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Research Article

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Plant growth regulating 4-methylbenzenesulfonic acid transition metal complexes

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ABSTRACT

The effect of 4-methylbenzenesulfonic acid (4-MBSA) and its binary complexes with Fe (III) and Cu (II) at pH 5.0 and 8.00 on plant growth of Brassica nigra L. (black mustard) were studied. Plant growth was decided by measurement of different growth parameters. The data obtained was used to know whether 4-methylbenzenesulfonic acid and its complexes are plant growth regulating.

Keywords: plant growth, germination, root/soot ratio, metal complexes.

INTRODUCTION

The information about role of metal complexes in biological systems, their concentrations and presence in different equilibrium is of immense important. It has been already reported that as compared to the free metal and ligand alone, the activity of metal chelate is considerably increased [1-2]. The observations of antifungal and antibacterial activities of the complexes show that they are more active as compared to the free metal and ligand involved. Narwade [3] reported use of unnatural chelating agents in biological systems.

The role of ternary complexes in transport of physiological active substances has been studied [4]. Powerful support for the connection between chelation and cancer has come out from the discovery that some of the coordination compounds of platinum are very effective in inhibiting the growth of tumors [5]. Popovici et al [6] showed that serum-calcium level can be regulated by use of EDTA in vivo some problems of metal toxicity may be overcome by used of chelation therapy [7]. The herbicidal and plant growth regulating activity of complexes of transition metal with bis-allyl thiourea are tested with wheat and cucumber. Complexes of piperidene-2-carboxylic acid with some bivalent metal ions have been reported to be useful in agriculture as plant growth regulating [8].

Plant growth regulating activities of various organic ligands and their transition metal ion complexes for various plants were studied by many workers [9-16]. Plant growth regulating activity of (2-chlorophenyl) (5-(2-hydroxyphenyl)-3-(pyridin-3-yl)-1H-pyrazol-4-yl) methanone and its Fe (III) and Cu (II) complexes on *Trigonella foenum-graecum* were studied [17].

Substituted sulphonic acids have intense biological activity and since no work is reported on the biological applications of binary complexes with 4-methylbenzenesulfonic acid, present work is carried out with binary complexes of Fe (III) and Cu (II) with 4-methylbenzenesulfonic acid to study the effect of these complexes on germination, survival, seedling height etc. on mohri plant in order to make suggestions whether binary complexes of this ligand can be used as plant growth regulators. The scientific classification of mohri plant is given in Table (1).

Table 1: Scientific Classification of Black Mustard (Mohri)

Kingdom	:	Plantae
Order	:	Brassicales
Family	:	Brassicaceae
Genus	:	*Brassica*
Species	:	*B. nigra*
Binomial name	:	*Brassica nigra* L.

Selection of plant system

The *Brassica campestris* (L.) was selected as a plant system amongst several economically important plants. This plant is in ideal system to study the germination and growth pattern. The plant is used as an important ingredient in spices. It is widely used for the extraction of fatty acids. The crude oil is edible when cold pressed and is used for greasing loaves of bread before baking. The oil from is also used in lamps, oiling wooden goods, and manufacture of soap, lubricant for delicate machinery, rubber substitute and for quenching or tempering steel plates. Therefore, *Brassica campestris* (L.) was selected as a plant system to study the germination.

EXPERIMENTAL SECTION

Solutions of Fe (III) and Cu (II) metal nitrates of 0.01 mol/dm^3 concentration were prepared by adding accurate amounts of metal salts in distilled water. The solution of 4-methylbenzenesulfonic acid ligand of 0.01 mol/dm^3 concentration was prepared in distilled water. The biological applications were studied at pH 5.0 and 8.00 and at 0.1 mol/dm^3 ionic strength of KNO_3 solution.

Fertilized soil was collected from agricultural land. Stones and other hard materials were removed from it. Two parts of this finely powdered soil was mixed with one part of filtered pink-stone-sand. This soil was filled in wooden trays having compartments of equal size. The soil in the tray was moistened with water. Sowing of seeds was done in this soil after one hour.

Healthy seeds of Mohri of equal size were selected. 700 seeds were soaked in water and kept in refrigerator for 4 hours. From these, healthy seeds of equal size were chosen out of which 50 seeds each were immersed in distilled water, ligand solution, and binary complex solution with Fe (III) and Cu (II) of pH 5.0 and 8.00 for 6 hours. The pH of test solutions was maintained using ELICO-pH meter-L1-10 (accuracy ±0.05 units). The seeds soaked were taken out of each solution and washed with distilled water. The seeds were sowed in the wooden trays in a row. The wooden trays were kept under the atmospheric pressure at room temperature. The germination trays were sterilized with 0.01% of $HgCl_2$ for 2 minutes. Effect of binary complexes of Fe (III) and Cu (II) studied at different pH (5.0 and 8.00), the seeds being immersed in experimental solution for 6 hours. Germination and survival were noted after 10 days and 12 days respectively. By noting survival of the plants after 12 days, they were taken out of the soil. The seedling height, soot length, root length, root/soot ratio, and thickness (width length) of young leaf survived plant were measured. Structures of 4-methylbenzenesulfonic acid (4-MBSA) and that of Iron (III) p-toluenesulfonate are shown below in figure (1).

