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RESEARCH ARTICLE

# EFFECT OF DIFFERENT IRRIGATION WATER SOURCES ON SOIL SODIFICATION IN TYPICAL BLACK SOILS OF KARNATAKA

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**ABSTRACT**

An extensive Soil survey was conducted to study the effect of irrigation water on soil sodification, in terms of soil Residual sodium carbonate (RSC) and sodium adsorption ratio (SAR), in a typical black soil of Karnataka and it was carried out in Bilagi and Bagalkot taluk of Bagalkot district. The soil SAR and RSC varied greatly up on different sources of irrigation water. The values of SAR ranged from 1.78 in canal + borewell irrigated soils to 19.08 in lift irrigated soils. Most of the studied soils (117 samples) were found to be safe from sodicity hazard with < 10 SAR values. In terms of RSC of soils ranged from-17.60 meq/l in lift irrigated soils to +7.30 meq/l in dryland soils. Majority of the black soils of Bilagi and Bagalkot taluk (62.5%; 101 samples) were found safe with low RSC values (< 1.25 meq/l) while, 28.1 per of 36 samples recorded higher RSC of > 2.5 meq/l.



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## INTRODUCTION

Salinity, alkalinity and sodicity usually occurs in association with normal soils of arid and semi arid region. The extent of salinity and sodicity are largely influenced by the quality of irrigation water and local management practices. The sodification process can be easily measured by residual sodium carbonate (RSC) and sodium adsorption ration (SAR). The black soils which are generally containing high amounts of clay are more prone for such a process. Keeping these things in view, this study was carried out to assess the extent of sodicity in a block (Bilagi taluka of Bagalkot district in Karnataka) having larger tracts of black soils and irrigated with canal, bore well, streams water sources.

## MATERIALS AND METHODS

Survey based soil characterization was carried out in a block of northern Karnataka (Bilagi block and Bagalkot block of Bagalkot district). The above study area is exposed to hot arid climate with mean temperature of 32.6 °C and average rainfall of 447.3 mm; and situated at an altitude of 620 to 660 MSL. The entire block was divided into smaller grides of 2.25 × 2.25 $km^2$ using toposheet (Number E43V3 E43V7, E43V8 and E43V12) of survey of India each of these grides were considered as a sampling point and the details on soil type, cropping system and the source of water used for irrigation were collected. This study was restricted only to black soil regions comprising of swell-shrink clay soil. A representative sampling point was identified based on the above parameters. Equal quantities of three surface soil samples (0-15 cm) were collected and podded in to on composite sample. The samples were air dried, sieved (2 mm) and stored for laboratory analysis. The soil samples were analysed for sodium adsorption ratio (SAR) and residual sodium carbonate (RSC).

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### Statistical analysis

The obtained data was analyzed by statistical significant at P<0.05 level, S.E. and C.D. at 5 per cent level by the procedure given by (Snedecor and Cochran, 1994).

## RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads:

### Sodium Adsorption Ratio (SAR)

Sodium Adsorption Ratio (SAR) is the relative proportion of $Na^+$ to divalent cations such as $Ca^{2+}$ and $Mg^{2+}$. In terms of SAR values of most of the studied soils (117 samples) were found to be safe from sodicity hazard with < 10 SAR values.

