



EFFECT OF IRRIGATION WATER SOURCES ON MICRONUTRIENTS AVAILABILITY IN A TYPICAL BLACK SOIL OF NORTHERN KARNATAKA

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ABSTRACT

Micronutrient availability is very sensitive to changes in soil environment as influenced by water and nutrient management practices. Surface soil samples representing, areas irrigated with different water sources were analysed for DTPA extractable micronutrients, pH and free CaCO₃. DTPA-extractable micronutrients varied significantly among soils with different irrigation sources. All the micronutrients indicated negative correlations with soil pH and CaCO₃ content but the free CaCO₃ and soil pH showed positive relationship among themselves. The soil micronutrients were found to be significantly higher in stream (lift) water irrigated soils followed by borewell water irrigated soils. However, the least availability was observed in soils with no irrigations. Frequent irrigations for sugarcane in stream irrigated areas resulted in loss of CaCO₃ and reduction in soil pH, which might have contributed for higher micronutrient availability.

KEYWORDS: Black soil, Borewell irrigation, Dryland, Irrigation sources, Soil Micronutrients

INTRODUCTION

Use of water for protective / regular irrigation is essential to achieve Indian Food Security. However, the productivity depends on soil and water quality. To a greater extent, the soil properties, more so the nutrient availability, are influenced by irrigation water. The availability of micronutrients is very sensitive to changes in soil environment especially pH and free CaCO₃ contents as influenced by irrigation water. These soil properties are directly influenced by native soil properties, crop management practices and irrigation sources. This study was conducted systematically for a Taluka (Block) to assess micronutrients availability in a black soil of northern Karnataka influenced by irrigation sources and certain soil properties.

MATERIAL AND METHODS

The study was conducted in black soils of Mudhol taluka / Block (Bagalkot Dist.) during 2014-15. A significant portion of Mudhol taluka was under sugarcane, irrigated with different water sources. The canal irrigation was recorded in areas where canal network system was present. The farmers of tail end portion used bore well water in lean period (Canal + Bore well water). Some of the farmers were found using only groundwater for irrigating sugarcane and other crops (Borewell water).

Water accumulated in streams drained from agricultural lands along the natural drain line was also used through lift irrigation (Lift/Stream water). In some areas, dryland agriculture was practiced without any irrigation facilities (No irrigation). Thus, the study area categorized into canal + borewell, Borewell, Stream, Stream + Borewell and no irrigation systems.

The entire study area was divided into smaller grids of 5.06 sq. km (2.25 × 2.25 km²) and each grid was considered as a sampling unit. The dominant irrigation sources of each grid were identified and a representative composite soil samples were collected. The exact soil sampling points were determined and marked on the toposheet by traversing through each of these sub-units and the sampling points were identified. Three surface soil samples (0-15 cm) were collected and made into one representative composite sample of that site. The soil samples were air dried, sieved (2 mm) and stored for further analysis.

Processed soil samples were analysed for soil reaction (1:2.5) by pH meter (Model Systronics 361), free CaCO₃ content by acid titration (Richards, 1954) and DTPA extractable micronutrients viz. Fe, Mn, Zn and Cu by Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978). Finally, these observations were subjected to suitable statistical tests for interpretations.

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Table 1. Effect of different irrigation water sources on DTPA-extractable iron and manganese contents (in ppm)

Irrigation Water Sources	No. of samples with Fe			Range	Mean \pm SD
	< 2.5	2.5 - 4.5	> 4.5		
Stream Irrigation (Lift)	(n = 22)	0	22 (15.38)	4.54 to 8.80	6.39 \pm 1.27 ^a
Stream + Bore well Irrigation	(n = 6)	0	1 (0.69)	3.42 to 7.58	5.75 \pm 1.60 ^b
Borewell Irrigation	(n = 89)	0	31 (21.67)	2.52 to 8.52	5.18 \pm 1.43 ^{bc}
Canal + Borewell Irrigation	(n = 10)	0	0 (6.99)	4.64 to 8.36	5.77 \pm 1.16 ^{ab}
No irrigation (Dry land)	(n = 16)	0	6 (4.19)	3.27 to 7.38	4.96 \pm 1.07 ^c
Total	(n=143)	0	38 (26.57)		
Statistical analysis Calculated F-value = 4.14; CD at 5% = 0.63					
Irrigation Water Sources	No. of samples with Mn			Range	Mean \pm SD
	< 2.0	2.0 - 4.0	> 4.0		
Stream Irrigation (Lift)	(n = 22)	0	22 (15.38)	4.20 to 15.20	9.06 \pm 2.72 ^a
Stream + Borewell Irrigation	(n = 6)	0	6 (4.19)	4.02 to 13.86	8.32 \pm 3.65 ^{ab}
Borewell Irrigation	(n = 89)	0	3 (2.09)	2.24 to 17.42	9.09 \pm 3.29 ^a
Canal + Borewell Irrigation	(n = 10)	0	0 (6.99)	4.46 to 13.84	7.59 \pm 2.99 ^b
No irrigation (Dry land)	(n = 16)	0	3 (2.09)	2.71 to 11.90	5.73 \pm 2.69 ^c
Total	(n=143)	0	6 (4.19)		
Statistical analysis Calculated F-value = 4.25; CD at 5% = 1.31					

