Characterization of Salinity and Sodicity Levels in Groundwater and Their Impact on the Yield of Banana (Musa Indicata) in District Lasbela

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Abstract
The study on characterization of different levels of salinity and sodicity was carried in district Lasbela during 2012-2013.The study area is situated between 24°-54 and 26°-37 north latitude and 64°-02 and 67°-28 east longitude. Lasbela's geography and landscape is diverse and interesting. A total no 32 groundwater samples were collected from the study area. Water was characterized in accordance to the diagram for the classification of irrigation waters based on EC and SAR values. 94 % of the sites were falling in the high salinity class of C3 where as only 6% of the sites were falling in the C4 class. On the other hand, nearly 81% of the sites have SAR values below 10, which fall in the low category of sodicity S1. Hence only 19% of the sites have medium SAR. The percentage of the salts of the same site is higher when compared to its sodicity. The combined EC_w-SAR classification of groundwater of 81% of the samples are in C3-S1 class followed by the respective classes of C4-S1 and C4-S2 at 13% and 6% of the groundwater analysed. Such water is classified as highly and very highly saline for irrigation. The average yield of banana in the whole area was 7447 kg/ha/year. EC_w has no impact on yield of crops in the region. However a weak but general increase in salinity shows a bit increasing trend in yield while a minute increase in salinity shows a decreasing trend. Also SAR has no noimpact on yield of crops in the region. This might be because of use of such water that was entirely feasible particularly on light (sandy) soils. The present groundwater may be considerably better under many conditions that might be usable which be able to be successfully be applied to produce good yields of salt tolerant crops.
Keywords: Lasbela, Groundwater Quality, Salinity, Sodicity, Yield, Banana, USDA

1. Introduction

Groundwater quality is the physical and chemical characterization of groundwater, which measures its suitability for human and animal consumption, irrigation and other purposes. The ground water present in the reservoirs changes its qualities by reacting with minerals and soil already present (Vineesha and Khare, 2007). Small amounts of salts are always present in the groundwater which dissolved in it. The sources of recharge and strata from where waters flow are the main sources on which these salts are dependent. When these are present in excess quantities they are harmful for many crops. Hence, it is necessary to understand the hydrochemistry of groundwater to properly evaluate groundwater quality for irrigation purpose.(Venkateswaran and Vediappan, 2013). Groundwater quality reflects inputs from the atomosphere, soil and water rock reactions as well as pollutant sources such as mining, land clearance, agriculture, acid precipitation, and domestic and industrial wastes (Zhang et al.,2011). The quality of groundwater quality is deterioting day by day due to continuous changing in the environment. It is not easy to monitor water quality parameters continuously because quality of water has far reaching consequences in terms of its effects on man and biota.(Ackah et. al 2011). The growth of plants varies in soils where soluble salts are present. This depends upon of many factors on which plant respond to salts. Which include type of plants, its variety, texture of soil, soil moisture contents ant type of salts which are main factors which cause salinity. The salt tolerance of a plant may be determined by its ability of germination its survival in saline soils. Also it the yield of crop in saline soils when it is compared to non saline soils.(Mccall 1980). Banana being one of the important fruit and food crop is grown all over the world. Due to the no of environmental factors its yield is decreasing day by day. One of the major factors is salinity which is decreasing the propagation of the crop on both natural and artificial levels conditions. (Chen *et al*., 2006).

2. Study Area

Former princely state in India, Lasbela takes its name from two words, las , meaning plain, and bela, meaning jungle. Situated between 24°-54 and 26°-37 north latitude and 64°-02 and 67°-28 east longitude. Lasbela's geography and landscape is diverse and interesting. The district is divided into three distinct geographical regions: the north-eastern mountains and hilly areas, the south-western hilly area and the central plain or the Porali trough. In between the ranges are the important valleys of Windar, Wirahab and Hub. These are the flood plains of the rivers and streams flowing from the hills of Moro and Pub ranges in the north and east of the plain and Haro and Hala ranges lying close to the western boundary of the district. The alluvial plain surrounding Bela Town extends southwards up to Sonmiani Bay (IUCN,2011).

