An investigative Study to Evaluate the Soil Health

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***Abstract*— Soil quality is a measure of the condition of soil. Soil quality reflects how well a soil performs the functions of maintaining biodiversity and productivity. Soil management has a major impact on soil quality. Soil properties are affected by past land use, current activities on the site, and nearness to pollution sources. Keeping in view the importance of soil quality which is quite useful for agricultural purposes, it is proposed to characterise the soils for physicochemical parameters Viz., pH, Electric Conductivity, Total Dissolved Solids, Total Hardness, Total Alkalinity, Chloride, Sulphate, Nitrate, Phosphate, Sodium, Potassium, Calcium and Magnesium and to determine the irrigation parameters like Percent Sodium, Sodium Adsorption Ratio, Kelly's Ratio and Magnesium Hazard to verify the quality for irrigation purpose particularly in mangrove region of East Godavari Region.**

***Index Terms*— Soil, Quality, Parameter, Irrigation, Mangrove**

I. INTRODUCTION

Soil quality is a measure of the condition of soil relative to the requirements of one or more biotic species and or to any human need or purpose[i]. Soil quality reflects how well a soil performs the functions of maintaining biodiversity and productivity, partitioning water and solute flow, filtering and buffering, nutrient cycling, and providing support for plants and other structures. Soil management has a major impact on soil quality. To minimize the negative effects of the mangrove felling on the ecosystem, extensive environmental studies have been carried out. In recent decades, the Mangroves forests have been affected mainly due to human activities resulting into the impact of climate on ecosystem[ii]. The concepts of soil quality and health imply an assessment of how well soil performs the multiple functions like a medium for plant growth, a regulator of water flow in the environment, an environmental filter, Maintenance of human and animal health and a part of the global storage and cycling of nutrients[iii,iv,v]. Quality soil will produce healthy crops over the long-term without increasing levels of inputs and It can control water flow, filter and degrade potential environmental contaminants. Soil is a dynamic and interacting component of our ecosystem but not just an inert medium to hold roots and nutrients for plants. Soil quality is an indicator of the fitness of soil for use[vi]. Soil can also be viewed as a community and in that community, the output and wastes of one group of individuals becomes the resources for another. Soils are formed by the decomposition of rock and organic matter over many years. Soil properties vary from place to place with differences in bedrock composition, climate and other factors. Soil properties are affected by past land use, current activities on the site, and nearness to pollution sources. Literature survey revealed that higher levels of pH, Sodium Adsorption Ratio (SAR), Exchangeable Sodium Percentage (ESP) and EC which in some locations exceeded the threshold requirements for cropping. The studies further revealed that pH, SAR and ESP were significantly higher in irrigated areas compared to non-irrigated areas of the scheme, indicating an influence of irrigation water on soils characteristics in irrigated land[vii]. The silt content is high in the sediments on which mangrove grows luxuriantly, in Godavari estuary[viii]. Keeping in view the importance of soil quality, it is proposed to characterise the soils particularly in mangrove region of East Godavari Region to evaluate the quality for considering them for application.

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II. EXPERIMENTAL

Soil samples are collected from three to four nearby locations of the ground water sample sources and are representative soil sample is prepared for analysis. The sampling locations at certain locations on the banks of the water stream joining the mouth of Bay of Bengal. Soil samples were collected and the details of Sample code, location, source and area coordinates are presented in Table –1, the study area selected and its satellite picture is presented in Figure –1

Figure –1: Study area – Matlapalem (RS-1)

Table –1: Sample code, location, Longitude and Latitude

Sampling Code	Sampling Location (Matlapalem (RS-1))	Longitude	Latitude
S – 1	Near Bridge (L Side)	$81^0$13'E	$16^0$51N
S – 2	Near Bridge (R Side)		
S – 3	Near Temple		
S – 4	Beside Temple		
– 5	Near Main Road		
S – 6	Matlapalem Area – 1		
S – 7	Matlapalem Area – 2		
S – 8	Matlapalem Area – 3		
S – 9	Matlapalem Area – 4		

S- Soil

Characterization of Physicochemical parameters: The Soil samples collected from Matlapalem mangrove region of East Godavari district of Andhra Pradesh, India during pre and post monsoon seasons were characterised for physicochemical parameters viz: pH, EC, TDS, TH, TA, Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-}, Na^+, K^+, Ca^{2+}, Mg^{2+}. The analytical data is presented from tables 2, 3 and 4. The parametric values are also represented graphically in figures 2–14.

