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INVESTIGATIONS ON WATER QUALITY IN SOUTHERN BLACK SOIL REGION OF FCV TOBACCO IN ANDHRA PRADESH

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A study on water quality of FCV tobacco growing areas of *Tanguturu mandal* under Southern Black Soils of *Prakasam* district was undertaken to explore and assess the water quality in order to develop different spatial maps of water quality to know the distribution and classify the available ground water suitable for irrigation with the help of Water quality Index (WQI) values calculated. The study area mostly black and mixed type of black and red soils. The pH of irrigation water in the study area was slightly alkaline to alkaline. The spatial thematic maps showed that ground water pH and chlorides in most of the area was in the range of 8.0-8.5 and 1.0 – 10.0 meq /l, respectively. While, bi-carbonate concentration of most of the study area ranged between 2.0 and 4.0 meq/l. Dominating ion is chloride in the system and following an order of *Chlorides* > *Sodium*> *Bicarbonates* > *Carbonates* > *Potassium.* Relatively high potassium (2.36 meq/l) was found in ground water in few villages which certainly help in better quality FCV tobacco. The major irrigation water quality class of the study area was moderately suitable (60 %) followed by suitable (14 %) with respect to FCV tobacco based on water quality index values developed. Conjunctive use of ground water and harvested rainwater is the effective way of utilisation of available ground water resource in the study area for FCV tobacco cultivation.

INTRODUCTION

Southern Black Soil area in *Prakasam* district of Andhra Pradesh is an important domain of FCV tobacco producing good quality leaf and high productivity. The soils are medium black soils (Silty clay loams) with patches of mixed red & black soils. The FCV tobacco is grown as semi- monsoon crop during October to March. Exploring and assessing the variation in water quality in areas under commercial crops such as FCV tobacco is important to have a comprehensive information for managing water, improving production and product quality. Irrigation water quality is one of the important components of crop production which affects the quality of soil and thereby the agricultural produce. Importantly if the water is polluted by yield restricting ions like chlorides and if the concentration in the irrigation water crosses the critical limits prescribed for the agriculture use deteriorates quality of commercial crops where quality of the produce is more important especially in FCV tobacco grown in rainfed dry lands mostly depend on ground water for supplemental irrigation. Especially chloride concentration in the leaf will deteriorates the burning quality which is an important trait for trade. Few studies related to irrigation water quality and its effect on FCV tobacco were done earlier (Krishnamurthy *et al.,* 1981,2002; Murthy K.S.N *et al.,* 1996). However, with the development of new techniques an evocative classification of a given area with the help of GIS can be a powerful means for developing solutions for natural resource status and for assessing water quality, on a local or regional scale (Ferry Ledi Tjandra *et al.,* 2003). Hence, the importance of spatial distribution of water quality parameter in an area cannot be ignored. Therefore, bearing in mind the importance of the above problem and tools for solutions a study on water quality of tobacco growing areas under Southern Black Soils of *Prakasam* district was undertaken.

MATERIALS AND METHODS

The study area is distributed in thirteen villages of *Tangutur* (15^0 16'01.17 to $15^0$28'59.76 N latitude & $79^0$53'43.88 to $80^0$06'30.28 E longitude)

Key words: Water Quality Index, SBS, Irrigation Classes

mandal. Based on spatial distribution of identified landforms (Uplands, low lands, low lands with saline patches and uncultivated barrens), cropping pattern and natural water sources in the study villages, water samples were collected from 13 villages of *Tangutur* mandal (SBS). Water samples were collected from dug wells, dug-cum-bore wells, and bore wells. All the samples were analyzed for pH, EC, Chlorides, Carbonates and Bi-carbonates , Sodium and Potassium using standard methods of water analysis (Richards et al.,1954). Water Quality Index was calculated with the following equation (Asadi etal, 2007).