Figure 2.1 Map of District Lasbela Showing The Study Area

2.2 Materials and Methods

A total no 32 groundwater samples were collected from the study area. Water samples are collected from these wells and analyzed during summer when temperature is on peak to asses chemical characteristics of groundwater. A total no 32 groundwater samples were collected from the study area. A one page detailed history questionnaire was filled before collecting samples to get the information regarding farmers cropping pattern and production. From proposed location that means there were 32 samples; so far 32 questionnaires were filled. Selected tube wells were allowed to flow for at least 10 minutes before water sample collection. Water samples for determining the water quality in general and other elements were collected in 1.0 liter plastic bottles according to standard methods. The field determinations were: electrical conductivity (EC) measured with a HACH analyzer (model HQ). Calcium and magnesium were assessed using the ethylenediaminetetraacetic acid (EDTA) titrimetric method. Water was characterized in accordance to the diagram for the classification of irrigation waters based on EC and SAR values (Richards, 1954). EC is the measurement of the total concentration of dissolved salts in water expressed in dSm−1 at 25 ◦C. Based on the EC values, water for agricultural purposes was classified as: (C1) low salinity (0–0.250 dSm−1), (C2)medium salinity (0.250–0.750 dSm−1), (C3) high salinity (0.750–2.250 dSm−1), and (C4) very high salinity (>2.250 dSm−1), not appropriate for irrigation of common crops but can be used for a previous selection of crops in highly permeable, well drained soils (Richards, 1954). The values of EC and SAR were plotted against the yield of Banana (Kg/ha/year) to assess the impact of groundwater quality on banana yield.

3. Results and Discussion

3.1 Classification of Groundwater Quality According to USDA

According to the USDA classification, the groundwater of the 94 % of the sites were falling in the high salinity class of C3 where as only 6% of the sites were falling in the C4 class. On the other hand, nearly 81% of the sites have SAR values below 10, which fall in the low category of sodicity S1. Hence only 19% of the sites have medium SAR. The percentage of the salts of the same site is higher when compared to its sodicity. The combined EC_w-SAR classification of groundwater of 81% of the samples are in C3-S1 class followed by the respective classes of C4-S1 and C4-S2 at 13% and 6% of the groundwater analysed. Such water is classified as highly and very highly saline for irrigation. These results are similar to those found by Aziz *et.al* (2003) when they classified the combine values of both salinity and sodicity as Jilh water in the C3–S1, C4–S1, C4– S2, C4–S3 and C4–S4 classes with 8%, 19%, 56%, 14% and 3% of the wells, respectively. They stated that such waters are highly and very highly saline for irrigation and these are not suitable for most of the crops. Special measures needed to overcome the salinity problem which includes leaching and adequate drainage. The low to medium sodicity and high salinity can be easily managed without application of any water and soil treatments. They can be leached with the application of irrigation water.

