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International Conference on Science, Engineering & Technological Innovations

(13 – 14 August, 2022)

Bangkok, Thailand

Conference Special Issue - 37 August - 2022

Jointly Organized by:

Scientific Research Association
Unicaf University, Zambia
Institute of Educational Technology, Eurasian University
&
Research Culture Society

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International Conference on Science, Engineering & Technological Innovations

Date: 13 – 14 August, 2022

Bangkok, Thailand

Conference Special Issue - 37

Managing Editor
Dr. C. M. Patel
(IJIRMF - Research Culture Society and Publication)

Associate Editors
Dr.(hc) Rania Lampou
Dr. Jessica C.
Prof. M. Narayani

Organized by :

Scientific Research Association
Chreso University (CU) Zambia
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About the organizing Institutions:

Institute of Science and Technology (EU) ; Institute of Science & Technology is a self financed institute, sponsored has been started in the year 2011 with a noble aim of imparting technical education. The institution enables them to be placed as the best professionals in industries and make them enter into high level programs with competence and confidence. Institute trains specialists in Physical Science, Life Science and Computer Science,

Eurasian University is one of the largest education institutions of the central region of EU, for qualified personnel training in science, management and technological specializations. Scientific subjects performed by the university aimed to increasing the efficiency of production and control processes, power saving and environmental protection.

Chreso University (CU), a faith based University founded by Dr. Helmut Reutter and Mrs. Esther Reutter, under the umbrella vision for Chreso Ministries, was officially established in the year 2010 under the Universities Act No. 26 of 1992. And in 2016, the University was duly registered with the Zambia Higher Education Authority under the Higher Education Act No. 4 of 2013. Chreso University operates three (03) University campuses namely: City campus (RC No. HEA 022); Makeni campus (RC No. HEA 084) and Ndola campus (RC No. 077) at Zambia, Southern Africa.

'Research Culture Society' is a Government Registered International Scientific Research organization. Society is working for research community at National and International level to impart quality and non-profitable services. Society has successfully organized 100+ conferences, seminars, symposiums and other educational programmes at national and international level in association with different educational institutions.

'Scientific Research Association' (Scientific Research Organization) is an esteemed research organization working on to promote scientific research studies, activities at international level, also coordinate with other research organizations for the educational research events.

Objective of the International Conference:

- Our main objective is to promote scientific and educational activities towards the advancement of common citizens' life by improving the theory and practice of various disciplines of science and engineering.
- To meet and discuss the practical solutions, scientific results and methods in solving various problems with people who are actively involved in emerging research fields.
- To organize lectures by scientists and experts and to disseminate their ideas and concepts among the science and technology community.
- Provide the delegates to share their new ideas and the application experiences face to face.
- The aim of the conference is to provide platform to students, scholars, academicians and industry persons to converse and share the ideas.

About the Conference :

International Conference on Science, Engineering & Technological Innovations (ICSETI-2020) conducted on 13 – 14 August, 2022 at Divalux Resort and Spa in Bangkok, Thailand. It aims at bringing together students, scholars, researchers, academicians and industry persons to deliberate on contemporary issues concern to Science, Engineering and Technology research and applications.

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Science, Engineering and Technology cross nearly every facet of modern life and, as problem solvers, engineers are perfectly capable of managing technical activities, mastering innovative ways of science and engineering field, when they spend time and efforts understanding and acting in the field. Scientific and technological innovation, as strategic support to improve social productivity and overall national strength, must be placed at the center for development of any country.

The framework includes engineering and technology as they relate to applications of science. Engineering is used to mean engagement in a systematic design practice to achieve solutions to particular human problems. Technology is used to include all types of human-made systems and processes.

The edited book is a collection of peer-reviewed scientific papers submitted by active researchers in the International Conference on Science, Engineering & Technological Innovation. This book can be helpful to understand the various concepts of Science and Technological Innovation to the researchers and academia.

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Dear Colleagues, Ladies and Gentlemen!!!

I am glad to be one of the members of the Organization Committee of two days Conference entitled, "International Conference on Science, Engineering & Technological Innovations" jointly organized by 'Scientific Research Association', 'Research Culture Society' and 'Chreso University, Zambia' dated on 13-14 August, 2022 in Bangkok, Thailand.

The world we live in today requires constant adjustments to the many challenges that our communities as well as our planet faces in this critical times. It is only through diligent and continuous research that we will be able to find better ways to deal with all the questions that confront us in this urgent manner.

