Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Der Pharmacia Lettre, 2013, 5 (3):481-491
(http://scholarsresearchlibrary.com/archive.html)

Scholars Research Library
ISSN 0975-5071
USA CODEN: DPLEB4

Water quality analysis of agricultural water from the villages of Vellore district

Amit Kumar Srivastav*, Padmakshi Agarwal, Kaushik Jyoti Talukdar and Suneetha Vuppu

School of Biosciences and Technology, VIT University, Vellore, Tamilnadu, India

---

ABSTRACT

This article delineates the agricultural water quality in the surrounding areas of Vellore district of Tamil Nadu by determining the sodium adsorption ratio, iron concentration and most probable number. The sodium adsorption ratio values of all water samples collected from the surrounding villages of the Vellore district were compared with the standard FAO values to ascertain the salinity of water. The concentration of calcium, magnesium and iron were also determined to evaluate the quality of water. A Most Probable Number analysis was conducted to determine the presence of Escherichia coli in the water used for irrigation. All the parameters tested for water quality analysis were found to fall within the acceptable range rendering the water suitable for the purpose of irrigation.

INTRODUCTION

India is an agrarian economy ranking second world wide in farm output. Agriculture accounted for 16.6% of India's GDP (Gross Domestic Product) in the year 2009 [1]. In light of this fact, adoption of proper methods of agriculture is of immense importance. The use of organic fertilizers, pesticides and insecticides; and irrigation water which is not saline or brackish helps in enhanced growth of crops.

The Vellore district occupies an area of 6077 square kilometer. It falls between 12° 15' to 13° 15' North latitudes and 78° 20' to 79° 50' East longitudes in the state of Tamil Nadu. The average maximum temperature recorded in the district each year is 39.5 degree Celsius whereas the average minimum temperature is usually 15.6 degree Celsius [2]. Such a tropical temperature with an average annual rainfall of 795mm favors the growth of a variety of crops and horticultural fruits and vegetables. An agricultural area in Vellore district covers an area of 433.6 square kilometers with groundnuts being cultivated most extensively [3]. Paddy, sugarcane and pearl millet are some of the other major field crops that are cultivated in this region. Horticulture crops such as mango, guava, banana, vegetables, spices, plantation crops and flowers are also grown widely, aided by the propitious climatic conditions and the readily availability of water [4].

Innocuous cultivation of such varied crops requires dexterity and steady availability of water for irrigation, fertile soil and viable seeds. Water can be contaminated by the byproducts of food and beverages industry[5]. An analysis of the water used for irrigation in the villages of Vellore district was therefore conducted to determine the quality of water. The important parameters for determining the irrigation water quality are water salinity, calcium, sodium, magnesium, iron, boron, manganese concentration respectively [6,7].High sodium ion concentration leads to salinity and can also result in sodium toxicity which can be observed in the form of burning or drying of the outer edges of the older leaves [8]. Presence of low concentration of iron (1.0mg/L) can also prove to be abominable, degrading the quality of soil, leading to formation of rust-colored sludge in the presence of bacteria [8].Low concentration of calcium ions is required by the crops for growth; however, high levels of calcium in water can affect the calcium to

magnesium ratio causing a scale up [8]. The infiltration rate of water being used for irrigation depends on the sodium adsorption ratio. Sodium adsorption ratio (SAR) can be defined as a measure of the suitability of water to be used for irrigation. A SAR value of 6 or less than 6 is considered to be desirable [9]. High sodium adsorption ratio adversely affects the soil stability and ultimately leads to inadequate crop yield and therefore low productivity [9].

Key words: Sodium adsorption ratio, Agricultural water, MPN.

MATERIALS AND METHODS

2.1 Collection of samples:

Water samples were collected from 20 villages of the Vellore District[10]. Figure 1 illustrates the map of Vellore District.

Figure 1: Map of Vellore District from where water samples were collected

2.2 MPN analysis:

Most Probable Number Analysis was performed to determine the presence of *E.Coli* [11] .

Step 1: 25ml from each of the water samples was taken in 20 test tubes and inverted Durham tubes were introduced. The test tubes were incubated at room temperature for 48 hrs.

Figure 2: Test tubes containing inverted durham tubes for MPN analysis

Step 2: The water samples which showed a positive result (bubbles are seen in 2 test tubes out of 20 test tubes) were then plated on Macconkey Agar followed by EMB (Eosinemethylene blue) agar.The petri-plates were incubated at room temperature for 72 hours.

