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Evaluation of fertilizer prescription equation in rice crop in relation to spillage water from iron ore mines at Darratola, Dist.- Balod

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Abstract

The present experiment entitled "Evaluation of fertilizer prescription equation in rice crop in relation to spillage water from iron ore mines at Darratola, Balod district" was conducted on during kharif season, 2021. The fertilizer prescription equation previously developed for rice variety MTU 1010 in STCR project as $FN = 4.05T - 0.57SN - 0.78 ON$, $FP_2O_5 = 1.46 T - 3.09 SP - 0.31 OP$ and $FK_2O = 1.61 T - 0.10 SK - 0.14 OK$ were validated on farmer's field with rice variety MTU 1010 the experimental field was laid out in randomized block design with three replications, consisting of seven treatments as Control (N₀P₀K₀), Farmer practice (80:40:20), GRD(100:60:40), GRD+Zn (100:60:40:5), STCR 50YT (92:44:66), STCR 60 YT (132:57:82) and STCR 60 q/ha YT +5 t/ha FYM (113:54:78). Results concluded that plant height, total number of effective tillers per hill and numbers of grains per panicle were recorded significantly higher with STCR 60 q/ha YT +5 t/ha FYM followed by STCR 60 q/ha. The highest grain and straw yield were recorded with treatment STCR 60 q/ha YT +5 t/ha FYM (113:54:78) and STCR 60 q/ha YT (132:57:82). The grain yields were achieved yield with + 10% variations under targeted yield based treatments STCR 60 q/ha YT +5 t/ha FYM, YT 50 and YT 60 q/ha due to different nutrient application as per yield target, so its proved that the fertilizer prescription equations developed previously were valid for rice crop. The total nutrient uptake and nutrient use efficiency (nitrogen and phosphorus) were observed in treatment STCR 60 q/ha YT +5 t/ha FYM, whereas potassium use efficiency was found higher in farmer practice. The highest B:C ratio was recorded in treatment STCR 60 q/ha YT and lowest in farmers practice.

Keywords: Economics, nutrient use efficiency, soil test crop response, target yield

Introduction

Rice (*Oryza sativa* L.) is staple food of millions of people and provide about 700 calories/day/person for about 3000 million people living mostly in developing countries. (Singh *et al.* 2017) [6]. India has the largest paddy output in the world and is also the largest exporter of rice in the world as of 2020. India has the largest rice area (43.77 million ha) in Asia, accounting 29.4 percent of the global rice area production of 116.4mt (Annual Report, Department of Agriculture Cooperation and Farmer Welfare 2019-2020). The costliest key inputs in knowing the yield productivity and yield potential of crops is fertilizers. The soil test crop response can be evolved as most appropriate balanced and economic doses of fertilizers. Rapid depletion in soil nutrient reserve has been seen in recent years which could be replenished by external supply. Taking into consideration the soil fertility status, productivity of fertilizer, crop requirement of nutrients, soil and organic source and the economic condition of crops, it is achievable to formulate a yield target oriented fertilizer schedule based on the principle of balanced nutrition of crops. In India, Ramamoorthy *et al.* (1967) [4] develop the theoretical basis and experimental proof for the fact that Liebig's law of minimum operates equally well for N, P, K and established relationship between the crop yield and soil test value. This forms the foundation of fertilizer application for target yields.

In these context a well known name in Chhattisgarh is DalliRajhara. DalliRajhara is a home of iron ore captive mines for Bhilai Steel Plant which is the largest integrated steel plant in India. DalliRajhara is located at 20.58°N 81.08°E which comes under district- Balod.

DalliRajhara is the twin mine and part of the Rajhara group of mines started in 1960. Iron ores mine of the study area are hematite and magnetite variety. The other mines in the neighbourhood produce dolomite, lime and other raw materials which go into steel production.

In continuation of mining over last 40 years in DalliRajhara, the spillage water flowing through small "nalas" in which mud like siltation deposited near places and farmers also uses these contaminated water as irrigation for their cultivated crops majorly in Rice. However, this contaminated water will put the impact on soil and existing crop positive or negative is a matter of research.

Materials and Methods

The present experiment was conducted at Darratola, Balod district during kharif season, 2021. The fertilizer prescription equation previously developed for rice variety MTU 1010 in STCR project as $FN = 4.05T - 0.57SN - 0.78 ON$, $FP_2O_5 = 1.46 T - 3.09 SP - 0.31 OP$ and $FK_2O = 1.61 T - 0.10 SK - 0.14 OK$ were validated on farmer's field with same variety. The experimental field was laid out in randomized block design with three replications, consisting of seven treatments as Control ($N_0P_0K_0$), Farmer practice (80:40:20), GRD (100:60:40), GRD + Zn (100:60:40:5), STCR 50YT (92:44:66), STCR 60 YT (132:57:82) and STCR 60 q/ha YT +5 t/ha FYM (113:54:78). The investigation was carried out by taking soil samples from different sites from farmer's field. Soil samples were collected from 0-15 cm depth with the help of screw-style augur. The experimental soil belongs to the soil order of *Vertisol* having clayey loam in texture. The soil fertility dynamics under various treatments were estimated by soil analysis of composite soil

