

## DAFTAR PUSTAKA

- Adrees, M., Ali, S., Rizwan, M., Zia-ur-Rehman, M., Ibrahim, M., Abbas, F., Farid, M., Qayyum, M. F., and KashifIrshad, M. 2015. Mechanisms of silicon-mediated alleviation of heavy metal toxicity in plants: A review. *Ecotoxicology and Environmental Safety*. 119: 186-197.
- Al-Farraj, A. S., Al-Wabel, M. I., Al-Shahrani, T. S., El-Maghraby, S. E., and Al-Sewailem, M. A. S. 2010. Accumulation coefficient and translocation factor of heavy metals through *Rhazya stricta* grown in the mining area of Mahad AD'Dahab, Saudi Arabia. *Waste Management and the Environment*. 140 (5): 325-336.
- Anggraeni dan Sita, A. R. 2004. Pemanfaatan Pupuk Guano sebagai Alternatif Menurunkan Serapan Cd pada Tanaman Bawang Merah (*Allium cepa ascalonicum* L.). *Disertasi*. Universitas Gadjah Mada.
- Badan Penelitian dan Pengembangan Pertanian. 2015. Kab. Bantul. Provinsi Yogyakarta. [online] di [katam.litbang.pertanian.go.id](http://katam.litbang.pertanian.go.id), diakses pada tanggal 21 November 2017.
- Baryla A., Carrier P., Franck F., Coulomb C., Sahut, C., and Havaux, M. 2001. Leaf chlorosis in oilseed rape plants (*Brassica napus*) grown on cadmium-polluted soil: causes and consequences for photosynthesis and growth. *Planta*. 212: 696-709.
- Beauchamp, C. and Fridovich, I. 1971. Superoxide dismutase: improved assays and an assay applicable to acrylamide gels. *Anal. Biochem*. 44: 276-287.
- Benavides, M. P., Gallego, S. M., and Tomaro, M. L. 2005. Cadmium toxicity in plants. *Braz. J. Plant Physiol*. 17 (1): 21-34.
- Bi, Y., Chen, W., Zhang, W., Zhou, Q., Yun, L., and Xing, D. 2009. Production of reactive oxygen species, impairment of photosynthetic function and dynamic changes in mitochondria are early events in cadmium induced cell death in *Arabidopsis thaliana*. *Bio. Cell*. 101 (11): 629-643.
- Chaneva, G., Parvanova, P., Tzvetkova, N., and Uzunova, A. 2010. Photosynthetic response of maize plants against cadmium and paraquat impact. *Water Air Soil Pollut*. 208: 287-293.
- Chen, X., Wangi, J., Shi, Y., Zhao, M. Q., and Chi, G. Y. 2011. Effects of cadmium on growth and photosynthetic activities in pakchoi and mustard. *Botanical Studies*. 52: 41-46.

- Cuong, T. X., Ullah, H., Datta, A., and Hanh, T. C. 2017. Effects of silicon-based fertilizer on growth, yield and nutrient uptake of rice in tropical zone of Vietnam. *Rice Science*. 24(5): 283-290.
- da Cunha, K. P. V. and Nascimento, C. W. 2009. Silicon effects on metal tolerance and structural changes in maize (*Zea mays* L.) grown on a cadmium and zinc enriched soil. *Water Air Soil Pollut*. 197: 323-330.
- Dai, H., Shan, C., Lu, C., Jia, G., Wei, A., Wenqing, S., and Yang, T. 2012. Response of antioxidant enzymes in *Populus × canescens* under cadmium stress. *Pak. J. Bot.* 44(6): 1943-1949.
- DalCorso, G., Farinati, S., and Furini, A. 2010. Regulatory networks of cadmium stress in plants. *Plant Signal Behav.* 5: 663-667.
- Dhindsa, R. S., Plumb-Dhindsa, P., and Thorpe, T. 1981. Leaf Senescence: correlated with increased levels of membrane permeability and lipid Peroxidation, and decreased levels of superoxide dismutase and catalase. *Journal of Experimental Botany*. 32 (126): 93-101.
