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Influence of integrated nutrient management practices on scented rice (*Oryza sativa* L.) pertaining to eastern Uttar Pradesh

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Abstract
A Field experiment was conducted to investigate the Influence of Integrated Nutrient Management Practices on Scented Rice (*Oryza sativa* L.) Pertaining to Eastern Uttar Pradesh at Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.), during *Kharif* season of 2015-16. The experiment with seven treatments of integrated nutrient managements *viz.,* T_1: 50% recommended NPK + 50% N as FYM + 5 kg Zinc ha^{-1}, T_2: Recommended N each equivalent to 1/3rd of total N as FYM, vermicompost and neem cake, T_3: 100% N as FYM + 5 kg Zn ha^{-1}, T_4: T_2 + hand weeding + Neem based biopesticide, T_5: 50% N as FYM + seedling treatment with Azotobactor and PSB, T_6: T_2 + seedling treatment with Azotobactor and PSB and T_7: 100% NPK + 5 kg Zn ha^{-1}, each treatment was replicated thrice in completely randomized block design. The results revealed that, T_1 which was found at par with T_3 and T_7 while significantly superior over rest of the treatments. Yield attributes, grain yield (36.60 q ha^{-1}) and straw yield (52.80 q ha^{-1}) were found maximum under T_1 which was at par with T_3 and T_7, significantly superior over rest of the treatments. The maximum gross return (` 108300.00 ha$^{-1}$), net return (`71155.00 ha^{-1}) and B: C (1.86) was recorded from the integrated (Fertilizer + FYM) treatment *i.e.* T_1 for basmati rice. The minimum gross return (` 81600 ha$^{-1}$) was recorded in the treatment received 100% nutrients through organic manures (50% N as FYM + Azotobacter + PSB) while the minimum net return (`31364 ha^{-1}) and B: C ratio (0.61) in basmati rice were recorded in the treatment received 100% nutrients through organic manures.

Keywords: scented rice, vermicompost, neemcake, azotobactor, PSB

Introduction
Rice (*Oryza sativa* L.) belongs to family Poaceae, is the most important and extensively cultivated food crop grown extensively in tropical and subtropical regions, which provides half of the daily food for one of every three persons on the earth. About 70 % of the world population takes rice as staple food while in Asia alone, more than two billion people obtain 60 to 70 per cent of their energy intake from rice and its derivatives. In India, area production and productivity of rice is 42.77 m ha, 106.54 mt and 2490 kg ha^{-1}, respectively. In Uttar Pradesh rice is grown over an area of 5.95 million hectare with total production of 13.53 million tones having average productivity of 2273 kg ha^{-1} (Anonymous 2014) [1]. Rice-wheat is the predominant cropping system of fertile Indo-Gangetic plain region, also in Uttar Pradesh. But it limits the oilseeds and pulses coverage, production as well supply, particular to rice-wheat dominated region. However, wheat replaced by mustard and addition of pulse crop in *Zaid* season in cropping sequence of rice- wheat is practically feasible, economical viable, eco-friendly, water saving technology for sustaining soil fertility and rice productivity. Different cultures have preference for different types of rice. Scented rice or aromatic rice is popular in Asia and has gained wide acceptance in Europe and the United States. Because of their quality like aroma, flavour and texture, and also fetches higher income in the rice market than non-aromatic rice varieties. It is generally used to prepare Pulao and Biryani which are served on special occasions. Demand of aromatic rice in recent years has increased to a great extent for both, internal consumption as well as for export. However, the total production of aromatic rice in the country is nearly 5 million tonnes from an area of 0.7 million ha, representing 1.5 per cent of the total rice area with an average productivity of 0.85 t ha^{-1}. Most of the trade of aromatic rice in the world is also from India, Pakistan and Thailand.
Among the list of essential nutrients, nitrogen plays a crucial role of growth and metabolic processes in rice plants which contribute more than 50% of the yield increase under usual growing conditions. Nitrogen management in rice field is different from other crops because of the incessant sub-mergence or intermittent drying and wetting the environment of root zone is

converted from aerobic to anaerobic conditions. During these processes loss of nitrogen takes place through leaching and de-nitrification (Buresh *et al*. 2008) [3]. Judicious and proper use of fertilizers can evidently increase the yield and improve the quality of rice (Yoshida *et al.*, 1981) [23]. Phosphorus is key plant nutrient for life as called as energy currency. Without adequate supply of phosphorus plants cannot reach its maximum yield potential.

