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Effect of conventional and graded source of macro, secondary and micro nutrients on morpho-physiological traits of rice cultivar Lalat

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Abstract
An experiment was conducted at Central Farm, OUAT, Bhubaneswar during *Kharif* 2016-17 in a Randomized Block Design (RBD) with 11 treatments consisted of control (T_1), 4 levels of conventional source of fertilizer application i.eT_2 (NPK), T_3 (NPKS-GYP 15% S), T_4 (NPKSZn-$ZnSO_4$), T_5 (NPK+FYM @ 5 t/ha), and 6 levels of graded source of fertilizer application i.e. T_6 (NPS-1), T_7 (NPS-2), T_8 (NPS-3), T_9 (S eqv NPS-1) T_{10} (S eqv NPS-2) T_{11} (S & Zn eqv NPSZn) to study the effect of conventional and graded source of macro, secondary and micro nutrients on morpho-physiological traits of rice cultivar Lalat. Application of NPK+FYM @ 5 t/ha recorded highest Plant height (98.8 cm); No. of tillers per hill (15.33), Number of leaves per hill (50); flag leaf area (23.71 cm^2); Physiological parameters like leaf area index (5.07); relative growth rate (0.29) shoot and root dry weight (14.72 g, 25.46 g); total biomass (70.89 g) respectively. Hence, use of conventional sources of fertilizer increases the morphological and physiological attributes of rice and found to be better treatment over control.

Keywords: Morpho-physiological, macro and micro nutrients, graded fertilizers, rice

Introduction
Rice (*Oryza sativa* L.) being rich in carbohydrates considered as staple food not only in India but in world. Balanced nutrition is important for achieving better yield goals, yet inefficient fertiliser usage and imbalanced fertiliser use are the main causes of the crop's low productivity. Even with the use of hybrid and high yielding cultivars, intensive cropping systems, blind use of fertilisers, and less application of organic sources of nutrients have led to disarray the soil's fertility and leads to deficient of sulphur and zinc in soil that affects crop yield in paddy. On the other hand, plants may become poisonous from the constant application of huge levels of micronutrients. More emphasis was given to use of major nutrients like nitrogen, phosphorous and potassium for crop production but now it is realized that apart from major macro nutrients use of other secondary and micro nutrients also play crucial role in crop growth and yield. In India, paddy cultivated fields are deficient in S and Zn.

In India, out of total paddy cultivable land around 40% lands are deficient in sulphur nutrient (Tripathi, 2003) [18] and it is important for increasing crop yield and productivity in leguminous and oil seed crops (Tewatia *et al.*, 2006) [17]. Zinc also reported to be another important micronutrient which is deficient in Indian soil. According to Singh 2004 [16] and Prasad 2006 [8], from study it was reported that soils collected from different parts of our country and approximately 40% soils prevail zinc deficiency and it is believed to be increased up to 63% by 2025. Gibbson, 2006 [22] also reported that around 50% of world soils are showing zinc deficiency. So, there is an urgency for correction of sulphur and zinc deficiency by adopting right fertilizers in crop production.

As far as Indian farmers are concerned it was reported that practice of use of major macro nutrients and very low or no use of micro as well as secondary nutrients in paddy cultivation. So, this experiment was carried out with the objective to find out the effectiveness of macro, micro and secondary nutrients in rice cultivation and its impact on crop morphological and physiological traits.

Materials and Methods
Experimental site
Experiment was conducted at Central Farm, OUAT, Bhubaneswar during *Kharif* 2016-17. Geographically the experimental site was located at Bhubaneswar (200 17' N and 850 49' E;

25.9 MSL).

Soil characteristics of the trial plot

The experimental field was sandy loam, texture slight acidic in nature. The physical-chemical properties of the soil are presented in Table 1.

Plant material

Rice cultivar Lalat which is having 120 days of cropping duration was taken for study and transplanted in the field at a distance of 15 cm x 10 cm with 2 seedlings in a hill. Crop was harvested at fully mature stage followed by thrashing and collection of grain.

Treatment details

The trial was designed using RBD comprised of eleven treatments and replicated thrice by application of fertilizer through conventional and graded sources. Treatments details presented in table-2. The plot size was maintained at 6.2 m×3.2 m and plants were spaced at 15x10 cm and maintained for 120 days crop cycle. To figure out which treatment work best for plant growth and development, data were taken in regards to morphological traits like plant height, number of leaves, number of tillers, flag leaf area; physiological traits like leaf area index (LAI), relative growth rate (RGR), shoot weight, root weight and total dry weight.

