Assessment of physico-chemical parameters of underground and sewage water of Bikaner city

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ABSTRACT

In India, the industrial growth is taking place at a very fast rate, but these industries pour their effluent unplannedly into water, which detorts its quality. This water when used for purposes like irrigation brings a lot of hazards, which becomes severe in certain conditions. The vallabh garden area is one of the biggest vegetable producing area in Bikaner city and it uses industrial effluent of cottage industries for irrigation. Various physiological disorders are present in plants/crops growing here, which might be due to the use of waste water. For analyzing quality of water (Physical & chemical) ten samples were collected from the field, which also have tube well and hand pump water samples. Physico–chemical parameters which include P^H, Na^+, K^+, Cl^-, SO_4^{2-}, NO_3^-, F^-, SAR, Total hardness, HCO_3^-, Ec, TDS were analyzed. The results show that the water samples have parameters excess in range than permissible value.

Key words : Physico-chemical analysis, deficiencies, roxicity.

INTRODUCTION

Pollution means the presence of undesirable substance in any segment of environment primarily due to human activity discharging by products, waste products or harmful secondary products, which are harmful to man and other organism.[1] So, quality of water is a vital concern for mankind since it is directly linked with human welfare. Generally speaking water pollution is a state of deviation from pure conditions where by its normal function and properties are affected[2]. The expanding waste production through over industrialization water quality in both surface and underground resources is deteriorating more and more.[3]

In Bikaner city of Rajasthan, various such cottage industries are located, who leach their industrial effluent into water. This effluent is collected in Sursagar and from here through various small and big drains it reaches to vallabh garden area, where finally it is used up for irrigation purpose.

Vallabh garden area is a leading producer of vegetables in Bikaner city and its vegetables are transported in each and every part of city. Various physiological disorders which include chlorosis, fall of fruits before ripping, diesel soaked appearance of leaves, interveinal chlorosis, cracking of leaves, small fruits or of uneven size are present in plants/crops growing there. This area also irrigate the field with tube well and hand pump water together with industrial effluent. Symptoms appearing in plants/crops are due to undesirable limit of parameters in water. So it becomes necessary to evaluate quality of water being used for irrigation.

EXPERIMENTAL

For the analysis of physico–chemical parameters in water ten samples were collected in wide–mouth plastic bottles. Out of these ten samples five samples are of industrial effluent (w_1 to w_5), two are of hand pump (D_6 & D_7) and three are of tube well water (D_8 to D_{10}). The samples of industrial effluent were filtered prior to analysis, while tube well and hand pump samples are analyzed as such.

Among cations Ca^{2+} & Mg^{2+} were determined titramatrically Na^+ & K^+ were determined by flame photometer and among anions Cl^-, SO_4^{2-}, HCO_3^- were determined titramatrically. While NO_3^-, F^- were by spectrophotometer; P^H and Ec were measured by P^H meter and conductometer respectively, while TDS is obtained by conversion [TDS = $E_c \times 640$][4]

RESULTS AND DISCUSSION

The values of physico–chemical parameters of irrigation water is tabulated as follows

pH

The pH required for the optimum growth of plant is 5.4 to 7.0. All the sample analyzed shows high pH. Leaf chlorosis, reduced root growth and decay, stunted shoot growth. Poor flower development are seen in plants/crops to high pH. Appearance of these symptoms is due to influence of pH on the solubility of ions such as iron. Due to reaction with hydroxyl ions at high pH conditions, ferrous form (Fe^{+2}) of iron is transformed in ferric form (Fe^{+3}), which is inactive in plant tissues.[5, 6]

Sodium (Na^+)

The amount of sodium require for the healthy growth of plant is 3 meq/*l*; but the samples of vallabh garden shows very high range of sodium (14.0 to 21.25 meq/l). In shoots, high concentration of Na^+ cause a range of osmotic and metal problems for plants. Leave are more vulnerable than roots to Na^+. Metabolic toxicity of Na^+ is largely a result of its ability to compete with K^+ binding sites essential for cellular function. In salt sensitive plants, shoots and to a lesser root growth is permanently reduced within hours of salt stress and this effect appear to depend on Na^+ concentration in the growing tissues. The time scale over which Na^+– specific damage manifested depends on the rate of accumulation of Na^+ in leaves and on the effectiveness of Na^+ compartmentation within leaf tissues and cells.[5, 7]

Potassium (K^+)

Potassium is involved in maintaining the water status of the plant and the turgor pressure of its cell wall and the opening and closing of the stomata. Potassium is required in the accumulation and translocation of carbohydrates. Plants require 0.26 meq/*l*. Potassium for their growth. From the table 1, it is clear that industrial effluent, hand pump have high level of potassium (1.1 to 1.3), & 0.40 respectively, while D–8 and D–9 samples of tube well shows low potassium and D–10 have slightly excess of it. Usually potassium is not absorbed excessively by plants, but its toxicity can aggravate the uptake of the magnessium, Manganese, zinc and iron and effect the availability of calcium, while