Critical tissue P concentrations for rice during vegetative growth range from 1.0 to 2.0 g P kg^{-1}. According to Yoshida (1981) [23], 2.0 g P kg^{-1} in the first fully opened leaf from the top was needed to realize the maximum tillering rate. De Datta (1981) [7] suggested that 1.0 g P kg^{-1} in the rice leaf blades at active tillering was the critical concentration. In general, whole plant P concentrations during vegetative growth at >2.0 g P kg^{-1} are suffecient for optimum rice growth and yield production. Decreased supply of phosphorus from soil, deficiency symptoms appear in the lower parts of the plants as consequences decreased leaf number, decreased leaf blade length, reduced panicle $plant^{-1}$, reduced seeds $panicle^{-1}$ and reduced filled seeds $panicle^{-1}$ (Kumar and Prasad, 2004). Phosphorus not only enhances the yield of rice but also play a key role in spikelets sterility. Nonetheless, the main problem concerning P fertilizer is its fixation with soil complex with in a very short period of application rendering more than two third unavailable (Shahrawat *et al.*, 2001).

Increased use of inorganic fertilizers in crop production has deteriorates effect on soil health, causes health hazard and insecurity of quality food, energy crisis, higher fertilizer cost, sustainability in agri-production system and ecological stability are the important issues which renewed the interest of farmers and research workers in non-chemical sources of plant nutrients like biofertilizers, farmyard manure, green manure, composts etc. The use of organic manures for improving and maintaining the soil health has been in practice since long time but its practicability is limited due to poor availability and higher cost of nutrients supplied through organic sources. But in balanced manner use of nutrients through organic sources like farmyard manure, vermicompost, green manuring, neem cake and biofertilizers are prerequisites to sustain soil fertility, to produce maximum crop yield with optimum input level (Dahiphale, *et. al.* 2003) [4]. Different nutrient sources through organics enrich soil organic carbon, supply all required plant nutrients and improve soil properties. Organic manures in agriculture add much needed organic and mineral matter to the soil. The proper management of these makes it possible to increase the efficiency of native and added nutrients. The appropriate use of organic fertilizers ensures better and sustainable yields, correcting some of the micro and secondary nutrient deficiency as well as increase the nutrient use efficiency, would lower the cost of production. The use of organic manures will also help in maintaining soil health and productivity. Since, soil microbial and enzyme systems are associated with presence of organic matter in soil therefore incorporation of organic manures into soil not only plays an important role in soil chemical and biological activity, but also affect the rate at which nutrients become available to crop plants. Nutrient management through organics plays a major role in maintaining soil health due to buildup of soil organic matter, beneficial microbes and enzymes, besides improving soil physical and chemical properties. Therefore, combined use of organic manure and inorganic fertilizers in an integrated manner will give better performance in cereals by sustaining higher yield and maintaining soil health as well. In view of the above facts, field experiment on "Influence of Integrated Nutrient Management Practices on Scented Rice (Oryza sativa L.) Pertaining to Eastern Uttar Pradesh." was conducted with the following objectives:

1) To study the influence of different sources of organic manures on yield attributes and yield of scented rice,
2) To work out the economics of different organic treatments on scented rice.

2. Materials and Methods

2.1 Experimental site and initial soil characteristics

Field experiment was conducted during *kharif* season of 2015-2016 at irrigated land of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad located at Eastern plain Zone Uttar Pradesh 26^0.47 North latitude, 82^0.12 East longitudes at an altitude of about 113.0 meter from mean sea level. The weekly mean minimum and maximum temperature during the crop season ranged from 18.7 to 29.4 ^{0}C and 28.2 to 42.5 ^{0}C and was received 192.3 mm total rainfall during course of experiment. Soil of experimental field was silt loam having low organic carbon, nitrogen and medium in phosphorus and potassium content. Soil testing of experimental field was done prior to transplanting taking soil samples at random from the experimental field for different soil properties using standard methods of soil analysis. The soil of the experimental field was clay loam in texture having a slightly alkaline pH of 8.25 with low soluble salts (EC = 0.45 $dS \cdot m^{-1}$), medium organic carbon content (0.46%), low in available nitrogen (267 kg ha^{-1}), medium in available phosphorus (17.4 kg ha^{-1}) and high in available potassium (247 kg ha^{-1}).