WQI = Antilog [SWn n=1 log10 qn]

W, Weightage factor (W) is computed using following equations

Wn = K/Sn and K is proportionality constant is derived from:

K= [1/(Sn n=1 1/Si)]

Sn and Si are standard values for Irrigation Water Quality parameters selected

Irrigation water quality index (IQWI) was calculated with the help of above WQI equation after modifying the rating pattern in quality parameters related to irrigation to crops and especially for tobacco. Classified the area in to 5 classes (0-100) of suitability with index values developed as per the above methodology.

Geo-referencing and digitization of boundaries was done with the help of GPS, longitude and latitude points extracted from digital spatial data sources and cadastral maps. Mandal boundary was digitized with the help of digitizing tool of natural resource data base software. Spatial analysis was done using interpolated surface from input data points using an inverse distance weighted (IDW) technique with help of Arc GIS spatial tool (Asadi et al.,2007 and 2008). Irrigation water quality and other water quality spatial maps of *Tanguturu* mandal was developed with the help of WQI values of the area and Arc GIS software.

RESULTS AND DISCUSSION

Natural resources and landforms of villages of *Tanguturu* mandal

a) Landforms and Soil type: Landforms observed are Uplands, low lands, low lands with saline patches and barren lands. The area is mostly medium black soils followed by red soils and coastal soils. Clay loams are found in uplands. While clay loams to clay are found in low lands. Depth of the soil is moderate to deep. Shallow red soils are seen in *Konijedu* village. Black clay loams to clay soils were spread over villages of *Marlapadu, Kanduluru, Mallavarapadu, Jayavaram, Karumanchi, Ponduru, Tangturu, Vasepallipadu*. Light mixed soils are found in *Valluru*. Coastal saline sandy soils are in *Velagapudi* and *Anathavaram.*

b) Water sources: Source of irrigation in the study area are dug wells, dug-cum-bore wells, deep tube wells, ponds and filter points near streams. Around 70 per cent irrigation is done with bore wells. Local streams like *Musi and Paleru supply better quality water for irrigation. Tanguturu* mandal is having 48 wet tanks including *kuntas*. Ground water wells/bores depth ranged between 100-200 feet.

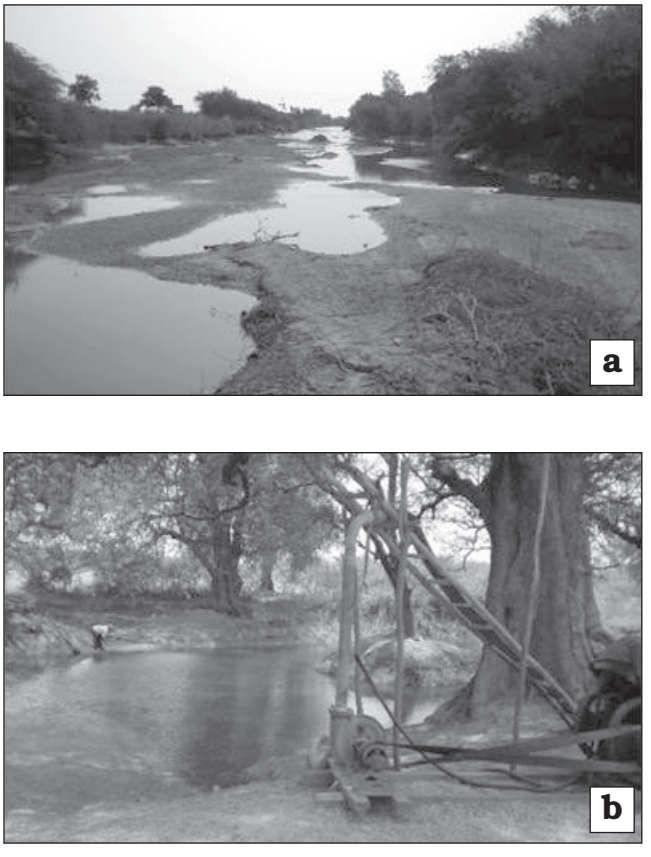

Fig.1: Natural sources of irrigation a) Musi river, b) Local pond in Jayavaram village

