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Impact Assessment of '*Bhoochetana*' – A Soil Test-Based Nutrient Management Scaling-Out Initiative in Karnataka

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ABSTRACT

A study was conducted during rabi 2014 to assess the impact of 'Bhoochetana', a soil test-based fertilizer management initiative in Karnataka, India. In selected six villages across Raichur, Deodurga, Manvi and Lingasugur blocks of Raichur district in Karnataka, India, soil samples and crop yield data were collected from farmers' fields having farmer practice (FP) of blanket application of nitrogen (N), phosphorus (P) and potassium (K), as well as improved practice (IP) of soil test-based application of N, P and K along with deficient sulphur (S), boron (B) and zinc (Zn) as recommended under 'Bhoochetana'. After five years (since 2010) of 'Bhoochetana' in Raichur district, significant improvement in soil health is noted in IP adopted plots. In five out of six villages, soil organic carbon under IP increased to medium (0.50% to 0.71%) levels as compared with low (0.26% to 0.43%) levels observed under FP. Soil fertility under IP improved in terms of macro and micro nutrients like N, P, K, S, B and Zn. Increase in crop yield of all major crops like cotton (19%), groundnut (17%), pigeonpea (13%), sorghum (11%), and sunflower (11%) was observed under IP.

Key words: *Soil fertility, crop productivity, sulphur, boron and zinc.*

INTRODUCTION

Soil fertility is an important factor, which determines the growth of a plant. A productive and healthy soil is critical to harness the potential of any agricultural technology. So, the fertility of our soils is an indicator of the health condition of the soil. Micronutrient elements are found in most of the naturally occurring mineral complexes in soil. The micronutrients are present as a part of mineral complex or in soil solution. Although, the micronutrients requirement of plants is small as compared to macronutrients (N, P and K), their role in getting good plant growth, yield and quality produce is appreciable. The adoption of intensive cropping, use of high analysis NPK fertilizers, decreased use of organic manures, use of high yielding varieties and different cropping systems have mined the soils micronutrient stocks.

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Therefore, to maintain soil productivity and to get sustainable yield, balanced use of fertilizers along with micronutrients is highly essential.

The Northern Eastern dry zone of Karnataka (Zone-2) comprising part of Raichur district has widespread deficiency of sulphur, zinc and boron in soil[15]. Based on stratified soil sampling methodology adopted by the ICRISAT-led consortium[9] to draw the 92,409 soil samples across the Karnataka, the results revealed that Karnataka soils are largely deficient in OC (52%), S (52%), Zn 55% and B (62%). Similarly Hydrabad-Karnataka region soils are also largely deficient in S, Zn and B. The Raichur district soils were deficient in S by 64%, in Zn by 79% and B by 39%. This paper presents the results of impact assessment of the Bhoo-chetana programme (2009 to 2013) in the farmers' fields that show improvement of the soil fertility status.

MATERIALS AND METHODS

Site description

The study area comprised of Gabbur and Sunkeshwarhal villages in Devadurga taluk, Chikkahesrur and Gejjalgatta villages in Lingasugur taluk, Kapagal village in Manvi taluk and Yeregera village in Raichur. The sampling locations were marked by using GPS.

Soil sampling and analysis

The survey work was conducted during r*abi* (2014) season before sowing. The surface (0 to 15cm) soil samples were collected randomly from different taluks of Raichur district under farmer practice (not adopted Bhoo-chetana programme) and improved practice (adopted Bhoo-chetana programme).Farmers practice (FP) - Involves the imbalanced application of fertilizers restricted to nitrogen, phosphorus and potassium only, as practiced by the farmer's in their fields. Improved practice (IP) - Soil test-based application of deficient sulphur, boron and zinc in addition to nitrogen, phosphorus and potassium.

Before analyses, the soil samples were air dried and powdered with wooden hammer and pass through 2 mm sieve. For organic carbon, the soil samples were finely powdered to pass through a 0.25 mm sieve. Processed soil samples were analyzed in the laboratory. The soil pH was measured by a glass electrode using a soil to water ratio of 1:2.5; electrical conductivity (EC) was determined by an EC meter using a soil to water ratio of 1:2. Organic carbon was determined using by Walkley-Black method[5]. Available nitrogen in the soil samples was determined by alkaline potassium permanganate method as outlined by Subbaiah and Asija[13]. Available phosphorous was extracted with 0.5 M sodium bicarbonate at pH 8.5 (Olsen's reagent) method as outlined by Jackson[5], Available potassium in soil was extracted by neutral normal ammonium acetate[5]. Available S was extracted by 0.15% calcium chloride ($CaCl_2$) solution as an extractant[2], available Zn was extracted by DTPA reagent[6] and available B by hot water[1].The critical limits in the soil used: 8–10 mg kg^{-1} for S; 0.58 mg kg^{-1} for hot water extractable B and 0.75 mg kg^{-1} for DTPA extractable Zn.

Yield estimation

At the time of harvesting the crops (cotton, groundnut, sorghum, sunflower and pigeonpea), Crop samples were randomly collected from both farmer practice and improved practice, harvested area was 25 m2. Thus crop plants covering a total area of about 12 m^2 were harvested, and the harvested plants were pooled. Economic parts of the plants were separated from the vegetative parts and weighed separately. Grain or pods and stover or haulm weights were taken separately, then yield per $25m^2$ areas were converted into yield per ha^{-1}.