Statistical analysis

Observations were taken for various morphological and physiological parameters of rice and data were statistically calculated and analysed using the formula as mentioned by Panse and Sukhatme (1967) [7].

Table 1: Physical and chemical properties of experimental soil

Physical properties	Value	Chemical properties	Value
Soil textural class	sandyloam	Organic carbon	4.10 kg ha^{-1}
pH	5.25	available N	105 kg ha^{-1}
EC	0.08dS/m	available P2O5	60 kg ha^{-1}
		available K2O	40 kg ha^{-1}
		available S	2.12 mg Kg^{-1}
		Available Zinc	0.53 mg Kg^{-1}
		Available Cupper	1.27 mg Kg^{-1}
		Available Iron	218.9 mg Kg^{-1}
		Available Manganese	5.25 mg Kg^{-1}
		Available boron	0.32 mg Kg^{-1}

Table 2: Treatment details

Control	T_1	No NPK
Conventional source	T_2	NPK (80:40:40)
	T_3	NPKS (45kg/ha)
	T_4	NPKSZn (5kg/ha)
	T_5	NPK+FYM
Graded source	T_6	NK+NPS-1
	T_7	NK+NPS-1
	T_8	NK+NPSZn
	T_9	NPK+NPS-1
	T_{10}	NPK+NPS-2
	T_{11}	NPK+NPSZn

N.B. NPS 1-N:P:K:S-19:38:00:07; NPS 2-N:P:K:S-12:46:00:07; NPSZn – N:P:K:S:Zn -12:45:00:05:01

Result & Discussion

Morphological attributes

Plant height

The data on plant height in rice presented in table 3. Plant height was maximum in T_5 (NPK +FYM @ 5 t/ha) followed by T_8 (NPS-3) & T_7 (NPS-2) ranging from 98.8 cm, 98.4 and 98.0 respectively. However, the minimum plant height is observed in T_9 (S eqv. NPS-1) having 91.1 cm in comparison to control T_1 (84.2 cm) at physiological maturity stage. Expression of plant height is due to genetic character of variety but some degree of variation may be observed due to application of nutrients and manures. The findings is well supported by results of Rahman *et al.* (2008) [9], Singh *et al.* (2011) [15].

Number of tillers/Hill

The effects of treatments on number of tillers of crop presented in Table-3. Data recorded for number of tillers was maximum in T_5 (15.33) followed by T_4 (14.05) & T_3 (14.00) respectively. However, minimum number of tillers were found in T_6 (9.77) in comparison to control T_1 (9.67) at physiological maturity stage. The treatment effect was significant. This result was in accordance with Chandel *et al.* (2002) [2], Chaturvedi (2005) [3], Massawe *et al.* (2017) [5].

Number of leaves/hill

Influence of treatments on number of leaves of crop presented in Table-3. Data recorded revealed that the no. of leaves was maximum in T_5 (50 per hill) followed by T_{11} (47 per hill) & T_{10} and T_4 (46 per hill) respectively. However, minimum no. of leaves was found in T_6 (39 per hill) in comparison to control T_1 (38 per hill) at physiological maturity stage and were significant among the treatment. These findings were reported by Chaturvedi (2005) [3], Ndaeyo *et al.* (2008) [6].

Flag leaf area

The effects of treatments on flag leaf area development of Lalat was depicted in Table-3. The observed data revealed that flag leaf area was maximum in T_5 (23.71 cm^2) followed by T_4 (23.65 cm^2) & T_8 (23.64 cm^2) respectively. However, minimum flag leaf area was found in T_6 (21.17 cm^2) in comparison to control T_1 (21.15 cm^2) at physiological maturity stage. However, the treatment effect was found significant when applied at different doses. This is because of more photosynthetic activity and with cellular function. Similar results were obtained by Watson *et al.* (1952) [19], Watson *et al.* (1963) [20].

Physiological parameters

Leaf Area Index (LAI)

The effects of treatments on LAI of crop presented in Table-3. The result was found significant within the treatments. LAI was maximum in T_5 (5.07) followed by T_4 (4.94) & T_8 (4.90) respectively. However, minimum LAI was found in T_6 (3.53) in comparison to control T_1 (2.15) at physiological maturity stage. The increase in LAI was increased up to flowering period and thereafter decreased in all the treatments. Significant difference within the treatments indicated positive response of different sources of nutrient application in rice plant over control. Thereby plant growth affected by the

fertilizer. Leaf is the site of photosynthesis in plant and increase in leaf size significantly increases photosynthetic production which may improves crop growth and yield. Similar findings were also reported by Sahaa *et al.* (2007) [12], Shekhawat and Shivay (2009) [13], Singh *et al.* (2011) [15].