Table - 1 : Physico–Chemical analysis of irrigtion water of vallabh garden:-

Sample	pH	Na^+	K^+	Cl^-	SO_4^{2-}	No_3^-	F^-	SAR	Total Hardness	HCO_3^-	EC	TDS
W–1	7.40	17.5	1.3	12.0	0.50	8..86	0.5	9.09	770.0	10.0	2.55	1632
W–2	7.45	18.25	1.1	12.50	3.15	13.29	1.5	9.36	780.0	9.5	2.58	1651.20
W–3	7.49	16.50	1.2	13.50	2.40	17.72	3.0	8.35	790.0	10.5	2.11	1734.40
W–4	7.49	16.50	1.1	15.0	1.58	6.64	3.5	8.43	780.0	10.0	2.85	1849.60
W–5	7.50	17.50	1.3	13.0	2.0	4.43	5.0	9.0	770.0	8.5	2.65	1696.
W–6	7.95	21.25	0.40	10.0	11.35	17.72	1.0	20.24	420.	4.5	2.68	1715.20
W–7	8.0	14.0	0.40	5.50	83.20	17.72	1.1	13.02	430.0	5.0	2.66	1702.40
W–8	8.40	19.0	0.20	6.5	12.20	15.05	1.1	15.20	500	5.5	266	1702.40
W–9	8.20	19.0	0.20	13.0	5.4	15.05	1.1	14.61	520.0	6.0	2.66	1702.40
W–10	7.96	21.25	0.50	13.50	9.35	14.19	1.3	16.61	510.0	4.0	2.69	1721.66

* Na^+, K^+, Cl^-, SO_4^{2-}, NO_3^-, , HCo_3^- is in meq/*l*
** EC is in mmho/cm
***TDS, F^-, Total hardness in PPm.

in its deficiency older leaves become initially chlorotic but soon develop dark necrotic lesions (dead tissue). First apparent on the tips and margins of the leaves. Stem and branches may become weak and easily broken, the plant may also stretch. The plant will become suceptible to disease and toxicity. In addition to appearing to look the iron deficiency, the tips of the leaves curl and the edges burn and die.

Chloride

Chloride is important in the opening and closing of stomata. The role of the chloride anion (Cl^-) is essential to chemically balance the potassium ion (K^+) concentration that increases the guard cells during the opening and closing of stomata. Chloride also functions in photosynthesis, especially in the water spillting system. It's functions in cations balance and transport within the plant, diminishes the effect of fungal infections, it competes with nitrate uptake, tending to promote the use of ammonium nitrogen, lowering nitrate uptake may be a factor in chlorides role in disease suppression since, high plant nitrates have been associated with disease severity. Plants require 2 meq/*l* Cl^- for their growth. All the analyzed samples shows a very high level of chloride ranging (5.50 to 15.0 meq/*l*); Chloride toxicity develop leaf margins are scorched and abscission is excessive, leaf/ leaflet size is reduced and may appear to be thickened, over all plant growth is reduced, chloride accumulation is higher in older tissue than in newly matured leaves.

Sulphate

For most of plants 1.26–1.88 meq/*l* sulphate is adequate. All the samples of Vallabh garden shows very high range of sulphate (1.58–12.20 meq/*l*) except sample W–1 which have low concentration of sulphate i.e. 0.50 meq/*l*. Deficiency of sulphate cause decreased photosynthetic capacity and Rubisco activities on a leaf area basis, while high level of sulphate cause decrease in weight of fresh fruits. Sulphate is involved in protein synthesis and is part of amino acid, cystine and thiamine which are the building block of protein. It is active in the structure and metabolism in the plant. It is essential for respiration and the synthesis and breakdown of fatty acids.[5, 8, 9]

Nitrate

Nitrogen from the soil is taken up by plant roots in the form of nitrate plants convert nitrate (NO_3^-) to nitrite (NO_2^-) which in turn is converted to ammonia and then to amino acid, the building blocks of protein. Plants require nitrate (0.16 meq/L), but a high level of nitrate (6.64 to 17.72 meq/L) is observed in irrigation water of Vallabh garden, Nodulation of legume seedling is generally inhibited by the presence of high nitrate.[5, 10]

Fluoride

Plant require fluoride in 1.0 ppm range, the study of Vallabh garden reveals that fluoride level is high in industrial effluents (1.5 to 5.0 ppm), except W–1 sample that has 0.5 ppm, while tube well & hand pump have adequate fluoride concentration, except W–1 which have 1.3 ppm fluoride. The increase level of fluoride cause increase respiration in plants/crops. The general symptoms of fluoride injury are necrotic lesions and burning, which appear first in the leaf tips and margins; excessive fluoride cause decrease in chlorophyll, diminish rate of photosynthesis, decrease plant growth.[5, 11]