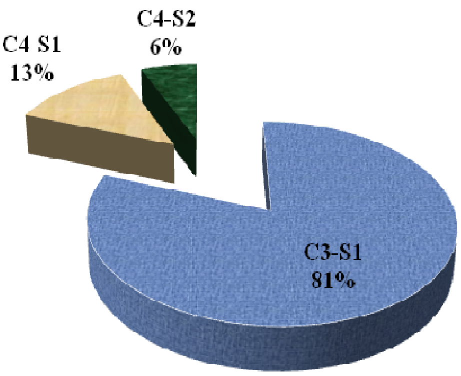

Figure 3.1 Percent Classification Groundwater Quality of According to USDA

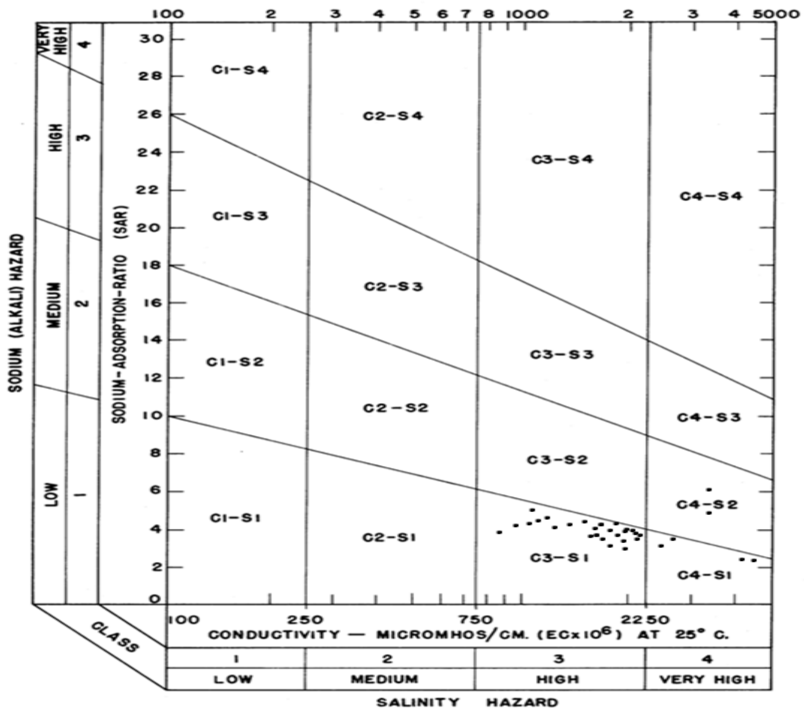

Figure 3.2 Classification of Groundwater Quality According to USDA

Table 3.1 Classification of Salinity Levels of Groundwater

S.No	Electrical Conductivity mmhos/cm	Type of water	Suitability for Irrigation	Total No of Samples
1	Below 250	Low Saline Water (1)	Entirely Safe	Nil
2	250-750	Moderately Saline (2)	Safe under Practically all Conditions	Nil
3	750-2250	Medium to High Salinity Water (3)	Safe under permeable Soil and Moderate Leaching	26
4	Above 2250	Highly Saline		06

3.2 Effect of Ground Water Quality on Yield of Major Crops

3.2.1 Cropping Pattern

The data regarding the areas of banana as a major crop and cotton as marginal were recorded Figure 3.3 which showed that the average areas obtained from the banana was 95% in the whole cultivated area which was followed by cotton crop on 5 % in the rest of the area. The average yield of banana in the whole area was 7447 kg/ha/year. This indicates that the difference in the cultivated area under both the crops is very high.

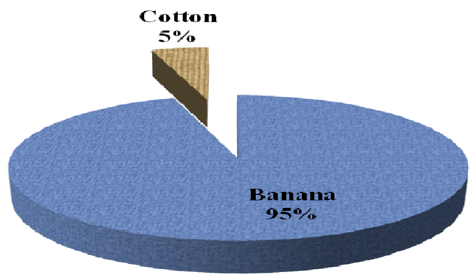

Figure 3.3 Cropping Pattern of Study Area

3.2.2 Effect of Groundwater Salinity on Yield of Banana

Figure 3.4 shows the relationship between yield and electrical conductivity of groundwater. It is clear that EC_w have no impact on yield of crops in the region. However a weak but general increase in salinity shows a bit increasing trend in yield while a minute increase in salinity shows a decreasing trend. These results can be associated with Bond (1999) who had analyzed the impact low quality water on agricultural soils and concluded that the adverse impact on agricultural soils is mainly due to the presence of high salt contents which are added to the soil over time. The present study further showed that the effect of increased EC on the production was obvious and highest banana production was observed. As banana and cotton falls in the category of salt tolerant crops and their yields are not affected by the use of saline water according to FAO (1974) production of many crops might be severe as affected due to use of saline water but satisfactory production of many tolerant crops might still be possible if certain corrective practices were adopted.

