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STUDIES ON IMPACT OF WATER PARAMETERS ON CROP YIELD OF COTTON AND PADDY FIELDS FROM VUYYURU KRISHNA DISTRICT ANDHRA PRADESH AND INDIA

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ABSTRACT

Water samples were collected from Vuyyuru, Krishna District, and Andhra Pradesh and screened to check the samples either fit or unfit to the agricultural practice of paddy and cotton fields. Crop yield enhancement studies were conducted, in that connection samples were drawn from April 2015 to April 2016. To predict the influencing water parameters like EC, RSC and SAR. The highest cotton and paddy yield on average basis was recorded as compared to previous reports lowest cotton yield. In the light of above findings, it is inevitable to treat the ground water, dilution with canal water and growing of salt tolerant crops. It is necessary to manage the soil structure on sustainable basis for obtaining optimum crop yield.

Key Words:EC, RSC, SAR, canal water, dilution, crop, yield, sustainability, Rice, Cotton.

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INTRODUCTION

Water is a key molecule which has many duties of life and is principally achieved in two ways, one is surface water, includes streams, canals as well as fresh water lakes, rivers etc., ground water like borehole water and well water. It has ability to soak, dissolve, suspend and absorb various conditions. Therefore, overall in nature the availability of pure water is impossible, as it receives the contaminants from its surroundings and from the human beings, insects, and animals from the other anthropogenic sources. The groundwater is one of the major sources of drinking water (Nishanthiny et al., 2010). Further, it is major source of water for agriculture and industrial purposes. The quality of water deteriorates day by day due to urbanization, civilization, solid and liquid waste disposal management and human activities (Nouri et al., 2017). Along with this agricultural sector is the largest consumer of ground water and approximately one-half of the total crop water requirements.

Vuyyurumandal, being in coastal area, the ground water quality of this area may change due to various reasons like salt water intrusion, tidal influx of river water, water loggin, domestic and industrial contamination etc., the effects of industrial effluents on the crops and soil ultimately affect the quality of surface and ground waters. The ground water quality variation problems can be understood only by regular monitoring of quality of water. Due to rapid urbanization of Vuyyurumandal, the quality of ground water may change further in future. Therefore, it was proposed to take up water quality monitoring in Gandigunta villageand Vuyyurumandal area.Total twenty four samples collected from the both villages of various places were analyzed for physicochemical assessment besides heavy metals assessment for evaluation of water quality in the VuyyuruMandal.However, the ill effects of the industrial effluents cannot be set aside (Kosemani et al., 2017).

MATERIAL AND METHODS

Description of the area under study:

Water Sampling: The water samples were collected from the running tube wells with great precautions. The following observations were recorded: The depth of the tube well, pipe diameter, area being irrigated, the name of the farmer, address of the farmer and agricultural area owned by the farmer and GPS (Geographical Positioning System) location of the area, prevailing cropping pattern, and sampling date. The precautionary measures adopted were: sample quantity was about 0.5 liter to 1.0 liter. The samples were collected in clean plastic bottles. The sampling bottles were rinsed thrice with the same water being sampled. Prior to sampling, the tube well was run about half an hour. The samples were taken from the tube well outlets and no sample was collated from the reservoir. The bottles were closed with the lids and labeled accurately.

Chemical Analysis:

The collected water samples were analyzed at Soil and Water Testing Laboratory for Research, Vuyyuru Krishna district for EC, pH, Ca^{+++} Mg^{++}, Na^{+}, CO_3^{-}, HCO_3^{-} and Cl^{-}. Then the sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) were calculated by using the formulas given by (Richards, 1954). Based on the values of EC, SAR, RSC, the water samples were classified by using international standards.

SAR was calculated by the following formula:

$SAR=Na^{+}/[(Ca^{2+}+ Mg^{2+})/2]$ ½ (Cations concentration=mmolc L^{-1})

RSC (meL^{-1}) = $(CO_3^{2-}+HCO_3^{-})-(Ca^{+++}+Mg^{++})$Where the concentrations are expressed in milliequivalents per liter (meL^{-1}) (Richards, L.A., 1954).

