Role of Micro Nutrients on Agricultural soil and Growth of Crops

[1]YOUSAF IQBAL, [1]SULTAN ALAM, [1]MUHAMMAD NASAR KAHN,
[1]MUHAMMAD ISHAQ, [2]SHAH ALAM KHAN AND [3]M. SALEEM
[1]Department of Chemistry, University of Peshawar
Peshawar NWFP, Pakistan
[2]PCSIR Labs, Jamrud Road, Peshawar
[3]NCE in Physical Chemistry, University of Peshawar

(Received 10th March, 2001, revised 1st August, 2001)

Summary: Soil and water samples from different localities of crop fields were collected from village Qalari, District charsadda N.W.F.P. and investigated for both physical and chemical parameters like pH, temp, conductivity, anions (SO_4^{-2}, Cl^{-1}, NO_2^{-1}, F^{-1}) and cations such as Cu^{+2}, Zn^{+2}, Mn^{+2}, Cd^{+2}, pb^{+3}, Ag^{+1}, Na^{+1} and K^{+1}. The values were compared with the standards and it was found that Cu^{+2}, Mn^{+2}, Na^{+1}, Ca^{+2} and K^{+1} have higher value that the recommended value while some were found within the range. The correlation between soil and irrigation water was studied and their impacts on crops have also been discussed.

Introduction

Pakistan is one of the agricultural countries in the world and about 80% of its population depend upon agriculture. Unfortunately our country has low yield per arc, which adversely affect our national economy. This low yield is due to the lack of knowledge in the farmers, old methods of farming, insufficient and inappropriate use of fertilizers and lack of better varieties of crops. For many years our deligent scientist (Chemists, Botanists and Agriculturists) are trying to minimize the problem, relating to the field of agriculture.

Soil (both allurium and Aeolian) may be very fertile but will not produce any crop unless it is in good physical conditions (such as inorganic soil colloids, exchangeable bases, organic matter and mineralogical relationship of the clay itself) [1]. Although addition of fertilizers increases the crop productivity per acr on one side but changing the soil conditions on the other side, as a result of which the erosion occur (leaching of micronutrients), which in turn effect the plant growth because the micronutrients such as Zn, Mo, Mn, Fe, Cu, Co, B, Na, K etc play a significant role in the physiological and metabolic functions in plant nutrition as well in soil fertility i.e. Na, K act as a flocculating and stabilizing agent. Zn function as a part of a series of enzymes (carbonic anhydrate and protein), Fe bring about redox reactions in plants and helps in plant metabolism, Mn is essential for CO_2 assimilation of nitrogen metabolism [2-5].

It is well known fact that there is a deep correlation between soil and water. Water has found many applications both on industrial and agricultural side. Among the uses of water, the use of water for irrigation purpose is the most important one. Mostly surface water is used for irrigation, which include river, stream, rain etc. These water bodies must be free from all types of pollutants but in recent years increasing population, urbanization, and industrialization have disturbed the normal quality of water, which change the soil conditions and results into poor production of crops.

Earlier workers have used different methods for the determination of micronutrients in solid.

Statistical parameters for the determination of various parameters in the soil of village Qalari district charsadda

Parameters	Mean	Standard Deviation (δ)	Correlation Variance (%)
pH in distill water	6.627	0.427	6.44
pH in 0.01M $CaCl_2$	6.193	0.354	5.72
Conductance	0.148	0.0365	24.6
Sodium	61.5	6.48	10.861
Potassium	29.8	13.73	46.07
Manganese	38.5	12.146	31.54
Cadmium	1.034	0	0
Silver	0.15	0	0
Lead	1.626	0.902	55.47
Copper	2.44	0.502	20.57
Calcium	1116	89.35	8896.8

Statistical parameters for the determination of various parameters in irrigation water of village Qalari district charsadda

Parameters	Mean	Standard Deviation (δ)	Correlation Variance (%)
pH in distill water	7.9	0	0
Conductance	0.63	0.0365	24.6
Sulfate	335.76	0	0
Fluorides	4.53	0	0
Chlorides	4.63	0	0
Nitrites	1.024	0	0
Silver	10	0	0
Lead	0.3	0	0
Copper	1.8	0	0
Manganese	0.30	0	0
Zinc	2.0	0	0
Cadmium	0.2	0	0
Calcium	430	0	0
Sodium	160	0	0
Potassium	140	0	0

Dahdoh, Gunstheimer, Sumida, Chen, Gaszczyk, Kong, Cieslinki, Wu-Xum, Bull, Atkirison, Holms, Francisco, Sommer, Toth and Chapman determined the micronutrients in soil at different concentrations and their effects on the plant growth have also been discussed [6-12].

