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Effect of integrated nutrient management on productivity and profitability of rice under SRI

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Abstract
A field Experiment was conducted during *kharif* season in 2017 and 2018 to find out the nutrient management methods on productivity and profitability of rice under SRI. The experiment was laid out in randomize block design with three replication. The experiment consisted 10 treatment *viz.* T_1 (control), T_2 (100% RDF), T_3 (125%RDF), T_4 (150%RDF), T_5 (75%RDF+25%FYM), T_6 (75% RDF+25% V.C.), T_7 (100% RDF+25% FYM), T_8 (100% RDF+25% FYM), T_9 (125% RDF+ 25% FYM) and T_{10} (125% RDF+ 25% V.C.). In case of integrated nutrient management the growth parameter character *viz.* plant height (cm), number of tillers (hill^{-1}), leaf area index, dry matter accumulation (gm^{-2}), crop growth rate (gm^{-2}d^{-1}), relative growth rates (mg g^{-1}d^{-1}), net assimilation rates (mg cm^{-2} d^{-1}), yield attributes *viz.* number of panicles (m^{-2}), length of panicle (cm), number of grain per panicle, test weight (g), grain yield and straw yield (q ha^{-1}), harvest index (%) of rice was significantly recorded the maximum values with T_{10} (125% RDF+ 25% V.C.) during both the cropping seasons.

Keywords: Integrated nutrient management, profitability, productivity, SRI

Introduction
Rice (*Oryza sativa* (L.)) is one of the most important stable food crop in the world. It belongs to family Poaceae (Gramineae). It is a high calorie food which contains 75% starch, 6-7% protein, 2-2.5 % fat, 0.8% cellulose and 5–9% ash. In Asia, more than two billion people are getting 60-70 % of their energy requirement from rice and its derived products. Rice is cultivated world-wide over an area of about 160.68 million ha^{-1} with an annual production of about 650.19 million tonnes. The total area of rice crop in India is 44.11 m ha, production is 104.79 million tonnes and average productivity is 2.38 t ha^{-1}. Uttar Pradesh is an important rice growing state in the country. The area and production of rice in this state is about 5.86 million hectares and production 15.30 million tonnes with an average productivity of 2.57 tonnes per hectare, respectively (Anonymous, 2015) [1]. The system of rice intensification (SRI) is a production system that involves the adoption of certain changes in management practices for rice cultivation that create a better growing environment for the crop. The SRI method follows transplanting of single plant in one clump at distances of 25x25cm or 30x30 cm. The uniqueness of this method is that the transplanting is being done between seventh and ninth day of sprouting of seeds. The current practice of transplanting is after 4 to 8 weeks and often 5 to 10 plants in one clump that cause trauma as root take 12 to 14 days for establishing after transplanting. SRI was found effective in minimizing pest and disease incidence, shortening the crop cycle, and improving plant stand. Thakur *et al.* (2009) [6] suggested that the system of rice intensification holds a great promise in increasing the productivity. The basic principles of SRI are planting young seedling (<14 days) singly in a square pattern (Stoop *et al*, 2002) [5]. According to proponents, SRI encompasses asset of principles, each of them fairly simple, but working synergistically with the others in order to achieve higher grain yield. Integrated use of organic source manures and chemical fertilizer resulted in higher crop yields, higher uptake of nutrients and enhanced the availability of post-harvest soil nitrogen, phosphorus and potassium. Sustainable rice productivity can be achieved through integrated nutrient management practices, comprising various sources, *viz.* chemical fertilizer, farm yard manure and vermicompost. INM favorably affected the physical, chemical and biological conditions of soil.

Material Methods
The present experiment was conducted during *kharif s*eason 2017 and 2018 at Agronomy Research Farm in Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, and Ayodhya. The soil of experimental field was silty loam in texture and medium in fertility status with the pH value (8.30 and 8.29), EC (0.37 and 0.37 dSm^{-1}) and organic carbon (0.31 and 0.32 %).