Note: 1. Values in parenthesis depict per cent; 2. Different letters in mean column imply significant differences at $P < 0.05$

Table 2. Effect of different irrigation water sources on DTPA-extractable copper and zinc contents (in ppm)

Irrigation Water Sources	No. of samples with Cu			Range	Mean \pm SD
	< 0.8	0.8 – 1.6	> 1.6		
Stream Irrigation (Lift)	(n = 22)	0	22 (15.38)	2.07 to 5.08	3.48 \pm 0.79 ^a
Stream + Borewell Irrigation	(n = 6)	0	6 (4.19)	2.50 to 4.48	3.63 \pm 0.76 ^a
Borewell Irrigation	(n = 89)	8 (5.59)	81 (56.64)	1.20 to 7.21	2.87 \pm 0.99 ^b
Canal + Borewell Irrigation	(n = 10)	2 (1.39)	8 (5.59)	1.33 to 3.70	2.56 \pm 0.76 ^b
No irrigation (Dry land)	(n = 16)	9 (6.29)	7 (4.89)	0.80 to 4.02	1.70 \pm 0.92 ^c
Total	(n=143)	0	19 (13.28)	124 (86.71)	
Statistical analysis Calculated F-value = 9.83; CD at 5% = 0.38					
Irrigation Water Sources	No. of samples with Zn			Range	Mean \pm SD
	< 0.6	0.6 - 1.5	> 1.5		
Stream Irrigation (Lift)	(n = 22)	0	12 (8.39)	0.75 to 4.38	1.68 \pm 0.89 ^b
Stream + Borewell Irrigation	(n = 6)	0	1 (0.69)	1.20 to 5.61	2.67 \pm 1.60 ^a
Borewell Irrigation	(n = 89)	8 (5.59)	55 (38.45)	0.11 to 5.54	1.37 \pm 0.97 ^{bc}
Canal + Borewell Irrigation	(n = 10)	1 (0.69)	7 (4.89)	0.50 to 2.80	1.10 \pm 0.68 ^c
No irrigation (Dry land)	(n = 16)	9 (6.29)	6 (4.19)	0.11 to 1.59	0.62 \pm 0.33 ^d
Total	(n=143)	18 (12.58)	81 (56.64)	44 (30.76)	
Statistical analysis Calculated F-value = 6.40; CD at 5% = 0.38					

Note: 1. Values in parenthesis depict per cent; 2. Different letters in mean column imply significant differences at P < 0.05

RESULTS AND DISCUSSION

DTPA –Fe, Mn, Zn, and Cu

DTPA-Fe in soils ranged from 2.52 to 8.80 ppm (Table 1) and in terms of distribution of available - Fe, nearly $\frac{3}{4}$ th of samples (73.42 %) were found in high range (> 4.5 ppm) while 26.57 per cent samples recorded medium levels (2.5 - 4.5 ppm). Among different irrigation sources, stream irrigated soils had significantly higher amounts of DTPA-Fe with a mean value of 6.39 ± 1.27 ppm and it was on par with canal +borewell irrigated soils (5.77 ± 1.16 ppm). However, dryland (no irrigation) areas recorded lower values of DTPA-Fe (5.18 ± 1.43 ppm).

DTPA-Mn ranged from 2.24 to 17.42 ppm and both of them were observed in borewell irrigated soils. Most of the soil samples (n=137; 95.80%) were found in high range of DTPA- Mn (> 4.00 ppm) while only 4.19 per cent of samples (n=6) were found to be in medium range (2.0-4.0 ppm). Comparison of DTPA-Mn in soils among different irrigation sources revealed that the soils under all irrigation systems were significantly different from each other. Borewell irrigated soils recorded significantly higher available manganese (DTPA- Mn) and the lowest was recorded in dryland areas (5.73 ± 2.69 ppm).

The DTPA-Zn and Cu in soils of different (Table 2) land use categories are ranged from 0.11 to 5.61 ppm. More than half of the soils (56.64%) were medium in DTPA-Zn, while, 30.76 per cent of samples (n=44) were found in high DTPA-Zn (> 1.5 ppm) and only 12.58 per cent of samples (n=18) registered low DTPA-Zn (<0.6 ppm). In terms of irrigation sources, DTPA-Zn content was significantly higher instream + borewell irrigation (2.67 ± 1.60 ppm) and dryland areas recorded significantly lower DTPA-Zn (0.62 ± 0.33 ppm).

