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Effect of soil test based nutrient management on crop yield, nutrient requirement and relationship between nutrient uptake and yield of mustard (*Brassica campestris*) in Alfisol

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Abstract
A field experiment was conducted based on STCR methodology on mustard with the variety '*Indira Toriya* - 1' in Re-inforced resovable block design (RRBD) plot sized 7x3 m with the spacing of 50x20 cm at research farm of Shaheed Gundadhoor College of Agriculture and Research Station Jagdalpur, Chhattisgarh during *Rabi* 2014-15. The field was prepared without any disturbance to the already created three fertility gradient strips (L_0, L_1, L_2). Then each strip was subdivided into 24 plots of equal size. A set of 24 treatments out of which 21 treatments in combination with four levels of nitrogen (0, 50, 100 and 150 kg ha^{-1}), four levels of phosphorus (0, 30, 60 and 90 kg ha^{-1}) four levels of potassium (0, 30, 60 and 90 kg ha^{-1}) and three levels of FYM (0, 5, 10 t ha^{-1}) and three controls were superimposed to different plots in each strip. The result showed that the yield of mustard increased with increasing nutrient addition. The nutrient requirement for production of one quintal mustard grain was 4.25:1.08:3.31 kg N:P:K and the relationship between crop yield and nutrient uptake was linear.

Keywords: STCR, mustard, crop yield, Alfisol, Bastar platue

Introduction
Rapeseed-mustard (*Brassica campestris*) is a major oilseed crop contributing important share in oilseed production in the country. Production of rapeseed and mustard declined from 8.03 MT in 2012-13 to 6.82 MT in 2015-16 (Anonymous 2016-17) [1]. There are several reasons behind such yield reduction including poor soil nutrient status. Soil fertility declination under continuous cropping has been witnessed which need to be restored for sustaining and increasing crop yield. Soil fertility restoration can effectively be achieved by integrated management of nutrient sources (Joshi *et al*., 2017) [6], but due to lack of proper knowledge of method and time of manuring and fertilizer application; the cost of cultivation increased. Soil fertility maintenance required adequate knowledge of soil nutrient status, fertilizer efficiency soil efficiency, time and methods of fertilizer application.
Adoption of soil test crop response (STCR) suggested by Ramamoorthy *et al*. (1967) [8] is efficient approach concerning all aspects of nutrient management. Supplying of plant nutrients based on STCR approach significantly improved crop yield as well as soil health (Rajput *et al*. 2016) [7] and is very important for yield sustainability and reducing fertilizer cost (Saxena *et al*., 2008) [9]. Implementation of inductive approach of STCR in Chhattisgarh may reduce cost of cultivation and may also encourage smart and strategic nutrient management practices.
There has not often been focused on such approach for nutrient management in mustard crop in this area. Thus, keeping above facts in view the present study was carried out to assess the effect of STCR approach on: (i) Grain yield of mustard (ii) nutrient requirement of mustard crop and (iii) relationship between nutrient uptake and crop yield.

Materials and methods
A field experiment was conducted based on STCR methodology on mustard with the variety '*Indira Toriya* - 1' at research farm of Shaheed Gundadhoor College of Agriculture and Research Station Jagdalpur, Chhattisgarh during *Rabi* 2014-15. The area is under forest and natural vegetative cover and occurs on gently sloping subdued plateaus, as well as on upper and lower piedmonts with different physiographic settings. The climatic condition is sub-humid type with average annual rainfall of 1440 mm and the soil type is Alfisol, Kaolinitic,

Isohyperthermic, Typic Haplustalfs. The plot size was 7x3 m with the spacing of 50x20 cm. The field was prepared without any disturbance to the already created three fertility gradient strips (L_0, L_1, L_2). Then each strip was subdivided into 24 plots of equal size. A set of 24 treatments out of which 21 treatments in combination with four levels of nitrogen (0, 50, 100 and 150 kg ha^{-1}), four levels of phosphorus (0, 30, 60 and 90 kg ha^{-1}) four levels of potassium (0, 30, 60 and 90 kg ha^{-1}) and three levels of FYM (0, 5, 10 t ha^{-1}) and three controls were superimposed to different plots in each strip and the experiment was conducted in a Re-inforced resovable block design (RRBD). Initial soil samples were collected from each sub-plot (0-15cm) before superimposition of 21 fertilizer treatments and three controls were analyzed for available nitrogen by alkaline potassium permanganate method (Subbiah and Asija, 1956) [10], available phosphorus (Bray method, 1948) [3] and available potassium by ammonium acetate method (Hanway & Heidal, 1952) [4] as described by Jackson (1973) [5]. The plant samples grain as well as straw sample collected at harvesting stage has been analyzed for N, P and K and the plant uptake of nutrients was calibrated by using grain and straw yield data. The experiment was conducted on the basis of whole field method in which the data of all plots were used in deriving the estimates. The computational procedure of basic data well discussed in Ramamoorthy *et al*. (1967) [8]. The efficiencies of fertilizer, soil test and FYM were estimated by using the conventional methods with the help of software developed by AICRP on STCR, Indian Institute of Soil Science, Bhopal (MP). The nutrient requirement can be given by the regression coeffîcient (b1) of yield (Y) and total nutrient uptake (U)

