FINAL REPORT

Evaluation of Efficacy of Indigenous and Introduced Arbuscule Mycorrhizae (AM) In Co-Inoculation with Nitrogen Fixing and Phosphate Solubilize Microbes On Crop-yield And Maintaining Sustainability Of Soil

F. No. F 42-940/2013(SR) dated 22.03.2013

DrSomdatta Ghosh

Assistant Professor
Department of Botany (UG & PG)
Midnapore College (Autonomous)

ATTESTED
Principal
MIDNAPORE COLLEGE
(AUTONOMOUS)
MIDNAPORE

Annexure –III

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002.

Final Report of the work done on the Major Research Project

(SUBMITTED IN TRIPLICATE)

1.	Project report No.	Final
2.	UGC Reference No. & Date	F 42-940/2013(SR) 22.03.2013
3.	Tenure of the project	01.08. 2013 to01.07. 2017
4.	Title of the Project	Evaluation of Efficacy of Indigenous and Introduced Arbuscular Mycorrhizae (AM) In Co-Inoculation with Nitrogen Fixing and Phosphate Solubilize Microbes On Crop-yield And Maintaining Sustainability Of Soil.
5.a	Name of the Principal Investigator	DR. SOMDATTA GHOSH
5.b.	Department and University/ College where the project has undertaken	Dept. of Botany,Midnapore College (Autonomous), Midnapore 721101, W.B
6.	Date of implementation	01.08.2013
7.	Grant approved and expenditure incurred during the period of the report:	
7.a.	Total Amount approved	₹.8,47,300.00
7.b.	Total Expenditure incurred	₹.8,49,331.00
7.c.	Report of work done	Separate sheet enclosed.

7.c.Report of the work done:

i.	Brief objective of the project a) To find out which indigenous and /or introduced AM and phosphate solubilizing microbe is/are most efficient as P substitute in lateritic soil. b) Identify the species/ strains and maintaining pure culture of them. c) To find out comparative and combined effects of efficient indigenous and introduced AMF with N fixers and P solubilizing bacteria on agricultural yield, nutrient uptake, biochemical contents of crop and phosphatase activity. d) To find out effects of efficient indigenous and introduced AMF and beneficial microbes on agricultural yield, nutrient uptake, and biochemical contents of successive crop with or without further inoculation. e) To find out comparative and combined effects of efficient indigenous and introduced AMF with N fixers and P solubilizing bacteria to chemical NP fertilizers on agricultural yield, nutrient uptake, biochemical contents of crop and phosphatase activity. f) To find out effects of efficient indigenous and introduced AMF and beneficial microbes on soil residual fertility and soil physical and chemical properties.
ii.	Work done so far and results achieved a) A detail and exhaustive survey of arbuscular mycorrhizal (AM) symbiotic condition in agricultural fields in lateritic soil with various fertilizer treatments; in weeds of barren lands and in forest plants was done. Soil organic carbon, pH, EC, NPK, moisture content was studied with AM status (colonization percentage, intensity, spore population and diversity. b) AM spores from different soil samples were isolated in repeated pure culture and mass culture and being maintained. Identification pending as no fund allotted for. c) Mass culture of introduced AM species is being maintained. d) Primary screening of isolated and introduced AM species with sesame have been done in field and the effect on growth was evaluated. e) Two phosphate solubilizing and nitrogen fixer bacteria have been isolated and being maintained. f) Comparative effect of triple inoculation with AM, phosphate solubilizing and nitrogen fixer bacteria is being studied with chili and sesame (30 days plant)

	g) Study the comparative effect of effective indigenous and/or introduced AM (Screened from previous step) and microbes (N-Fixer and P solubilizes) on growth, nutrient uptake and enzyme activity of test crop in lateritic soil. h) Study the residual effect of indigenous and introduced AM fungi, N-Fixer and P solubilizing bacteria on successive crop with and without further inoculation. i) Identification pending as no fund allotted for.	
iii.	Has the progress been according to original plan of work and towards achieving objectives if not, state reasons	**Yes, the progress is according to plan of work, but hampered somehow for fund pending.**
iv.	Please indicate the difficulties, if any, experienced in implementing the project	a) For lack of net/glass house it is very difficult to maintain the mycorrhizal culture in pure form. That wasted time &labour. b) Animal and peoples disturbance in study site for poor fencing done from contingency fund. c) Fund pending and deprived hampered some work.
v.	If project has not been completed, please indicate the approximate time by which it is likely to be completed. A summary of the work done for the period (Annual basis) may please be sent to the Commission on a separate sheet	**Completed**
vi.	vi. If the project has been completed, please enclose a summary of the findings of the study. Two bound copies of the final report of work done may also be sent to the Commission	**Copy Enclosed**
vii.	Any other information which would help in evaluation of work done on the project. At the completion of the project, the first report should indicate the output, such as (a) Manpower trained (b) Ph. D. awarded (c) Publication of results (d) other impact, if any	

a.	Manpower trained	M. Sc. special paper project students of two years were trained for study, isolation and pure-culture and done projects regarding this area of work.
b.	Ph. D Enrolled. If yes. Details	**Yes** Fellow registered for Ph.D. in 2016 in Vidasagar University, under supervision of principal investigator, co-supervised by Dr. Gunjan Biswas, V.U. **Ph.D. Registration CertificatePhotocopy Enclosed** 01
c.	Details of the Publications resulting from the project work / letter of Acceptance of paper communicated(re-printsattached). 1. **Somdatta Ghosh**, N. K. Verma and D. Kuila. **2015**. Comparative productivity and mycorrhizal infectivity of fly ash with other soils and standerdization of amendment ratio of fly ash with lateritic soil. J mycopathology Res. 53(1): 83-89 2. **Somdatta Ghosh** and D. Kuila**2015**. Comparison of arbuscular mycorrhizal colonization and spore density in vegetation of fly ash deposited area of Kolaghat thermal power station and normal soil vegetation. J mycopathology Res. 53(1): 83-89 3. **Somdatta Ghosh**,N. K. Verma and D. Kuila. **2016.** Arbuscular mycorrhizal dependency of plants.**In: Recent trends in bioferilizer (Ed. B.R. Pati& S.R. Mondol).** I.K. International Publ, New Delhi. 4. **Somdatta Ghosh,** Gunjan Biswas, N. K. Verma and D. Kuila, 2016. Arbuscular mycorrhizal status of some ethnomedicinal and medicinal plants of Paschimmedinipur. Advanced Journal of Basic and Applied Sciences. 1(1): 67-78. 5. DebashisKuila, **Somdatta Ghosh**, and SubrataGiri, **2017**. Plant Growth, Yeild and AM Status in Combined and Single Application of Exogenous Arbuscular Mycorrhiza and Isolated *Azotobacter* on *Capsicum fruitescens*Grown in Lateritic Soil, In: Role of Microbes for Sustainable Agriculture and Environment, UGC Sponsored National Seminar Proceedings (Ed: Dey D.), Midnapore College (Autonomous), West Bengal, India. 6. DebashisKuila, **Somdatta Ghosh**, and SubrataGiri, **2017**.Study of Mycorrhizal Status and Comparative Productivity of *Capsicum fruitescens* Inoculated with Different Arbuscular Mycorrhizae and Beneficial Microbes in Lateritic Soil. In: Plants and Microbes in Human Welfare and Sustainability, UGC Sponsored National Seminar Proceedings (Eds: Ghosh

	S. and Maiti P.), Midnapore College (Autonomous), West Bengal, India. pp: 9-16. 7. DebashisKuila, **Somdatta Ghosh**, and Nagendra Kumar Verma,**2018**. Study of Arbuscular Mycorrhizal Status of Crops and Soil Physico-chemical Characteristics with Different Agricultural Applications in Lateritic Zones of Midnapore District, West Bengal. Mycorrhiza news, 30(1); 3-10. 8. DebashisKuila, **Somdatta Ghosh**, and Nagendra Kumar Verma,**2018**. An effective bio-fertilization technique applied in infertile lateritic soil to improve plant growth and productivity. In: Biotechnology and Nature, (Eds: De. Dulal, S. Roy, G. C. Bera), Kabitika, India.pp: 88-93. ISBN 978-93-87602-66-3. +9, 10, 11 **(Re-prints Enclosed)**	
	Invited Lecture: Mycorrhiza in low cost- benefit, yield, sustainability, soil reclamation and organic farming 2016. In:National Seminar on Research Trends in Medicine and Biology: The issue of Health, Ecology and Management. Kankabati Rishi Arabinda Rural Development and Social Welfare Institute, Midnapore. **Papers presented in seminar:** **(Re-prints Enclosed)**	
d.	Any other information which would help in evaluation of work done on the project	Papers Presented in National and International Seminars. **(Abstracts Enclosed)** 02 .

