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**T Suresh**
Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India

**P Santhy**
Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India

**M Baskar**
Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India

**Corresponding Author:**
**T Suresh**
Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India

# Influence of ameliorated alkaline water and soil amendments on soil physico-chemical properties, growth, and yield of hybrid cotton in sodic soil under drip irrigation

**T Suresh, P Santhy and M Baskar**

**Abstract**
Field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Trichy using cotton (RCH- 20) as a test crop to examine the effect of ameliorated alkali water and soil amendments on soil properties, growth, and yield of hybrid cotton in sodic soil under drip irrigation. Drip irrigation with gypsum treatment water and drip irrigation with spent wash treatment water were used as main-plots treatments. Soil application of gypsum @ 50% GR (5.2 t $ha^{-1}$) and one time soil application of distillery spent wash @ 5 lakh litter $ha^{-1}$ were imposed as sub-plot treatments. The treatment without amendments both under main plot and sub plots were used as control. The experiment was conducted in the strip-plot design with four replications. The amendments application either through irrigation water (or) through soil significantly reduced the pH of post-harvest soil. The maximum reduction in pH was recorded in spent wash applied plots (7.51) followed by gypsum applied plots (7.77) and control (8.73). Slight increase in EC with spent wash treated plots was observed due to increase in amount of soluble salt. A decrease in ESP of 0.5 and 1.1 was recorded due to the drip irrigation with gypsum treated water and drip irrigation with DSW treated water respectively over control. Similarly, a decrease in ESP of 8.4 and 10.6 was recorded due to soil application of gypsum and DSW respectively over control. Application of amendments had significant influence on the exchangeable cation of the post-harvest soil especially the beneficial cations Ca, Mg, and K.

**Keywords:** Sodicity, gypsum, distillery spent wash, ameliorated alkali water, drip irrigation

## 1. Introduction
Food security concerns coupled with the scarcity of new productive land has put productivity enhancement of degraded lands back on the agenda of research and development. In India, nearly 9.38 million ha area is occupied by salt affected soils, out of which 5.50 million ha are saline soils and 3.77 million ha are alkali soils and in Tamil Nadu 3.5 lakh ha are sodic soil. Sodic soils can be reclaimed by different amendments which can be selected based on their availability and severity of problem. Gypsum is a common amendment for sodic soils reclamation because of its (i) moderate solubility, (ii) ability to replace sodium ion ($Na^+$) on the exchange sites with calcium ion ($Ca^{2+}$), and (iii) low cost and wide-spread availability. The scarcity of organic manures like FYM or compost and the problem in availability and cost of gypsum have limited the scope of using them for reclamation. So, it is necessary to develop cheap and locally available highly efficient sources for reclamation. One such possibility is the addition of an acidic by-product of distillery industry wastewater i.e., raw spent wash. Thus, current experiment was aimed to study the influence of ameliorated alkali water and soil amendments on soil properties, growth and yield of hybrid cotton in sodic soil under drip irrigation.

## 2. Material and Methods
The experiment was conducted at the Anbil Dharma lingam agricultural college and research institute, Department of Soil Science and Agricultural Chemistry, Tiruchirappalli Tamil Nadu (10 45 5.465N,78.36 1.227 E). The soil was *Typic Ustropept* with clay texture. The field experiment was laid out in Strip plot design, four replication and three mail plots, three sub plots followed.

***Main plots*** **(Irrigation water treatment)**
$M_1$: Drip irrigation with gypsum treated water
$M_2$: Drip irrigation with spent wash treated water
$M_3$: Drip irrigation with untreated alkali water

**Sub plots:** Soil treatment
$S_1$: Soil application of gypsum @ 50% GR
$S_2$: One time application of DSW @ 5 lakh litter $ha^{-1}$
$S_3$: No treatments (control)
A few important of soil properties related observation *viz.*, Physico-chemical properties of untreated raw and primary treated spent wash, soil physic- chemical properties exchangeable cations, were recorded.