2.2. Experimental design, treatment details and selection of cultivar

The field experiment was laid out in randomized block design with three replications comprising of seven treatments *viz.*, T_1: 50% recommended NPK+50% N as FYM + 5 kg Zinc ha^{-1}, T_2: Recommended N each equivalent to 1/3rd of total N as FYM, vermicompost and neemcake, T_3: 100% N as FYM + 5 kg Zn ha^{-1}, T_4: T_2 + hand weeding + Neem based biopesticide, T_5: 50% N as FYM + seed treatment with Azotobactor and PSB, T_6: T_2 + seed treatment with Azotobactor and PSB and T_7: 100% NPK + 5 kg Zn ha^{-1}. Based on the equal N basis, required quantities of organic manures *viz*. FYM, vermicompost and neemcake were applied in moist soil as per treatment about one week before transplanting. In 100% and 50% chemical fertilizer treatments the recommended doses of NPK (120, 60, 60) and Zn (5 kg ha^{-1}) was applied through urea, diammonium phosphate, muriate of potash, zinc sulphate respectively. The half of nitrogen and entire dose of phosphorus, potassium and zinc sulphate was applied as basal during the final field preparation. While the rest half dose of nitrogen was top-dressed in two equal splits after 40 and 60 days after transplanting (DAT).

2.3 Nursery raising, seedling treatment and transplanting

The consumer preferred and eminent scented rice variety, Pusa basmati 1 was raised. A common procedure was followed in raising seedlings in the seedbed which was prepared by puddling (churning of soil in standing water) with repeated ploughing followed by planking. Seedling treatment is done with azotobacter and PSB at transplanting time on treatment basis. Inoculants and inoculation procedure are followed as per standard regulations. Azotobacter and PSB cultures obtained from the Biotech Park (Lucknow). The required quantity of Azotobactor and PSB were mixed together in 15 - 25 L water for dipping of seedlings required for one-hectare land at one corner of the field. Roots of 23-days old seedlings were dipped in respective solutions for half an hour before transplanting. Transplanting was done in the main field at spacing of 20 × 10 cm with using three seedlings hill^{-1}. All the crop management practices were done as per the standard methods for all the plots under different treatments except nutrient management practices. After harvesting of rice, other management practices were adopted as per recommendation of the crops.

2.4. Yield attributes

Yield governing characters like effective tillers was counted at 90 DAT by placing a quadrate of 50x50 cm at three places at random in each plot and total number of effective tillers per square meter were computed. Five panicles were sampled from the tagged plants in each plot for taking panicle length in centimeter, number of filled spikelets, unfilled spikelets and total grains panicle^{-1}. Test weight taken by counting 1000 seed and their weight in gram.

