



## Effects of Long-Term Fertilizer Application and Rainfall Distribution on Cotton Productivity, Profitability, and Soil Fertility in a Semi-arid Vertisol

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*Long-term fertilizer experiments were conducted on cotton (Gossypium hirsutum) for 21 years with eight fertilizer treatments in a fixed site during 1987–2007 to identify an efficient treatment to ensure maximum yield, greater sustainability, monetary returns, rainwater-use efficiency, and soil fertility over years. The results indicated that the yield was significantly influenced by fertilizer treatments in all years except 1987, 1988, and 1994. The mean cotton yield ranged from 492 kg ha<sup>-1</sup> under the control to 805 kg ha<sup>-1</sup> under 25 kg nitrogen (N) [farmyard manure (FYM)] + 25 kg N (urea) + 25 kg phosphorus (P) ha<sup>-1</sup>. Among the nutrients, soil N buildup was observed with all treatments, whereas application of 25 kg N + 12.5 kg P ha<sup>-1</sup> exhibited increase in P status. Interestingly, depletion of potassium (K) was recorded under all the fertilizer treatments as there was no K application in any of the treatments. An increase in soil N and P increased the plant N and P uptake respectively. Using relationships of different variables, principal component (PC) analysis technique was used for assessing the efficiency of treatments. In all the treatments, five PCs were found significant that explained the variability in the data of variables. The PC model of 25 kg N (FYM) + 25 kg N (urea) + 25 kg P ha<sup>-1</sup> explained maximum variability of 79.6% compared to other treatments. The treatment-wise PC scores were determined and used in developing yield prediction models and measurement of sustainability yield index (SYI). The SYI ranged from 44.4% in control to 72.7% in 25 kg N (FYM) + 25 kg N (urea) + 25 kg P ha<sup>-1</sup>, which attained a mean cotton yield of 805 kg ha<sup>-1</sup> over years. Application of 25 kg N (FYM) + 25 kg N (urea) + 25 kg P ha<sup>-1</sup> was significantly superior in recording maximum rainwater-use efficiency (1.13 kg ha<sup>-1</sup> mm<sup>-1</sup>) and SYI (30.5%). This treatment also gave maximum gross returns of Rs. 30272 ha<sup>-1</sup> with benefit–cost*