**Table 1. SAR and its magnitude in black soils of Bilagi taluk**

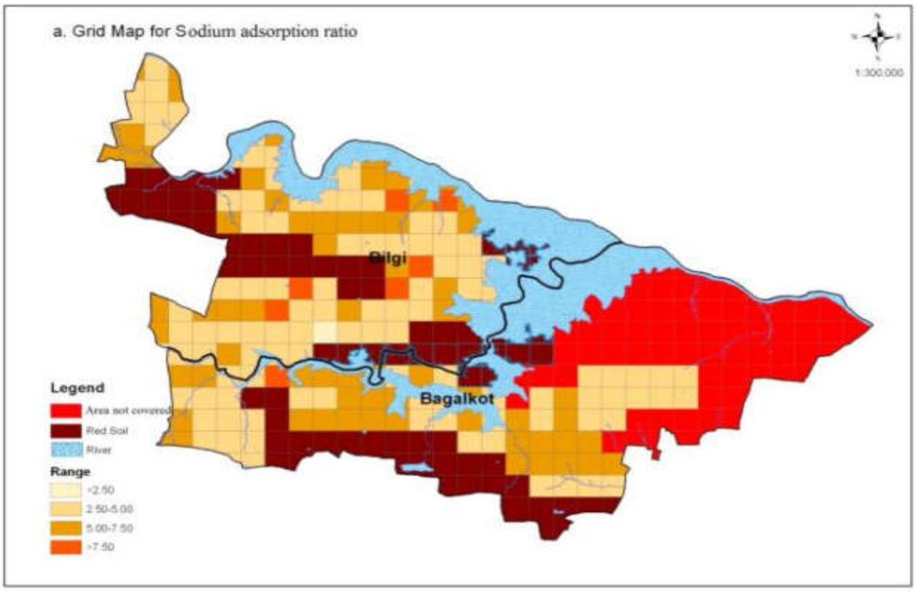
| Land Category | Number of samples with different SAR values | | | | SAR Range | SAR Mean |
|---|---|---|---|---|---|---|
| | < 10 (Low) | 10 – 18 (Medium) | 18 – 26 (High) | > 26 (Very High) | | |
| Based on different irrigation sources | | | | | | |
| Dry land (no irrigation) (n = 26) | 26 (100) | 0 | 0 | 0 | 2.59 to 6.88 | 3.46 ±0.20$^{a}$ |
| Borewell Irrigation (n = 76 ) | 70 (92.2) | 5 (6.5) | 1 (1.3) | 0 | 2.10 to 18.15 | 5.69 ±0.31$^{b}$ |
| Lift Irrigation (n = 13) | 11 (84.6) | 1 (7.6) | 1 (7.6) | 0 | 2.82 to 19.08 | 7.37 ±1.11$^{c}$ |
| Canal + Borewell Irrigation (n =5) | 3 (60.0) | 2 (40.0) | 0 | 0 | 1.78 to 10.30 | 6.39 ±1.28$^{b}$ |
| Lift + Borewell Irrigation (n = 8) | 7 (87.5) | 1 (12.6) | 0 | 0 | 4.00 to 10.66 | 6.15 ±0.83$^{b}$ |
| Total (n = 128) | 117 (91.4) | 9 (7.1) | 2 (1.5) | | | |
| Statistical analysis | Calculated F-value =5.59*; CD at 5 % =1.18 | | | | | |

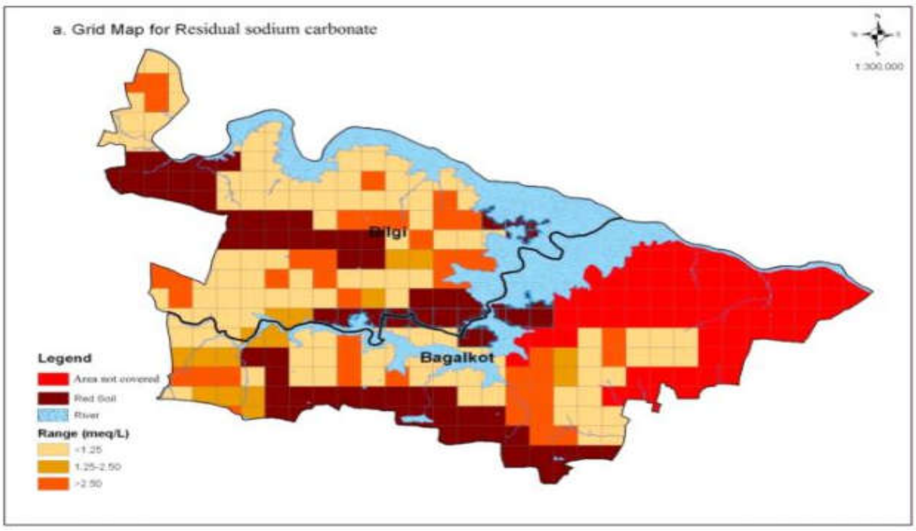
Note: 1. Values in parenthesis depict per cent; 2. Different letters in mean column imply significant difference at P < 0.05

