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Targeted yield equations of wheat crop for acid Alfisol soil of Jharkhand

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Abstract
An experiment was conducted in the experimental plot of Birsa Agricultural University Ranchi in the year on wheat crop. Soil type of the site was acid Alfisol. Three strips each of 24 sub-plots were created to develop 3 distinct fertility gradients, low medium and high during Kharif season to take test crop as wheat during Rabi season. Soil Test Crop Response (STCR) equations were developed for Targeted yield of wheat, cultivar K1006 in the acidic soil. Available nitrogen, phosphorus and potash along with uptake of NPK were estimated to before calculation of STCR fertilizer prescribed equations for targeted yield. A Ready Reckoner for different Soil Test Value for targeted yield of 50 q/ha and 60 q/ha of wheat crop, cv. K 1006 in acidic soil of Jharkhand were estimated.

Keywords: STCR, wheat, acid soil, targeted yield, fertilizer and soil status

Introduction
Maize commonly known as makka or locally, Bhutta is heavy nutrient feeder which was sown to create fertility gradient during Kharif 2016 in STCR plots. It is a very popular cereal crop in entire districts of Jharkhand. Immature maize (before drying of grain) is used in snacks in roasted form in north and north-east India. It is cultivated in both season Kharif and Rabi in Jharkhand state. Kharif crop is doing better in Jharkhand in production point of view. Due to its high nutritive importance, photo-insensitive crop, several eating form and wide range of soil suitability, maize is very famous crop among tribals in Jharkhand state. Keeping in view of its importance, maize crop was sown in experimental plots of STCR in Ranchi centre during Kharif 2016 to create fertility gradient.

Review of Literature
Soil test based yield targeted equation, which need to be establish a relationship between the status of soil available nutrients determined in the laboratory and crop response to the fertilizer applied in the field. In this regard, targeted yield equation approach had been found to be the beneficial to recommend balanced fertilizer considering the available soil nutrient status and crop yield requirement. Application of different levels of fertilizers (NPK) based on targeted yield approaches influences the growth and yield of several crops. In the present study an effort has been made to create the targeted yield equations of wheat in acid Alfisol soil of Jharkhand based on available soil nutrient status.
Singh *et al.* (2023) [6] conducted an experiment at 5 locations of Naugarh block of Chandauli, UP during Rabi season of 2019 to test the STCR model. Patil *et al.* (2018) [4] took the supply factor into consideration for the prescription of different doses of fertilizer for various crops.

Biradar *et al*. (2012) [1] used a formula to estimate the fertilizer nutrients required to achieve the targeted yield through site specific nutrient management (SSNM) given as nutrients required for the crop = Target yield (q ha^{-1}) × Nutrient removal by a crop (kg q^{-1}). Thus, nutrients required = Target yield (q ha^{-1}) × Nutrient removal (kg q^{-1}).

Materials and Methods

A field experiment was conducted in the experimental site of the department of soil Science of Birsa Agricultural University Ranchi in the year 2016-17. Soil type of the site was acid Alfisol. Three strips each of 24 sub-plots were created to develop 3 distinct fertility gradients, low medium and high during *Kharif* season to take test crop as wheat during *Rabi* season. In the present experiment, selected field was divided into 3 strips horizontally. The front strip of the experimental plot were control and was not given any fertilizer. All the plots of second strip receives RDF dose of N, P and K whereas all the plots of third strip were given double dose of RDF so that a distinct gradient of fertility status of soil may be created among these 3 strips. Each strips was sub-divided into 24 sub-plots whose size was 6 m X 3 m per plot and recommended dose of fertilizer as 120:60:40 NPK for wheat crop (cultivar K1006) during *Rabi* season to develop STCR fertilizer prescribed equations for targeted yield of the crop. Row spacing was 22 centimeter with seed rate of 125 kg per hectare.

Post harvested soil samples were collected for the analysis of available nitrogen, phosphorus and potash. Uptake of NPK was also determined in the laboratory following the standard methods of estimation.

Available nitrogen was estimated by distillation of soil with alkaline potassium permanganate and determining the ammonia liberated as per method suggested by Subbiah and Asija (1956) [7].

Available phosphorus was extracted with Bray P1 extractant (0.03 N NH4F in 0.025 N HCL solution) and was determined Bray and Kurtz (1945) as described by Jackson (1973) [3] on a double beam digital Spectrophotometer (Spectrascan UV 2600).

Available potassium was determined by using 1N NH_4 OAC (pH 7.0) extractant in soil to solution ratio of 1:10 w/v with the help of Flame Photometer (CL-361) (Woodruff and McIntosh, 1960) [8].

In STCR project, Targeted yield approach suggested by Ramamoorthy, *et al*. (1967) [5] and fertilizer prescribed equations was adopted. There are three basic data which is essential to be calculate and utilized for the calculation of STCR fertilizer prescribed equations for targeted yield:

a. NR (Nutrient requirement) in kg/q of produce, grain or other economic produce
b. CS (Percent contribution) from the soil available nutrients and
c. Cf (Percent contribution) from the applied fertilizer nutrients in the soil (Ramamoorty *et al.* 1967) [5].

