01	6.56	0.33	0.03	0.03	5.42	1.95	6.93

and transfer more photosynthesis to sink. Prakash *et al*. (2002) reported that dry matter production of crop were higher in plants supplied with organic fertilizers in combination with chemical fertilizers than to those treated with chemical fertilizers only.

The maximum and significantly higher values of leaf area recorded by RDF + NC @ 3 t ha^{-1} than to all other treatments, however it was at par with $\mathbf{T_8}$ and $\mathbf{T_9}$ during both the year. The increased leaf area in $\mathbf{T_{10}}$ ascribed due to production of more number of leaves as well as size due to superimposition of organic sources as compared to recommended dose of fertilizer alone. Singh *et al*. (2006) also reported that superimposition of organic sources increased leaf area as compared to the control.

Yield attributes and yield

The grain yield in any crop depends upon the photosynthetic source it can build up. A sound source in terms of plant height, number of tillers to support and hold the leaves are logically able to increase the total dry matter and later lead to higher grain yield. Partitioning of dry matter production and its distribution in different parts is important for determination of total yield of the crop. Yield attributes of rice such as length of panicles, panicle weight, number of grains per panicle, thousand grains weight were significantly higher in treatment received recommended dose of fertilizers and neem cake @ 3 t ha^{-1} than control (table 2). These attributes directly contribute for increased grain and straw yield of rice. This might be due to increased supply of nutrients directly through organic and inorganic sources to the crop, as well as, due to the indirect effect resulting from reduced loss of organically supplied nutrient. Similar results were also reported by Singh *et al*. (2006) and Murthy (2012).

In the present study, treatment $\mathbf{T_{10}}$: RDF + NC @ 3 t ha^{-1} improved the grain yield better than all other treatments (table 3). The magnitude of increase in yield an average as assess to 53 percent over the control. The yield increase is due to application of recommended dose of fertilizers and organic sources of manures which could be reasoned out that superimposed application of organic and inorganic nutrient sources increase the availability of nitrogen, phosphorus and potassium in soil and in turn increase the number of tillers, panicle and other growth attributes as a result better uptake of nutrients from soil (Singh *et al*., 2006). Straw yield also followed a similar trend as that of grain yield; increase in straw yield was due to the influence of fertilizer with different levels of organic sources of manures, which was mainly due to more number of tillers and plant height. The results are in close conformity with the finding of Singh *et al*. (2006)

and Kumar *et al*. (2014).

Effect on soil health

Application of recommended dose of fertilizers in combination with organic sources of manures had favourable effect on soil chemical properties. The soil pH differed significantly in soil after harvest due to treatments. The superimposition of organic manures helps in stabilizing pH and resists fluctuation in pH due to management practices. The EC values differed significantly among treatments, which may be due to varying degrees of soluble salts in organic sources of manures (table 4).

There was a significant increase in the OC content of the soil and is due to different levels of organic sources of manures application. The OC content of soil changed in accordance with chemical composition of the organic manures. Organic carbon content of the soil was higher in the treatment which received RDF + neem cake @ 3 t ha^{-1} (0.52%) followed by RDF + VC @ 6 t ha^{-1} and RDF + FYM @ 12 t ha^{-1}. Singh and Chandra (2011) reported that soil organic carbon was higher with organic sources than inorganic sources.

Available nitrogen, phosphorus and potassium (kg ha^{-1}) increased significantly from initial stage and over treatment $\mathbf{T_1}$ on the completion of two-year experiments. The maximum available N, P and K was noticed with recommended dose of fertilizers with combination of neem cake @ 3 t ha^{-1} followed by $\mathbf{T_9}$ and $\mathbf{T_8}$ during both the years. The continuous application of organic sources in sufficient quantities have been reported to improve the soil organic carbon and available N, P and K in soil thereby sustaining the soil health (Meena *et al*., 2012).

Conclusion

The superimposition of organic sources of manures on RDF significantly increased growth and yield attributing characters *viz*., plant height, number of tillers per plant, dry weight per plant and leaf area and length of panicle, panicle weight, number of grains per panicle and 1000 grain weight and yield of scented rice. Application of neem cake @ 3 tonnes ha^{-1} along with RDF not only maximize the grain yields (53.60 and 54.76 q ha^{-1}), but also improved the available NPK after harvest of crop and soil health (OC 0.51%).

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