The present study was therefore carried out to assess the correlation between water and soil of village Qalari Distt; Charsada N.W.F.P. and their contribution toward the productivity of various crops.

Results and Discussion

Soil

Soil and water (irrigation) samples were collected from village Qalari Distt; charsadda and were analyzed for various parameters like pH, conductivity, micronutrients Viz, Cu, Zn, Mn, Cd, Pb, Na, Ca, K and Ag. Anions like SO^{-2}, F^{-1}, Cl^{-1} and NO_2^{-1} were also investigated in irrigation water.

pH of various soil samples ranges from 6.08-7.28 in distilled water and from 5.7-6.9 in 0.01 M $CaCl_2$ solution as can be seen from Fig. 1. Samples A, C and D are slightly acidic while sample B show alkaline nature. Which affect the concentration of trace elements [13]. In acidic soil Cd, Hg, Ni and Zn are relatively mobile while As, Be and Cr are moderately mobile and Cu, Pb, and Se are slowly mobile [13].

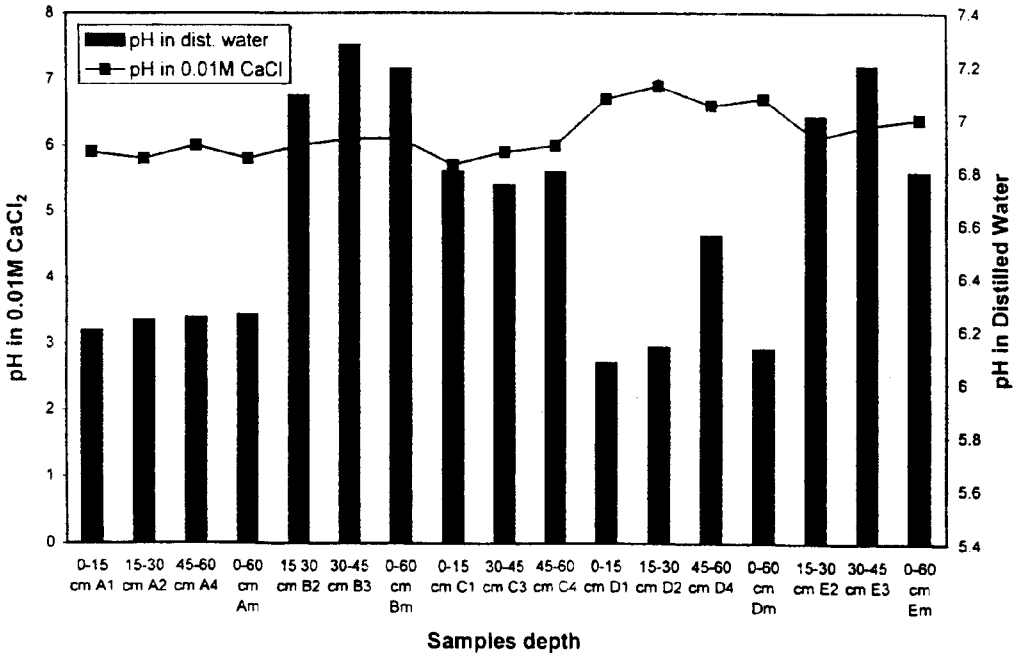

Fig. 1: Deterination of pH of soil samples of village Qalari Distt. Charsadda, NWFP

