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RESEARCH ARTICLE :

Soil test crop response (STCR) approach as an optimizing plant nutrient supply on yield and economics of Bt Cotton

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SUMMARY : STCR approach for target yield is unique in indicating both soil test based fertilizer dose and the level of yield that can be achieved with good agronomic practices. A field experiment was conducted to validate the STCR equation developed for Bt Cotton crop of cuddapah soils of Andhra Pradesh. It was observed that the highest yield of 30.03 q/ha was obtained in treatment T_3 (Targeted yield of 30 q ha^{-1} with chemical fertilizers+ VC 5 t ha^{-1}) over farmers practice (27.71 q/ha). Even the B:C ratio was more in T_3 compared to farmers practice.

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BACKGROUND AND OBJECTIVES

Cotton (*Gossypium* spp.) is an important commercial fibre crop grown under diverse agro-climatic conditions and is called as a "white gold" and also as "king of fibre" crops contributing 85 per cent of raw materials to textile industry. It plays a vital role in the country's economic growth by providing substantial employment and making significant contributions to export earnings. India ranks first in area (11.95 m. ha^{-1}) of cotton on a global scale and is the second largest producer of cotton in the world after China accounting for about 18 per cent of the world cotton production (36.5 m bales). The productivity of cotton lint is 540 kg per ha which is much lower than the world average of 766 kg per ha (Anon., 2014). At present genetically modified cotton is widely accepted by Indian farmers. Out of 110.0 lakh ha area, 88% area (96.14 lakh ha) is occupied by Bt cotton hybrids.

The rising prices for fertilizers and other inputs are of increasing concern for farmers as fertilizer management has an important impact on the profitability of cotton production (Bazen *et al.*, 2007). Also, cotton cultivation of late is proving to be less remunerative enterprise primarily because of high cost of production due to indiscriminate use of pesticides and fertilizers (Tayade and Dhoble,

2010). In the prevailing regime of widespread negative nutrient balances, it is difficult to expect depleted soils to support bumper crops or yield high growth rates, even in a superior hybrid or a genetically modified crop. In the era of precision agriculture, the concept of "Soil test based fertilizer recommendation harmonizes the much debated approaches namely, "Fertilizing the soil versus "Fertilizing the crop ensuring for real balance (not apparent balance) between the applied fertilizer nutrients among themselves and with the soil available nutrients. Truog (1960) illustrated the possibility of „Prescription method of fertilizer use for obtaining high yields of corn using empirical values of nutrient availability from soil and fertilizer. However, Ramamoorthy and his associates established during 1965-67 the theoretical basis and field experimental proof and validation for the fact that Liebig s Law of Minimum of Plant nutrition operates equally well for N, P and K for the high yielding varieties of wheat, rice and pearl millet, although it is generally believed that this law is valid for N and not for P and K which were supposed to follow the percentage sufficiency concept of Mitscherlich and Baule and Mitscherlich and Bray. Among the various methods of formulating fertilizer recommendations, the one based on yield targeting is unique in the sense that this method not only indicates soil test based fertilizer dose but also the level of yield the farmer can hope to achieve, if good cultivation package is followed.

Recommendation to Bt Cotton crop is 55kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}. However, sandy loam soil with poor soil fertility and also depletion of soil nutrients due to low organic matter in soil is resulting in poor Bt cotton yields. Adequate fertilizer application is considered as most important factor in enhancing yield of Bt Cotton crop through different fertilizer applications such as general recommended dose of fertilizer, soil test based recommendation, critical value approach etc. The soil test crop response (STCR) approach for targeted yield is unique in indicating both soil test based fertilizer dose and the level of yield that can be achieved with good management practices. In order to sustain the yield and reduce the cost of fertilizers and in turn cost of cultivation, the STCR approach is very important (Saxena *et al.*, 2008 and Chatterjee *et al.*, 2010). Targeted yield approach stricken a balance between fertilizing the crop and fertilizing the soil (Sonar *et al.*, 1982). The yield targeted STCR equation for Bt Cotton crop was developed for cuddapah soils of Andhra Pradesh. Bt Cotton is one of the major crop in Cuddapah district and farmers are applying inadequate and imbalanced fertilizers.

