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Impact of Customized Fertilizers on Yield and Soil Properties of Lowland Rice Ecosystem

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Field experiments were conducted in two different agro-climatic zones during kharif 2011 at Tamil Nadu Rice Research Institute, Aduthurai and Wetlands, TNAU farm, Coimbatore to study the effect of customized fertilizers on yield and soil properties of lowland rice ecosystem. Two formulations of customized fertilizers *viz*., N: P: K mixture (CF I) and N: P: K: Zn mixture (CF II) have been developed based on the blanket recommendation (BR) of straight fertilizers being followed in Tamil Nadu. Three levels of CF I and CF II *viz*., 50%, 75% and 100% of RDF were compared with 100% RDF through straight fertilizers. The results revealed that application of 100% RDF in the form of CF II increased the productive tillers (21 nos.), panicle length (27.70 cm) and number of filled grains per panicle (203 nos.). Application of 100% RDF in the form of CF II recorded the highest grain yield of 6878 kg ha^{-1} followed by the application of 100 % RDF in the form of CF I + 25 kg Zn SO_4 ha^{-1} (6622 kg ha^{-1}). Per cent increase in yield of 22.2 per cent over the application of straight fertilizers was recorded due to the application of 100 % RDF in the form of CF II.

Key words: Customized fertilizers, balanced fertilization, rice yield, soil properties

In India, fertilizers have contributed 60 percent of recent increases in food production. Balanced fertilization is the major strategy used with an ideal N: P_2O_5:K_2O ratio of 1:0.5:0.25 for grain-based production systems (Tandon, 1997). When N, P and K applications are imbalanced, large quantities of the nutrients not applied in adequate amounts are mined from the soil until they become critically deficient. India is already in the era of multiple nutrient deficiencies with N, P, K, S and Zn being the most widespread. Nutrient depletion can be attributed to insufficient fertilizer use and imbalanced fertilization (Tan *et al*., 2005). The decline in productivity of rice and wheat with continuous cropping was related to deficiency of P, K, S, Zn and imbalanced nutrition (Kumar and Yadav, 2005).

The main causes for low and declining crop response to fertilizers are : continuous use of fertilizer N alone or with inadequate P and K application leading to mining of native soil P and K; continued practice of intensive cropping systems with high yielding varieties even under recommended NPK use, use of high analysis fertilizers devoid of secondary and micronutrients leading to imbalanced fertilization . To improve the fertilizer use efficiency through balanced fertilization, customized fertilizers based on crop response are to be developed. For the present investigation, the customized fertilizers have been developed based on the blanket recommendation (BR) of straight fertilizers being followed in Tamil Nadu as per the crop production guide and evaluated through field trials.

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Materials and Methods

Field experiments were conducted in two different agro-climatic zones during kharif 2011 at Tamil Nadu Rice Research Institute, Aduthurai (Cauvery Delta zone) and Wetlands, TNAU farm, Coimbatore (Western zone) with rice (*var* .ADT.43) as test crop. The treatments included straight fertilizers applied through urea, super phosphate and muriate of potash, customized fertilizer of N: P: K mixture (CF I) and N:P:K: Zn mixture (CF II) as follows : T1- 100% RDF through straight fertilizers (150: 50 : 50 kg N, P_2O_5 , K_2O ha^{-1} + 25 kg $ZnSO_4$ ha^{-1}) (Control) , T2-50% RDF in the form of CFI + 25 kg $ZnSO_4$ ha^{-1}, T3-75% RDF in the form of CFI+25 kg $ZnSO_4$ ha^{-1}, T4-100% RDF in the form of CFI+ 25 kg $ZnSO_4$ ha^{-1},T5-50% RDF in the form of CFII, T6-75% RDF in the form of CFII, T7-100% RDF in the form of CFII . For the preparation of CFI, N and P were supplied through ammonium phosphate and K through muriate of potash and for the preparation of CFII, N and P were supplied through ammonium phosphate, K through muriate of potash and Zn through Zinc sulphate. In CF I applied plots, basal application of 25 kg $ZnSO_4$ ha^{-1} as straight fertilizer was carried out. The soils of the experimental sites (Tamil Nadu Rice Research Institute, Aduthurai and Wetlands, TNAU farm, Coimbatore) were neutral and slightly alkaline in soil reaction (pH: 7.55 and 8.25) and free from salt hazards with the electrical