The available nitrogen, phosphorus and potassium were (180.20 and 182.82 kg ha^{-1}) (13.70 and 13.80 kg ha^{-1}) and (208.22 and 212.32 kg ha^{-1}) during both the years, respectively. The experiment was laid out in randomized block design with three replication. The experiment consisted 10 treatment *viz*. T_1 (control), T_2 (100% RDF), T_3 (125%RDF), T_4 (150%RDF), T_5 (75%RDF+25%FYM), T_6 (75% RDF+25% V.C.), T_7 (100% RDF+25% FYM), T_8 (100% RDF+25% FYM), T_9 (125% RDF+ 25% FYM) and T_{10} (125% RDF+ 25% V.C.). The rice variety Pusa basmati-1 was done in square pattern i.e 25 x 25 cm spacing with the seed rate of 4 kg/ha for the period of during both the years of experiment. Nursery for system of rice intensification involved preparation of 4-5 cm raised beds with soil and farm yard manure (2:1) on which seed was uniformly spread. The bed was then covered with rice straw for 2-3 days and kept moist by sprinkling water frequently. After the harvest of previous crop the experimental field was ploughed once with soil turning plough and cross harrowed two times. After each ploughing, planking was done to level the field and to obtain the fine tilth and lay out was done. The specific quantity of each fertilizer was calculated on the basis of gross plot size and as per treatment taken per plot. The half quantity of nitrogen and full quantity of phosphorus and potassium were broadcasted in the field during final field preparation as basal dose before the transplanting in the field. The rest half dose of nitrogen was top dressed in two splits i.e. after first at 45 and second at 60 days after transplanting. Farm yard manure and vermicompost were applieded mixed in soil 15 days before the transplanting. Farm yard manure and vermicompost was manually incorporated plot wise as per the treatment. Separated seedlings were immediately transplanted in the main field with gentle placement but not with harsh pushing, which may revert root direction to cause transplanting trauma. The transplanting was done with 12 days old seedlings. Seedlings were transplanted in the prepared plot just after uprooting from the nursery bed and this process was completed within four hours during both the years of experimentation. Only one seedling was used per hill. The transplanting was done in square pattern i.e 25 x 25 cm spacing. Irrigation to the crop was applied by alternate wetting and drying cycles to keep the soil in saturated condition. Weed control was done by conoweeder, first at 25 days after transplanting (DAT) and second at 45 days after transplanting (DAT). Conoweeder was run manually between row of rice crop twice, in both direction, at 25 and 45 days after transplanting (DAT), because it is essential to remove the weeds closer to rice root zone. At the time of harvesting the grains were subjected to hard enough, having less than 16 percent moisture in the grains. First of all, the border area was harvested. The harvesting of net plot area was done separately and the harvested material from each net plot was carefully bundled and tagged after drying for three days in the field and then brought to the threshing floor. Threshing of each bundle of individual plot was done manually by wooden sticks. The grain yield of individual plot after winnowing was weighed. The quantity of straw per plot was calculated by subtracting the weight of grains from biological produce. Yield of both grain and straw was expressed in q ha^{-1}. All the data obtained were statistically analysed using the F-test and conclusion were drawn at 5% probability level.

Result and Discussion

Effect on growth

Nutrient management practices was significantly affected on LAI, dry matter accumulation CGR, RGR, and NAR however, maximum leaf area index, dry matter accumulation CGR, RGR, and NAR was recorded with the application of T_{10} (125% RDF+ 25% V.C.) which was closely followed with T_9 (125% RDF+ 25% FYM) in LAI, dry matter accumulation, CGR, RGR and NAR. Might be due to nutrient is the fundamental basis of life. Growth of plant is controlled by rates of cell division, their enlargement and by the supply of organic and inorganic compounds required for the synthesis of new protoplasm and cell wall. Cell enlargement is particularly dependent on least minimum degree of cell turgor. Stem and leaf elongation is quickly checked by nutrient. Thus decreasing nutrient content is accompanied by loss of turgor and wilting, cessation of cell enlargement, closure of stomata, reduction in photosynthesis and interference with many basic metabolic processes (Harikesh *et al*. 2017) [4].

Effect on yield

Yield is the ultimate resultant of the bio-physiological process which co-ordinated interplay of growth characters and yield attributes. Grain and straw yields were influenced significantly by applying various nutrient management practices. The highest grain (56.50, 59.00 qha^{-1}) and straw yield (75.93 and 78.43 qha^{-1}) of rice was also recorded under T_{10} (125% RDF+ 25% V.C.) it was significantly superior to all inorganic and organic source of nutrients and minimum grain (28.24 and 28.74 qha^{-1}) and straw yield (55.02, 55.52 qha^{-1}) was recorded under control plots, respectively. This might be due to better vegetative growth coupled with higher yield attributes resulted in higher grain and straw yields. The similar results were reported by Das *et al.,* (2002) [2], Wolie and Admassu (2016) [7].