Statistical Analysis: https://www.lenntech.com/calculators/accuracy/accuracy-water-analysis.htm

RESULTS

The overall data showed that Gandigunta and Vuyyuru samples were fit and one or two samples were considered to be unfit in future for irrigation. The interesting thing is that about all samples are marginally fit for irrigation purposes according to the WHO standards.

Electrical conductivity (dSm-1) status: Gandigunta samples resulted EC values were ranged from 1.64 to 4.37dSm^{-1}. All the water Samples were within the safe limits (<2.00 dSm-1) whereas, Vuyyuru samples were fit (>2dSm^{-1}) are fit and are marginally saline in nature, even though they are fit for irrigation.

Sodium Adsorption Ratio (SAR) status: In the present study Vuyyuru samples showed SAR ranged from 4.47 to 14.42 meL^{-1}. The water samples categorized based on the concentration of SAR (Sodium Adsorption Ratio) in the case of Vuyyuru samples the SAR concentration which obtained was not suitable and are above acceptable condition indicates almost all the water samples were not within the safe limits (>14) but only one sample has (<5) indicates were not fit for irrigation because of more sodium or alkali in nature where plants are in stress condition. But in the case of Vuyyuru water samples SAR ranged from 2.56 to 8.39me L^{-1}. Gandigumta samples are permissible for irrigation and are suitable for plant growth and development of plant Gandigunta.

Residual Sodium Carbonates (RSC) Status: The RSC concentration of the Vuyyurumandal ranged from +0.39 to +3.9 and other samples were -1.33 to -5.71meL^{-1}. All the VuyyuruMandal water samples were safe limits (<4 meL^{-1}). This indicates that all the water samples are suitable for irrigation in nature due. But in the case of Gandigunta all the samples were shown higher concentration range from +0.74 to + 3.74 meL^{-1} indicates water have greater and also tells 75% of sodium and less than 25% of calcium and magnesium and >550 rainfall is the maximum limit of RSC. 50% of the samples have shown -0.04 to -3.39meL^{-1} indicates very less concentration of RSC in the water samples. With accordance of the obtained results have shown 50% of the Gandigunta

water samples were fit for irrigation and 50% were below normal ranges of RSC but in the case of Vuyyuru 50% of the samples are fit for cultivation and remained are shown below normal range of RSC indicate that all are suitable for irrigation and the samples were having good range of salinity.

Sulfates (SO_4), pH and Alkalinity:

As for the WHO standards of water, which contains less than 100mgL^{-1} sulfate are not toxic to the plant growth and development. More than 1000 mg/L toxic to the plant growth and developmental process (Ghoraba et al., 2013). In the present study, the SO_4 ranges from 57 to 86.9 mgL^{-1} present in the GandiguntaMandal samples. In the case of Vuyyuru SO_4 was observed 70.2 to 95.6 mg/L concentration were observed in the all samples analysis indicates both the villages samples are more permissible and suitable for irrigation and that water promotes the plant growth and development of the plant. Water samples were examined for the percentile of Hydrogen ion or pH concentration present in the entire study was starts from 8.2 to 10 represent the values of collected both Vuyyuru and Gandigunta samples were slightly alkaline in nature. This status of the both mandals samples pH was crossed the drinking water range according to the BSI. Because this adverse condition the water samples unfit for drinking but are suitable for irrigation purpose. Water samples due high levels of EC, SAR, RSC and their cumulative affect shown in the majority of the samples having high EC. This condition is ahead responsible to be unfit for crop irrigation in future?.

Effect of irrigation water on rice and cotton yield: The highest cotton yield was recorded in (23 Kgha-1), in the VuyyuruMandal followed by Gandigunta 22 Kgha^{-1}. This is because of the reason that most of the water samples from those areas were fit for irrigation in the year 2015. The lowest cotton yield was observed in Vuyyuru 16.90 Kgha^{-1} due to the high EC of waters in that area. Similarly, maximum rice yield was found in 46 Kgha^{-1} in VuyyuruMandal, followed by Gandigunta 43 Kgha^{-1} were observed and recorded simultaneously in the conseqitive year.