Academic communities have no choice but put their heads together in collaboration making all the required efforts in order to find intelligent alternatives to the way we are doing business today. I'm therefore greatly encouraged to see such a great community of researchers come together for this Conference.

This conference will facilitate the formulation of the novel research ideas for innovations in the field of science and technology. Currently the same collaborative conferences are really helpful to display African talents in research and innovation efforts and outputs. Special thanks to Research Cultural Society for arranging this type of jointly Scientific Research Conferences.

Best wishes for the ample success of this conference.

Thank you!!!

Rev. Dr. Helmut Reutter

Chancellor, Chreso University, Zambia, Southern Africa.

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Dear Colleagues!!!

I am delighted and excited to be part of the Organization Committee of two days Conference entitled, "International Conference on Science, Engineering & Technological Innovations" jointly organized by 'Scientific Research Association', 'Research Culture Society', 'Eurasian University' and 'Chreso University, Zambia' dated on 13 & 14 August, 2022 in Bangkok, Thailand.

This international forum will allow the participants and academicians to reveal their endeavors, extend professional networks and jointly ascertain the existing and upcoming research instructions/guidelines and innovations at international level. I believe that all the presentations in this research conference will bring interesting topics with fruitful discussions. It is really helpful to Chreso University to showcase our students/scholars research outputs and grow in research and innovation through this platform.

I honestly hope that this conference will consider and discuss all the facts, issues, challenges, advanced development and updation in the specified topic globally and come up with solutions and recommendations that will contribute significantly to a healthier world.

My hearty wishes and regards for the great success of this conference.

Thank you!!!

Professor. Christopher Simoonga
Vice Chancellor, Chreso University, Zambia, Southern Africa.

Dr.C. M. Patel

Director, RESEARCH CULTURE SOCIETY

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Message

Dear Professional Colleagues,

It is gratifying to note that 'Scientific Research Association'; Chreso University (CU) Zambia; Institute of Science and Technology, Eurasian University in collaboration with 'Research Culture Society' (Government Registered Scientific Research organization) are organizing - 'International Conference on Science, Engineering & Technological Innovations' at Bangkok during 13 – 14 August, 2022.

The aim of the conference is to provide an interaction stage to researchers, practitioners from academia and industries. The main objective is to promote scientific and educational activities towards the advancement of common citizen's life by improving the theory and practice of various disciplines of science and engineering. Provide the delegates to share their new research ideas and the application experiences face to face.

I believe, this International Conference will help in redefining the strong connection between students and academicians from different institutions. An additional goal of this international conference is to combine interests and scientific research related to General Science, Physical Science, Applied Sciences, Engineering and Technology Development to interact with members within and outside their own disciplines and to bring people closer for the benefit of the scientific community worldwide.

My best wishes to the committee members, speakers and participants of this scientific conference ICSETI-2022.

Dr.C. M. Patel

Director, Research Culture Society.

Dr.Jessica C.
Founder President, Scientific Research Association.
Email : scientificresearchassociation@gmail.com

Message

Dear Colleagues !

I am grateful to co-organizing institutions, all the speakers, committee members and presenters of 'International Conference on Science, Engineering & Technological Innovations' (ICSETI-2022) The overwhelming response to the contributors were acknowledged in very positive manner and its shows that new age is very much eager to work with technical literature. The rising researcher and scholar from various institutions and in-house participants motivate us to improve ourselves.

We are currently in the era of science and engineering revolution, spearheaded by recent developments in engineering, technology and sciences, providing sustainable solutions to various issues.

Here I am delighted that the series of conference on contemporary issues in computer technology has successfully completed its three folds and entered into fourth one, it's all due to the valuable efforts of faculty members of computer science and engineering department.

I extend my best wishes for the editorial team of the special issue, at last I hope this technological literature interaction will be a source of inspiration to upcoming educationists, technocrats and stakeholders.

Jessica

ICSETI - 2022 Conference Chair
Founder, Scientific Research Association

Prof. Maria Eropenko
Head, Institute of Science and Technology
EURASIAN UNIVERSITY
Email : ist@eurasianuniversity.uk

MESSAGE

Dear Colleagues!!!

I am proud to be the part of Organizational Committee of "International Conference on Science, Engineering & Technological Innovations - 2022", jointly organized by 'Scientific Research Association'; Chreso University (CU) Zambia; and Institute of Science and Technology, Eurasian University in collaboration with 'Research Culture Society' (13-14 Aug, 2022).