Somdatta Ghosh 21. 11. 2017

SIGNATURE OF THE PRINCIPAL INVESTIGATOR

Principal Investigator
MAJOR PROJECT
Department of Botany
MIDNAPORE COLLGE (AUTONOMOUS)
Midnapore-721 101, W.B.

Swbrata Giri

SIGNATURE OFCOINVESTIGATOR

PRINCIPAL /REGISTRAR

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WORK SUMMERY

In the red lateritic zone challenge to agriculture is the deficiency of available phosphorus and nitrogen; that is trying to be managed by application of chemical phosphate fertilizers like DAP, SSP etc and huge quantity of chemical nitrogen fertilizers like urea (46% N), and potash along with organic manure for cultivation of economic crops. From our survey it was found that, the high residual high N and P-content and other agrochemicals in the conventional agricultural land soil affect the natural AM symbioses with native species belong to *Acaulospora, Glomus, Gigaspora, Scutellospora* etc.

In this experiment, different indigenous arbuscular mycorrhizal (AM) species were isolated in pure culture in pot culture. Test plants were first screened with different isolated indigenous and one introduced AM *Glomus mosseae*. Virgin lateritic land is used as test field and *Capsicum frutescens* and *Sesamum indicum* as test crop. Test plants were inoculated with different isolated indigenous and one introduced AM *Glomus mosseae*. The mycorrhiza helping microbes i.e., nitrogen fixing bacteria (NFB), *Azotobacter* and phosphate solubilizing bacteria (PSB) were isolated from indigenous soil, applied in both separated and combined treatments associated with these AM. Parameters ware measured per month interval compared for AM root colonization, spore population and productivity of the plants in term of plant height, leaf number, leaf area, root collar dimeter, flower number, fruit number, fruit fresh and dry weight etc.Total chlorophyll content in leaf, soluble and insoluble sugar of shoot, NPK status of plant body and enzymatic activity in term of catalase activity, acid phosphatase activity and IAA oxidase activity of plants were compared. Soil pH, moisture, organic carbon and NPK contenwere compared in before and after plantation.

Free living nitrifying bacteria i.e., *Azotobacter* spp. And phosphate solubilizing microbes like, *Bacillus* spp., *Pseudomonas* spp., *Aspergillus* spp. were isolated from the indigenous lateritic soil. Among the isolated growth promoting rhizo microbes, one nitrifying bacteria, best was one Azotobacter species and one phosphate solubilizing bacteria (though some phosphate solubilizing fungi, *Aspergillus* species and *Trichoderma* was isolatedand worked slightly better but they were difficult to maintained in culture form and sometimes it may produce

pathogenecity to many crops and other rhizo-microbes in humid and hot environmental conditions; therefore, best synergistic spp. were selected from the isolates). Local AM species belong to the above mentioned genera were isolated and maintained as pure and mass culture for further experiments. The exogenous AM species, *Glomus mosseae* were collected from Centre for Natural Biological Resource and Community Development, Bangaluru.

In Experiment 1 to screen the isolated local AM species of total eight species including five *Acaulospora* and three *Glomus* species and exogenous *Glomus* species, it was found that *Acaulospora delicata*, two unidentified *Acaulospora* and two *Glomus* species and the exogenous *Glomus* species, performed better increasing overall growth of plants. *Acaulospora delicata, Acaulospora sp 1, Glomus sp 3,* worked better than all other indigenous AM species. *Acaulospora delicata, Acaulospora sp 1, Glomus sp3,* worked better than all other indigenous and exogenous sp *Glomus mossae* in indigenous sterile lateritic soil in pot. In Experiment 1 in field, *Acaulospora delicata* worked best followed by Glomus *mossae, Acaulospora sp 1, and Glomus sp 3* in virgin lateritic soil with both hosts increasing overall growth of plants. Among them indigenous *Acaulospora delicata* was performed maximum followed by exogenous *Glomus mosseae* and Acaulospora1 and Glomus 3 species. Soil quality in term of moisture content, organic carbon, nitrogen and phosphorus content were improved than control by these five mycorrhizal treatments.

In the next, 2nd experiment, those best five AM specis, *Azotobacter* and PSB were inoculated with the plant in separate single treatments. It was observed that, among all the treatments *Acaulospora delicata* performed best in overall growth followed by *Glomus mosseae*, Glomus 3 and Acaulospora 1 species. Another local unidentified inoculated Glomus 2 performed poorest among all introduced spp, which worked slightly better than control (no inoculation). In between applied Azotobacter and phosphate solubilizing bacteria (PSB), Azotobacter performed much better than PSB.

From soil analyses it was found that, soil pH were slightly improved towards neutral by the AM and plant growth promoter (i.e., Azotobacter, PSB) inoculations except control. Other important soil characters like moisture content, organic carbon, soil NPK etc. were slightly improved by AM colonization.

In the 3rd experiment effective best four AM, i.e., *Acaulospora delicata, Glomus mosseae,* local *ndigenous* unidentified *Acaulospora 1 and Glomus 3 species* and the best Azotobacter and PSB isolates were selected from previous experiments were compared in single and combined dual and triple treatments for 90 days. At the end of the experiment, *Acaulospora delicata* along with Azotobacter and PSB worked best followed by *Glomus mosseae* associated with Azotobacter and PSB and then *Acaulospora* with Azotobacter. Among the single treatment Acaulospora *delicata* worked best, followed by local Acaulospora1 and Glomus mosseae. Between Azotobacter and PSB in single application, Azotobacter performed better. Among best four AM species combinations with each other, *Acaulospora delicata* with *Glomus mosseae* combination performed maximum growth than others.

In further single application of best four effective AM spp and combined (dual and triple) application of best AM with Azotobacter and PSB, both Acaulospora delicata and Glomus mosseae combined with Azotobacter and PSB worked best followed by Acaulospora delicata + Glomus mosseae + Azotobacter combination and local Acaulospora 1 +Azotobacter+PSB. This result was much effective with indigenous rhizospheric plant growth promoting and mycorrhiza helping microbes in the indigenous soil, as their synergetic or symbiotic association is established strongly.

In fourth experiment, the same treatments were done in fields with same replica plots without any further application of inocula after three months. This experiment was done to find out the residual effect of single inoculation in field. *Acaulospora delicata* with Azotobacter+PSB performed maximum followed by with *Acaulospora delicata* +Azotobacter, *Acaulospora1+ Glomus mossae+PSB, Glomus mossae+PSB, Acaulospora delicata +Glomus mossae+PSB, Acaulospora delicate+PSB. Acaulospora delicata* and 1 performed better with Azotobacter than PSB while *Glomus mossae* better with PSB. Glomus 3 offered poor result with any combinations. In this gap experiment, we found local Acaulospora 1 to work better than *Glomus mosseae* probably for inconsistency of later. Though Glomus 3 worked below than other AM treatments in previous exp, was better than Bacterial fertilizers, here it worked similar as PSB. In other cases result almost same in comparisons; but the yield in next time is much improved , almost double of the prior experiment. The season may be a factor, but increased number of inocula in field in most cases influenced greatly.

In second time plantation of same without inocula after one year of inoculated and 3 months of 1st without inocula treatment (though not in schedule) Maximum yield was by triple inoculation of NFB+PSB+ *Acaulospora delicata* followed by NFB+PSB+ *Glomus mossae*, NFB+PSB+ *Acaulospora sp 1* and NFB +PSB+ *Glomus sp 3.* in dual applications, *Acaulospora delicata* with Azotobacter performed best followed by *Glomus mosseae* +PSB and *Acaulospora delicata* + PSB.

In final experiment, all the successful effective spp and their combination were applied with full and half dose of different recommended chemical fertilizers (NPK, Urea, SSP) were performed.

Treatment with full dose of recommended NPK and Urea performed maximum growth respectively. Acaulospora + Glomus mosseae+ full dose NPK followed its ½ dose and then Acaulospora delicata+ ½ dose NPK worked best in rest of all the treatments, where local Glomus sp with ½ dose NPK performed poorest followed by Glomus mosseae+1/2 dose NPK and local unidentified indigenous Acaulospora+1/2 dose NPK. The growth parameter in term of height, leaf area, chlorophyll content, root collar diameter were relatively high found in chemical fertilizer treated plants. The acidity of rhizospheric soil was increased in chemical fertilizer applied treatments, where the mycorrhizal root colonization and spore population were decreased in same treatments.

Therefore it may be concluded that, indigenous species *Acaulospora delicata* associated with Azotobacter and PSB isolated from local soil when applied with ½ dose of NPK, it may increase growth and productivity of test plants. *Acaulospora delicata* along with local PGP (Azotobacter and PSB) applied without any chemical introductions may also gave better result. It was also found that the residual effect of *Acaulospora delicata* for next time cropping has offered advantage.

