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# STUDIES ON THE INFLUENCE OF BICARBONATE WATERS ON SOIL PROPERTIES IN THE PRESENCE AND ABSENCE OF PYRITE APPLICATION

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## ABSTRACT

Pot experiment conducted to find out the changes in soil properties due to the use of bicarbonate waters for rice in the presence and absence of pyrite application revealed that increase in the RSC of water, increased Soil pH, E.C., $CO_3^{-2}$, $HCO_3^{-}$, $Na^{+}$, exchangeable $Na^{+}$, Exchangeable Sodium Percentage (ESP) and $CaCO_3$. Decrease in $SO_4^{-3}$, $Ca^{+2}$, Ex.$Ca^{+2}$, Ex.$Mg^{+2}$ and Ex.$K^{+}$ was observed with the increase in levels of RSC of the water used. Pyrite application altered all the above said soil properties to an appreciable magnitude, commensurate with the quantity. However, the trend was exactly in contrast with the absence of pyrite application.

Key words: Bicarbonate waters, Soil properties.

Number of methods which have been advocated for improving saline water for irrigation. For the past two decades, pyrite and $Fe_2S$ being used as an amendment in reclaiming the salt affected soils. So far no work has been carried out on the use of pyrite as an amendment on soils which are irrigated with waters of high Residual Sodium Carbonate (RSC). This paper deals with the effect of bicarbonate water on soil properties in the presence and absence of pyrite application.

## MATERIALS AND METHODS

A pot culture experiment with rice (variety TKM-9) as test crop was conducted during Kharif season in the Annamalai University to find out the changes in soil properties (Vertisol) due to the use of bicarbonate waters (expressed as RSC levels) in the presence as well as absence of applied pyrite. The soil was clayey, pH and E.C. being 7.8 and 0.73 mmhos/cm respectively. It had water soluble anions $Co_3^{-2}$, $HCO_3^{-}$, $Cl^{-}$ and $SO_4^{-2}$ at 73, 64, 214 and 0.63 ppm, respectively, and the cations $Ca^{+2}$, $Mg^{+2}$ and $Na^{+}$ at 46, 24 and 2.6 ppm respectively. The exchangeable cations viz., $Ca^{+2}$, $Mg^{+2}$, $Na^{+}$ and $K^{+}$ were at 13.63, 11.41. 0.94 and 0.20 me/100 g respectively and the exchangeable Sodium per cent (ESP) being 2.84

Calculated quantities of $NaHCO_3$ salt was dissolved in rain water and the values were expressed as Residual Sodium Carbonate (RSC) levels on the basis of Eaton's concept (Eaton, 1950). Three levels of RSC water viz., 0,11 and 22 were used. The chemical composition of irrigation water used was

| | *0 RSC* | *11 RSC* | *22 RSC* |
|---|---|---|---|
| $CO_3^{-2}$(me/l) | 0.05 | 0.8 | 1.8 |
| $HCO^{-3}$(me/l) | 0.10 | 10.4 | 20.2 |
| $Na^{+}$ (me/l) | 0.21 | 11.97 | 23.57 |
| E.C. (m.mhos/cm) | 0.2 | 6.4 | 5.9 |
| pH | 7.2 | 8.6 | 8.2 |

Three levels of pyrite @ 0, 0.5 and 1.0 t/ha were applied. Pyrite had 22 per cent of Sulphur. There were nine treatments in all each replicated thrice. The treatments were as follows:

$T_1$ = No Pyrite + 0 RSC water
$T_2$ = Pyrite @ 0.5 t/ha + 0 RSC water
$T_3$ = Pyrite @ 1.0 t/ha + 0 RSC water
$T_4$ = No Pyrite + 11 RSC water
$T_5$ = Pyrite @ 0.5 t/ha + 11 RSC water

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$T_6$ = Pyrite @ 1 t/ha + 11 RSC water
$T_7$ = No pyrite + 22 RSC water
$T_8$ = Pyrite @ 0.5 t/ha + 22 RSC water
$T_9$ = Pyrite @ 1.0 t/ha + 22 RSC water