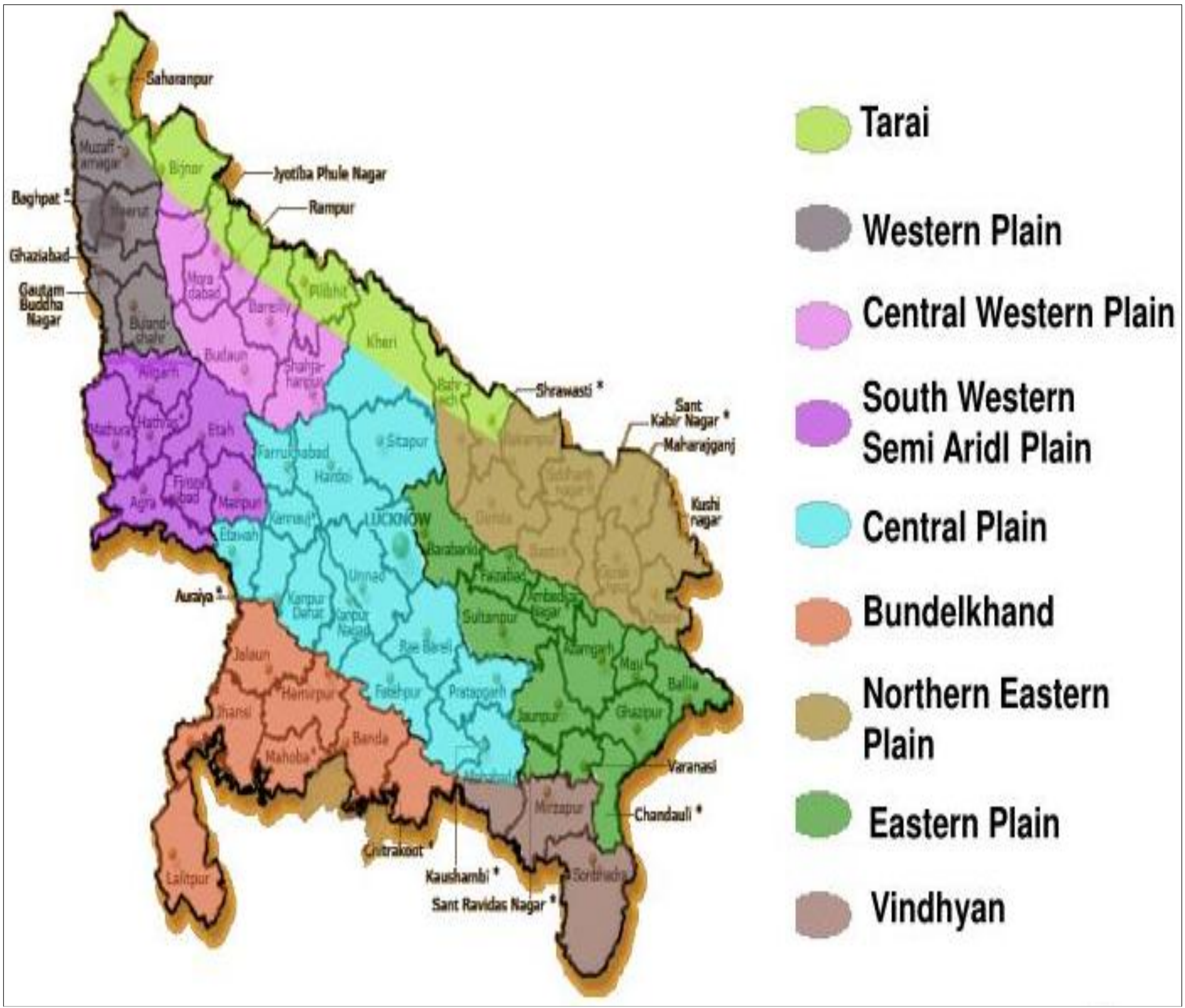

Fig 1: Field location under agroclimatic zones of Uttar Pradesh

2.5. Yield Observations

The harvested produce from each net plot was threshed, sun dried, winnowed separately then grain yield was recorded at 14 per cent moisture content and expressed in kg ha^{-1}. The straw yield of rice was recorded from the net plot area after enough sun drying and expressed in kg ha^{-1}. While harvest index was calculated by taking the ratio of the economic yield and biological yield as expressed in percentage given by Donald (1962).

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}}$$

2.6 Economics

The cost of cultivation was worked out by taking into consideration all the expenses incurred. The cost of input and price of produce prevalent at the Agricultural Research Farm, NDUAT Kumarganj, Faizabad were taken into consideration for calculating economics of different treatments. Gross return was worked out by multiplying grain and straw yield with their prevailing market prices and expressed in rupees per hectare. The net return (ha^{-1}) was calculated by deducting cost of cultivation from gross return.

2.7 Statistical Analysis

The data on various characters studied during the course of investigation were statistically analysed for completely randomized block design. Wherever treatment differences were significant (“F” test), critical differences were worked out at five per cent probability level. Treatment differences that were not significant were denoted as “NS” (Gomez and Gomez, 1984) [10].

