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Summary

My research interest in the biological control of plant diseases with beneficial bacteria started with my Ph.D. program wherein I worked on a project entitled “Molecular basis of antifungal activity of a fluorescent Pseudomonad” at the Division of Microbiology, Indian Agricultural Research Institute, New Delhi, one of the premier institutes of agricultural education. I have been working on the broad area of “Plant-microbe interaction” with special emphasis on the biological control of plant diseases since then. In the last two and a half decades of my research career, I have worked on different pathosystems with several crops and am convinced that biological control could do wonders if it is practiced meticulously. I am proud to state that a bacterial strain (*Pseudomonas fluorescens* PN026) which I had isolated during my early career stage is being distributed by the Kerala Agricultural University, to the farmers on a commercial scale as a biocontrol agent against plant diseases. My current research interest is in the use of endospore-forming beneficial bacteria for plant health management.

Research Highlights

- Isolated, characterized and developed the *Pseudomonas fluorescens* strain PN026, currently being commercially distributed by KAU
 - For the first time developed a fungal-bacterial co-culture system in a single fermentation vessel, involving the beneficial endophytic fungus, *Piriformospora indica* and PGPR strain *Bacillus pumilus* VLY17
 - Developed a rapid and effective screening procedure for selection of efficient bacterial antagonists against *Phytophthora capsici*
 - Developed a coconut water based, farmer-friendly field level multiplication method for *Pseudomonas fluorescens* PN026
 - Formulated a coconut water based liquid bioformulation for *Pseudomonas fluorescens* PN026
 - Devised for the first time in vitro screening methods for testing antagonism of one or a couple of bacterial biocontrol isolate(s) against multiple fungal phytopathogens in a single agar plate
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Experience

Joined Kerala Agricultural University as Assistant Professor (Microbiology) in the year 1997

Education

- Graduated in Agricultural Science from Kerala Agricultural University (1990)
 - Post Graduation in Microbiology from Indian Agricultural Research Institute, New Delhi (1993)
 - Ph.D in Microbiology from Indian Agricultural Research Institute, New Delhi (1997)
 - Postdoctoral training at University of Florida, USA (2003)
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Area of Specialization

Plant microbe interactions, Biological Control of Plant Diseases

Awards & Recognitions

- IARI Junior fellowship for doing M. Sc in Microbiology
 - IARI Senior fellowship for doing Ph. D in Microbiology
 - BOYSCAST (Better opportunity for Young Scientists in Chosen Areas of Science and Technology) fellowship instituted by Department of Science and Technology, Government of India for doing postdoctoral training in the field of Plant-Microbe interaction in the area of Life Science at University of Florida, USA for a period of one year.
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Research Projects

Ongoing

1. Network project on Utilization of Beneficial endophytes for plant growth promotion and management of plant diseases in important crops of Kerala. Funded by Planning Board, Government of Kerala.
2. All India Network Project on Soil Biodiversity and Biofertilizers. Funded by Indian Council of Agricultural Research.

Completed

1. Exploitation of the endosymbiotic fungus *Piriformospora indica* for biotic and abiotic stress management in black pepper (*Piper nigrum* L.). Funded by Kerala State Council for Science Technology and Environment, Government of Kerala, India
2. Role of bacterial endophytes in plant defense mechanisms against *Phytophthora capsici* in black pepper (*Piper nigrum* L.). Funded under Department of Science and Technology, Government of India
3. Development of bacterial endophytes for insect pest management. Funded by Kerala Biotechnology commission, Kerala State Council for Science Technology and Environment, Government of Kerala, India
4. Exploitation of bacterial endophytes of *Piper* spp. from western Ghats for the management of *Phytophthora capsici* infecting black pepper (*Piper nigrum* L.). Funded by Western Ghat Development Program, Government of Kerala.

Publications

Journal Articles

(Scopus indexed)

