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DAFTAR PUSTAKA

Abraham, E., Cabassa, C.H., Erdei, L. and Szabados, L. 2010. *Methods for Determination of Proline in Plants*. p: 317-331. *In* Sunkar, R. (Ed.). *Plant Stress Tolerance, Methods and Protocols*. Human Press. Springer. New York. pp : 317-331.

Abdolahi, M., Andelibi, B., Zangani, E., Shekari, F., and Somarin, S.J. 2012. Effect of accelerated aging and priming on seed germination of rapeseed (*Brassica napus* L.) cultivars. *Intl. Res. J. Appl. Basic. Sci*. 3 : 499-508.

Aguilar, F.J.A., Wrobel, K., Lokits, K., Caruso, J.A., Alonso, A.C., Corona, J.F.G., and Wrobel, K. 2008. Analytical speciation of chromium in in-vitro culture of chromate-resistant filamentous fungi. *Anal. Bioanal. Chem*. 392 : 269-276.

Anonim, 2005. *Ecological Soil Screening Levels for Chromium*. Interim Final. U.S. Environmental Protection Agency. Washington, DC. pp. 1-106.

Anonim. 1999. *Background Report on Fertilizer Use, Contaminants and Regulation*s, Environmental Protection Agent. Battelle 505 King Avenue. Washington, D.C. pp : 27-51.

Akinci, I.E. and Akinci, S. 2010. Effect of chromium toxicity on germination and early seedling growth in melon (*Cucumis melo* L.) *Afr. J. Biotechnol.* 9 : 4589-4594.

Ali, M.A., Abbas, A., Niaz, S., Zulkiffal, M. and Ali, S. 2009. Morpho-physiological criteria for drought tolerance in sorghum (*Sorghum bicolor*) at seedling and post-anthesis stages. *Int. J. Agric. Biol.* 11 : 674–680.

Ali, S., Zeng, F., and Zhang, G. 2011. The effect of chromium and aluminium on growth, root morphology, photosynthetic parameters and transpiration of the two barley cultivars. *Biol. Plant.* 55 : 291-296.

_____, Cai, S., Qiu, B., and Zhang, G. 2011. The interaction of salinity and chromium in the influence of barley growth and oxidative stress. *Plant Soil Environ.* 57 : 153-159.

Apel, K. and Hirt, H. 2004. Reactive oxygen species: metabolism, oxidative stress, and signal transduction. *Annu.Rev. Plant. Biol*. 55 : 373-399.

Arora, A., Saxena, S., and Sharma, D.K. 2006. Tolerance and phytoaccumulation of chromium by three *Azolla* species. *World J. Microb. Biot.* 22 : 97-100.

Arduini, I., Masoni, A., and Ercoli, L. 2006. Effects of high chromium applications on miscanthus during the period of maximum growth. *Environ. Exp. Bot*. 58 : 234–243.

Agustina, K., Sopandie, D., Trikoesoemaningtyas, dan Wirnas, D. 2010. Uji daya adaptasi sorgum pada lahan kering masam terhadap toksisitas aluminium

UNIVERSITAS GADJAH MADA
MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS, BIOKIMIA DAN MOLEKULAR
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dan defisien fosfor (*Sorghum bicolor*, L. Moench). *Prosiding Pekan Serealia Nasional*. hal : 55-64.

Arun, K.S., Cervantes C., Herminia, L.T., and Avudainayagamd, S. 2005. Chromium toxicity in plants. *Environ. Int.* 31 : 739–753.

Babula, P., Adam, V., Opatrilova, R., Zehnalek, J., Havel, L., and Kizek, R. 2008. Uncommon heavy metals, metalloids, and their plant toxicity: a review. *Environ. Chem. Lett*. 6 : 189-213.

Barouchas, P., Moustakas, N., Tsakalidi, A.L., and Ioannidou, A.A. 2014. Effect of trivalent and hexavalent chromium (Cr) on the total Cr concentration in the vegetatif plant parts of spearmint (*Mentha spicata* L.), lemon verbena (*Lippia citriodora* L.) and peppermint (*Mentha piperita* L.). *Aust. J. Crop Sci.* 8 : 363-368.

