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A Study of Zinc Metal in Industrial Effluent of Bikaner City and its Impact on Various Plants and Crops

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Zinc occurs naturally in air, water and soil, but zinc concentration are rising due to accumulation of zinc through human activities. It is a micronutrient which is required in 0.3 ppm range in water for optimum growth of plants and crops. It plays a vital role in plant physiology and its deficiency causes various disorders in plants like smaller leaves, slow growth of plant, chlorosis, poor nitrogen formation in legumes, *etc*. To analyze zinc metal, ten samples were collected from various stations of the field and analyzed on atomic absorption spectrophotometer. All the samples shows very low level of zinc ranging from (0.05 to 0.15 ppm).

Key Words: Dyes, Heavy metal, Zinc, Deficiency, Plants.

INTRODUCTION

Dyes can generally be described as a coloured substance that has an affinity to the substrate to which it is being applied. The dye is generally applied in an aqueous solution and may require a mordant to imporve the fastness of the dye in the fiber. These mordents are generally heavy metals. In Bikaner city of Rajasthan various such big and small dyes industries are located, whose effluent is used for irrigation purpose.

Zinc is a very common substance that occurs naturally and is regarded as a micronutrient. It is required in 0.3 ppm range for optimum growth of plant. Plants take up zinc in its divalent form. Zinc is transported in the xylem tissue from the roots to the shoots. However high levels of zinc have been detected in the phloem tissues, which indicate that zinc moves through both transport tissues and may be remobilization of zinc towards the grain ripening. Substantial translocation of zinc towards the grain during ripening. Substantial translocation of zinc takes place from the older leaves to the younger ones during grain development phase.

Zinc is essential for plant growth because it controls the synthesis of indolacetic acid, which dramatically regulates plant growth. Zinc is also active in many enzymatic reactions and is necessary for chlorophyll synthesis and carbohydrate formations. It helps to enable plant to withstand at lower air temperature and helps in the biosynthesis of cytochrome; a pigment and maintains plasma-membrane integrity and synthesis of leaf cuticle.

Onion, corn, citrus, lima beans, peas, grapes, hopes, flax, pecans, pines soyabeans are the crops/plants that really depend on zinc while cotton, alfalfa, sorghum, clovers, sugarbeets, potatoes need zinc but not as much as those above, whereas aspargus, mustard, carrots, peppermint are plants, that are not dependent on zinc.

The area under investigation is the critical example of discharge of dye effluent and finally it is being used for irrigation. Various crops/plants are grown here for *e.g.*, wheat, barley, citrus, sorghum, onion, potatoes, mustard, cauliflower, oat, maize, pulses etc. In these crops/plants various disorders like chlorosis stunted growth, fall of fruits before ripping, cracking of leaf, burning of leaves *etc.* are present.

By keeping all these facts in mind, it was thought interesting to analyze zinc in the industrial effluent (wastewater) of area under investigation being used for irrigation.

EXPERIMENTAL

For the collection of samples, whole area is divided into 10 stations. These 10 stations are at a 25 meter distance from one another. These collection points were given name w-1 to w-10 and waste water (industrial effluent) were collected in wide-mouth plastic bottles. These samples were than filtered using Whatman filter paper no. 42. The reagents used were of AnalR grade, while double distilled water was used whenever required. The samples were analyzed on atomic absorption spectrophotometer[1,2].

RESULTS AND DISCUSSION

The concentration of zinc metal in the 10-analyzed samples is illustrated in Table-1. All the analyzed samples show very low concentration of zinc (0.05-0.15 ppm) which shows that plants/crops grown here are zinc deficient. Zinc deficiency generates various disorders in plants such as dusty brown spots of upper leaves of stunted plants, uneven plants growth and patches of poorly established plants in the field, decreased tillering, spike or spikelet sterility and interveinal chlorosis on leaves, dicots shows drastic decreases in leaf size, loss of lustre and shoots die off. Premature leaf fall (chiefly in apples).

In rice, the midrib at the base of youngest leaf of zinc-deficient rice becomes chlorotic 2-4 weeks after showing or transplanting. Brown spots then appear on the older leaves. These spots enlarge, coalesce and give the leaves a brown colour. Some varieties exhibit a yellow orange discoloration of older leaves, spreading from the tip, instead of the brown spots. In severe deficiency, the entire leaf turns orange or brown and the rice plant dies.

