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Quality Evaluation of Soils in Coringa Mangroves region in East Godavari District for Assessment of its Quality for Application

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Abstract— **Soil with quality can produce healthy crops over a long term. Soil quality is an indicator of its fitness for use. Man made activities can change the quality of soil. In the present research study, six representative soil samples collected during pre and post monsoon season from Coringa mangrove region of East Godavari estuaries were characterised for physicochemical characters pH, EC, TDS, TH, TA, Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-}, Na^+, K^+, Ca^{2+} and Mg^{2+} and irrigation parameters like %Na, SAR, RSC, KR and MH were determined. In majority soils EC, TDS, TH and TA are on the higher side of permissible limits indicating the saline nature of the soils and the presence of solids in soils. pH values indicate the slight alkaline nature of soil, Total Alkalinity values also indicate the alkaline nature of soils. Higher Chloride value in one sample also indicate the saline nature of soil. Nitrate and Phospate levels also indicate the occational discharge of agricultural runoff into the soil. Higher values of Magnesium indicate the Magnesium Hazard of soil. Irrigation parameters like SAR, KR indicated the suitability of soil for irrigation while higher levels of Magnesium Hazard can deplete the soil quality in consequently. The production of crop yields in the study area reduce. Hence the soils are to be reclaimed accordingly to reduce the chemical contamination and Magnesium Hazard to attain good crop yields in the study area.**

Index Terms— **Soil, Estuaries, Characterisation, Irrigation**

I. INTRODUCTION

Soil quality is the capacity of soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health[1]. 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[2-4]. 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[5]. Soil can also be viewed as a community[6] 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.

Soils are classified as saline or sodic based on the soluble salts in saturated extracts (EC) and the proportion of Na to Ca and Mg in saturated extracts (SAR=Na $(Ca+Mg/2)^{1/2}$ or the proportion of exchangeable Na to cation exchange capacity (ESP=Na/CEC/100)[7]. 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[8]. The silt content is high in the sediments on which mangrove grows luxuriantly, in Godavari estuary[9]. Human activities have intentionally added substances such as pesticides, fertilizers and other amendments to soils[10].

Keeping in view the importance of soil quality which is quite useful for agricultural purposes, it is proposed to characterise the soils particularly in mangrove region of East Godavari Region to evaluate the quality of soils for considering them for application.

II. EXPERIMENTAL

Study Area: The present study area Corangi is located in East Godavari District of Andhra Pradesh between the latitude $82^0$19'E and longitude $16^0$52'N. Soil samples were collected in the mangrove region of Coringa and are represented in figure-1 and the details of sampling code, source and location are presented in Table – 1.

Characterization of Soil: Six representative Soil samples were collected from Korangi mangrove region 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 representative water samples were characterized for physicochemical parameters viz., pH, Electrical conductivity (EC), Total Dissolved solids(TDS), Total Alkalinity(TA),Total hardness(TH), Calcium and Magnesium, Na^+, K^+, Chloride, Sulphate and Phosphate as per standard procedures[11]. pH determined by pH meter (Global-DPH 505,India-Model) and Conductivity measured by the digital conductivity meter (Global-DCM-900- Model). TDS is determined from the relation TDS = Electrical conductivity (EC) X 0.64. Chloride, Total hardness, Total Alkalinity and Chloride are estimated

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by titrimetry. Sulphate and Phosphate by spectrophotometer (Model-167, Systronics), Na and K by Flame photometer (Model-125, Systronics). The analytical data is presented in tables from 2 to 4. The parametric values are also represented graphically in figures 2(1) – 2(13)

Irrigation Parameters: The irrigation parameters like Percent Sodium (% Na)[12], Sodium Adsorption Ratio (SAR)[13,14] , Kelly's Ratio (KR)[15] and Magnesium Hazard (MH)[16] were determined by using the relationship. The analytical data is presented in table – 3 and are shown graphically in figure – 2(14) – 2(17)

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

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

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

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

III. Results and Discussion

pH: pH of soils of pre and post monsoon ranges from 7.2 - 7.8 and 7.0 - 7.5 and are well within the permissible limit of irrigation standards[17], however the pH levels indicate slight alkaline nature of the soils.

Electrical Conductivity (EC): Electrical Conductivity of pre monsoon season ranges from 399 µmhos/cm - 7310µmhos/cm. Electrical Conductivity of soil sample S - 6 is considered to be the soil with high salinity and the soil is unsuitable for irrigation purpose[18]. Higher values of Electrical Conductivity may be due to the increased rate of percolative and agricultural waters containing more dissolved solids. EC of soils of post monsoon season are below the permissible limit indicating the non saline nature of soils.