Irrigation parameters: The irrigation parametric values will act as indicators for the suitability of soils for irrigation purposes. The irrigation parameters like Percent Sodium (%Na)[ix], Sodium Absorption Ratio (SAR)[x,xi], Kelly's Ratio (KR)[xii] and Magnesium Hazard (MH)[xiii] are determined by using the relationship as detailed below.

$$\%Na(me/l) = \frac{Na^+ x\ 100}{Na^+ + K^+ + Ca^{2+} + Mg^{2+}}$$

$$SAR\ (me/l) = \frac{Na^+}{\sqrt{Ca^{2+} + Mg^{2+}/2}}$$

$$KR = \frac{Na^+}{Ca^{2+} + Mg^{2+}}$$

$$MH = \frac{Mg^{2+}\ X\ 100}{Ca^{2+} + Mg^{2+}}$$

The analytical data of irrigation parameters determined are presented in table – 5. The parametric values are graphically represented in figures from 15 – 18.

Table – 2: Physicochemical Parameters of soil

Sample code	pH		EC (µmhos/cm)		TDS (mg/l)		TH (mg/l)		TA (mg/l)	
	Monsoon		Monsoon		Monsoon		Monsoon		Monsoon	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
S-1	7.6	5.3	422	606	270.1	387.8	500	1800	800	1000
S-2	7.6	6.4	303	681	193.9	435.8	600	1700	900	1000
S-3	7.6	6.9	349	351	223.4	224.6	500	2100	400	1000
S-4	7.5	6.5	375	166	240	106.2	500	1400	300	1000
S-5	7..4	7.3	351	439	224.6	281.0	500	1600	500	1000
S-6	7.1	6.9	224	228	143.4	145.9	400	1200	500	1000

Table – 3: Physicochemical Parameters of soil

Sample code	Cl^- (mg/l)		SO_4^{2-} (mg/l)		NO_3^- (mg/l)		PO_4^{3-} (mg/l)	
	Monsoon		Monsoon		Monsoon		Monsoon	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
S-1	106.4	248.2	123.9	130.7	31.6	32.4	3.2	1.0
S-2	35.5	106.4	239.4	215.3	32.4	34.2	1.8	1.0
S-3	106.4	177.3	215.3	239.4	36.8	37.4	1.4	BDL
S-4	70.9	177.3	60.3	71.9	38.4	41.6	1.4	BDL
S-5	70.9	106.4	215.3	239.4	42.6	44.4	1.6	1.0
S-6	70.9	35.5	229.7	215.3	40.4	42.2	1.0	BDL

Table – 4: Physicochemical Parameters of soil

Sample code	Na^+ (mg/l)		K^+ (mg/l)		Ca^{2+} (mg/l)		Mg^{2+} (mg/l)	
	Monsoon		Monsoon		Monsoon		Monsoon	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
S-1	8.49	4.89	4.1	1.1	60	40	85	415
S-2	5.52	3.69	7.2	2.3	100	80	85	366
S-3	7.41	9.54	4.1	1.6	40	80	98	464
S-4	9.13	3.15	1.9	0.3	80	40	73	317
S-5	6.03	4.11	3.1	1.4	60	40	85	366
S-6	3.94	3.31	3.4	0.5	80	80	49	244