Earthen pots were selected and five Kg. soil was taken in each pot. A uniform basal dose of farm yard manure @ 5 t/ha and fertilisers to supply 20 Kg.N, 20 Kg.$P_2O_5$ and 20 kg. $K_2O$/ha were applied, to all the pots. Twenty five day-old seedlings of rice variety TKM-9 were planted in three hills per pot and were allowed to grow under submerged conditions using the different levels of RSC waters for irrigation. At tillering stage another dose of N @ 20 Kg/ha was applied to all the pots.

The soil samples collected at tillering, panicle initiation and at harvest of rice were analysed for chemical characteristics as per the procedures outlined by Jackson (1967).

## RESULTS AND DISCUSSION

Increase in soil PH, E.C., water soluble $CO_3^{2}$, $HCO_3^{-}$, $Cl^{-}$, $Na^{+}$, Ex. $Na^{+}$, ESP and

Table 1. Studies on the influence of bicarbonate waters on soil properties in the presence and absence of pyrite application (Mean of three replications)

| Treatment | pH | | | E.C.(m.mhos/cm) | | | $CO_3^{-2}$(ppm) | | | $HCO_3^{-}$ (ppm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | PI | H | T | PI | H | T | PI | H | T | PI | H |
| $T_1$ | 7.8 | 7.8 | 7.8 | 0.74 | 0.74 | 0.73 | 72 | 74 | 74 | 66 | 64 | 65 |
| $T_2$ | 7.6 | 7.7 | 7.7 | 0.74 | 0.73 | 0.73 | 69 | 69 | 70 | 61 | 61 | 62 |
| $T_3$ | 7.5 | 7.6 | 7.5 | 0.73 | 0.72 | 0.72 | 66 | 66 | 67 | 57 | 57 | 56 |
| $T_4$ | 8.1 | 8.2 | 8.5 | 0.90 | 0.92 | 1.08 | 107 | 114 | 124 | 100 | 106 | 112 |
| $T_5$ | 8.0 | 8.1 | 8.4 | 0.87 | 0.90 | 0.99 | 102 | 108 | 116 | 92 | 96 | 101 |
| $T_6$ | 8.0 | 8.0 | 8.3 | 0.86 | 0.88 | 0.95 | 100 | 100 | 111 | 87 | 90 | 97 |
| $T_7$ | 8.3 | 8.4 | 8.8 | 1.10 | 1.23 | 1.36 | 137 | 147 | 158 | 129 | 134 | 143 |
| $T_8$ | 8.2 | 8.3 | 8.6 | 1.04 | 1.18 | 1.27 | 124 | 129 | 144 | 122 | 129 | 133 |
| $T_9$ | 8.1 | 8.2 | 8.4 | 0.99 | 1.11 | 1.19 | 121 | 122 | 128 | 119 | 122 | 125 |
| S.E | 0.05 | 0.04 | 0.04 | 0.02 | 0.03 | 0.01 | 0.96 | 1.1 | 1.46 | 1.26 | 1.99 | 1.64 |
| C.D. | 0.11 | 0.10 | 0.10 | 0.06 | 0.80 | 0.3 | 2.00 | 2.4 | 3.11 | 2.70 | 4.24 | 3.47 |