- Ding, T. P., Zhou, J. X., Wan, D. F., Chen, Z. Y., Wang, C. Y., and Zhang, F. 2008. Silicon isotope fractionation in bamboo and its significance to the biogeochemical cycle of silicon. *Geo chimica et Cosmo chimica Acta*. 72: 1381-1395.
- Eriksson. 1989. The influence of pH, soil type, and time on adsorbtion and uptake by plants of Cd added to the soil. *Water Air Soil Pollut*. 48: 317-335.
- Fageria, V. D. 2001. Nutrient interactions in crop plants. *Journal of Plant Nutrition*. 24 (8): 1269-1290.
- Fan, X., Wen, X., Huang, F., Cai, Y., and Cai, K. 2016. Effects of silicon on morphology, ultrastructure and exudates of rice root under heavy metal stress. *Acta Physiol. Plant*. 38:197.
- Farooq, M. A., Detterbeck, A., Clemens, S., and Dietz, K. J. 2016. Silicon-induced reversibility of cadmium toxicity in rice. *Journal of Experimental Botany*. 67 (11): 3573-3585.
- Feng, J., Shi, Q., Wang, X., Wei, M., Yang, F., and Xu, H. 2010. Silicon supplementation ameliorated the inhibition of photosynthesis and nitrate metabolism by cadmium (Cd) toxicity in *Cucumis sativus* L. *Scientia Horticulturae*. 123: 521-530.
- Fleck, A. T., Nye, T., Repenning, C., Stahl, F., Zahn, M., and Schenk, M. K. 2011. Silicon enhances suberization and lignification in roots of rice (*Oryza sativa*). *Journal of Experimental Botany*. 62 (6): 2001-2011.

- Gao, L., Chang, J., Chen, R., Li, H., Lu, H., Tao, L., and Xiong, J. 2016. Comparison on cellular mechanisms of iron and cadmium accumulation in rice: Prospects for cultivating Fe-rich but Cd-free rice. *Rice*. 9:39.
- Gill, S.S. and Tuteja, N. 2010. Reactive oxygen species and antioxidant machinery in abiotic stress tolerance in crop plants. *Plant Physiology and Biochemistry*. 48: 909-930.
- Godt, J., Scheidig, F., Grosse-Siestrup, C., Esche, V., Brandenburg, P., Reich, A., and Groneberg, D. A. 2006. The toxicity of cadmium and resulting hazards for human health. *Journal of Occupational Medicine and Toxicology*. 1(22): 1-6.
- Gogorcena, Y., Larbi, A., Andaluz, S., Carpena, R. O. A. Abadía, and Abadía, J. 2011. Effects of cadmium on cork oak (*quercus suber* l.) plants grown in hydroponic. *Tree Physiology*. 31: 1401-1412.
- Guo, Q., Meng, L., Zhang, Y., Mao, P., Tian, X., Li, S., and Zhang, L. 2017. Antioxidative systems, metal ion homeostasis and cadmium distribution in *Iris lactea* exposed to cadmium stress. *Ecotoxicology and Environmental Safety*. 139: 50-55.
- Hammami, S. S., Chaffai, R., and El Ferjani, E. 2004. Effect of cadmium on sunflower growth, leaf pigment and photosynthetic enzymes. *Pakistan Journal of Biological science*. 7 (8): 1419-1426.
- Hatch, D. J., Jones, L. H. P. and Burau, R. G. 1988. The effect of pH on the uptake of cadmium by four plant species grown in flowing solution culture. *Plant and Soil*. 105: 121-126.
- Hattab, S., Dridi, B., Chouba, L., Kheder, M. B., and Bousetta, H. 2009. Photosynthesis and growth responses of pea *Pisum sativum* L. under heavy metals stress. *Journal of Environmental Sciences*. 21: 1552-1556.