Figure 3 and 4: Macconkey agar and EMB agar plates being inoculated with water samples

2.3 **Determination of Na and Ca ions concentration:**
The sodium and calcium ion concentrations in water samples was determined by flame photometer[12].

The concentration of sodium and calcium ions of 20 samples was determined with the help of flame photometry. Four standards of 100ppm, 75ppm, 50ppm and 25ppm were prepared for two ions separately.

Preparation of stock solution: 2.54g of sodium chloride and 2.775g of calcium chloride was taken in 1000 ml of distilled water separately each for preparation of 1000ppm of stock.

Preparation of standards: 10, 7.5, 5 and 2.5ml was pipetted out from the stock solution for each ion and the volume was made up to 100ml by adding distilled water to prepare standards of 100ppm, 75ppm, 50ppm, 25ppm respectively.

Figures 5 and 6: Flame photometer and Flame Photometry readings for sodium ion

Flame photometer was calibrated with all four standards and samples are diluted 10 times for the measurement of sodium ion concentration then readings were taken for 20 samples. Concentration of sodium and calcium was calculated by plotting a graph of emission readings against the standard concentrations. The value obtained by graph was multiplied by 10 for sodium ion to get the actual concentration.

2.4 Determination of Mg and Fe ion concentration:

The magnesium and iron ion concentrations in water samples was determined by AAS (Atomic Absorption Spectroscopy).

Preparation of stock solution: 2.90 gram of ferric chloride and 3.95 gram of $MgCl_2$ was taken in 1000 ml of distilled water separately to make stock solution of 1000ppm.

Figure 7 : Atomic Absorption Spectrophotometer

Preparation of standards: Three standards of 5, 10 and 15 ppm were prepared from the stock solution by pipetting 0.125, 0.250 and 0.375 ml respectively for iron ions and another three standards of 0.5, 0.10 and 0.15 ppm were prepared by pipetting 0.125, 0.250 and 0.375 ml from 100ml of standard prepared from the stock solution for magnesium ions.

Atomic absorption spectrophotometer was calibrated with the three standards and then readings were taken. The concentration of Mg and Fe was calculated by plotting a graph of emission readings against the standard concentrations.

Sodium adsorption ratio was then calculated by using the formula given below.

Formula: $SAR = [Na^+] / \{([Ca^{2+}] + [Mg^{2+}]) / 2\}^{1/2}$

Where sodium, calcium and magnesium are in milliequivalent/liter.

RESULTS AND DISCUSSION

3.1 Quality assessment for Agricultural purposes:

MPN analysis of the 20 water samples yielded negative results with the exception of Arakonnam and Valimalai which yielded positive results for the presence of *Escherichia coli*. The presence of E. Coli in the water sample collected from these two places is a direct indication of contamination of irrigation water with sewage. Figure 10 and 11 illustrate the presence of air bubbles in the inverted Durham's tubes, whereas Figure 12 and 13 delineate the growth of pink E. Coli colonies on Macconkey agar which acts as a differential media for the selective screening of lactose fermenting bacteria that is E. Coli. Figure 14 and 15 illustrates the metallic growth of E.Coli on EMB agar.

Figure 8 and 9: Air bubble observed in the sample from Valimalai and Arakonnam

Figure 10 and 11: Pink colonies of E. Coli growing on Macconkey agar for water samples of Arakonnam and Valimalai

Figure 12 and 13: Metallic colonies of Escherichia coli as cultured on EMB agar

Tables 1 and 2 give the flame photometer readings of sodium and calcium which determines the concentration of the two ions respectively.

Table 1: Calcium ion concentration

Places in Vellore	Flame Photometry readings of Ca^{+2}	Ca^{+2} conc^n (ppm) by graph	Ca^{+2} conc^n (meq/L)
Kaveripakkam	293.8	71.88	3.59
Arakonnam	1316.1	325.17	16.25
Vallimalai	382	93.73	4.68
Thimiri	3.4	-0.07	0
Walajapet	258.9	63.23	3.16
Arcot	366.7	89.94	4.49
Ranipet	354.6	86.94	4.34
Ammur	128.5	30.92	1.54
Nagavedu	168.6	40.86	2.04
Nemili	244	59.54	2.97
Ponnai	202.5	49.26	2.46
Pannapakkam	48.7	11.15	0.55
Palur	637.1	156.94	7.84
Thakollam	264.8	64.69	3.23
Vellapakkam	464	114.05	5.7
Gandhinagar	668.9	164.82	8.24
Gudiyattam	242.2	59.09	2.95
Pernarnpet	386.4	94.82	4.74
Pallikondan	134	32.28	1.61
Natham	231.4	56.42	2.82

