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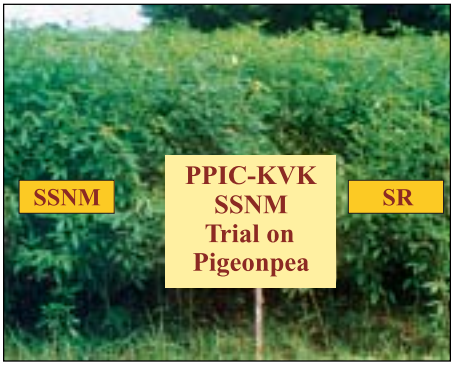
Site-Specific Nutrient Management for Optimal Foodgrain Production in Haryana

By K.S. Yadav and Hira Nand

Cropping systems governed by either generalized state soil testing recommendation systems or common farmer practice are incapable of maximum economic yield. In this study, it is evident that inadequate nutrient use is severly limiting pearl millet and pigeonpea production in Haryana State.

A five-fold increase in foodgrain production in Haryana State during the last 35 years combined with inadequate and unbalanced nutrient supply has led to continued and accelerated soil nutrient depletion of all essential plant nutrients. Farmers in Haryana apply generalized quantities of nitrogen (N), phosphorus (P), and zinc (Zn) in foodgrain crops, and as a consequence, deficiencies of P, potassium (K), sulfur (S), iron (Fe), manganese (Mn), and copper (Cu), and boron (B) are increasing. Deficiencies of S and Fe have become especially widespread during the last decade in fields growing pearl millet, sugarcane, wheat, and legumes. The desire for sustained productivity in these important soils places an urgent need to arrest this trend.

Pearl millet and pigeonpea crops presently occupy 586,000 ha and 16,000 ha, respectively, in Haryana, and corresponding productivity for these two crops is quite low at 1.42 t/ha and 0.81 t/ha. Opportunity for improvement exists through better nutrient management coupled with other best management practices. A research project was initiated to study the effect of site-specific nutrient management (SSNM) on crop yield and profit while demonstrating the drawbacks of relying on common farmer practice or even state fertilizer recommendations.



Site-specific nutrient management (SSNM) can increase productivity of pigeonpea.

Field experiments were conducted during 2001-02 in farmers' fields in the village of Tikli in Gurgaon District. Soils were sandy loam, alkaline in reaction, low in organic matter, with cation exchange capacities varying between 10 to 12 $cmol_{(+)}/kg$. Soils were generally deficient in available N, P, K, S, Zn, Fe, and Mn. Pigeonpea var. UPAS-120 was sown in the last week of June while pearl millet hybrid

Table 1. Effect of fertilizer treatments on pigeonpea grain and stover yield and net profits, Haryana.

Treatments	Grain yield	Stover yield	Net profits[2],
	----- t/ha -----		US$/ha
1. N_{20} P_{90} K_{125} plus S+Micros'[1]	2.03	4.08	354
2. N_{20} P_{60} K_{125} plus S+Micros'	2.01	3.90	355
3. N_{20} P_{30} K_{125} plus S+Micros'	1.89	3.85	338
4. N_{20} P_{0} K_{125} plus S+Micros'	1.84	3.55	325
5. N_{20} P_{60} $K_{62.5}$ plus S+Micros'	1.81	3.80	310
6. N_{20} P_{60} K_{187} plus S+Micros'	2.02	4.10	271
7. N_{20} P_{60} K_{0} plus S+Micros'	1.77	3.35	300
8. N_{20} P_{60} K_{125}	1.86	3.70	331
9. N_{20} P_{40} (State recommendation)	1.49	3.16	231
10. N_{20} P_{60} (Farmers' practice)	1.66	3.12	285
Critical difference (CD) = 5%	0.18	0.29	

[1]Includes 30 kg S/ha, 5 kg Zn/ha, 3.8 kg Fe/ha, and 3 kg Mn/ha. Urea, diammonium phosphate, and potassium chloride were the N, P, and K sources, while Zn, Fe, Mn, and Cu were supplied via respective sulfate sources.
[2]1 US$ = 45.28 Indian Rupees.

var. HHB-67 was sown in first week of July. Ten nutrient treatments were applied as a randomized block design (RBD) with four replications (**Table 1 and 2**). In pigeonpea, all nutrient quantities were applied as a basal dressing. In pearl millet, N was applied as two splits divided between sowing and a first mid-season irrigation. Crops were irrigated as required and weed growth was controlled. Pigeonpea was harvested in November and pearl millet in September. Data for grain and straw/stover yields were recorded on an air-dry basis. Economic analysis included treatment and general cultivation costs.

