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Soil Test based Fertilizer Recommendation under IPNS for Pearl millet in Torripsamments of Rajasthan

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Abstract: Soil test crop response correlation studies were conducted with pearl millet (var. HHB-67) under integrated plant nutrition system (STCR-IPNS) in Torripsamments soils of Rajasthan during kharif 2002. Fertilizer adjustment equations under IPNS were formulated for pearl millet following Ramamoorthy's inductive-cum targeted yield model. The nutrient requirement for producing 100 kg of pearl millet was found to be 2.12, 1.51 and 3.19 kg of N, P_2O_5 and K_2O, respectively. The per cent nutrient utilization efficiencies from soil and fertilizer nutrients were found to be 31.83 and 18.06 for N, 60.83 and 20.35 for P_2O_5 and 79.52 and 40.78 for K_2O, respectively. Likewise the per cent nutrient utilization efficiency from farm yard manure (FYM) was 34.57 for N, 21.74 for P_2O_5 and 137.10 for K_2O, respectively. In STCR-IPNS technology, the fertilizer doses are tailored to the requirements of specific yield targets of pearl millet taking into account the contribution from soil, fertilizers and organics.

Key words: Pearl millet, STCR-IPNS, fertilizer adjustment equations, Torripsamments.

The modern crop production technology emphasizes the need for integrated plant nutrient supply involving the judicious use of a combination of organic and inorganic. The use of chemical fertilizers is a must for Indian agriculture but at least one third of the total nutrients must be in organic form for enhancing the efficiency of the inorganic-component, cost effectiveness and reducing the burden of environmental damage (Sankaran, 1997).

Since, pearl millet in Rajasthan is being cultivated in an area of about 45.56 lakh hectare with a production of 29.07 lakh tons and average productivity of 6.38 q ha^{-1}. Hence, in order to step up the productivity of the pearl millet in the state, soil test based balanced fertilization is essential. Currently, a general recommendation of 90:32:0 kg N, P_2O_5 and K_2O ha^{-1}, respectively is being followed. Fertilization based on blanket recommendation results in either over use or under use of fertilizers, so balanced fertilization is a must for realizing higher efficiency and economy of fertilizer use (Velayutham and Reddy, 1990). In fertilizing the crop existing soil fertility and crop requirements should be taken into account (Ramamoorthy *et al*., 1967). This demands the maintenance of optimum balance between all essential nutrients, as per the crop requirements of the nutrients and their availability in soil and possible recycling of organic sources. In this background attempt was made to develop technology under IPNS for pearl millet for torripsamments of consumption of non-renewable sources of nutrients.

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Materials and Methods

A field experiment based on inductive methodology was conducted in Torripsamments soils at Bikaner during kharif 2002 with pearl millet (var. HHB-67). The soil of the experimental field is loamy sand in texture with pH 8.4 and non-saline (EC_2 0.3 dS m^{-1}). The initial $KMnO_4$-N, Olsen-P and NH_4OAc-K status were 96.20, 23.70 and 148.90 kg ha^{-1}, respectively. The P and K fixing capacity of the soil observed 62 and 80 kg ha^{-1}, respectively. Following the inductive methodology of the Ramamoorthy *et al*. (1967), four fertility gradients were created in the preceding season by dividing the experimental field into four equal stripes which were fertilized with $N_oP_oK_o$, $N_{1/2}P_{1/2}K_{1/2}$, $N_1P_1K_1$ and $N_2P_2K_2$ levels. An exhaust crop of fodder (oat var. Kent) was grown so that the fertilizers could undergo transformations in the soil with plant microbial agencies.

By growing the exhaust crop, the operational range of soil fertility was created in the fertility stripes, which was evaluated in terms of variations in yield, uptake and soil test

values. After the harvest of the exhaust crop, each strip of the fertility gradient was divided into four equal blocks across the strip for FYM levels. Then each strip was divided into 32 plots and distributed fertilizer treatments in such a manner that every treatment was accommodated in each gradient strip as well as in FYM block.

Pre-sowing soil samples were collected from each gradient plot before superimposition of the treatments and were analyzed for alkaline $KMnO_4$-N (Subbiah and Asija, 1956), Olsen-P (Olsen *et al*., 1954) and neutral N NH_4OAc-K (Hanway and Heidel, 1952). Pearl millet (Var. HHB-67) crop was grown with usual agronomic practices. After the harvest of crop, the grain and stover yields of pearl millet were recorded plot wise. The plant samples from each plot were analyzed for total N, P and K content (Piper, 1966) and total uptake was computed using pearl millet yield data.

Using the data of pearl millet yield, nutrient uptake, pre-sowing soil available nutrients and fertilizer doses applied, the basic parameters viz., nutrient requirement (kg q^{-1}), contribution of nutrients from soil (Cs) and fertilizer (Cf) were calculated as described by Ramamoorthy *et al*. (1967). The per cent utilization efficiency of nutrients from applied FYM was also estimated in the similar manner. These parameters were used for the formulation of fertilizer adjustment equations for deriving fertilizer doses and the soil test based fertilizer recommendations were prescribed in the form of a ready reckoner for desired yield target of pearl millet under IPNS.