Table 2: Sodium ion concentration

Places in Vellore	Flame Photometry readings of Na^+	Conc^n of Na^+ (ppm) by graph *10	Conc^n of Na (meq/L)
Kaveripakkam	91.9	30.2	13.13
Arakonnam	88.7	29.56	12.85
Vallimalai	95	30.82	13.4
Thimiri	27.5	17.32	7.5
Walajapet	93.8	30.58	13.29
Arcot	101.2	32.06	13.93
Ranipet	65.1	24.82	10.79
Ammur	70.1	25.84	11.23
Nagavedu	98.5	31.52	13.7
Nemili	95.2	30.86	13.41
Ponnai	93	30.42	13.22
Pannapakkam	47.4	21.3	9.26
Palur	98.7	31.56	13.72
Thakollam	94.5	30.72	13.35
Vellapakkam	83.9	28.6	12.43
Gandhinagar	92.8	30.38	13.2
Gudiyattam	127.8	37.38	16.25
Pernarnpet	102.8	32.38	14.07
Pallikondan	96.4	31.1	13.52
Natham	99.6	31.74	13.8

The concentration of sodium and calcium ion was determined by plotting a graph. Calcium concentration lies in the range of 0-325.17ppm whereas the sodium concentration lies in the range of 17.32-37.38 ppm. The concentration unit was then converted to milliequivalent per liter in order to compare the obtained results with standard values of FAO .

Figure 14: Graph to calculate Ca^{+2} concentration

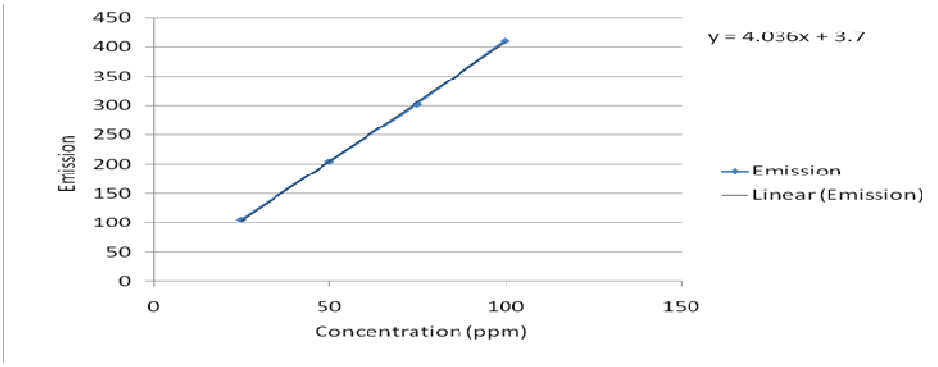

Figure 15: Graph to calculate Na^{+} concentration

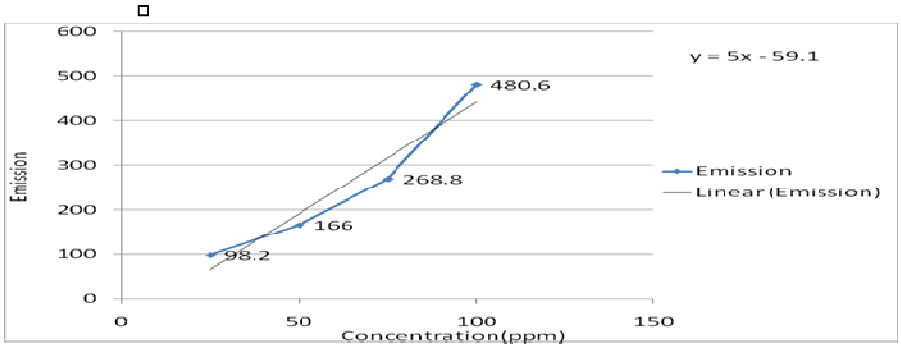

Table 3 and 4 give the readings of standards and atomic absorption spectroscopy which determines the concentration of Mg^{+2} .