3. Results and Discussion

3.1 Yield attributing characters

The data pertaining to yield attributes as influenced by nutrient management practices is presented in Table 1. All the yield attributes *viz*., number of effective tillers m^{-2}, length of panicle, filled and unfilled grain $panicle^{-1}$, number of grain $panicle^{-1}$ and test weight are the resultant of vegetative development of the crop which determine yield were influenced by various organic manures, fertilizers and inoculants. The maximum effective tillers m^{-2} was recorded with 50% recommended NPK+ 50% N as FYM + 5 kg Zinc ha^{-1} (T_1) treatment which was at par to 100% fertilizers of NPK + Zinc (T_7) and 100% N as FYM + Zinc (T_3) treatments which was significantly superior over other treatments. The maximum length of panicle was obtained with integrated (fertilizer + FYM) treatment which was at par to 100% fertilizers (100% NPK + Zinc) and 100% FYM + Zn treatments which was significantly superior to rest of the treatments. The maximum number of grain $panicle^{-1}$ was observed and obtained with integrated (fertilizer + FYM) treatment which was at par to 100% fertilizers (100% NPK + Zinc) and 100% N as organic manure (FYM + Zn) treatment which was significantly superior to rest of the treatments. The effect of various treatments did not influence on test weight significantly.

Table 1: Effect of different treatments on yield attributes of scented rice crop.

Treatments	Effective Tillers (m^{-2})	Length of panicle (cm)	Filled spikelet $panicle^{-1}$	Unfilled spikelet $panicle^{-1}$	Number of grains $panicle^{-1}$	Test weight (g)
T_1: 50% recommended NPK + 50% N as FYM + 5 kg zinc ha^{-1}	334.33	25.65	180.66	14.00	194.66	22.68
T_2: recommended N each equivalent to 1/3rd of total N as FYM, vermicompost and neemcake	275.40	20.60	134.00	22.00	156.00	20.76
T_3: 100% N as FYM + 5 kg Zn ha^{-1}	310.00	23.48	160.33	18.67	179.00	21.95
T_4:T_2 + hand weeding + biopesticide and (Neem based)	275.34	21.40	143.07	21.33	164.40	21.38
T_5: 50% N as FYM + seedling treatment with azotobactor and PSB	273.6	19.80	122.99	26.33	149.33	20.66
T_6: T_2 + seedling treatment with Azotobactor and PSB	290.00	22.28	163.01	12.33	175.34	21.85
T_7: 100% NPK + 5 kg Zn ha^{-1}	314.40	24.30	172.27	16.33	189.00	22.46
Sem±	9.51	0.811	6.67	1.42	7.05	0.785
CD (p=0.05)	29.30	2.498	20.54	4.37	21.73	NS

The increase in yield attributes was mainly due to increase in photosynthesis activity of leaves, translocation of photosynthates from source to sink and nutrients uptake under higher nutrients availability. The minimum values of all the yield attributes were observed in the treatment received lower doses of nutrients (50% FYM + PSB + Azotobacter) because plants did not get sufficient amount of nutrients which resulted in poor yield attributes. The result is in close proximity to those obtained by Tripathi *et al.* (2011) [22], Deol *et al.* (2008) [8] and Kashved *et al*. (2010) [13].

3.2 Yield parameters

Yield is the resultant of coordinated interplay of growth characters and yield attributes. Grain and straw yield were influenced significantly by applying various organic manures, fertilizers and inoculants is presented in Table 2.