Among biofertilizer treatments, in tripple inoculation of indigenous AM, *Acaulospora delicata* along with NFB and PSB showed maximum growth in test plants than others. This result was followed by that of treatment with combined application of recommended half dose of chemical fertilizers (NPK). Though treatment of full recommended chemical NPK fertilizer (without

application of AM, NFB and PSB), boosted biomass, the soil quality in term of soil pH, organic carbon NPK etc. were better in combined biofertilizers than full recommended chemical NPK fertilizer application. In final experiment, all the successful effective spp and their combination were applied with full and half dose of different recommended chemical fertilizers (NPK, Urea, SSP) were performed. Treatment with full dose of recommended NPK and Urea performed maximum growth respectively. Acaulospora + Glomus mosseae+ full dose NPK followed its ½ dose and then Acaulospora delicata+ ½ dose NPK worked best in rest of all the treatments, where local Glomus sp with ½ dose NPK performed poorest followed by Glomus mosseae+1/2 dose NPK and local unidentified indigenous Acaulospora+1/2 dose NPK.The growth parameter in term of height, leaf area, chlorophyll content, root collar diameter were relatively high found in chemical fertilizer treated plants. The acidity of rhizospheric soil was increased in chemical fertilizer applied treatments, where the mycorrhizal root colonization and spore population were decreased in same treatments.

Therefore it may be concluded that, indigenous species *Acaulospora delicata* associated with Azotobacter and PSB isolated from local soil when applied with ½ dose of NPK, it may increase growth and productivity of test plants. *Acaulospora delicata* along with local PGP (Azotobacter and PSB) applied without any chemical introductions may also gave better result. It was also found that the residual effect of *Acaulospora delicata* for next time cropping has offered advantage.

Soil pH tends to enhance towards neutral. The tendency is more in triple application sites followed by dual and single applications sites with AM. Soil moisture was increased gradually in soil but maximally increased in AM applied sites followed by tripple and dual applications sites with AM. Soil organic carbon was enhanced 0.18 to 1.2 in *Glomus mossae, 1. 0 in Acaulospora delicata, Azotobacter 0.76*. In brief, soil quality was increased in physicochemical properties and leads to sustainable form.

PI : Sondalta Ghosh 21.11.2017

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Annexure - IV

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002.

Utilization certificate

Certified that the grant of Rs. 7,79,500.00 (Rupees Seven Lakh Seventy Nine Thousand Five Hundred only) received from the University Grants Commission under the scheme of support for Major Research Project entitled **"Evaluation of efficacy of indigenous and introduced arbucular mycorrhizae (AM) in co-inoculation with nitrogen fixing and phosphate solubilizing microbs on crop yield and maintaining sustainability of lateritic soil"** vide UGC letter No. F.42-940/2013 (SR) Dated- 22.03.2013 has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grants Commission.

Somdatta Ghosh 21.11.17
SIGNATURE OF THE
PRINCIPAL INVESTIGATOR

REGISTRAR/PRINCIPAL

MIDNAPORE COLLEGE
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MIDNAPORE

STAUTORY AUDITOR

K. C. Chakraborty & Associates
Chartered Accountants

K. C. Chakraborty, Proprietor
M. No.- 054888

Sabyasachi Giri
SIGNATURE OF THE CO-
INVESTIGATOR

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Midnapore
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Principal
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Annexure - V

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002.

STATEMENT OF EXPENDITURE IN RESPECT OF MAJOR/MINOR RESEARCH PROJECT

1. Name of Principal Investigator- Dr. Somdatta Ghosh
2. Deptt. of University/College- Dept. of Botany, Midnapore College (Autonomous)
3. UGC approval No. and Date- F.42-940/2013 (SR) Dated- 22.03.2013
4. Title of the Research Project - "Evaluation of efficacy of indigenous and introduced arbucular mycorrhizae (AM) in co-inoculation with nitrogen fixing and phosphate solubilizing microbs on crop yield and maintaining sustainability of lateritic soil"
5. Effective date of starting the project- 01.08.2013
6. (a) Period of Expenditure: From 01.08.2013 to 31.03.2017

h. Details of Expenditure _____

S.No.	Item	Amount Approved Rs.	Expenditure Incurred Rs.
i.	Books & Journals	25,000.00	25,019.00
ii.	Equipment	78,500.00	78,679.00
iii.	Contingency	50,000.00	50,276.00
iv.	Field Work/Travel (Give details in the proforma at Annexure- VII).	20,000.00	20,015.00
v.	Hiring Services	30,000.00	30,000.00
vi.	Chemicals & Glassware	50,000.00	51,542.00
vii.	Overhead	65,800.00	65,800.00
viii.	Honorarium to Project Fellow (Debasis Kuila)	5,28,000.00	5,28,000.00
	TOTAL	8,47,300.00	8,49,331.00

i. Staff

ate of Appointment: 01.08.2013

il. lo	Expenditure Incurred	From to	Amount Approved (Rs.)	Expenditure Incurred(Rs.)
1				
2				
3				
4	Salary to Project Fellow @ Rs. 14,000/- p.m. for initial two years and Rs. 16,000/- p.m. from the 3rd year onwards	01.08.13 to 31.07.16	5,28,000.00	5,28,000.00

1. It is certified that the appointment(s) have been made in accordance with the terms and conditions laid down by the Commission.
2. It as a result of check or audit objective, some irregularly is noticed, later date, action will be taken to refund, adjust or regularize the objected amounts.
3. Payment @ revised rates shall be made with arrears on the availability of additional funds.

4. It is certified that the grant of Rs7,79,500.00 (Rupees Seven Lakh Seventy Nine Thousand Five Hundred only) received from the University Grants Commission under the scheme of support for Major Research Project entitled **"Evaluation of efficacy of indigenous and introduced arbucular mycorrhizae (AM) in co-inoculation with nitrogen fixing and phosphate solubilizing microbs on crop yield and maintaining sustainability of lateritic soil"** vide UGC letter No. F.42-940/2013 (SR) Dated- 22.03.2013 has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grants Commission.

Somdatta Ghosh 21.11.2017

SIGNATURE OF PRINCIPAL INVESTIGATOR

Principal Investigator
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Department of ...
MIDNAPORE COLLGE (AU...
Midnapore-721 101, W.B.

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Subrata Guru

SIGNATURE OF THE CO-INVESTIGATOR

K.C. CHAKRABORTY & ASSOCIATES Chartered Accountants

For
K. C. Chakraborty & Associates
Chartered Accountants

K. C. Chakraborty, Proprietor
M. No.- 054838

MIDNAPORE COLLEGE Midnapore ESTD-1873 AUTONOMOUS

Principal
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Annexure - VI

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002.

Name of the Principal Investigator- Dr. Somdatta Ghosh

STATEMENT OF EXPENDITURE INCURRED ON TRAVEL

Place visited (with date)	Duration of visit		Expenditure incurred ₹.
	From	To	
NBU, Darjeeling 10.01.2015	Howrah	New Jalpaiguri	700.00
Kolkata 26.02.2015	Kharagpur	Howrah	30.00
Kharagpur 05.03.2015	Howrah	Kharagpur	30.00
Kharagpur 29.03.2015	Howrah	Kharagpur	30.00
Balichak up & down 28.04.2015 /2 persons	Kharagpur	Balichak	40.00
Kharagpur 03.05.2015 /2 persons	Mechada	Kharagpur	30.00
Kolkata up & down 03.08.2015	Kharagpur	Howrah	60.00
Kolkata 31.12.2015	Kharagpur	Howrah	30.00
Panskura 08.01.2016 up & down	Kharagpur	Panskura	20.00
SKBU, Purulia 18.01.2016	Kharagpur	Purulia	180.00
Kolkata 28.02.2016 up (SF) & down (ordinary)	Kharagpur	Howrah	100.00
Kolaghat 31.03.2016 up & down	Midnapore	Mechada	30.00
Digha 25.04.2016 /2pr	Midnapore	Digha	90.00
Howrah 19.06.2016 up & down	Kharagpur	Howrah	60.00
Garhbeta 10.07.2016 up & down (SF) /2 pers	Kharagpur	Garhbeta	110.00
Kolaghat 31.07.2016	Kharagpur	Mechada	15.00
Kharagpur 01.08.2016	Mechada	Kharagpur	30.00