Table 3: Standards reading

STANDARDS	Concentration(ppm)	Mean Absorbance
CAL zero	0.0000	0.0008
Standard 1	0.5000	0.2323
Standard 2	1.0000	0.3857
Standard 3	1.5000	0.4470

Table 4: Magnesium ion concentration

Places in Vellore district	Absorbance reading of AAS	Conc^{n} of Mg^{+2} (ppm)	Conc^{n} of Mg^{+2} (meq/L)
Kaveripakkam	1.2177	3.1538	0.0262
Arakonnam	1.2999	3.3667	0.28
Vallimalai	1.2599	3.2631	0.27
Thimiri	0.1177	0.3048	0.02
Walajapet	1.2087	3.1305	0.26
Arcot	1.2485	3.2336	0.26
Ranipet	1.1567	2.9959	0.24
Ammur	1.1552	2.9920	0.24
Nagavedu	1.52	3.9368	0.32
Nemili	1.2604	3.2644	0.27
Ponnai	1.189	3.0795	0.25
Pannapakkam	1.1393	2.9508	0.24
Palur	1.2728	3.2966	0.27
Thakollam	1.1971	3.1005	0.25
Vellapakkam	1.2332	3.1940	0.26
Gandhinagar	1.297	3.3592	0.27
Gudiyattam	1.3417	3.4750	0.28
Pernarnpet	1.383	3.5820	0.29
Pallikondan	1.1499	2.9782	0.24
Natham	1.3222	3.4245	0.28

Table 5: sodium adsorption ratio in meq/L

Places	Na (meq/l)	Mg (meq/l)	Ca (meq/l)	SAR (meq/L)
Kaveripakkam	13.13	0.262	3.59	9.46
Arakonnam	12.85	0.28	16.25	4.46
Vallimalai	13.4	0.27	4.68	8.51
Thimiri	7.5	0.02	0	75
Walajapet	13.29	0.26	3.16	10.16
Arcot	13.93	0.26	4.49	9.03
Arcot	10.79	0.24	4.34	7.13
Ammur	11.23	0.24	1.54	11.9
Nagavedu	13.7	0.32	2.04	12.61
Nemili	13.41	0.27	2.97	10.53
Ponnai	13.22	0.25	2.46	11.35
Pannapakkam	9.26	0.24	0.55	14.73
Palur	13.72	0.27	7.84	6.81
Thakollam	13.35	0.25	3.23	10.12
Vellapakkam	12.43	0.26	5.7	7.2
Gandhinagar	13.2	0.27	8.24	6.39
Gudiyattam	16.25	0.28	2.95	12.78
Pernarnpet	14.07	0.29	4.74	8.87
Pallikondan	13.52	0.24	1.61	14.05
Natham	13.8	0.28	2.82	11.08

According to FAO the acceptable levels of Ca^{+2}, Na^{+}, Mg^{+2} and SAR is given in table 6. Based on the standard levels given conclusions could be drawn regarding the quality of water used for irrigation in the 20 villages mentioned above.

Table 6: Assessment of water quality based on the FAO standards for irrigation water (FAO 1970)[13].

Parameters	Acceptable levels (meq/L)
Calcium	0-20
Sodium	0-40
Magnesium	0-5
SAR	0-15

Table 7 and 8 give the readings of standards and atomic absorption spectroscopy which determines the concentration of iron ion .

Table 7: Standard reading

STANDARDS	Concentration(ppm)	Mean Absorbance
CAL zero	0.000	-0.0006
Standard 1	5.000	0.1952
Standard 2	10.000	0.3281
Standard 3	15.000	0.5144

Table 8: Iron ion concentration

Places in Vellore district	Absorption reading of AAS	conc of Fe (ppm)
Kaveripakkam	-0.0023	-0.058
Arakonnam	-0.0008	0.021
Vallimalai	0.0008	0.021
Thimiri	-0.0025	-0.063
Walajapet	-0.0028	-0.071
Arcot	-0.003	-0.075
Ranipet	-0.0039	-0.099
Ammur	-0.0042	-0.106
Nagavedu	-0.0025	-0.063
Nemili	-0.0044	-0.112
Ponnai	-0.0051	-0.128
Pannapakkam	-0.0046	-0.117
Palur	-0.0047	-0.119
Thakollam	-0.0057	-0.143
Vellapakkam	-0.0039	-0.099
Gandhinagar	-0.0052	-0.132
Gudiyattam	-0.0049	-0.125
Pernarnpet	-0.0046	-0.117
Pallikondan	-0.0061	-0.155
Natham	-0.0055	-0.138

