Studies on Creation of Operational Range of Soil Fertility to Evolve Fertilizer Prescription Equations under Soil Test Crop Response Correlation Studies on Rainfed Bt Cotton

ABSTRACT

To derive fertilizer prescription equations for rainfed Bt cotton within the framework of Soil Test Crop Response (STCR) studies, a meticulously designed gradient experiment was executed at the esteemed Cotton Research Station located in Perambalur district, Tamil Nadu, India. Employing a targeted yield methodology, the investigation centered on the cultivation of fodder sorghum as the exhaustive crop during the kharif season.

Adhering to an inductive-cum-yield target approach, the experimental plot was meticulously partitioned into three equitably-sized strips, each delineating a distinct fertility gradient. These gradients were meticulously established through the application of varying fertilizer regimes: N0P0K0, N1P1K1, and N2P2K2. Notably, the recommended fertilizer regimen (N1P1K1) encompassed precise quantities of essential nutrients, specifically 60 kg ha-1 of nitrogen (N), 345 kg ha-1 of phosphorus pentoxide (P2O5), and 96 kg ha-1 of potassium oxide (K2O).

Fodder sorghum emerged as the strategic choice for the exhaustive crop, strategically cultivated to expedite the transformation of applied fertilizers within the soil matrix, leveraging both plant and microbial processes. The overarching objective of this methodological approach was to establish a discernible operational range of soil fertility across the designated fertility strips. This was meticulously evaluated through meticulous analyses of variations in fodder yield uptake and pertinent soil test values.

Keywords: Fertility gradient; fertilizer prescription equations and fodder sorghum

INTRODUCTION

The current levels of fertilizer production in India fall short of meeting the comprehensive plant nutrient requirements necessary to sustainably support the burgeoning population of the nation. The persistent and indiscriminate application of chemical fertilizers has emerged as a pressing concern, posing threats to the long-term sustainability of agricultural production and exacerbating environmental degradation. This phenomenon is compounded by imbalanced and inadequate fertilizer utilization, alongside the diminishing efficacy of other agricultural inputs in response to added nutrients, particularly in the context of intensive agricultural practices.

Bt cotton, a pivotal commercial cash crop within India, commands the largest acreage globally, spanning 95.30 lakh hectares, with a productivity of 553 kg lint ha-1, thereby ranking second in production (310 lakh bales) after China during the 2007-08 period. However, its productivity continues to lag behind the global average (642 kg ha-1). Despite India's preeminence in terms of area under cultivation, it ranks third, following the USA and China, in terms of production. A significant proportion of foreign exchange (amounting to Rs. 50,000 crores) is derived from cotton and textile exports.

The prevailing fertilizer application practices underscore the latent potential for augmenting the production capacities of rainfed Bt cotton. Consequently, it is imperative to undertake meticulous assessments of soil fertility and crop requirements prior to fertilization endeavors. Such endeavors necessitate an inductive-cum-targeted yield approach, as pioneered by Ramamoorthy et al. (1967), which furnishes a scientifically sound framework for achieving balanced fertilization not only across various fertilizer nutrients but also in harmony with the prevailing soil nutrient profiles (Subba Rao and Srivastava, 1999).

Despite the widespread cultivation of Bt cotton in the Perambalur district of Tamil Nadu, India, there exists a notable dearth of Soil Test Crop Response (STCR) studies in this domain. Thus, the present study was conceived with the explicit aim of establishing soil fertility gradients within the experimental domain, operationalizing a nuanced approach to balanced fertilization through the judicious amalgamation of organic and inorganic fertilizers, predicated on a targeted yield paradigm.

MATERIALS AND METHODS

The experimental field possesses a clayey loam texture, with a pH level of 8.1 and an electrical conductivity (EC) of 0.30 dSm-1. Soil analysis revealed low availability of nitrogen, medium levels of phosphorus, and potassium. It is classified as a deep Vertisol of the Pilamedu series (Typic Haplusterts).

To introduce fertility variations, a gradient experiment was conducted using fodder sorghum as the exhaustive crop before initiating the main test crop experiment involving BRAHMA BG-II. Initially, a composite soil sample was collected from the experimental field and analyzed for nutrient status, as well as phosphorus and potassium fixing capacities.