1. Rajeshwaran, B., Faizal, M.H., Themuhi, M. and **Anith, K. N***. 2025. Harnessing endophytic allies: Defense priming in *Vigna unguiculata* (L) walp. against *Spodoptera litura* (Fabricius) by bacterial endophytes. *Symbiosis*. <https://doi.org/10.1007/s13199-025-01034-5>
2. Varghese, E. M., Kour, B. S. Ramya, Krishna, P. D., Nazla, K.A, Sudheer, K., **Anith, K.N.**, Jisha, M.S. and Ramakrishnan. B. 2024. Rice in Acid Sulphate Soils: Role of Microbial Interactions in Crop and Soil Health Management. *Applied Soil Ecology*, 196, 105309. (IF 4.8).
3. Samyukta, S. M. S., Viji, M. M., Manju, R. V., **Anith, K. N.**, Nisha, S. K. and Beena, R. 2024. Synergy of biochar and biofertilizers to improve bell pepper fruit biochemical quality with increased soil carbon, *Azospirillum* population and mycorrhization. *Plant Science Today*, 11(4): 1605-1614.
4. Lekshmi, P. R. G., Aparna, G. S and **Anith, K. N.** 2024. Biochemical profiling and byproduct utilization of *Garcinia aril*. *Plant Science Today*, 11(sp3): 12-17.
5. Swathi, G. S., Thara, S. S., **Anith, K. N.**, Divya, S., Nair, C. B. and Jesna, N. B. 2024. Silver nanoparticles green synthesized using leaf extract of *Piper* spp. reduce *Phytophthora capsici* infection in black pepper (*Piper nigrum* L.). *Plant Science Today*, 11(sp3): 146-153.

