



## DAFTAR PUSTAKA

- Abidin, Z. 1985. *Dasar-dasar pengetahuan tentang zat pengatur tumbuh*. Angkasa, Bandung.
- Ahmad, E., Zaidi, A., Khan, M.S. and Oves, M. 2012. *Heavy metal toxicity to symbiotic nitrogen-fixing microorganism and host legumes* pp. 29-44. In Zaidi *et al.* (Eds.). *Toxicity of heavy metals to legumes and bioremediation*. DOI 10.1007/978-3-7091-0730-0\_2, Springer-Verlag.
- Ahmad, F., Ahmad, I. and Khan, M.S. 2005. Indole acetic production by the indigenous isolates of *Azotobacter* and fluorescent *Pseudomonas* in the presence and absence of tryptophan. *Turk. J. Biol.* **29**: 29-34.
- Akbari, Gh.A., Arab, S.M., Alikhani, H.A., Allahdadi, I. and Arzanesh, M.H. 2007. Isolation and selection of indigenous *Azospirillum* spp. and IAA of superior strains on wheat roots. *World Journal of Agricultural Sciences* **3**: 523-529.
- Al Jassim, R.A.M., Scott, P.T., Trebbin, A.L., Trott, D. and Pollitt, C.C. 2005. The genetic diversity of lactic acid bacteria in the Equine gastrointestinal tract. *FEMS Microbiology Letters* **248**: 75-81.
- Andrew, J.W., Jonathan, D., Andrew, R., Lei, S., Katsaridou, N. N., Mikhail, S. and Rodionov A.D. 2007. Living without Fur: the subtlety and complexity of iron-responsive gene regulation in the symbiotic bacterium *Rhizobium* and other  $\alpha$ -proteobacteria. *Biometals* **20**: 501-511.
- Anonim. 2010. Setelah ditambang lahan pasir besi lebih subur. Dinas Perindustrian Perdagangan dan Energi Sumber Daya mineral Kabupaten Kulon Progo. ([www.disperindagesdm.kulonprogokab.go.id](http://www.disperindagesdm.kulonprogokab.go.id)). Diakses tanggal 11 Juni 2012.
- Anonim. 2012a. Evaluasi potensi dan konservasi kawasan tambang pasir besi pada jalur pantai selatan di Kabupaten Purworejo-Kebumen Jawa Tengah. (<http://km.ristek.go.id/index.php/klasifikasi/detail/20701>). Diakses tanggal 25 Juni 2012.
- Anonim. 2012b. The construction of an iron sand processing plant in Purworejo Regency. ([www.central-java.com/uploaded/pasir%20besi\\_purworejo.pdf](http://www.central-java.com/uploaded/pasir%20besi_purworejo.pdf)). Diakses tanggal 25 Juni 2012.
- Ansori, C., Sudarsono and Saefudin. 2011. Distribusi mineralogi pasir besi pada jalur pantai selatan Kebumen – Kutoarjo. *Buletin Sumber Daya Geologi* **6(2)**: 81-96.
- Arora, N.K., Khare, E., Singh, S. and Maheshwari, D.K. 2010. Effect of Al and heavy metals on enzyme of nitrogen metabolism of fast and slow growing rhizobia under explanta conditions. *World J. Microbiol. Biotechnol.* **26**: 811-816.
- Atlas, R.M. 1995. *Handbook of media for environmental microbiology*. CRC Press, Boca Raton, New York, London, Tokyo.



- Atlas, R.M. and Bartha, R. 1994. *Microbial ecology: Fundamentals and applications*. Fourth edition, Benjamin/Cummings, Addison Wesley Longman.
- Attitalla, I. H., Alhasin, A.M., Nasib, M.A., Ghazali, A.H., Zakaria, L., Jais, H.M., Balal, I.A.A. and Salleh, B. 2010. Occurance and microbiological characteristics of *Azospirillum* strains associated with leguminous and non-leguminous plants in Al Jabar Al Akhdar Eco-Region, Libya. *American-Eurasian J. Agric. & Environ. Sci.* **8**(6): 617-625.
- Baldani, J.E., N.R. Krieg, V.L.D. Baldani, A. Hartmann and J. Dobreiner. 2005. Genus II. *Azospirillum*. In: Brenner *et al.* (Eds.). *Bergey's Manual of Systematic Bacteriology* pp. 7-26, Second edition, Vol. 2, Part C, Springer.
- Bano, A. 2006. Altitudinal variation in *Azospirillum* species collected from the rhizosphere and roots of *Zea mays* (L). *Asian Journal of Plant Sciences* **5**(6): 1051-1053.
- Bashan, Y. 1999. Interactions of *Azospirillum* spp. in soils: a review. *Biol. Fertil. Soils* **29**: 246-256.
- Bashan, Y. and Holguin, G. 1997. *Azospirillum*-plant relationship: environmental and physiological advances (1990-1996). *Can. J. Microbiol.* **43**: 103-121.
- Bashan, Y., Holguin, G. and de-Bashan, L.E. 2004. *Azospirillum*-plant relationship: physiological, molecular, agricultural, and environmental advances (1997-2003). *Can. J. Microbiol.* **50**: 521-577.
- Bashan, Y., Holguin, G. and Lifshitz, R. 1993. *Isolation and characterization of plant growth-promoting rhizobacteria*. In Bashan *et al.* (Eds.). *Methods in Plant Molecular Biology and Biotechnology*. CRC Press, Inc., pp. 331-345.
- Bashan, Y., Levanony, H. and Whitmoyer, E. 1991. Root colonization of non-cereal crop plants by pleomorphic *Azospirillum brasilense* Cd. *Journal of General Microbiology* **137**: 187-196.
- Berber, I. 2004. Characterization of *Bacillus* species by numerical analysis of their SDS-PAGE protein profiles. *Journal of Cell and Molecular Biology* **3**: 33-37.
- Bergersen, F.J. 1980. *Measurement of nitrogen fixation by direct means*. In F.J. Bergersen (Ed.), *Methods for evaluating biological nitrogen fixation*. John Wiley and Sons. Inc., New York, pp. 65-110.
- Brock, T.D. and Madigan, M.T. 1988. *Biology of microorganisms*. Fifth Ed., Prentice-Hall International Edition, New Jersey, USA.
- Burdman, S., Okon, Y. and Jurkevitch, E. 2000. *Critical Reviews in Microbiology* **26**(2) : 91-110.
- Caceres, E.A.R. 1982. Improved medium for isolation of *Azospirillum* spp.. *Journal of Applied and Environmental Microbiology* **44**(4): 990-991.
- Castellanos, T., Ascencio, F. and Bashan, Y. 1998. Cell-surface lectins of *Azospirillum* spp.. *Current Microbiology* **36**: 241-244.