We have an exciting program at this conference that will allow participants to reflect upon and celebrate their accomplishments, renew friendships and extend networks, and jointly explore current and future research directions. I hope that all participants will have a productive and fun-filled time at this online conference.

I sincerely hope that this conference will deliberate and discuss all the different facets of this exciting topic and come up with recommendations that will lead to a better world.

I wish the conference great success.

Maria Eropenko
Head, Institute of Science and Technology,
Eurasian University

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Professor. Christopher Simoonga, Vice Chancellor, Chreso University, Zambia, Southern Africa.
Dr. C. M. Patel, Director – Research Culture Society.
Dr. Jessica C., Founder President, Scientific Research Association.

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Conference Photo Gallery

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13 - 14 August, 2022 : Bangkok, Thailand


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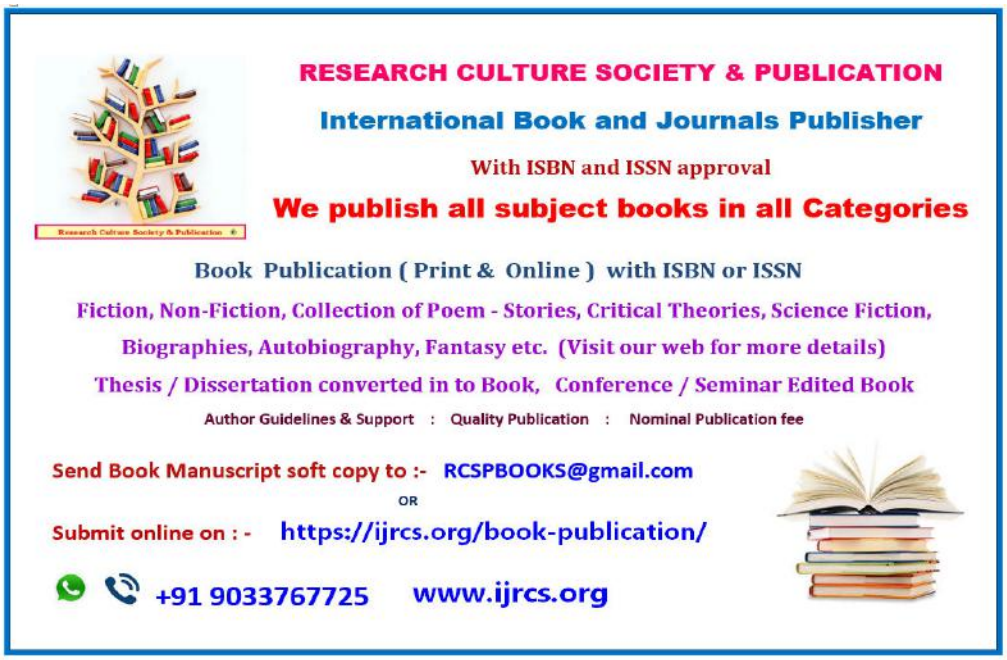

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Investigation of Siderophore in Mycorrhizal and Non-Mycorrhizal roots on two experimental plants

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Abstract : Mycorrhizae establish symbiotic relationships with plants and play an essential role in plant growth, disease protection and overall soil quality. Siderophores are potent ferric ion chelators produced by microbes like bacteria and fungi during iron stress. The study was to investigate the siderophore content in soil and root in inoculated with *Rhizophagus fasciculatus* compared with noninoculated control plant PMK-1 and Vaibhav variety of *Solanum lycopersicum* L,.Randomized block design of 3 replicates for each treatment and of both the varieties were inoculated with a thin layer on inoculums *Rhizophagus fasciculatus* around2cm below the soil surface except in non-inoculated control pots before sowing.After 45 days the uprooted plants were subjected to qualitative and quantatative analysis.The qualitative test of Chrome Azurol sulphonate(CAS) Assay showed positive reaction, produced orange/golden yellow color indicated the presence of hydroxamate siderophore. The estimation of siderophore content in root of inoculated *Solanum lycopersicum* L., of PMK-1 variety showed 1.59µmol/m land vaibhav variety 0.93µmol/mlsimilarly in soil of both the variety recorded 0.67µmol/ml and 0.84µmol/ml respectively. The content of siderophore was recorded high in the *Rhizophagus fasciculatus* inoculated roots compared to in noninoculated control, the roots produced higher siderophore than soil. This investigation has clearly demonstrated and recorded that the Arbuscular mycorrhizal symbiosis is shown to accompanying the greater Fe uptake rates by a different host plants solubilization of Fe from insoluble iron sources must be regarded a pre requisite for improvement of plant Fe nutrition.