Total Dissolved Solids (TDS): Total Dissolved Solids of soils range from 255mg/l - 4678mg/l in case of samples of pre monsoon seasons. TDS of sample S - 2, S - 3 and S - 6 of Pre monsoon crossed the permissible limit and are unsuitable for irrigation purposes. TDS of soil samples of both pre and post monsoon season ranges from 156mg/l - 282mg/l are within the permissible limit[19].

Total Hardness (TH): Total Hardness of soils of both pre and post monsoon season crossed the permissible limits indicating the hardness of soils.

Total Alkalinity (TA): Total Alkalinity of soils of pre monsoon season ranges from 400mg/l - 600mg/l and TA in all soils of post monsoon season is 1000mg/l. The higher values of TA indicate the alkaline nature of soils.

Chloride (Cl^-): Chloride ion concentration in soils of pre monsoon season ranges from 70.9mg/l - 425.4mg/l. In sample S-6 only, the chloride ion concentration exceeded the permissible limit indicating the saline nature of the soil. Chloride concentration in soils of post monsoon season ranges from 35.5mg/l to 248.2mg/l and are within the permissible limit of irrigation standards[20].

Sulphate (SO_4^{2-}): Sulphate ion concentration in soils of pre monsoon season ranges from 38.2mg/l - 215.3mg/l. In case of soils of post monsoon season sulphate ranges from 60.3mg/l - 239.4mg/l.

Nitrate (NO_3^-): Nitrate ion concentration in case of pre monsoon soil samples ranges from 34.6mg/l to 40.8mg/l while its concentration in post monsoon soil samples ranges from 36.2mg/l to 42.4mg/l.

Phosphate (PO_4^{3-}): Phosphate ion concentration in pre monsoon soil samples ranges from 1.0mg/l -6.4mg/l. While in case of soil samples of post monsoon season, phosphate ion concentration ranges from BDL to 7.6mg/l. In case of sample S-1, the level exceeded the limit of 5mg/l indicating occasional discharge of agricultural runoff into the soil.

Sodium (Na^+) and Potassium (K^+): Sodium ion concentration in soil samples of pre monsoon season varies from 6.63mg/l - 66.77mg/l and in case of post monsoon season, it ranges from 3.14mg/l - 3.84mg/l. Potassium ion concentration in soils of Pre monsoon season ranges from 6.2mg/l - 27.5mg/l, while its concentration ranges from 0.5mg/l - 1.1mg/l in case of post monsoon soil samples.

Calcium (Ca^{2+}) and Magnesium (Mg^{2+}): Calcium ion concentration in soil samples of pre monsoon season ranges from 40mg/l - 220mg/l, while its concentration ranges from 40mg/l - 80mg/l in case of soil samples of post monsoon season. Magnesium ion concentration ranges from BDL to 256.2mg/l in pre monsoon soil samples while its concentration ranges from 195.2mg/l - 292.8mg/l. Higher concentration of Magnesium contributes Magnesium Hazard to the soils and consequently the quality of soil reduces and the crop yields will be affected.

Percent Sodium (%Na): Percent Sodium value of soils of pre monsoon season ranges from 1.35me/l - 21.30me/l while the values range from 0.54me/l - 0.69me/l in soil samples of post monsoon season. The values are well within the permissible limit[20] of irrigation standards.

Sodium Adsorption Ratio (SAR): Sodium Adsorption Ratio of soils of pre monsoon season ranges from 0.09-1.30me/l and the SAR of soils of post monsoon ranges from 0.04me/l - 0.05me/l. The levels are within the permissible limit of irrigation standards[21].

Kelley's Ratio (KR): Kelley's Ratio of soils of pre monsoon season ranges from 0.01 - 0.29 while KR of post monsoon season soil samples 0.01 in all samples. The levels are within the permissible limits of irrigation standards[20].

Magnesium Hazard (MH): Magnesium Hazard of soil samples of pre monsoon samples ranges from BDL – 87.23. MH of soil sample S-6 is at BDL while in other samples. MH exceeded the permissible limit of irrigation standards[20]. MH

of post monsoon soil samples ranges from 79.61 - 93.40 and all the values exceeded the permissible limit of irrigation standards indicating the Magnesium Hazard of soils in the study area.

