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Effect of inoculation with arbuscular mycorrhizal fungi on growth, nutrient uptake and curcumin production of turmeric (*Curcuma longa* L.)

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ABSTRACT

Profitable turmeric (*Curcuma longa* L.) production requires adequate nutrients. We have investigated the effect of inoculation with arbus cular mycorrhizal fungi (AMF) on growth, nutrient uptake, yield and curcumin production of turmeric under field and glasshouse conditions. Although AMF inoculation slightly increased plant height, leaf number and shoot N content, no statistical differences were observed in vegetative growth parameters, biomass production, nutrient uptake and curcumin content compared to control plants under field conditions. It was difficult to determine the exact effect of inoculated AMF on turmeric growth because of indigenous AMF. On the other hand, turmeric showed better response to AMF inoculation under greenhouse conditions. AMF inoculation resulted in higher biomass production and nutrient uptake of turmeric. Moreover the concen tration of curcumin, contained in the rhizome of turmeric, increased in AMF treatment. These results indicate that AMF inoculation has beneficial effects on turmeric growth and curcumin production. AMF inoculation to turmeric field would be effective when indigenous soil populations of AMF are low or native AMF are no longer effective.

KEYWORDS

Arbuscular Mycorrhizal Fungi; Curcumin; Rhizome; Turmeric

Cite this paper

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References

[1] Ruby, A.J., Kuttan, G., Babu, K.D., Rajasekharan, K.N. and Kuttan, R. (1995) Anti-tumour and antioxidant activ ity of natural curcuminoids. Cancer Letters, 94, 79-83. doi:10.1016/0304-3835(95)03827-J

[2] Conney, A.H., Lysz, T., Ferraro, T., Abidi, T.F., Manchand, P.S., Laskin, J.D. and Huang, M.T. (1991) Inhibitory ef fect of curcumin and some related dietary compounds on tumour promotion and arachidonic acid metabolism in mouse skin. Advances in Enzyme Regulation, 31, 385-396. doi:10.1016/0065-2571(91)90025-H

[3] Mukhopadhyay, A., Basu, N., Ghatak, N. and Gujral, P.K. (1982) Anti-inflammatory and irritant activities of curcu min analogues in rats. Agents Actions, 12, 508-515. doi:10.1007/BF01965935

[4] Kelloff, G.J., Boone, C.W., Crowell, J.A., Steele, V.E., Lu bet, R. and Sigman, C.C. (1994) Chemopreventive drug development: Perspective and progress. Cancer Epidemi ology, Biomarkers and Prevention, 3, 85-98.

[5] Govind, S., Gupta, P.N. and Chandra, R. (1990) Response of N and P levels on growth and yield components of turmeric in acid soils of Meghalaya. Indian Journal of Horticulture, 47, 79-84.

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[6] Yamgar, V.T., Kathmale, D.K., Belhekar, P.S., Patil, R.C. and Paul, P.S. (2001) Effect of different levels of nitrogen, phosphorus and potassium and split application of N on growth and yield of turmeric (Curcuma longa). Indian Journal of Agronomy, 46, 372-374.

[7] Jagadeeswaran, R., Murugappan, V. and Govindaswamy, M. (2005) Effect of slow release NPK fertilizer sources on the nutrient use efficiency in turmeric (Curcuma longa L.). World Journal of Agricultural Sciences, 1, 65-69.

[8] Hossain, M.A. and Ishimine, Y. (2007) Effects of farm yard manure on growth and yield of turmeric (Curcuma longa L.) cultivated in dark-red soil, red soil and gray soil in Okinawa, Japan. Plant Production Science, 10, 146-150. doi:10.1626/pps.10.146

[9] Leaungvutiviroj, C., Piriyaprin, S., Limtong, P. and Sa saki, K. (2010) Relationships between soil microorgan isms and nutrient contents of Vetiveria zizanioides (L.) Nash and Vetiveria nemoralis (A.) Camus in some prob lem soils from Thailand. Applied Soil Ecology, 46, 95-102. doi:10.1016/j.apsoil.2010.06.007

[10] Newsham, K.K., Fitter, A.H. and Watkinson, A.R. (1995) Multi-functionality and biodiversity in arbuscular mycorrhizas. Trends in Ecology and Evolution, 10, 407-411. doi:10.1016/S0169-5347(00) 89157-0

[11] Clark, R.B., Zeto, S.K. and Zobel, R.W. (1999) Arbuscu lar mycorrhizal fungal isolate effectiveness on growth and root colonization of Panicum virgatum in acidic soil. Soil Biology and Biochemistry, 31, 1757-1763. doi:10.1016/S0038-0717(99)00084-X

[12] Wang, B. and Qui, Y.L. (2006) Phylogenetic distribution and evolution of mycorrhizas in land plants. Mycorrhiza, 16, 299-363. doi:10.1007/s00572-005-0033-6

[13] Guether, M., Neuh?user, B., Balestrini, R., Dynowski, M., Ludewig, U. and Bonfante, P. (2009) A mycorrhizal-spe cific ammonium transporter from Lotus japonicus ac quires nitrogen released by arbuscular mycorrhizal fungi. Plant Physiology, 150, 73-83. doi:10.1104/pp.109.136390