- Chalal, P.P.K., Chalal, V.P.S., Kaur, N.P. and Arora, C.L. 1997. Effect of iron interaction with *Rhizobium* sp. and *Meloidogyne incognita* in relation to uptake of nitrogen, iron and zinc in mungbean. *Nematol. Medit.* **25**: 37-40.
- Colwell, R.R., Wicks, T.C. and Tubiash, H.S. 1975. A comparative study of the bacterial flora of the hemolymph of *Callinectes sapidus*. *Marine Fisheries Review* **37**: 29-33.
- Chun, J. 1999. *Phylogenetic Editor (PHYDIT) Windows Version*.
- Costacurta, A. and Vanderleyden, J. 1995. Synthesis of phytohormones by plant associated bacteria. *Crit. Rev. Microbiol.* **21**: 1-18.
- Da Silva, K., Nobrega, R.S.A., Lima, A.S., Barberi, A. and Moreira, F.M.S. 2011. Density and diversity of diazotrophic bacteria isolated from Amazonian soils using N-free semi-solid media. *Scientia Agricola* **68** (5): 518-525
- de-Bashan, L.E., Hernandez, J-B., Nelson, K.N., Bashan, Y. and Maier, R.M. 2010. Growth of quailbush in acidic, metalliferous desert mine tailings: Effect of *Azospirillum brasilense* Sp6 on biomass production and rhizosphere community structure. *Microb. Ecol.* **60**: 915-927.
- Denton, B. 2007. Advances in phytoremediation of heavy metals using plant growth promoting bacteria and fungi. *MMG. 445 Basic Biotechnology* **3**: 1-5.
- Dewi, I.R. 2007. *Fiksasi N biologis pada ekosistem tropis*. Program Pasca Sarjana UNPAD, Bandung.
- Djajakirana, G., Tjahyandari, D. and Supijatno. 2009. *Reklamasi lahan bekas tambang pasir besi melalui teknik ameliorasi in situ bahan organik*. Laporan Penelitian, IPB Bogor.
- Dobereiner, J., Marriell, I.E. and Nevy, M. 1976. Ecological distribution of *Spirillum lipoferum* Beijerinck. *Canadian J. Microbiology* **22**: 1464-1473.
- Eckert, B., Weber, O.B., Kirchhof, G., Halbritter, A., Stoffels, M. and Hartmann, A. 2001. *Azospirillum doebereineriae* sp. nov., a nitrogen-fixing bacterium associated with the C4-grass *Miscanthus*. *International Journal of Systematic and Evolutionary Microbiology* **51**: 17-26.
- El-Komy, H.M.A. 2005. Coimmobilization of *Azospirillum lipoferum* and *Bacillus megaterium* for successful phosphorus and nitrogen nutrition of wheat plants. *Food Technol. Biotechnol.* **43**(1): 19-27.
- Fallik, E., Okon, Y., Epstein, E., Goldman, A. and Fischer, M. 1989. Identification and quantification of IAA and IBA in *Azospirillum brasilense* inoculated maize roots. *Soil Biology and Biochemistry* **21**: 147-153.
- Fedonenko, Y.P., Konnova, O.N., Zatonsky, G.V., Konnova, S.A., Kocharova, N.A., Zdorovenko, E.L. and Ignatov, V.V. 2005. Structure of the O-polysaccharide from the *Azospirillum lipoferum* Sp59b lipopolysaccharide. *Carbohydrate Research* **340**(6): 1259-1263.