6. ManjuBhargavi, Y., Rajan, S. A., Chitra, N., Soumya, V. I., Beena, R. and **Anith, K. N.** 2024. Pink Pigmented Facultative Methyloprotophs (PPFMs) improve rooting in black pepper (*Piper nigrum* L.) cuttings and mitigate drought stress. *Plant Science Today*, 11(sp3): 43-53.
7. Shibana, S. N., Nair, D. S., Sreekala, G. S., Shalini, P. P., Alex, S., **Anith, K. N.** and Joseph, A. 2024. Growth, yield and secondary metabolite elicitation in response to chitosan application in turmeric (*Curcuma longa* L.). *Plant Science Today*, 11(sp3): 83-95.
8. Nandana, M. S. and **Anith, K. N.*** 2024. Biological management of rhizome rot in ginger (*Zingiber officinale*) plants and stored ginger seeds. *Plant Science Today*, 11(sp3): 124-136.
9. Amrutha, V., Reshma, M., Manju, R.V., **Anith, K.N.**, Gopinath, P.P., Sarada, S. and Beena, R., 2024. High temperature stress induced changes in physiological, biochemical, hormonal and gene expression patterns in contrasting tomato genotypes. *Plant Physiology Reports*, 29: 872–888.
10. Mani, K. M., Ameena, M., **Anith, K. N.**, Pratheesh, P. G., Adarsh, S. and Shifina, S. 2024. Altered physiological response in drought stressed rice plants upon root colonization with the beneficial endophytic fungus *Piriformospora indica* under field conditions. *Plant Science Today*, 11: 576-582.
11. Biji, C.L., Dagala, A.K., Sinha, M.G., Priyanka, N.D., Dhanasekaran, G., Suresh, S., Shahina, K., Nair, A.S., Sabu, K.K. and **Anith, K.N.** 2024. Transcriptome sequencing and differential expression analysis in bacterial wilt tolerant and susceptible clones of tomato (*Solanum lycopersicum* L.) following *Ralstonia solanacearum* infection. *Physiological and Molecular Plant Pathology*, 133, p.102360.
12. Varghese, E.M., Manirajan, B.A., **Anith, K.N.** and Jisha, M.S. 2024. Physicochemical properties of acid sulphate soil profoundly influence the composition of rhizobacterial community of rice (*Oryza sativa* L.). *Rhizosphere*, p.100971.
13. Siva, M., Sreeja, S.J., Thara, S.S., Heera, G. and **Anith, K.N.*** 2024. Screening and evaluation of bacterial endophytes of cowpea [*Vigna unguiculata* (L.) Walp.] for plant growth promotion and biocontrol potential. *Plant Science Today*, 11: 44-57. (IF 0.9).
14. Jacob, M.E., Nair, D.S., Sreekala, G.S., **Anith, K.N.**, Alex, S., Rani, T.S. and Viji, M.M. 2024. Chitosan seed priming enhanced germination and seedling growth in Ashwagandha (*Withania somnifera* (L.) Dunal.). *Medicinal Plants*, 16: 119-127.
15. Mani, K.M., Ameena, M., Johnson, J.M., **Anith, K.N.**, Pillai, P.S., John, J. and Beena, R., 2023. Endophytic fungus *Piriformospora indica* mitigates moisture stress in rice by modifying root growth. *Rhizosphere*, 28, p.100799. (IF 3.129).
16. Anjana, H.N., **Anith, K.N.** and Sabu, K.K. 2023. Growth promoting effects of endophytic fungus *Piriformospora indica* in small cardamom (*Elettaria cardamomum* Maton). *Symbiosis* 91: 79-89. <https://doi.org/10.1007/s13199-023-00949-1> (IF 2.5).
17. Siva, M., Sreeja, S. J., Susha S. Thara. Heera, G. and **Anith, K. N.*** 2023. Endophytic *Bacillus* spp. suppress *Rhizoctonia solani* web blight of bush cowpea. *Rhizosphere*, 25, 100682. (IF 3.129).
18. Bhavya, M.S.P., Manju, R.V., Viji, M.M., Roy, S., **Anith, K.N.** and Beena, R., 2023. Impact of biofertilisers on iron homeostasis and grain quality in the rice variety Uma under Elevated CO₂. *Frontiers in Plant Science*, 14, 1144905. (IF 6.627)
19. Divya, S., Anusree, A.R., Vigi, S., Jiji, S.G., Das, P.A., Dev, A.R., Thara, S.S., Varghese, E.M., Gopinath, P.P. and **Anith, K.N.*** 2023. Silver nanoparticles green synthesized with leaf extract of disease-resistant amaranthus genotypes effectively suppress leaf blight (*Rhizoctonia solani* Kühn) disease in a susceptible red amaranthus cultivar. *3 Biotech*, 13: 196. (IF 2.406).
20. Anju, A.B., Natarajan, C., Preetha, R., Rajan, S.A., Soumya, V.I. and **Anith, K, N.*** 2023. Bacterization with Endospore-forming *Bacillus* spp. Promotes Plant Growth and Suppresses Foot Rot Disease in Black Pepper (*Piper nigrum* L.) in the Nursery. *J Pure Appl Microbiol.* 17(2):768-779. doi: 10.22207/JPAM.17.2.02 (IF 0.8)
21. Nysanth, N.S., Rajan, S.A., Sivapriya, S.L., **Anith, K.N.*** 2023. Pink Pigmented Facultative Methyloprotophs (PPFMs): Potential Bioinoculants for Sustainable Crop Production. *J Pure Appl Microbiol.* 17(2):660-681. doi: 10.22207/JPAM.17.2.17 (IF 0.8)
22. Lekshmi, R. S., Sora, S., **Anith, K. N.**, and Soniya, E. V. 2022. Root colonization by the endophytic fungus *Piriformospora indica* shortens the juvenile phase of *Piper nigrum* L. by fine tuning the floral promotion pathways. *Frontiers in Plant Science.* <https://doi.org/10.3389/fpls.2022.954693> (IF 6.627)
23. Nysanth, N.S., Divya, S., Chitra B. Nair, Anju, A.B., Praveena, R. and **Anith, K. N.*** 2022. Biological control of foot rot (*Phytophthora capsici* Leonian) disease in black pepper (*Piper nigrum* L.) with rhizospheric microorganisms. *Rhizosphere* **23**: 100578. (IF 3.129)
24. Yshaswini, M.S., Nysanth, N.S. and **Anith, K. N.*** 2022. Endospore-forming phyllosphere bacteria from *Amaranthus* spp. suppress leaf blight (*Rhizoctonia solani* Kuhn) disease of *Amaranthus tricolor* L. *Journal of Tropical Agriculture* **60**: 95-108.
25. Benny, A., Alex, S., Soni, K.B., **Anith, K.N.**, Kiran, A.G. and Viji, M.M., 2022. Improved transformation of Agrobacterium assisted by silver nanoparticle. *BioTechnologia. Journal of Biotechnology Computational Biology and Bionanotechnology*, **103**:311-317.
26. Nysanth, N.S., Sivapriya, S.L., Natarajan, C. and **Anith, K. N.*** (2022) Novel *in vitro* methods for simultaneous screening of two antagonistic bacteria against multiple fungal phytopathogens in a single agar plate. *3 Biotech* **12**: 140. (IF 2.406).