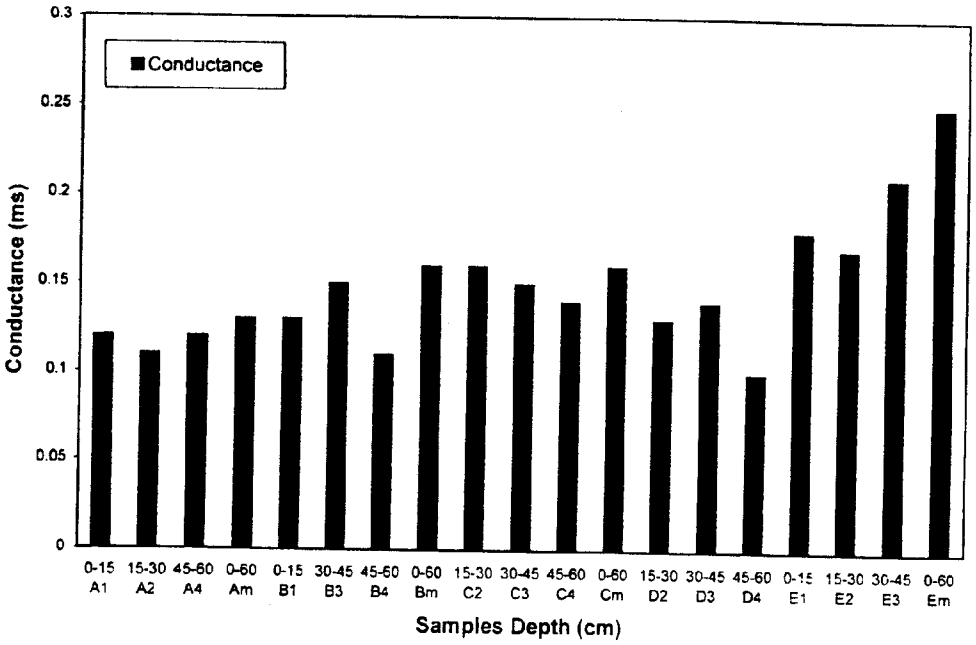

Fig. 2 Deterination of Conductance of Soil Samples of village Qalari Distt. Charsadda, NWFP

The Fig 2 shows the conductivity of all soil samples varying from 0.1 mS - --0.25 mS. The average value of electrical conductivity for "A" is 0.124 ms, for sample "B" is 0.14 ms and "C" is 0.202 ms. These variations are due to the difference in concentration of free cations and anions like Na^{+}, K^{+}, Cl^{-1} etc in the soil samples.

The value of copper in all soil samples ranges from 2.3-3.7 ppm as can be seen from Fig. 3. The suitable values for agricultural soil ranges from 1-50 ppm, as reported by Baker *et al.*, [14,15]. All samples shows the concentration of copper within the acceptable limits: plants need 5-20 ppm Cu^{++} for their normal growth. While less than 4 ppm may affect various physiological processes like carbohydrate metabolism, seed production [15,16] Robson [17] characterized its deficiency by chlorosis, leaf distortion. Whereas high concentration (above 50 ppm) may cause stunting, and reduce branching [17].

The concentration of Zn in all samples is less than 0.5 ppm (Fig. 3). The desirable level for Zn is from 10-300 ppm [6], depending upon the nature of parent rocks, organic matter, texture, pH and soil. The concentration of Zn in our samples was found in very low quantity, which may effect the growth of plant like apple and deciduous trees [18].

Fig. 3 shows the concentration of manganese is from 24 – 63 ppm recorded in our samples. Earlier workers [19] reported a mean of 450-ppm Mn for world soil. Deficiency of Mn is soil may cause "gray speck" in oats, "yellow disease" in spinach, "speckled yellow" in sugar beets etc [20].

The value of cadmium was founded in the range of 0.22-2.2 ppm (Fig. 3) showing high concentration than the recommended value (i.e.) 0.1-1 ppm, also depending upon the soil texture and its origin. Cadmium is likely to be more toxic as compared to other metals. Earlier investigators [21] have found many toxic effects in beet, bean, turnip, tomato like necrosis, wilting, red orange coloration of leaves and general reduction in growth.

Fig 3 indicates the concentration of lead (Pb) in the range of 0.3-3.1 ppm that is below the permissible limit i.e. 5-1, 200 ppm [21]. The maximum permissible limit of lead is different for different plants depending upon many factors such as parent materials, anthropogenic input etc. Therefore