Barackpore 05.08.2016	Kharagpur	Sheorahphuly	60.00
Kolaghat 06.08.2016	Kharagpur	Mechada	15.00
Kharagpur 07.08.2016 /2 persons	Mechada	Kharagpur	30.00
Midnapore29.08.2016	Howrah	Midnapore	30.00
Kolkata 09.09.2016 up & down	Midnapore	Howrah	60.00
Midnapore 19.09.2016 / 2 persons	Howrah	Midnapore	60.00
Howrah 23.09.2016 up & down	Midnapore	Howrah	60.00
Kolkata 06.10.2016	Midnapore	Howrah	60.00
Mechada 13.10.2016 up & down	Kharagpur	Mechada	30.00
Mechada 01.11.2016 up & down /2 persons	Kharagpur	Mechada	60.00
Kolkata 06.11.2016	Midnapore	Kolkata	2300.00
Kolkata (SF) 07.11.2016	Midnapore	Howrah	65.00
Howrah 13.11.2016 up & down	Kharagpur	Howrah	60.00
Kolaghat 21.11.2016 up & down /2 persons	Midnapore	Kolaghat	80.00
Kolkata 27.11.2016 up & down	Kharagpur	Howrah	60.00
Kolkata 29.11.2016 up & down /2 persons	Midnapore	Howrah	120.00
Kolkata 11.12.2016	Midnapore	Kolkata	2250.00
Midnapore 16.12.2016	Howrah	Midnapore	30.00
Howrah 19.01.2017 up & down	Midnapore	Howrah	60.00
Kolkata 20.01.2017 up & down	Kharagpur	Howrah	60.00
Midnapore 21.01.2017	Panskura	Midnapore	1400.00
Kharagpur 15.02.2017	Mechada	Kharagpur	15.00
Kolkata 19.02.2017 up & down /2persons	Kharagpur	Howrah	120.00
Kharagpur 05.03.2017 /2 persons	Shyamchak	Kharagpur	10.00

Mechada 08.03.2017	Kharagpur	Mechada	15.00
Mechada 08.03.2017 up & down /monthly	Midnapore	Mechada	270.00
Panskura 21.03.2017 up and down	Panskura	Midnapore	1400.00
Garhbeta 23.03.2017 up and down	Garhbeta	Midnapore	1600.00
Mechada 23.03.2017 up and down	Mechada	Midnapore	1650.00
Kharagpur 27.03.2017	Santragachhi	Midnapore	30.00
Gophgarh 29.03.19	Midnapore	Gopgarh	535.00
Total			₹. 14,240.00

Certified that the above expenditure is in accordance with the UGC norms for Major Research Projects

Somdatta Ghosh 20.11.2019

SIGNATURE OF PRINCIPAL INVESTIGATOR

Principal Investigator
MAJOR PROJECT
Department of Botany
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Midnapore-721 101, W.B.

Subrata Giri

SIGNATURE OF THE CO-INVESTIGATOR

REGISTRAR/PRINCIPAL

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Chartered Accountants

For
K. C. Chakraborty & Associates
Chartered Accountants

K. C. Chakraborty, Proprietor
M. No.- 054838

Principal
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Keranitola
Midnapore – 721101
Ph.: (03222) 263025, Fax – 297166
E-mail : kgp_vas001@sancharnet.in

UTILISATION CERTIFICATE

Certified that a grant of Rs. 8,47,300.00 (Rupees Eight Lakh Forty Seven Thousand Three Hundred) only was approved by University Grants Commission, Bahadur Shah Zafar Marg, New Delhi-110002 in favour of Dr. Somdatta Ghosh, Dept. of Botany, Midnapore College, Midnapur, Paschim Medinipur, Pin-721101, West Bengal for Major Research Project entitled **"Evaluation of efficacy of indigenous and introduced arbucular mycorrhizae (AM) in co-inoculation with nitrogen fixing and phosphate solubilizing microbs on crop yield and maintaining sustainability of lateritic soil"** vide letter no-F.42-940/2013 (SR) Dated- 22.03.2013.

Midnapore College has received an amount of Rs. 5,08,300.00 (Rupees Five Lakh Eight Thousand Three Hundred) only as first installment and Rs. 2,71,200.00 (Rupees Two Lakh Seventy One Thousand Two Hundred) only as Second Installment by RTGS to Bank of India, Midnapore Branch on 08.04.2013 and 14.06.2016 respectively and the College has utilized an amount of Rs. 8,49,331.00 (Rupees Eight Lakh Forty Nine Thousand Three Hundred Thirty One) only during the period from 01.08.2013 to 31.03.2017 as per annexed receipt & expenditure account for the purpose for which it was sanctioned. Utilization of first installment dated 06.01.2015 was already submitted before UGC Office.

It is further certified that the asset accrued wholly or substantially out of the grants from University Grants Commission have not been disposed off, encumbered or utilized for the purpose other than those for which the grant was sanctioned and asset register in maintained in the prescribed from and kept up to date.

For
K. C. Chakraborty & Associates
Chartered Accountants

K. C. Chakraborty, Proprietor
M. No.- 054898

Midnapore
31st July, 2017

Audited Statement of Receipt & Expenditure Account in respect of Grant from University Grant Commission (ERO) for Minor Research Project entitled **"Evaluation of efficacy of indigenous and introduced arbucular mycorrhizae (AM) in co-inoculation with nitrogen fixing and phosphate solubilizing microbs on crop yield and maintaining sustainability of lateritic soil"** for the period from 01.08.2013 to 31.03.2017.

RECEIPT	AMOUNT(Rs.)	EXPENDITURE	AMOUNT(Rs.)
To Grant received from University Grant Commission, New Delhi vide letter no- F.42-940/2013 (SR) Dated- 22.03.2013 Through RTGS to Bank of India, Midnapore Branch on 08.04.2013	5,08,300.00	**(In addition to earlier U/C dated 06.01.15)**	
		By Non-Recurring:-	
		Books & Journal	25,019.00
		Equipments	78,679.00
		By Recurring:-	
		Honorarium to project fellow	5,28,000.00
		Contingency	50,276.00
		Travel/ Field Work	20,015.00
On 14.07.2016	2,71,200.00	Chemical and Glassware	51,542.00
		Hiring Service	30,000.00
Loan from College Fund	69,831.00	Institutional Over Head	65,800.00
Rs.	8,49,331.00	Rs.	8,49,331.00

Examined & found correct

Midnapore
31st July, 2017

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MIDNAPORE

For
K. C. Chakraborty & Associates
Chartered Accountants

K. C. Chakraborty, Proprietor
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VIDYASAGAR UNIVERSITY

MIDNAPORE ❖ WEST BENGAL ❖ PIN 721102

Phone : (03222) 276554 :: 276555 :: 276557 :: 276558 :: 262297

Ref. No..... Date 22.09.2021

Assessment Report regarding Major Research Project (UGC) of Dr. Somdatta Ghosh, Assistant Professor, Department of Botany, Midnapore College

Project Title: "Evaluation of efficacy of indigenous and introduced Arbuscule Mycorrhizae (AM) in co-inoculation with nitrogen fixing and phosphate solubilize microbes on crop yield and maintaining sustainability of soil"

UGC Ref. No: F 42-940/2013(SR) 22.03.2013

PI: Dr. Somdatta Ghosh, Assistant Professor, Department of Botany, Midnapore College

Co PI: Dr. Subrata Giri, Assistant Professor, Department of Botany, Midnapore College

Tenure of the project: 01.08.2013 – 01.07.2017

After going through the report prepared by Dr. Somdatta Ghosh, the following observations are noted:

i. A project fellow was appointed during the tenure of the project and the fellow was registered for PhD degree at Vidyasagar University;

ii. Dr. Ghosh published some papers related to this project and presented papers in seminars during the tenure of the project:

After observing the report prepared by Dr. Somdatta Ghosh, it is found that Dr. Ghosh has successfully completed the project. The overall work made through this project is found satisfactory.

22/09/2021

Prof. Prakash Karmakar

Dr. Prakash Karmakar
Professor
Department of Botany & Forestry
Vidyasagar University, Midnapore-721102
West Bengal, India