- Figueiredo, M.V.B., L. Seldin, F.F. de Araujo, and R.L.R. Mariano. 2010. *Plant growth promoting rhizobacteria: Fundamentals and Applications* pp.21-36. In D.K. Maheshwari (Ed.). *Plant growth and health promoting bacteria. Microbiology Monographs* 18, Springer-Verlag Berlin Heidelberg.
- Frankenberger, W.F. and Arshad, M. 1995. *Phytohormones in soil*. Marcel Dekker Inc., New York.
- Fulchieri, M. and Frioni, L. 1994. *Azospirillum* inoculation on maize (*Zea mays*): The effect on yield in a field experiment in central Argentina. *Soil Biology & Biochemistry* 7: 921-923.
- Gamo, T. 1991. *Azospirillum* spp. from crop roots; A promotor of plant growth. *Journal of Agriculture* 24(4): 253-259.
- Gamo, T. and Ahn, S.B. 1991. Growth promoting *Azospirillum* spp. isolated from the root of several non-*Gramineae* crops in Japan. *Soil Science & Plant Nutrition* 37(3): 455-461.
- Ganapathy, B.A. and Savalgi, V.P. 2006. Effect of micronutrients on the performance of *Azospirillum brasilense* on the nutrient uptake, growth and yield in maize crop. *Karnataka J. Agric. Sci.* 19(1): 66-70.
- Ge, S-M., Tao, L. and Chen, S-F. 2009. Expression and functional analysis of aminotransferase involved in indole-3-acetic acid biosynthesis in *Azospirillum brasilense* Yu62. *Biochemistry (Moscow)* 74(1): 81-84.
- Gillis, M., P. Vandamme, P. De Vos, J. Swings, and K. Kersters. 2005. Polyphasic taxonomy. In Brenner *et al.* (Eds.) *Bergey's Manual of Systematic Bacteriology*, Second Edition, Volume Two, *The Proteobacteria Part A Introductory Essays*, East Lansing USA.
- Glickman, E. and Dessaux, Y. 1995. A critical evaluation of the specificity of Salkowski reagent for indole compounds produced by phytopathogenic bacteria. *Appl. Environ. Microbiol.* 61: 793-796.
- Goebel, E.M. and Krieg, N.R. 1984. Fructose catabolism in *Azospirillum brasilense* and *Azospirillum lipoferum*. *J. Bacteriol.* 159: 86-92.
- Gonzalez-Lopez, J., Salmeron, V., Martinez-Toledo, M.V., Ballesteros, F. and Ramos-Cormenzana, A. 1986. Production of auxins, gibberellins and cytokinins by *Azotobacter vinelandii* ATCC 12837 in chemically-defined media and dialysed soil media. *Soil Biology & Biochemistry* 18(1): 119-120.
- Goodfellow, M. and A.G. O'Donnel. 1993. *The roots of bacterial systematics*. In Goodfellow & O'Donnel (Eds.) *Handbook of New Bacterial Systematics*, Academic Press Ltd, London.
- Harari, A., Kigel, J. and Okon, Y. 1988. Involvement of IAA in the interactions between *Azospirillum brasilense* and *Panicum miliacum* roots. *Plant and Soil* 110: 275-282.
- Hartmann, A. 1988. Ecophysiological aspects of growth and nitrogen fixation in *Azospirillum* spp.. *Plant and Soil.* 110: 225-238.
- Hartmann, A. and J.I. Baldani. 2006. *The genus Azospirillum* pp. 115-140. In Dworkin *et al.* (Eds.) *The Prokaryotes: A handbook on the biology of bacteria*. Springer, Singapore.



- Hartmann, A., Fu, H.-A. and Burris, R.H. 1986. Regulation of nitrogenase activity by ammonium chloride in *Azospirillum* spp.. *J. Bacteriol.* **165**: 864–870.
- \_\_\_\_\_. 1988. Influence of amino acids on nitrogen fixation activity and growth of *Azospirillum* spp.. *Appl. Environ. Microbiol.* **54**: 87-93.
- Hartmann, A., Singh, M. and Klingmuller, W. 1983. Isolation and characterization of *Azospirillum* mutants excreting high amounts of indoleacetic acid. *Can. J. Microbiol.* **29**: 916-923.
- Henri, F., Laurette, N.N., Annette, D., John, Q., Wolfgang, M., Francois-Xavier, E. and Dieudonne, N. 2008. Solubilization of inorganic phosphates and plant growth promotion by strains of *Pseudomonas fluorescens* isolated from acidic soils of Cameroon. *African J. Microbiol. Res.* **2**: 171-178.
- Hince, E.C. and Robbins, E.I. 2009. Probing an underground acid-mine drainage ecosystem. ([www.geotimes.org/dec03/feature\\_AMD.html](http://www.geotimes.org/dec03/feature_AMD.html)). Diakses 10 Juni 2012.
- Holt, J.D., Krieg, N.R., Sneath, P.H.A., Staley, J.T. and Williams, S.T. 2000. *Bergey's Manual of Determinative Bacteriology*, 9<sup>th</sup> Edition, Lippincott Williams & Wilkins, Philadelphia.
- Horeman, S. and K. Vlassak. 1985. *Production of indol-3-acetic acid by Azospirillum brasilense*. In W. Klingmuller (Ed.), *Azospirillum III: genetics, physiology, ecology*, Springer-Verlag, Berlin.
- Ilyas, N., Bano, A., Iqbal, S. and Raja, N.I. 2012. Physiological, biochemical and molecular characterization of *Azospirillum* spp. isolated from maize under water stress. *Pak. J. Bot.* **44**: 71-80.
- Jain, D.K. and Patriquin, D.G. 1985. Characterization of a substance produced by *Azospirillum* which causes branching of wheat root hairs. *Canadian Journal of Microbiology* **31**: 206-210.
- Janda, J.M. and Abbott, S.L. 2007. 16S rRNA gene sequencing for bacterial identification in the diagnostic laboratory: pluses, perils, and pitfalls. *Journal of Clinical Microbiology* **45**(9): 2761-2764.
- Jolly, S.N., Shanta, N.A. and Khan, Z.U.M. 2010. Quantification of heterotrophic bacteria and *Azospirillum* from the rhizosphere of Taro (*Colocasia esculenta* L. Schott) and the nitrogen fixing potential of isolated *Azospirillum*. *International Journal of Botany* **6**(2): 117-121.
- Kamicker, B.J. and Brill, W.J. 1986. Identification of *Bradyrhizobium japonicum* nodule isolates from Winconsin Soybean Farms. *Appl. Environ. Microbiol.* **51**(3): 487-492.
- Kanimozhi, K. and Panneerselvam, A. 2010a. Studies on isolation and nitrogen fixation ability of *Azospirillum* spp. isolated from Thanjavur district. *Der Chemica Sinica* **1**(3): 138-145.
- \_\_\_\_\_. 2010b. Studies on molecular characterization of *Azospirillum* spp. isolated from Thanjavur district. *International Journal of Applied Biology and Pharmaceutical Technology* **1**(3): 1209-1219.



