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Effect of long term manure and fertilizer application on major available nutrient status and sulphur fractions under finger millet-maize cropping system in Karnataka

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ABSTRACT

The AICRP on long term fertilizer experiment (LTFE) ie finger millet-maize cropping system was initiated at the Zonal Agricultural Research Station, GKVK, UAS, Bangalore during 1986-87. Soil in 1986 had 69 per cent sand, 16 per cent silt, 14 per cent clay, 6.17 pH (1:2.5), 0.45 dS/m electrical conductivity (1:2.5), 12.2 cmol (p+)/kg CEC, 0.46 g/kg soil organic carbon, 257 kg/ha available N, 34.3 kg/ha available P and 123.1 kg/ha available K. Available status of major nutrients increased significantly by application of organic sources of nutrients either alone or in combination with fertilizers over fertilizers alone viz available nitrogen 247.86 kg/ha, available phosphorus 194.06 kg/ha, available potassium 175.30 kg/ha; different sulphur fractions were available S 9.92 to 34.77, water soluble S 8.74 to 33.87, organic S 30.44 to 73.15 and total S 110.47 to 427.76 mg/kg.

Keywords: Long term; available nutrients; sulphur fractions; finger millet; maize; cropping sequence

INTRODUCTION

In recent years trends of soil fertility changes in many of the long term studies in India or elsewhere have been reported from samples obtained after the crop harvest or prior to growing next crop (Manna et al 2005).

Sulphur is an essential plant nutrient as it is essential for the growth and development of all crops. Sulphur is absorbed through the roots in sulphate (SO_4^-) form. Sulphur also has certain specific functions to perform like formation of chlorophyll, protein production, synthesis of oils and activation of enzymes specifically with reference to crop quality.

In soil, sulphur can be found in organic and inorganic forms. The contribution of S organic fractions in

meeting plant requirements is not well known. The total content of sulphur in soil usually ranges from 0.01 and 0.1 per cent. The major portion of total S in soil is bound in soil organic matter. Plant available S consists of soluble inorganic SO_4^{--}, sorbed inorganic $SO_4^{-}$and the portion of organic S in soil that is mobilized during vegetative stage.

MATERIAL and METHODS

The AICRP on long-term fertilizer experiment (LTFE) ie finger millet–maize cropping system was initiated at the Zonal Agricultural Research Station, GKVK, UAS, Bengaluru during 1986-87. The soil is classified as fine, mixed isothermic Kandic Paleustalfs of Vijayapura series. Soil in 1986 had 69 per cent sand, 16 per cent silt, 14 per cent clay, 6.17 pH (1:2.5), 0.45 dS/m electrical conductivity (1:2.5), 12.2 cmol (p+)/kg CEC, 0.46 g/kg soil organic carbon, 257 kg/ha available N, 34.3 kg/ha available P and 123.1 kg/ha available K.

The treatments were planned as per the technical programme of All India Coordinated Research Project (AICRP) on LTFE consisting of 11 fertiliser treatments and 4 replications. Treatments were 50 per cent NPK, 100 per cent NPK, 150 per cent NPK, 100 per cent NPK + hand weeding, 100 per cent NPK + lime, 100 per cent NP, 100 per cent N, 100 per cent NPK + FYM, 100 per cent NPK (S-free), 100 per cent NPK + FYM + lime and control.

The experiment was done on finger millet-maize to investigate the levels of different fractions of sulphur and available nutrients in soil. Total 64 soil samples were collected after the harvest of crops at 0 to 15 cm depth.

Analytical methods

Available nitrogen: The alkaline permanganate method was adopted to assess the available nitrogen content in soil (Subbaiah and Asija 1956). The easily oxidizable portion of the soil organic matter was oxidized by boiling of soil with alkaline potassium permanganate solution and the distilled ammonia was collected in boric acid. Later the ammonia trapped in boric acid was quantified by titration using standard acid.

Available phosphorus: The collected soil samples were found acidic. Hence Bray's # 1 extractant was used for extracting available P content (1:10). The phosphorus content in the soil extract was determined by developing blue color using ascorbic acid-molybdate complex. The color intensity was read at 660 nm using spectrophotometer (Jackson 1973).

Available potassium: The available potassium in soil was extracted with neutral normal ammonium acetate. The content of K in the extract was determined by flame photometer (Page et al 1982).

Estimation of sulphur fractions

Sulphate sulphur: Sulphate sulphur content was estimated by extracting the soil with 0.15 per cent $CaCl_2.2H_2O$ solution as described by Williams and Steinbergs (1959).

Water soluble sulphur: Five g soil was extracted with 33 ml of one per cent sodium chloride solution and 25 ml aliquot was evaporated to dryness with two ml of three per cent H_2O_2. It was kept in hot air oven at 102ºC for one hour to remove excess peroxide. After cooling, 25 ml distilled water was added to the residue and filtered to remove suspended matter. Sulphur in the extract was estimated turbidimetrically (Chesnin and Yien 1951).

Organic sulphur: Organic sulphur content in soil was estimated as described by Bardsley and Lancaster (1965).

Total sulphur: Total sulphur content was estimated by acid digestion method as per the procedure given by Tabatabai (1996).

RESULTS and DISCUSSION

The results of major available nutrients and different fractions of sulphur viz sulphate-S, water soluble-S, organic-S and total-S are presented in Tables 1 and 2.