22/9/2021

Prof. Debdulal Banerjee

Dr. Debdulal Banerjee

Principal
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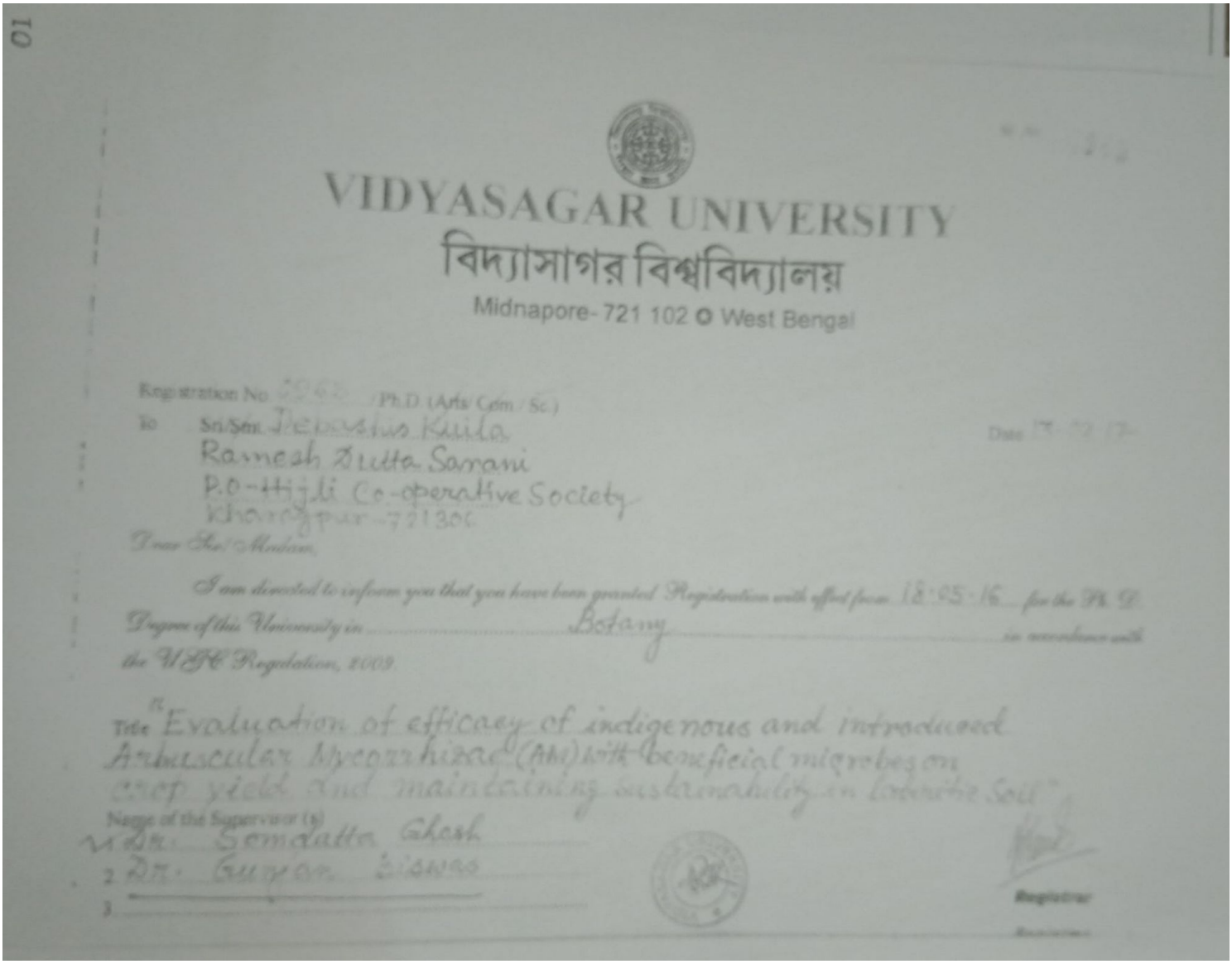


VIDYASAGAR UNIVERSITY

বিদ্যাসাগর বিশ্ববিদ্যালয়

Midnapore- 721 102 ○ West Bengal

Registration No 2068 / Ph.D. (Arts / Com. / Sc.)

To Sri/Smt. Debasmita Kuila

Ramesh Dutta Sarani

P.O-Hijli Co-operative Society

Kharagpur-721306

Date 17.12.17

Dear Sir/Madam,

I am directed to inform you that you have been granted Registration with effect from 18.05.16 for the Ph.D. Degree of this University in Botany in accordance with the UGC Regulation, 2009.

Title "Evaluation of efficacy of indigenous and introduced Arbuscular Mycorrhizae (AM) with beneficial microbes on crop yield and maintaining sustainability in Lateritic Soil"

Name of the Supervisor (s)

1 Dr. Somdatta Ghosh

2 Dr. Gunjan Biswas

3 _____

Registrar

Encosure: 03.

Papers presented in seminars and conferences.

Sl. No.	Title of the paper presented	Title of Seminar /Conference	Organised by
1.	Comparative effect of indigenous and introduced arbuscular mycorrhizae on growth and dependency of *Accacia mangium* Wild.	International Symposium on role of Fungi and Microbes in the 21st Century- A Global Scenario	Indian Mycological Society, Kolkata in collaboration with Deptof Botany, University of Calcutta, Kolkata; 2014(20th -22nd February, 2014)
2.	A comparison of arbuscular mycorrhizal colonisation and ……..vegetation …….of Kolaghat Thermal Power Station and adjacent normal soil vegetation		
3.	Study of comparative growth and AM status of Capsicum fruiticens in agri soil, latr soil…combined treatments	23nd West Bengal State Science & Technology Congress	Burdwan University, & Dept of Science and Technology, Govt. of W.B.March,2016
4.	Study of comparative productivity of sesanme ……..in fly ash	National symposium on resource management	Vidyasagar University NSBM 2016
5.	Arbuscular mycorrhizal status of some ethnomedicinal plants of PaschimMedinipur district	UGC DRS SAP & DST, Sponsored National Seminar on Medicinal Plants	Department of Botany & Forestry, Vidyasagar University, Midnaporre. (16th-17th February, 2016)
6.	Comparative productivity and AM status of Capsicum fruitiscens with Acaulospora and Azotobacter… midnapore	1st regeonalScience & Technology Congress	Depertment of Science and Technology, Govt. of W.B;Band Bankura cristian college.2016
7.	Pre-seasonal dynamics of arbuscular mycorrhizae (AM) and (PGPR) n lateritic forest of GopGarh in PaschimMedinipur, W.B.	UGC- Sponsored National Seminar on Microbiology in 21st Century(NSM21C2016	Department of Microbiology, Vidyasagar University, Midnapore.
8.	Assay of enzymatic….in lateritic soil	UGC- Sponsored National Seminar NSMB 2017	Do
9.	Study of mycorrhizal status and productivity of Capsicum fruitiscens with different beneficial microbes in lateritic soil	UGC- Sponsored National Seminar NSPM	D Dept of Botany, Midnapore College in collaboration with Narajole Raj College Feb 2017
10.	Study of arbuscular mycorrhizae…… in Paschim midnapore	UGC-Sponsored National Seminar	K D College of Commerce NSOCHLGO 2017
11.	A study of comparative productivity of Capsicum fruitiscens with inoculation of indigenous and exogenous AM… lateritic soil	2nd regeonalScience & Technology Congress	Burdwan University . Depertment of Science and Technology, Govt. of W.B;2017
12.	Application of indigenous and exogenous AM …….Sesame	National seminar UGC sponsored on 'Trends in Contemporary Research in Plant Sc." 29-30 th March,	2018Organised by Dept of Botany and Forestry, Vidyasagar University

Comparative productivity and Mycorrhizal infectivity of Fly Ash with other soils and standerdization of amendment ratio of Fly Ash with lateritic soil

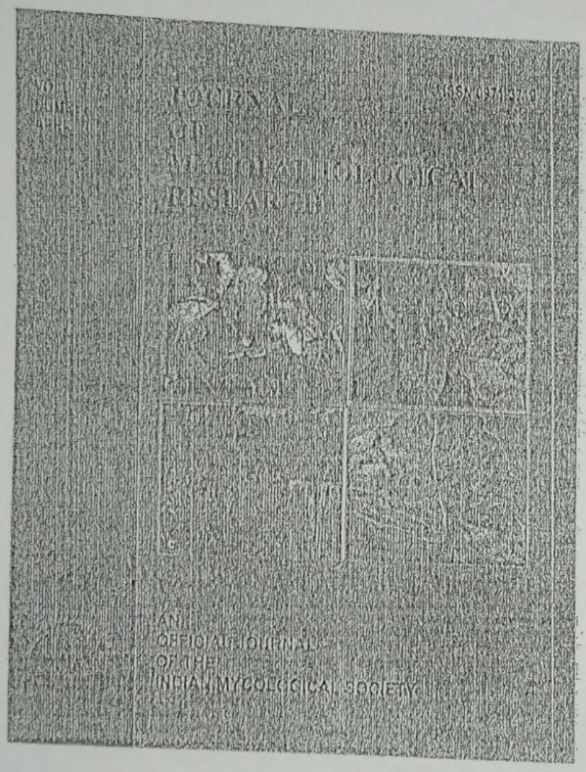
DEBASHIS KUILA, SOMDATTA GHOSH AND N. K. VERMA

J. Mycopathol. Res. 53(1) : 83-89, 2015;
ISSN 0971-3719

Department of Botany,
University of Calcutta,
Kolkata 700 019, India

A Comparison of Arbuscular Mycorrhizal colonization and spore diversity in vegetation of Fly Ash deposited area of Kolaghat Thermal Power Station and adjacent normal soil vegetation

SOMDATTA GHOSH AND DEBASHIS KUILA



J. Mycopathol, Res, 53(1) : 131-136, 2015;
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Department of Botany,
University of Calcutta,
Kolkata 700 019, India

Recent Trends in Biofertilizers

Bikas R. Pati
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Santi M. Mandal
Assistant Professor
Department of Microbiology
Vidyasagar University
Midnapur, India

2016 18cm x 24cm 284pp Hardback ISBN: 978-93-84588-65-6 Price 2195.00

Recent Trends in Biofertilizers comprises sixteen articles contributed by over forty distinguished academicians from India, Brazil and Egypt. These articles jointly address the broader need of increasing soil fertility through sustainable methods and practices.