conductivity of 0.19 dSm^{-1}and 0.40 dSm^{-1} and low in organic carbon status (0.40 and 0.50 per cent); while available N (229 and 275 kg ha^{-1}), P (30.9 and 28.3 kg ha^{-1}) and K (290 and 680 kg ha^{-1}) status were in low, high and high status respectively. DTPA extractable micronutrients viz., Zn (3.02 and 5.16 mg kg^{-1}), Fe (71.97 and 81.55 mg kg^{-1}), Mn (8.16 and 9.10 mg kg^{-1}) and Cu (5.58 and 4.86 mg kg^{-1}) were recorded at sufficient levels. Recommended package of practices were followed in raising the crop. Full dose of P was applied as basal and N, K were applied in four equal splits viz., basal, at tillering, panicle initiation and at heading stages. The post harvest soil samples were analyzed by using standard procedures for pH, EC, OC, N, P, K, Fe, Mn, Zn and Cu.

Results and Discussion

Yield attributes and grain yield

The pooled analysis of two locations indicated that application of 100% RDF in the form of CF II increased the productive tillers (21 nos.), panicle length (27.70 cm) and number of filled grains per panicle (203 nos.).The number of productive tillers recorded in the treatment that received 100 % RDF in the form of CF II was on par with 100 % RDF through CF I +25 kg Zn SO_4 ha^{-1} and 100% RDF through straight fertilizers. The lowest number of productive tillers, panicle length and number of filled grains per panicle were recorded in the treatment that received 50 % RDF through CF I +25 kg Zn SO_4 ha^{-1} (Table 1). Successive increase in fertilizer levels

Table.1 Effect of customized fertilizers on no. of productive tillers, panicle length and no.of filled grains per panicle and grain yield of rice (*var.*ADT.43)

(Pooled mean of two locations)

Treatment	Productive tillers (No./ hill)	Panicle length (cm)	Filled grains Panicle^{-1} (No.)	Grain yield (kg ha^{-1})	Per cent increase over control
T1: Check 100% RDF -150:50:50 kg N,P_2O_5,K_2O ha^{-1} +25 kg Zn SO_4 ha^{-1}	19	22.85	152	5628	-
T2: 50 % RDF as CF I +25 kg Zn SO_4 ha^{-1}	15	20.55	117	5061	-10.1
T3: 75% RDF as CF I +25 kg Zn SO_4 ha^{-1}	20	24.70	171	6250	11.1
T4: 100 % RDF as CF I +25 kg Zn SO_4 ha^{-1}	20	26.65	187	6622	17.7
T5: 50 % RDF as CF II	17	22.75	144	5372	-4.5
T6: 75% RDF as CF II	21	25.40	180	6478	15.1
T7: 100 % RDF as CF II	21	27.70	203	6878	22.2
SEd	1	0.29	8	89	
CD (p: 0.05)	3**	0.72**	19**	218*	

from 50% RDF to 100% RDF had marked influence on the yield attributes of rice.

Application of 100% RDF of straight fertilizers recorded a grain yield of 5628 kg ha^{-1}. Application of 100% RDF in the form of CF II recorded the highest grain yield of 6878 kg ha^{-1} followed by the application of 100 % RDF as CF I + 25 kg Zn SO_4 ha^{-1} (6622 kg ha^{-1}). The lowest yield of 5061 kg ha^{-1} was recorded with the application of 50 % RDF in the form of CF I + 25 kg Zn SO_4 ha^{-1} (Table 1). Yadav *et al.* (1998) showed that significant yield decline in rice in the treatments with imbalanced application of N, P and K fertilizers.