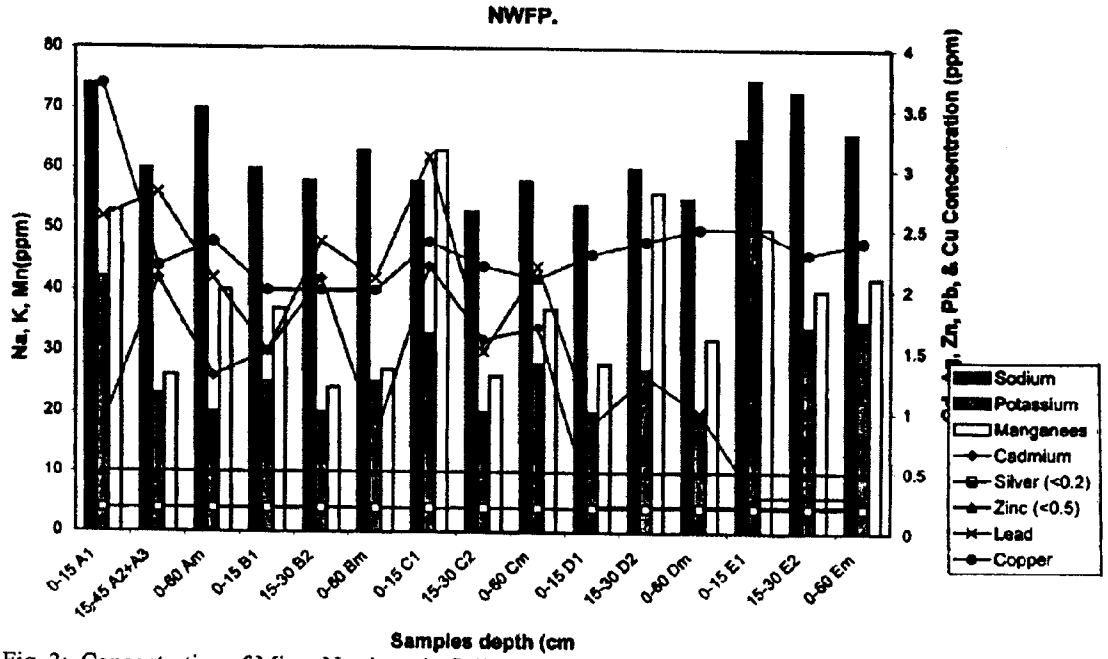

Fig. 3: Concentration of Micro Nutrients in Soil Samples of village Qalari Distt. Charsadda, NWFP

the toxic effects of lead varies from species to species. At high level it may alter the physiological and biological processes like mitochondrial respiration in corn and soybean [22].

Silver (Ag) contents were found less than 0.2-ppm (Fig. 3). This shows that all samples are deficient in Ag. The silver contents were found a mean of 0.4 ppm in different parts of the world [23]. The maximum permissible range of silver in plant tissues is below 1 ppm [24]. Above this level it may be harmful to bush beans and many other plants [25].

The Fig. 3 shows the sodium concentration in the range of 53 – 74 ppms. High amount of sodium act as destroying agent for soil texture, having poor capillary rise because of low porosity in soil, which affect the crops growth and productivity [26].

The total contents of Ca^{2+} in all soil samples vary from 950 – 1250 ppm Fig. 4. The results show that all samples contain high amount of calcium. These high contents of calcium may be due to the nature of parent texture of soil. In soil it act as a soil structure improver and also serve as a good flocculating agent. It also increases the aggregation, percolation rate and capillary rise [27].

The amount of potassium in soil samples ranges from 20 – 75 ppm (Fig. 3). It lies in properties in between the sodium and calcium. However its presence in soil is essential for the crops growth.

Water

The Fig. 5 shows that the pH of irrigation water is 7.9 and that of soil ranges from 6.08-7.28. The pH of irrigation water is basic in nature while the soil shows acidic as well as basic in nature. The basic media affect the concentration of trace elements whereas acidic soil is highly sensitive toward the mobility of cation like Cd^{++}, Hg^{++}, Zn^{++}, Cu^{++}, Pb^{+++} etc.

Results show (Fig. No. 5) that the electrical conductivity of irrigation water and soil is 0.63 mS and 0.1 mS-0.25 ms respectively. This difference is due to the number of free cations and anions like Na^{+1}, K^{+1}, Cl^{-1}, NO_2^{-1} etc.

The Fig. 6 shows the concentration of sulfates in irrigation water is 335.5 PPM. The USEPA recommended limit for sulfate is 250 mg/L [29] our values are above the permissible limit hence may cause diarrhea and dehydration in human beings.