## 3. Results and Discussion

### 3.1 Physico-chemical properties of untreated raw and primary treated spent wash

The pH of primary treated spent wash was 8.0 with the electrical conductivity of 32.5dSm $^{-1}$. The total suspended solids (TSS) and total dissolved solids (TDS) were 1.24 percent and 2.41 percent respectively. The biological oxygen demand (BOD) and chemical oxygen demand (COD) load were 5625 $mgL^{-1}$ and 45000 $mgL^{-1}$ respectively. The concentration of nitrogen, phosphorus and potassium were 0.17, 0.031 and 1.06 per cent respectively. The spent wash contained calcium, magnesium and sodium to an extent of 11050.0, 2208.0, 510 $mgL^{-1}$ respectively. The average concentration of iron, manganese, zinc and copper were 85, 4.8, 8.0 and 4.8$mgL^{-1}$ respectively. The sulphate and iron concentration 2440 $mgL^{-1}$ and 11200 $mgL^{-1}$ respectively.

### 3.2 Effect on physic –chemical properties

Application of amendments resulted in significant decrease in soil pH (Table 1). pH of the soil ranged from 8.80 to 7.45. The pH declined from 8.73 in control ($S_3$) to 7.77 and 7.51 due to soil application of gypsum @ 50% GR ($S_1$) and one time application of distillery spent wash @ 5 litter $ha^{-1}$ ($S_2$) application, respectively. The findings are in line with Sharma *et al.* (1981) [10] who reported that the soil pH reduced from 10.4 to 8.04 due to gypsum application. The reduction in soil pH was attributed to displacement of exchangeable Na by the calcium ion of gypsum and subsequent formation of sodium sulphate which get leached out of soil through drainage. Decrease in soil pH with DSW was attributed to acidic nature of raw spent wash (pH 3.8) which might have solubilized the native calcium carbonate and released free calcium ions and other calcium bearing minerals to the soil. In addition, the spent wash has calcium to an extent of 2600 mg $L^{-1}$. Results obtained in this study are in conformity with the findings of Mohammed Haroon and Subash Chandra Bose (2004) [5] and Mahindra (2007).
The EC of the post-harvest soil varied from 0.45 to 1.09 $dSm^{-1}$. Among the soil treatments, one time application of distillery spent wash @ 5 lakh liter $ha^{-1}$ ($S_2$) registered the highest EC (1.03 $dSm^{-1)}$ whereas the control ($S_3$) recorded the lowest EC (0.23 $dSm^{-1}$). The increase in the soluble salt content in the gypsum amended plots might be attributed to the chemical reactions of gypsum in the soil rendering them to more soluble sulphate of sodium. Significant reduction in the soil exchangeable sodium percentage was noted due to application of amendments. The decrease in soil ESP with addition of amendments may be attributed to increased Ca in soil solution as a result of addition of gypsum and organic sources which promoted Na displacement and its subsequent removal during irrigation to lower soil layers (Galabieh *et al.*, 2009 and 2011). An increase of 0.14 percent of organic carbon was observed with drip irrigation with spent wash treated water ($M_2$) application over the control**.** The usefulness of DSW as a valuable organic amendment on account of its high organic carbon content has been reported by several workers (Nehra and Hooda, 2002 and Ramaswamy, 1999) [8, 9].

**Table 1:** Physico-chemical properties of untreated raw and primary treat spent wash

| Parameters | Raw spent wash | Primary treated spent wash |
|---|---|---|
| pH | 3.8-4.0 | 8.0 |
| EC ($dSm^{-1}$) | 30.5 | 32.5 |
| BOD (mg $L^{-1}$) | 55000 | 1100 |
| COD (mg $L^{-1}$) | 110000 | 2500 |
| Total N (%) | 0.19 | 0.17 |
| Total $P_2O_5$ (%) | 0.030 | 0.031 |
| Total $K_2O$ (%) | 0.88 | 1.06 |
| Ca (mg $L^{-1}$) | 3000 | 1050 |
| Mg (mg $L^{-1}$) | 3300 | 2208 |
| Na(mg $L^{-1}$) | 300 | 1093 |
| Total Suspended Solids (%) | 6.8 | 2.41 |
| Total dissolved solids (%) | 5.20 | 1.24 |
| Cl (mg $L^{-1}$) | 6000 | 11200 |
| $SO_4$ (mg $L^{-1}$) | 3316 | 758 |
| Fe (mg $L^{-1}$) | 65 | 85.0 |
| Mn (mg $L^{-1}$) | 5.5 | 4.8 |
| Zn (mg $L^{-1}$) | 10.5 | 8.0 |
| Cu (mg $L^{-1}$) | 4.2 | 5.5 |