IV. CONCLUSIONS

pH of pre and post monsoon season soils indicates slight alkaline nature. Electrical Conductivity of soils of all locations of pre monsoon season except S-6 indicates the suitability for irrigation. EC of S-6 crossed the permissible limit indicating high saline nature and indicates its unsuitability of irrigation. Total Dissolved Solids of soils except S-6 sample are within the permissible limit, while TDS of S-6 crossed the permissible limit indicating the presence of more dissolved solids in soil. Total Alkalinity of soils of both pre and post monsoon season crossed the permissible limit indicating the alkaline nature. Chloride concentration of both seasons samples except in S-6 is within the permissible limit but Chloride concentration in S-6 crossed the limit indicating the saline nature of soils. Sulphate levels are also within the permissible limit indicating the non discharge of industrial affluent into the soils. Lower concentration of Nitrate and Phosphate indicate the occasional discharge of agricultural runoff into the soils. Concentration levels of Sodium and Potassium in majority soil samples are within the limits of WHO standards. Calcium concentration in S-6 and in majority soils of post monsoon season crossed the permissible limit. Magnesium levels are on the higher side in almost all samples indicating the Magnesium Hazard in soils of the study area.

Higher Magnesium levels in soils can cause Magnesium Hazard so that the utility can be depleted and consequently the crop yields will be reduced and shortage in foodstuffs will be experience in the study area.

Though the values of percent sodium, SAR and KR are within the permissible limit of irrigation standards. Higher values of Magnesium Hazard deplete the quality of soil and consequently the crop yields will be reduced in the study area, if the soils are consumed for irrigation, suitable methods of treatment are to be employed to reclaim the soils from Magnesium Hazard.

Table-1: Sample code, location, source type, Longitude and Latitude

Sampling Code	Sampling Location (Coringa)	Type of Source	Longitude	Latitude
S-W-1	Near Bridge (left)	SW	$82^0$19'E	$16^0$52'N
S-W-2	Near Bridge (Right)	SW		
S-W-3	Near Sub Stream	SW		
G-W-1	Coringa Area-1	OW		
G-W-2	Coringa Area -2	OW		
G-W-3	Coringa Area -3	OW		
G-W-4	Coringa Area -4	BW		
G-W-5	Coringa Area -5	BW		
G-W-6	Coringa Area -6	OW		

SW – Surface Water, GW – Ground Water, OW – Open Well, BW – Bore Well

Table – 2(1): pH, EC, TDS, TH, TA 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	7.4	7.5	767	279	491	179	500	1300	600	1000
S-2	7.5	7.1	904	333	579	213	400	1300	600	1000
S-3	7.8	7.1	1140	287	730	184	600	1000	600	1000
S-4	7.5	7.0	399	244	255	156	500	1550	500	1000
S-5	7.6	7.2	423	440	271	282	1200	1400	500	1000
S-6	7.2	7.5	7310	262	4678	168	500	1100	400	1000

Table – 2(2): Cl^- , SO_4^{2-}, NO_3^- and PO_4^{3-} ion concentration 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	215.3	239.4	34.6	36.2	6.4	7.6
S-2	141.8	177.3	120.4	130.7	38.4	38.6	1.0	1.0
S-3	177.3	70.9	71.9	60.3	40.8	42.4	1.4	1.2
S-4	70.9	70.9	38.2	71.9	38.8	39.2	1.0	0.0
S-5	70.9	35.5	60.3	71.9	36.8	38.4	1.2	0.8
S-6	425.4	248.2	215.3	229.7	38.2	40.2	1.6	1.0

