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RESPONSE OF CUSTOMIZED FERTILIZER ON PRODUCTIVITY, NUTRIENT UPTAKE AND ENERGY USE OF RICE (*Oryza sativa* L.)

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ABSTRACT

The field experiment was conducted at Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidalaya, Raipur (C.G.) during *kharif* season of 2011 to study the effect of Customized fertilizer on growth, yield, energetic study and nutrient uptake of rice. Customized fertilizer is advance nutrient combination of different element to fulfill the requirement of rice crop for their growth. The results revealed that amongst the different doses of customized fertilizer (CF) and other nutrient management practices, superior result was found under 150% dose of CF (T_6), however it recorded the highest growth and yield attributing characters viz. grain yield of rice (6.9 t/ha) with HI (46.18 %)and Net energy output (183.2 MJ x 10^{-3}/ha). The uptake of NPK and Zn was also higher under this treatment. Other different doses of customized fertilizer i.e. 50% (T_2) and 75% (T_3) dose of CF and RDF (T_7) failed to provide considerable yield advantage and uptake of nutrients in plant as compared to optimum level of customized fertilizer.

KEY WORDS
Customized fertilizer
NPK
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INTRODUCTION

Rice is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of the planet's human population. With ever increasing population, demand for rice continues to increase. India need to raise its food grains targets at a rate of more than 4 million tonnes per annum and to maintain self-sufficiency, annual production needs to increase by two million tonnes every year (Anonymous, 2011).The annual consumption of fertilizers, in nutrient terms (N, P & K), has increased from 0.07 million MT in 1951-52 to more than 28 million MT in 2010-11 and per hectare consumption, has increased from less than 1kg in 1951-52 to the level of 135 kg 2010-11(DOF, 2012). In Chhattisgarh, rice is important crop, play a vital role in Indian production and economy. The livelihood of almost 83% of rural population of the state is dependent only on rice cultivation, but productivity of rice in the state is very low (1.3 t/ha) even below to the national average (2.37 t/ha).The decrease in productivity was observed to beassociated with the new emerging problems of deficiency ofmicronutrients such as zinc (Zn).In cultivation of rise, health and nutrient status of soil was noted decline even in irrigated areas due to application of inadequate and unbalanced quantity of fertilizers (Sharma *et al*., 2003).There is yield gap due to inadequate and imbalance supply of fertilizers and lack of distinct fertilizer recommendation for plenty of varieties and hybrid of rice.The balance nutrients supply for the cropsresulted no or minimal deleterious effect on environment aswell as soil (Hegde *et al.,* 2007). Customized fertilizers importance and defined as: Multi-nutrient carriers designed to contain macro, secondary and/or micro-nutrient both from inorganic sources and/or organic sources, manufactured through a systematic process of granulation, satisfying the crop's nutritional needs, specific to its site, soil and stage validated by a scientific crop model, capability developed by an accredited fertilizer manufacturing /marketing company(Rakshit*et al*., 2012).The experiment was conducted to find out theoptimum dose of customized fertilizer on rice productionby providing required nutrient (NPKS and Zn) in single way toget optimum yield with reference to Chhattisgarh condition.

MATERIALS AND METHODS

A fixed plot field experiment was carried out at Research Cum Instructional Farm of the Krishi Vishwavidalaya during *kharif* season 2011.This region comes under dry moist to sub humid climatic condition. The region receives on an average of 1200-1400 mm rainfall annually. The total rainfall of 1216.3 mm was received during *kharif* 2011. The maximum temperature ranged in crop seasons was 28.3ºC to 33.4ºC and minimum temperatures during the same seasons was 15.2ºC to 25.8ºC. The open pan evaporation mean values ranged from 2.8 to 4.7 mm day^{-1}. The other weather parameters were normal during season.

The soil of experiment field was '*Inceptisols*' (sandy loam) which is locally known as '*Matasi*'. The data on physico- chemical properties of the experimental soil are with neutral pH (7.42), EC 0.19 ds/m^2, being low in organic carbon (0.47%),

Table 1: Treatment details

Treatment	Quantity (kg/ha)	Nutrient supplied through Customized fertilizer and at basal (kg/ha)				N applied in split(kg/ha)		Total N applied (kg/ha)
		N	*P*	*K*	*Zn*	*I*	*II*	
T_1: Control	0	0	0	0	0	0	0	0
T_2: 50% dose of CF	156.2A	21.8	32.8	12.5	0.93	22	19.0	62.8
T_3: 75% dose of CF	234.3	32.8	49.2	18.7	1.40	33	28.5	94.3
T_4: 100% dose of CF*	312.5	43.7	65.6	25.0	1.87	44	38.0	125.7
T_5: 125% dose of CF	390.6	54.6	82.0	31.2	2.34	55	47.5	157.1
T_6: 150% dose of CF	468.7	*65.6*	*98.4*	*37.5*	*2.81*	*66*	*57.0*	*188.6*
T_7: RDF (Nutrient dose recommended for CG state)		50.0	60.0	40.0	0	25	25.0	100.0
T_8: RDF + 5 t FYM/ha	-	75.0	70.0	65.0	1.02	25	25.0	125.0