DISCUSSION

Conductivity is defined as the current carrying capacity of water. Water with high salinity is toxic to plants and creates salinity hazards (Borecka et al., 2016) (Ogunfowokan et al., 2013). Soils with high levels of salinity are called saline soils (Pooja Shrivastava and Rajesh Kumar, (2015)). High concentrations of salt in the soil can result in a change of physiological appearance leads to the drought conditions (Kamran et al., 2019). That is, even though the field appears to have plenty of moisture, but the plants start wilting because the roots become unable to absorb the water(Isbell, 2016). Water salinity is usually measured by the TDS (total dissolved solids) or through EC (Electrical Conductivity). In present study most of the water was unfit in due to high electrical conductivity. Sodium Adsorption Ratio conveys the relative movement of sodium (Na^+) ions in the exchange reactions with the soil (Wakeel, Abdul, (2013)). This ratio processes the relative concentration of Na^+ to calcium and magnesium (Wang, 2013). When water with high SAR is applied to a soil, the sodium (Na+) in the water can dislocate the calcium (Ca^{+2}) and magnesium (Mg^{+2}) in the soil (TanvirRahman et al., 2017). It creates hindrance in developing the stable soil aggregates and in turn result damage to soil structure. This also result decline in the permeability and infiltration of water in the soil with concomitant decrease in crop yield.

Residual sodium carbonate (RSC) occurs in irrigation water when the carbonate (CO_3) plus bicarbonate (HCO_3) content exceeds the calcium (Ca) plus magnesium (Mg) content of the water (Naseem et al., 2010). The extended use of that water with high RSC for irrigation will lead to an accumulation of Na^+ in the soil. It will result.

1. Nonstop toxicity to plants, 2. Surplus soil salinity and sodicity and associated poor plant development, and 3. Where significant amount of silt or clay is available in the soil, loss of soil structure and associated decrease in soil permeability (Zaman, Shahid and Heng, (2018)).

In the he study area water with high RSC was found in many areas indicating sign of danger in future to the soil structure of these areas which in turn hamper the crop yield in future. Regular use of waters with high RSC (>2.5 meL^{-1}) leads to salt build up and which may hinder the air and water movement by clogging the soil pores (Arora,et al., 2012). Sulfite ions have very strong correlation with Mg. The pH and alkalinity are valuable characteristics that can greatly manipulate the suitability of water for irrigation purposes (Riaz et al., 2018). The normal pH ranges for irrigation water is 6.5 to 8.4. The alkalinity is imparted due to CO_3 and HCO_3 ions in the ground water (Poyen et al., 2018). More concentration of HCO_3 get combine with Ca and Mg and will precipitate as carbonates when the soil solution concentrates in drying condition (Cao et al., 2008). The application of water with high EC directly affects the crop yields (Kumar et al., 2017)

CONCLUSION: The present investigation result suggests that the collected Vuyyuru and Gandiguntawater samples from various areas or stations were fit due to EC, SAR and RSC. It has been noticed that irrigation with poor quality water may cause salinity, specific ion toxicity or infiltration problems in the soil occurs. Such kind of situation effect the irrigation adversely crop production. And also show the impact of usage of different agro ecological conditions and their salinity, sodicity\ alkalinity hazards on soils would be formed in future.

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Statement showing the details of water samples chemical quality data of VuyyuruMandal, Krishna District.