### 3.3 Effect on soil exchangeable cation

The soil exchangeable Ca and Mg were found significant due to soil application of amendments only and value ranged from 8.51 to 9.35 and 5.03 to 5.20 cmol (p+) $kg^{-1}$) respectively (Table 2). The acidic nature of raw spent wash (pH 3.8) might have solubilized native free lime which released Ca, Mg in free ionic forms which might have also contributed for increased Ca, Mg on exchange sites with the replacement of exchangeable sodium. Similar observations were also reported by Baskar *et al*. (2003) [2] and Mahindra (2007) that application of raw spent wash increased the Ca and Mg contents of soil. Application of concentrated form of spent wash helped in greater exchange of sodium by calcium and subsequent leaching with good quality water replaced the sodium from the exchange sites. Similar observations were also reported by Mohammed Herron and Subash Chandra Bose (2004) [5]. There was an increase in the content of exchangeable K with addition distillery spent wash due to composition of applied organic amendments (Ahmed *et al.*, 1988 and Muhammad and Khattak, 2009) [1, 6].

**Table 2:** Effect of ameliorated alkali water and soil amendments on soil physic-chemical properties of post-harvest soil

| Treatments | pH | | | | EC (dSm$^{-1}$) | | | | ESP (%) | | | | Organic carbon (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean |
| $M_1$ | 7.76 | 7.50 | 8.75 | 8.00 | 0.60 | 1.04 | 0.48 | 0.70 | 14.8 | 12.7 | 23.2 | 16.9 | 0.52 | 0.70 | 0.42 | 0.54 |
| $M_2$ | 7.70 | 7.45 | 8.65 | 7.93 | 0.75 | 1.09 | 0.54 | 0.79 | 14.2 | 11.8 | 22.6 | 16.2 | 0.71 | 0.80 | 0.44 | 0.65 |
| $M_3$ | 7.85 | 7.60 | 8.80 | 8.08 | 0.50 | 0.98 | 0.45 | 0.64 | 15.5 | 13.3 | 23.5 | 17.4 | 0.48 | 0.68 | 0.39 | 0.51 |
| Mean | 7.77 | 7.51 | 8.73 | 8.00 | 0.61 | 1.03 | 0.23 | 0.71 | 14.8 | 12.6 | 23.1 | 16.7 | 0.57 | 0.72 | 0.41 | 0.56 |
| | M | S | M at S | S at M | M | S | M at S | S at M | M | S | M at S | S at M | M | S | M at S | S at M |
| SE d | 0.12 | 0.08 | 0.33 | 0.23 | 0.01 | 0.02 | 0.05 | 0.22 | 0.27 | 0.23 | 0.76 | 0.65 | 0.01 | 0.01 | 0.04 | 0.05 |
| CD (0.05) | NS | 0.23 | NS | NS | 0.05 | 0.06 | 0.12 | 0.48 | 0.76 | 0.6 0.64 | 1.66 | 1.42 | 0.04 | 0.05 | 0.09 | 0.11 |

**Main plot (Irrigation Treatment):** $M_1$: Drip irrigation with gypsum treated water, $M_2$: Drip irrigation with spent wash treated water, $M_3$: Drip irrigation with untreated alkali water

**Subplot:** (Soil treatment): $S_1$: Soil application of gypsum@50% GR, $S_2$: One time application of distillery spent wash@5 lakh litter ha$^{-1}$ (90,000 L), $S_3$: No amendments

## 4. Conclusion

The present investigation concludes that one time application of distillery spent wash @ 5 lakh litter ha along with drip irrigation of gypsum bed treatments water can be effectively used as an amendments for reclamation of sodic soil and for getting higher yield of cotton.

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