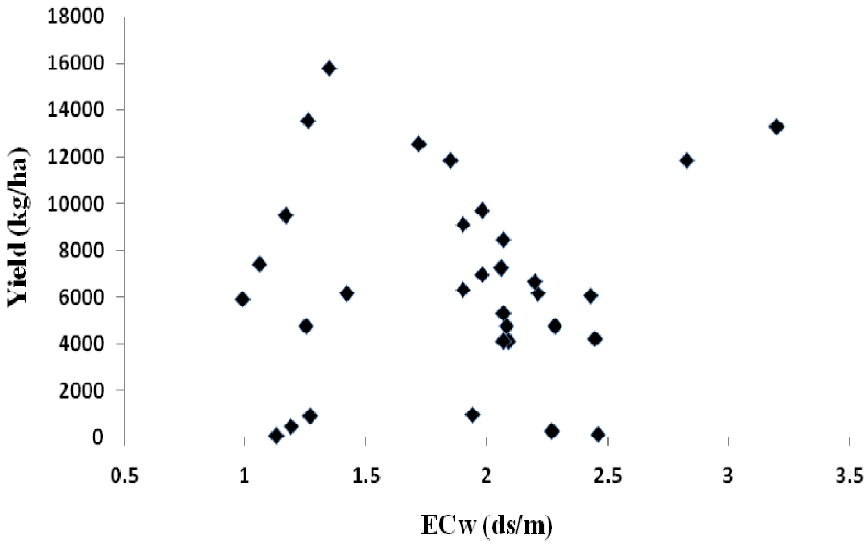

Figure 3.4 Relationships between Groundwater Salinity and Banana Yield

3.2.3 Effect of Groundwater Sodicity on Yield of Major Crops.

Figure 3.5 shows the relationship between yield and SAR of groundwater. It is clear that they have no impact on yield of crops in the region. This might be because of use of such water that was entirely feasible particularly on light (sandy) soils. The present groundwater may be considerably better under many conditions that might be usable which can successfully be applied to produce good yields of salt tolerant crops. The decreasing trend with SAR can be proved by the findings of Khedkar and Dixit (2003) who examined the effect of lower quality ground water on the crop productivity and reported that wastewater of cities have inhibiting effect on seed setting and yield of the crop. The decreasing trend is similar to those reported by Bajwa *et al.* (1992) who concluded that under the cotton-wheat rotation, yield decreases by application of irrigation waters with low RSC content and high SAR content and the decrements in the yields of both wheat and cotton crops were almost similar under increasing levels of RSC in irrigation water.

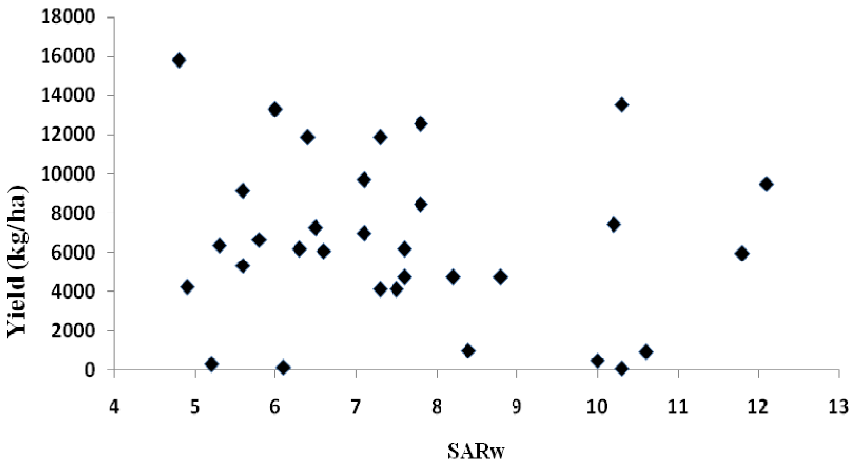

Figure 3.5 **Relationships between Groundwater Sodicity and Banana Yield**

Conclusions

The combined EC_w-SAR classification of groundwater of 81% of the samples are in C3-S1 class followed by the respective classes of C4-S1 and C4-S2 at 13% and 6% of the groundwater analysed. Such water is classified as highly and very highly saline for irrigation. The average yield of banana in the whole area was 7447 kg/ha/year. EC_w have no impact on yield of crops in the region. However a weak but general increase in salinity shows a bit increasing trend in yield while a minute increase in salinity shows a decreasing trend. It is clear that they have no impact on yield of crops in the region. This might be because of use of such water that was entirely feasible particularly on light (sandy) soils.

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