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ZINC SOLUBILIZATION BY ASPERGILLUS NIGER AND ITS EFFECT ON THE GROWTH OF TOMATO PLANTS

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ABSTRACT

Zinc is an important mineral, though required in small amounts to plants. They are found to be low in plant tissues because they occur in complex form with organic compounds, enzymes or proteins. Reduction in this small concentration leads to deficiency disorders in plants. In this study an attempt was made to check the status of Aspergillus niger as a potential fungi to degrade complex compounds containing zinc and its effect on the growth of Tomato plants.

KEYWORDS: *Zinc Solubilization, Aspergillus Niger, Tomato Plants*

Article History

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INTRODUCTION

In fertile soils, it is estimated that there are 1-6 million bacteria/g and 1 million fungi/g of the soil. Soil biodiversity is a complex combination of living organism, physico-chemical environment and quality of organic matter. (Swift et al., 1979). *Aspergillus niger* is once such fungi that occurs very commonly in most soils.

Minerals when present in solution are in a free ionic form and hence can be easily absorbed by the plants. The uptake of Zinc along with the transpiration flux is very low whereas the uptake by diffusion from its solid state into solution is much rapid. (Emmanuel Frossard et al., 2000) The plants require zinc in smaller quantities, the available forms are solution zinc, absorbed zinc on clay, organic matter, oxide minerals and zinc in organic complexes.

Zinc deficiency is common in almost all soil types resulting in shortened internodes, dwarfed plants, loss of root hair and root system getting affected apart from chlorosis and spotting on leaves.

Zinc solublization by species of *Bacillus* and *Pseudomonas* has been reported by Saravanan et al., (2003). Some fungal genera have proven ability to solubilize zinc. *Aspergillus niger* was observed to grow under 1000mg of zinc and this fungus is used to quantify zinc in soils (Bullen et al., 1997)

Hence the present study was carried out to identify potential beneficial fungi which can solubilize the insoluble forms of zinc and to exploit a commonly occurring fungi like *A. niger* to bring about the process of solubilization which could reduce deficiency disorders caused due to reduced zinc status.

MATERIALS AND METHODS

Organism Used

Aspergillus niger used in the study was isolated from the local gardens and was maintained on Martin's Rose Bengal Agar.

Laboratory Media

Potato dextrose broth and Martin's rose Bengal agar was used for further studies

Zinc Salts Used

The zinc salts used in the study include soluble and insoluble forms including zinc chloride, zinc sulphate and zinc oxide

Zinc solubilization

Aspergillus niger was grown on MRBA containing 0.5g/litre of zinc chloride, zinc sulphate and zinc oxide. Plates were incubated at room temperature for 6 days. Similarly, *Aspergillus niger* was inoculated in broth-MRB and PDB containing 0.5g/litre in the three different zinc salts in different sets and the observations were recorded

Parameters Recorded

Growth of *A.niger*- the diameter of the fungal colony on the three salts was recorded

Growth of *A.niger* on MRB broth and PDB-the fungal mat weight was recorded

The amount of zinc solubilized in the broth was estimated by the EDTA method.

Test Plants

Tomato (*Lycopersicon esculentum* var -Pusa ruby) was selected for the study and was grown in containers on red soil.

Treatment schedules

Tomato seeds were sown in containers containing red soil. The treatment of Tomato plants was as follows:

1. C- Control set (without any addition)
2. Zn- Plants treated only with soluble zinc salt -ZnCl
3. Zn1+A- Plants treated with insoluble zinc salt -ZnO
4. A-Plants treated with *A. niger*

The experiments were carried out in triplicates and grown for a period of 30 days.

The growth parameters recorded include shoot length, root length, number of leaves, disease incidence, deficiency disorders and death over an interval of 15-, 20- and 30-days interval.

RESULTS AND DISCUSSION

The growth of *Aspergillus niger* on MRBA containing zinc chloride-control, zinc sulphate and zinc oxide was found to be 2.7cms, 2.3cms and 2.1cms in colony diameter, while in MRB broth the fresh mat weight was found to be 7.62g, 12.81g, 14.21gm respectively.