RESULTS AND DISCUSSION

Soil fertility

A summary of the chemical analysis of soil sample collected from the farmers' fields in the four taluks of Raichur district during rabi season 2014 showed that the field had a wide range in pH both in FP and IP. The organic carbon (OC) content in soils of improved practice was comparatively higher than farmers practice. The low organic matter content in Raichur soils in general might be due to high temperature and low rainfall in these regions and also low or little addition of organic matter to the soil[7]. However, the relatively high OC under IP (Table 1) might be due to high biomass production through more roots and shoot biomass and addition to soil[4]. The soils in study area were low to medium in available nitrogen. Results revealed that the nitrogen content under FP were comparatively lower than the IP. It might be due to the lower organic carbon content under FP and imbalanced application of fertilizers[10]. The available phosphorus content of the soils under IP was higher than the FP. This might be due to the balanced application of nutrients under improved practice leading to higher organic carbon and apparently higher microbiological activity. The role of organic matter in reducing P-fixation is well known. Similarly, higher microbial activity is expected to convert more of insoluble-P into soluble-P. Further, microbial biomass C is another pool which responds more rapidly to changes in soil management, and earlier studies have shown significant higher values of biomass C under improved management over the FP[14]. A positive relationship of soil organic C with available P explains higher available P content in soil[14]. The results collaborate with the finding of Singh *et al*[11]., Rego *et al*[8]., Chander *et al*[4]., The available potassium content in the IP and FP soils recorded were medium to high status[10,12].

The sulphur, boron and DTPA extractable zinc content in the FP soil samples was low as compared with IP samples. The extensive and widespread deficiency of zinc, boron and sulphur under FP was apparently due to the poor organic carbon status of soil[12] and depletion under continuous cropping without application of these nutrients[8]. Of the higher levels of zinc, boron and sulphur (Table 1) in soils under IP are on expected lines due to the balanced application of S, B, Zn fertilizers along with N, P, and K.

Crop yields

Response of crops due to Zn, B and S application along with N, P and K (IP) over Farmers' Practice (FP) (only N, P and K) in cotton, groundnut, pigeonpea, sorghum and sunflower (Table 2) showed a significant yield response. It might be due to the combined and balanced application of N, P, K and S, B, Zn[3,4,9]. The average yield responses were in cotton (19%), groundnut (17%), pigeonpea (13%), sorghum (11%) and sunflower (11%) in IP over FP. The same was reported by Sahrawat *et al*[10].

Table 1: Soil fertility status under farmers' (FP) and improved (IP) practices in Raichur study area (Average values)

Taluk	Village	% deficiency in soil organic C and available nutrients													
		Org C		N		P_2O_5		K_2O		S		B		Zn	
		FP	IP	FP	IP	FP	IP	FP	IP	FP	IP	FP	IP	FP	IP
Devadurga	Gabbur	60 (0.43)	10 (0.65)	30 (286)	30 (288)	70 (19)	60 (19.5)	10 (267)	00 (298)	20 (13.3)	10 (23.7)	10 (1.03)	00 (2.65)	80 (0.42)	70 (0.44)
	Sunkeshwarhal	75 (0.4)	00 (0.67)	38 (287)	13 (311)	100 (15.9)	62.5 (22.5)	00 (282)	00 (301)	13 (15.8)	00 (27.9)	00 (1.37)	00 (1.62)	100 (0.25)	100 (0.48)
Lingsuguru	Chikkahesrur	100 (0.26)	78 (0.38)	44 (286)	11 (308)	67 (18)	44 (19.5)	11 (228)	11 (235)	22 (12.5)	00 (21.7)	33 (0.56)	00 (2.53)	100 (0.29)	100 (0.42)
	Gejjalgatta	88 (0.37)	38 (0.5)	88 (259)	63 (273)	100 (15.6)	88 (16.3)	00 (260)	00 (254)	38 (11.1)	00 (24.6)	25 (0.64)	00 (1.79)	100 (0.24)	100 (0.56)
Manvi	Kapagal	93 (0.38)	00 (0.71)	40 (299)	7 (321)	20 (30.4)	7 (38.3)	7 (330)	00 (256)	7 (18)	00 (31.3)	00 (1.51)	00 (1.73)	100 (0.3)	100 (0.52)
Raichur	Yeregera	80 (0.34)	20 (0.57)	40 (290)	10 (297)	50 (22.1)	40 (24.1)	00 (296)	00 (297)	10 (12.6)	00 (26.3)	20 (0.65)	00 (1.41)	100 (0.36)	90 (0.53)

Note: FP: Blanket application of recommended N + P + K; IP: Soil test-based application of N + P + K and deficient S + B + Zn ; the data within () indicate average content in soil

Table 2: Responses of different crops under farmers' practice and improved practice (Average values)

Taluk	Village	Crop	Crop yield kg ha^{-1})		
			FP	IP	% increase
Devadurga	Gabbur	Cotton	1694	1844	8.13
	Sankeswarhal	Cotton	2068	2762	25.1
Manvi	Kapagal	Cotton	2209	2885	23.4
Raichur	Yeregere	Cotton	1960	2324	15.7
Raichur	Yeregere	Groundnut	998	1202	17.0
Lingasugur	Gejjalgatta	Pigeonpea	1133	1308	13.4
Devadurga	Sankeswarhal	Sorghum	2003	2383	16.0
Lingasugur	Chikkahesrur	Sorghum	2050	2105	2.61
	Gejjalgatta	Sorghum	2033	2337	13.0
Devadurga	Gabbur	Sunflower	988	1156	14.5
Lingasugur	Chikkahesrur	Sunflower	1067	1149	6.84

Note: FP: Blanket application of recommended N + P + K; IP: Soil test-based application of N + P + K and deficient S + B + Zn ;

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