- Heath, R. L. and Packer, L. 1968. Photoperoxidation in isolated chloroplast. I. Kinetics and stoichiometry of fatty acid peroxidation. *Arch Biochem Biophys*. 125: 189-198.
- He'diji, H., W. Djebali, C. Cabasson, M. Maucourt, P. Baldet, A. Bertrand, L. B. Zoghalmi, C. Deborde, A. Moing, R. Brouquisse, W. Chaibi, and P. Gallusci. 2010. Effects of long-term cadmium exposure on growth and metabolomic profile of tomato plants. *Ecotoxicology and Environmental Safety*. 73: 1965-1974.
- Hogendorp, B., Cloyd, R., and Swiader, J. 2012. Determination of Silicon Concentration in Some Horticultural Plants. *Hort Science*. 47(11): 1593-1595.

- Hose, E., Clarkson, D. T., Steudle, E., Schreiber, L., and Hartung, W. 2001. The exodermis: a variable appoplastic barrier. *Journal of Experimental Botany*. 52 (365): 2245-2264.
- Hossain, M. T., Mori, R., Soga, K., Wakabayashi, K., Kamisaka, S., Fujii, S., Yamamoto, R., and Hoson, T. 2002. Growth promotion and an increase in cell wall extensibility by silicon in rice and some other Poaceae seedlings. *J. Plant Res.* 115: 23-27.
- Hossain, M. A., Piyatida, P., da Silva, J. A., and Fujita, M. 2012. Molecular mechanism of heavy metal toxicity and tolerance in plants: central role of glutathione in detoxification of reactive oxygen species and methylglyoxal and in heavy metal chelation. *Journal of Botany*. 1-37.
- Huang, C. F., Yamaji, N., Ono, K., and Ma, J. F. 2012. A leucine-rich repeat receptor-like kinase gene is involved in the specification of outer cell layers in rice roots. *Plant J.* 69: 565-576.
- Irfan, M., Ahmad, A. and Hayat, S. 2013. Effect of cadmium on the growth and antioxidant enzymes in two varieties of *Brassica juncea*. *Saudi Journal of Biological Sciences*. 21: 125-131.
- Jain, M., Pal, M., Gupta, P., and Gadre, R. 2007. Effect of cadmium on chlorophyll biosynthesis and enzymes of nitrogen assimilation in greening maize leaf segments: role of 2-oxoglutarate. *Indian Journal of Experimental Biology*. 45: 385-389.
- John, R., Ahmad, P., Gadgil, K., and Sharma, S. 2007. Antioxidative response of *Lemna polyrrhiza* L. to cadmium stress. *Journal of Environmental Biology*. 28(3): 583-589.
- Kristamtini dan Purwaningsih, H. 2009. Potensi Pengembangan Beras Merah sebagai Plasma Nutfah Yogyakarta. *Jurnal Litbang Pertanian*. 28(3).
- Liang, Y., J. Wong, W. C. and Wei, L. 2005. Silicon-mediated enhancement of cadmium tolerance in maize (*Zea mays* L.) grown in cadmium contaminated soil. *Chemosphere*. 58: 475-483.
- \_\_\_\_\_, Wanchun, S., Zhu, Y., and Christie, P. 2007. Mechanisms of silicon-mediated alleviation of abiotic stresses in higher plants: A review. *Environmental Pollution*. 147: 422-428.
- Lichtenthaler, H. K and AR Wellburn. 1983. Determinations of total carotenoids and chlorophylls *a* and *b* of leaf extracts in different solvents. *Biochemical Society Transactions*, 11: 591-592.

- Liu, D., Kai-qi, H., Jing-jing, M., Wei-wei, Q., Xiu-ping, W., and Shu-pan, Z. 2013. Effects of cadmium on the growth and physiological characteristics of sorghum plants. *African Journal of Biotechnology*. 10(70): 15770-15776.