*(100% Customized fertilizer(312.5 kg ha^{-1}) contains N-P_2O_5-K_2O-Zn in the quantities of 14%, 21%, 8% and 0.6%, respectively)

available N (200.7 kg/ha) and available zinc (0.49 ppm), while, medium in available phosphorus (13.0 kg/ha) and high in available potassium (394.01 kg/ha). Field experiments were laid out in randomized block design (RBD) replicated thrice to evaluate the effect of a customized fertilizer (CF) product provided by M/s Nagarjuna Fertilizers and Chemical Limited, Hyderabad. The grade of CF (CF-11-12) was 14: 21:8:0.6 (N-P_2O_5-K_2O-Zn) and rate of CF was taken @ Rs11.25/kg.The data was analyzed by the method of analysis of variance as described by Gomez and Gomez (1984). The level of significance used in "F" test was given at 5%.Both experiments consisted of eight treatments (Table 1). The planting was done at a spacing of 20 cm x 10 cm. The different plant parts viz. grain and straw were grinded and analysed for N, P, K and Zn at harvest. Cost of production for all treatments was worked out on the basis of the prevailing input and market price of the produce. The economic returns and energy use with respect to rice yield were computed for the rice crop. The variety '*Mahamaya*' for rice crop was used as test crop. During the years of experimentation, the crop was transplanted on 25th July 2011 and harvested on 16th November 2011.

RESULTS AND DISCUSSION

Growth and yield attributes of rice

Customized fertilizer had significant effect on growth parameters such as plant height and dry matter accumulation (Table 2). Plant height at harvest was recorded highest (129.5 cm)under treatment 150% dose of CF and which was found at par with 125% dose of CF, 100% dose of CF and RDF + 5 FYM/ha. However, the dry matter accumulation was higher (43.9 g/ plant) with 150% dose of CF and which was found at par with 125% dose of CF. Important yield attributing characters such as total number of effective tillers/hill was recorded significantly maximum (8.2) under 150% dose of CF and it was found at par with 125% dose of CF and RDF + 5 FYM/ha. Panicle length (24.8) and filled grains/panicle (148.9) was also significantly highest under application 150% dose of CF. Sharma*et al.* (2013) also reported that to good response of rice to NPK & Zn application. In case of test weight, non-significantdifference was observed.

Yield of rice

Experimental results revealed that different doses of customized fertilizer brought significant improvement in yield. Among different treatment significantly higher grain yield (6.9 t/ha) was recorded under 150% dose of CF (T_6). Treatment 150% dose of CF (T_6) provide N, P, K & Zn in sufficient quantity to produce maximum yield, the required amount through Customized fertilizer showed the efficient response on rice yield (Chandrapala *et al.* 2010). From the observed data for grain yield compared with the application of recommended dose of fertilizer (RDF), 150% dose of CF, 125% dose of CF, 100% dose of CF, 75% dose of CF and RDF + 5 t FYM gave32, 20, 12, 1 and 9% more yield, respectively. The maximum straw yield (7.9 t/ha) was also recorded in 150% dose of CF which found at par with 125% dose of CF.Similar findings have been also reported by Dwivedi *et al.* (2014). The higher straw yield can be described to higher number of tillers and maximum leaf area. Whereas, the maximum harvest index was also observed under 150% dose of CF (46.39 %), harvest index mainly governed by grain yield and with respective straw yield. As we know that the higher grain yield may be due

Table 2: Growth, yield attributes and yields of rice as influenced by customized fertilizer

Treatment	Plant height (cm)	Dry matter accumulation (g/hill)	Effectivetillers/ plant (No.)	Panicle length (cm)	Filled grain /panicle (No.)	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (HI %)
T_1:Control	101.8	22.4	4.07	20.63	98.13	32.06	2.98	4.22	41.39
T_2:50% dose of CF	116.5	28.7	5.80	21.87	103.47	32.93	4.32	5.81	43.32
T_3:75% dose of CF	120.9	32.7	6.00	22.52	126.80	34.20	5.30	6.73	44.37
T_4:100% dose of CF	125.1	35.2	6.53	22.80	130.70	33.56	5.87	7.41	44.97
T_5:125% dose of CF	127.4	39.2	7.27	23.42	136.13	34.86	6.25	7.72	45.39
T_6:150% dose of CF	129.5	43.9	8.20	24.85	148.97	34.60	6.90	7.90	46.18
T_7:RDF	120.3	32.8	6.07	22.41	119.33	33.46	5.23	6.70	43.38
T_8:RDF + 5 t FYM/ha	124.5	36.0	7.33	23.62	136.60	34.63	5.69	6.84	44.71
SEm ±	2.56	1.61	0.29	0.35	5.65	0.62	1.65	1.97	0.35
CD (P = 0.05)	7.76	4.89	0.90	1.08	17.14	NS	5.01	5.98	1.06