The above mentioned three parameters can below calculated as follows

$$NR\ (\text{Kg of nutrient/ q of grain}) = \frac{\text{Total uptake of nutrient (kg)}}{\text{Grain yield (q)}}$$

$$CS\ (\%\ \text{contribution from soil}) = \frac{\text{Total uptake in control plots (kg/ha)}}{\text{Soil test values of nutrient in control plots } (\frac{\text{kg}}{\text{ha}})} \text{X100}$$

Cf = Total uptake of nutrients in treated plots – STV of nutrients in fertilizer treated plots × CS

$$\text{Percent contribution from Fertilizer} = \frac{Contribution\ from\ fertilizer}{\text{Fertilizer dose}} \text{X100}$$

Calculation of the fertilizer dose (Fertilizer Adjustment Equation)

The above base data are being transformed into workable adjustment equation as follows:

Fertilizer dose= $\frac{\text{Nutrient requirement in kg/q of grain}}{\%Cf}$ X100 X T - $\frac{\%CS}{\%Cf}$ X STV (kg/ha) = a constant × yield target (q /ha) − b constant × soil test value (kg/ha)

Whereas, T is the Targeted Yield of the crop

Results and Discussion

In the Table 2, maximum grain yield of wheat (cultivar K1006) was observed 63.67 q/ha in the fertility strip plot III. This highest yield was observed where maximum fertilizer was given. However, lowest yield of the wheat grain was observed in the front line of strips, particularly 6.67 q/ha when no fertilizer was applied in the plot.

Table 1 indicate the treatment plan of 3 strips; low, medium and high before sowing of test crop wheat in such a way that total amount of applied NPK fertilizer in each strip become equal.

Table 1: Treatment plan: Fertilizer used for wheat

Plot	Strip I Treatment code	Strip II Treatment code	Strip III Treatment code
	N1P1K1	N2P1K2	N2P1K2
2..	N2P0K2	N2P2K2	N1P2K1
3.	N2P2K3	N1P2K1	N3P1K1
4.	N2P2K0	N3P3K2	N3P3K1
5.	N3P1K1	N3P2K1	N3P3K3
6.	N3P2K2	N2P3K3	N2P2K2
7.	N3P2K3	N0P2K2	N0P0K0
8.	N3P3K1	N0P0K0	N3P2K3
9.	N1P2K1	N2P2K1	N2P3K2
10.	N0P0K0	N2P0K2	N2P1K1
11.	N1P2K2	N1P2K2	N3P2K1
12.	N2P3K3	N3P3K1	N1P1K1
13.	N2P2K1	N2P3K2	N0P0K0
14.	N2P1K1	N0P0K0	N1P1K2
15.	N3P3K2	N2P2K0	N2P2K0
16	N0P0K0	N3P2K3	N2P0K2

17.	N1P1K2	N1P1K1	N3P3K2
18.	N2P2K2	N3P1K1	N0P0K0
19.	N0P0K0	N2P1K1	N1P2K2
20.	N3P2K1	N2P2K3	N3P2K2
21.	N0P2K2	N0P0K0	N2P2K3
22.	N3P3K3	N3P3K3	N2P3K3
23.	N2P3K2	N1P1K2	N2P2K1
24.	N2P1K2	N3P2K2	N0P2K2