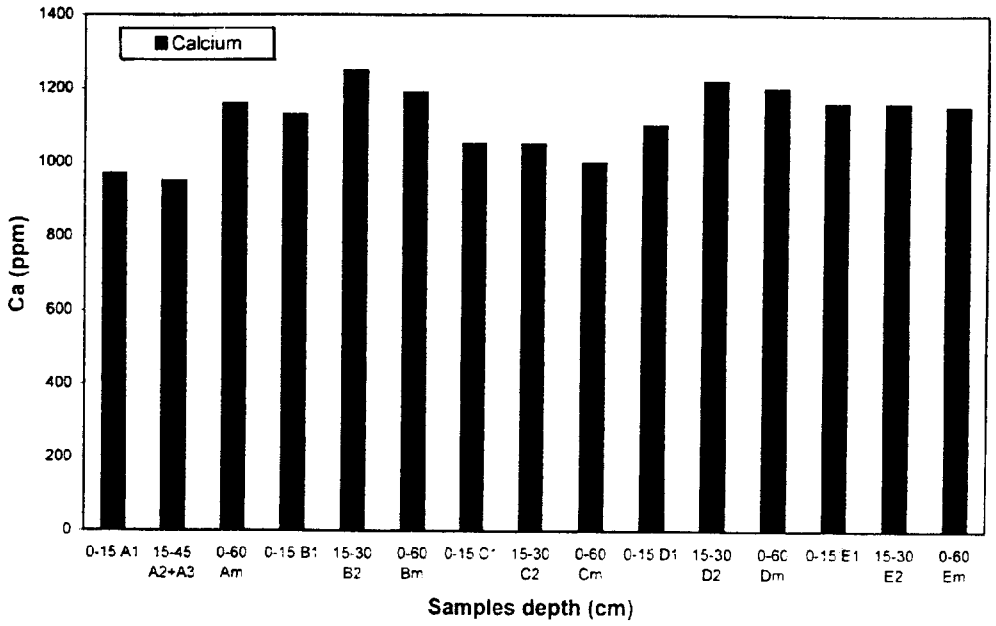

Fig. 4: Concentration of Micro Nutrients in Soil Samples of village Qalari Distt. Charsadda, NWFP

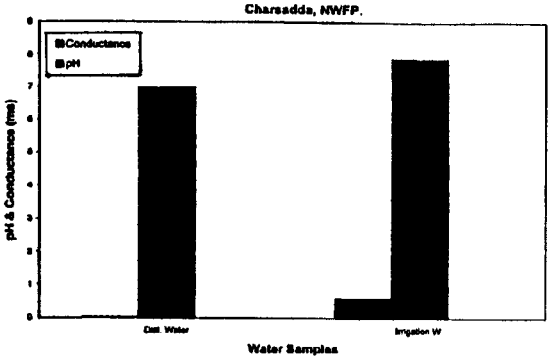

Fig. 5: Determination of Conductance and pH in the irrigation Water of Village Qalari Distt. Charsadda, NWFP.

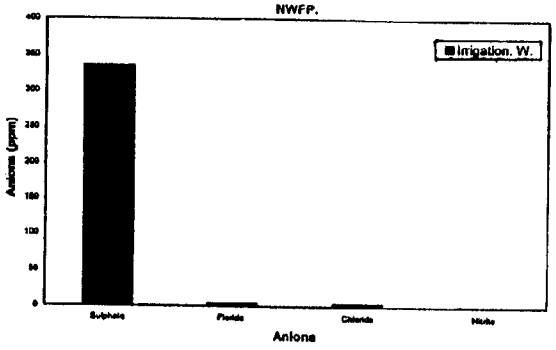

Fig. 6: Determination of Anions in the Irrigation Water of village Qalari Distt. Charsadda, NWFP.

The chlorides founds in irrigation water are listed in Fig. 6, Crops are more sensitive than man to high chloride contents is; therefore 250 mg/L remains a good limit for chlorides, with a maximum of 100 mg/L when water is used for irrigation. Above this limit is dangerous for crops [29].

High level of nitrite is found is irrigation watering i.e. 1.024 ppm. The recommended limit of nitrites is 1 mg/L. This high level may be harmful for crop growth [30].

4.53 ppm (Fig. 6) concentration was found for fluoride in irrigation water, which is above the permissible level i.e. 1.2 mg/L. hence, may cause adverse effect on the plant growth [30].

