AS> Vol.3 No.3, May 2012

OPEN ACCESS

Effects of a low-voltage electric pulse charged to culture soil on plant growth and variations of the bacterial community

PDF (Size:1856KB) PP. 339-346 DOI: 10.4236/as.2012.33038

Author(s)

Jun Yeong Yi, Ji Won Choi, Bo Young Jeon, Il Lae Jung, Doo Hyun Park

ABSTRACT

This study was conducted to verify the effect of an electric pulse on growth of crops (lettuce and hot pepper) that were cultivated in lab-scale soil. The electric pulse generated from direct-circuited 2, 4, 6, 8, and 10 V of electricity by periodic exchange of the anode and cathode was charged to a culture soil that is an electrically pulsed culture soil (EPCS) but not charged to a conventional culture soil (CCS). Growth of lettuce increased and growth duration of hot pepper plants was more prolonged at 4, 6, 8, and 10 V of EPCS than at 2 V of EPCS and CCS. The fruiting duration and yield of hot pepper fruits were proportional to the growth duration of the hot pepper plants. Temperature gradient gel electrophoresis (TGGE) patterns of 16S-rDNA obtained from the bacterial community inhabiting the CCS and EPCS were identical at the initial time and did not change significantly at days 28 and 56 of cultivation. The bacterial communities inhabiting the surface of lettuce roots were not influenced by the electric pulse but were significantly different from those inhabiting the culture soil based on the TGGE patterns. Growth of lettuce and hot pepper plants that were cultivated in 4 - 10 V of EPCS may increase; however, the bacterial community inhabiting the soil and the surface of plant roots may not be influenced by an electric pulse.

KEYWORDS

Electrically Pulsed Soil; TGGE; Lettuce; Hot Pepper Plant; Bacterial Community

Cite this paper

Yi, J. , Choi, J. , Jeon, B. , Jung, I. and Park, D. (2012) Effects of a low-voltage electric pulse charged to culture soil on plant growth and variations of the bacterial community. *Agricultural Sciences*, 3, 339-346. doi: 10.4236/as.2012.33038.

References

[1] Lee, H.J. and Moon, S.H. (2005) Enhancement of electrodialysis performances using pulsing electric fields during extended period operation. Journal of Colloid and Interface Science, 287, 597-603. doi:10.1016/j.jcis.2005.02.027

[2] Na, B.K., Sang, B.I., Park, D.W. and Park, D.H. (2005) Influence of electric potential on structure and function of biofilm in wastewater treatment reactor: Bacterial oxidation of organic carbons coupled to bacterial denitrification. Journal of Microbiology and Biotechnology, 15, 1221-1228.

[3] Sale, A.J.H. and Hamilton, W.A. (1967) Effect of high electric fields on microorganism. I. Killing of bacteria and yeast. Biochimica et Biophysica Acta, 15, 1031-1037.

[4] Gilliland, S.E. and Spec, M.L. (1967) Inactivation of microorganisms by electric shock. Applied Microbiology, 15, 1031-1037.

[5] Wouters, P.C., Dutreux, N., Smelt, J.P.P.J. and Lelieveld, H.L.M. (1999) Effect of pulsed electric field on inactivation kinetics of Listeria innocua. Applied and Environmental Microbiology, 65, 5364-5371.

[6] Somolinos, M., García, D., Condón, S., Mañas, P. and Pagán, R. (2007) Relationship between sublethal injury and inactivation of yeast cells by the combination of sorbic acid and pulsed electric fields. Applied and Environmental Microbiology, 73, 3814-3821. doi:10.1128/AEM.00517-07

[7] Cong, Y., Wu, Z. and Li, Y. (2008) Electrochemical inactivation of coliforms by insitu generated hydroxyl radicals. Korean Journal of Chemical Engineering, 25, 727- 731. doi:10.1007/s11814-008-0119-x

[8] Min, H.R., Jeon, B.Y., Seo, H.N., Kim, M.J. , Kim, J.C., Kim, J.K. and Park, D.H. (2009) Effect of low intensity pulsed electric field on ethanol fermentation and chemical component variation in a winemaking culture. Food Science and Biotechnology, 17, 2358-1364.