RESOURCES AND METHODS

The present investigation was taken up to evaluate and validate the STCR equation developed for Bt Cotton crop. STCR approach was adopted to conduct the field experiment at Agricultural Research Station, Utukur, Cuddapah, Andhra Pradesh, India. Composite soil sample was drawn from the experimental site at 0-15 cm depth prior to laying out of experiment. The soil samples were analyzed by adopting standard procedures (Nitrogen - Subbaiah and Asija method (1956), Phosphorus - Olsen *et al.* (1954), Potassium - Jackson (1973).

The soil was slightly alkaline in reaction (7.8), non saline (0.180 dS m^{-1}) low in available nitrogen (138 kg ha^{-1}), medium in phosphorus (25 kg ha^{-1}) and medium in available potassium (150 kg ha^{-1}). The experiment was laid out in randomized block design with the following four treatments and 5 replications.

T_1: RDF (55-60-60)

T_2: Cotton targeted yield of 30 q ha^{-1} with chemical fertilizers

T_3: Cotton targeted yield of 30 q ha^{-1} with chemical fertilizers + VC 5 t ha^{-1}

T_4: Farmer's Practice (180:150:60)

The fertilizer adjustment equation was developed in Bt Cotton for Cuddapah district soils by STCR scheme, AICRP on STCR, Agricultural Research Institute, Rajendranagar, Hyderabad was used for validation of that equation with other fertilizer practices

Fertilizer adjustment equation adopted :

$FN = 8.15\ T - 0.57\ SN - 0.39\ VC\ N$

$FP_2O_5 = 2.95\ T - 2.80\ SP - 1.28\ VC\ P$

$FK_2O = 5.92\ T - 0.66\ SK - 0.77\ VC\ K$

Using the above fertilizer adjustment equations the quantity of fertilizer nutrients required for achieving 30 q ha^{-1} of Bt Cotton were worked out and quantity of fertilizers applied to each treatment as per STCR equation is presented in Table A.

OBSERVATIONS AND ANALYSIS

Bt Cotton has recorded highest yield in T_3 treatment over farmers practice (T_4) and recommended dose of

Table A: Fertilizers applied to each treatment in sunflower

Treatment	Nutrient (kg/ha) $N\text{-}P_2O_5\text{-}K_2O$
T_1: RDF (55-60-60)	55-60-60
T_2: Cotton targeted yield of 30 q ha^{-1} with chemical fertilizers	55-18-47
T_3: Cotton targeted yield of 30 q ha^{-1} with chemical fertilizers + VC 5 t ha^{-1}	46-18-43
T_4: Farmer's Practice (180:150:60)	73- 95 -24

Table 1: Effect of different approaches on Seed cotton yield (q ha^{-1}) of Bt Cotton during 2014-15

Treatments	Yield (q ha^{-1})
T_1: RDF (55-60-60)	25.25
T_2: Cotton targeted yield of 30 q ha^{-1} with chemical fertilizers	27.64
T_3: Cotton targeted yield of 30 q ha^{-1} with chemical fertilizers + VC 5 t ha^{-1}	30.03
T_4: Farmer's Practice (180:150:60)	27.71

Table 2: Effect of different approaches of fertilizer application on BC ratio

Treatment	B:C ratio 2014-15
T_1: RDF (55-60-60)	2.68
T_2: Cotton targeted yield of 30 q ha^{-1} with chemical fertilizers	3.23
T_3: Cotton targeted yield of 30 q ha^{-1} with chemical fertilizers + VC 5 t ha^{-1}	2.78
T_4: Farmer's Practice (180:150:60)	2.41

fertilizer (T_1).The per cent increase in T_3 over T_4 was 7.72%. The increase in yield due to application of fertilizers based on different approaches was attributed to the increase in growth and yield attributes as a consequent of improved nutrient supply and efficiency of applied fertilizers in soil (Apoorva *et al.*, 2010, Debarati and Poonam, 2013, Tegegnework *et al.*, 2015).The deviation in seed yield obtained from that of desired targeted yield of 30 qha^{-1} was -7.86 in T_2. This indicated that the fertilizers applied along with VC for targeted yield of ~~22~~ 30 q ha^{-1} recorded higher seed yields without any negative deviation in all seasons than targeted yield of ~~22~~ 30 q ha^{-1} with chemical fertilizers alone.

Conclusion :

The results revealed that application of fertilizers based on STCR equation for target yield of 30 q ha^{-1} recorded highest yield in T_3, respectively over T_4 and T_1. However, the STCR equation for targeted yield of 30 q ha-1 in Bt Cotton could be achieved in Cuddapah district soils.

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