The concentration of copper in irrigation and soil sample was 1.8 ppm and 2.3-3.7 ppm respectively Fig. 7. For the normal growth of plants, 1. –50 ppm amount is essential as reported by earlier investigators [14]. All samples show the copper contents within the permissible range. At low concentration (below 4 ppm) may effect various

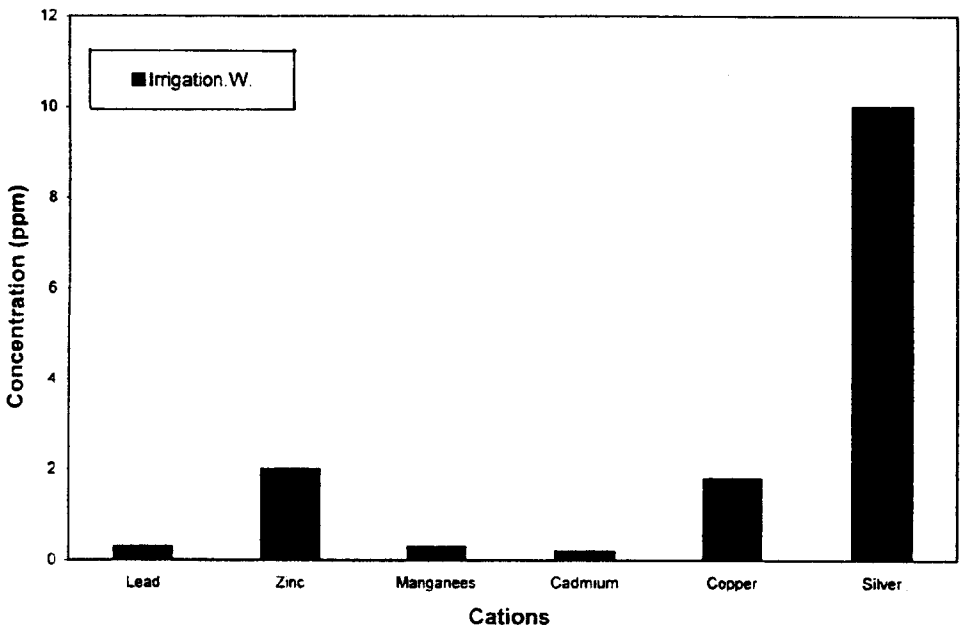

Fig. 7: Determination of Micro Nutrinets in irrigation Water of Village Qalari Distt. Charsadda, NWFP.

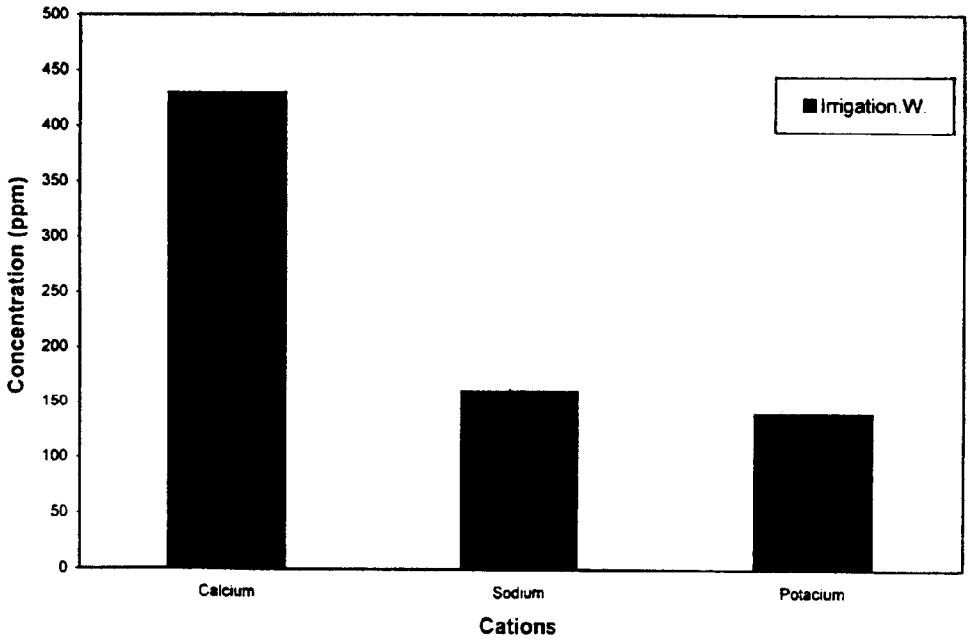

Fig. 8: Determination of Micro Nutrinets in irrigation Water of Village Qalari Distt. Charsadda, NWFP.

physiological processes like carbohydrate metabolism, productivity of grains, and diseases like chlorisis, necrosis, leaf distortion etc. whereas at high concentration i.e. up to 50 ppm is dangerous in the form of stunting and reduction of branches [17].