Parenthesis plan for above table

	N (kg/ha)	P2O5 (kg/ha)	K2O (kg/ha)
0	0	0	0
1	60	30	20
2	120	60	40
3	180	90	60

Table 2: Wheat (cultivar K1006) grain yield (q/ha) under STCR experimental field

Treatment code	Strip I	Treatment code	Strip II	Treatment code	Strip III
$N_1P_1K_1$	32.78	$N_2P_1K_2$	42.22	$N_2P_1K_2$	50.22
$N_2P_0K_2$	28.33	$N_2P_2K_2$	43.44	$N_1P_2K_1$	42.56
$N_2P_2K_3$	37.78	$N_1P_2K_1$	36.67	$N_3P_1K_1$	51.56
$N_2P_2K_0$	35.56	$N_3P_3K_2$	55.44	$N_3P_3K_1$	58.61
$N_3P_1K_1$	36.11	$N_3P_2K_1$	54.56	$N_3P_3K_3$	63.67
$N_3P_2K_2$	43.33	$N_2P_3K_3$	50.56	$N_2P_2K_2$	53.78
$N_3P_2K_3$	40.56	$N_0P_2K_2$	15.44	$N_0P_0K_0$	16.22
$N_3P_3K_1$	41.11	$N_0P_0K_0$	11.44	$N_3P_2K_3$	60.44
$N_1P_2K_1$	35.56	$N_2P_2K_1$	41.67	$N_2P_3K_2$	54.12
$N_0P_0K_0$	8.89	$N_2P_0K_2$	45.66	$N_2P_1K_1$	49.17
$N_1P_2K_2$	37.78	$N_1P_2K_2$	35.44	$N_3P_2K_1$	55.56
$N_2P_3K_3$	39.17	$N_3P_3K_1$	52.89	$N_1P_1K_1$	36.94
$N_2P_2K_1$	35.56	$N_2P_3K_2$	47.56	$N_0P_0K_0$	18.22
$N_2P_1K_1$	35.89	$N_0P_0K_0$	13.39	$N_1P_1K_2$	37.50
$N_3P_3K_2$	47.32	$N_2P_2K_0$	43.78	$N_2P_2K_0$	48.33
$N_0P_0K_0$	6.94	$N_3P_2K_3$	56.11	$N_2P_0K_2$	49.00
$N_1P_1K_2$	27.78	$N_1P_1K_1$	34.44	$N_3P_3K_2$	61.33
$N_2P_2K_2$	34.12	$N_3P_1K_1$	50.78	$N_0P_0K_0$	17.67
$N_0P_0K_0$	6.67	$N_2P_1K_1$	41.78	$N_1P_2K_2$	38.33
$N_3P_2K_1$	38.89	$N_2P_2K_3$	43.72	$N_3P_2K_2$	56.78
$N_0P_2K_2$	12.89	$N_0P_0K_0$	14.67	$N_2P_2K_3$	54.33
$N_3P_3K_3$	48.67	$N_3P_3K_3$	57.78	$N_2P_3K_3$	55.56
$N_2P_3K_2$	40.89	$N_1P_1K_2$	40.56	$N_2P_2K_1$	52.56
$N_2P_1K_2$	37.66	$N_3P_2K_2$	55.56	$N_0P_2K_2$	20.78
Mean	32.93	Mean	41.06	Mean	45.97
Range	42.00	Range	46.34	Range	47.45

Wheat equation
STCR Prescribed equations for Acidic soil of Jharkhand
Crop: Wheat
Variety: K 1006

Table 3: Development of *fertilizer prescribed equation* for wheat (K 1006)

Parameters	NR kg/q.	CS %	CF %	Fertilizer Prescription Equations
N	1.48	18.52	35.66	$FN = 4.15\ T - 0.52\ SN$
P_2O_5	0.08	8.85	3.595	$FP_2O_5 = 2.23\ T - 2.46\ SP_2O_5$
K_2O	0.44	8.34	23.129	$FK_2O = 1.90\ T - 0.36\ SK_2O$

Fertilizer Prescription Equations

Calculation of fertilizer dose based on different nutrient status of soil was calculated using NR (Nutrient requirement), CS (Percent contribution) and Cf (Percent contribution) from the applied fertilizer nutrients in the soil indicated in Table 3. As per the equations written above in Table 3 a Ready-Reckoner was calculated and depicted in Table 4 for the ease of farmers/scientist to get a targeted yield of wheat crop as per the nutrient status of soil. Here, for the example, 2 Target were fixed 50 q/ha and 60 q/ha. If soil available nitrogen, phosphorus and potash will be 150 kg/ha, 10 kg/ha and 90 kg/ha respectively, then to get a target of 50 q/ha yield of wheat, farmers/scientist should apply 129.50 kg N/ha, 86.90 kg P_2O_5/ha and 62.60 kg K_2O/ha. Similarly, a person can

apply other doses of fertilizer as per the nutrient status of soil and target yield of wheat. So a Ready Reckoner table for different Soil Test Value for targeted yield of 50 q/ha and 60 q/ha of wheat crop, cv. K 1006 in acidic soil of Jharkhand is being depicted in Table 4.

Table 4: Ready Reckoner table for different Soil Test Value for targeted yield of 50 q/ha and 60 q/ha of wheat crop, cv. K 1006 in acidic soil of Jharkhand

Fertilizer Recommendation Schedule for Yield Target (50 q/ha & 60 q/ha) at different Soil Test Value								
Soil Available Value			**Fertilizer Nutrients Required (Kg/ha) for Yield target of**					
Kg/ha			**50 q/ha**			**60 q/ha**		
N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
150	10	90	129.50	86.90	62.60	171.00	109.20	81.60
160	12	100	124.30	81.98	59.00	165.80	104.28	78.00
170	14	110	119.10	77.06	55.40	160.60	99.36	74.40
180	16	120	113.90	72.14	51.80	155.40	94.44	70.80
190	18	130	108.70	67.22	48.20	150.20	89.52	67.20
200	20	140	103.50	62.30	44.60	145.00	84.60	63.60
210	22	150	98.30	57.38	41.00	139.80	79.68	60.00
220	24	160	93.10	52.46	37.40	134.60	74.76	56.40
230	26	170	87.90	47.54	33.80	129.40	69.84	52.80
240	28	180	82.70	42.62	30.20	124.20	64.92	49.20
250	30	190	77.50	37.70	26.60	119.00	60.00	45.60
260	32	200	72.30	32.78	23.00	113.80	55.08	42.00
270	34	210	67.10	27.86	19.40	108.60	50.16	38.40
280	36	220	61.90	22.94	15.80	103.40	45.24	34.80
290	38	230	56.70	18.02	12.20	98.20	40.32	31.20
300	40	240	51.50	13.10	8.60	93.00	35.40	27.60

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