The fresh mat weight recorded using PDB showed 3.37g, 2.66g and 2.88 g for zinc chloride, zinc sulphate and zinc oxide.

The amount of zinc present in the samples after 7 days of incubation was 292mg/litre for samples with zinc chloride, 208mg/litre, 460mg/litre for zinc sulphate and zinc oxide containing samples.

Growth parameters recorded over a period of 30 days showed a better growth with the insoluble zinc salt and *Aspergillus niger*.

Table 1: Growth of Aspergillus Niger in Mrba Containing Zinc Salts

MEDIA COMPOSITION	DIAMETER OF FUNGAL MAT (in cms)
MRNA + ZINC CHLORIDE (CONTROL)	2.7
MRBA + ZINC SULPHATE	2.8
MRBA + ZINC OXIDE	2.1

Table 2: Growth of Aspergillus Niger in Mrb Broth With Zinc Salts

MEDIA COMPOSITION	WEIGHT OF PETRIPLATE+FUNGAL MAT (in gms)	FRESH MAT WEIGHT (in gms)
MRBA + ZnCl	92.14	7.62
MRBA + $ZnSO_4$	106.32	12.81
MRBA + ZnO	112.31	14.21

Table 3: Mat Weight of Aspergiluus Niger in Pd Broth With Zinc Salts

MEDIA COMPOSITION	WEIGHT OF PETRIPLATE + FUNGAL MAT (in gms)	FRESH MAT WEIGHT (in gms)
PDB + ZnCl	108.15	3.37
PDB + $ZnSO_4$	104.47	2.66
PDB + ZnO	97.76	2.88

Table 4: Zinc Solubilization-Analysis of Mrb Broth For Zinc Content

SL. NO.	MEDIA COMPOSITION	AMOUNT OF ZINC (in mg/ltr)
1	MRB + ZnCL	292
2	MRB + $ZnSO_4$	208
3	MRB + ZnO	460

Table 5: Growth Parameters of 15 Days Old Tomato Plants

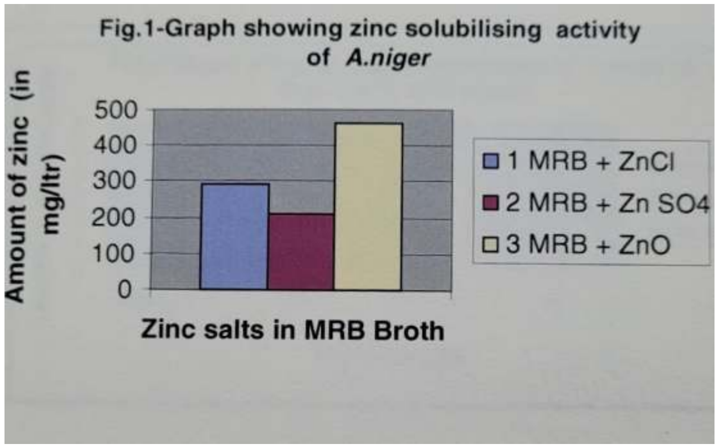
SL. NO.	TREATMENTS	SHOOT LENGTH (cms)	ROOT LENGTH (cms)	NO. OF LEAVES
1	Control/c	4.5	1.8	3
2	Zn	5.1	3.2	3
3	Zn1 + A	4.0	2.2	3
4	A	4.5	1.1	3