Biofertilizers contain a wide range of naturally chelated plant nutrients, carbohydrates, amino acids, trace elements and plant growth promoting vitamins and hormones. These components are discussed appropriately in the book. Fresh insights into biofertilizer technology, biotechnology-based biofertilizers, and other recent developments in this area are covered in depth. Discussion of the tremendous advancements made in the last decade in biofertilizer technology through development of biotic and abiotic stress tolerant microbial strains is one of the hallmark features of this book. The book also appropriately addresses the soil aspects -- nutrient index values for different types of soil have been presented. Other major highlights of the book are coverage of liquid biofertilizers; benefits of different biofertilizer efficient strains along with the constraints in the production, distribution, field and marketing; quality control and assurance aspects; and application of bioinformatics.

With its coverage and emphasis, this book will be an immensely useful reference for teachers and students of undergraduate colleges, universities, and research scholars who are engaged in this aspect of research, such as agricultural microbiology, trainees in biofertilizer industry and agricultural development officers.

Contents:

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11

Arbuscular Mycorrhizal Dependency of Plants

Somdatta Ghosh[1], Debashis Kuila[1] and Nagendra Kumar Verma[2]

[1]*Department of Botany, Midnapore College (Autonomous), Midnapore – 721101*

[2]*Department of Botany & Forestry, Vidyasagar University, Midnapore – 721102 WB*

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ABSTRACT

Arbuscular mycorrhizal (AM) symbioses occur with more than 80% of land plants and are widely distributed in almost all the ecological range where plants grow. Mycorrhizal fungi as such are non-host specific but as reported, the preference and mycorrhizal dependency of plants may vary with the soil. It is known that phosphorus is a relatively immobile element in soil and its demand is much higher than its mobility. Other than phosphorus, AM fungi also help plants to capture micronutrients such as copper, zinc, Boron, etc. AM is said to be a key factor of plant establishment in different plant communities, plant growth and soil sustainability in nutrient poor soils. Several workers have worked on the mycorrhizal dependency of different plants which include weeds, agricultural, horticultural and forest crops. Parameters mainly used to determine MD is biomass, leaf phosphorous, phosphpous utilization of plants, root morphology, etc. Mycorrhizal dependency is the degree to which a plant is dependent on the mycorrhizal condition to produce its maximum growth or yield, at a given level of soil fertility. Even same plant with same VA fungi may vary on MD, according to some reports. Majority of the agricultural species are either obligate or facultative mycorrhizal. Most of the mycorrhiza dependent plant species show better result at lower P content. Increased soil P concentration depresses the mycorrhizal infection and also the intensity of infection which is reflected in the degree of MD of such plant species. However, totally dependent species may continue to derive benefit from mycorrhizal symbiosis irrespective of concentration of soil P.

Keywords: Vesicular Arbuscular Mycorrhiza, Arbuscular Mycorrhiza, Soil P, Mycorrhizal Dependency.

Advanced Journal ofBasic & Applied Sciences.
Appearance Issue: Vol. 1, No.1 (2017).
Published on 14th January 2017

ARBUSCULAR MYCORRHIZAL STATUS OF SOME ETHNOMEDICINAL ANDMEDICINAL PLANTS OF PASCHIM MEDINIPUR

DebashisKuila[1], Somdatta Ghosh[1*], GunjanBiswas[2], Nagendra KumarVerma[3]

1. *UG & PG Department of Botany, Midnapore College (Autonomous), Midnapore.*
2. *Department of Botany & Forestry, Vidyasagar University, Midnapore.*
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**Corresponding Author e-mail: somdattaghosh@yahoo.co.in*

ABSTRACT

PaschimMedinipur district is rich in ethno medicinal flora.Arbuscularmycorrhizae (AM) are obligate symbiotic fungi which activates nutrient and water uptake in plants.A survey was conducted to evaluate the Arbuscularmycorrhizal status of ethno-medicinal plant species from lateritic belt of Jhargram, Garhbeta and Midnapore subdivisions. Root and rhizospheric soil samples were investigated for arbuscularmycorrhizal colonization and AM spore. Species belonging to the families Poaceae, Lamiaceae, Meliaceaeand Papilionaceaeshowed maximum colonization with high intensity class and presence of arbuscular vesicles. Species with wide distribution showed comparatively high colonization than locally confined species. So status may be related to their availability, though some tendency of host preference was noticed.

Keywords: Arbuscle, Intensity class, Lateritic soil, Mycorrhizal colonization, Vesicle.

Seminar Proceedings

UGC Sponsored National Seminar On

"Role of Microbes for Sustainable Agriculture and Environment"

(NSAE-2017)

28th January, 2017

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Department of Microbiology,
Midnapore College (Autonomous),
Midnapore, Paschim Medinipur,
West Bengal -721101

In collaboration with

Department of Microbiology,
R. N. L. Khan Women's College,
Midnapore, Paschim Medinipur,
West Bengal -721102

Plant Growth, Yeild and AM Status in combined and single application of exogenous Arbuscular Mycorrhiza and isolated Azotobacter on Capsicum frutescens Grown in Lateritic Soil

Debashis Kuila, Somdatta Ghosh* and Subrata Giri

PG & UG Department of Botany, Midnapore College (Autonomous), Midnapore.

**Corresponding Author: somdattaghosh@yahoo.co.in, dk89ian@gmail.com*

ABSTRACT

In Paschim Medinipur district red soil of lateritic belt is low in fertility and deficient in phosphorus, Nitrogen and other essential macro and micro nutrients. Arbuscular Mycorrhiza (AM) have a key role to uptake bound Phosphorus (P) from less fertile soil. Application of AM may enhance the P-uptake of plants growing under P-poor conditions and helps to improve water and nutrient uptake. Azotobacter act as nitrogen biofertilizer and mycorrhiza helper bacteria. Common chilli, Capsicum frutescens is an economic crop and can grow easily in normal local environment. Capsicum frutescens was grown as test crops in the experiment inoculated with one exogenous Glomus mosseae and isolated Azotobacter from lateritic soil. Experiment was conducted in both separated and combined treatments; compared for AM spore count, root colonization and productivity of chilli in term of height, leaf number, leaf area, root collar dimeter, number of flowers and number of fruits, fresh weight and dry weight. The growth of chilli showed maximum in combined treatment of Glomus mosseae and Azotobacter. Also the AM spore count, root colonization found maximum in that treatment than others. Hence application of AM in low fertile soil with Azotobacter may present better productivity.

Keywords: Arbuscles, Colonisation, Infection Class, Soil Phosphorus, Yield.

INTRODUCTION

Chilli (Capsicum frutescens L.) is belonging to the family, Solanaceae, is a commercially important vegetable, cultivated throughout India and West Bengal, making our country the largest producer in the world. It contains volatile oils, fatty oils, capsaicinoids, carotenoids, vitamins, proteins, fibres and mineral elements and act as a natural bactericidal agent. It is used to treat muscle pain, cough, asthma, and sore throat, stomach ache etc. (Bosland and Votava, 2000). Beside the fact, India is the leading producer - the average yield of chilli is very low as compared to other developed countries. This is may be due to day by day increasing of low fertile soil in agricultural fields throughout the country in conventional agricultural practices with heavy use of chemical fertilizers and pesticides, resulting toxic soil, unavailability of nutrients to the plant and pesticide resistant pests. A high demand of organically produced vegetables is increasing.