Table – 2(3): Na^+, K^+, Ca^{2+}, Mg^{2+} ion concentration of soil

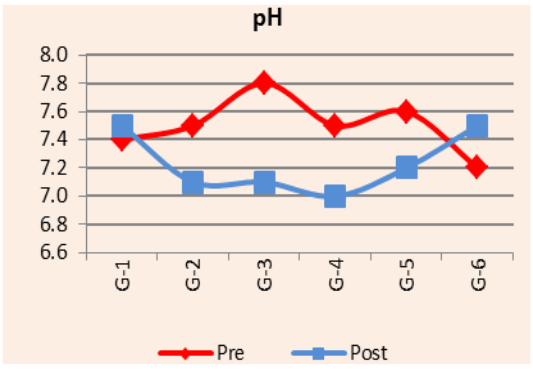
Sample code	Na^+ (mg/l)		K^+ (mg/l)		Ca^{2+} (mg/l)		Mg^{2+} (mg/l)	
	Monsoon		Monsoon		Monsoon		Monsoon	
	Pre	Pre	Pre	Post	Pre	Post	Pre	Post
S-1	13.58	3.18	6.6	1.1	40	80	97.6	268.4
S-2	18.25	3.5	6.8	0.8	60	80	61.0	268.4
S-3	20.22	3.14	10.0	0.8	60	80	109.8	195.2
S-4	6.63	3.26	6.2	0.5	60	40	85.4	353.8
S-5	7.45	3.84	6.6	0.9	60	80	256.2	292.8
S-6	66.77	3.17	27.5	0.5	220	40	BDL	244

Table – 3: % Na, SAR, KR & MH of soil

Sample Code	%Na (me/l)		SAR (me/l)		Kelly's Ratio(KR)		MH	
	Monsoon		Monsoon		Monsoon		Monsoon	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
S-1	5.59	0.54	0.27	0.04	0.06	0.01	79.61	84.30
S-2	8.97	0.59	0.40	0.04	0.10	0.01	61.93	84.30
S-3	6.80	0.69	0.36	0.04	0.07	0.01	74.54	79.61
S-4	2.80	0.47	0.13	0.04	0.03	0.00	69.49	93.40
S-5	1.35	0.60	0.09	0.05	0.01	0.01	87.23	85.41
S-6	21.30	0.64	1.30	0.04	0.29	0.01	BDL	90.71

Fig-1: Satellite picture of study area.

Figure – 2(1) – 2(17): Graphical representation of soil parameters.



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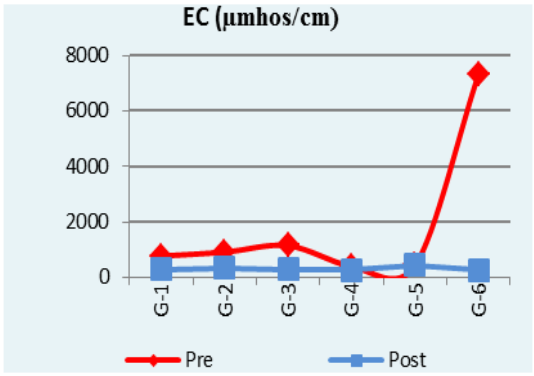

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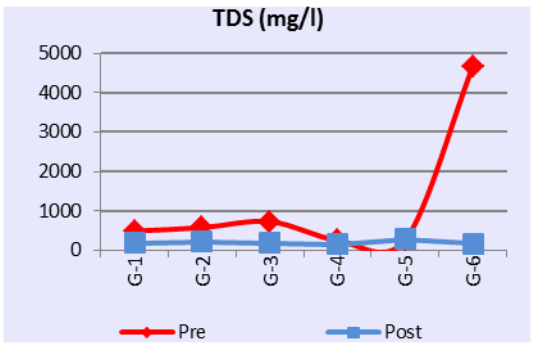

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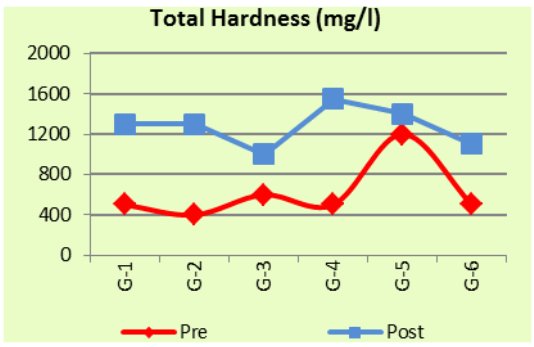

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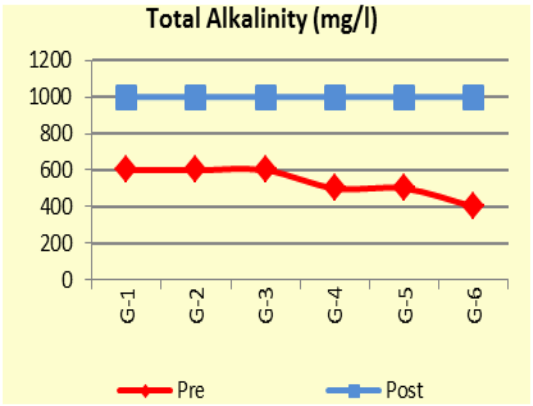

