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Effect of site specific nutrient management on productivity and profitability of rice in low land situation

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Abstract
A field experiment was conducted for three Kharif season of 2014-16 at the Crop Research Station, Ghaghraghat Bahraich of Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya to study the effect of site specific nutrient management on productivity and profitability of rice in low lands. Result revealed that application of 100% recommended dose of fertilizers (RDF) through inorganic fertilizers + vigore @ 625g/ha at 8 days after sowing (DAS) recorded significantly the higher values of growth, yield and yield attributes. This treatment increase the grain yield of rice to the tune of 21.5%, 7.5%, 5.6%, 96.1%, 37.9%, 28.2% and 138% over T_1, T_2,T_3, T_4, T_5,T_6, and T_7 respectively. This treatment also had the highest nutrient uptake i.e. 108.5 kgN/ha, 35.4 kgP/ha and 121.4 kgK/ha followed by site specific nutrient management (SSNM) based on LCC-4(T_3), and site specific nutrient management (SSNM) based on nutrient expert advise (T_2). The gross income of Rs.68292/ha was highest with application of 100% RDF+Vigore @625g/ha at 8 days after planting (T_8) but net income worth Rs. 29254/ha and B:C ratio(1.84) was recorded the highest with SSNM on LCC-4(T_3) which was closely followed by 100% RDF+Vigore @625g/ha at 8 days after planting (T_8) with net income of Rs.28134/ha and B:C ratio(1.70).

Keywords: specific nutrient, profitability, rice, low land

Introduction
Nitrogen is the most common and vastly use fertilizer nutrient in rice and its consumption has increased substantially in the past decade. But the quantity of rice grain produced over per unit areas of applied fertilizer N (PPP) of nutrients has continuously reduced to very low values (Doberman and Cossman, 2002) [5] and N- use efficiency following blanket fertilizers no application has been reported as low as 30% in rice- weed cropping system (Krupnik *et al*, 2004) [7]. The reason behind the poor N- use efficiency is an in sufficient splitting of N- dose coupled with more N- application, what is required for the crop. When managed inefficiently, a large portion of the applied N is lost which create environmental problems. Blanket recommendation is based on fixed time application of fertilizer, N- dose at specific growth stage do not combine the dynamic soil properly for nitrogen supply and crop N- requirement which leads to untimely application of nitrogenous fertilizer. The soil N- supply capacity varies form plot to plot and even in the same plot from year to year. Injudicious use, and application of N at wrong time is common. Farmers tended to use more nitrogenous fertilizer than which so required because of low price (Cremnet, 1998) [4], and its immediate visible impact on growth of plant leaf greenness. Nitrogen recovery by rice is low ranging from 20% to 40% because N losses via ammonia volatilization, denitrification and moves away with water horizontally and vertically. Use of nitrogenous fertilizer at higher dose miss- match with another plant growth make plants vulnerable to lodging and attraction to insert insects, pests and diseases. Leaf greenness is directly co- related to chlorophyll content and leaf nitrogen status. Japanese scientist (Furuya, 1987) [6] designed a real time N- management tool called Leaf Colour Chart (LCC) which was subsequently modified by Chinese scientist. The International Rice Research Institute(IRRI) and Phill Rice Research Institute used the concepts and further improvised the LCC in late 1990 to guide farmer to apply nitrogenous fertilizer at right amount to feed the plant when needed (Sukla *et al*, 2004) [9]. A recently developed decision support system (DSS), Nutrient Expert in rice and wheat synthesized from recorded date into a rational nutrient supply system that ensure rice and wheat farmers rapidly

implement site specific nutrient management for their individual field. Nutrient expert was developed to provide crop advisors with a simple and faster way to use site specific nutrient management apply nitrogen as per crop demand and N-supply will enhance N-use efficiently in rice and wheat system, this is also known as real time N-management.

Vigore is a nanotechnology product which includes all nutrients required for complete and healthy development of the plant. It is an eco-friendly product and non-toxic for humans, animals and plants, as it has been prepared from substances found in nature by using infinite decimal doses and with denomination which increase effective and reduced toxicity of vigore which was applied 5-10 days after planting rice @625g/ha as broadcast method. Combine use of recommended dose of fertilizer (RDF) with soil applications of vigore @625g/ha at 5- 10 days after sowing gave higher yield as compared to other treatments (Singh *et al*, 2017) [8]. Hence, an attempt was made to study the effect of site specific nutrient management practices (SSNM) on productivity and profitability of rice under low land situation.