[9] Seo, H.N., Jeon, B.Y., Tran, H.T., Ahn, D.H. and Park, D.H. (2010) Influence of pulsed electric field on growth of soil bacteria and pepper plant. Korean Journal of Chemical Engineering, 27, 560-566. doi:10.1007/s11814-010-0090-1

[10] Volkov, A.G. (2000) Green plants: Electrochemical interfaces. Journal of Electroanalytical Chemistry, 483, 150-156. doi:10.1016/S0022-0728(99)00497-0

[11] Chalmers, J.D.C., Coleman, J.O.D. and Walton, N.J. (1984) Use of an electrochemical technique to study plasmamembrane redox reactions in cultured cells of Daucus carota L. Plant Cell Report, 3, 243-246. doi:10.1007/BF00269303

[12] Pickard, B.G. (1973) Ac-tion potentials in higher plants. Botanical Review, 39, 172-201. doi:10.1007/BF02859299

[13] Pickard, W.F. (1969) The correlation between electrical behavior and cytoplasmic streaming in Chara braumii. Canadian Journal of Botany, 47, 1233-1240. doi:10.1139/b69-174

[14] Williams, S.E. and Pickard, B.G. (1972) Receptor potentials and action potentials in Drosera tentacles. Planta, 103, 193-221. doi:10.1007/BF00386844

[15] Racusen, R.H. and Etherton, B. (1975) Role of membrane-bound fixed-charge changes in phytochrome-mediated mung bean root tip adherence phenomenon. Plant Physiology, 55, 491-495. doi:10.1104/pp.55.3.491

[16] Eichner, C.A., Erb, R.W., Timmis, K.H. and Wagner-D?bler, I. (1999) Thermal gradient gel electrophoresis analysis of bioprotection from pollutant shocks in the activated sludge microbial community. Applied Environmental Microbiology, 65, 102-109.

[17] Sambrook, J., Fritsch, E.F. and Maniatis, T. (1989) Molecular cloning: A laboratory manual. 2nd Edition, Cold Spring Harbor Laboratory, New York.

[18] Desert, G., Lebender, D. and Schneider, F.W. (1995) Electrical pulses to determine chemical phase response curves. Journal of Physical Chemistry, 99, 11432-11435. doi:10.1021/j100029a021

[19] Nishimura, Y., Ohta, N., Yamamoto, M. and Yamazaki, I. (1998) Electric field effect on the charge migration of methylene-linked carbazole and terephthalic acid metyl ester in PMMA polymer films. Molecular Crystals and Liquid Crystals, 315, 181-186. doi:10.1080/10587259808044329

[20] Doi, T., Morita, S., Abe, J., Zhu, S. and Yamagishi, J. (2009) Analaysis of determining factors on community structure of soil bacteria in volcano ash soil (Kanto Loan) farming field using PCR-DGGE method. International Symposium " Root Reserarch and Applications " , Vienna, 2-4 September 2009.

[21] Glick, B.R., Karaturovic, D.M. and Newell, P.C. (1995) A novel procedure for rapid isolation of plant growth promoting Pseudomonads. Canadian Journal of Microbiology, 41, 533-536. doi:10.1139/m95-070

[22] Kennedy, I.R., Perg-Gerk, L.L., Wood, C., Deaker, R., Gilchrist, K. and Katupitiya, S. (1997). Biological nitrogen fixation in non-leguminous field crop: Facilitating the evolution of an effective asso-ciation between Azospirillum and wheat. Plant Soil, 194, 65-79. doi:10.1023/A:1004260222528

[23] Kleeberger, A., Castroph, H. and Klingmuller, W. (1983) The rhizosphere microflora of wheat and barley with special reference to gramnegative bacteria. Archives of Microbiology, 136, 306-311. doi:10.1007/BF00425222

[24] Sakthivel, N. and Gnanamanikam, SS. (1987) Evaluation of Pseudomonas fluorescens for suppression of sheath rot disease and for enhances in rice (Oryza sativa L.). Applied and Environmental Microbiology, 53, 2056-2059.

[25] Yamaguchi, K.E. (2001) Evolution of the geochemical cycles of redox-sensitive elements. Frontier Research on Earth Evolution, 1, 249-252.

[26] Freitas, J.R., Banerjee, M.R. and Germida, J.J. (1997) Phosphate-solubilizing rhizobacteria enhance

the growth and yield but not phosphorus uptake of canola (Brassica napus L.). Biology and Fertility of Soil, 24, 358-364. doi:10.1007/s003740050258

[27] Narsian, V. and Patel, H.H. (2000) Aspertgillus aculeatus as a rock phosphate solubilizer. Soil Biology& Biochemistry, 32, 559-565. doi:10.1016/S0038-0717(99)00184-4

[28] Hilda, R. and Reynaldo, F. (1999) Phosphate solubilizing bacteria and their role in plant growth promotion. Biotechnology Advances, 17, 319-339. doi:10.1016/S0734-9750(99)00014-2

[29] Shenker, M., Seitelbach, S., Brand, S., Haim, A. and Litaor, M.I. (2005) Redox reactions and phosphorus release in reflooded soils of an altered wetland. European Journal of Soil Science, 56, 515-525. doi:10.1111/j.1365-2389.2004.00692.x

[30] Mesén, F, Newton, A.C. and Leakey, R.R.B. (1997) The effects of propagation environment and foliar area on the rooting physiology of Cordia alliodora (Ruiz & Pavon) oken cutting. Trees-Structure and Function, 11, 404-411