Land use pattern in villages of *Tanguturu* mandal

Total geographical area is 20.37 thousand ha and net sown area is around 11.9 thousand ha while barren lands are 1.78 thousand ha. Land under non-agricultural use is 2.82 thousand ha. Rice is grown during *kharif* in black soils followed by summer pulses. Cotton is grown in black soil villages which are near to *Paleru* and *Musi* streams. Pigeon pea is grown in all type soils as *kharif* crop. During *rabi*, main crops grown are tobacco and chickpea. Summer ground nut and sesamum are grown on river beds in *Vasepallipadu.* Vegetables are being grown in red soils of *Konijedu* and in some parts of *Maralapadu.* Tobacco is grown with irrigation water from streams, rain fed tanks and ponds in most of the villages under black soils. Major fruit crops existing in the area are *Mango and Sapota.* Orchard crops are seen in upland black soils of *Jayavaram* and *Karumachi* where ground water quality is poor. Soft wood trees *Subabool,* and *Eucalyptus* are grown in light soils and *Casuarina* in coastal sands of *Velagapudi* and *Ananthavaram.* Most of the land of these villages is being utilized for brackish water prawn culture. Correlating present land use, water resource and its quality result in a meaning full approach of classification suitable for different uses and to evaluate the impact of land use on water quality (Asadi *et al.*,2007).

Soil and water sampling and geo-referencing of sampling points

Land marks were identified for 13 villages of *Tangutur* mandal (SBS) and geo reference points of samples were recorded with the help of GPS. Based on spatial distribution of identified landforms, cropping pattern and natural water sources the water samples were collected. Water samples from dug wells, dug-cum-bore wells, and bore wells were collected form the study area for quality assessment.

Physico-chemical and ionic concentration in ground water

pH of the ground water varied from 7.5 to 8.7. Most of the samples are in alkaline range. Highest pH recorded in ground water of *Vasepallipadu.* EC values ranged from 1.30 *(Ponduru)* to 6.02 dS/m *(T. Naidupalem)* in groundwater. While chloride values are between 1.07 *(Karumanchi*) and 105.4 meq/l *(Jayavaram*). Carbonate concentration varied from 0.01 - 3.2 meq/l while bicarbonate content ranged between 0.08 *(Karumachi)* and 4.48 meq/l *(Mallvarpadu*). Sodium content in ground water ranged from 0.57 (*Marlapadu)* to 112.4 meq/ l *(T. Naidupalem).* While Potassium content varied from 0.02 to 2.36 meq/l. High potassium content in ground water was found in *Marlapadu* and *Mallavarapadu* in comparison to other village samples (Table.1).

Ionic concentration showed that with increase in bi-carbonate concentration chloride concentration decreased. There was inverse relationship between bi-carbonate and carbonate levels to chloride concentration in the samples. (Fig.2).Dominating ion is chloride in the system and following orderof *Chlorides>Sodium>Bicarbonates>Carbonates>Potassium.* Bicarbonates were high in the ground water of red soil areas. Total dissolved solids in ground water originate from natural resources, run off and industrial wastes (Kurian Joseph., 2001). High concentrations of all these anions were observed in irrigation tube wells and shallow bore wells in parts of *Prakasam* district (Krishnamurthy et al., 2002, Prasad *et al.,* 2012). Concentrations of ground water vary spatially, and alkali earths and strong acids dominate over alkalis and weak acids (Subramani *et al.,* 2005). Samples with high pH and EC showed low chlorides and dominated by bicarbonate salts (Krishnamerthy *et al.,*2002, Prasad *et al.,* 2012).