Methods and Materials

A field experiment was conducted for 3 consequtive years in Kharif seasons of 2014- 2016 at the Crop Research Station, Ghaghraghat, Baihraich of Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya (UP) to study the effect of site specific nutrient management on productivity and profibality of rice under ranifed lowland situations.

The eight treatments comprised of 100% recommended dose of fertilizers (RDF) i.e. $80N+60P_2O_5+40K_2O$ $kgha^{-1}$ through inorganic fertilizer(T_1), Site specific nutrient management (SSNM) based on nutrient expert i.e. $125N+36P_2O_5+66K_2O$ kg ha^{-1} (T_2), site specific nutrient management based on LCC-4 i.e. $90N+60P_2O_5+40K_2O$ kg ha^{-1}(T_3), 100% state recommended dose of PK i.e. $60P_2O_5+40K_2O$ kg ha^{-1}(T_4), 100% state recommended dose of NK $80N+40K_2O$ kg ha^{-1}(T_5), 100% state recommended dose of NP i.e. $80N+60P_2O_5$ kg ha^{-1} (T_6), No fertilizers application (T_7), and 100% state recommended dose of fertilizer (RDF) i.e. $80N+60P_2O_5+40K_2O$ kg ha^{-1}+Vigore spray @625g ha^{-1} at 8 days after sowing(T_8) were tested in randomized block design with four replication, Twenty one days old seeding of rice variety "NDR 2001" was transplanted in second week of July in all years at 20X10 cm hill spacing. The required quantity of fertilizers was applied as per treatments. The full dose of phosphorus and potash and ¼ dose of nitrogen as per treatments was applied at sowing as basal.

The data on plants height, dry matter accumulation, and leaf area index was recorded at 90 days of sowing in all years. Five panicles were selected from each plot randomly to gather the data on yield attributing character like panicle length, grain weight of panicles, grains/panicle, panicle weight. The grain and straw yield recorded by threshing produce manually and reported quintal per hactare. The grain samples collected from each plot at threshing was utilized for counting 1000 grain weight, and nitrogen, phosphorus and potash content in grain and straw. The uptake of nutrients by grain and straw was rercorded by using formula i.e. nutrient content (%) of grain and straw multiplied by grain and straw yield ($kgha^{-1}$) and divided by 100. The leaf area index (LAI) was calculated as per formula i.e. leaf area per plant divided by ground area covered by plant. The content (%) of P, K and N in grain and straw was determined as per laboratory standerd procedure. The data on various characters like growth, yield, uptake of nutrient were subjected to statistical analysis as per procedure given by (Chandel, 1978) [3].

Result and Discussion

Growth attributes

Significantly, higher number of panicles/m^2, dry matter accumulation and leaf area index(LAI) were recorded with applications of 100% recommended dose of fertilizer(RDF) + spray of vigore @625g/ha(T_8) as compared to rest of the treatment (Table- 2). The higher value of growth with this treatment was mainly due to higher availability of nutrients through vigorous root system and higher uptake of nutrients from soil by improving photosynthesis efficiency of plant. Similar higher values of growth was reported with INM practices by Singh *et al*, (2017) [8]. However, site specific nutrient management (SSNM) based on nutrient expert(T_2) and site specific management(SSNM) based on leaf colour chart (LCC- 4) (T_3) were on par but recorded higher values of all growth attribute over 100% recommended dose of fertilizers(RDF) through inorganic fertilizer(T_1). This improvement in growth attributes was owing to supply of nutrients as per plant needs which helped in better utilization of nutrients in term of higher photosynthetic efficiency of rice plants as compared to state recommendation of N, P and K in treatment (T_1). Application of 100% state recommendation of NP(T_6) and NK(T_5) improved the growth attributes significantly over 100% state recommended PK(T_4). Poor growth attributes with 100% state recommended PK (T_4) was mainly due to insufficient supply of nitrogen (Depending on soil nitrogen) as compared to NP (T_5) and NK (T_6) treatment.