27. Bijula, B.L., Alex, S., Soni, K.B., **Anith, K. N.**, Joy, M., Nair, D.S., Beena, R. and Benny, A. (2022) Algicidal Effects of Green Synthesized Silver Nanoparticles using *Tinospora cordifolia* on *Chlamydomonas reinhardtii*. *Journal of Pure and Applied Microbiology* **16**, 1122-1129. doi: 10.22207/JPAM.16.2.38 (IF 0.8)
28. Innazent, A., Jacob, D., Bindhu, J.S., Joseph, B., **Anith, K.N.**, Ravisankar, N., Prusty, A.K., Paramesh, V. and Panwar, A.S. (2022) Farm typology of smallholders integrated farming systems in Southern Coastal Plains of Kerala, India. *Scientific Reports* **12**: 1-14. (IF 4.379). <https://doi.org/10.1038/s41598-021-04148-0>
29. Yashaswini, M.S., Nysanth, M.S., and **Anith, K.N.*** (2021) Endospore-forming bacterial endophytes from *Amaranthus* spp. improve plant growth and suppress leaf blight (*Rhizoctonia solani* Kühn) disease of *Amaranthus tricolor* L. *Rhizosphere* **19**: 100387. (IF 3.129). <https://doi.org/10.1016/j.rhisph.2021.100387>
30. **Anith, K.N.***, Nysanth, N.S., and Natarajan, C. (2021) Novel and rapid agar plate methods for *in vitro* assessment of bacterial biocontrol isolates' antagonism against multiple fungal phytopathogens. *Letters in Applied Microbiology* **73**: 229-236. (IF 2.858). <https://doi.org/10.1111/lam.13495>
31. Rajkumari, N., Alex, S., Soni, K.B., **Anith, K.N.**, Viji, M.M. and Kiran, A.G. (2021) Silver nanoparticles for biolistic transformation in *Nicotiana tabacum* L. *3 Biotech* **11**: 1-7. (IF 2.406). <https://doi.org/10.1007/s13205-021-03043-9>
32. Vyshakhi, A.S. and **Anith, K.N.*** 2021. Co-inoculation with the root endophytic fungus *Piriformospora indica* and endophytic bacteria improves growth of solanaceous vegetable seedlings. *International Journal of Vegetable Science* **27**:536-551.
33. Paul, T., Nysanth, N.S., Yashaswini, M.S. and **Anith, K.N.*** (2021) Inoculation with bacterial endophytes and the fungal root endophyte, *Piriformospora indica* improves plant growth and reduces foliar infection by *Phytophthora capsici* in black pepper. *Journal of Tropical Agriculture* **59**: 224-235.
34. Athira, P.V., Radhakrishnan, N.V. and **Anith, K.N.*** (2021) Seed biopriming and spraying at fruit set with microbial agents suppress anthracnose disease and improve growth and yield in chilli. *Journal of Tropical Agriculture* **59**: 273-285.
35. Raj, S.K., Syriac, E.K., Kumari, K.S. and **Anith, K.N.** (2021) Compatibility of Pre-mix Herbicide Mixture, Penoxsulam 1.02%+ Cyhalofopbutyl 5.1% OD with Bio-fertilizer Organisms and Biocontrol Agents. *Pesticide Research Journal* **33**: 66-71. <https://doi.org/10.1080/19315260.2021.1885555>
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37. Kollakkodan, N., **Anith, K.N.***, and Nysanth, N. S. (2021) Endophytic bacteria from *Piper colubrinum* suppress *Phytophthora capsici* infection in black pepper (*Piper nigrum* L.) and improve plant growth in the nursery. *Archives of Phytopathology and Plant Protection* **54**: 86-108. <https://doi.org/10.1080/03235408.2020.1818493> (IF 1.0)
38. Athira, S., and **Anith, K.N.*** (2020) Plant growth promotion and suppression of bacterial wilt incidence in tomato by rhizobacteria, bacterial endophytes and the root endophytic fungus *Piriformospora indica*. *Indian Phytopathology* **73**: 629-642. <https://doi.org/10.1007/s42360-020-00283-2>
39. Nagamani, G., Alex, S., Soni, K. B., **Anith, K. N.**, Viji, M. M., and Kiran, A. G. (2019) A novel approach for increasing transformation efficiency in *E. coli* DH5 α cells using silver nanoparticles. *3 Biotech* **9**: 113. (IF 2.406). <https://doi.org/10.1007/s13205-019-1640-9>
40. Jisha, S., **Anith, K. N.**, and Sabu, K. K. (2019) The protective role of *Piriformospora indica* colonization in *Centella asiatica* (L.) *in vitro* under phosphate stress. *Biocatalysis and Agricultural Biotechnology* **19**: 101088. <https://doi.org/10.1016/j.bcab.2019.101088> (IF 4.0)
41. **Anith, K. N.***, Aswini, S., Varkey, S., Radhakrishnan, N. V., and Nair, D. S. (2018) Root colonization by the endophytic fungus *Piriformospora indica* improves growth, yield and piperine content in black pepper (*Piper nigrum* L.). *Biocatalysis and Agricultural Biotechnology* **14**: 215-220. <https://doi.org/10.1016/j.bcab.2018.03.012> (IF 4.0)
42. Varkey, S., **Anith, K. N.***, Narayana, R., and Aswini, S. (2018) A consortium of rhizobacteria and fungal endophyte suppress the root-knot nematode parasite in tomato. *Rhizosphere* **5**: 38-42. (IF 3.129). <https://doi.org/10.1016/j.rhisph.2017.11.005>
43. Jisha, S., Gouri, P. R., **Anith, K. N.**, and Sabu, K. K. (2018) *Piriformospora indica* cell wall extract as the best elicitor for asiaticoside production in *Centella asiatica* (L.) Urban, evidenced by morphological, physiological and molecular analyses. *Plant Physiology and Biochemistry* **125**: 106-115. (IF 4.270). <https://doi.org/10.1016/j.plaphy.2018.01.021>
44. Binseena, S.R., Anitha, N., Paul, A., Amritha, V.S. and **Anith, K.N.** (2018) Management of rice weevil, *Sitophilus oryzae* using essential volatile oils. *Entomon* **43**: 277-280.
45. Kollakkodan, N., **Anith, K. N.***, and Radhakrishnan, N. V. (2017) Diversity of endophytic bacteria from *Piper* spp. with antagonistic property against *Phytophthora capsici* causing foot rot disease in black pepper (*Piper nigrum* L.). *Journal of Tropical Agriculture* **55**: 63-70.
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47. **Anith, K. N.***, Vaishakhi, A. S., Viswanathan, A., Varkey, S., and Aswini, S. (2016) Population dynamics and efficiency of coconut water based liquid formulation of *Pseudomonas fluorescens* AMB-8. *Journal of Tropical Agriculture* **54**: 184-189.
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<https://doi.org/10.1007/s13199-015-0313-7>
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<https://doi.org/10.1007/s13199-011-0143-1>
54. Nair, C. B. and **Anith, K. N.*** (2009) Efficacy of the plant activator, acibenzolar-S-methyl and rhizobacteria for the management of foliar blight disease of amaranthus. *Journal of Tropical Agriculture* **47**: 43-47.
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Articles not indexed in Scopus