Bartlett, R.J. 1991. Chromium cycling in soil and water: links, gaps, and methods. *Environ. Health Persp*. 92 : 17–24.

Baycu, G. 2002. Phytochelatin biosynthesis and cadmium detoxification. *J. Cell. Mol. Biol*. 1 : 45-55.

Bertrand, M. and Guary, J.C. 2002. *How Plant Adopt Their Physiology to an Excess of Metals*. pp 751-761. *In* M. Pessarakli (Ed). *Handbook of Plant and Crop Physiology*. 2nd Edition. New York. Marcel Dekker.

Bibi, H. Sadaqat, A., Tahir, M. H. N. and Akram, H. M. 2012. Screening of sorghum (S*orghum bicolor* var Moench) for drought tolerance at seedling stage in polyethylene glycol. *J. Anim. Plant Sci*. 22 : 671-678.

Bielicka, A., Bojanowska, I., and Wisniewski, A. 2005. Two Faces of Chromium–Pollutant and Bioelement. *Pol. J. Environ. Stud.* 14 : 5-10.

Bouazizi, H., Jouili, H., and Ferjani, E.E. 2007. Effects of copper excess on growth, H_2O_2 production and peroxidase activities in maize seedling (*Zea mays*). *Pak. J. Biol. Sci*. 10 : 751-756.

Carpici, E.B., Celik, N., and Bayram, G. 2009. Effects of salt stress on germination of some maize (*Zea mays* L.) cultivars. *Afr. J. Biotechnol*. 8 : 4918-4922.

Chandra, P. and Kulshreshtha, K. 2004. Chromium accumulation and toxicity in aquatic vascular plants. *Bot. Rev.* 70 : 313-327.

Chadikun, P. 1998. Isolasi protein spesifik akibat induksi logam berat Cu, Pb, dan Cd pada tanaman *Crotalaria* sp. *Tesis*. Bioteknologi. C.1 (465/H/68). Universitas Gadjah Mada.Yogyakarta. hal : 36-40.

Cheng, C.H., Jien, S.H., Iizuka, Y., Tsai, H., Chang, Y.H., and Hseu, Z.Y. 2011. Pedogenic chromium and nickel partitioning in serpentine soil along a toposequence. *Soil Sci. Soc. Am. J*. 75 : 659–668.

Choppala, G., Bolan, N., Mallavarapu, M., and Chen, Z. 2010. *Sorption and mobility of chromium species in a range of soil types*. World Congress of

MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS, BIOKIMIA DAN MOLEKULAR
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Soil Science, Soil Solutions or a Changing World, Brisbane Australia. pp : 239-341

Chirwa, E.M.N. and Molokwane, P.E. 2011. *Biological Cr(VI) Reduction: Microbial Diversity. Kinetics and Biotechnological Solutions to Pollution*. *In* Sofo, A.,(Ed). 2011. *Biodiversity*. InTech. Croatia. ISBN 978-953-307-715-4.

Choudhury S. and Panda, S.K. 2005. Toxic effects, oxidative stress and ultrastuctural changes in moss *Taxithelium nepalense* (Schwaegr.) Broth under chromium and lead phytotoxicity. *Water Air Soil Pollut.* 167 : 73–90.

Cobbet, C., and Goldsbrough. 2002. Phytochelatins and metallothioneins: roles in heavy metal detoxification and homeostasis. *Annu. Rev. Plant Biol.* 53 : 159-182.

Costa, P.H.A., Neto, A.D.A., Bezerra, M.A., Prisco, J.T., and Gomes-Filho, E. 2005. Antioxidant-enzymatic system of two sorghum genotypes differing in salt tolerance. *Braz. J. Plant Physiol*. 17 : 353-361.

Dabrowska, G., Kata, A., Goc, A., Szechynska-Hebda, M., and Skrzypek, E. 2007. Characteristics of the plant ascorbate peroxidase family. *Acta Biol. Cracoviensia Ser. Bot.* 49 : 7-17.

Datta, R., and Sarkar, D. 2004. Effective integration of soil chemistry and plant molecular biology in phytoremediation of metals: an overview. *Environ. Geosci.* 11 : 53-63.