Table 3: Available soil nutrient and Nutrient uptake of rice as influenced by customized fertilizer

Treatment	Available N (kg/ ha)	Available P (kg /ha)	Available K (kg /ha)	Available Zn(kg/ ha)	N uptake (kg/ha)		P uptake(kg/ha)		K uptake (kg/ha)		Zn uptake (g/ha)	
					Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1: Control	182.3	13.4	210.7	0.14	22.4	13.4	3.5	1.3	14.7	119.9	124.5	201.8
T_2: 50% CF dose	195.2	15.2	248.6	0.67	35.5	21.8	10.2	3.2	26.2	144.1	137.4	220.2
T_3: 75% CF dose	205.7	15.8	253.1	0.72	50.4	27.4	12.0	4.2	34.2	196.6	152.8	236.8
T_4: 100% CF dose	243.5	16.6	265.7	1.16	62.7	35.9	16.9	5.1	36.8	230.1	165.4	244.1
T_5: 125% CF dose	250.0	18.1	278.4	1.46	82.9	40.8	20.1	5.5	47.5	249.7	176.0	264.8
T_6: 150% CF dose	276.8	21.2	291.8	1.53	99.5	47.7	22.9	5.9	63.5	277.6	185.8	286.3
T_7: RDF	237.4	16.0	297.5	0.95	56.4	26.8	15.1	4.4	38.2	221.9	147.2	243.1
T_8: RDF +5 t FYM/ha	257.3	17.9	319.5	1.28	76.5	34.0	17.4	5.1	55.5	236.4	165.1	252.2
SEm±	11.8	0.7	12.6	0.08	1.58	0.95	0.40	0.11	0.65	8.51	3.79	5.16
CD (P = 0.05)	35.9	2.2	38.3	0.25	4.81	2.89	1.22	0.34	1.99	25.82	11.51	15.65

Table 4: Energetic study of rice as influenced by customized fertilizer

Treatment	EnergyInput (MJ x 10^{-3} /ha)	Net energy output (MJ x 10^{-3}/ha)	Energy use efficiency (MJ x 10^{-3}/ha)	Energy output: Inputratio
T_1: Control	4.25	92.25	16.93	22.70
T_2: 50% CF dose	8.52	127.26	11.85	15.94
T_3: 75% CF dose	10.65	151.44	11.29	15.21
T_4: 100% CF dose	12.78	166.13	10.39	13.99
T_5: 125% CF dose	14.91	173.48	9.37	12.63
T_6: 150% CF dose	17.05	183.16	8.68	11.74
T_7: RDF	11.24	149.42	10.61	14.29
T_8: RDF +5 t FYM/ha	13.04	156.17	9.61	12.98

to the application of sufficient nutrients in combination which resulted to greater availability of essential nutrients to plants, improvement of soil environment which facilitate in better root proliferation leading to higher absorption of water and nutrients and ultimately resulting in higher yield. Superiority of combined application of N, P, K, Zn and FYM over recommended fertilizer application was also reported by Reddy *et al*. (2009) and Mandal *et al*. (2004).

Available soil and uptake of NPK and Zn

The related with available soil nutrient and plant samples were analyzed for nitrogen, phosphorous, potassium and zinc at harvest (Table 3**).** Application of 150% dose of CF helped to accumulate the significantly higher N (276.8 kg ha^{-1}), P (21.2 kg ha^{-1}) and Zn (1.53 kg ha^{-1}) in soil over rest of the treatment. RDF + 5 t FYM (T_8) showed the highest amount of K (319.5 kg ha^{-1}) available in soil at harvest. In different treatments available N ranged from 182.3 to 276.8 kg ha^{-1}, available phosphorous ranged from 13.4 to 21.2 kg ha^{-1}, available K ranged from 210.7 to 319.5 kg ha^{-1} and available Zn ranged from 0.14 to 1.53 kg ha^{-1}. The similar finding was observed by Srinivas *et al*. (2010) and Bajpai *et al* (2006).The data indicate that the uptake of N, P, K and Zn were significantly higher under the application of 150 % dose of CF and minimum was observed under control. The higher nutrient uptake was mainly due to higher biological (straw + grain) yield. The similar findings have been also reported by Pandey *et al*. (2007).Application of customized fertilizer helps to provide essential nutrient to get the targeted yield. This shows that NPK and Zn combination is useful for rice growth and yield. Similar findings have been also reported for N, P, K and Zn by Singh (2006) and Das *et al*. (2003).

Energetic

The maximum net energy output was obtained under 150% dose of CF (T_6). However, in case of 150% dose of CF (T_6), output : input energy ratio and energy use efficiency was lower as compared to other treatment options due to higher energy input in terms of inorganic fertilizers.The maximum output : input energy ratio was observed under control treatment (T_1). Despite of lower energy output, the control treatment registered highest input: output energy ratio due to smaller quantum of energy consumed.

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