The DTPA-Cu in black soils of Mudhol taluka ranged from 0.80 to 7.21 ppm. Among 143 soil samples analysed, most of the soil samples (n=124) showed high levels of DTPA-Cu (>1.6 ppm) and 13.28 per cent of samples (n=19) were in medium range (0.8-1.6 ppm). Among different irrigation sources, soils from stream + borewell irrigated soils recorded highest DTPA-Cu (3.63 ± 0.76 ppm) followed by stream irrigation (3.48 ± 0.79 ppm) and no significant differences were observed between them. However, dryland (no irrigation) areas recorded significantly lower amounts of DTPA-Cu (1.70 ± 0.92 ppm).

Table 3. Correlation coefficients of DTPA – micronutrients with pH and CaCO₃

Parameters	pH	CaCO ₃
DTPA-Fe	-0.190*	-0.260**
DTPA-Mn	-0.168*	-0.194*
DTPA-Zn	-0.177*	-0.198**
DTPA-Cu	-0.181*	-0.334**

*: Significance at 5% level; **: Significance at 5% level

The variations in micronutrient availability among different irrigation sources may be attributed to the direct effects of pH and CaCO₃ on solubility and precipitation reactions (Lindsay, 1972). The soil minerals tend to stay in respective hydroxides at higher pH and thus, the release of nutrients through solubilisation decreases (Pulakeshi *et al.*, 2012). Varied amounts of CaCO₃ in soils also might have altered soil pH and hence, micronutrient availability. The positive relationship between soil pH and CaCO₃ contents (Fig. 1) confirms its negative effect on micronutrient availability. Similar results on reduced micronutrient availability in lime enriched alkaline soils of Madhya Pradesh have been reported by Chouhan *et al.* (2012).

The alkaline pH in these black soils may be attributed to higher free CaCO₃ contents as they are mostly derived from lime parent material (Doddamani, 1994). Occurrence of different sized lime crystals in these soils also indicates CaCO₃ precipitation. However, the amounts of CaCO₃ in soils varied with sources of irrigation water (Fig. 2). Higher amounts of CaCO₃ and alkalinity in soils of dryland and borewell irrigated areas could be attributed to alternate wetting and drying cycles associated with addition of higher amounts of carbonates and bicarbonates through borewell water (Kanwar and Kanwar, 1968). The amounts of free CaCO₃ was found significantly lesser in stream and canal irrigated areas as compared to drylands. This could be attributed to gradual removal of total CaCO₃ by irrigation water. The carbonic acids produced by the dissolution of CO₂ in irrigation water might have reduced total CaCO₃ content in irrigated soils.

CONCLUSION

The DTPA extractable micronutrients in black soils are very sensitive to changes in soil caused by nutrient and water management practices in a cropping systems. The study also revealed that pH and free CaCO₃ contents

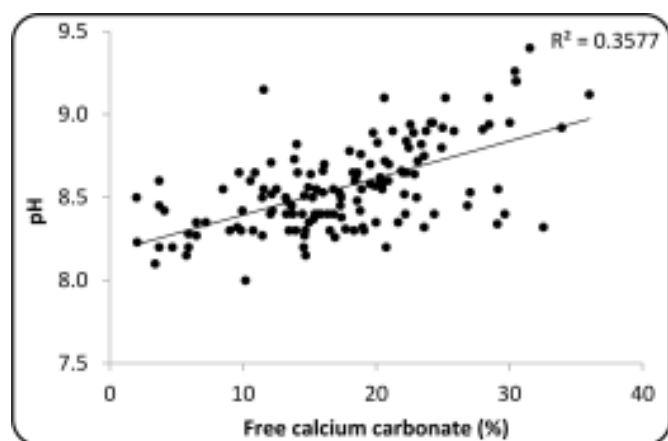


Fig. 1. Relationship between soil pH and free Calcium carbonate (CaCO₃ in %)

varied differently with source of irrigation water and are negatively correlated with availability of DTPA extractable Fe, Mn, Zn and Cu.

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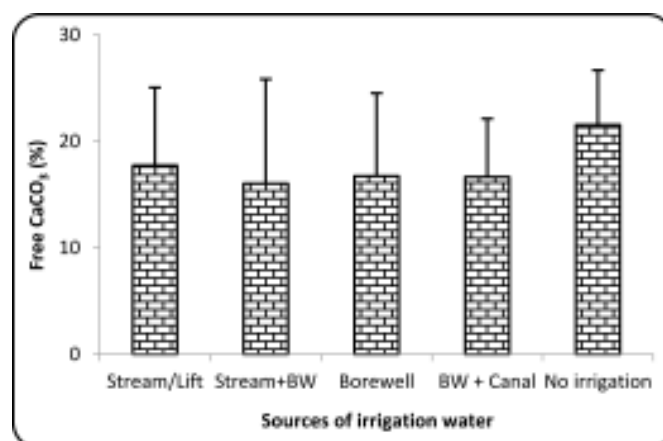


Fig. 2. Distribution of free CaCO₃ in soils irrigated with different water sources

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