From above tables it can be discerned that Calcium ion concentration lies within the range deduced by FAO and the sodium ion concentration also falls within the acceptable range, Thimri and Panapakkam have concentration lying in the lower range having sodium ion concentration of less than 10meq/L. The magnesium ion concentration was observed to be less than 1 meq/L in all water samples and thus falling within the normal range. Sodium adsorption ratio which determines the infiltration rate of irrigation water in the soil, thus calculated, does not exceed the acceptable range of 0-15. The AAS reading for iron concentration for all samples was found to be negative. This indicates that the concentration of iron is zero which again lies within the acceptable limit.

CONCLUSION

Water quality analysis of 20 villages lying within the Vellore district was accomplished by studying its physical as well as chemical properties. Based on the analysis it can be concluded that the water used for irrigation in these villages is suitable for the purpose as the sodium, calcium, iron and magnesium concentration falls within the acceptable range. The sodium adsorption ratio thus calculated does not exceed the standard range as proposed by FAO. The MPN analysis performed also yielded negative results with the exception of Arakonnam and Valimalai sample. A positive MPN result followed by growth of pink colonies on Macconkey agar and metallic colonies on EMB agar confirms the presence of *Escherichia coli* in water indicating contamination of water to be used for irrigation with sewage. Albeit the above mentioned parameters lie within range, presence of *Escherichia coli* in water renders it partially unsuitable for the purpose of irrigation. Abatement of contamination by ensuring separate pipe lines for sewage and irrigation water can help curb the problem.

Acknowledgements
We wish to express our sincere gratitude to our beloved and honorable Chancellor Dr. G. Viswanathan, VIT University for providing us an opportunity to perform our project successfully. We sincerely thank him for his support and guidance throughout our endeavor. Last but not least we wish to avail this opportunity to express a sense of gratitude to everyone involved to help and support.

REFERENCES

[1] "CIA Factbook: India". *CIA Factbook*. Central Intelligence Agency. Archived from the original on 11 June **2008**.Retrieved 2008-06-10.
[2] Vellore climate on Vellore Corporation website:http://vellorecorp.tn.gov.in/abs_Corporation.html
[3] Directorate of Economics & Statistics (**2008**-**09**), Agriculture Contingency Plan for District: Vellore, State: Tamil Nadu
[4] Area under major field crops & horticulture etc. (**2009**-10 – Source: Office of JDA, Vellore)
[5] Alok Prakash, Kanupriya Mathur, Ankita Vishwakarma, Suneetha Vuppu, Bishwambhar Mishra , (**2013**),. *Int. J. Pharm. Sci. Rev. Res.*, 19(1), Mar – Apr **2013**; nº 25, 131-135.
[6] M. Hussain, S.M. Ahmed, W. Abderrahman (**2008**), *Journal of Environmental Management*, Volume 86, Issue 1, Pages 297–307.
[7] T.A Bauder, R.M Waskon, P.L Sutherland and J.G Davis, Irrigation Water Quality Criteria, Colorado State University
[8] Interpretation of water analysis for irrigation**,** Department of Agriculture, Fisheries and Forestry, Queensland Government
[9] Amin Banderi, Mohammad Modarres Sheikh, HasanHamdi , Mahmoud Shomeli , Ali SheiniDashteGol (**2012**), *Journal of Environment and Ecology* ISSN 2157-6092 **2012**, Vol. 3, No. 1
[10] http://www.mapsofindia.com/maps/tamilnadu/districts/vellore.htm
[11] J. L. Oblinger and J. A. Koburger, food science department, university of Florida, Gainesvilla, J. *Milk Food Technol*. Vol 38, No. 9, pages 540-545(September, **1975**).
[12] Flame photometric determination of Na+ and K+ ion using internal standard method (http://vedyadhara.ignou.ac.in/wiki/images/c/c1/EXPERIMENT_10.pdf).
[13] A. Banderi, M.M. Sheikh, H. Hamdi, M Shomeli, A.S.D. Gol, *Journal of environmental and ecology*, ISSN 2157-6092, **2012**, Vol 3, No. 1 .