Spatial distribution of pH and anions

The thematic maps were developed for different water quality parameters. Spatial distribution of water quality in thematic maps presented that irrigation water pH varied from 7.4 to 9.1. Most of the area is in the range of 8.0-8.5. Chlorides varied from less than 2 meq/l to more than 60 meq/l and most of the area is in the range of 0 -10 meq / l (Fig.4). Water from a saline creek had highest chlorides (630 meq/l). Carbonates varied from 0.01 to 0.72 meq/l. Bicarbonates in most of the area ranged between 2.0-4.0 meq/l. Area near to streams and ponds ranged from 1 to 2 meq/l. Spatial representation of quality parameters at local level help in decision making by farmers and

local organizations (Asadi etal.,2007; Wasim Iftikar et al., 2010 Prasad et al.,2012).

Water quality index and irrigation classes of *Tanguturu* mandal

Irrigation water quality indexes were developed for *Tanguturu* mandal based on WQI equation and using WQI values GIS spatial map of *Tanguturu mandal* was developed. Irrigation water was classified based on index values and the 60 % samples of irrigation water was classified under the irrigation class moderately suitable and around 14 % samples were suitable for FCV tobacco. Presence of chlorides especially in ground water affecting the quality however, mostly the crop in the area is rainfed and ground & pond water is generally used only for life saving irrigation. Conjunctive use of irrigation water can be adopted in case of 20 % of the samples and only six percent of the samples are un-suitable for FCV tobacco (Fig.5).

The study area is having mostly black and mixed type of red and black soils with moderate ground water quality. High chloride concentration was observed in areas mostly near to seacoast and under coarse textured mixed soils. Ground water quality was of relatively low chlorides in villages near to local river i.e *Musi* and ponds. The pH of the irrigation water in the study area was mostly slightly alkaline to alkaline in nature. The irrigation water quality class based on water quality index in most of the area was moderately suitable to suitable with respect to FCV tobacco. Relatively high potassium content in the ground water in some areas help in better quality tobacco. The spatial thematic maps developed for the *Tanguturu mandal* of SBS of FCV tobacco will help in visualizing the prevailing ground water quality situation and managing the resource for better product quality in a local scale. It can be concluded that conjunctive use of ground water and rainwater harvested in ponds is the effective way of utilisation of available water resource in the study area for FCV tobacco.

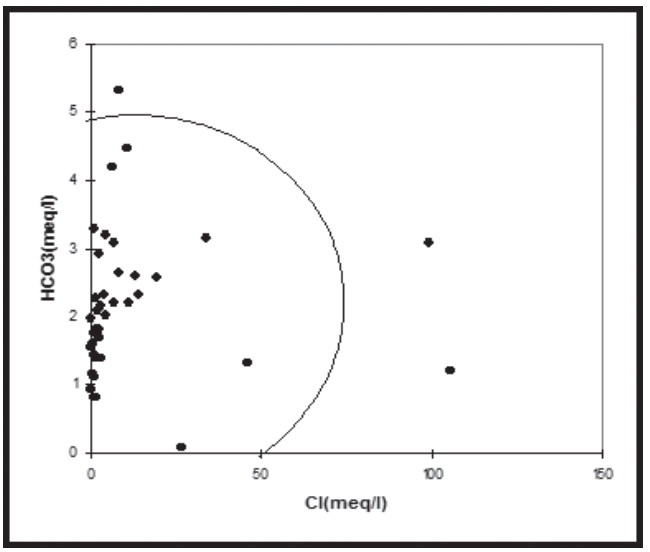

Fig. 2: Relationship of Bi-carbonate and chloride concentration in ground water of *Tanguturu mandal* of SBS under FCV tobacco.

