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Measuring potassium fractions is not sufficient to assess the long-term impact of fertilization and manuring on soil's potassium supplying capacity

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Abstract

Purpose Potassium (K)-fractions, thresholds of K release and fixation, quantity-intensity (Q/I) parameters of K, K-release kinetics, and K-fixation capacity were compared for their effectiveness in differentiating the effect of various nutrient management practices on K supplying capacity of an Aeric Endoaquept soil after 45 years of puddled rice cultivation.

Materials and methods Soil samples (0–15 cm) were collected after the completion of 45 rice-rice cycles from an on-going long-term fertilizer experiment located in ICAR-National Rice Research Institute, Cuttack, India. The treatments involved control (unfertilized), N (nitrogen fertilizer), NP (N+ phosphorus fertilizer), NK (N+ potassium fertilizer), NPK (N + P + K fertilizer), FYM (farmyard manure), N + FYM, NP + FYM, NK + FYM, and NPK + FYM.

Results and discussion Rice cultivation without K fertilizer application resulted in lower values of soil K parameters than the K-fertilized treatments. Treatment effects were most prominent on release threshold concentration (RTC), followed by cumulative K release, K-release rate constants, and K-fixation capacity. Parameters of K-release kinetics and Q/I relationships showed better correlation with rice grain yields than soil-K fractions. Soil K thresholds were closely related with exchangeable (K_{ex}) and non-exchangeable K (K_{nx}), but not clay minerals.

Conclusions Among the soil K parameters, RTC, cumulative K release (K_f) with 0.01 M $CaCl_2$, release rate constants (b_K and b_S) of parabolic diffusion equation, and K-fixation capacity were most effective in revealing the nutrient management induced variations in soil K fertility. In the studied soil, K-thresholds were significantly related to K_{ex} and K_{nx}.

Keywords Fixation capacity · Fixation threshold concentration · Long-term fertilizer experiment · Q/I relationship · Release kinetics · Release threshold concentration