An increase in yield of 15.1 per cent over the application of 100 % RDF of straight fertilizers was obtained with the application of 75% RDF through CF II. Application of 100 % RDF through CF II registered an increase in yield of 22.2 per cent over the application of straight fertilizers. This could be attributed to the addition of Zn increased the number of tillers and reduced the spikelet sterility. These results were in concurrent with the findings of Buri

Table 2. Effect of customized fertilizers on soil pH, electrical conductivity, organic carbon and available N, P and K at harvest stage

(Pooled mean of two locations)

Treatment	pH	EC (d S m^{-1})	Organic carbon (g kg^{-1})	N	P (kg ha^{-1})	K
T1: Check 100% RDF 150 : 50 :50 kg N,P_2O_5,K_2O ha^{-1} + 25 kg Zn SO_4 ha^{-1}	7.75	0.20	6.6	307	33.9	469
T2: 50 % RDF as CF I +25 kg Zn SO_4 ha^{-1}	7.74	0.17	5.3	253	27.1	355
T3: 75% RDF as CF I +25 kg Zn SO_4 ha^{-1}	7.65	0.19	4.8	289	42.0	509
T4: 100 % RDF as CF I +25 kg Zn SO_4 ha^{-1}	7.62	0.23	5.6	312	40.0	537
T5: 50 % RDF as CF II	7.68	0.19	5.6	272	25.8	384
T6: 75% RDF as CF II	7.67	0.17	6.3	322	38.5	528
T7: 100 % RDF as CF II	7.71	0.15	5.7	343	35.7	543
SEd	0.08	0.05	0.4	23	2.6	58
CD (p: 0.05)	NS	NS	0.9	NS	6.36	NS

et al. (2000). The increase in grain yield over the application of straight fertilizers was 11.1 per cent in the treatment that received 75% RDF in the form of CF I + 25 kg Zn SO_4 ha^{-1}. Application of 100 % RDF as CF I + 25 kg Zn SO_4 ha^{-1} registered an increase in yield of 17.7 per cent over the application of straight fertilizers (Table 1). Balanced fertilization strategy enhanced the rice yield as compared to the conventional method of nutrient addition through straight fertilizers. Similar results were reported by Khalid *et al*. (2003).

Soil Properties

The soil organic carbon status in the treatments 100% RDF through straight fertilizers, 75% RDF in the form of CF II and 100% RDF as CF II were on par (Table 2). The initial available N status of the experimental site at TRRI, Aduthurai and wet lands, TNAU farm, Coimbatore were 229 and 275 kg ha^{-1}.

Table 3. Effect of Customized fertilizers on DTPA-micronutrients in soil at harvest stage

(Pooled mean of two locations)

Treatment	Zn	Fe	Cu	Mn
			(mg kg^{-1})	
T1:Check100% RDF -150:50:50 kg N,P_2O_5,K_2O ha^{-1} +25 kg Zn SO_4 ha^{-1}	4.21	87.26	6.38	9.76
T2: 50 % RDF as CF I +25 kg Zn SO_4 ha^{-1}	3.26	86.35	5.89	8.73
T3: 75% RDF as CF I +25 kg Zn SO_4 ha^{-1}	4.52	89.19	6.44	10.69
T4: 100 % RDF as CF I +25 kg Zn SO_4 ha^{-1}	4.41	89.18	6.72	10.45
T5: 50 % RDF as CF II	4.16	86.89	6.22	9.12
T6: 75% RDF as CF II	5.22	87.75	6.96	10.68
T7: 100 % RDF as CF II	5.30	87.42	6.79	10.46
SEd	0.24	1.24	0.43	0.78
CD (p: 0.05)	0.59	NS	NS	NS

The available micronutrient status revealed that the DTPA - Zn ranged from 3.26 mg kg^{-1} to 5.30 mg kg^{-1}. The highest DTPA-Zn content (5.30 mg kg^{-1}) was recorded in the treatment that received 100% RDF as CF II and was on par with 75% RDF as CF II (5.22 mg kg^{-1}). Application of 75% RDF as CF I + 25 kg Zn SO_4 ha^{-1} recorded DTPA-Zn content of 4.52 mg kg^{-1} and was found to be on par with 100% RDF through straight fertilizers + 25 kg Zn SO_4 ha^{-1}.The lowest Zn status was recorded in the treatment that received 50% RDF as CF I + 25 kg Zn SO_4 ha^{-1} (Table 3). There were no significant changes in the status of DTPA extractable Fe, Cu, and Mn. Mehlal *et al*. (2006) reported an increase in soil available nutrient status due to the balanced application of N:P:K: Zn fertilizers.

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