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Module 4.6-4 Nitrogen, phosphate and potash contribute to profitability of maize-wheat in Jharkhand, India.

The maize-wheat crop rotation is an important cropping system in Jharkhand, a state located in eastern India and known for its acidic soil. The average maize and wheat productivity in Jharkhand is 1.4 t/ha and 1.6 t/ha, respectively; and are lower than the national averages of 2.5 t/ha and 3.1 t/ha. The maximum attainable yields of these crops in the state are much higher – about 6 to 7 t/ha or higher for rainfed maize and more than 4 t/ha for irrigated wheat. Increased productivity of cereal crops can be achieved through proper nutrient management practices along with good quality seeds of high-yielding cultivars. Red and lateritic soils of eastern India, especially in Jharkhand, have poor fertility because of coarse texture, low organic matter content, soil pH, and nutrient availability of nitrogen (N), phosphorus (P) and potassium (K). At the same time, farmers use inadequate amounts of fertilizer and apply nutrients in unbalanced proportions.

A field experiment was conducted to assess the effect of nutrient use and nutrient omission on crop yields, nutrient uptake, soil health, and the economics of the maize-wheat cropping system for two consecutive years (2009-10 and 2010-11) at the Birsa Agricultural University Farm in Ranchi, Jharkhand. The cropping system included hybrid maize (var. Pioneer 30V92) grown during the rainy season as a rainfed crop (June to October) and wheat (var. DBW 17) grown in winter as an irrigated crop. The experimental area comes under the Eastern Plateau and Hill region of India. The climate is sub-tropical; total rainfalls were 1,247 and 1,443 mm during 2009-10 and 2010-11, respectively. The soil was sandy loam in texture with pH 5.2, 4.9 g/kg of organic carbon, 272 kg/ha available N, 32 kg P_2O_5/ha, 139 kg K_2O/ha, and 14 kg S/ha. The plant available soil N was determined by alkaline permanganate distillation method while P_2O_5, K_2O, and S were determined with the Olsen, ammonium acetate, and calcium chloride extraction methods, respectively. Treatments comprising ample NPK (250-120-110 kg N-P_2O_5-K_2O/ha for maize and 150-110-100 kg N-P_2O_5-K_2O/ha for wheat), three treatments with omission of N, P and K from the ample treatment and a prototype Site Specific Nutrient Management (SSNM) treatment of 200-90-100 kg N-P_2O_5-K_2O/ha for maize and 120-70-60 kg N-P_2O_5-K_2O/ha for wheat were laid out in a randomized block design with four replications. The objective was to determine the right rate of application for each of the three nutrients, considering the targeted yield as well as economic benefit.

Maize grain yields increased to more than 5 t/ha with the SSNM treatment as well as with the ample NPK treatment (**Table 1**). The study highlights that proper nutrient management and improved variety could increase maize and wheat grain yields by two to three-fold, while keeping all other agronomic management practices the same. Omission plot data reveal that omission of a single nutrient could decrease the maize and wheat yield significantly ($p \leq 0.05$). One of the advantages of the omission plot approach for determining the nutrient requirement is that it circumvents the infrastructural issues associated with soil testing in India and provides an alternate method of estimating site-specific nutrient rates for a crop sequence. Also this approach provides the response and requirement on the end product (i.e., the plant itself). This can help in disseminating SSNM strategies for farmers in eastern India for improved productivity, farm profit and environmental sustainability.

Table 1. Effect of nutrient omission on yield in maize-wheat sequence.

Treatments	Grain yield, t/ha		
	Maize	Wheat	System
NPK	5.38	4.63	10.0
(-N)	1.22	0.86	2.1
(-P)	3.48	2.98	6.5
(-K)	4.13	3.63	7.8
SSNM	5.67	3.78	9.5
LSD (p = 0.05)	0.83	0.52	1.1

Economic assessment of the nutrient management practices was determined through a benefit-to-cost (B:C) ratio (i.e., gross return : gross investment) analysis. The study revealed that the B:C ratio was highest with SSNM (2.00) with a cropping system yield of 11.3 t/ha, followed by the NPK treatment plot (1.93) that yielded 12.3 t/ha (**Table 2**). A lower B:C value associated with the NPK treatment can be attributed to higher input cost associated with additional nutrients prescribed for the "ample" treatment in the omission plot protocol. Omission of N generated a negative net return and lowest B:C ratio (0.44). Omission of P and K produced B:C values of 1.55 and 1.64, respectively. This indicates that balanced nutrient management practices can increase the production and profitability of maize-wheat cropping system in Jharkhand. It could be considered that a B:C ratio of 2 might be adequate for risk-averse smallholder farmers, especially in the state of Jharkhand.

Table 2. Effect of nutrient omission on economics in maize-wheat sequence.

Treatments	Cost of cultivation, INR/ha	Gross return, INR/ha	Net return, INR/ha	Benefit-to-Cost ratio
NPK	60,316	116,470	56,154	1.93
(-N)	53,628	23,750	-29,878	0.44
(-P)	48,241	74,860	26,619	1.55
(-K)	55,057	90,155	35,098	1.64
SSNM	53,535	106,970	53,435	2.00

Price assumptions: N = INR 11.40/kg; P_2O_5 = INR 32.20/kg; K_2O = INR 18.33/kg; Wheat = INR 11.7/kg; Maize = INR 10.5/kg. INR = Indian rupee (US$1 = INR 60).

References

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