- Llamas, A., Ullrich, C. I., and Sanz, A. 2000. Cd<sup>2+</sup> effects on transmembrane electrical potential difference, respiration and membrane permeability of rice (*Oryza sativa* L.) roots. *Plant and Soil*. 219 (1-2): 21-28.
- Lux, A., Martinka, M., Vaculík, M., and White, P. J, 2011. Root responses to cadmium in the rhizosphere: a review. *Journal of Experimental Botany*. 62 (1): 21-37.
- Ma, J. F. and Yamaji. 2006. Silicon uptake and accumulation in higher plants. *Trends in Plant Science*. 11 (8): 1-6.
- \_\_\_\_\_, \_\_\_\_\_ and Mitani, N. 2011. Transport of silicon from roots to panicles in plants. *Proc. Jpn. Acad., Ser B*. 87 (7): 377-385.
- Makarim, A. K. dan Suhartatik, E. 2009. *Morfologi dan Fisiologi Tanaman Padi*. Sukabumi: Balai Besar Penelitian Tanaman Padi. Pp 296-330.
- Malhotra, C., Kapoor, R., and Ganjewala, D. 2016. Alleviation of abiotic and biotic stresses in plants by silicon supplementation. *Scientia Agriculturae*. 13(2): 59-73.
- Mali, M. and Aery, N.C. 2008. Influence of silicon on growth, relative water contents and uptake of silicon, calcium and potassium in wheat grown in nutrient solution. *Journal of Plant Nutrition*. 31: 1867-1876.
- Maathuis FJ and Diatloff E. 2013. Roles and functions of plant mineral nutrients. *Methods in Molecular Biology*. 953: 1-21.
- Meena, V. D., Dotaniya, M. L., Coumar, V., Rajendiran, S., Ajay , Kundu, S., and Rao, S. 2014. A case for silicon fertilization to improve crop yields in tropical soils. *Proc. Natl. Acad. Sci., India, Sect. B, Biol. Sci*. 84(3): 505-518.
- Mitani, N., Yamaji, N., and Ma, J. F. 2009. Identification of maize silicon influx transporters. *Plant Cell Physiol*. 50 (1): 5-12.
- Miyamoto N., Steudle E., Hirasawa T., and Lafitte, R. 2001. Hydraulic conductivity of rice roots. *Journal of Experimental Botany*. 52: 1-12.
- Moldenhauer, K., Wilson, C. E., Counce, P., and Hardke, J. 2013. *Arkansas Rice Production Handbook*. Little Rock Arkansas: University of Arkansas, Division of Agriculture.

- Naeem, A, Saifullah, Ghafoor, A. and Farooq, M. 2015. Suppression of cadmium concentration in wheat grains by silicon is related to its application rate and cadmium accumulating abilities of cultivars. *J. Sci. Food and Agric.* 95(12): 2467-2472.
- Nazar, R., Iqbal, N., Masood, A. Khan, M. I. R., Syeed, S., and Khan, N. A. 2012. Khan. Cadmium toxicity in plants and role of mineral nutrients in its alleviation. *American Journal of Plant Sciences.* 3: 1476-1489.
- Niazy, M. M and Fouda, S. 2016. Reducing the Risk of Cd in Lettuce (*Lactuca sativa* L.) via Silicon Application. *Egypt. J. Soil Sci.* 56 (3): 489-501.
- Parmar, P., Kumari, N., and Sharma, V. 2013. Structural and functional alterations in photosynthetic apparatus of plants under cadmium stress. *Botanical Studies.* 54 (45): 1-6.
- Pati, S., Pal, B., Badole, S., Hazra, G. C., and Mandal, B. 2016. Effect of silicon fertilization on growth, yield, and nutrient uptake of rice. *Commun Soil Sci Plant Anal.* 47: 284-290.
- Perfus-Barbeoch, L., Leonhardt, N., Vavasseur, A., and Forestier, C. 2002. Heavy metal toxicity: cadmium permeates through calcium channels and disturbs the plant water status, *Plant Journal.* 32 (4): 539-548.