Pigeonpea Response

The complete treatment supplying 20-60-125 kg N-P_2O_5-K_2O/ha as well as a S+micronutrient package provided the best result by producing the highest profit of US$355/ha with a grain yield of 2.01 t/ha (**Table 1**). Treatments based on the state recommendation (SR) and common farmer practice (FP) both omitted K fertilizer and returned significantly less grain yields, i.e. 1.49 t/ha (-26%) and 1.66 t/ha (-17%), respectively. Corresponding net returns were US$231/ha (-35%) for SR and US$285/ha (-20%) for FP. Little change in grain yield resulted from applying P at rates beyond 60 kg P_2O_5/ha, but the introduction of K in combination with N and P returned a yield level that was statistically equivalent to, yet less profitable than, the best complete treatment.

Table 2. Effect of fertilizer treatments on pearl millet grain and stover yield and net profits, Haryana.

Treatments	Grain yield	Stover yield	Net profit[2]
	----- t/ha -----		US$/ha
1. N_{150} P_{90} K_{80} plus S+Micros'[1]	3.18	7.61	154
2. N_{150} P_{60} K_{80} plus S+Micros'	3.28	7.70	156
3. N_{150} P_{30} K_{80} plus S+Micros'	2.95	6.85	159
4. N_{150} P_{0} K_{80} plus S+Micros'	2.89	5.95	145
5. N_{150} P_{60} K_{40} plus S+Micros'	2.99	6.75	146
6. N_{150} P_{60} K_{20} plus S+Micros'	3.21	7.11	156
7. N_{150} P_{60} K_{0} plus S+Micros'	2.91	5.74	136
8. N_{150} P_{60} K_{80}	3.06	6.30	161
9. N_{125} P_{62} (State recommendation)	2.50	4.45	77
10. N_{150} P_{60} (Farmers' practice)	2.75	4.90	90
CD = 5%	0.23	0.38	

[1]Includes 30 kg S/ha, 5 kg Zn/ha, 3.8 kg Fe/ha, and 3 kg Mn/ha. Urea, diammonium phosphate, and potassium chloride were the N, P, and K sources, while Zn, Fe, Mn, and Cu were supplied via respective sulfate sources.
[2]1 US$ = 45.28 Indian Rupees.

Large improvements in stover biomass were achieved. The largest increases were seen at the highest levels of nutrient input, which included K plus the S+micronutrient package.

Similar to the grain yield response, when K fertilizer was applied, a significant increase was measured relative to the FP and SR treatments. The same was not true if K was omitted and only the S+micronutrient package was applied.

Leaf biomass from pigeonpea is commonly used as fodder, while plant

stems are often used for either fuel or mulching. After the rainy season, mulched stems become soft and decomposable…they in turn can be returned to the field to help improve organic matter, soil physical properties, and nutrient availability. Total biomass production from pigeonpea is estimated at 13 million metric tons (M t) using normal farmer practices. With adoption of SSNM in only 25% of Haryana's planted area, it could increase to 15 M t.

Pearl Millet Response

Highest grain yields were achieved with treatments supplying at least 60 kg P_2O_5/ha and 80 kg K_2O/ha. However, lower rates of K seemed able to produce statistically equivalent grain yields if co-applied with a S+micronutrient package (**Table 2**). Although both the SR and FP yields were inferior to the improved treatments, FP yielded more than the SR, which highlights the inadequate N recommendations being promoted by the state. Net return from grain was highest (US$161/ha) with the NPK combination, which was 109% and 79% higher than the SR and FP, respectively.

As in pigeonpea, enhanced nutrient availability produced large improvements in stover biomass. Although K alone had a large effect on pearl millet stover production (42% more than the SR and 28% more than FP), much higher biomass production was possible while still maintaining high grain yield and profitability, under the complete treatments—the best at this site being 150-60-80 kg N-P_2O_5-K_2O/ha plus the S+micronutrient package.

Pearl millet stover is also used as animal fodder, but the potential is great for recycling this biomass back into the field for the purposes of improving soil qualities such as organic carbon content, soil physical properties, and particularly K, secondary nutrients, and micronutrients. At current levels of productivity, total pearl millet stover production is estimated 15 M t. However, with adoption of SSNM practice on 25% of Haryana's planted area, an additional 3 M t could become available.

These results provide a clear example of the value of SSNM research in narrowing the gap between actual farmers' yield and true yield potential. BC

Dr. Yadav is Technical Officer (agronomy) and Dr. Hira Nand (deceased) was Chief Training Organizer, Krishi Vigyan Kendra (IARI), Shikohpur, Gurgaon 122 001, Haryana, India.

Pearl millet is an important foodgrain crop.