$Y = b1\ U$ or $U = 1/b1 * Y$

Where, 1/ b1 gives the NR.
The nutrient requirement (NR) was also estimated by the conventional method as given below:

$$NR\ (kg\ q^{-1}) = \frac{\text{Total Nutrient Uptake (kg ha}^{-1})}{\text{Grain yield in q ha}^{-1}}$$

Result and Discussion

Effect of soil test based nutrient management on grain yield of mustard

The mustard yield was recorded in the range from 1.62 to14.90 q ha^{-1} with an average yield of 9.61 q ha-1. It was observed that standard deviation (SD) and coefficient of variation (CV%) were higher in L_0 strip and declined under L_1 and L_2 strip in both the crop season indicating thereby that yield variations were higher in L_0 strip due to variation in soil nutrient concentration. The increase in mustard yield with respect to fertility strips may be due to fertility gradient in soil P status from L_0 to L_2 (Table 1). Verma *et al*. (2017) [11] also recorded 15.74, 16.65 and 17.75 q ha^{-1} average yield of mustard grain under I, II and III strips. Yield of grain was greater when nutrient doses were increased which resembled with the result of this experiment.

Effect of soil test based nutrient management on nutrient requirement of mustard

Nutrient requirements for mustard crops have been estimated based on conventional and regression methods which are almost similar values and are shown in the Table (2). The amount of nutrient required to produce one quintal of mustard grain was found to be 4.25 kg N, 1.08 kg P and 3.31 kg. This parameter gives better results with the regression method which is being followed in present study. Several workers have reported the nutrient requirement of different crops at various places. Verma *et al*. (2017) [11] reported that the nutrient requirement for the production of one quintal of mustard grain was 5.22 kg of nitrogen (N), 0.99 kg of phosphorus (P2O5) and 4.25 kg of potassium (K2O). Similarly, 5.08:1.24: 3.96 kg of N:P:K required for producing one quintal grain of yellow sarson was also found by Avtari *et al*. (2010) [2].

Relationship between nutrient uptake and grain yield of mustard

The amount of nutrients absorbed by the crop is directly related to biomass production. Nutrient requirements for direct seeded rice and mustard crops have been estimated based on conventional and regression methods which are almost similar values and are shown in the Table 3 and depicted graphically in Figs. 1 to 3 showing a close association between crop yields and nutrient uptake with almost a linear relationship. The values clearly indicated that the yield of mustard grain was increased with increasing level of NP and K.

4.5 Efficiencies of fertilizer, soil test and FYM

The fertilizer efficiencies of N, P and K for mustard crop were estimated as 35.78, 23.61 and 61.50 per cent, respectively. The efficiencies of soil test were recorded as 6.20% N, 24.34%P and 4.06% K. The efficiencies of organic source (FYM) were observed as 5.16, 4.77, 2.79 per cent N, P and K respectively (Table 4). It is well known that approximate 2/3rd of the applied fertilizer N lost through leaching, volatilization, de-nitrification and by run-off. Similarly, a large fraction of applied fertilizer P is fixed in soil by reacting with dominant cations present in the soil like Fe, Mn, Ca, Mg etc. High efficiency of applied fertilizer K observed seems to be due to higher uptake of this nutrient as luxury consumption. Ramamoorthy *et al.* (1967) [8] reported the efficiency of soil N, P and K were 37, 14 and 44.0 per cent, respectively and the efficiency of fertilizer N, P and K were 34, 41 and 36 per cent, respectively.

Table 1: Range and mean of grain yields of mustard during *Rabi* season, 2014-15 in relation to fertility strips.