- \_\_\_\_\_ . 2011. Investigation of soil characters and *Azospirillum* isolated from paddy soils of Thanjavur district, East Coast of Tamilnadu, India. *Arch. Appl. Sci. Res.* **3**(2): 525-536.
- Kapulnik, Y., Sarig, S., Nur, I. and Henis, Y. 1981. Effect of temperature, nitrogen fertilization, and plant age on nitrogen fixation by *Setaria italica* inoculated with *Azospirillum brasilense* (strain Cd). *Applied and Environmental Microbiology* **51**: 1116-1124.
- Karti, P.D.M.H. 2005. Penggunaan *Azospirillum* pada tanah masam dengan aluminium tinggi terhadap produksi dan serapan nitrogen rumput *Setaria splendida* dan *Chloris gayana*. *Media Peternakan* **28**(1): 37-45.
- Khan, A.A., Jilani, G., Akhtar, M.S., Naqvi, S.M.S. and Rasheed, M. 2009. Phosphorus solubilizing bacteria: occurrence, mechanisms and their role in crop production. *J. Agric. Biol. Sci* **1**(1): 48-58.
- Khan, M.S., Zaidi, A. and Wani, P.A. 2007. Role of phosphate-solubilizing microorganisms in sustainable agriculture – a review. *Agron. Sustain. Dev.* **27**: 29-43.
- Kim, K-Y., Jordan, D. and McDonald, G.A. 1998. Effect of phosphate-solubilizing bacteria and vesicular-arbuscular mycorrhizae on tomato growth and soil microbial activity. *Biol. Fert. Soils* **26**: 79-87.
- Kovach, W.L. 1999. *MVSP – a multivariate statistical package for windows, version 3.1*. Kovach Computing Services. Wales, UK.
- Kunia, K. 2008. *Menyelamatkan Mikroorganisme Indonesia*. Biotechnology Research Center ITB, Bandung.
- Lavrinenko, K., Chemousova, E., Gridneva, E., Dubinina, G., Akimov, V., Kuever, J., Lysenko, A. and Grabovich, M. 2010. *Azospirillum thiophilum* sp. nov., a diazotrophic bacterium isolated from a sulfide spring. *International Journal of Systematic and Evolutionary Microbiology* **60**(12): 2832-2837.
- Lee, W.K., Lee, J.Y., Kang, K.Y. and Cho, M.J. 1988. Synthetic pathway of indole acetic acid in *Azospirillum lipoferum*. *Korean Biochem. J.* **21** (4): 519-524.
- Lengeler, J.W., Drews, G. and Schlegel, H.G. 1999. *Biology of the prokaryotes*. Blackwell Science, New York.
- Liang, Y.Y., Arsene, F. and Elmerich, C. 1993. Characterization of the ntrBC genes of *Azospirillum brasilense* Sp7: Their involvement in the regulation of nitrogenase synthesis and activity. *Molec. Gen. Genet.* **240**: 188–196.
- Lin, S-Y., Liu, Y-C., Hameed, A., Hsu, Y-H., Lai, W-A., Shen, F-T., and Young, C-C. 2013. *Azospirillum fermentarium* sp. nov., a novel nitrogen-fixing species isolated from a fermenter in Taiwan. *International Journal of Systematic and Evolutionary Microbiology* **63**(10): 3762-3768.
- Lin, S.-Y., Young, C.C., Hupner, H., Siering, C., Arun, A.B., Chen, W-M., Lai, W-A., Shen, F-T., Rekha, P.D. and Yassin, A.F. 2009.



- Azospirillum picis* sp. nov., isolated from discarded tar. *International Journal of Systematic and Evolutionary Microbiology* **59**: 761-765.
- Lin, S.-Y., Shen, F-T., Young, L-S., Zhu, Z-L., Chen, W-M. and Young, C-C. 2011. *Azospirillum formosense* sp. nov., a novel diazotrophic bacterium isolated from agricultural soil. *International Journal of Systematic and Evolutionary Microbiology* **62**(5): 1185-90.
- Liu, T.S., Lee, L.Y., Tai, C.Y., Hung, C.H., Chang, Y.S., Wolfram, J.H., Rogers, R. and Goldstein, A.H. 1992. Cloning of an *Erwinia herbicola* gene necessary for gluconic acid production and enhanced mineral phosphate solubilization in *Escherichia coli* HB101: Nucleotide sequence and probable involvement in biosynthesis of the co-enzyme pyrroloquinoline quinone. *J. Bacteriology* **174**: 5814-5819.
- Liu, Z-H., W-S. Chen, and C-H. Chou. 2009. *Roles of plant growth regulating substances*. In O.O.P. Hanninen and M. Atalay (Eds.) *Physiology and Maintenance* Vol. V, Eolss, Paris.
- Loper, J.E. and Scroth, M.N. 1986. Influence of bacterial sources on indole-3 acetic acid on root elongation of sugarbeet. *Phytopathology* **76**: 386-389.
- Lu, Z., An, X. and Zhang, W. 2011. Isolation and phylogenetic analysis of chromium (VI) reducing bacteria of a magnetite mine drainage from Hebei China. *Modern Applied Science* **5**(2): 113-118.
- Massoud, F.I. 1975. Physical properties of sandy soils in relation to cropping and soil conservation practices. In Sandy soil, Report of FAO/UNDP Seminar on Reclamation and Management of Sandy Soils in the Near East and North Africa. FAO-UNO, Rome, pp. 47-72.
- Matthew, C.J., Bjorkman, M.K., David, M.K., Saito, A.M. and Zehr, P.J. 2008. Regional distributions of nitrogen-fixing bacteria in the Pacific Ocean. *Limnol. Oceanogr.* **53**: 63-77.
- Mehnaz, S., Wesellowski, B. and Lazarovites, G. 2007a. *Azospirillum canadense* sp. nov., a nitrogen-fixing bacterium isolated from corn rhizosphere. *International Journal of Systematic and Evolutionary Microbiology* **57**: 620-624.
- \_\_\_\_\_. 2007b. *Azospirillum zeae* sp. nov., a diazotrophic bacterium isolated from rhizosphere soil of *Zea mays*. *International Journal of Systematic and Evolutionary Microbiology* **57**: 2805-2809.
- Mikhailouskaya, N. 2006. The effect of flax seed inoculation by *Azospirillum brasilense* on flax yield and its quality. *Plant and Soil* **52**(9): 402-406.
- Moghaddam, M.J.M., Emtiazi, G. and Salehi, Z. 2012. Enhanced auxin production by *Azospirillum* pure cultures from plant root exudates. *J. Agr. Sci. Tech.* **14**: 985-994.
- Mohite, B. 2013. Isolation and characterization of indole acetic acid (IAA) producing bacteria from rhizospheric soil and its effect on plant growth. *Journal of Soil Science and Plant Nutrition* **13**(3): 638-649.
- Mora, R.R. and Amann, R. 2001. The species concept for prokaryotes. *FEMS Microbiology Rev.* **25**: 39-67.