- Remans, T., Opdenakker, K., Smeets, K., Mathijsen, D., Vangronsveld, J., and Cuyper, A. 2010. Metal-specific and NADPH oxidase dependent changes in lipoxygenase and NADPH oxidase gene expression in *Arabidopsis thaliana* exposed to cadmium or excess copper. *Funct Plant Biol.* 37: 532-544.
- Roberts, Terry L. 2014. Cadmium and Phosphorous Fertilizers: The Issues and the Science. *Procedia Engineering.* 83: 52-59.
- Ross, S. M. 1994. *Toxic Metals in Soil-Plant System.* New York: John Wiley & Sons, Inc. pp 7-8.
- Rubio, M. I., Escrig, I., Martinez-Cortina, C., Lopez-Benet, F. J., and San, A. 1994. Cadmium and nickel accumulation in rice plants. Effects on mineral nutrition and possible interactions of abscisic and gibberellic acids. *Plant Growth Regulation.* 14: 151-157.
- Shao, J. F., Che, J., Yamaji, N., Shen, R. F., and Ma, J. F. 2017. Silicon reduces cadmium accumulation by suppressing expression of transporter genes involved in cadmium uptake and translocation in rice. *Journal of Experimental Botany.* 1-11.

- Sharma, S., Goloubinoff, P., and Christen, P. Heavy metal ions are potent inhibitors of protein folding. 2008. *Biochemical and Biophysical Research Communications*. 372: 341-345
- Shi, Q., Bao, Z., Zhu, Z., He, Y., Qian, Q., and Yu, J. 2005. Silicon-mediated alleviation of Mn toxicity in *Cucumis sativus* in relation to activities of superoxide dismutase and ascorbate peroxidase. *Phytochemistry*. 66: 1551-1559.
- Shi, X. Chaochun, Z., Wang, H. and Zhang, F. 2005. Effect of Si on the distribution of Cd in rice seedlings. *Plant and Soil*. 272: 53-60.
- Stańczyk, M., Gromadzińska, J., and Wąsowicz, W. 2005. Roles of reactive oxygen species and selected antioxidants in regulation of cellular metabolism. *International Journal of Occupational Medicine and Environmental Health*. 18(1): 15-26.
- Street, R.A., Kulkarni, M. G., Stirk, W.A., Southway, C., and Staden, Van. 2010. Effect of cadmium on growth and micronutrient distribution in wild garlic (*Tulbaghia violacea*). *South African Journal of Botany*. 76: 332-336.
- Supriyanti, A., Supriyanta, dan Kristamini. 2015. Karakterisasi dua puluh padi (*Oryza sativa* L.) lokal di Daerah Istimewa Yogyakarta. *Vegetalika*, 4(3): 29-41.
- Supriyanto dan Sunardi. 2009. Analisis Sebaran Logam Berat dalam Cuplikan Sedimen Sungai Gajahwong secara SSA, *Prosiding Seminar Nasional Kimia dan Pendidikan Kimia*.
- Tamas, L., Dudikova, J., Durcekova, K., Haluskova, L., Huttova, J., and Mistrik, I. 2009. Effect of cadmium and temperature on the lipoxygenase activity in barley root tip. *Protoplasma*. 235: 7-25.
- Tamás, M. J., Sharma, S. K., Ibstedt, S., Jacobson, T., and Christen, P. 2014. Heavy metals and metalloids as a cause for protein miss folding and aggregation. *Biomolecules*. 4: 252-267.
- Tang, H., Liu, Y., Gong, X., Zeng, G., Zheng, B., Wang, D., Sun, Z., Zhou, L., and Zeng, X.. 2015. Effects of selenium and silicon on enhancing anti oxidative capacity in ramie (*Boehmeria nivea* (L.) Gaud.) under cadmium stress. *Environ Sci Pollut Res*. 22: 9999-10008.
- Tjitrosoepomo, G. 1994. *Taksonomi Tumbuhan Obat-obatan*. Yogyakarta: Gadjah Mada University Press. pp 420-421.