Table 2: Effect of different treatments on yield parameters of scented rice crop

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index (%)
T_1: 50% Recommended NPK + 50% N as FYM + 5 kg Zn ha^{-1}	36.60	52.80	40.80
T_2: Recommended N each equivalent to 1/3rd of total N as FYM, vermicompost and neemcake	27.50	42.20	39.44
T_3: 100% N as FYM + 5 kg Zn ha^{-1}	31.34	48.10	39.46
T_4: T_2 + hand weeding + biopesticide (Neem based)	29.66	45.55	39.50
T_5: 50% N as FYM + seed treatment with Azotobactor and PSB	25.84	41.34	38.40
T_6: T_2 + Seed treatment with Azotobactor and PSB	30.33	45.70	29.89
T_7: 100% NPK+ 5 kg Zn ha^{-1}	33.56	50.25	40.04
Sem±	1.80	1.60	-
CD (P=0.05)	5.40	4.94	-

The maximum grain yield, straw yield and higher harvest index was recorded in treatment T_1 received 50% recommended NPK through fertilizers and 50% recommended N through FYM and 5 kg zinc which was statistically at par to the treatments T_7 received 100% recommended dose of NPK and zinc through chemical fertilizers and T_3 received 100% nutrients through FYM + 5 kg Zn was significantly superior over rest of the treatments. This might be due to adequate nutrient availability, which contributed to better growth parameters and yield attributes. Productivity of crop collectively determined by vigour of the vegetative growth and yield attributes which resulted in higher grain and straw yield. The increase in yield was further attributed to better translocation of photosynthates from source to sink due to higher uptake of NPK which are responsible for quick and easy translocation of photosynthates. Contrary to this, nutrients stress due to reduced supply of nutrients in treatment T_5 – received 50% N as FYM with bio-inoculants (PSB + Azotobacter) provided minimum grain and straw yield due to poor growth and yield attributing characters. Similar results have also been reported by Dongarwar *et al*. (2007) [9], Mondal *et al.* (1992) [14], Payare *et al.* (2009) [16] and Shukla *et al*. (2002) [17]. However, different inorganic, organic treatments and their combination have shown no marked effect on harvest index.

3.3 Economics

Table 3: Effect of different treatments on economics of scented rice crop

Treatments	Total cost (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B-C ratio
T_1: 50% recommended NPK + 50% N as FYM + 5 kg zinc ha^{-1}	38145	108300	71155	1.86
T_2: recommended N each equivalent to 1/3rd of total N as FYM, vermicompost and neemcake	51136	82500	31364	0.61
T_3: 100% N as FYM + 5 kg Zn ha^{-1}	51714	90990	39296	0.75
T_4:T_2 + hand weeding + biopesticide and (Neem based)	53190	88980	35790	0.67
T_5: 50% N as FYM + seedling treatment with azotobactor and PSB	34820	81600	46780	1.34
T_6: T_2 + seedling treatment with Azotobactor and PSB	52250	94020	51770	1.22
T_7: 100% NPK + 5 kg Zn ha^{-1}	35230	100680	65450	1.85

The cost of cultivation was calculated with taking variable and fixed cost of the treatments. The maximum total cost of cultivation (₹ 53590.00 ha^{-1}) was recorded under the treatment received 100% nutrients through organic manures (FYM, vermicompost and neemcake) along with weeding and pest control through agronomic practices for basmati rice. Higher cost of cultivation in this treatment might be due to the huge amount of organic manures used in this treatment in comparison to chemical and integrated treatments. The maximum gross income (₹ 108300.00 ha^{-1}), net return (₹ 71155.00 ha^{-1}) and B:C (1.86) was recorded from the integrated (Fertilizer + FYM) treatment for basmati rice. The minimum gross income (₹ 81600 ha^{-1}) was recorded in the treatment received 100% nutrients through organic manures (50% N as FYM + Azotobacter + PSB), minimum net return (₹ 31364 ha^{-1}) was recorded in the treatment received 100% nutrients through organic manures (recommended N each equivalent to 1/3rd of total N requirement of crop as FYM, vermicompost and neemcake) and the minimum B:C ratio (0.61) in basmati rice. The result is in close proximity to those obtained by Tripathi *et al*. (2012) [21] and Singh and Singh. (2007) [18].

4. Conclusion

On the basis summarized results, it can be concluded that integrated use of nutrients *viz.*, 50% recommended dose of NPK and Zn through chemical fertilizers and 50% N equivalent farm yard manure provided higher yield of scented rice which was comparable to 100% recommended NPK and Zn through chemical fertilizers alone. Integration of FYM and chemical fertilizer results the maximum gross return, net return and benefit cost ratio in basmati rice.

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