The Zn contents in irrigation water are 2.0 ppm and in soil samples is less than 0.5-ppm Fig. 7. The desirable range of Zn for agricultural crops is from 10-300 ppm [27]. This range shows the diverse nature of soil due to the presence of parent rocks, dead bodies of living substances etc. Both in water and soil samples the amount of Zn is low, therefore it is dangerous for the normal physical activities of plant like apple and deciduous trees [27].

The value of Cd in irrigation water is 0.2 ppm (Fig. 3 and 7) and in soil sample is in the range of 0.22-2.2 ppm. The recommended range of Cd is from 0.1-1 ppm which is above the permissible limit in both cases. Hence it many cause toxic effects like necrosis, wilting, redorange coloration in leaves of beat, bean, turnip, tomato etc. as discussed before [27].

The concentration of manganese in irrigation water is 0.5 ppm (Fig. 3 and 7) and in soil sample is 24-63 ppm. The average value for normal growth is 450 ppm, as reported by earlier researchers. The concentration of Mn in irrigation water is low; hence may cause diseases like "gray speck in oats" and "yellow disease in spinach" [20].

As can be seen from Fig. 7. The concentration of lead in irrigation water is below 0.5 ppm and 0.30-3.1 ppm in soil samples (Fig. 7) which is below the desirable range (i.e.) 5-1200 ppm [22]. At high level it may alter the physiological process like oxidative-reductive process in mitochondria [22].

Silver content, were found upto 10 ppm in irrigation water (Fig. 7) and is below 0.2 ppm in soil samples (Fig. 3). For normal physiological activities in plant bodies its limits is 1 ppm [27]. Above this limit it may reduce the productivity in bush beans [25].

The Fig. 8 and 3 shows that the total calcium contents in irrigation water are 430 ppm and in soil samples are from 950-1250 ppm [27]. The result shows that both water and soil have high amount of Ca^{+2}, which may be due to the soil texture. However its toxicity is low because it is soil structure improver, good flocculating agent and capillary riser [27].

The amount of Na^+ and K^+ in irrigation water is 160 and 140 ppm respectively as shown in (Fig 8 and 3) while in soil sample are 53-74 ppm and 20-75 ppm. No permissible range has been issued because of it significant role in soil and lack of toxicity [27].

Experimental

Soil and water samples were collected from different localities of village Qalari Distt Charsadda N.W.F.P.

For soil samples, fields were dug to a depth of approximately 1-15, 15-30, 30-45 and 45-60 cm respectively. Samples were dried at 105°C, ground and passed through a 100 mesh and stored in airtight plastic bottles.

Irrigation water samples were collected and stored in clean polyethylene bottles. Before filling the samples, bottles were first rinsed with the sample water.

Physical and chemical parameters such as pH conductivity, anions like SO_4^{-2}, F^{-1}, Fl^{-1}, NO_2^{-1} and micronutrients such as Na, K, Mn, Cd, Cu, Ca, Ag, Pb and Zn were investigated in the soil and water samples.

pH was determined by using pH – meter (Model Hanna 1+1 – 8418) and conductivity by conductometer meter (Model PCm^3 – Jenway). Sulphate, Fluoride, Chloride and Iodide [28] were determined by volumetric method. The amounts of micronutrients were determined by using atomic absorption spectrophotometer (model Pu 9100x).

Conclusion

Agriculture is the most widespread form of human activity and is more basic than any other industry. Soil is fundamental component to all agriculture practices and with the interference of man in ploughing up earth and removing the crops i.e. harvesting using traditional techniques like overcropping, monoculture, multicropping, overgrazing, slopewise cultivation and shift cultivation, varieties of pesticides including 2,4-D, carbaryl, crabmats etc and infrequent use of

fertilizers such as nitrogeneous, phosphatic, potash, phosphatic cum nitrogen and NPK, lead to low yield of crops. Therefore sound farming techniques like crop rotation for example rice, maize, sugar cane and wheat varieties i.e. Fakhir-e-Sarhad, Inqilab, suleeman, Bakhtawar, controlled grazing, recent techniques of ploughing, afforestation, cover-cropping, terracing, stripcropping, soil additives and irrigation (basin, canal, tank, well etc) must be employed to prevent the soil erosion (leaching of micronutrients) and improvement of all agriculture activity to the farmers and also provide better crops (wheat, maize or corn etc) for the consumers.

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