- Muthezhilan, R., Sindhuja, B.S., Hussain, A.J. and Jayaprakashvel, M. 2012. Efficiency of plant growth promoting rhizobacteria isolated from sand dunes of Chennai coastal area. *Pakistan Journal of Biological Science* **15**(16): 795-799.
- Nghia, N.H. and Gyurjan. 1987. Problems and perspectives in establishment of nitrogen-fixing symbioses and endosymbioses. *Endocyt. C. Res.* **4**: 131-141.
- Nguyen, C., Yan, W., Le-Tacon, F. and Lapeyrie, F. 1992. Genetic variability of phosphate solubilizing activity by monocaryotic and dicaryotic mycelia of the ectomycorrhizal fungus *Laccaria bicolor* (Maire) P.D. Orton. *Plant and Soil* **143**: 193-199.
- Nigam, A. And Ayyagari, A. 2007. *Lab manual in biochemistry, immunology and biotechnology*, Tata McGraw-Hill, New Delhi.
- Oedjijono., Widodo, L.U., Ryandini, D. dan Prayogo, L. 1996. Isolasi *Azospirillum* dan uji kemampuannya dalam meningkatkan pertumbuhan tanaman jagung (*Zea mays* L.). *Biosfera* **5**: 9-18.
- O'Hara, G.W. 2001. Nutritional constraint on root nodule bacteria affecting symbiotic nitrogen fixation: a review, *Aust. J. Exp. Agric.* **41**: 417-433.
- Okmen, G., Donmez, G. and Donmez, S. 2007. Influence of osmotic and metal stresses on nitrogenase activity of cyanobacteria isolated from paddy fields. *African Journal of Biotechnology* **6**(15): 1828-1832.
- Okon, Y., Albrecht, S.L. and Burris, R.H. 1976. Factors affecting growth and nitrogen fixation of *Spirillum lipoferum*. *Journal of Bacteriology* **127**(3): 1248-1254.
- Okon, Y.L. and Kapulnik, Y. 1986. Development and function of *Azospirillum* inoculated roots. *Plant and Soil* **90**: 303-304.
- Omar, S.A. 1998. The role of rock-phosphate-solubilizing fungi and vesicular-arbuscular mycorrhiza (VAM) in growth of wheat plants fertilized with rock phosphate. *World J. Microbiol. Biotechnol.* **14**: 211-218.
- Ona, O., Smets, I., Gysegom, P., Bernaerts, K., Impe, J.V., Prinsen, E. and Vanderleyden, J. 2003. The effect of pH on indole-3-acetic acid (IAA) biosynthesis of *Azospirillum brasilense* Sp7. *Symbiosis* **35**: 199-208.
- Ona, O., Impe, J.V., Prinsen, E. and Vanderleyden, J. 2005. Growth and indole-3-acetic acid biosynthesis of *Azospirillum brasilense* Sp245 is environmentally controlled. *FEMS Microbiology Letters* **246**: 125-132.
- Oren, A. 2014. Systematics of *Archaea* and *Bacteria*. *Biological Science Fundamentals and Systematics* Vol. II. <http://www.eolss.net?Eolss-sampleAllChapter.aspx>. Diakses tanggal 29 Mei 2014.
- Partoyo. 2005. Analisis indeks kualitas tanah pertanian di lahan pasir pantai Samas Yogyakarta. *Jurnal Ilmu Pertanian* **12**(2): 140-151.
- Patten, C.L. and Glick, B.R. 2002. Regulation of indoleacetic acid production in *Pseudomonas putida* GR12-2 by tryptophan and the stationary-phase sigma faktor RpoS. *Can. J. Microbiol.* **48**: 635-642.
- Paudyal, S.P., Aryal, R.R., Chauchan S.V.S. and Maheshwari, D.K. 2007. Effect of heavy metals on growth of *Rhizobium* strains and symbiotic efficiency of two species of tropical legumes. *Sci. World* **5**: 27-32.



