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Effects of farmyard manure and fertilizers on yield, fibre quality and nutrient balance of rainfed cotton (*Gossypium hirsutum*)

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Abstract

Two-year field experiments were conducted to evaluate the effect of fertilizer with or without farmyard manure (FYM) application on cotton productivity and fibre quality. A partial nutrient balance was calculated by the difference method (nutrient applied—crop removal). Seed cotton yield was improved with addition of FYM (5 Mg ha^{-1}). Application of both N and P resulted in significant improvements in seed cotton yield than the control and without N plots (PK). Uniformity ratio and ginning outturn (GOT) was greater in the FYM amended plots than the plots without FYM. Nitrogen and P balance was positive in the fertilizer-N and P applied plots whereas K balance was negative in spite of the addition of fertilizer-K. Potassium balance was positive only when FYM was applied. These studies suggest that it is advantageous to apply FYM as it improves fibre yield by way of improved GOT and maintains a positive nutrient balance.

Keywords: *Gossypium hirsutum*; Ginning out turn; Nutrient balance; Staple length; Uniformity ratio; Micronaire

1. Introduction

Cotton is the major crop grown in the vertisols of central India occupying about 5.0×10^6 ha. Poor soil fertility is a major cause of the low crop productivity. High risk associated with this rainfed agriculture is the major cause for the non-investment in fertilizer and/or manure. Importance of fertilizer N on the growth and yield of cotton is well known (Prasad and Prasad, 1998). Potassium is considered abundant in the cotton growing vertisols (Pasricha and Bansal, 2002) and most often is not included in the fertilizer recommendations (Tandon, 1994). Response to P has also not been consistent (Kairon et al., 2002). The cotton-growing farmers, therefore, generally apply only nitrogenous fertilizers. However, application of K (Shanmugham and Bhatt, 1991) has been observed to improve fibre quality. On the contrary, Jambunathan et al. (1986) observed no significant influence of fertilizers on fibre quality whereas Singh et al. (1989) reported fibre quality tended to deteriorate when the crop was over fertilized with N. Information on the effects of fertilizer and manure on fibre quality of cotton grown under rainfed conditions is generally limited.

The difference between the removal of nutrients by the crop and the addition of nutrients to soil as fertilizer or manure determines the nutrient balance of a cropping system. Construction of nutrient budgets is an important step in understanding the efficient nutrient management in agro-ecosystems (Lanyon and Beegle, 1989; Smaling et al., 1993). While such nutrient budgets have been prepared for the intensive cropping systems such as the rice–rice (Dobermann et al., 1996), rice-wheat (Singh et al., 2002) systems, information for cotton under rainfed conditions of central Indian vertisols is not available.

Of late integrated nutrient management involving organic manure and chemical fertilizer has received considerable attention (Swarup et al., 1998). Field studies, therefore, were conducted to assess the impact of organic manure in combination with fertilizer on the seed cotton yield, fibre quality and nutrient uptake. The N, P and K balance due to cotton cropping was also worked out.

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2. Methods

Field experiments were conducted over two years (2001–02 and 2002–03) under rainfed conditions at the experimental farm of the Central Institute for Cotton Research, Nagpur, (21° 9′N and 17° 7′E). This region has a typical semi-arid climate with most of the rainfall received between June and October. The soil at the site was a medium deep vertisol (Typic Haplustert). The soil was slightly alkaline in reaction (pH 8.1), low in organic C (4.6 g C kg^{-1} soil), and 0.5 M $NaHCO_3$ extractable P (6 mg P kg^{-1} soil). Soil exchangeable K (1 N NH_4COOCH_3) was high (280 mg K kg^{-1} soil).