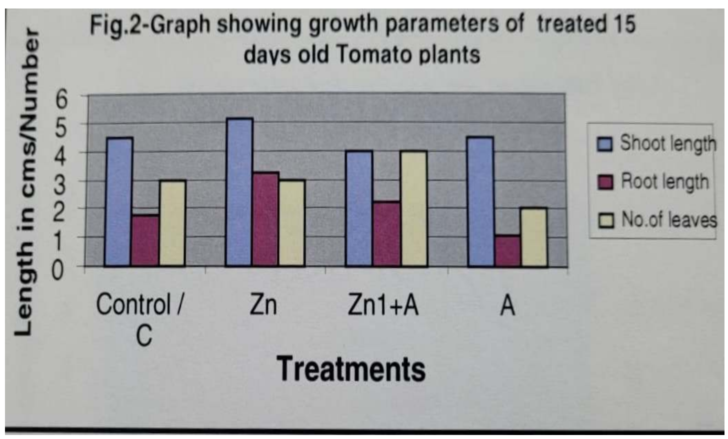
Table 6: Growth Parameters of 20 Days Old Tomato Plants

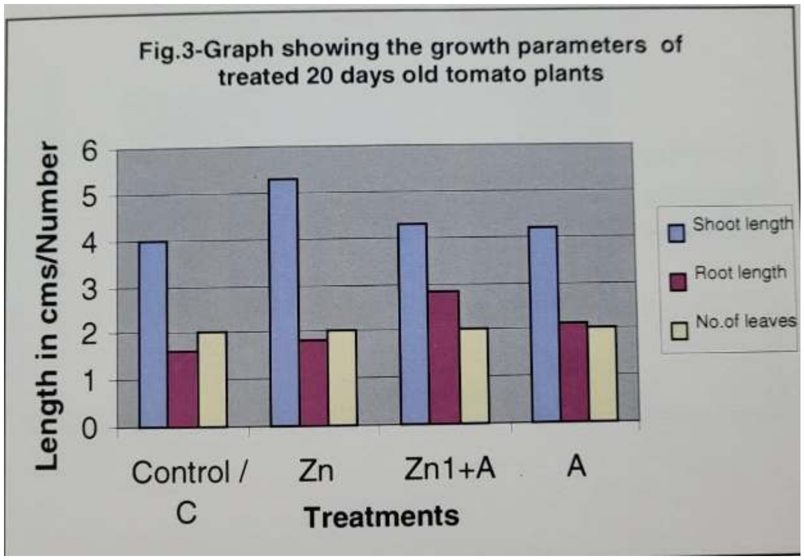
SL. NO.	TREATMENTS	SHOOT LENGTH (cms)	ROOT LENGTH (cms)	NO. OF LEAVES
1	Control/c	4.0	1.6	2
2	Zn	5.3	1.8	2
3	Zn1 + A	4.3	2.8	2
4	A	4.2	2.1	2

Table 7: Growth Parameters of 30 Days Old Tomato Plants

SL. NO.	TREATMENTS	SHOOT LENGTH (cms)	ROOT LENGTH (cms)	NO. OF LEAVES
1	Control/C	3.0	4.3	3
2	Zn	3.5	2.7	3
3	Zn1 + A	4.0	3.6	3
4	A	3.1	2.5	3







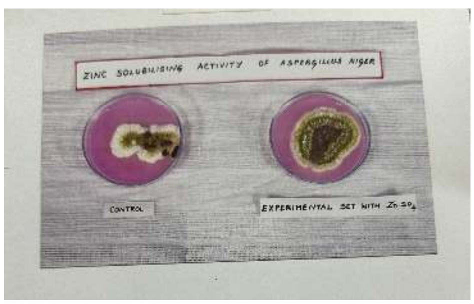
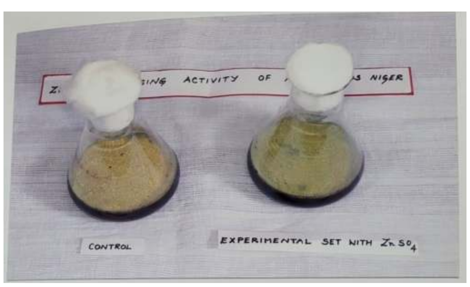
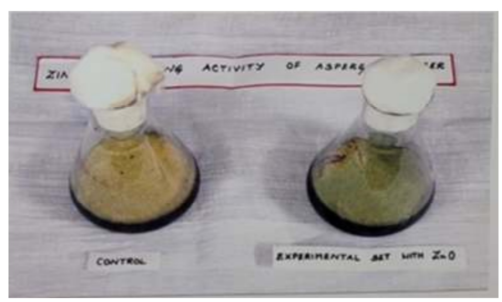