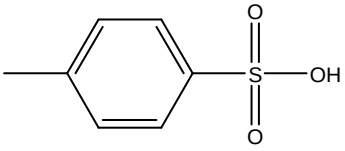

Figure 1. The structure 4-methylbenzenesulfonic

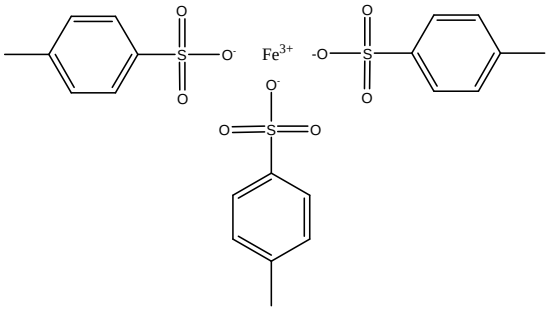

Figure 2. Structure of Iron (III) p-toluenesulfonate

RESULTS AND DISCUSSION

Plant growth was decided on the basis of parameters such as percentage of germination, survival, seedling height, soot length, root length, root/soot ratio, and thickness of young leaf. The average values of these parameters are reported in Table (2). The root/shoot ratio is one of the measures of overall health of the plants and it was determined by using equation (1):

$$\text{root/shoot ratio} = \text{dry weight for roots/dry weight for top of plant} \quad ...(1)$$

The dry weight was measured by keeping 25 fresh plantlets in oven first at 70°C and later at 100°C to obtain a constant weight. It can be seen from Table (2) that there is change in the root: shoot ratio over control (water) which indicates change in overall health of the plant. In present investigation the root: shoot ratio has increased for both Fe (III) and Cu (II) complex at pH 5.0 and 8.0 compared to control treatment, this increase is an indication of a healthier plant compared to other treatments. Increase in this ratio came from greater root size and not from a decrease in shoot weight.

Vigor index was determined using equation (2):

$$\text{Vigour index} = \%\,\text{germination} \times (\text{root length in mm} + \text{soot length in mm}) \quad ...(2$$

The maximum value of vigor index at pH 5.0 and 8.0 are shown for the treatment of Cu (II) complex solutions as shown in figure (1). The vigor index values for various treatments are increased compared to control.

The overall general order of plant growth regulators found at different pH is shown below:

At pH 5.0 and 8.0, Cu (II)-Ligand complex solution > Fe (III)-Ligand complex solution > Ligand > Control (water). The Cu (II) - 4-MBSA complex solution is proposed as a plant growth regulator at pH 8.0 for *Brassica nigra L.* (black mustard) plant.

Table 2: Effect of ligand (4-MBSA) and its complexes with Fe (III) and Cu (II) on growth parameters of Mohri plant (I=0.1 mol/dm^3 KNO_3)

Parameters	Effect of following solutions on different growth parameters			
	Control (water) **(1)**	Ligand **(2)**	Fe (III)-Ligand complex **(3)**	Cu (II)-Ligand complex **(4)**
pH 5.0				
Germination seed number	50	50	50	50
% Germination after 10 days	60	65	78	71
% Survival after 12 days	70	76	83	94
Seedling height (cm)	6.5	6.8	7.3	7.9
Root length (cm)	2.1	2.4	3.1	3.1
Shoot length (cm)	4.6	4.9	5.6	6.0
Root/shoot	0.33	0.43	0.56	0.61
Vigor index	4020	4745	6786	6461
Width of young leaf (cm)	0.4	0.5	0.6	0.6
pH: 8.0				
Germination Seed no.	50	50	50	50
% Germination after 8 days	61	60	67	75
% Survival after 12 days	72	78	82	89
Seedling height (cm)	7.7	7.9	8.2	8.3
Root length (cm)	2.5	2.9	3.3	3.6
Shoot length (cm)	4.6	5.0	5.7	6.1
Root/shoot	0.47	0.52	0.63	0.68
Vigor index	4331	4740	6030	7275
Width of young leaf (cm)	0.5	0.5	0.6	0.7

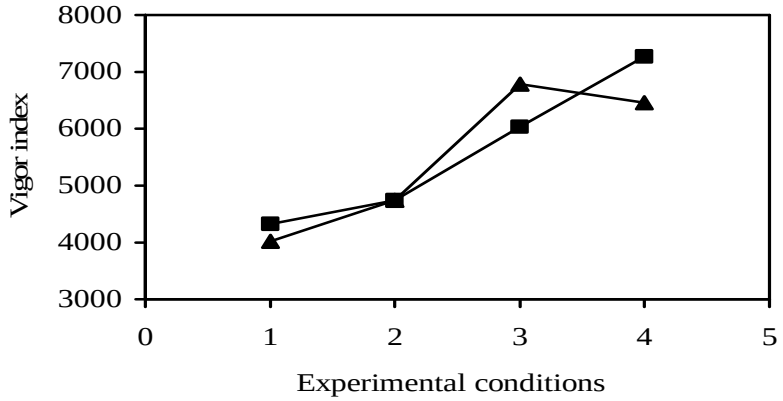

Fig. 3: Effect of various treatments like water, ligand (4-MBSA) and Fe (II) and Cu (II) complexes on vigor index at different pH of medium

(▲= pH 5.0 and ■ = 8.0; 1= Water; 2=Ligand; 3=Fe (III) complex and 4=Cu (II) complex)

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