Sodium Adsorption Ratio (SAR)

The index used is the sodium adsorption ratio that express the relative activity of sodium in the exchange reaction with the soil. This ration measures the relative concentration of sodium to calcium and magnesium. The optimum value of SAR should be 4 or less for plants. High sodium concentration become a problem when the infilteration rate is reduced to such a rate that the crops does not have enough water available or when the hydraulic conductivity of the soil profile is too low to provide adequate drainage. Level of SAR is too high in the irrigation water of investigation area (8.35 to 20.24).

Total Hardness

Hardness of water is due to presence of Ca^{2+} and Mg^{2+}. Plants require 150 ppm hardness in water, but samples have hardness range (420–780 ppm); which disturbs the Ca: Mg ratio in water which should be 3:5. If calcium is more it blocks the ability of plant to uptake magnesium which cause. Magnesium deficiency, whose signs are yellowish green blotch near the base of the leaf between the midrib and the outer–edge; with acute deficiency leaves may become entirely yellow–bronze and eventually drop, and if in hard water magnesium is more, it will cause calcium deficiency in plants, whose signs are young leaves are affected first and become small and disorted or chlorotic with irregular margins. Spotting or necrotic areas, bud development is inhibited blossom, end root and internal decay may also occur and root may be developed or die back.[5, 12]

Bicarbonates

The level of Bicarbonate in water should be 2 meq/*l* for irrigation purpose, but investigated area shows high bicarbonate concentration (4.0 to 10.0 meq/*l*), which results into increased ratio of root to shoot, it reduces iron translocation towards shoots, bicarbonates provoked a considerable accumulation of iron in roots, this accumulation was due to iron accumulated in extraplasm of roots.

Electrical conductivity (E_c) and Total dissolved Solids

The range of E_c and TDS in irrigation water should be 1.5 moles/cm and 960 ppm respectively for general production; samples shows high E_c (2.11–2.85) and high TDS (1632–1849.60 ppm). At high level of E_c causes reduced growth mainly due to water stress. (Low osmotic potential). The total amount of dissolved salts in a water as a result of the differences in osmotic pressure between the cell content and the surrounding soil water. When over salinity of the soil solution is near to or greater than that of the cell contents, plants are unable to take up sufficient water for growth and other process.[5, 14, 15]

In the above studies it is concluded, that irrigation water of Vallabh garden area (industrial effluent, hand pump, tubewell) is unfit for irrigation. If irrigation with this water continuous; it will continually to affect each and every member of food chain i.e. plants, animals, man leading to serious disease in them. So in order to prevent these hazards it is suggested to use this water after proper treatment, which includes, reverse osmosis, membrane filtration, chemical treatment etc.

REFERENCES

1. R.S. Ambasht & P.K. Ambasht, *Environment & Pollution (an ecological approach)* students friends & co. 2nd Edition, Varanasi Page –7 (1992).
2. A.K. De, Environmental Chemistry, *New age international publishers*, 5th Edition Page–187 (2003).
3. Berkant odemis, Mustafa Kemal Sangum & Dursun Bujuktas, *Asian Journal of Chemistry* Vol–19, no. 1 Page–**711** (2007).
4. M.M. Saxena; *Environmental analysis water, Soil and Air, Agro Botanical publishers* (India) 1990.
5. Boug Bailey, Ted Bilder back and Dick Bir : Water considerations for container production of plants.
6. N. Zieslin : ISHS Acta Horticulture 361 : International Symposium on New Cultivation Systems on Green house.
7. Mark tester and Romala Daven part : *Annals of Botany* **91** no. 51 page 503–527 (2003).
8. Altaf Ahmad and M.Z. Abdin, *Physiologia plantarum* **110** no. 1 Page – 144–149 (2000).
9. H.L.XU, J. Lopez, et al, *Physiologia platarum*, **96** Issue 4 page 722 (1996).
10. Peter P. wong : *Plant physio* **66** no. 1 Page 78–81 (1980).
11. S.F. Yang and G.W. Miller *Biochem J.* **88** no. 3 page 505–509 (1963).
12. M.G. Burton, M.J. Lower and M.B. Mc Bonald : *Annals of Botany* **91** no. 51 Page 503–527 (2003).
13. Kais zribi, Mohamed Gharsalli, *Journal of plant nutrition*, **25** no. 10 Page 2143–2149 (2002)
14. Soil and plant testing laboratory, university of missouri extension live and learn 573–882–0623
15. M. Heinen etal, ISHS Acta Horticulturae 593. IV International symposium on models for plant growth and control in Green houses.