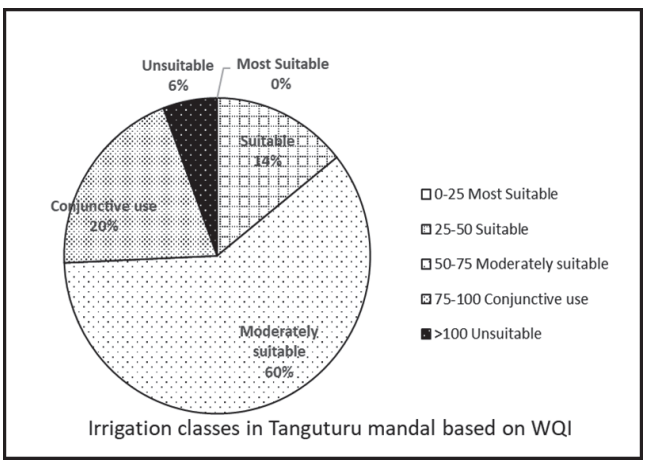

Fig. 3: Irrigation classes in *Tanguturu mandal* of SBS of FCV tobacco based on WQI

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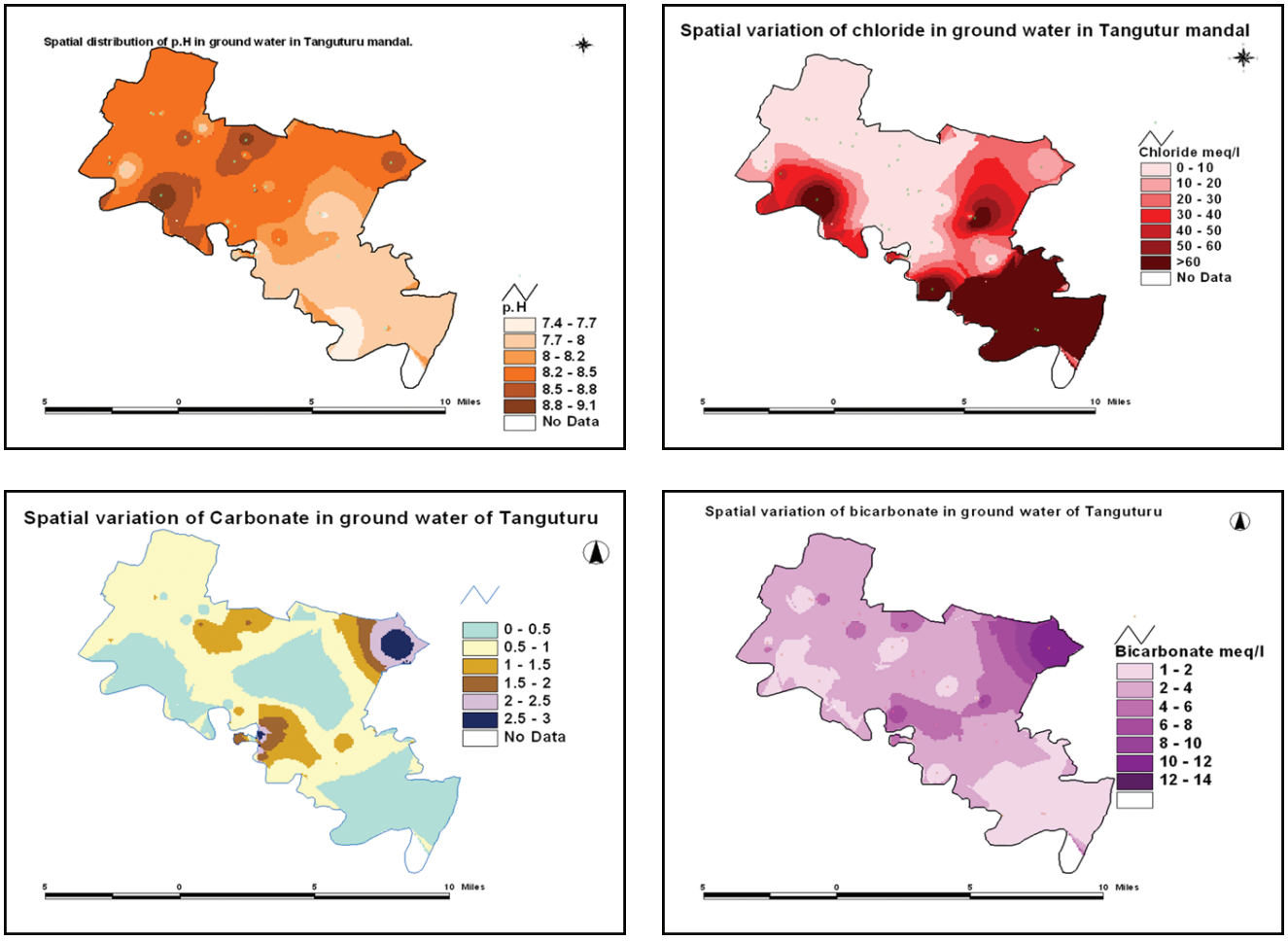