Sample. No	Mandal	location	pH	Sp. Cond. at 25^{0}c in Micro siemans	TDS	CO3 as Ca CO3	HCO3as Ca CO3	SO_4	Cl	Na	K	Ca	Mg	T.H. expressed as ca co3	RSC	SAR	EC
					ppm	ppm	ppm	mgL^{-1}	ppm	ppm	ppm	ppm	ppm	ppm	$me\ L^{-1}$	$me\ L^{-1}$	dSm^{-1}
1	Vuyyuru	Gandigunta Village	9.0	1284.0	821.8	60.0		63.35	240.0	221.0	50.0	8.0	14.6	80.0	0.39	10.79	1.643
2			8.8	2050.0	1312.0	40.0	80.0	64.35	450.0	377.3	8.2	32.0	29.2	200.0	-1.35	11.63	2.624
3			8.4	2268.0	1451.5	40.0	120.0	86.9	430.0	NA	NA	16.0	63.2	300.0	-2.7	NA	2.903
4			8.8	2050.0	1312.0	40.0	80.0	81.3	450.0	370.9	8.0	32.0	29.0	200.0	-1.33	11.52	2.624
5			8.8	1804.0	1154.6	80.0	170.0	79.7	420.0	365.0	7.0	8.0	24.3	120.0	3.06	14.55	2.309
6			8.6	1817.0	1162.9	60.0	220.0	82.94	410.0	362.0	12.5	16.0	19.4	120.0	3.21	14.44	2.325
7			8.4	1578.0	1009.9	80.0	250.0	78.64	320.0	NA	NA	40.0	39.0	260.0	1.56	NA	2.019
8			7.3	3416.0	2186.2	0.0	310.0	70.04	970.0	NA	NA	88.0	77.8	540.0	-5.71	NA	4.372
9			8.4	1844.0	1180.2	60.0	230.0	57.28	440.0	326.2	6.7	16.0	14.6	100.0	3.76	14.32	2.360
10			9.6	1608.0	1029.1	40.0	230.0	65.35	350.0	NA	NA	8.0	19.5	100.0	3.1	NA	2.058
11			8.2	1780.0	1139.2	0.0	306.9	64.35	270.0	242.6	10.1	56.0	102.0	560.0	-3.5	4.47	2.278
12			8.9	1857.0	1188.5	79.2	356.4	86.9	310.0	NA	NA	40.0	97.2	500.0	-1.51	NA	2.377

Statement showing the details of water samples chemical quality data of VuyyuruMandal, Krishna District.

Sample. No	Mandal	location	pH	Sp. Cond. at 25^0c in Micro siemans	TDS	CO3 as Ca CO3	HCO3as Ca CO3	SO_4	Cl	Na	K	Ca	Mg	T.H. expressed as ca co3	RSC	SAR	EC
					ppm	ppm	ppm	mgL^{-1}	ppm	ppm	ppm	ppm	ppm	ppm	me L^{-1}	me L^{-1}	dSm^{-1}
1	Vuyyuru	Vuyyuru village	9.0	1511.0	967.0	80.0	170.0	75.9	171.0	245.0	26.9	16.0	43.8	220.0	1.05	7.24	1.934
2			9.0	1772.0	1134.1	140.0	170.0	76.9	210.0	139.4	33.5	72.0	87.5	540.0	-3.35	2.61	2.268
3			10.0	1888.0	1208.3	160.0	190.0	94.8	210.0	NA	NA	24.0	44.0	240.0	3.63	NA	2.416
4			9.0	1772.0	1134.1	140.0	170.0	80.0	210.0	137.1	32.1	72.0	88.0	540.0	-3.39	2.56	2.268
5			8.6	1543.0	987.5	140.0	130.0	75.6	200.0	165.0	50.0	16.0	77.8	360.0	-0.43	3.79	1.975
6			8.0	2138.0	1368.3	0.0	460.0	70.2	280.0	355.0	15.0	48.0	53.5	340.0	0.74	8.39	2.736
7			7.9	1695.0	1084.8	0.0	520.0	75.8	190.0	NA	NA	40.0	34.0	240.0	3.74	NA	2.169
8			8.4	874.0	559.4	40.0	160.0	87.74	110.0	NA	NA	32.0	29.2	200.0	-0.04	NA	1.118
9			9.6	1010.0	646.4	39.6	168.3	72.5	140.0	197.4	22.9	16.0	43.8	220.0	-0.33	5.83	1.292
10			7.5	842.0	539.0	0.0	227.7	95.9	80.0	NA	NA	32.0	53.0	300.0	-2.22	NA	1.078
11			8.5	1162.0	743.7	19.8	227.7	86.9	160.0	229.0	24.2	8.0	48.6	220.0	0	6.77	1.487