Harvest index indicate the relationship between economical yield and biological yield. Data clearly reveals that maximum (42.66, 42.93%) harvest index was recorded where treatment T_{10} (125% RDF + 25% V.C.) was applied. It was due to higher gra in yield of rice per unit biological yield, which led to higher harvest index. Ghosh *et al*. (2015) [3] observed that organic manure alone in combination with inorganic fertilizer which prevented nutrient losses due to its slow release and might have supplied nutrients in optimum amount to crop demand responsible for increase in grain and straw yield and harvest index as well. The minimum harvest index (33.91, 34.10) was observed in T_1 (control).

Table 1: Effect of different nutrient management practices on LAI, dry matter accumulation (gm^{-2}), CGR (gm^{-2}d^{-1}), RGR(mg g^{-1} d^{-1}), NAR (mg cm^{-2} d^{-1}) of rice crop under SRI.

Treatment	LAI at 90 DAT at harvest stage		Dry matter accumulation at harvest stage		CGR at 60-90 DAT at harvest stage		RGR at 60-90 DAT at harvest stage		NAR at 60-90 DAT at harvest stage	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
T_1-Control	3.53	3.54	544.26	548.92	7.11	7.20	10.04	10.07	0.44	0.50
T_2-100% RDF	3.80	3.81	805.59	806.50	7.40	7.48	10.48	11.25	0.59	0.64
T_3-125% RDF	3.88	3.89	811.32	812.44	7.66	8.01	11.55	12.28	0.67	0.71
T_4-150% RDF	4.00	4.06	817.81	818.83	8.15	8.73	12.91	13.07	0.76	0.82

T_5-75% RDF+25% FYM	3.81	3.85	807.12	808.29	7.46	7.56	10.57	11.40	0.63	0.68
T_6-75% RDF+ 25% V.C.	3.86	3.88	808.71	809.46	7.59	7.84	11.26	11.95	0.65	0.70
T_7-100%RDF +25%FYM	3.90	3.91	813.90	814.18	7.90	8.36	11.97	12.40	0.71	0.75
T_8-100% RDF +25% V.C.	3.94	4.04	816.00	817.06	8.12	8.58	12.21	13.08	0.74	0.81
T_9- 125% RDF+25%FYM	4.33	4.35	819.38	820.42	8.28	8.92	13.05	14.04	0.75	0.84
T_{10}-125% RDF+25% V.C.	4.40	4.41	820.44	821.35	8.43	9.13	13.42	14.12	0.81	0.89
SEM±	0.04	0.05	17.57	18.13	0.02	0.03	0.02	0.03	0.01	0.02
C.D. (p=0.05)	0.12	0.14	52.19	53.85	0.06	0.08	0.05	0.10	0.04	0.05

Table 2: Effect of different nutrient management practices on grain yield, straw yield and harvest index of rice crop under SRI.

Treatment	Grain yield (q/ha)		Straw yield(q/ha)		Harvest index (%)	
	2017	2018	2017	2018	2017	2018
T_1-Control	28.24	28.74	55.02	55.52	33.91	34.10
T_2-100% RDF	43.95	44.70	62.32	63.07	41.36	41.48
T_3-125% RDF	46.78	47.68	65.66	66.56	41.60	41.73
T_4-150% RDF	52.07	53.47	70.61	72.01	42.44	42.61
T_5-75% RDF+25% FYM	44.02	44.82	64.06	64.86	40.73	40.86
T_6-75% RDF+ 25% V.C.	45.65	46.50	64.70	65.55	41.37	41.50
T_7-100%RDF +25%FYM	48.28	49.28	66.91	67.91	41.91	42.05
T_8-100% RDF +25% V.C.	51.48	52.68	69.00	70.20	42.73	42.87
T_9- 125% RDF+25%FYM	54.52	56.42	73.43	75.33	42.61	42.82
T_{10}-125% RDF+25% V.C.	56.50	59.00	75.93	78.43	42.66	42.93
SEM±	0.40	0.42	0.30	0.33	-	-
C.D. (p=0.05)	1.18	1.25	0.88	0.97	-	-

Conclusion
On the basis of two years experimentation finding the conclusions that INM proved its superiority in increasing the yield as well as soil health which provides sustainable productivity under SRI.

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