CALIBRATION OF SOIL TEST BASED BALANCE FERTILIZATION WITH FYM FOR CHICKPEA [CICER ARIETINUM] IN VERTISOL

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A field experiment was conducted during rabi 2013 in Vertisol at Instructional farm of Indira Gandhi Agricultural University; Raipur (C.G) to study the calibration of soil test based balance fertilization with FYM for chickpea in Vertisol. The objectives of the study were to estimate the nutritional requirement, efficiencies of fertilizer, soil test and organic source (FYM), to estimate the fertilizer requirement for varying yield goals of Chickpea crop based on soil test levels using INM approach. Chickpea, crop required 0.47 kg S, 0.46 kg P and 2.40 kg K to produce one quintal of grain. Fertilizer and Soil test efficiencies estimated were 12.06 and 21.53 percent, respectively for sulphur, 10.01 and 30.03 percent, respectively for P and 38.62 and 5.40 percent, respectively for K. The FYM contribution for S, P and K nutrients were estimated 1.93, 4.42 and 7.19 percent, respectively. Based on these basic parameters, fertilizer adjustment equation for different yield targets of chickpea based on soil nutrients level using FYM as INM component.

In India Chickpea is grown in area of 8.56 million ha with an annual production of 7.35 million tonnes and productivity 858 kg/ha (Anon., 2012). India ranks first in Chickpea (Cicer arietinum) production. The fertilizer application practices based on targeted yield approach indicated the possibility of enhancing production potential of chickpea crop.

Several approaches have been used for fertilizer recommendation based on chemical soil test so as to attain maximum yield per unit of fertilizer use. Among the various approaches, the targeted yield approach has been found popular in India. Targeted yield concept is based on quantitative idea of the fertilizer needs based on yield and nutritional requirement of the crop, percent contribution of the soil nutrients and that of applied fertilizer. This method not only estimates the soil test based fertilizer dose but also the level of farmer's yield can achieve with that particular dose. Application of fertilizer by the farmers in the field without the knowledge of crop requirement may cause adverse effect on soils and crop owing to imbalanced fertilization. The imbalance use of fertilizer has further aggravated the multiple nutrient deficiencies, specially sulphur (S) which is most vital for the growth and development of chickpea crop and resistance to abiotic and biotic stress.

Continuous use of inorganic nutrients without organic source may adversely affect the physico-chemical property of soil and thereby affect the crop yields. In recent years, there has been increasing recognition of the importance of the organics as a source of nutrients due to growing ecological concern and depleting inherent soil fertility. Organic manures offer the twin benefits of increase in organic matter content and improvement in physical, chemical and microbiological properties of soil while meeting a part of nutrient needs of the crop. The present study was undertaken to develop balanced fertilizer schedule with FYM application for desired yield targets of chickpea in Vertisols of Chhattisgarh state.

MATERIAL AND METHODS

A field experiment was carried out during rabi season, 2013 in Vertisol at the Instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) to study the soil test crop response correlation with chickpea (JG-130). The experimental soil is locally known as Kanhar and represents Arang II series and classified as typical fine montmorillonitic, hyperthermic, udic Chromustert. The soil was clayey in texture, dark brown in color, pH 8.03, Organic carbon 5.80 g kg⁻¹, EC 0.18 dSm⁻¹ and CEC 36.32 Cmol (p+) kg⁻¹. The available S, N, P and K status of the representative sample were 25.85, 238, 19.3 and 486 kg ha⁻¹, respectively. The inductive-cum fertility gradient approach of Ramamurthy et al. was followed for conducting the experiment. Three fertility gradients were created by dividing the experimental field in to three equal strips and denoted as L₀, L₁, and L₂ which were fertilized with