The standard dose of nitrogen (N1) was determined based on blanket recommendations, while phosphorus (P1) and potassium (K1) doses were established according to the soil's fixing capacities for these nutrients. The experimental field was divided into three equal strips, each measuring 627 m2, designated as N0P0K0 (strip I), N1P1K1 (strip II), and N2P2K2 (strip III), to create distinct fertility gradients. Prior to fertilizer application and sowing the gradient crop, eight pre-sowing soil samples were collected from each strip, totaling 24 samples. Strip I received no fertilizer, while strip II received 60 kg ha-1 of nitrogen, 345 kg ha-1 of phosphorus pentoxide (P2O5), and 96 kg ha-1 of potassium oxide (K2O). Strip III received single and double doses of the standard N1P1K1 regimen. Fodder sorghum was sown, and regular agronomic practices were implemented as per crop production guidelines. Harvesting occurred after two months, with yields recorded for each strip.

Post-harvest, soil samples were collected from each fertility strip and analyzed to assess the impact of graded fertilizer applications on available nitrogen, phosphorus, and potassium levels.

RESULTS AND DISCUSSIONS

Green Fodder Yield and Nutrient uptake

In strip I, where no fertilizers were applied (N0P0K0), the green fodder yield of sorghum amounted to 12.2 t ha-1. Comparatively, in strips II and III, the yields were notably higher at 32.7 t ha-1 and 42.7 t ha-1, respectively. The corresponding nitrogen uptake by the crop exhibited an escalating trend, with values of 29.25 kg/ha, 58.86 kg/ha, and 66.61 kg/ha in strips I, II, and III, respectively. Similarly, phosphorus uptake followed a similar pattern, with values of 6.30 kg/ha, 17.46 kg/ha, and 20.49 kg/ha in strips I, II, and III, respectively. Potassium uptake mirrored this trend, with quantities of 35.14 kg/ha, 68.67 kg/ha, and 74.30 kg/ha recorded in strips I, II, and III, respectively.

The consistent upward trend in fodder yield and NPK uptake from strip I to strip III highlights distinct variations in fertility gradients across the experimental strips. These observations align closely with the conclusions drawn by Deshmukh et al. in their 2011 study. Further insights into the available nutrient status of the soil pre-sowing and post-harvest are warranted.

Available nutrient status of pre sowing and post-harvest soil.

The twenty-four soil samples collected before sowing of the gradient crop revealed mean KMnO4 –N values of 162, 167, and 160 kg ha-1 in strips I, II, and III, respectively. The mean Olsen –P status recorded in strips I, II, and III was 11.8, 10.3, and 10.7 kg ha-1, respectively. Similarly, the mean NH4OAc –K values were 120, 122, and 128 kg ha-1 in strips I, II, and III, respectively.

Post-harvest, the mean $KMnO_4$ –N status in the soil was 144, 180, and 202 kg ha-1 in strips I, II, and III, respectively. Regarding Olsen –P, the values were 10.2, 23.1, and 26.3 kg ha-1 in strips I, II, and III, respectively. The mean NH_4OAc –K of the soil after the harvest of the gradient crop was found to be 107, 175, and 218 kg ha-1 in strips I, II, and III, respectively.

These results indicate a progressive increase in available N, P, and K with the higher levels of N, P_2O_5, and K_2O applied. Thus, the creation of soil fertility gradients for the three primary nutrients was well-reflected in the soil analytical data as well, as reported by Abishek et al. in 2024.

Conclusion

The study's findings unequivocally demonstrate that cultivating the exhaustive crop effectively established an operational range of soil fertility within the fertility strips. This operational range was meticulously assessed through variations in fodder yield uptake and soil test values, revealing a wide variability in the soil test results across the gradient experiment.

The creation of distinct soil fertility gradients for the three primary nutrients was clearly evident in the soil analytical data. This robust foundation provides a solid platform for the development of fertilizer prescription equations under Integrated Plant Nutrient Systems (IPNS) to achieve the desired yield targets for rainfed Bt cotton in the Perambalur district of Tamil Nadu, India.

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