Mycorrhiza is a symbiotic relationship between arbuscular fungi and

ch Today (July-December 2018) : 8 (2) 65-70
: 10.5958/2322-0996.2018.00023.6

EARCH ARTICLE

digenous And Introduced Arbuscular Mycorrhzae (Am) And *izobium* On Growth, Nodulation And Physiology Of *Albizzia bbeck* Benth. In Red Lateritic Soil

idatta Ghosh[1]*, Subrata Giri[1], N.K.Verma[2] and B.C Ghosh[3]

ived: 11 March 2018, Revised: 23 May 2018, Accepted: 27 May 2018, Published : Online 02 July 2018.

tract

izia lebbeck Benth. is used for afforestation in dry nutrient r area, in agro-forestry as shade tree for tea and coffee. Dry ient poor soils constrain the growth of the plant. raction between *Rhizobium* and two AM fungi, isolated *mus aggregatum* from lateritic soil and introduced *G. seae* and their symbiotic effect on growth and nutrition of *izia lebbeck* seedlings were studied. *Rhizobium* enhanced t and shoot growth, shoot Nitrogen and soluble sugar tent more than AM fungi while other parameters were anced by AMF. Dual interaction of *Rhizobium* and AMF anced all parameters over single inoculations except ible sugar content and root shoot ratio.

yword: AM colonization, Amino acid, Chlorophyll itent, carbohydrate content. growth, nodulation,

roduction

-inoculation of tree Legumes in nursery with *Rhizobium* is oured for early enhancement of growth of seedlings before nsplantation (dos santos *et al.*, 2014; Wullandary *et al.*, 16) to overcome the transplantation shock and increased wth rate. Arbuscular mycorrhizal fungi (AMF) are gaining portance through last decades for their role in absorption of ter (Aúge, 2001) and less mobile nutrients, specially osphous along with N, K, Ca and other less mobile nutrients rundett, 2009). AMF are more active in nutrient poor dry ils (Bagyaraj and Reddy, 2000). Most tropical soils are not ly P-deficient but also P-fixing (Mamatha *et al.*, 2002). The l lateritic soil is acidic and rich in A1 and Fe and low in ailable Phosphous. Scarcity of available P delimits the N tation and legume establishment in absence of arbuscular ycorrhizae in Phosphous deficient soil (Barea *et al.*, 1997). vailability of phosphous is a necessary prerequisite for dulation (Gentili *et al.*, 2006; Soares, *et al.*, 2016) as well as fixation (Roldan-Fajardo, 1994). Nitrogenese activity quires more ATP for reduction of atmospheric dinitrogen o ammonia (Subbarao *et al.*, 1993), which necessitates high requirement of Phosphous in legumes. In Al rich acid soils phosphous uptake is only provided by AM symbiosis (Cardoso *et al.*, 2003), by alleviation acid stress (Muthukumar *et al*, 2012). As AM fungi are obligate symbionts, in denuded areas which are generally utilized for afforestation, AM propagules are naturally low in quantity. Hence pre-inoculation is a must. The beneficial effect of inoculating tree seedlings in nurseries with AM fungi for improved seedling growth in red lateritic soil is well established (Ghosh and Verma, 2006 and 2016). A prior screening experiment revealed that *Glomus mosseae* and *G. aggregatum* are effective AM for *A. lebbeck*. *A. lebbeck* is a timber yielding as well as shade tree in tea and coffee plantations and other agro-forestry managements. Growth enhancement may lessen the time required for optimum growth, yield and felling of the tree. The experiment was designed to understand the interaction between *Rhizobium* and the two AM fungi, one is locally isolated and other is introduced from alkaline soil and their synergistic effect on growth of *A. lebbeck* seedlings in nursery.

Materials and Methods

The experiment was carried out in a net house of Vidyasagar University, Midnapore (22°30N and 87° E 19), West Bengal, India. Here the dry summer, (March to June) has an average temperature of 30°C with a maximum of 42°C. In winter the average temperature is 18°C (range 11°C to 26°C). The soil is acid lateritic with low silica/sesquioxide ratio. The soil used in the experiment was a denuded top soil up to 30 cm. depth having 35% coarse sand, 30% sand, 20% silt and 15% clay. A chemical analysis of soil following standard techniques (Jackson, 1973) indicated pH 5.6, available nitrogen 0.0064%, available phosphorus 0.0021%, available potassium 0.0028% and organic matter 0.4%.

Starter culture of *Glomus mosseae* was procured from the Department of Agricultural Microbiology, University of Agricultural Sciences, Bangalore and multiplied on *Sorghum vulgare* in sterilized sand soil (1:1 v/v) mixture (Sylvia, 1994). The final inoculum contained 60 spores g^{-1}. The local strain of *Glomus aggregatum* was isolated in pure culture and multiplied similarly. The inoculum contained 6.2 spores g^{-1}. Inocula of the two AM fungi weighing 20 g were used for the

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partment of Botany and Forestry, Vidyasagar University, dnapore. W.B India.
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CONTENTS

RESEARCH FINDING PAPER

Study of Arbuscular Mycorrhizal Status of Crops and Soil Physico-chemical Characteristics with Different Agricultural Applications in Lateritic Zones of Midnapore District, West Bengal

Debashis Kuila[a], Somdatta Ghosh[a,c], and Nagendra Kumar Verma[b]

INTRODUCTION

Arbuscular mycorrhizal fungi (AMF) have been found to increase the growth and yield of various agricultural crops (Johansen *et al.*, 1994; Sengupta *et al.*, 2001, 2006; Samanta and Verma, 2006). Arbuscular mycorrhizae (AM) play a key role in uptake of phosphorous along with other less mobile nutrients (Bolan, 1991); particularly in P deficient soils (Powell and Daniel, 1978). AM fungi also absorb water from low water gradient and prevent wilting (Aúge *et al.*, 2001). The arbuscular mycorrhizal (AM) symbiosis has evolved in most terrestrial environments as an efficient system of phosphorus uptake in plants (Brundrett, 2009). But, despite increasing fertilizer costs and disappearing world phosphorus reserves (Gilbert, 2009), progression in the use of the AM symbiosis in plant production has been extremely slow. Although the causes of this poor performance have been diverse, it is true that the conditions for the expression of mycorrhizal effectiveness are poorly known, leading to inconsistency in response to AM inoculation (Ryan and Graham, 2002). According to the principles in ecology, the success of an AM symbiosis depends not only on the plant and fungal genotypes, but also on the conditions of the environment. The functional specificity that exists between plants and AM fungi has been documented (Helgason *et al.*, 2002; Klironomos, 2003). The factors controlling the effectiveness of AM fungal strains must be understood before AM inoculation. It is well-known that plants influence AM fungi through the provision of C substrate, but the influence of the soil on these fungi should not be overlooked. The soil not only provides mineral nutrients to AM fungi, but also constitutes the chemical and physical environment where both these fungi and their plant associates live.

There is much evidence supporting the hypothesis of a large influence of soil properties on AM fungi (Hamel *et al.*, 1994; Frey and Ellis, 1997; van Aarle *et al.*, 2002). It appears that AM strains may survive and function well only within a range of soil environmental conditions.

The present study was conducted last year (2017) to acquire first hand preliminary information on the AM status of some agricultural crops growing in Midnapore district lateritic belt region of south-west West Bengal. The study includes a survey in five agricultural sites of Kadamdiha, Paikarapur, Anandapur, Kanshijora, and Gopgarh area, where farmers cultivated the vegetable crops via conventional agricultural practices.

MATERIALS AND METHODS

Sampling was done in agricultural field located in Paschim Medinipur district of West Bengal (22.30° N latitude and 87.20° E longitude). Root and rhizospheric soil from each site up to 15 cm soil depth of approximately 60–90 day old agricultural crops

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ISSN No. 0019-4816 (Print)
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Effect of Preinoculation with Indigenous and Introduced Arbuscular Mycorrhizae (AM) on Growth, Biomass and Biochemical Contents of *Albizia lebbeck* Benth. Seedlings in Acid Lateritic Soil

Afforestation in most tropical soils is a real problem as those are not only P-deficient but also P-fixing. Acid lateritic soil is dry and deficient in essential nutrients and rich in Al and iron. Application of chemical fertilizer is of little use and expensive for plantation in this soil type. Nursery inoculation with selected arbuscular mycorrhizal (AM) fungi, as phosphate biofertilizer may be a better option. Albizia lebbeck Benth is widely used as avenue tree roadsides and in tea and coffee plantations; and a good quality fodder. Inoculation of the tree seedlings in nursery with three indigenous AM-fungal isolates: Glomus aggregatum, Acaulospora delicata, Paraglomus occultum and one introduced Glomus mosseae enhanced growth within 60 days. At 240th day, maximum total biomass was enormously high ($P<0.001$); in treatments of G. aggregatum (140%), followed by A. delicata (135%), G. mosseae (134 %) and Paraglomus occultum (121%). Shoot P content was also increased significantly ($P<0.01$) in all AMF treatments except in Paraglomus occultum ($P<0.05$) than control. Mycorrhizal dependency on G. aggregatum is maximum (58.3%), on A. delicata and G. mosseae was almost same (57.1-57.5%), least dependency on Paraglomus occultum (54.7%).

Key words: Arbuscular mycorrhizae (AM), Growth, Biomass, Chlorophyll, Mycorrhizal dependenc.

Preinoculation with indigenous and introduced arbuscular mycorrhizae (AM) enhanced growth, biomass and biochemical contents of Albizia lebbeck Benth. seedlings in acid lateritic soil.

SOMDATTA GHOSH AND N.K. VERMA[1]
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Received November, 2018
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Introduction

Arbuscular mycorrhizal fungi (AMF) are gaining importance for their role in absorption of water (Aúge, 2001) and less mobile nutrients, specially P along with N, K, Ca and other less mobile nutrients (Tinker, 1984). AMF are more active in nutrient poor dry soils (Bagyaraj and Reddy, 2000). Afforestation is a real problem in dry tropic. Most tropical soils are not only P-deficient but also P-fixing (Mamatha *et al.*, 2002). Application of chemical fertilizer is of little use and expensive for plantation in this soil type. Phosphorus is most immobile as it quickly binds with aluminium and iron. Use of selected AM-fungi, as biofertilizer may be a better option for growth enhancement as well as improvement of soil structure and retaining the sustainability of soil (Haselwandter, 1997).