- Peng, G., Wang, H., Zhang, G., Hou, W., Liu, Y., Wang, E.T. and Tan, Z. 2006. *Azospirillum melinis* sp. nov. A group of diazotrophs isolated from tropical molasses grass. *International Journal of Systematic and Evolutionary Microbiology* **56**: 1263-1271.
- Perrig, D., Boiero, M.L., Masciarelli, O.A., Penna, C., Ruiz, O.A., Cassan, F.D. and Luna, M.V. 2007. Plant-growth-promoting compounds produced by two agronomically important strains of *Azospirillum brasilense*, and implications for inoculant formulation. *Appl. Microbiol. Biotechnol.* **75**(5): 1143-1150.
- Petti, C.A., Polage, C.R. and Schreckenberger, P. 2005. The role of 16S rRNA gene sequencing in identification of microorganisms misidentified by conventional methods. *Journal of Clinical Microbiology* **43**(12): 6123-6125.
- Pinton, R., Varanini, Z., and Nannipieri, P. 2001. *The rhizosphere as a site of biochemical interactions among soil components, plants and microorganisms*. pp.1-17. In Pinton et al. (Eds.). *The Rhizosphere. Biochemistry and Organic Substances at the Soil-Plant Interface*, Marcel Dekker, New York.
- Prakash, O., Verma, M., Sharma, P., Kumar, M., Kumari, K., Singh, A., Kumari, H., Jit, S., Gupta, S.K., Khanna, M. and Lal, R. 2007. *Polyphasic approach of bacterial taxonomy*. Second edition. Chapman & Hall, London.
- Prinsen, E., Costacurta, A., Michiels, K., Vanderleyden, J. and Van-Onckelen, H. 1993. *Azospirillum brasilense* indole-3-acetic acid biosynthesis: evidence for a non-tryptophan dependent pathway. *Mol. Plant-Microb. Interact.* **6**: 609-615.
- Puente, M.L., Garcia, J.E. and Alejandro, P. 2009. Effect of the bacterial concentration of *Azospirillum brasilense* in the inoculum and its plant growth regulator compounds on crop yield of corn (*Zea mays* L.) in the field. *World Journal of Agricultural Sciences* **5**(5): 604-608.
- Purwowidodo. 1992. *Metode selidik tanah*. Usaha Nasional, Jakarta.
- Qaisrani, M.M., Mirza, M.S., Zaheer, A. and Malik, K.A. 2014. Isolation and identification by 16S rRNA sequence analysis of *Achromobacter*, *Azospirillum* and *Rhodococcus* strains from the rhizosphere of maize and screening for the beneficial effect on plant growth. *Pak. J. Agric. Sci.* **51**(1): 91-99.
- Quiviger, B., Franche, C., Lutfalla, G., Rice, D., Haselkorn, R. and Elmerich, C. 1982. Cloning of a nitrogen fixation (nif) gene cluster of *Azospirillum brasilense*. *Biochimie* **64**: 495-502.
- Ramachandran, K., V. Srinivasan, S. Hamza and M. Anandaraj. 2007. Phosphate solubilizing bacteria isolated from the rhizosphere soil and its growth promotion on black pepper (*Piper nigrum* L.) cuttings. In Velazquez and Rodriguez-Barrueco (Eds.) *First international Meeting on Microbial Phosphate Solubilization*: 325-331.
- Rao, N.S. 1982. *Biofertilizer in agriculture*. Oxford and IBH Publishing Co., New Delhi, Bombay, Calcuta.



- Ravikumar, S., G. Ramanathan, N. Suba and L. Jeyaseeli. 2002. Quantification of halophilic *Azospirillum* from mangroves. *Indian Journal of Marine Sciences* **31**(2): 157-160.
- Reece, J.B., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V. and Jackson, R.B. 2011. *Campbell Biology*. Ninth Edition, Pearson Education, Inc., San Fransisco, USA.
- Reinhold, B., Hurek, T., Fendrik, I., Pot, B., Gillis, M., Kersters, K., Thielemans, S. and Ley, J.D. 1987. *Azospirillum halopraeferens* sp. nov., a nitrogen-fixing organism associated with roots of Kallar grass (*Leptochloa fusca* (L.) Kunth). *International Journal of Systematic Bacteriology* **37**(1): 43-51.
- Reinhold, B., Hurek, T., Niemann, E-G. and Fendrik, I. 1986. Close association of *Azospirillum* and diazotrophic different root zones of Kallar grass. *Applied and Environmental Microbiology* **52**(3): 520-526.
- Rodriguez, H., Gonzalez, T. and Bashan, Y. 2004. Gluconic acid production and phosphate solubilization by the plant growth-promoting bacterium *Azospirillum* spp.. *Naturwissenschaften* **91**(11): 552-555.
- Rodriguez, H. and Fraga, R. 1999. Phosphate solubilizing bacteria and their role in plant growth promotion. *Biotechnology Advances* **17**: 319-339.
- Rusmana, I. and Hadijaya, D.D. 1994. Aktivitas nitrogenase *Azospirillum* sp. dan efektivitas simbiotiknya dengan jagung. *Hayati* **1**(2): 51-54.
- Saharan, B.S. and Nehra, V. 2011. Plant growth promoting rhizobacteria: A critical review. *Life Sciences and Medicine Research*, **2011**: 1-30.
- Saitou, N. and Nei, M. 1987. The neighbour-joining method: A new method for reconstructing phylogenetic tree. *Molecular Biology and Evolution* **4**: 406-425.
- Salisbury, W.F. and Ross, C.W. 1995. *Fisiologi Tumbuhan III*. Penerbit ITB, Bandung.
- Samekto, R. 2008. Bioteknologi dan keharaan tanaman (mikroorganisme, nitrogen dan fosfor). *J. Inov. Pertan.* **7**: 66-85.
- Santa, O.R.D., Hernandez, R.F., Alvarez, G.L.M., Junior, P.R. and Soccol, C.R. 2004. *Azospirillum* sp. inoculation in wheat, barley and oats seeds greenhouse experiments. *Brazilian Archives of Biology and Technology* **47**(6): 843-850.
- Saparso, S. Harsono, and Tohari. 2003. Pengembangan tanaman kubis lahan pasir pantai: Pertumbuhan tanaman pada berbagai kombinasi mulsa dan cara pemupukan nitrogen. *Agrin* **7**(2): 60-73.
- Saxena, R.K. 2006. Iron induced metabolic changes in the diazotrophic cyanobacterium *Anabaena* PCC 7120. *Indian Journal of Experimental Biology* **44**: 849-851.
- Schleifer, K.H. 2009. Classification of *Bacteria* and *Archaea*: past, present and future. *Systematic and Applied Microbiology* **32**: 533-542.
- Schleifer, K.H. and Stackebrandt, E. 1983. Molecular systematics of prokaryotes, *Ann. Rev. Microbiol. Physiol.* **13**: 143-187.



