Agri Mirror: Future India
Vol 1 Issue 1: May 2020

STCR (Soil Test Crop Response) – An Approach Towards Integrated Nutrient Management

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Introduction

Soil is an integral part of the natural resources on earth and is considered as a prime source of nutrients for the crops. Maintenance of soil health and quality is crucial for enhancing crop productivity and to feed the growing human population on earth. Fertilizers are one of the costliest inputs used in agriculture for increasing the soil fertility but use of correct amount of fertilizer is fundamental for agricultural sustainability and environmental protection. Without any information about the soil fertility status and crop nutrient requirement, farmers are dumping fertilizers in the field. This has led to either nutrient toxicity or nutrient deficiency by overuse of one nutrient and underuse of the other nutrient and this has caused adverse effects on soil and crop productivity.

It is established by various authors that use of organic manures or use of chemical fertilizers alone cannot achieve agricultural sustainability in the present farming system. Therefore, in order to maintain soil fertility and to maintain good soil health, it is necessary to use organic manures. Integrated plant nutrient management system which includes site-specific knowledge of crop nutrient requirement, nutrient supply from the soil, nutrient supply from the fertilizer and recovery efficiency of applied fertilizers are required for maintenance of soil fertility. At the same time, it can aid in meeting the ultimate goal of balanced fertilization. Applying various inputs more specifically fertilizers based on soil testing could help in using the various inputs judiciously.

Historical Perspective

The most appropriate method for balance fertilization is targeted yield approach. Target yield approach is known as soil test crop response approach**.** This approach is the basis for optimum resource utilization and balanced crop nutrient management. Fertilizer application based on soil test is a useful tool and fertilizer prescription equation is a unique technology to optimize need-based fertilizer application.

The concept of fertilizer prescription equation for desired yield target was first given by Troug, 1960. Subsequently, Ramamoorthy, 1967 established the theoretical basis and experimental technique to suit Indian conditions showing the linear relationship between yield and nutrient uptake. For a given quantity of yield of any crop, fertilizer requirement can be estimated considering efficiency of soil and fertilizer nutrients. Subsequently, ICAR started AICRP on Soil Test Crop Response (STCR) to develop soil test-based fertilizer recommendation for different crops. The project was initiated in 1967-68 by eminent soil scientists, Dr. B. Ramamurthy and Co-workers, at IARI, New Delhi, with eight centres at other locations. During 1970-71, five more centers were added. Fertilizer recommendations based on target yield as proposed by Ramamoorthy is different from the other approaches as it not only indicates soil test-based fertilizer dose but also the yield level that can be attained if appropriate management practices are followed in the crop production. Targeted yield approach also provides the scientific basis for balanced fertilization not only between the nutrients applied from the external sources but also with soil available nutrients.

Methodology

The basic data which is required for formulating fertilizer recommendation for targeted yield are-

1. Nutrient requirement (NR) in kg/quintal of produce
2. Percentage contribution from the soil available nutrient (CS)
3. Percentage contribution from the applied fertilizer nutrient (CF)
4. Percentage contribution from organic source (CFYM)

The above-mentioned parameters are calculated as:

1. *Nutrient requirement (NR)*:

$$\text{NR} = \frac{\text{Total uptake of nutrient}}{\text{Grain yield}}$$

2. *Per cent contribution from soil available nutrients (CS)*:

$$\text{CS} = \frac{\text{Total nutrient uptake in control plots (kg / ha)}}{\text{Soil test value of nutrient in control plots (kg / ha)}} \times 100$$

3. Per cent contribution from added fertilizers (CF):

$$\text{CF} == \frac{(\text{Total uptake of nutrients in treated plots}) - \left(\text{STV of nutrient in treated plots x}\frac{\text{Cs}}{100}\right)}{\text{Amount of nutrient added as fertilizer (kg / ha)}} \times 100$$

4. *Per cent contribution from organic sources (CFYM):*

$$\text{CFYM} = \frac{(\text{Total uptake of nutrients in FYM treated plots}) - (\text{STV of nutrient in FYM treated plots x CS}/100}{\text{Amount of nutreint added as FYM (kg / ha)}} \times 100$$

In STCR experimentation there are two approaches deductive and inductive approach. In the deductive approach, since different levels of soil fertility is not expected to occur at a single place, therefore, normally different sites are selected to represent different levels of soil fertility and the inference is deduced and applied in general. In the Inductive Approach of STCR field experimentation, variations in soil fertility is created deliberately at a single place in the same field experiment. This approach reduces the heterogeneity in the soil type, management practices adopted and climatic conditions.

