Impact of grazing intensity on nutrient use efficiency in Integrated crop-livestock systems

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The scenario of increased food demand requires the use of process technologies focused on sustainable intensification. Similarly, there is an urgent need for efficient production systems, especially related to plant nutrition and nutrient use efficiency. Integrated crop-livestock systems (ICLS) are valuable strategies to achieve these goals. We aimed to evaluate the efficiency of phosphorus (P), potassium (K), and nitrogen (N) utilization in the productivity of both pasture and crop production in a long-term ICLS. The research was conducted at the Espinilho Farm in 2001, in the municipality of São Miguel das Missões, RS, Brazil. Data were gathered from the database spanning a time series from 2001 to 2023. The experiment was established as a randomized block design with three replicates distributed into 16.6 hectares (ha). Treatments consisted of three grazing intensities (high, moderate, and light) defined by different sward heights (10, 20, and 40 cm) of mixed black oat *(Avena strigosa* Schreb.*)* and annual ryegrass (*Lolium multiflorum* Lam.), and an ungrazed treatment. The nutrient use efficiency of N, P, and K fertilization was evaluated using an index that estimates the productive potential of systems as a function of nutrient inputs. Partial factor productivity (PFP) was assessed for the pasture phase through total herbage production (THP, kg DM ha^{-1}), and for the crop phase through soybean yield (kg ha^{-1}). PFP was then calculated by relating primary production to the total amounts of N, P, and K applied annually through fertilization. Data were analysed using ANOVA and Tukey's test, with a significance level set at 5% ($P < 0.05$). The results indicate that there were no statistically significant differences in nutrient use efficiencies between pastures managed with light and moderate grazing intensities for both pasture (P = 108, K = 87, N = 116 kg DM ha^{-1}, and P = 112, K = 93, N = 126 kg DM ha^{-1}, respectively) and crop phases (P = 43, K = 36, N = 45 kg ha^{-1}, and P = 44, K = 37, N = 46 kg ha^{-1}, respectively) compared to the ungrazed treatment (P = 102, K = 86, N = 116 kg DM ha^{-1} for pasture, and P = 42, K = 36, N = 43 kg ha^{-1} for soybean). Conversely, high grazing intensity significantly reduces the nutrient use efficiency in all cases (P = 94, K = 77, N = 105 kg DM ha^{-1} for pasture, and P = 40, K = 34, N = 41 kg ha^{-1} for soybean). When considering only the pasture phase, the P and K use efficiency of the ungrazed treatment was analogous to that of the high grazing intensity treatment. The results highlight the importance of proper pasture management in ICLS. Grazing management significantly influenced nutrient use efficiency in both system phases (pasture and crop). Maintaining temperate pastures under grazing at 20 cm or above is essential for optimizing nutrient utilization.

Keywords: nutrient use efficiency, mixed crop-livestock, herbage production, soybean yield

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