Table 1. Range and mean values of available nutrients in the pre-sowing surface soil and yield of pearlmillet

Parameters Soil test values	Range	Mean
$KMnO_4$-N	96.20-130.40	120.93
Olsen-P	23.70-40.10	36.40
NH_4OAc-K	148.90-172.70	164.61
Pearl millet yield (kg ha^{-1})		
Treated plots	857-1658	1329.00
Control plots	105-990	467.00
Nutrient uptake (kg ha^{-1})		
N uptake		
Treated plots	22.50-37.80	32.44
Control plots	2.90-25.70	13.40
P uptake		
Treated plots	18.44-24.80	22.61
Control plots	1.90-14.85	7.03
K uptake		
Treated plots	36.50-64.20	52.00
Control plots	4.95-35.20	22.70

Results and Discussion

Soil available nutriments and pearl millet yield

The range and mean values of pearl millet yield, uptake and available soil nutrients of treated and control plots are furnished in Table 1. The $KMnO_4$-N ranged from 96.20 to 130.40 kg ha^{-1} with a mean of 120.93 kg ha^{-1}, Olsen P ranged from 23.70 to 40.10 kg ha^{-1} with a mean of 36.40 kg ha^{-1} and NH_4OAc-K ranged from 148.90 to 172.70 kg ha^{-1} with a mean 164.61. The pearl millet yield in fertilizer treated plots ranged from 857 to 1658 kg ha^{-1} with a mean value of 13.29 and in control plots ranged from 105 to 990 kg ha^{-1} with a mean value of 467 kg ha^{-1}. The above data clearly indicate that a wide variability existed in the soil test values and pearl millet yield of treated and control plots, which is a pre-requisite for calculating the basic parameters and fertilizer adjustment equations for calibrating the fertilizer doses for specific yield targets.

Basic parameters

The basic data, viz., nutrient requirement for producing 100 kg of pearl millet yield, the per cent nutrient utilization efficiency for soil, fertilizer and FYM have been calculated and presented in Table 2. For calculation of nutrient requirement of pearl millet, 32 plots (response based) were selected (Ramamoorthy, 1993) and the uptake of nutrients regressed with the yield to obtain the nutrient requirement in kg $h^{-1.}$ Similarly, for calculating the soil nutrient utilization efficiency (Cs), fertilizer nutrient utilization efficiency (Cf) and nutrient utilization

Table 2. Nutrient requirement, per cent contribution from soil, fertilizer and FYM for pearl millet

Parameters	N	P_2O_5	K_2O
Nutrient requirement (kg per 100 kg grain)	2.12	1.51	3.19
Soil nutrient utilization efficiency (%)	31.83	60.83	79.52
Fertilizer nutrient utilization efficiency (%)	18.06	20.35	40.78
Nutrient contribution from FYM (%)	34.57	21.74	137.10

Table 3. Soil based fertilizer equations for targeted yield of pearl millet

FN = 0.1174 T - 1.76 SN - 1.91 FYM
FP = 0.742 T - 2.99 SP - 1.07 FYM
FK = 0.782 T - 1.95 SK - 3.36 FYM

Note: FN, FP and FK - Fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T - Yield target in kg ha^{-1}; SN, SP and SK - $KMnO_4$-N, Olsen- P and NH_4OAc-K in kg ha^{-1}, respectively,

efficiency from FYM (C_{FYM}), the uptake of nutrients from all the 32 plots regressed with their respective soil nutrients value, fertilizer dose for particular nutrient and FYM dose for obtaining the respective regression coefficients, identified as Cs, Cf and C_{FYM}.

On the basis of these equations a ready reckoner was prepared for range of soil test values and for a yield target of 2000 kg ha^{-1} (Table 4) under different fertilization programmes. For producing 2000 kg ha^{-1} of pearl millet in Torripsamments soils, the fertilizer doses required for the average soil test values 100, 25 and 170 kg ha^{-1} N, P_2O_5 and K_2O, respectively was found to be 49.20, 68.20 and 0 kg N, P_2O_5 and K_2O, respectively with 5 ton FYM.

The finding of the above study indicate that in STCR-IPNS technology, the fertilizer doses are tailored to the requirements of specific yield targets of pearl millet taking into account the contribution from soil, fertilizers and organics.

Table 4. Estimates of soil test based fertilizer recommendations for 2000 kg ha^{-1} grain yield target of pearl millet (kg ha^{-1})

Soil test values(kg ha^{-1})			Fertilizer for 2000 kg ha^{-1}					
			Without FYM/compost			With 5t FYM/compost		
N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
80	15	150	94.0	103.5	-	84.4	98.1	-
90	20	160	76.4	88.6	-	66.8	83.2	-
100	25	170	58.8	73.6	-	49.2	68.2	-
110	30	180	41.2	58.7	-	31.6	53.3	-
120	35	190	23.6	43.7	-	14.0	38.3	-
130	40	200	6.0	28.8	-	-	23.4	-

The nutrient requirements of N, P_2O_5 and K_2O were 2.12, 1.51 and 3.19 per 100 kg of pearl millet grain, respectively. The per cent nutrient utilization efficiencies from soil and fertilizer nutrients were found to be 31.83 and 18.06 for nitrogen, 60.83 and 20.35 for phosphorus (P_2O_5) and 79.52 and 40.78 for potassium (K_2O). Similarly, the per cent contribution of N, P_2O_5 and K_2O from FYM was 34.57, 21.74 and 137.10, respectively.

The data presented in Table 2 indicated that application of FYM not only contributes for particular nutrient but also improves the utilization efficiency of soil and fertilizer nutrients. The findings are in close agreement with those reported by Reddy *et al*. (1994), Rao *et al*. (1997) and Santhi *et al*. (2002).

Fertilizer adjustment equations for desired yield targets of pearl millet

Soil test based fertilizer models or equations for targeted yield of pearl millet were formulated using the basic parameters and are furnished in Table 3.

Hence, there will be a balanced supply of nutrients coupled with recycling of organic wastes avoiding either under or over uses of fertilizer inputs.

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