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N, P, K, N, P, K and N, P, K levels. These fertility gradients were fertilized as L₀: no N, P, O₃ and K₂O, L₁: 100:75:50 kg ha⁻¹ and L₂: 200:150:100 kg ha⁻¹ N, P₂O₅ and K₂O, respectively. The sources of N, P and K were used as Urea, SSP, and MOP, since SSP contains sulphur (12%) along with phosphorus hence, variations with respect to soil sulphur in three fertility strips were estimated and soil N was not considered due to leguminous crop (chickpea) under study. After the harvest of soybean crop, the experiment with chickpea was carried out in subsequent rabi season. Soybean crop was grown during kharif season 2013. After the harvest of the soybean crop, all strips were divided in to three equal sizes across the fertility gradient and FYM levels (0, 5 and 10 t ha⁻¹) were imposed in each fertility gradient that was treated as block. Twenty one selected fertilizer treatments (SₐPₐKₐ) plots having different combinations of S (0, 10, 20 and 30 kg ha⁻¹), P₂O₅ (0, 30, 60 and 90 kg ha⁻¹) and K₂O (0, 30, 60 and 90 kg ha⁻¹) were randomly distributed in three blocks of each strip along with three control (N₀P₀K₀) plots having seven treatments in each block with one control. Bentonite sulphur, single super phosphate and muriate of potash were used as a source of fertilizer S, P and K. Plot wise soil samples were collected before application of fertilizer and FYM treatments. Soil samples were analysed for available S (0.15% CaCl₂ extractable-S), P (Olsen) and K (neutral normal ammonium acetate extractable K). The yield data of grain and straw for all the plots were recorded at crop maturity stage. Grain and straw samples were analysed for S, P and K content and nutrient uptake was computed.

Using the data on grain yield, nutrient uptake, pre-sowing soil available nutrients and applied fertilizer doses, basic parameter, viz. nutrient requirement (kg q⁻¹), contribution of nutrients from soil and fertilizer sources were estimated as described by Ramamoorthy et al. (1967). The contribution of nutrients from applied FYM was estimated by relating the yield with fertilizer nutrients and FYM. These parameters were used for the formulation of fertilizer adjustment equations based on varying soil nutrients level using FYM as IPNS approach. A representative sample of FYM applied was analysed for nutrient content as 0.40, 0.30 and 1.00 per cent N, P and K, respectively.

RESULTS AND DISCUSSION

Establishment of Fertility Gradient

Soil available nutrients: The range and mean values of available nutrients (S, P and K) (Table-1) indicate that soil test S, P and K varied with different fertility strips although soil test S and K variations with respect to fertility strip were marginal however, soil P variation in different fertility strips were quite marked and it increased across the fertility strips.

Crop response to applied fertilizers nutrients: Table-2 shows the range and averages of chickpea yield in relation to different fertility strips. It was observed from the results that there was increasing trends in chickpea yields from L₀ to L₂ fertility strips due to increasing P level. Highest yield of 23.51 q ha⁻¹ was observed in L₂ strip with a good response to the application of highest dose of fertilizer and 7.33 qha⁻¹ was observed in the L₁ strip without fertilizer (Control). It was observed that standard deviation (SD) and coefficient of variation (CV%) were higher in L₀ strip and declined under L₁ and L₂ strip indicating thereby that yield variations were higher in L₀ strip due to soil nutrients variation.

The crop responses to the application of fertilizer S, P, K and FYM have been depicted in Figs.-4-7 which showed that good crop responses to the fertilizer S and P application were observed. Crop response to K application was also observed but had less consistent. Crop response to FYM application was not quite marked.

Relation of grain yield with soil test and fertilizer nutrients:

The relation of chickpea yields with different plant nutrients as independent variables were derived by regression analysis to evaluate the yield variations due to various nutrients and presented in the Table-3. Results indicate that the larger proportion of variation in grain yields of chickpea was accounted for by S and P. Good crop response to applied S may be attributed to the higher S requirement and medium level of S status in experimental field. It is accessible to the plant in the root surface sorption zone. Fertilizer P and K were the next to explained the rest of variations. The P ions react very quickly with soil constituents to form insoluble compounds and are thus rendered immobile in the soil. Furthermore the requirement of P nutrient in chickpea was lower than S. Application of fertilizer S and P explained the 84 % yield variation and by
Fig. 1: Relationship between Chickpea grain yield and total S uptake.

Fig. 2: Relationship between Chickpea grain yield and total P uptake.

Fig. 3: Relationship between Chickpea grain yield and total K uptake.

Fig. 4: Chickpea grain yield response to fertilizer S application.

Inclusion of fertilizer K did not contribute much variation in grain yield of chickpea. The yield variation due to FYM application was accounted very poor correlation.