sample from each plot before transplanting and after harvesting of crop. Some physico-chemical properties of experimental soil were analyzed which was found slightly acidic pH (5.7), 0.25 dsm^{-1} electrical conductivity (EC), 0.51% organic carbon, low (210 kg ha^{-1}) in available nitrogen, medium in phosphorus (18.3 kg ha^{-1}) and potassium (276 kg ha^{-1}) and available micronutrient Fe, Mn, Cu and Zn found in sufficient level (30.26, 25.18, 5.92, and 1.32 ppm respectively). Grain and straw samples were analyzed for N, P and K content as per standard procedures (Piper 1966) [3].

Result and Discussion

Growth and yield attributes

Results concluded that plant height, total number of effective tillers per hill and numbers of grains per panicle were recorded significantly higher with STCR 60 q/ha YT +5 t/ha FYM followed by STCR 60 q/ha while test weight of grains showed non-significant difference due to different nutrient management practices (Table 1). The highest grain and straw yield were recorded with treatment STCR 60 q/ha YT +5 t/ha FYM (113:54:78) and STCR 60 q/ha YT (132:57:82) which were statistically at par and significantly higher than rest of treatments. Treatments STCR 50 q/ha YT, GRD + Zn and GRD gave almost similar grain yield and significantly higher than farmers practice dose and control. The grain yields were achieved yield with + 10% variations under targeted yield based treatments STCR 60 q/ha YT +5 t/ha FYM, YT 50 and YT 60 q/ha due to different nutrient application as per yield target, so it proved that the fertilizer prescription equations developed previously were valid for rice crop. Similar result also reported by Krishna *et al.*, (2019) [2].

Table 1: Effect of different organic manures and inorganic fertilizers on growth and yield attributes of rice

S. No.	Treatment	Plant height (cm)	No. of tillers per hill	No. of grain per panicle	Test weight(g)	Grain yield (q/ha)	Straw yield (q/ha)
1	Control (0:0:0)	104.8 ^c	3.73 ^c	110.46 ^b	25.80	22.19 ^d	27.68 ^d
2	Farmer practice (80:40:20)	119.7 ^b	5.00 ^b	136.58 ^a	27.88	40.07 ^c	47.6 ^c
3	GRD(100:60:40)	124.07 ^{ab}	6.15 ^a	144.93 ^a	27.10	48.7 ^b	60.47 ^b
4	GRD + Zn (100:60:40:5)	124.87 ^{ab}	6.27 ^a	146.92 ^a	28.57	49.17 ^b	62.47 ^b
5	STCR 50 q/ha YT (92:44:66)	123.93 ^{ab}	6.08 ^a	144.18 ^a	27.60	47.5 ^b	58.94 ^b
6	STCR 60 q/ha YT (132:57:82)	127.27 ^a	6.49 ^a	148.7 ^a	27.88	55.57 ^a	70.7 ^a
7	STCR 60 q/ha YT +5 t/ha FYM (113:54:78)	127.4 ^a	6.54 ^a	150.2 ^a	28.44	56.27 ^a	72.07 ^a
	SEm±	1.932	0.219	4.084	0.871	1.464	2.052
	CD (p=0.05)	5.952	0.676	12.583	NS	4.511	6.323

Nutrient uptake

The highest total N P and K uptake were found in treatment STCR 60YT+ 5 t/ha FYM (81.63 kg/ha, 18.26 kg/ha, 118.27 kg/ha) and lowest was observed in control plot (44.49 kg/ha,

7.81 kg/ha and 49.75 kg/ha). Similarly, total Fe, Mn, Cu and Zn uptake in treatment STCR 60YT+ 5 t/ha FYM (944.81 g/ha, 815.52 g/ha, 629.73 g/ha, 173.11 g/ha) and the lowest value was observed in control plot.

Table 2: Effect of different sources of organic manure and inorganic fertilizer on nitrogen, phosphorous and potassium uptake (kg/ha) in rice

S. No.	Treatment	Nutrient uptake (kg/ha)		
		Nitrogen	Phosphorus	Potassium
1	Control (0:0:0)	44.49 ^c	7.81 ^d	49.75 ^d
2	Farmer practice (80:40:20)	70.37 ^b	14.76 ^c	85.55 ^c
3	GRD(100:60:40)	75.48 ^{ab}	17.58 ^{ab}	99.56 ^b
4	GRD + Zn (100:60:40:5)	75.67 ^{ab}	17.98 ^a	102.3 ^b
5	STCR 50 q/ha YT (92:44:66)	73.86 ^{ab}	15.49 ^{bc}	103.53 ^b
6	STCR 60 q/ha YT (132:57:82)	81.18 ^a	17.57 ^{ab}	116.26 ^a
7	STCR 60 q/ha YT +5 t/ha FYM (113:54:78)	81.63 ^a	18.26 ^a	118.27 ^a
	SEm±	2.54	0.74	3.48
	CD (p=0.05)	7.82	2.29	10.73