Table – 5: Irrigation Parameters of Soil

Sample Code	%Na (me/l)		SAR (me/l)		KR		MH	
	Monsoon		Monsoon		Monsoon		Monsoon	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
S-1	3.58	0.39	0.17	0.04	0.04	BDL	69.49	94.32
S-2	1.96	0.34	0.10	0.03	0.02	BDL	57.74	87.98
S-3	3.15	0.68	0.15	0.08	0.03	0.01	79.61	90.26
S-4	3.85	0.33	0.18	0.03	0.04	BDL	59.42	92.69
S-5	2.58	0.37	0.12	0.04	0.03	BDL	69.49	93.61
S-6	2.10	0.45	0.09	0.04	0.02	BDL	49.39	82.99

Figures – 2 to 14: Graphical representation of physicochemical parameters of soil

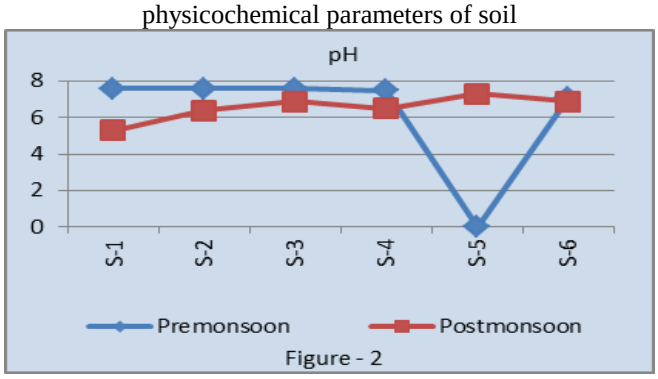


Figure - 2

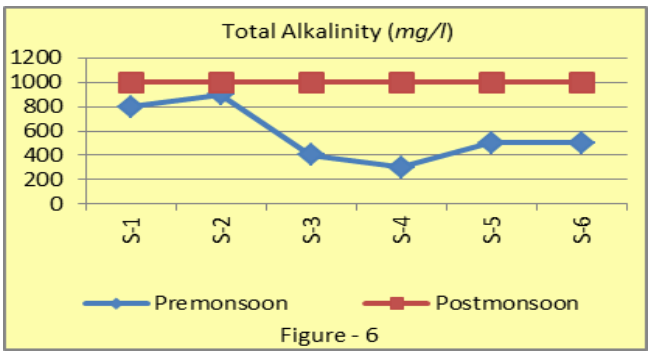


Figure - 6

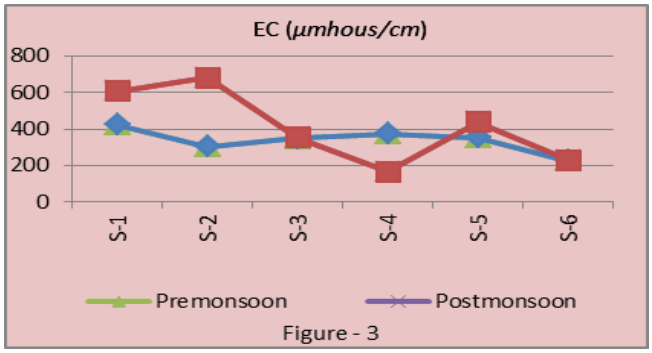
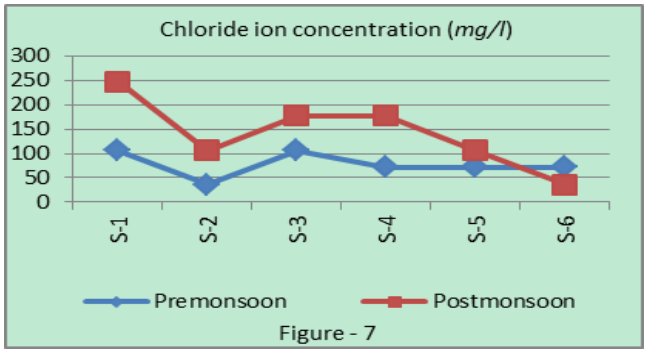