Plate 1a: Control (Soluble Zinc Salt-Zncl and Znso$_4$

1b: Control (Soluble Zinc Salt-Zncl and Zno





2a: Control (with Soluble Zinc salt-ZnCl) and $ZnSO_4$ 2b: Control (with soluble zinc salt-ZnCl) and ZnO

Plate: Showing growth of Aspergillus niger in PDB Containing

Plate 3: Showing 15 days old Treated Tomato Plants

1. C - Control (without any addition)
2. Zn -with soluble zinc salt
3. Zn!+A -with insoluble zinc salt+Aspergillus niger
4. A - with only Aspergillus niger

Plate: 4 showing 20 days old treated Tomato plants

1. C - Control (without any addition)
2. Zn -with soluble zinc salt
3. Zn!+A -with insoluble zinc salt+*Aspergillus niger*
4. A - with only *Aspergillus niger*

Plate: 5 Showing 30 days old Treated Tomato Plants

1. C - Control (without any addition)
2. Zn -with soluble zinc salt
3. Zn!+A -with insoluble zinc salt+*Aspergillus niger*
4. A - with only *Aspergillus niger*

CONCLUSIONS

Most microorganisms in soil have the capacity to break down complex insoluble forms for minerals by the production of organic acids and enzymes. By the process of solubilization, the nutrients are easily taken up and assimilated by other forms of life. Zinc is a limiting nutrient for the growth of Tomato plants. Non-availability causes deficiency disorders in plants. Hence the role of *Aspergillus niger* in a less exploited area of zinc solubilization was considered. Efficient and promising strains may be available in current times and requires further exploration.

REFERENCES

1. *(Bullen P, Kemila APF (1997). Influence of pH on the toxic effect of zinc, cadmium and pentachlorophenol on pure cultures of soil microorganisms. Entl.Toxi.Chem, 16pp.146-153.*
2. *Catmax I and Mafschner H (1988). Enhanced superoxide radical production in roots of zinc deficient plants. J. Exp.Bot.39 pp:1449-1460*
3. *Chernavina P (1970). Importance of trace elements in pigment production of microbes. Molekulasnaya Biologya 6. Pp: 340-355*
4. *(Emmanuel Frossard, Marcel Bucher, Felix Machler, Ahmad Mozafer and Richard Husell (2000). Potential for increasing the content and bioavailability of Fe, Zn and Ca in plants for human nutrition. Journal of science of food and agriculture. Pp: 861-879*
5. *Harvey L, Mc Neil B (1994), Biotechnology handbook 7. Pp: 141-176*
6. *Marschner H (1995). Mineral nutrition of higher plants. Second edition, Academic press, London*
7. *Rengel Z, Batten G D and Crowley D E (1999). Agronomic approaches for improving the micronutrient. Field crops.Res.60 pp:27-40*
8. *Simine C D D, Sayer J A, Gadd G M (1998). Solubilisation of zinc phosphate by a strain of Pseudomonas Fluorescens isolated from forest soil. Biol. Fertil. Soils. 28 pp:87-94*

9. *Swift m j, Heal O W and Anderson J M (1979). Decomposition in terrestrial ecosystems, Blackwell, Oxford, UK.*
10. *Van Brunt (1986) , Biotechnology 4. Pp: 1057-1062*
11. *Venkatakrishnan Sivaraj Saravanan, Sudalayandy Rama Subramoniam and Savariappan Anthony Raj (2003). Assessing in vitro solubilization potential of different zinc solubilizing bacterial isolates. Brazilian Journal of Microbiology 34.pp: 121-125*