Relative growth rate (RGR)

The effects of treatments on RGR of crop presented in Table-3. Data recorded revealed that RGR was maximum in T_5 (0.29) followed byT_4 (0.28) & T_8 (0.27). However, minimum RGR was found in T_6 (0.24) in comparison to control T_1 (0.22). Progress in crop age causes senesecence and reduction in plant metabolic actions which leads to decline in relative crop growth rate. This finding agreed with the result of Resurreccion *et al.* (2012) [11], Rajput *et al.* (2017) [10].

Shoot and root dry weight (g)

The effects of treatments on shoot dry weight of crop presented in Table-3. Data recorded on dry weight of shoot revealed that shoot dry weight was maximum in T_5 (14.72 g) followed by T_8 (12.78 g) & T_4 (11.85 g) respectively. However minimum shoot dry weight was found in T_2 (10.09 g) in comparison to control T_1 (9.55 g) at physiological maturity stage and was significant among the treatments. The effects of treatments on root dry weight of crop presented in Table-4.7. Data recorded revealed that root dry weight was maximum in T_5 (25.46 g) followed by T_{11} (23.96 g) & T_4 (23.90 g) respectively. However, minimum root dry weight was found in T_6 (21.23 g) in comparison to control T_1 (21.10 g) at physiological maturity stage and was non-significant among the treatments.

Total biomass

The effects of treatments on total biomass of crop presented in Table-3. Data recorded revealed that biomass was maximum in T_5 (70.89 g) followed by T_4 (63.54 g) & T_8 (62.89 g) respectively. However, minimum biomass was found in T_6 (53.41 g) in comparison to control T_1 (45.96 g) at physiological maturity stage and was significant within the treatments. The total biomass accumulation was highest in T_5 (NPK+FYM) with an increase of 54.24% over control indicated the high response of nutrient effect to rice plant. Graded application of Zn and S was less effective contributing total biomass compared to conventional sources. This might be non- release of nutrient to the plant at different developmental stages. Similar effect of nutrient also observed in case of root and shoot dry weight. However, in all the treatments significant difference is observed compare to control. Dry weight in both root and shoot increased at different developmental stage proceeding to maturity. Similar results were obtained by Anandana and Arunachalam (2012) [1], Winkel *et al.* (2013) [21], Singh *et al.* (2014) [14].

Table 3: Effect of conventional and graded source of fertilizers on morphological and physiological traits of rice cv. Lalat

Treatments	Plant height	No. of tillers	No. of leaves	Flag leaf area	LAI	RGR	Shoot dry weight	Root dry weight	Total biomass
T_1	84.2	9.67	38	21.15	2.15	0.22	9.55	21.1	45.96
T_2	92	12	44	22.02	4.4	0.25	10.09	22.48	53.6
T_3	92.3	14	45	22.83	4.66	0.26	10.19	23.14	59.8
T_4	92.9	14.05	46	23.65	4.94	0.28	11.85	23.9	63.54
T_5	98.8	15.33	50	23.71	5.07	0.29	14.72	25.46	70.89
T_6	97.7	9.77	39	21.17	3.53	0.24	10.58	21.23	53.41
T_7	98	10.67	40	21.92	3.83	0.25	10.7	21.43	56.3
T_8	98.4	13.67	42	23.64	4.9	0.27	12.78	22.79	62.89
T_9	91.1	10	42	22.22	3.54	0.23	10.63	22.8	64.42
T_{10}	93	11.01	46	22.93	4.48	0.24	11.05	23.5	59.24
T_{11}	95.1	11	46	23.61	4.51	0.25	11.74	23.96	54.83
S.E (m)	2.5	0.48	3.53	0.17	0.37	0.02	0.81	2.2	0.31
CD	6.1	1.17	8.6	0.42	0.9	NS	2.36	NS	0.76

Conclusion

From the experiment it can be concluded that application of macro and micro nutrients on rice was significantly influences the crop growth and development. Hence, morphological and physiological attributes like plant height, number of leaves, number of tillers, flag leaf area; leaf area index (LAI), relative growth rate (RGR), shoot weight, root weight and total dry weight of rice cultivar "Lalat" significantly influence by application of NPK + FYM @ 5 t/ha.

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