Fertility Strips	Grain Yield (q ha^{-1})			SD	CV (%)
	Minimum	Maximum	Average		
L_0	1.6	13.1	8.9	3.8	42.7
L_1	2.1	14.3	9.8	3.9	39.8
L_2	3.1	14.9	10.2	3.7	36.3
All strips	1.6	14.9	9.61	3.8	39.5

Table 2: Nutrient requirement for mustard crop

Nutrient	Nutrient requirement (kg q-1)
N	4.25
P	1.08
K	3.31

Table 3: Relationship of mustard yield (Y) with total nutrient uptake (U)

Nutrient	$Y = b_1 U$	R2
N	y = 0.2346 UN	0.9703
P	y = 0.9722 UP	0.8955
K	y = 0.2996 UK	0.9362

Table 4: Efficiencies of fertilizer, soil and FYM for mustard crop.

Parameters	N	P	K
Fertilizer Efficiency (%) Ef	35.78	23.61	61.50
Soil Test Efficiency (%) Es	6.20	24.34	4.06
FYM Efficiency (%) Eorg	5.16	4.77	2.79

*Efficiency of K exceeded 100% due to higher uptake of K as luxury consumption.

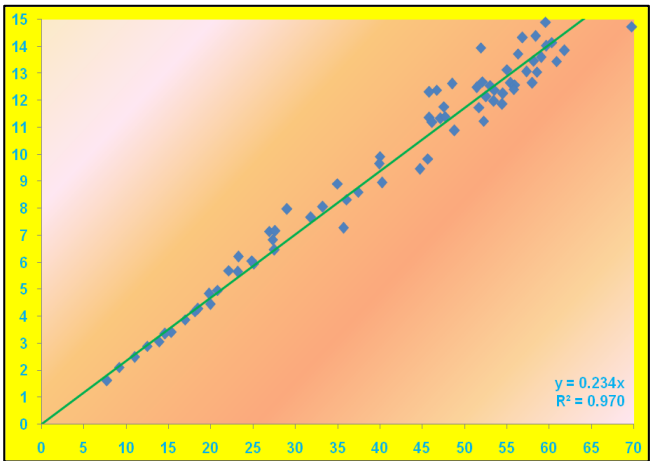

Fig 1: Relationship between mustard grain yield and N uptake.

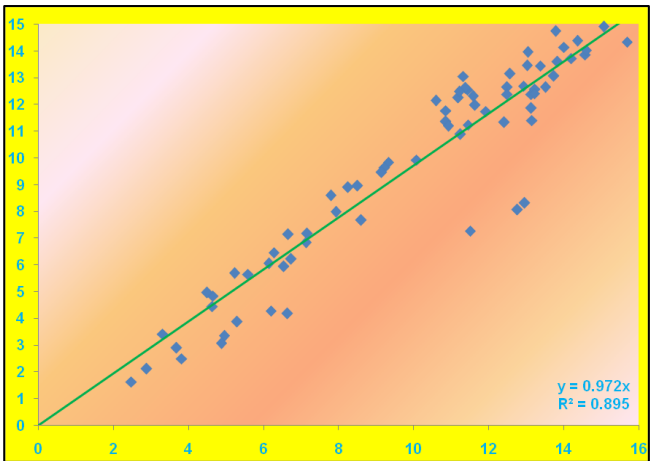

Fig 2: Relationship between mustard grain yield and P uptake

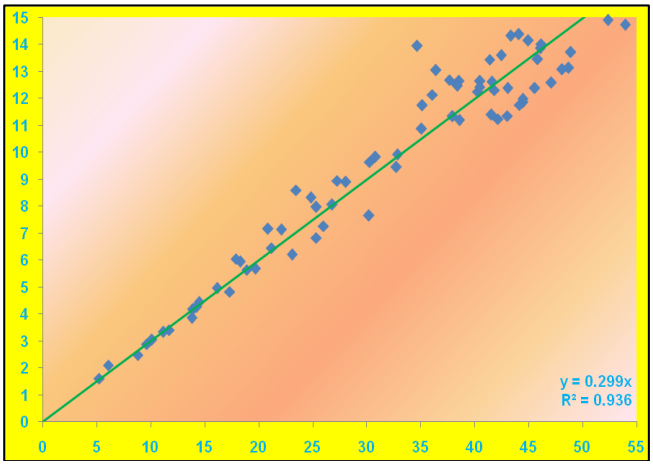

Fig 3: Relationship between mustard grain yield and K uptake

Conclusion

Adoption of STCR approach for plant nutrient management showed better response to added nutrients. The yield of mustard increased with increasing nutrient addition. The nutrient requirement for production of one quintal mustard grain was 4.25:1.08:3.31kg N:P:K and the relationship between crop yield and nutrient uptake was linear. The above experiment suggested that implementation of STCR approach for Mustard crop under Bastar platue of Chhattisgarh is very helpful for efficient and strategic nutrient management in this region.

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