Figure - 3



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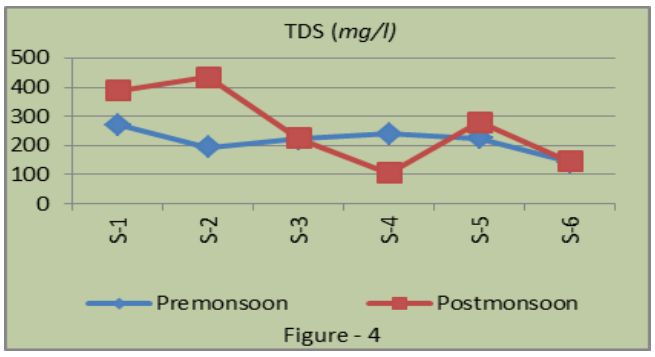

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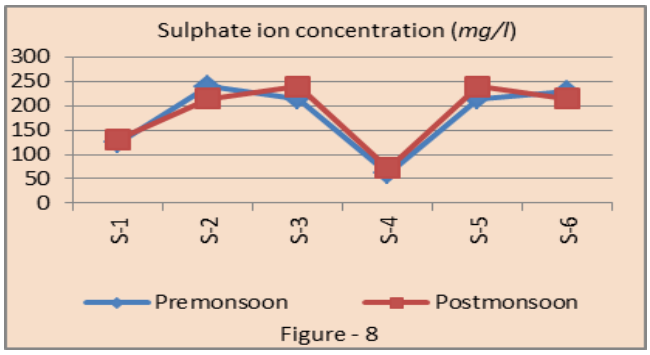

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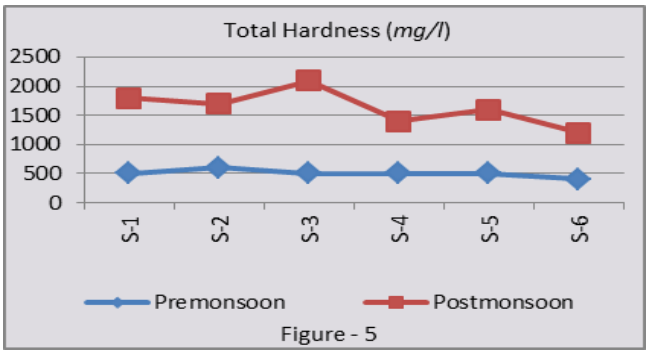