**Estimation of basic parameters:** Basic parameters include nutrients requirement (kg/q), efficiencies of fertilizer, soil test and organic source of S, P and K for the formulation of balanced fertilizer adjustment equations with organic source. Results presented in Table 4 show the nutrient requirement (NR) for S, P and K (kg q⁻¹), efficiencies of fertilizer (Ef), Soil test (Es) and FYM. The Chickpea required about 0.47 kg S, 0.46 kg P and 2.40 kg K to produce one quintal of chickpea grain. Fertilizer efficiencies for S and P were less than soil test efficiencies.
Contrary to this, fertilizer efficiency for K was observed higher than soil test efficiencies. The efficiency of FYM for K was found to be higher and minimum was observed with S.

Development of fertilizer adjust equation and ready reckoner for targeted yield of Chickpea: Using the basic parameters estimated soil test based fertilizer prescription equations were developed for desired yield target of chickpea for the range of soil test values and yield goals; ready reckoner is prepared for SPK with 5 tonnes of FYM as given in Table-5. The ready reckoners show that the fertilizer requirement decreases with increase in soil test values. Therefore, a slightly lower yield target may be considered for poor farmers. This can be illustrated taking an example to achieve a yield target of 14 q/ha and if soil test values for 0.15% CaCl$_2$ extractable-S, Olsen’s-P and 1N NH$_4$-Ac extractable-K were estimated as 16:12:300 kg/ha, respectively then amounts of fertilizer S, P$_2$O$_5$ and K$_2$O would be required as 25 kg S/ha, 26 kg P$_2$O$_5$/ha and 44 kg K$_2$O/ha, respectively.

**Fertilizer adjustment equations based on response data:**

\[
FS = 3.89Y - 1.79SS - 0.16FYM \\
FP = 4.60Y - 3.00SP - 0.44FYM \\
FK = 6.22Y - 0.14SK - 0.19FYM
\]

Where, FS, FP and FK are fertilizer S, P$_2$O$_5$ and K$_2$O (kg ha$^{-1}$) respectively. FYM is Farm Yard Manure (t ha$^{-1}$). SS, SP and SK are soil test values (kg ha$^{-1}$) for, 0.15% CaCl$_2$ extractable-S, Olsen’s P and ammonium acetate extractable-K and Y is crop yield in q ha$^{-1}$.

Such kind of fertilizer prescription equations for different crops (rice, wheat, maize, mustard, rapeseed) have also been documented by earlier workers$^{6-7}$.

In the present investigation, presence of adequate variability in Chickpea grain yield and S, P and K uptake was observed due to operational range of soil test values. Variation in soil fertility is major pre-requisite and underlying principle for
development of soil test based fertilizer recommendations. 0.15% CaCl$_2$ extractable-S were found to be the highest in strip II(L$_1$) followed by strip III(L$_2$) and least in strip I(L$_0$) and Olsen's P and ammonium acetate extractable-K were found to be the highest in strip III(L$_2$) followed by strip II(L$_1$) and the least in strip I(L$_0$). The marked fertility gradient build up was reflected in terms of grain yield and nutrient uptake. Similar kind of trend for mean nutrient uptake was observed in the experiment. Similar experiment was carried out by Mahajan et al. (2013) with wheat crop. The results of the present experiment was in agreement with the results reported by earlier workers$^{8-10}$.

**Fertilizer prescription equation:** Fertilizer prescription equations were developed in the present study for S, P and K recommendation in chickpea. Such kind of fertilizer prescription equations for different crops (rice, wheat, maize, mustard, rapeseed) have been documented by earlier workers$^9$.

**CONCLUSION**

The soil test based fertilizer prescription equation with IPNS developed for chickpea crop could be used for making fertilizer recommendation for targeted yield of chickpea (Var. JG-130 ) in Vertisols of Chhattisgarh. Fertilizer recommendations based on this concept are more quantitative, precise and meaningful because combined use of soil and plant analysis is involved in it. By adopting this technique, farmers can choose the yield target according to their resources and management conditions. The use of fertilizer prescription equations considering nutrient requirement (0.47 kg S, 0.46 kg P and 2.40 kg K), percentage contribution from soil (21.53, 30.03 and 5.40 for S, P and K respectively), fertilizer (12.06, 10.01 and 38.62 for S, P and K respectively) and FYM (1.93, 4.42 and 7.19 for S, P and K) to total uptake ensured balanced nutrient supply to soybean crop. Target yield equations generated from STCR -IPNS technology ensure not only sustainable crop production but also economize use of costly fertilizer inputs. Practice of fertilizing crops using fertilizer prescription equations needs to be popularized among farmers to achieve higher productivity, nutrient use efficiencies and profitability.

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**REFERENCES**