Available nitrogen: Significant differences were recorded with respect to available nitrogen content among treatments. Higher available nitrogen was recorded in treatment receiving FYM along with inorganic fertilizers. Whereas lower nitrogen content was recorded in control compared to all other treatments. Similar results were reported by Sudhir et al (1998) that the higher available nitrogen in FYM applied plots might be due to the positive impact of the organic manure and its mineralization into available forms.

Available phosphorus: The higher available phosphorus was observed in combined application of the inorganic fertilizers, FYM and lime (T_{10}) over other treatments. Incorporation of FYM in combination with fertilizers increased the available P content in soil compared to other treatments. The positive effect of FYM on P availability may be due to organic anions which were produced during the decomposition of organic matter. These anions compete with inorganic PO_4^{-3} and therefore reduce the fixation of phosphate thereby increasing the availability. Significantly high available phosphorus in all the plots receiving P at either recommended dose or at higher dose of phosphorus clearly justify the build up of phosphorus in soil over the years. Build up of phosphorus in soil due to similar reasons of fertilization was also reported by many workers (Anon 2004).

Available potassium: The results indicated that build up of available potassium was higher in the plots where

Table 1. Effect of long term manure and fertilizers application on major content of soil under finger millet–maize cropping system

Treatment	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
T_1: 50% NPK	202.95	43.68	99.82
T_2: 100% NPK	210.98	96.10	153.03
T_3: 150% NPK	241.32	149.21	163.98
T_4: 100% NPK + HW	218.77	91.80	145.75
T_5: 100% NPK + lime	213.80	97.40	152.75
T_6: 100% NP	207.84	105.77	59.90
T_7: 100% N	197.14	10.68	56.96
T_8: 100% NPK + FYM	240.39	186.80	173.63
T_9: 100% NPK (S-free)	218.83	92.56	130.69
T_{10}: 100% NPK + FYM + lime	247.86	194.06	175.30
T_{11}: Control	174.53	13.21	75.37
SEm±	3.39	1.49	2.02
$CD_{0.05}$	9.79	4.32	5.85

Table 2. Effect of long term manure and fertilizers application on fractions of sulphur in soil under finger millet–maize cropping system

Treatment	Available sulphate S (mg/kg)	Water soluble S (mg/kg)	Organic S (mg/kg)	Total S (mg/kg)
T_1: 50% NPK	17.85	18.67	57.95	251.14
T_2: 100% NPK	22.46	28.63	61.19	375.54
T_3: 150% NPK	31.92	31.06	68.43	424.52
T_4: 100% NPK + HW	24.57	27.04	55.34	373.68
T_5: 100% NPK + lime	21.04	29.43	64.18	378.67
T_6: 100% NP	22.14	28.72	65.51	353.50
T_7: 100% N	13.16	07.29	32.58	110.47
T_8: 100% NPK + FYM	24.32	31.96	69.70	391.75
T_9: 100% NPK (S-free)	9.92	08.74	30.44	117.93
T_{10}: 100% NPK + FYM + lime	34.77	33.87	73.15	427.76
T_{11}: Control	10.41	16.37	35.69	128.77
SEm±	0.34	0.39	0.90	5.12
$CD_{0.05}$	1.00	1.14	2.60	14.78

FYM along with inorganic fertilizers was applied over the years. It was observed that in T_{10} and T_8 receiving FYM there was significantly higher available potassium content compared to only inorganic fertilizer applied plots. Sudhir et al (1998) have reported similar findings that the plots incorporated with FYM also recorded relatively higher amounts of available K than those which were not treated with FYM. Farmyard manure is not only a direct and ready source of K but also aids in minimizing the leaching loss of K by retaining K ions on exchange sites of its decomposed products.

Available-S/sulphate sulphur (mg/kg): The values of sulphate sulphur were generally higher in surface soil treated with higher dosage of fertilizer compared to control and treatment receiving only 100 per cent N. Higher amount of available sulphate content in treatment (T_{10}) might be due to application of sulphur containing fertilizers in combination with FYM over the years. Above results are in conformity with the findings of Setia and Sharma (2005).

Water soluble sulphur: The water soluble sulphur fraction content of soil ranged from 7.29 to 33.89 mg/kg. The amount of water soluble sulphur present in soil was greater than that of sulphate sulphur. This might be due to the clayey nature of the soil and higher organic carbon content of the surface soil. Similar results were also reported by Sharma and Jaggi (2001).

Organic sulphur: The organic sulphur content of soil varied from 30.44 to 69.70 mg/kg. Compared to all the treatments the fertilizer with combination of FYM applied treatments showed higher amount of organic sulphur than other treatments. It might be due to its being intimately related with organic carbon content of the soil. Similar results were reported by Jat and Yadav (2006) who observed that the organic sulphur content of soil in Jaipur district of Rajasthan ranged from 20.50 to 76.40 mg/kg.

Total sulphur: The total sulphur content which indicates the reserve of this element in soil ranged from 110.47 to 427.76 mg/kg. The lowest value of total sulphur was recorded in T_7 which received only 100 per cent N. It may probably be due to insoluble sulphates or sulphates occluded in calcium carbonate. Farmyard manure and SSP treated plots contained the highest amount of total S. These results are similar to the findings of Shanthakumari (2007) who found that farmyard manure and SSP treated plots contained the highest amount of total S in the long term fertilizer experiment field at Bangalore.

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