| Treatment | $Na^{+}$ (ppm) | | | Ex.$Na^{+}$ (me/100g) | | | ESP | | | $CaCO_3$(%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | PI | H | T | PI | H | T | PI | H | T | PI | |
| $T_1$ | 2.60 | 2.62 | 2.62 | 0.95 | 0.95 | 0.96 | 2.87 | 2.87 | 2.90 | 2.86 | 2.83 | |
| $T_2$ | 2.58 | 2.58 | 2.60 | 0.86 | 0.84 | 0.83 | 2.60 | 2.54 | 2.51 | 2.71 | 2.66 | |
| $T_3$ | 2.57 | 2.57 | 2.58 | 0.76 | 0.75 | 0.73 | 2.30 | 2.27 | 2.21 | 2.68 | 2.53 | |
| $T_4$ | 3.53 | 4.14 | 5.86 | 1.27 | 1.62 | 1.98 | 3.84 | 4.90 | 6.00 | 2.91 | 3.24 | |
| $T_5$ | 3.47 | 3.97 | 5.31 | 1.21 | 1.59 | 1.77 | 3.66 | 4.81 | 5.36 | 2.88 | 3.08 | |
| $T_6$ | 3.43 | 3.84 | 5.24 | 1.17 | 1.43 | 1.17 | 3.54 | 4.33 | 5.18 | 2.86 | 2.98 | |
| $T_7$ | 6.28 | 8.14 | 12.56 | 1.96 | 2.16 | 3.00 | 5.93 | 6.54 | 9.09 | 3.21 | 3.84 | |
| $T_8$ | 6.17 | 7.96 | 12.46 | 1.82 | 2.02 | 2.83 | 5.51 | 6.12 | 8.57 | 3.16 | 3.70 | |
| $T_9$ | 6.04 | 7.83 | 12.31 | 1.75 | 1.94 | 2.44 | 5.30 | 5.87 | 7.39 | 3.06 | 3.29 | |
| S.E. | 0.02 | 0.08 | 0.28 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.12 | 0.03 | 0.05 | |
| C.D. | 0.03 | 0.17 | 0.60 | 0.13 | 0.02 | 0.02 | 0.02 | 0.02 | 0.25 | 0.05 | 0.01 | |

T - Tillering PI - -Panicle initiation H - Harvest

Table 2. Studies on the influence of bicarbonate waters on soil properties in the presence and absence of pyrite application (Mean of three replication)

| Treatment | $SO_4^{-2}$(ppm) | | | $Ca^{2+}$(ppm | | | $Mg^{2+}$(ppm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | T | PI | H | T | PI | H | T | PI | H |
| $T_1$ | 0.63 | 0.63 | 0.63 | 48 | 44 | 43 | 26 | 23 | 22 |
| $T_2$ | 0.71 | 0.72 | 0.73 | 74 | 73 | 65 | 30 | 26 | 23 |
| $T_3$ | 0.82 | 0.83 | 0.84 | 85 | 84 | 78 | 39 | 34 | 31 |
| $T_4$ | 0.42 | 0.41 | 0.40 | 38 | 30 | 25 | 20 | 17 | 15 |
| $T_5$ | 0.63 | 0.64 | 0.40 | 63 | 53 | 51 | 25 | 22 | 18 |
| $T_6$ | 0.80 | 0.81 | 0.81 | 71 | 64 | 61 | 29 | 23 | 20 |
| $T_7$ | 0.31 | 0.30 | 0.29 | 33 | 27 | 23 | 16 | 14 | 12 |
| $T_8$ | 0.41 | 0.41 | 0.42 | 41 | 38 | 34 | 23 | 20 | 17 |
| $T_9$ | 0.58 | 0.58 | 0.58 | 52 | 47 | 43 | 28 | 26 | 20 |
| S.E. | 0.02 | 0.28 | 0.02 | 1.12 | 1.65 | 1.35 | 0.99 | 1.44 | 0.7 |
| C.D. | 0.03 | 0.03 | 0.04 | 2.37 | 3.49 | 2.87 | 2.11 | 3.06 | 1.56 |