Fig.4: Spatial variation in a) pH, b) Chlorides c) Carbonates d) Bi carbonates concentration in *Tangutur* mandal of SBS of FCV tobacco

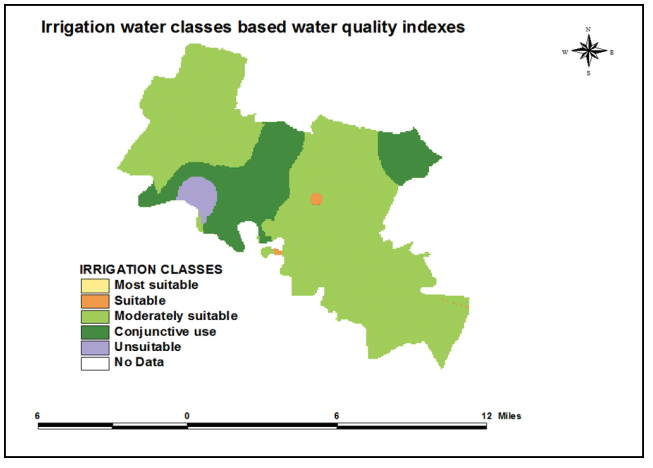

Fig.5: Spatial maps of Irrigation water classes in SBS of FCV tobacco in *Tangutur* mandal according to Water Quality Index

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Table 1: Physico-chemical properties and ionic concentration in selected irrigation water samples of villages under *Tangutur mandal.*

S no.	Study village	Source	Physico-chemical		Ionic concentration (meq/l)				
			pH	EC (dSm^{-1})	Chlorides	CO_3^{2-}	HCO_3^-	Na^+	K^+
1	*Marlapdu*	BW	8.5	1.65	4.51	0.4	3.2	0.57	2.10
2	*Ponduru*	BW	7.8	1.30	45.9	0.01	1.32	101.1	0.02
3	*Mallavarapadu*	BW	8.1	2.71	10.7	0.24	4.48	2.72	2.36
4	*Karumanchi*	BW	8.5	2.60	26.6	3.2	0.08	57.8	0.19
5	*Karumanchi*	P	8.4	1.53	1.07	0.01	1.12	0.61	0.06
6	*Konijedu*	BW	8.6	1.42	2.82	0.48	2.16	0.45	0.10
7	*Kanduluru*	BW	8.5	1.53	6.7	0.72	2.2	0.77	0.07
8	*T.Naidupalem*	BW	7.7	6.02	99.2	0.8	3.08	112.4	0.29
9	*Tanguturu*	BW	8.3	2.36	8.5	0.16	2.64	1.31	0.22
10	*Jayavaram*	BW	7.5	5.43	105.4	0.08	1.2	67.2	0.32
11	*Vasepallipadu*	P	8.7	3.07	14.1	0.08	2.32	1.49	0.46
12	*Nidamanuru*	BW	8.4	2.60	12.9	0.24	2.6	2.54	0.18

BW: Bore Well, P:Pond

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