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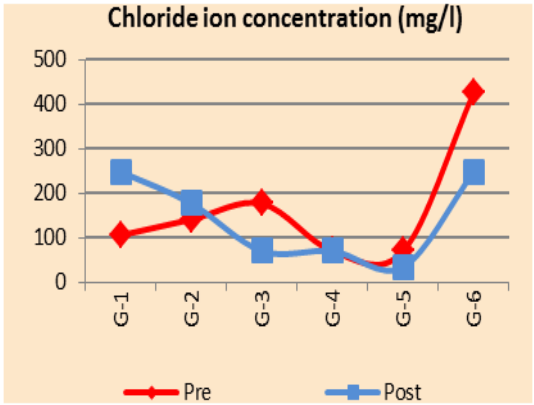

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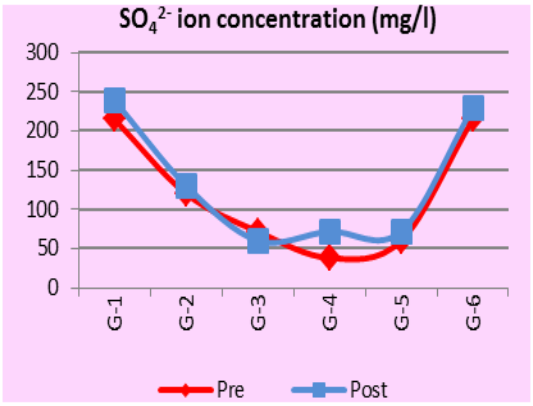

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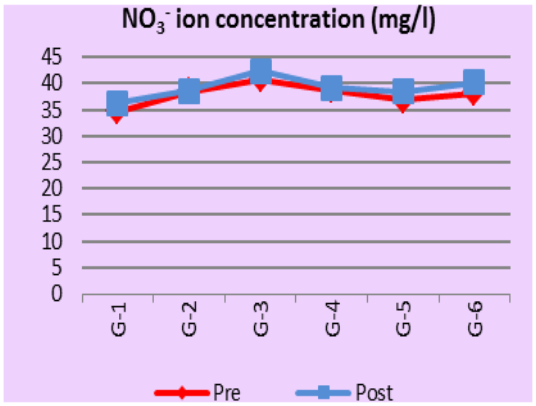

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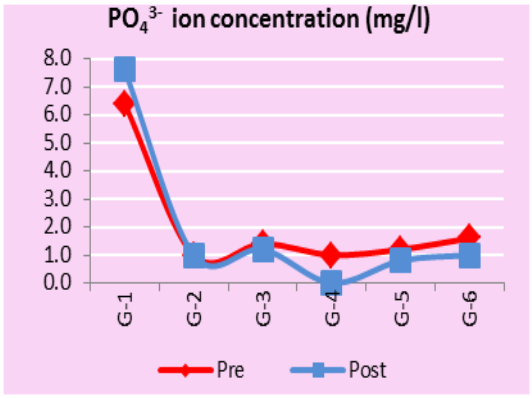

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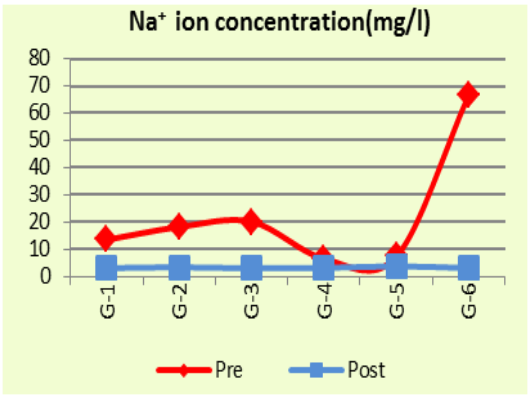

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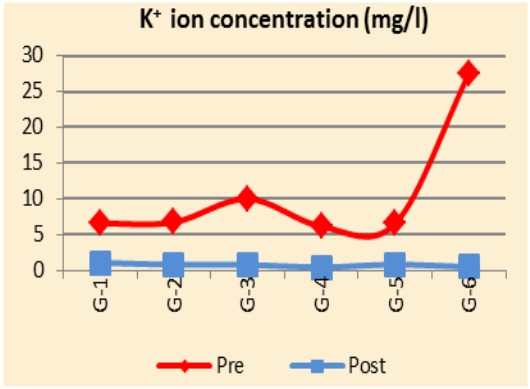