| Treatment | $Ex.Ca^{+2}$(me/100g) | | | $Ex.Mg^{+2}$(me/100g) | | | $Ex.K^{+}$ (me/100 g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | T | PI | H | T | PI | H | T | PI | H |
| $T_1$ | 13.78 | 13.13 | 12.95 | 11.56 | 11.39 | 11.22 | 0.19 | 0.19 | 0.20 |
| $T_2$ | 14.46 | 14.40 | 13.93 | 12.18 | 12.08 | 11.81 | 0.20 | 0.20 | 0.21 |
| $T_3$ | 15.19 | 15.14 | 14.62 | 13.21 | 12.97 | 12.93 | 0.20 | 0.21 | 0.22 |
| $T_4$ | 11.28 | 10.61 | 9.47 | 9.57 | 9.06 | 8.16 | 0.16 | 0.15 | 0.15 |
| $T_5$ | 12.15 | 11.05 | 10.54 | 10.44 | 9.39 | 8.93 | 0.17 | 0.16 | 0.17 |
| $T_6$ | 12.92 | 11.15 | 10.92 | 11.17 | 10.21 | 9.48 | 0.18 | 0.18 | 0.18 |
| $T_7$ | 10.15 | 9.49 | 8.16 | 8.06 | 7.86 | 7.04 | 0.16 | 0.15 | 0.14 |
| $T_8$ | 10.93 | 10.09 | 9.15 | 8.90 | 8.88 | 8.12 | 0.17 | 0.16 | 0.15 |
| $T_9$ | 11.55 | 10.94 | 10.10 | 10.01 | 9.82 | 9.06 | 0.18 | 0.17 | 0.16 |
| S.E. | 0.2 | 0.12 | 0.16 | 0.03 | 0.07 | 0.29 | 0.01 | 0.09 | 0.01 |
| C.D. | 0.4 | 0.27 | 0.34 | 0.06 | 0.15 | 0.61 | 0.02 | 0.18 | 0.01 |

T - Tillering PI - Panicle initiation H - Harvest

$CaCO_3$ was observed with the increase in the levels of RSC of water used without pyrite application. This is in agreement with the report of Sharma *et al.* (1980). The values increased from tillering to harvest. All the above soil properties tended to decrease with pyrite application and the decrease was higher with increasing levels of pyrite. This could be due to the oxidation of pyrites and subsequent release of $H_2SO_4$. This is in contrast with the observation of Ramaswamy *et al.* (1985). The increase in EC could be due to use of saline water.

Decrease in the grain yield was observed with the increase in the levels of RSC of the waters used. Pyrite appliation increased the grain yield and the increase was greater with higher levels of pyrite. Use of water containing higher contents of $CO_3^{-2}$ and $HCO_3$ increased the soluble $CO_3^{-2}$ and $HCO_3^-$ in the soil (Pajaniswamy and Dhanapalan Mosi, 1973). Sulphuric acid formed on oxidation of pyrite reacted with soluble $CO_3^{-2}$ and $HCO_3^-$ and released $CO_2$. This process would have decreased the quantities of $CO_3^{-2}$ and $HCO_3^-$ in the soil. Pyrite on oxidation forms $SO_3^{-2}$ thus increasing the quantity of $SO_4^{2}$

in the soil. This is in concurrence with reports of Ram and Ramesh Prasad (1981). Higher proportions of $Na^{+}$, $CO_3^{-2}$ and $HCO_3^{-}$ in water used led to the desorption of $Ca^{+2}$ and $Mg^{+2}$ from the exchange sites of the soil and these would have precipitated as carbonates, thereby decreasing the soluble $Ca^{+2}$ and $Mg^{+2}$ and subsequent enrichment of $Na^{+}$ in the soil.

When water containing high proportions of $Na^{+}$, $CO_3^{-2}$ and $HCO_3^{-}$ were used for soil adequately supplied with $Ca^{+2}$, $CaCO_3$ precipitation would have occured, thus lowering the exchangeable $Ca^{+2}$. This in turn would lead to the enrichment of exchangeable $Na^{+}$ at the exchange site of the soil. Precipitation of $CaCO_3$ due to the use of high RSC waters were also reported by Wilcox *et al.*(1954). Pyrite application increases the $Ca^{+2}$ and $Mg^{+2}$ in soil solution by mobilising these ions from their respective carbonates which inturn replace the exchangeable $Na^{+}$ from exchange site of the soil (Rai *et al.*, 1977; Pathak *et al.* (1978).

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