- \_\_\_\_\_. 2007. *Morfologi Tumbuhan*. Yogyakarta: Gadjah Mada University Press. pp 78-226.

- Tkalec, M., Stefanic', P. P., Cvjetko, P., Š'ikic', S., Pavlica, M., and Balen, B. 2014. The effects of cadmium-zinc interactions on biochemical responses in tobacco seedlings and adult plants. *PLoS ONE*. 9(1): e87582.
- Tripathi, D. K., Singh, V. P., Kumar, D., and Chauhan, D. K. 2012. Rice seedlings under cadmium stress: effect of silicon on growth, cadmium uptake, oxidative stress, antioxidant capacity and root and leaf structures. *Chemistry and Ecology*. 28 (3): 281-291.
- Tubana, B., Babu, T., and Datnoff, L. 2016. A review of silicon in soils and plants and its role in us agriculture: History and future perspectives. *Soil Science*, 9/10 (181): 393-411.
- Vaculík, M, Landberg, T., Greger, M., Luxova', M., Stola'rikova', M. , and Lux, A. 2012. Silicon modifies root anatomy, and uptake and subcellular distribution of cadmium in young maize plants. *Annals of Botany*. 110: 433-443.
- \_\_\_\_\_, Lux, A., Luxova', M., Tanimoto, E., and Lichtscheidl, I. 2009. Silicon mitigates cadmium inhibitory effects in young maize plants. *Environmental and Experimental Botany*. 67: 52-58.
- Velikova, V., Yordanov, I., and Edreva, A. 2000. Oxidative stress and some antioxidant systems in acid rain-treated bean plants protective role of exogenous polyamines. *Plant Science*. 151: 59–66.
- Veselov, D., Kudoyarova1, G., Symonyan, M., Veselov, St. 2003. Effect of cadmium on ion uptake, transpiration and cytokinin content in wheat seedlings. *Bulg. J. Plant physiol*. 353-359.
- Wardhani, E., Roosmini, D., dan Notodarmojo, S. 2016. Pencemaran Kadmium di Sedimen Waduk Saguling Provinsi Jawa Barat. *Jurnal Manusia dan Lingkungan*. 23(3): 285-294.
- Wei-min, D., Ke-qin, Z., Bin-wu, D., Cheng-xiao, S., Kang-le, Z., Run, C., and Jie-yun, Z. 2005. Rapid Determination of Silicon Content in Rice. *Rice Science*. 12(2): 145-147.
- Wijayanti, Titik. 2017. Profil Pencemaran Logam Berat pada Perairan Daerah Aliran Sungai (DAS) Grindulu Pacitan. *Jurnal Imiah Sains*. 17 (1): 20-25.
- Wu, J., Geilfus, C. M., Pitann, B., Mühling, K. H. 2016. Silicon-enhanced oxalate exudation contributes to alleviation of cadmium toxicity in wheat. *Environmental and Experimental Botany*. 131: 10-18.
- Xue, Z., Gao, H., & Zhao, S. 2014. Effects of cadmium on the photosynthetic activity in mature and young leaves of soybean plants. *Environ Sci Pollut Res*. 21: 4656-4664.

- Yamaji, N., Chiba, Y., Mitani, N., and Ma, J. F. 2012. Functional characterization of a silicon transporter gene implicated in silicon distribution in barley. *Plant Physiology*. 160: 1491-1497.
- Yamaji, N., Mitani, N., and Ma, J. F. 2008. A transporter regulating silicon distribution in rice shoots. *The Plant Cell*. 20: 1381-1389.
- Zhang, Q., Liu, J., Lu, H., Zhao, S., Wang, W., Du, J., and Yan, C. 2015. Effects of silicon on growth, root anatomy, radial oxygen loss (ROL) and Fe/Mn plaque of *Aegiceras corniculatum* (L.) Blanco seedlings exposed to cadmium. *Environmental Nanotechnology, Monitoring & Management*. 4: 6-11.