TABLE-1
CONCENTRATION OF ZINC IN VARIOUS SAMPLES OF INVESTIGATION AREA

Sample no.	Concentration of Zn (ppm)	Sample no.	Concentration of Zn (ppm)
W-1	0.14	W-6	0.05
W-2	0.07	W-7	0.05
W-3	0.15	W-8	0.08
W-4	0.06	W-9	0.07
W-5	0.04	W-10	0.06

Zinc deficiency of corn affects the development of the leaves. The leaves are stunted, a condition sometimes known as little leaf. Chlorosis is common in the interval area of the leaves, which have light yellow strips and are yellowish in colour. The leaves often fall prematurely shortening of the stem internodes results in dwarfism of the plant. Delayed maturity and the abnormal development of stem, decrease the yield.

In caco deficiency starts in leaves and the bean pods, leaves develop in a deformed rosette shape, with cholorosis of the interveinal areas, which are coloured pale green or yellowish. The leaves are smaller than normal and often fall prematurely. The main symptom of zinc deficiency in grapes is that the grape bunches have grape of uneven size. Small grapes are mixed with large ones in the same bunch[3].

Deficiency in onions shows up as stunting with marked twisting and bending of yellow-stripped tops. In potatoes, early symptoms are similiar to leaf role. The plants are generally more rigid than normal with smaller than normal leaves and shorter upper Internodes[4].

Wheat plants shows dusty brown spots on upper leaves of stunted plants. Shoot growth is more inhibited that root growth, tillering decreases, spikelet sterility increases, midrib becomes chlorotic particularly near the leaf base of younger leaves, leaves lose turgor and turn brown as brown blotches and streaks appear on lower leaves. A white line sometimes appears along the midrib and the size of leaf blade is reduced. During Zn deficient conditions barley leaves shows uniform chlorosis and drying and tip growth decreases. Deficiency symptoms in sorghum are similiar to those of maize but less pronounced. In oat the leaves becomes pale green older leaves show collapsed areas at the margins and tips are greyish in colour. Necrosis extends down the leaf and reminder of the leaf is grey to bronze green[5].

In cereals, symptoms are usually seen on seedlings early in the growing season. An early symptoms is a longitudinal pale-green stripe on one or both sides of the mid-vein of young leaves. The leaf tissue in this stripe soon dies and the necrotic area turns a pale brown colour. Severely affected plants have a diesel-soaked appearance[6].

Symptoms of zinc deficiency in citrus appear on new growth and include distinctive chlorotic leaf pattern, small leaves and short internodes. The chlorosis develops in the interveinal areas of the leaf leading to a stricking light green to yellow discolouration against an irregular dark green background, particularly the lateral veins. When the deficiency is mild, the symptoms usually develop only on a few widely scaltered terminals. In extreme cases of zinc deficiency the new growth appears bushy and upright and in advanced cases the tree is bushy and stunted and twig die-back is common.

Zinc deficiency induced increases in epicuticular wax deposits, lamina thickness, degree of succulence, water saturation deficit, diffusive resistance and proline accumulation and decreases in carbonic anhydrase activity, water potential, stomatal aperture and transpiration in the leaves of cauliflower[7].

From the above studies it is concluded that zinc is necessary for the growth of plants/crops. In its deficiency many physiological activities of plants get disturbed and in some cases results in death of plant. To get rid off from these critical stituations following suggestions are suggested: (a) zinc sulphate is usually used to supply the needed amount of zinc. In season, zinc deficiency may be corrected by spraying the crop with 0.5 % $ZnSO_4$ solution (1 % for potatoes) at the rate of 20 to 30 gallons per acre (b) zinc-ammonia complex (10 % Zn) can be used to supply Zn when fluid-fertilizers are used. This water mixes easily with other fluid-fertilizers (c) zinc oxide can correct a Zn deficiency but is slowly soluble and not effective in a granular form. To effectively correct a Zn deficiency Zinc oxide must be finely grounded (d) zinc chelate can also be mixed with water. The amount of chelate mixed with water should supply 0.1 Zn per acre when water is sprayed at a rate of 20 gallons per acre. Zinc chelate is very advantageous as it is three times more effective that $ZnSO_4$ in so far as uptake is concerned. It is easily translocated within the plants because unlike zinc sulphate it is partly systemic[8].

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