As nitrogen supply to plant promotes its growth and development and enhances the synthesis and accumulation of amino acids which are responsible for cell division and cell elongation that promotes plant height, number of panicle/m^2, dry matter accumulation, LAI and chlorophyll content of leaf. Thus, no supply of nitrogen in 100% state recommended PK (T_4) treatment as compared to 100% state recommended NP (T_6) and NK (T_5) treatments resulted in poor growth attributes. These result are in close confirmity with Akram *et al*, (2014) [2] and Akhter *et al*, (2017).

Yield Attributes

Applications of 100% RDF through fertilizers + vigore @625g/ha at 8 days after planting(T_8) recorded significantly maximum mean values of paniclses/m^2, number of grains/panicle, grain weight/panicle, panicle length, and 1000 grain weight over other treatments. The increase in grain/panicle might be due to its enhance effect on physiological activities, photosynthesis, translocation and assimilation of photosynthects and formation of higher length of panicle during panicle initiation stage which ultimately resulted higher panicle/m^2, Vigore application increased the photosynthetic rate of the crop, material transition in phloem, grain filling process, facilitate the quick transportation of nutrients and assimilates towards grain which increase 1000 grain weight(g). Similar findings have been reported by Singh *et al*, (2017) [8]. Crop received nutrients based on site specific nutrient management (SSNM) as per nutrient expert (T_2), and SSNM based on LCC- 4(T_3) resulted significantly higher values of yield attributes as compared to rest of the treatments. It might be due to sufficient availability of nitrogen as per need of the plant which enhance the photosynthesis efficiency of rice plant resulted in higher values of growth and yield attributes.

Application of 100% state recommended PK(T_4) resulted lower values of yield attributes because of insufficient availability of nitrogen (Only soil) resulted poor growth, and yield attributes as compared to application of 100% state recommended NK(T_5), and NP(T_6) treatment. Crop received 100% RDF through fertilizer (T_1) recorded significantly higher values of all yield attributes as compared to 100% state recommended NK (T_5), and NP (T_6) treatments. This was because of balance fertilizer(NPK) in treatment(T_1) as compared to treatment T_5 and T_6 resulted poor growth and yield attributes to the fact that balanced and judicious application of fertilizers ensure synergistic reaction among nutrients translocation photosynthetic from source to sink.

Grain and straw yield

The grain yield was significantly higher with application of 100% recommended dose of fertilizers through inorganic fertilizer+ vigore@625g/ha at 8 days after transplanting (T_8) over rest of treatments. The higher yield with 100% RDF + vigore@625g/ha days after sowing was owing to higher growth of crop in terms of leaf area index (LAI) and yield attrributes which was improved due to presence of plant nutrients through improvement in root system and higher uptake of nutrients from the soil by improving photosynthesis efficiency of plants with vigore application. Similar results were obtained by Singh *et al* (2013). The percent increase in grain yield by this treatment was recorded to be 21.5%, 7.5%, 5.6%, 96.1%, 37.9%, 28.2% and 138% over T_1, T_2,T_3, T_4, T_5,T_6, and T_7 respectively.

Application of SSNM based on LCC- 4(T_2) and SSNM based on nutrient expert (T_2) recorded significantly higher grain yield (46.78q/ha and 43.68q/ha) over 100% RDF through fertilizer (T_1). The higher grain and straw yield with SSNM based on LCC- 4 (T_2) was mainly attributed to higher values of growth, and yield parameters and supply of nitrogen as per demand of the crop, utilized the nitrogen efficiency and transferred the photosynthets to sink. Similar higher grain and straw yield of rice with N- management based on LCC-4 was reported by Kumar *et al,* (2017) [8].

Inclusion of 40kg/ha each of the potassium and phosphorus in state recommendation of NP and NK, respectively produced an additional grain yield of 1.99 and 4.56q/ha, respectively. However, inclusion of 80kg/ha nitrogen in 100% state recommendation of PK improved the grain yield to the tune of 15.45q/ha. This indicates that experimental soil was deficient in nitrogen and phosphorus as compared to potassium. Straw yield in different treatments also followed the similar trend as in case of grain yield.