1. Sivapriya, S. L. and **Anith, K. N.** 2024. Isolation, Characterization, and Screening of Endospore Forming Endophytic Bacteria from Cowpea [*Vigna unguiculata* (L.) Walp.] for Plant Growth Promotion and Abiotic Stress Mitigation. *International Journal of Plant & Soil Science*, 36, 214-227.
2. Satheesh, A., Raj, S.K., Jacob, D., Pillai, S. and **Anith, K.N.**, 2024. Co-composting: A Comprehensive Review of Its Potential in Transforming Coir Pith Waste into Nutrient-rich Manure. *International Journal of Environment and Climate Change*, 14: 208-218.
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Popular Articles

1. Divya, S., Das, A., Anusree, A.R. and **Anith, K.N.** (2022) The root endophytic fungus *Piriformospora indica* as a bio-hardening agent for tissue cultured plantlets. *Biotica Research Today*, **4**: 69-271.
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Books/Chapters in Books

1. Zargar, M.Y. and **Anith, K. N.** (2004) Biological control of plant diseases with plant growth promoting rhizobacteria (PGPR): Role of induced systemic resistance (ISR). Khan, M.A. and Zargar, M.Y (eds) *Agriculture and Environment*. APH Publishing House, New Delhi, India. pp 59-66. ISBN 10: 9788176486033
2. Girija, V. K. and **Anith, K. N.** (2006) *Bacillus* as biological control agents of plant diseases. Trivedi, P. C. (ed) *Applied Microbiology*. Agribios (India), Jodhpur. pp 97-111. ISBN 10: 8177542842
3. Eapen, S.J., Anith, K.N., Praveena, R. and Dinesh, R., 2023. Microbial Inoculants for Sustainable Plant Health. In *Handbook of Spices in India: 75 Years of Research and Development* (pp. 4055-4105). Singapore: Springer Nature Singapore.

Student Guidance (Major Advisor/ Advisory Committee member)

M. Sc.

Within KAU: Completed: 16

Outside KAU: Completed : 3

Ph. D

Within KAU: Completed: 1; Ongoing : 5

Other Institutional Responsibilities

1. Currently acting as student Advisor/faculty mentor to 20 Undergraduate students.
2. Currently Chairman of committee to monitor “Prevention of Caste-based Discrimination in Higher Education Institutions” at College of Agriculture, Vellayani campus.

Membership in Professional Associations

1. Three Year full Global Outreach membership in International Symbiosis Society