Dalvi, A.A. and Bhalerao, S.A. 2013. Response of plants toward heavy metal toxicity: an overview of avoidance, tolerance, and uptake mechanism. *Annals of Plant Sciences*. 2 : 362-368.

De Brito, A.J., Kumar, P.B.J.R., Gracelin, D.H. S., and Jency, S.S. 2011. Drought stress and its impact on protein in three species of *Vitex*. *J. Stress Physiol. Biochem.* 7 : 153-158.

Dezfuli, P.M., Sharif-zadeh, F., and Janmohammadi, M. 2008. Influence of priming techniques on seed germination behavior of maize inbred lines (*Zea mays* L.). *ARPN J. Agri. Biol. Sci.* 3 : 22-25.

Diwan, H., Khan, I., Ahmad, A., and Iqbal, M. 2010. Induction of phytochelatins and antioxidant defence system in *Brassica juncea* and *Vigna radiata* in response to chromium treatment. *Plant Growth Regul.* 61 : 97-107.

Dubey, S., Mishra, P., Dwivedi, S., Chatterjee, S., Bag, S.K., Mantri, S., Asif, M.H., Rai, A., Kumar, S., Shri, M., Tripathi, P., Tripathi, R.D., Tivedi, P.K., Cakrabarty, D., and Tuli, R. 2010. Transcriptomic and metabolomic shifts in rice roots in response to Cr(VI) stress. *BMC Genomic*. 11 : 648.

El-Hendawy, S.E., Hu, Y., Yakout, G.M., Awad, A.M., Hafiz, S.E., and Schmidhalter, U. 2005. Evaluating salt tolerance of wheat genotypes using multiple parameters. *Europ. J. Agronomy*. 22 : 243-253.

UNIVERSITAS GADJAH MADA
MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS, BIOKIMIA DAN MOLEKULAR
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

El-Khatib, A.A., Hegazy, A.K., and Kassem, A.A.E. 2011. Cadmium-induced response of protein profile and antioxidant enzymes in aquatic macrophytes *Myriophyllum spicatum* and *Ceratophyllum demersum*. *Journal of Environmental Studies*. 7 : 17-23.

Fatchiyah, Arumingtyas, E.L., Widyarti, S., dan Rahayu, S. 2011. *Biologi Molekuler. Prinsip Dasar Analisis*. Penerbit Erlangga. Jakarta. 191 pp.

Fernandez, G.C.J. 1992. *Effective selection criteria for assessing stress tolerance*. *In* Kuo, C.G. (Ed.), *Proceedings of the International Symposium on Adaptation of Vegetables and Other Food Crops in Temperature and Water Stress*, Publication, Tainan, Taiwan. pp. 257-270.

Fendorf, S.E. 1995. Surface reactions of chromium in soils and waters. *Geoderma*. 67 : 55-71.

Gardea-Torresdey J.L., De La Rosa G., Peralta-Videa J.R., Montes M., Cruz-Jimenez G., and Cano-Aguilera I. 2005. Differential uptake and transport of trivalent and hexavalent chromium by tumbleweed (*Salsola kali*). *Arch Environ. Contam. Toxicol.* 48 : 225–232.

Ganesh, K.S., Baskaran, L., Rajasekaran, S., Sumathi, K., Chidambaram, A.L.A., and Sundaramoorthy, P. 2008. Chromium stress induced alterations in biochemical and enzyme metabolism in aquatic and terrestrial plants. *Colloids and Surfaces B.* 63 : 159-163.

Gheju, M., Balcu, I., and Ciopec, M. 2009. Analysis of hexavalent chromium uptake by plants in polluted soils. *Ovidius University Annals of Chemistry*. 20 : 127-131.

Gill, S.S., and Tuteja, N. 2010. Reactive oxygen species and antioxidant machinery in abiotic stress tolerance in crop plants. *Plant Physiol. Biochem*. 48 : 909-930.

Gomes, M.P., Marques, T.C.L.L.S.M., Nogueira, G., Castro, E.M., and Soares, A.M. 2011. *Sci.Agric*. 68 : 566-573.

Grill, E., Winnacker, E.L., and Zenk, M.H. 1985. Phytochelatins: the principal heavy-metal complexing peptides of plants. *Science*. 230 : 674–676.