Key words: Mycorrhiza, Siderophores, *Rhizophagus fasciculatus,*Vaibhav, Bacteria, Environment.

1. INTRODUCTION:

Arbuscular mycorrhizal fungi (AMF) that enhance the nutrient uptake by establishing a hyphal network inside and around the plant roots (Lee and George, 2005). This fungus penetrates into the roots of a plant, growing between the root cells and into the part of the root where the products of photosynthesis, carbohydrates, are stored in the cortex. To transfer the nutrients absorbed from the soil for the carbohydrates, the fungal hyphae penetrate in the cell walls and grow into tree like structures called arbuscules. The plant cells cooperatively accommodate this intrusion. Increase of Fe, Zn and Cu uptake by mycorrhizal symbiosis plants have been reported by (Clark and Zeto, 1996; Caris*et al.,* 1998).Arbuscular mycorrhizal fungi secretes number of very low molecular weight (<10 KD) proteins called siderophores. These proteins having ferric specific ligand are produced by microbes as iron (Fe) scavenging agents in order to prevent low iron stress. Siderophores solubilize the insoluble iron in the external environment and transport it into the microbial cell. Under conditions of Fe limitation, microorganisms and plants commonly dependent on chelating agents to solubilize the iron and transport inorganic Fe. Iron produced by the grasses is the most important naturally occurring, biosynthetic chelates are the great number variety of siderophores, microbes and the relatively few phytosiderophores.

2. LITERATURE REVIEW:

It was Cox and Sanders (1974), and Kinden and Brown (1975), who have detected enzymes such as chitinase, peroxidase cytochrome oxidase and proteins in AM fungi colonized roots. Scannerini (1979), have investigated that the interfacial matrix and arbuscules were filled with polysasccharides and proteins. Gianinazzi*et al.,* (1979), have reported on enzymatic activities of acid and alkaline phosphatases in onion roots colonized with *Glomus* species. Rai*et al.,*(1982), have suggested that, the iron deficiency in nodulated legumes is very common on alkaline soils and affects such common agricultural crops as Chick pea, French bean (Hemantaranjan and Garg, 1986) and, Peanut (O'Hara *et al.,* 1988). Crowley *et al.,*(1991), have suggested that the microbial siderophores are of general importance in Fe nutrition, even in the case of graminaceae species. Cress *et al.,*(1986), have showed that mycorrhizal inoculated *Hilariajanesii* grass showed greater Fe uptake compared with that of non-mycorrhizal controls and tested positively when bioassayed for hydroxamate siderophores. Some fungal species produce more siderophore than bacteria (Milagres*et al.,*1999).Leyvaland andBerthelin, (1986), have revealed that mycorrhizal inoculation has showed increase iron solubilization from sparingly soluble sources such as iron phosphate, silicate minerals, sand and iron uptake rate by pine and ericaceous plants. Ma *et al.,*(2003), have investigated the response to iron (Fe) deficiency in two cultivars of *Festucarubra* L. used in correction of chlorosis of fruit trees cultivated on calcareous soils. It was Arefa*et al.,*(2004), who have done a comparative study on siderophore production by fungi from marine and terrestrial habitats. Haselwandter and Winkelmann, (2007), have reported that Arbuscular mycorrhizal symbiosis lead to greater Fe uptake rates by a range of different host plants.

Solubilization of Fe from rather insoluble Fe sources must be regarded a pre-requisite for improved plant Fe nutrition. Johnson, (2008), have suggested that the release of siderophores is a powerful strategy AM fungal host interactions, and for obtaining Fe from the environment. Ueno *et al.,*(2007), have identified, characterized and purified with various chromatographic root exudates collected from grasses, *Loliumperenne* Cv.Tove and *Poapratensis* Cv.Boron, the siderophores secreted from the roots of Fe deficient grasses. Grime *et al.,* (1987), have observed in a classic experiment involving several grass and herbaceous species demonstrated after inoculated with mycorrhiza had greater plant diversity than non-inoculated control. Under conditions of iron deficiency, graminaceous plants (Barley and Wheat) have developed an efficient strategy for acquiring Fe from insoluble sources (Kraemer,*et al.,* 2006). These plants secrete ferric iron-chelating compounds called phytosiderophores, which form specific strong complexes with Fe (Ma, 2005). Sorghum plants inoculated with mycorrhiza have shown uptake of iron in higher concentrations than that of non-mycorrhizal plants (Caris*et al.,* 1998). Jurkevitch (1986), have reported that Peanut plants grown on a calcareous soil with improvement of Fe, pseudobactin act as Fe source to plants and decreased the symptoms of Fe deficiency.