Table 3: Effect of different sources of organic manure and inorganic fertilizer on micronutrient uptake (g/ha) in rice

S. No.	Treatment	Micro nutrient uptake			
		Fe Uptake (g/ha)	Mn Uptake (g/ha)	Cu Uptake (g/ha)	Zn uptake (g/ha)
1	Control (0:0:0)	360.71 ^d	306.36 ^d	242.5 ^d	64.53 ^d
2	Farmer practice (80:40:20)	624.65 ^c	539.75 ^c	417.1 ^c	112.81 ^c
3	GRD(100:60:40)	778.03 ^b	661.45 ^b	523.2 ^b	143.58 ^b
4	GRD + Zn (100:60:40:5)	778.03 ^b	704.49 ^b	545.8 ^b	151.19 ^b
5	STCR 50 q/ha YT (92:44:66)	790.6 ^b	662.54 ^b	522.2 ^b	140.22 ^b
6	STCR 60 q/ha YT (132:57:82)	901.71 ^a	793.98 ^a	619.5 ^a	167.41 ^a
7	STCR 60 q/ha YT +5 t/ha FYM (113:54:78)	944.81 ^a	815.52 ^a	629.7 ^a	173.11 ^a
	SEm±	33.54	21.41	21.10	4.84
	CD (p=0.05)	103.34	65.97	65.01	14.91

Nutrient Use Efficiency

The maximum nitrogen use efficiency was recorded in T₇- STCR +FYM (60YT) (32.87%) and lowest in T₆- STCR 60 q/ha YT (27.80%). Highest P use efficiency was recorded at treatment T₇-(19.35%) which involve STCR +FYM (60YT) and lowest in T₃- GRD (16.28%) followed by T₄-GRD +

Zn(16.94%). The highest potassium use efficiency was recorded at treatment T₂- farmer practice (179.01%) and lowest in T₆- STCR 60 YT (81.11%) followed by T₅- STCR 50 q/ha YT (81.49%). Similar findings were also reported in rice by Sahu *et al* (2017)^[5], Beena *et al.* (2018)^[1].

Table 4: Effect of different nutrient management practices on nutrient use efficiency (%) of rice

S. No.	Treatment	N (%)	P(%)	K(%)
1	Control (0:0:0)	-	-	-
2	Farmer practice (80:40:20)	32.36	17.37	179.01
3	GRD(100:60:40)	31.00	16.28	124.53
4	GRD + Zn (100:60:40:5)	31.18	16.94	131.38
5	STCR 50 q/ha YT (92:44:66)	31.93	17.43	81.49
6	STCR 60 q/ha YT (132:57:82)	27.80	17.12	81.11
7	STCR 60 q/ha YT +5 t/ha FYM (113:54:78)	32.87	19.35	87.85

Economics

The gross return was found higher in treatment STCR 60 q/ha YT +5 t/ha (Rs. 109157) followed by STCR 60 YT (Rs.107799) and lowest in control plot (Rs. 43042). In case of net return, higher returns were found in treatment STCR 60 YT (Rs. 66396)

followed by STCR 60 q/ha YT +5 t/ha FYM (Rs. 65288) and lowest was recorded in control plot (Rs. 9042). The highest B:C ratio was recorded in treatment STCR 60 YT (1.60) followed by STCR 60 q/ha YT +5 t/ha FYM (1.49) and lowest was recorded in control plot (0.27).

Table 5: Effect of different nutrient management practices on economics of rice crop

S. No.	Treatment	Cost of cultivation	Gross return(Rs/ha)	Net return(Rs/ha)	B:C Ratio
1	Control (0:0:0)	34000	43042	9042	0.27
2	Farmer practice (80:40:20)	37781	77729	39948	1.06
3	GRD(100:60:40)	39748	94478	54730	1.38
4	GRD + Zn (100:60:40:5)	41036	95383	54347	1.32
5	STCR 50 q/ha YT (92:44:66)	39678	92150	52472	1.32
6	STCR 60 q/ha YT (132:57:82)	41403	107799	66396	1.60
7	STCR 60 q/ha YT +5 t/ha FYM (113:54:78)	43869	109157	65288	1.49

Conclusion

The study revealed that grain yields were achieved yield with + 10% variations under targeted yield based treatments STCR 60 q/ha YT +5 t/ha FYM, YT 50 and YT 60 q/ha due to different nutrient application as per yield target, so its proved that the fertilizer prescription equations developed previously were valid for rice crop. Target yield equations generated from STCR-IPNS technology ensures not only sustainable crop production and maintenance of soil fertility but also economise use of costly fertilizer inputs.

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