- Sembiring, L. 2002. *Sistematika mikrobial* (BIO 668). Petunjuk Praktikum, Laboratorium Mikrobiologi Fakultas Biologi UGM.
- Seshadri, S., Muthukumarasamy, R., Lakshminarasimhan, C. and Ignacimuthu, S. 2000. Solubilization of inorganic phosphates by *Azospirillum halopraeferans*. *Current Science* **79**(5): 565-567.
- Shridhar, B.S. 2012. Review: Nitrogen fixing microorganisms. *International Journal of Microbiological Research* **3**(1): 46-52.
- Siddiqui, Z.A. 2010. PGPR: *Prospective biocontrol agents of plant pathogens*. In Siddiqui (Ed.) PGPR: Biocontrol and biofertilization. Springer, Netherlands.
- Singh, S. and Kapoor, K.K. 1994. Solubilization of insoluble phosphate by bacteria isolated from different sources. *Environ. Ecol.* **12**: 51-55.
- Slater, J. and Capone, D.G. 1984. Effects of metals on nitrogen fixation and denitrification in slurries of anoxic saltmarsh sediment. *Mar. Ecol. Prog. Ser.* **18**: 89-95.
- Sneath, P.H.A. 2005. *Numerical taxonomy*. In Brenner et al. (Eds). *Bergey's Manual of Systematic Bacteriology*, Second Edition, Volume Two, The *Proteobacteria Part A Introductory Essays*, East Lansing USA.
- Spaepen, S. and Vanderleyden, J. 2011. Auxin and plant-microbe interactions. *Cold Spring Harb Perspect Biol* **2011**, **3**: a001438.
- Spaepen, V.W., Vanderleyden, J. and Steyaert, J. 2007. The crystal structure of phenylpyruvate decarboxylase from *Azospirillum brasilense* at 1.5 Å resolution. Implication for its catalytic and regulatory mechanism. *FEBS J.* **274**: 2363-2375.
- Spaepen, S., Vanderleyden, J. and Remans, R. 2007. Indole-3-acetic acid in microbial and microorganism-plant signaling. *FEMS Microbiol. Rev.* **31**: 425-448.
- Steenhoudt, O. and Vanderleyden, J. 2006. *Azospirillum*, a free-living nitrogen-fixing bacterium closely associated with grasses: genetic, biochemical and ecological aspects. *FEMS Microbiol. Rev.* **24**: 487-506.
- Sulaeman, Suparto and Eviati. 2005. *Petunjuk Teknis Analisis kimia tanah, tanaman, air, dan pupuk*. Balai Penelitian Tanah, Badan Penelitian dan Pengembangan Pertanian Departemen Pertanian, Bogor.
- Suliasih and Widawati, S. 2005. Isolation and identification of phosphate solubilizing and nitrogen fixing bacteria from soil in Wamena Biological Garden, Jayawijaya, Papua. *Biodiversitas* **6**(5): 175-177.
- Sumarni, S. 2006. *Penggunaan pasir besi dan barit untuk beton berat sebagai perisai radiasi sinar gamma*, Tesis, Sekolah pascasarjana Jurusan Teknik Sipil Fakultas Teknik UGM, Yogyakarta.
- Sutedjo, M.M. 1990. *Analisis tanah, air dan jaringan tanaman*. Rineka Cipta, Jakarta.
- Swedrzynska, D. and Niewiadomska, A. 2011. Effect of zinc and iron supply and inoculation with *Azospirillum* on growth of maize and wheat seedlings. *Archives of Environmental Protection* **37**(2): 49-59.



- Syarifudin, A. 2002. Teknik identifikasi mikroorganisme penyedia unsur hara tanaman pada ultisols pulau Buru. *Buletin Teknik Pertanian* **7**(1): 21-23.
- Sylvia, D.M., Fuhrmann, J.J., Hartel, P.G. and Zuberer, D.A. 1999. *Principles and applications of soil microbiology*. Prentice Hall Inc., Upper Saddle River, New Jersey.
- Syukur, A. and Harsono, E.S. 2008. Pengaruh pemberian pupuk kandang dan NPK terhadap beberapa sifat kimia dan fisika tanah pasir pantai Samas Bantul. *Jurnal Ilmu Tanah dan Lingkungan* **8**(2): 138-145.
- Tabary, F., Balandreau, J. and Bourrillon, R. 1984. Purification of the rice embryo lectin and its binding to nitrogen-fixing bacteria from rhizosphere of rice. *Biochem. Biophys. Res. Communication* **119**: 549-555.
- Tahir, M., Mirza, M.S., Zaheer, A., Dimitrov, M.R., Smidt, H. and Hameed, S. 2013. Isolation and identification of phosphate solubilizer *Azospirillum*, *Bacillus* and *Enterobacter* strains by 16S rRNA sequence analysis and their effect on growth of wheat (*Triticum aestivum* L.). *Australian Journal of Crop Science* **7**(9): 1284-1292.
- Tamura, K., Stecher, G., Peterson, D., Filipski, A. and Kumar, S. 2013. MEGA6: Molecular Evolutionary Genetics Analysis version 6.0. *Molecular Biology and Evolution* **30**: 2725-2729.
- Tarrand, J.J., Krieg, N.R. and Dobereiner, J. 1978. A taxonomic study of *Spirillum lipoferum* group, with description of a new genus *Azospirillum* gen. nov. and two species *Azospirillum lipoferum* (Beijerinck) comb. nov. and *Azospirillum brasilense* sp. nov.. *Can. J. Microbiol.* **24**(8): 967-980.
- Tejera, N., Lluch, C., Martinez-Toledo, M.V. and Gonzalez-Lopez, J. 2005. Isolation and characterization of *Azotobacter* and *Azospirillum* strains from the sugarcane rhizospheres. *Plant and Soil* **270**: 223-232.
- Tien, T.M., Gaskins, M.H. and Hubbell, D.H. 1979. Plant growth substances produced by *Azospirillum brasilense* and their effect on the growth of pearl millet (*Pennisetum americanum* L.). *Applied and Environmental Microbiology* **37**(5): 1016-1024.
- Tilak, K.V.B.R., Pal, K.K. and Dey, R. 2010. *Microbes for sustainable agriculture*. I.K. International Publishing House Pvt. Ltd., New Delhi, India.
- Truper, H.G. and K-H. Schleifer. 2006. *Prokaryote characterization and identification*. pp. 58-79. In: Dworkin et al. (Eds.). *The Prokaryotes: A Handbook on the Biology of Bacteria* 3rd Edition, Vol. 1. Springer Science+Business Media, Inc., Singapore.
- Tyagi, S. and Singh, D.K. 2014. *Azospirillum himalayense* sp. nov., a *nifH* bacterium isolated from Himalayan valley soil, India. *Ann. Microbiol.* **64**: 259-266.
- Umali-Garcia, M., Hubbel, D.H., Gaskins, M.H. and Dazzo, F.B. 1980. Association of *Azospirillum* with grass roots. *Applied and Environmental Microbiology* **37**: 219-226.