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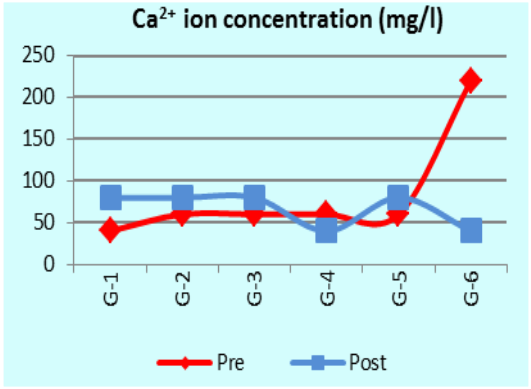

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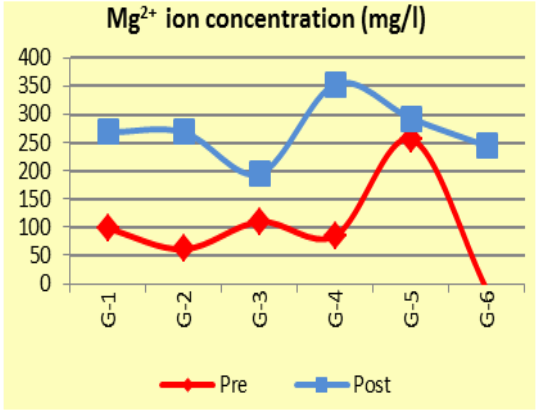

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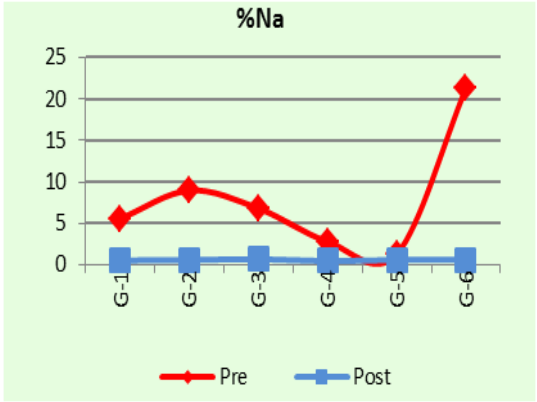

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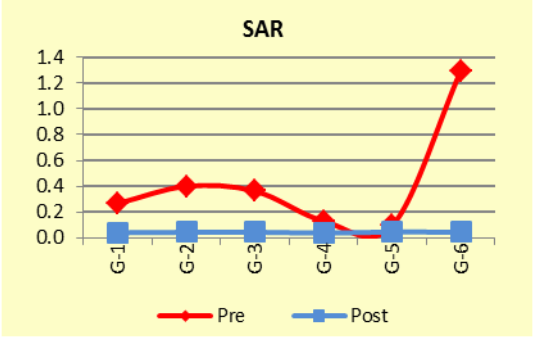

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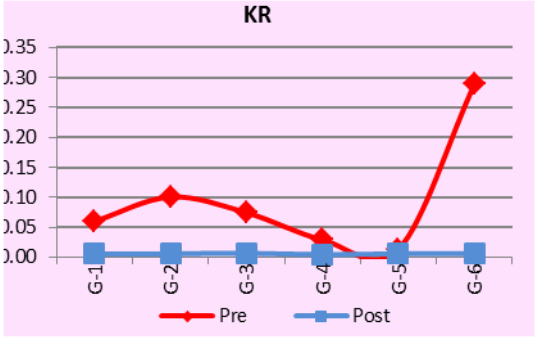

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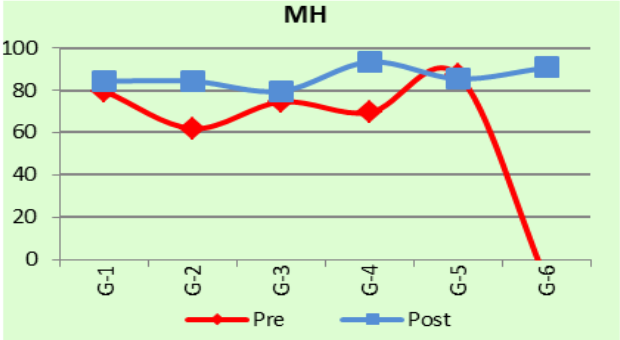

Fig. 2(17)

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