A field trial was conducted as a factorial randomized block design with three replications. The treatments comprised application of FYM (0 vs. 5 Mg ha^{-1}) and combinations of N, P and K (control, PK, NK, NP and NPK). The rates and sources of N, P and K were 60 kg N ha^{-1} as urea, 13 kg P ha^{-1} as super phosphate and 25 kg K ha^{-1} as muriate of potash. Nitrogen was applied in two splits, half at 15 days after sowing (DAS) and the remainder at square formation (approximately 45 DAS). Entire P and K were applied along with the first dose of N. FYM was broadcast applied before sowing in the first week of June 2001 and 2002. Following application, FYM was incorporated into the soil with a blade harrow. FYM was a mixture of cattle dung, urine, cereal and legume crop residues and farm wastes. FYM applied contained on average, 0.56% N, 0.19% P and 0.51% K.

Cotton was sown on 26 June (cv. LRK-516) and 28 June (cv. Rajat) in 2001 and 2002, growing seasons, respectively. Each plot comprised of ten rows spaced at 0.60 m with a plant to plant distance of 0.3 m. Gross plot size was 36 m^2. Six central rows were hand picked for determining the seed cotton yield.

A 200 g sub-sample of the seed cotton after cotton picking in 2003 was taken and ginned and ginning percentage was calculated. Staple length (2.5% span length), uniformity ratio (%), micronaire (g/in.) and bundle strength (g/tex) were also determined on the fibre samples using a high volume instrument (Iyer and Iyer, 1999). Three plant samples were collected at random from the sample row at maturity. The plant parts (leaves, stem, bur and seed cotton) were separated and oven dried at 65 °C to constant weight. Plant parts were ground on a Wiley Mill and wet digested prior to analyses. Nitrogen and P were determined colorimetrically and K was determined using a flame photometer following the procedures mentioned in Prasad (1998), to quantify the nutrient uptake. A partial nutrient balance for N, P and K was computed as the difference between the nutrients applied and nutrient removed by the crop.

Data were statistically analysed using MSTATC and the treatment differences were separated out using the least significant difference (LSD) at the 5% probability level. The p values were estimated whenever F ratio was >1 and are discussed in the text.

3. Results and discussion

3.1. Seed cotton yield and yield attributes

The effects of FYM and fertilizer treatments on seed cotton yield were significant only in the first year (2001–02) of the study (Table 1). The effects of FYM were also seen in the second year (2002–03) when the plots receiving FYM produced more seed cotton than those not receiving FYM ($p > 0.118$). Control plots had lower seed cotton yield than the fertilized plots. Among the major plant nutrients, only N (NPK vs. PK) increased

Table 1
Seed cotton yield (kg ha^{-1}) and yield attributes as influenced by application of FYM and fertilizers

Treatment[a]	Seed cotton yield		Number of bolls per plant		Number of sympodia per plant	
	2001–02	2002–03	2001–02	2002–03	2001–02	2002–03
With FYM	427.1	1088.3	7.5	13.9	15.7	23.1
Without FYM	297.6	1015.8	5.4	13.0	15.1	22.1
LSD[b]	**	NS[c]	**	NS	NS	*
Fertilizer addition						
Control	280.3	957.7	6.7	9.1	15.0	20.7
PK	318.3	993.2	6.1	12.7	15.0	22.7
NK	397.2	1078.1	7.0	11.9	15.5	22.8
NP	399.0	1083.5	6.0	17.3	14.9	23.8
NPK	417.0	1147.8	6.4	16.6	16.4	22.8
LSD ($p < 0.05$)	97.4	NS	NS	5.7	NS	1.4

*Significant at $p \leqslant 0.05$; **significant at $p \leqslant 0.01$.

[a] With FYM: 5 Mg ha^{-1} applied annually in first week of June: control—no fertilizer added; PK—13 kg P and 25 kg K ha^{-1}; NK—60 kg N and 25 kg K ha^{-1}; NP—60 kg N and 13 kg P ha^{-1}; NPK—60 kg N, 13 kg P and 25 kg K ha^{-1}.

[b] LSD: least significant difference.

[c] NS: non-significant.