**Table 2. RSC and its magnitude in black soils of Bilagi taluk**

| Land Category | Number of samples with different RSC values (meq/l) | | | RSC Range (meq/l) | RSC Mean (meq/l) |
|---|---|---|---|---|---|
| | < 1.25 (Low) | 1.25 - 2.5 (Medium) | > 2.5 (High) | | |
| Based on different irrigation sources | | | | | |
| Dry land (no irrigation) (n = 26) | 5 (19.2) | 2 (7.6) | 19 (73.0) | -0.70 to 7.30 | 3.95 ± 0.48$^{a}$ |
| Borewell Irrigation (n = 76 ) | 52 (68.4) | 9 (11.8) | 15 (19.7) | -10.83 to 6.90 | -2.05 ± 0.50$^{b}$ |
| Lift Irrigation (n = 13) | 13 (100) | 0 | 0 | -17.60 to 0.30 | -8.28 ± 1.72$^{c}$ |
| Canal + Borewell Irrigation (n =5) | 5 (100) | 0 | 0 | -6.80 to 1.20 | -3.58 ± 0.96$^{b}$ |
| Lift + Borewell Irrigation (n = 8) | 5 (62.5) | 1 (12.5) | 2 (25.2) | -10.80 to 3.70 | -2.23 ± 1.80$^{b}$ |
| Total (128) | 80 (62.5) | 12 (9.3) | 36(28.1) | | |
| Statistical analysis | Calculated F-value = 19.06*; CD at 5 % =1.89 | | | | |

Note: 1. Values in parenthesis depict per cent; 2. Different letters in mean column imply significant difference at P < 0.0



However, (9 soil samples were found to be moderately safe with SAR values of 10 - 18 while, only 2 samples from lift irrigation exhibited the risks of sodicity with high SAR (18 - 26). Dryland soils with no irrigation recorded the least SAR (3.46 ±0.20) as compared to other areas (Table 1 and spatial distribution in Fig.1). Addition of sodium salt by irrigation water in soils would increase with the removal of $Ca^{2+}$ from soil (both exchangeable and solution) by precipitation. Interaction of $Ca^{2+}$ with carbonates results in formation of $CaCO_3$ and gets precipitated later due to its low solubility (Kanwar and Kanwar, 1968). The process of removal of $Ca^{2+}$ and its precipitation as $CaCO_3$ increases with the use of water containing higher amount of carbonates and bicarbonates (Nakayama, 1970). Along with this alternate wetting and drying of soils in irrigated areas would also enhance CaCO3 precipitation (Abrol and Bhumbla, 1981 and Bhargava *et al*., 1980) and it induces sodicity in soils. Addition of sodium salts by irrigation water would also increase sodium in soil and would encourage sodicity at a later stage (Costa *et al*., 1991). Significant differences in SAR values were observed among soils irrigated with different water sources in the order - dryland < borewell < canal plus borewell = lift plus borewell < lift irrigation

**Residual Sodium Carbonate (RSC)**

The RSC values of soils irrigated by different water sources are varied significantly. The RSC of soils ranged from-17.60 meq/l in lift irrigated soils to +7.30 meq/l in dryland soils (Table 2). It was observed that majority of the black soils of Bilagi taluka (62.5 %; 101 samples) were found safe with low RSC values (< 1.25 meq/l) while, 28.1 per cent of the samples recorded higher RSC of > 2.5 meq/l. Comparison of RSC values of soils from different irrigated areas indicated that dryland areas with no irrigation facility had higher RSC value 3.95 ± 0.48 meq/l compared to other irrigated areas. Most of these soils from dryland (19 out of 26 samples) exhibited > 2.50 meq/l of RSC indicating higher risks of sodicity (spatial distribution in Fig 1). In case irrigated soils, RSC was found < 1.25 meq/l in most of the soils (75 samples). Moderate to higher RSC values were observed in 1/3rd of soils from borewell irrigated areas. Soil samples from other irrigated areas with lift and canal water recorded low RSC values. Susceptibility of soils for sodicity based on RSCs of different cropping systems indicated that nearly 73 per cent of the area under cereal-pulse cropping system and 43 per cent of the area under maize/groundnut-onion system were found susceptible for sodicity. In sugarcane grown areas, majority of the soils (72 samples; 75.7 per cent) recorded lower RSC values of < 1.25 meq/l. However, large tract of sugarcane areas (14 samples; 14.7 per cent) were found susceptible for sodicity due to higher amounts of $CO_3$= and $HCO_3$- than $Ca_{2+}$ and $Mg_{2+}$ as observed by higher RSC values (Sharma *et al*., 2011; Edgar *et al*., 2012).

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