Figure - 5

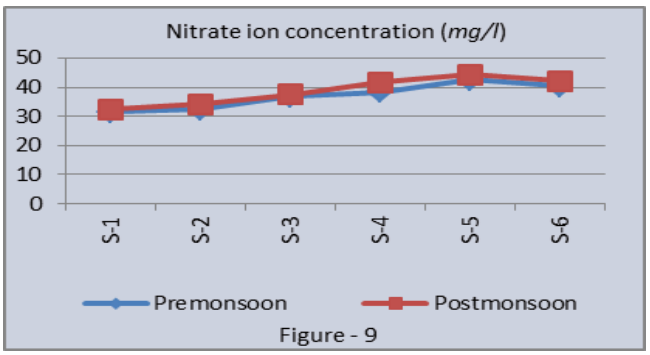

Figure - 9

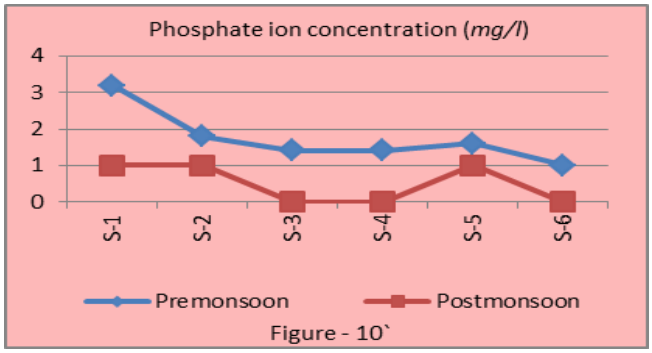

Figure - 10`

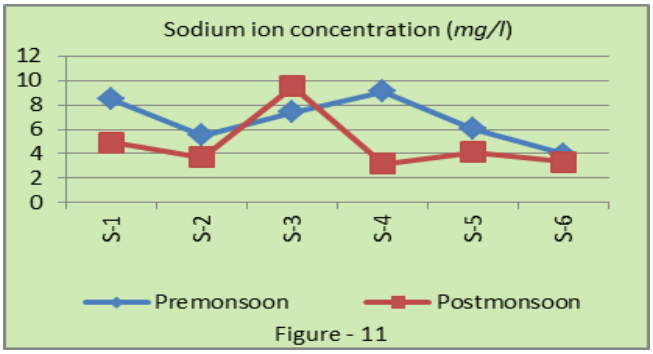

Figure - 11

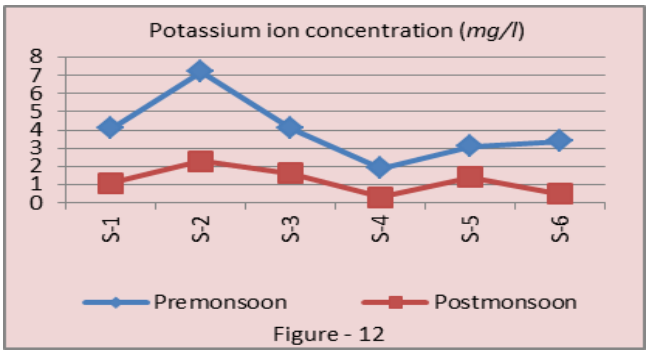

Figure - 12

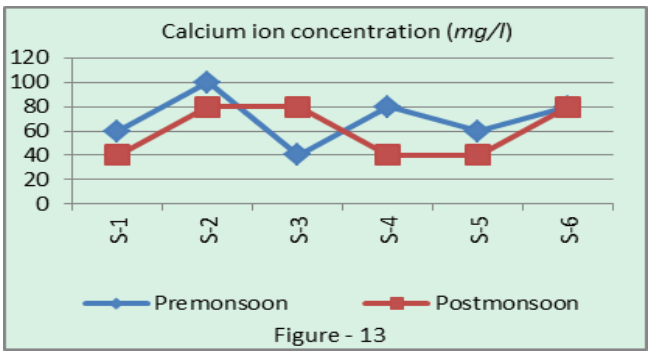

Figure - 13

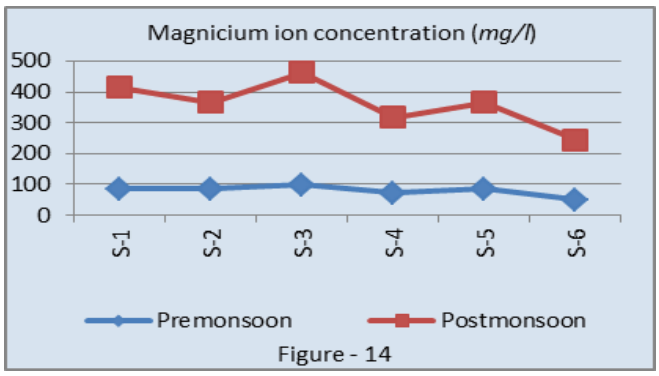

Figure - 14

Figures –16 – 19: Graphical representation of irrigation parameters of soil

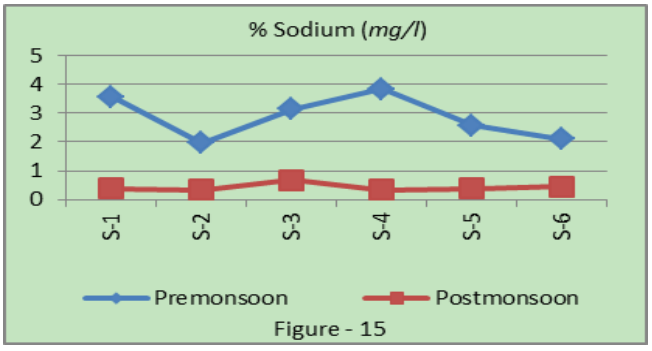

Figure - 15

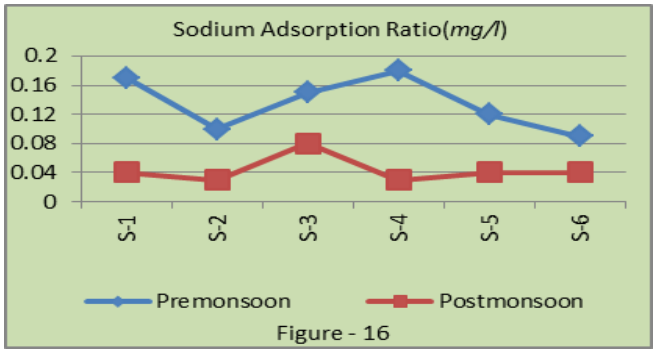

Figure - 16

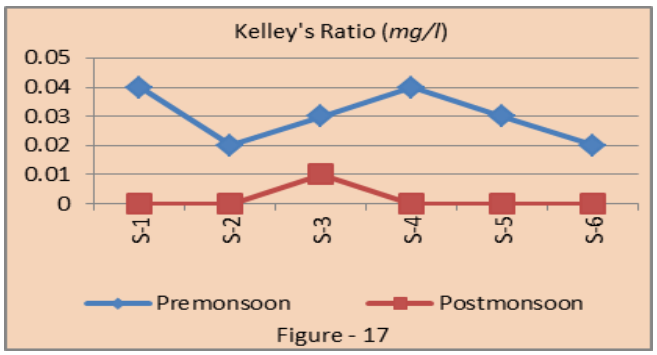

Figure - 17

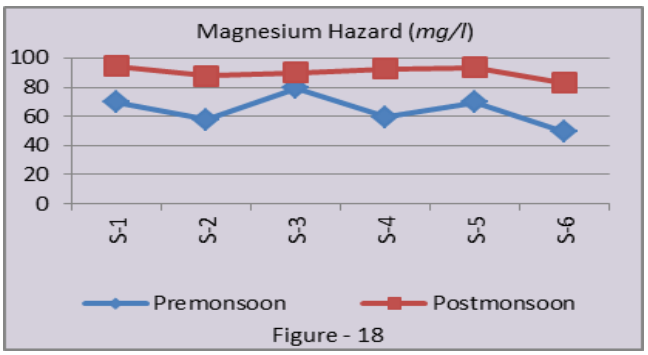

Figure - 18

III. Results and Discussion:

pH: pH of soil sample of the Pre Monsoon season ranges from 7.1 to 7.6 and are with the permissible limit[xiv] of no problem range, while the pH of soils of Post Monsoon season ranges from 5.3 to 7.3. The pH of soil sample S-1 and S-2 are 5.3 and 6.4 and are in problematic range of pH range and hence the soils can exhibit acidic nature while the pH of other soil samples is in the no problematic range.

Electrical Conductivity (EC): The EC values of soils of Pre Monsoon ranges from 224-422µmhos/cm while the pH values of soils of Post Monsoon season ranges from 166-681µmhos/cm and all the values are within the permissible limit of irrigation standards[xv] of soil.

Total Dissolved Solids (TDS): The TDS of soil of Pre Monsoon ranges from 143.4-270.1mg/l while the TDS of soils of Post Monsoon ranges from 106.2-435.8mg/l and the TDS levels are within the permissible limits[15] indicating the presence of the lower concentration of dissolved solids.

Total Hardness (TH): The Total Hardness of soils of the Pre Monsoon season range from 400-600 mg/l while TH in post monsoon ranges from 1200-2100mg/l. The TH exceeded the permissible limits[15].