The acidic lateritic soils of southern West Bengal, India have low phosphorus content. Because of low moisture content the forests of this area are characterized as dry deciduous forests (Champion and Seth, 1968). AMF association in seedling stage may enhance the growth and vigour to cope with transplantation shock and help in better establishment in the field. As in normal practice of afforestation, transplantation of nursery raised seedlings is done; there is enough scope for inoculation with AM fungi. Being obligate symbiont, AMF cannot survive without host plant. As the soil is mostly poor in vegetation cover, natural AMF population is usually low. Hence, pre inoculation in nurseries before transplantation is essential to have the benefit. Arbuscular mycorrhizal inoculation in seedlings in nursery may

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Effect of an indigenous AM and PGPR combination on chilli growth and productivity in lateritic soil

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ABSTRACT
Infertile lateritic soil is particularly deficient in phosphorus (P) and Nitrogen (N). Arbuscular Mycorrhiza (AM) has a key role to uptake bound P from the soil and provide to the plants growing under P-poor conditions and improve water and nutrient uptake. *Azotobacter* fixes free nitrogen and phosphate solubilizing bacteria (PSB) release bound phosphate, are the important groups of plant growth-promoting rhizobacteria (PGPR), sometimes they may act as mycorrhiza helper and applied with AM as biofertilizer. This pot experiment was conducted to determine the primary impact of singly and combined application of native bio-inoculants, the AM, *Acaulospora*, and the PGPR, *Azotobacter* and *Pseudomonas* sp. (PSB) on growth and yield of chilli (*Capsicum frutescens* L.), growing in acid lateritic soil. Inoculated treatments were compared for growth and productivity of chilli in terms of height, leaf number, leaf area, root collar diameter, number of flowers and number of fruits, final fresh and dry yield. The productivity of chilli showed a maximum in combined treatment of *Acaulospora*, *Azotobacter*, and PSB. Also the AM spore count and root colonization found maximum in that treatment. Hence the application of indigenous AM inoculation along with native PGPR, *Azotobacter* and PSB may present better productivity in low fertile lateritic soil.

Keywords: *Acaulospora*, *Azotobacter*,.infertile soil, mycorrhiza, PSB

Efecto de una combinación indígena de AM y PGPR sobre el crecimiento y la productividad de los chiles en suelos lateríticos

RESUMEN
El suelo laterítico infértil es particularmente deficiente en fósforo (P) y nitrógeno (N). Las micorrizas arbusculares (AM) tiene un papel clave para absorber el P unido del suelo y proporcionar a las plantas que crecen en condiciones de P pobre y mejorar la absorción de agua y nutrientes. *Azotobacter* que fija el nitrógeno libre y las bacterias solubilizadoras de fosfato (PSB), son grupos importantes de rizobacterias que promueven el crecimiento de las plantas (PGPR). A veces pueden actuar de conjunto con micorrizas y aplicarse con AM como biofertilizante. Este experimento en maceta se realizó para determinar el impacto primario de la aplicación individual y combinada de bio-inoculantes nativos, AM *Acaulospora* y PGPR *Azotobacter* y *Pseudomonas* sp. (PSB) sobre el crecimiento y el rendimiento del chile (*Capsicum frutescens* L.), que crece en suelo ácido laterítico. Los tratamientos inoculados se compararon para el crecimiento y la productividad del chile en términos de altura, número de hojas, área foliar, diámetro de raíz, número de flores, número de frutos, rendimiento final fresco y seco. La productividad de los

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Response of *Capsicum frutescens* Inoculated with an Indigenous Arbuscular Mycorrhiza *Acaulospora* sp. DSM8 and *Azotobacter* sp. DK14 in Single and Dual Treatment in Dry Acid Lateritic Soil of Midnapore

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INTRODUCTION

Chilli (*Capsicum frutescens L.*) belongs to the Solanaceae family and is commercially cultivated throughout India. It contains volatile oils, fatty oils, capsicinoids, carotenoids, vitamins, proteins, fibres, and mineral elements and acts as a natural bactericidal agent. It is used to treat muscle pain, cough, asthma, and sore throat, stomach ache, so on (Bosland and Votava 2000). India is the leading producer of chilli in the world, however, average yield of chilli is very low as compared to other developed countries. This is may be due to day-by-day decreasing fertility of soil in agricultural fields throughout the country which is a result of conventional agricultural practices which involve heavy use of chemical fertilizers and pesticides, resulting toxic soil, unavailability of nutrients to the plant and pesticide-resistant pests. Nowadays, demand for organically produced vegetables is increasing.

Red lateritic soil is dry, acidic, and poorly fertile in nature because it is deficient in phosphorus, nitrogen, and other essential micronutrients, resulting promotion of unfavourable condition for plant growth.

Arbuscular Mycorrhiza (AM) form a symbiotic relationship between fungi and the roots of the majority of vascular plants. These non-pathogenic fungi colonize in the cortical tissue of plant roots during periods of active growth (Kirk, Cannon, David, *et al.* 2001) and provide plants with nutrients; especially, phosphorous along with nitrogen and other trace elements, particularly in nutrient-poor soil (Brundrett 2009). AM can also improve P-uptake of plants growing under P-poor conditions (Webber, *et al.* 1992; Powell and Daniel 1978) and help to improve water and nutrient uptake, enduring in drought (Aúge 2001; Bolan 1999; Smith and Read 1997). *Azotobacter* are free-living bacteria, used as nitrogen biofertilizer. They fix free nitrogen directly from the environment, act as plant growth promoter and mycorrhiza helper. Mycorrhization with indigenous AM and *Azotobacter* may benefit plants with better growth and yield in low-cost organic agriculture practice in lateritic soil.

Materials and Methods

The experiment was conducted with *C. frutescens* in sterilized lateritic soil in plastic pots in college experimental garden (22.30° N and 87.20° E), Midnapore College (Autonomous), West Bengal, India, in post-winter season during March. The characteristics of the experimental soil were tested according to Jackson (1973), having pH 5.57, electrical conductivity (EC) of 0.17 m mhos/cm^2, moisture content of 2.2%, organic carbon (OC) of 0.6 g kg^{-1}, total nitrogen (N) of 0.04%, and phosphate (P) of 0.03%.

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Effect of Arbuscular Mycorrhiza and Fly Ash Amendment in Red Lateritic Soil to Compare the Chilli Growth

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ABSTRACT: *Application of fly ash with soil may act as a source of readily available micro and macro nutrients to the plants and improve physico-chemical and biological properties of the soil. In contrast lateritic soil is low fertile, deficient in available phosphorus and other nutrients to the plants. In the experiment Capsicum annuum (chilli) were grown as test crops planted in lateritic soil and fly ash separately, and in the combined mixture of them, with inoculation of the arbuscular mycorrhiza, Acaulospora delicata. Parameters were compared for AM spore count, root colonization, growth and productivity of chilli in term of height, leaf number, leaf area, root collar dimeter, number of flowers and fruits, fresh weight and dry weight. Among all soil samples the growth of chilli showed maximum in combined mixture of lateritic soil and fly ash inoculated with the AM. Also the combined treatment of AM inoculated lateritic soil and fly ash showed better mycorrhization than others. Hence application of AM inoculated low fertile soil with fly ash may present better productivity.*
Keywords: *AM, Acaulospora, Mycorrhization, Lateritic Soil, Yield.*

INTRODUCTION

The lateritic soil is acidic and dry in nature with less fertility. The soil is deficient in basic essential elements like, phosphorus, nitrogen, calcium, magnesium etc. Heavy leaching due to acidity resulting soil infertility, and nutrients remain unavailable to the plant (Koley, 2000).

Fly ash is the residue being generated as byproduct from coal based thermal power stations, that its huge depositions are problematize as air and water pollution. It is highly alkaline (Adriano et al., 1998). The amorphous mixture contains several essential plant nutrients C, Ca, Cu, Fe, K, Mg, Na, Zn etc. (Pandey et al., 1994; Singh et al., 1997; Tiwari et al., 2008). The amorphous, heterogeneous mixture improves soil properties (Weinstein et al., 1989) and provides plant growth (Aitken and Bell, 1985; Sharma et al., 1990). Application of fly ash may provide positive influence to the plants and increase the crop productivity.

Arbuscular mycorrhiza (AM) are the widely occurring, obligatory aerobic, non-pathogenic soil fungi develops symbiotic relationship with the plant roots (Harley and Smith, 1983). They plays important roles to enhance the water and nutrient uptake particularly phosphorus and nitrogen with other essential micronutrients