Nutrient uptake

Nutrient uptake (kg/ha) through grain and straw was affected significantly due to various site specific nutrient management practices (Table-). Application of 100% RDF + spray of Vigore@625g/ha at 8 days after sowing (T_8) depleted significantly highest amount of N (105.65kg/ha), P (44.80kg/ha) and K (132.72kg/ha) as compared to rest of the treatment (Table- 2). Site specific nutrient management (SSNM) based on LCC- 4(T_3) depleted significantly higher amount of N, P and K (95.26, 36.16 and 115.4 kg/ha) over rest of the treatments except T_8. Site specific nutrient management (SSNM) based on nutrient expert (T_2), and 100% RDF through fertilizer was on par but recorded higher uptake of N, P and K significantly as compared to rest of the treatments. Higher uptake of nutrient with T_8, T_3, T_2 and T_1 was mainly attributed to higher grain and straw yield and nutrient content (%) as nutrient uptake is a function of nutrient content (%) and grain or straw yield, and treatment having higher grain or straw yield depleted higher amount of nutrients. Similar higher uptake of nutrient with site specific nutrient management practices was reported by Singh *et al*, (2017) [8].

Economics

The highest gross income (Rs. 65485/ha) was recorded with 100% RDF + Vigore@625g/ha(T_8) which was followed by site specific nutrient management(SSNM) based on LCC-4(T_3), site specific nutrient management(SSNM) based on nutrient expert (T_2) and 100% RDF through fertilizer. However, net income (Rs.2618/ha) was highest with site specific nutrient management (SSNM) based on LCC- 4(T_3) followed by site specific nutrient management (SSNM) based on nutrient expert T_2(Rs.26115/ha). The higher net income with above treatment could be attributed to lower cost of cultivation as compared to higher cost of cultivation with 100% RDF + Vigore@625g/ha(T_8). Benefit: Cost ratio also followed the similar trend as in case of net income.

It is concluded that adoption of site specific nutrient management (SSNM) based on LCC-4 (T_2) was found to be the most remunerative nutrient management practices from rice in lowlands obtaining higher net income & benefit: cost ratio fallowed by 100 % RDF + Vigore @625 g/ha after 8 day of sowing in soil.

Table 1: Effect of site specific nutrient management on growth and yield attributes of rice (Mean of 3 years)

Treatment	Plant height (cm)	Dry matter (q/ha) 90 DAS	Leaf area index 90 DAS	Effective panicles/m^2 at harvest	Panicle length (cm)	Panicle weight (g)	Grains /panicle	1000 grain weight (g)
T1	99.8	34.64	5.97	280	23.50	3.22	100	19.11
T2	100.7	37.22	6.10	303	23.82	3.37	104	19.60
T3	100.9	9.9	6.30	328	24.01	3.43	110	19.98
T4	97.0	21.4	4.10	189	22.10	2.81	80	18.60
T5	97.9	30.6	4.90	226	22.30	2.93	90	18.78
T6	98.7	32.9	5.10	251	23.07	3.10	95	19.07
T7	94.9	17.63	4.03	170	21.50	2.61	71	18.50
T8	101.4	42.10	6.50	349	24.15	3.52	119	20.10
CD (P = 0.05)	3.2	4.32	0.51	25	1.12	0.15	09	0.11

Table 2: Effect of site specific nutrient management on yield, nutrient uptake and economics (Pooled over 3 years)

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Nutrient uptake (kg/ha)			G.I. (Rs./ha)		
			N	P_2O_5	K_2O		Net income (Rs./ha)	B:CR
T1	38.49	47.18	90.50	28.60	109.90	56386	21814	1.63
T2	41.45	50.03	94.39	30.91	115.72	60390	24425	1.68
T3	44.29	53.15	101.30	33.82	119.60	64656	29554	1.84
T4	23.86	28.39	52.77	20.62	95.36	34854	2450	1.07
T5	33.93	41.06	84.80	25.62	103.50	49552	15702	1.46
T6	36.50	43.80	88.70	27.80	115.18	53300	19890	1.59
T7	19.59	23.70	45.07	17.53	70.61	28626	1284	1.05
T8	46.78	56.13	108.50	35.41	121.45	68292	28134	1.70
CD (P = 0.05)	2.79	3.36	8.19	2.04	2.15	-	-	-

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