STCR experimentation is conducted under three phases –

1. Development of fertility gradient – In this phase, a field which is representative of the major soil type in a region is selected and fertility gradient is developed in it by dividing it into equal strips. The first strip receives no fertilizer and subsequently increasing the standard dose of N, P and K in the other strips such that a gradient ranging from low to high is created. Then, a short duration exhaust crop is grown so that the nutrients undergo transformations in the soil with plant and microbial activity as a result of interaction between them.

2. Test crop is grown - After harvest of this exhaust crop, each of the strips is divided into sub plots. Selected treatment combinations of N, P and K and FYM in addition to controls are randomly allocated in each of the strips and the test crop for which soil test calibration is required is grown to maturity following standard agronomic practices. Before application of fertilizers, soil samples are collected from each sub plot and analyzed for available nutrients by defined soil test methods. After harvest, grain and straw yield and total nutrient uptake are also determined.

NR, CS, CF and CFYM were calculated with the help of soil & applied fertilizer nutrient, crop yield and nutrient uptake of grain and straw. Equations for fertilizer requirement of nitrogen, phosphorus and potassium for targeted yield are worked out as follows:-

Fertilizer requirement equations for nutrients through use of chemical fertilizer are worked out

as -

$$FN = (NR/CF) \times 100\ T - (CS/CF) \times SN$$

$$FP = (NR/CF) \times 100\ T - (CS/CF) \times SP$$

$$FK = (NR/CF) \times 100\ T - (CS/CF) \times SK$$

Fertilizer requirement equations for nutrients through conjoint use of chemical fertilizer and FYM are worked out as –

$$FN = (NR/CF^*) \times 100\ T - (CS/CF^*) \times SN - (CFYM/CF^*) \times M$$

$$FP = (NR/CF^*) \times 100\ T - (CS/CF^*) \times SP - (CFYM/CF^*) \times M$$

$$FK = (NR/CF^*) \times 100\ T - (CS/CF^*) \times SK - (CFYM/CF^*) \times M$$

Where,

FN = Fertilizer nitrogen (kg N ha^{-1})
FP = Fertilizer phosphorus (kg P ha^{-1})
FK = Fertilizer potassium (kg K ha^{-1})
NR = Nutrient requirement of nitrogen, phosphorus and potassium
CF = Percent contribution of concerned nutrient from fertilizer
CF* = Percent contribution of concerned nutrient from FYM.
CS = Percent contribution of concerned nutrient from soil
CFYM = Percent contribution of concerned nutrient from FYM
T = Targeted yield (q ha^{-1})
SN = Soil test value for available nitrogen (kg ha^{-1})
SP = Soil test value for available phosphorus (kg ha^{-1})
SK = Soil test value for available potassium (kg ha^{-1})
M = Concerned nutrient content in organic matter

Then, statistical analysis was carried out and target yield equation was developed by fitting up of multiple regression equation

3. Verification or follow up trial – The target yield equation developed is then verified at different locations for validity of the equation and target yield.

Conclusion

There is a difference between "Fertilizing the soil" and "Fertilizing the crop" and Soil test crop response-based fertilizer recommendation maintains the real balance between the applied fertilizer nutrients among themselves and with the soil available nutrients. Based on this concept, soil test crop response studies have been undertaken in different parts of India in various crops like wheat, rice, pearl millet**.** Application of plant nutrients based on soil test helps in realizing higher response ratio because nutrients are applied taking into consideration the deficiency of that particular nutrient. In return, this helps in correction of the nutrient imbalance in soil and also helps to harness the synergistic effects of balanced fertilization.

References

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