- Usha, D.K. and Kanimozhi, K. 2011. Isolation and characterization of saline tolerant *Azospirillum* strains from paddy field of Thanjavur district. *Adv. Appl. Sci. Res.* **2**(3): 239-245.
- Vandamme, P., Pot, B., Gillis, M., Vos, P.D., Kersters, K. and Swings, J. 1996. Polyphasic taxonomy, a consensus approach to bacterial systematics. *Microbiological Reviews* **60**(2): 407-438.
- Vande-Broek, A., Gysegom, P., Ona, O., Hendriks, N., Prinsen, E., Van Impe, J. and Vanderleyden, J. 2005. Transcriptional analysis of the *Azospirillum brasilense* indole-3-pyruvate decarboxylase gene and identification of a cis-acting sequence involved in auxin responsive expression. *Mol. Plant-Microbe Interact.* **18**: 311-323.
- Vande-Broek, A., Lambrecht, M., Eggermont, K. and Vanderleyden, J. 1999. Auxins upregulate expression of the indole-3-pyruvate decarboxylase gene from *Azospirillum brasilense*. *J. Bacteriol.* **181**: 1338-1342.
- Vasquez, P., Holguin, G., Puente, M., Cortes, A.E. and Bashan, Y. 2000. Phosphate solubilizing microorganisms associated with the rhizosphere of mangroves in a semi arid coastal lagoon. *Biol. Fert. Soils* **30**: 460-468.
- Venieraki, A., Dimou, M., Vezyri, E., Kefalogianni, I., Argyris, N., Liara, G., Pergalis, P., Chatzipavlidis, I. and Katinakis, P. 2011. Characterization of nitrogen-fixing bacteria isolated from field-grown barley, oat, and wheat. *The Journal of Microbiology* **49**(4): 525-534.
- Verplancke, H.J.W. 1992. Managing water in stress environment. In H.J.W. Verplancke, E.B.A., De Strooper and M.F.L. De Boodt (Eds.). *Water saving techniques for plant growth*. Kluwer Academic Publisher. Dordrecht, Netherlands.
- Weisany, W., Raeli, Y. and Allahverdipoor, K.H. 2013. Role of some mineral nutrients in biological fixation. *Bulletin of Environment, Pharmacology and Life Sciences* **2**(4): 77-84.
- Widawati, S. and Muharam, A. 2012. Uji laboratorium *Azospirillum* sp. yang diisolasi dari beberapa ekosistem. *Jurnal Hortikultur* **22**(3): 258-267.
- Widi, B.N. 2005. Penyelidikan endapan pasir besi di daerah pesisir selatan Ende-Flores Propinsi Nusa Tenggara Timur. Laporan Hasil Penyelidikan PT. Ever Mining.
- Woese, C.R. 1987. Bacterial evolution. *Microbiol Rev.* **51**: 221-272.
- Woo, P.C.Y., Lau, S.K.P., Teng, J.L.L., Tsei, H. and Yuen, K-Y. 2008. Then and now: use of 16S rDNA gene sequencing for bacterial identification and discovery of novel bacteria in clinical microbiology laboratories. *Clin. Microbiol. Infect.* **14**(10): 908-934.
- Xie, C-H. and Yokota, A. 2005. *Azospirillum oryzae* sp.nov., a nitrogen-fixing bacterium isolated from the roots of the rice plant *Oryza sativa*. *International Journal of Systematic and Evolutionary Microbiology* **55**: 1435-1438.
- Yaqoob, A., Farooq, N., Sajid, I. and Ali, B. 2013. Auxin production by *Azospirillum*: role in growth promotion of *Triticum aestivum* L. and



- Lens culinaris* Medik. *Global Journal of Scientific Researches* **1**(1): 26-32.
- Yasir, I.Z. 2011. Eksplorasi pasir besi pantai Adipala Cilacap Jawa Tengah. <http://tri-online.biz/eksplorasi-pasir-besi-pantai-adipala-cilacap-jawa-tengah/>. Diakses tanggal 25 Juni 2012.
- Young, C.C., Hupfer, H., Siering, C., Ho, M-J., Arun, A.B., Lai, W-A., Rekha, P.D., Shen, F-T., Hung, M-H., Chen, W-M., and Yassin, A.F. 2008. *Azospirillum rugosum* sp.nov., isolated from oil-contaminated soil. *International Journal of Systematic and Evolutionary Microbiology* **58**: 959-963.
- Yuwono, N. 2009. Membangun kesuburan tanah di lahan marginal. *Jurnal Ilmu Tanah dan Lingkungan* **9**(2): 137-141.
- Zakharova, E.A., Iosipenko, A.D., and Ignatov, V.V. 2000. Effect of water-soluble vitamins on the production of indole-3-acetic acid by *Azospirillum brasilense*. *Microbiol. Res.* **155**: 209-214.
- Zhou, S., Han, L., Wang, Y., Yang, G., Zhuang, L., and Hu, P. 2013. *Azospirillum humicireducens* sp. nov., a nitrogen-fixing bacterium isolated from a microbial fuel cell. *International Journal of Systematic and Evolutionary Microbiology* **63**(7): 2618-2624.
- Zhou, Y., Wei, W., Wang, X., Xu, L. and Lai, R. 2009. *Azospirillum palatum* sp. nov., isolated from forest soil in Zhejiang province, China, *J. Gen. Appl. Microbiol.* **55**: 1-7.