[14] Leigh, J., Hodge, A. and Fitter, A.H. (2009) Arbuscular mycorrhizal fungi can transfer substantial amounts of ni trogen to their host plant from organic material. New Phytologist, 181, 199-207. doi:10.1111/j.1469-8137.2008.02630.x

[15] Muthukumar, T., Senthikumar, M., Rajangam, M. and Udaiyan, K. (2006) Arbuscular mycorrhizal morphology and dark septate fungal associations in medicinal and aromatic plants of western Ghats, southern India. My corrhiza, 17, 11-24. doi:10.1007/s00572-006-0077-2

[16] Mridha, M.A.U. and Dhar, P.P. (2007) Biodiversity of arbuscular mycorrhizal colonization and spore population in different agroforestry trees and crop species growing in Dinajpur, Bangladesh. Journal of Forestry Research, 18, 91-96. doi:10.1007/s11676-007-0018-8

[17] Sumathi, C.S., Balasubramanian, V., Ramesh, N. and Kan nan, V.R. (2008) Influence of biotic and abiotic features on Curcuma longa L. plantation under tropical condition. Middle-East Journal of Scientific Research, 3, 171-178.

[18] Radhika, K.P. and Rodrigues, B.F. (2010) Arbuscular my corrhizal fungal diversity in some commonly occurring medicinal plants of western Ghats, goa region. Journal of Forestry Research, 21, 45-52. doi:10.1007/s11676-010-0007-1

[19] Katsuyama, Y., Kita, T. and Horinouchi, S. (2009) Identi fication and characterization of multiple curcumin syn thases from the herb Curcuma longa. FEBS Letters, 583, 2799-2803. doi:10.1016/j.febslet.2009.07.029

[20] Hause, B., Maier, W., Miersch, O., Kramell, R. and Strack, D. (2002) Induction of jasmonate biosynthesis in arbus cular mycorrhizal barley roots. Plant Physiology, 130, 1213-1220. doi:10.1104/pp.006007

[21] Akiyama, K., Matsuoka, H. and Hayashi, H. (2002) Iso lation and identification of a phosphate deficiency-in duced C-glycosylflavonoid that stimulates arbuscular my corrhiza formation in melon roots. Molecular Plant-Mi crobe Interactions, 15, 334-340. doi:10.1094/MPMI.2002.15.4.334

[22] Fester, T., Schmidt, D., Lohse, S., Walter, M.H., Giuliano, G., Bramley, P.M., Fraser, P.D., Hause, B. and Strack, D. (2002) Stimulation of carotenoied metabolism in arbus cular mycorrhizal roots. Planta, 216, 148-154. doi:10.1007/s00425-002-0917-z

[23] Zhu, H.H. and Yao, Q. (2004) Localized and systemic increase of phenols in tomato roots induced by Glomus versiforme inhibits Ralstonia solanacearum. Journal of Phytopathology, 152, 537-542.

doi:10.1111/j.1439-0434.2004.00892.x

[24] Phillips, J.M. and Hayman, D.S. (1970) Improved proce dures for clearing roots and staining parasitic and vesicu lar-arbuscular mycorrhizal fungi for rapid assessment of infection. Transactions of the British Mycological Society, 55, 158-161. doi:10.1016/S0007-1536(70)80110-3

[25] Giovannetti, M. and Mosse, B. (1980) An evaluation of techniques for measuring vesicular arbuscular mycorrhi zal infection in roots. New Phytologist, 84, 489-500. doi:10.1111/j.1469-8137.1980.tb04556.x

[26] Karasawa, T., Kasahara, Y. and Takebe, M. (2002) Dif ferences in growth responses of maize to preceding crop ping caused by fluctuation in the population of indige nous arbuscular mycorrhizal fungi. Soil Biology and Bio chemistry, 34, 851-857. doi:10.1016/S0038-0717(02)00017-2

[27] Iqbal, S.H. and Nasim, G. (1991) Are under ground non root portions of tropical plants vesicular arbuscular my corrhizal? Transactions of the Mycological Society of Japan, 32, 467-476.

[28] Sampath, P. and Sullia, S.B. (1992) The occurrence of VAM fungi in the scale leaves of turmeric. Mycorrhiza News, 14, 5.

[29] Sangwan, N.S., Farooqi, A.H.A., Shabih, F. and Sangwan, R.S. (2001) Regulation of essential oil production in plants. Plant Growth Regulation, 34, 3-21. doi:10.1023/A:1013386921596

[30] Silva, M.F., Pescador, R., Rebelo, R.A. and Stürmer, S.L. (2008) The effect of arbuscular mycorrhizal fungal iso lates on the development and oleoresin production of mi cropropagated Zingiber officinale. Brazilian Journal of Plant Physiology, 20, 119-130. doi:10.1590/S1677-04202008000200004

[31] Hayman, D.S. and Stovold, G.E. (1979) Spore popula tions and infectivity of vesicular arbuscular mycorrhizae fungi in new south Wales. Australian Journal of Botany, 27, 227-233. doi:10.1071/BT9790227

[32] Koske, R.E. (1987) Distribution of VA mycorrhizal fungi along a latitudinal temperature gradient. Mycologia, 79, 55-68. doi:10.2307/3807744

[33] Gemma, J.K., Koske, R.E. and Carreiro, M. (1989) Sea sonal dynamics of selected species of V-A mycorrhizal fungi in a sand dune. Mycological Research, 92, 317-321. doi:10.1016/S0953-7562(89)80072-3