3. Research Objectives / Aims:

In the present investigation following are the research objectives

- Effect of the Arbuscular mycorrhizal symbiosis of *Solanum lycopersicum* L., (Var.PMK-1 and Vaibhav) inoculated with *Rhizophagus fasciculatus.*
- Extraction and analysis of siderophore from soil and roots of *Solanum lycopersicum* L., (Var.PMK-1 and Vaibhav) inoculated with *Rhizophagus fasciculatus* and the non-inoculated control plants.

4. RESEARCH METHOD:

Soil and plant material

Physico-chemical characteristic of soil used for pot experiments were determined according to Jackson (1973). 3 kg of soil: sand (3:1 v/v) mixture was filled into 18 cm diameter pots. The seeds of

PMK 1, Vaibhav, NS 524 and NS 585 varieties of *Solanum lycopersicum* L., were procured from Namdhari seed Company Bangalore, Karnataka, India. Seeds were surface sterilized by treating with 1% sodium hypochlorite for 2-3 min before sowing and after germination uniform seedlings were made one per pot.

Inoculums production

The*Rhizophagusfasciculatus* (Thax.)Walker&Schußler were mass multiplied in 18 cm diameter containing 8 kg sterilized sand : soil (1:1 v/v) mixture as the substrate and *Sorghum vulgare* L., (Jowar) as host plant. After 60 days of growth shoots of Jowar were chopped and the inoculum containing spores, root bits was air dried and 10 g of the mycorrhizal inoculum was applied to the planting area at a depth of about 4 cm to the pots (except non-inoculated control plants) before sowing seeds.

Pot experimental set up

The treatments were set as inoculated with *Rhizophagus fasciculatus* of *Solanum lycopersicum* L.,(PMK-1 and Vaibhav varieties) and non-inoculated control pots. The Pots measuring 18 cm diameter filled with 3 kg of air-dried sterilized soil:sand (3:1 v/v) mixture pots were arranged in a randomized block design with triplicates per treatment and non-inoculated control of each variety. Before sowing seeds of PMK-1 and Vaibhav varieties of *Solanum lycopersicum* L., a thin layer of inoculum *Rhizophagus fasciculatus* was placed 2cm below the soil surface except non-inoculated control pots. The pots were exposed to sunlight and received 10 ml of Hoagland nutrient solution without phosphate, once in 15 days. To maintain moister pots were watered every alternate day. The plants were uprooted after 45 days for the estimation of siderophore in the soil and roots of all the four varieties of *Solanum lycopersicum* L. The roots were washed under running water to remove the soil particles, cleaned; the oven dried roots were taken for the siderophore estimation.

Detection and estimation of siderophore production

Extraction of siderophorefrom soil

100g of soil sample was mixed with 100ml of 0.1 M phosphate buffer (pH 7.0) and kept inside the refrigerator for overnight. Supernatant was filtered, centrifuged at 5000 rpm for 30 minutes, cooled and mixed with ice acetone (1:3) to precipitate and the pellet obtained was resuspended in 0.1 M phosphate buffer (pH 7.0).

Extraction of siderophore from root

The roots were dried at 72^0 C for 48 hr, in hot air oven then 1g of grinded root was mixed with 70 % ethanol and placed in the shaker for 1 hr and filtered by using Whatman filter paper No 42. The solvent was evaporated using the rotary evaporator then remaining powered maintained used for siderophore assessment.

Chrome Azurol Sulphonate (CAS) Assay

The CAS assay is the universal chemical assay for siderophore detection described by Schwyn and Neilands, (1987), based on a siderophore's high affinity for ferric iron. When siderophore is present the following reaction occurs, which releases the free dye, which is strong in color blue to orange/ golden yellow .