Total Alkalinity (TA): The total Alkalinity values range from 300-900mg/l in case of Pre Monsoon soil samples while TA level is 1000mg/l in case of Post Monsoon soil sample. The higher values of TA indicate the alkaline nature of soils.

Chloride (Cl^-): The Chloride concentration in soils of the Pre Monsoon season ranges from 35.5 – 106.4mg/l while it ranges from 35.5 – 248.2mg/l in Post Monsoon season soil samples. The levels are within the permissible limit[15].

Sulphate (SO_4^{2-}): Sulphate ion concentration of soils of Pre Monsoon season ranges from 60.3-239.4mg/l while the sulphate level Sulphate level in soils of Post Monsoon season ranges from 71.9-239.4mg/l. The values are within the permissible level[14].

Nitrate (NO_3^-): The Nitrate ion concentration of soils of Pre Monsoon ranges from 31.6 to 42.6mg/l and ranges from 32.4-44.4mg/l and the lower values of Nitrate indicating the non discharge of agricultural runoff into the soils.

Phosphate (PO_4^{3-}): The phosphate ion concentration of soil samples of Pre Monsoon season ranges from 1.0-3.2mg/l while the Phosphate ion concentration ranges from BDL to 1.0mg/l indicating the non discharge of agricultural runoff into the soils.

Sodium (Na^+) and Potassium (K^+): The Sodium ion concentration in Pre Monsoon and Post Monsoon seasons range from 3.94-9.13mg/l and 3.15-9.54mg/l while Potassium ion concentration ranges in 1.9-7.2mg/l and 0.3to 2.3mg/l in soils of Pre and Post Monsoon.

Calcium (Ca^{2+}) and Magnesium (Mg^{2+}): Calcium ion concentration ranges from 40-100mg/l in Pre Monsoon soil samples while it ranges from 40-80mg/l in Post Monsoon soil samples. Magnesium levels range from 49 - 98mg/l in Pre Monsoon soil samples, while it ranges from 244-464mg/l in Post Monsoon soil samples. Higher values of Mg can create Magnesium Hazard and which can deplete quality of the soil.

Percent Sodium (%Na): The Percent Sodium of soil samples range from 1.96-3.85me/l in case of pre monsoon soil samples while it ranges from 0.33 to 0.68me/l in respect of soil samples of post monsoon are within the possible limit of irrigation standards[15].

Sodium Adsorption Ratio (SAR): SAR levels in pre monsoon soil samples ranges from 0.09 to 0.18me/l in pre monsoon soil samples while it ranges from 0.03 to 0.08me/l in post monsoon soil samples. The levels are within the permissible limit of irrigation standards[14].

Kelly's Ratio (KR): KR of soil samples of pre monsoon season ranges from 0.02 to 0.04 and in post monsoon soil samples except in sample (S-3), the KR level is at BDL and hence the values are within the permissible limit of irrigation standards[14].

Magnesium Hazard (MH): MH of soil samples of pre monsoon season ranges from 49.39 to 79.61 while the level ranges from 82.99 to 94.32 in case of soils of post monsoon season. MH exceeded the permissible limit of irrigation standards[14] and can deplete the soil quality.

IV. Conclusions

Though all the parametric values like pH, EC, TDS, TH, Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3}, Na^+, K^+, Ca^{2+} are within the permissible limit, the Total Alkalinity indicates the alkaline nature of the soils. The Magnesium concentrations are on the higher side which indicate the Magnesium Hazard of the soil. The higher concentrations of Magnesium deplete the soil quality as such the crop yields will be reduced. Though the irrigation parametric values like Percent Sodium, SAR, KR are within the permissible limits, the exceeded levels of Magnesium Hazard can cause depletion in the soil quality and consequently crop yields reduce in the study area. Hence suitable and appropriate treatment methods are to be initiated to reduce the Magnesium levels in the soil to enhance the crop yields in the study area.

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