Procedure

5ml of CAS (Chrome Azurol Sulphonate) solution and 1ml of soil and root sample were taken in a test tube and mixed thoroughly then allow to stand for few minutes. when siderophore present are remove the iron from dye complex resulting in the formation of blue to orange/ golden yellow color. The absorbance of the solution was measured by using UV-Spectrophotometer (Hitachi-Japan (U-3310) model) at 630 nm.

5. Discussion and Analysis:

The occurrence of siderophore content in *Solanum lycopersicum* L.,(PMK-1 and Vaibhav varieties) AM fungal inoculation influenced in rhizospheric soil and roots compared to non-inoculated plants. These findings are in accordance with Powell *et al.,*(1982, 1983). Arbuscular mycorrhizal fungi are reported to enhance Fe uptake rates of associated with host plants, which can be taken as an indication that mycorrhizal siderophores of a unknown structure may be involved(Haselwandter, 2008). Investigations of siderophore produced by mycorrhizal fungi may well lead to the discovery of novel siderophore structures as suggested previously by Haselwandter in(1995).Recently on different factors that lead to research on the siderophores have received much attention because of their potential roles and applications in various areas. The total concentration of hydroxamates, as well as ferrichrome-type siderophores earlier have been estimated by using microbial assays it has revealed that the presence of siderophores in soil. Soil microorganisms like bacteria and fungi have a particular important role to evaluate these new actions of approaches. So, that siderophore producing organisms will be making the soil fertile and they also have antifungal activity against phytopathogens observed by Girish*et al.,*(2010). High plant root Fe^{+3} concentrations were also found by other authors for plants grown in soil by Mengel and Schaumberger (1999) and on nutrient solutions (Mengel and Geurtzen, 1988; Fox *et al.,* 1996).

In many instances, the siderophores act as a plant growth promoters(Yadav*et al.,* 2011; Verma*et al.,* 2011), biocontrol agents (Schenk *et al.,* 2012) and bioremediation agents (Wang *et al.,* 2011; Ishimaru*et al.,* 2012), in addition to their valuable role in soil mineral weathering (Reichard*et al.,* 2005;Shirvani and Nourbakhsh, 2010).In fact Fe^{++}siderophore complex is formed at the mineral surface and the mechanism is that transferred into the surrounding soil solution and becomes available for uptake by the cell membrane of microorganisms or plants (Kalinowski*et al.,* 2000; Kraemer, 2004).

In addition Arbuscular Mycorrhizal fungi (AMF) can also be used as biofertilizer to improve the plant growth that depends on the production of siderophores (Van Scholl *et al.,* 2008). Kloepper*et al.,* (1980), have investigated that the role of siderophoresin the mechanism of biological control, this mechanism depends on the role of siderophores as competitors for iron in the soil that become less amount of iron availability for the phytopathogens (Scher and Baker, 1982; Thomashow*et al.,* 1990). Powell *et al.,*(1980), have presented earlier that some reservoirs of siderophores are adsorbed to soil organic matter. In addition, recently it was by Haselwandter*et al.,* (2011), have reported that the siderophores could be dissolved or adsorbed regards to their susceptibility to degradation. Some studies reported that hydroxamate siderophores are more commonly found in the dissolved phase in the soil since they consist of strong cyclic hexapeptides that make them highly resistant to the environmental degradation by some enzymes produced by plants such as hydrolases and proteases, which affect the duration of the siderophores (Hider and Kong, 2010).

6. RESULTS / FINDINGS:

The siderophore content in the soil and roots of *Solanum lycopersicum* L. varieties PMK-1, and Vaibhav inoculated with AM fungi and in the non-inoculated soil and roots shown in (Table-1). The qualitative test (CAS test) showed positive reaction, produced orange/golden yellow color indicating the presence of hydroxamate siderophore. Siderophore concentrations in AM fungi inoculated and non-inoculated soil and roots are shown in (Figure-1).

***Solanum lycopersicum* L. var. PMK-1**

In soil, inoculated with *Rhizophagus fasciculatus*produced higher siderophore(0.73µmol/ml)compared to non-inoculated control (0.05µmol/ml). Mycorrhizal roots produced considerably higher siderophore (0.96µmol/ml) than non-mycorrhizal roots (0.36µmol/ml).Siderophore content was higher in the rhizosphere soil compared to root as shown in (Table-1).

***Solanum lycopersicum* L. var. Vaibhav**

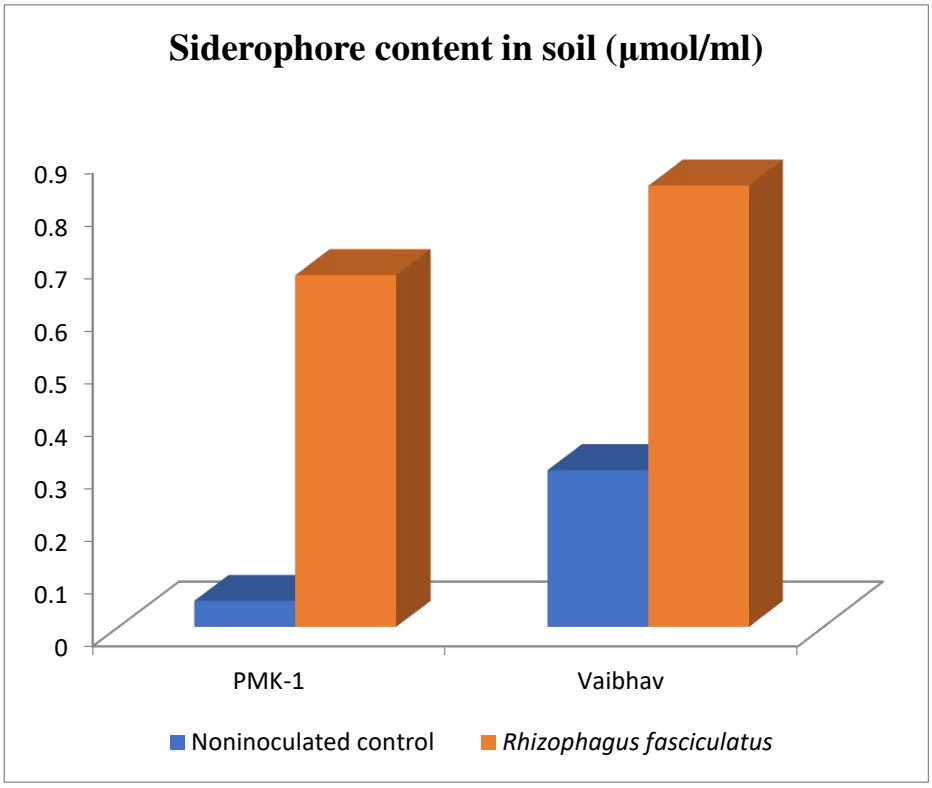
There was an increased siderophore content in the plant rhizosphere soil inoculated with *Rhizophagus fasciculatus*(0.82µmol/ml)compared to non-inoculated control (0.28 µmol/ml). Significantly increased siderophore production was observed in plant roots grown in presence of AM fungus *Rhizophagus fasciculatus*(1.64µmol/ml)than that of the non-inoculated control (0.52µmol/ml) plants. Siderophore production in the root of *Solanum lycopersicum*L., (var. PMK-1 and Vaibhav) was more with AM fungus *Rhizophagus fasciculatus* inoculation compared to non-mycorrhizal plants. Similar trend was observed in the rhizospheric soil (Table-

Table 1: Showing the siderophore content in rhizospheric Soil and Root of *Solanum lycopersicum* L., (Var, PMK-1 and Vaibhav) with and without AM fungus *Rhizophagus fasciculatus* inoculation at 45 days.

Treatments	Rhizospheric Soil	Root
PMK-1		
Noninoculated Control	0.05±0.03	0.36±0.11
Rhizophagus fasciculatus	0.73±0.03	0.96±0.03
Vaibhav		
Noninoculated Control	0.28±0.01	0.52±0.03
Rhizophagus fasciculatus	0.82±0.39	1.64±0.09

Each value is the mean of three sample ± standard error.

Figure 1: Showing the siderophore content in soil inoculated with *Rhizophagus fasciculatus* and noninoculated control of *Solanum lycopersicum* L.,(Var. PMK-1 and Vaibhav) at 45 days.



7. CONCLUSION:

The CAS (Chrome Azurol Sulphonate) assay was used for the detection of siderophore.The qualitative test CAS assay showed positive reaction, produced orange/golden yellow color indicated the presence of hydroxamate siderophore. *Solanum lycopersicum* L., var. Vaibhav had maximum siderophore production in both the root and rhizospheric soil with AM fungal inoculation compared to non-mycorrhizal plants. It was also observed that, siderophore production was more in the rhizosphere compared to roots colonized with AM fungus.

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