_____, Loftier,S., Winnacker, E.L., and Zenk, M.H. 1989. Phytochelatins, the heavy-metal-binding peptides of plants are synthesized from glutathione by a specific γ-glutamyl cysteine dipeptidyl transpeptidase (phytochelatin synthase). *Proceeding National Academy Science USA*. 86 : 6838–6842.

Gupta, S., Srivastava, S. and Saradhi, P.P. 2009. Chromium increases photosystem 2 activity in *Brassica juncea*. *Biol. Plant*. 53 : 100-104.

Gyawali, R. and Lekhak, H.D.2006. Chromium tolerance of rice (*Oryza sativa*) cultivar from Kathmandu Valley. *Scientific World*. 4 : 102-106.

Hall, J. L. 2002. Cellular mechanism of heavy metal detoxification and tolerance. *J. Exp. Bot*., 53 : 1–11.

UNIVERSITAS GADJAH MADA
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Haryoko, W., Kasli, Suliansyah, I., Syarif, A., dan Prasetyo, T.B. 2012. Toleransi beberapa varietas padi pada sawah gambut berkorelasi dengan kandungan asam fenolat. *J. Agron. Indonesia*. 40 : 112 –118.

Hayat, S., Khalique, G., Irfan, M., Wani, A.S., Tripathi, B.N., and Ahmad, A. 2011. Physiological changes induced by chromium stress in plant: an overview. *Protoplasma*. 249 : 599-611

Hassinen, V.H. 2009. Search for metal-responsive gene in plants: Putative roles in metal tolerance or accumulation. *Doctoral Dissertation*. Department of Biosciences. University of Kuopio. Finland. 255 pp.

Hefny, M.M., Metwali, E. M.R., and Mohamed, A.I. 2013. Assessment of genetic diversity of sorghum (*Sorghum bicolor* L. Moench) genotypes under saline irrigation water based on some selection indices. *Aust. J. Crop Sci*. 7 : 1935-1945.

Henriques, F.S. 2010. Changes in biomass and photosynthetic parameters of tomato plants exposed to trivalent and *hexavalent* chromium. *Biol. Plant*. 54 : 583-586.

Henderson, T., 1994. Geochemical reduction of hexavalent chromium in the Trinity sand aquifer. *Ground Water*. 3 : 477-486.

Hoeman, S. 2008. Prospek dan Potensi Sorghum sebagai bahan baku bioetanol. Makalah disajikan dalam Pelatihan Bioetanol Berbasis Sorgum oleh BSL Energi kerjasama dengan PATIR-BATAN dan PT. Blue Indonesia, Jakarta, 22-23 November 2008. Diakses dari http://www.bsl-online.com/energi/archive/1.html. tanggal 10 September 2012.

Hossain, M.A., Piyatida, P., da Silva, J.A.T., 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*. Article ID 872875. 37 pp.

Hossner, L.R., Loeppert, R.H., Newton, R.J., Szaniszlo, P.J., and Attrep, M. 1998. Literature Review: *Phytoaccumulation of Chromium, Uranium, and Plutonium in Plant Systems*. Amarillo National Resource Center for Plutonium. Texas. pp : 1-26.

Ismail, M.A. 2008. Involvement of Ca^{2+} in alleviation of Cd^{2+} toxicity in common bean (*Phaseolus vulgaris* L.) plant. *Asian. J. Biol. Sci*. 1 : 26-32.

Jahangir, M.M., Amjad, M., Afzal, I., Iqbal, Q., and Nawaz, A. 2009. Lettuce achene invigoration through osmopriming at supraoptimal temperature. *Pak. J. Agric. Sci*. 46 :1-5.

Jamali, M.K., Kazi, T.G., Arain, M.B., Afridi, H.I., Jalbani, N., Baig, J.A., and Niaz, A. 2008. Effect of liming on the distribution of heavy metals in untreated industrial sewage sludge produced in Pakistan for the cultivation of *Sorghum bicolor* (L.). *Environmentalist*. 28 : 366-375.

UNIVERSITAS GADJAH MADA
MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS, BIOKIMIA DAN MOLEKULAR
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

James, B.R. 2002. *Chemical Transformations of Chromium in Soils: Relevance to Mobility, Bio-availability and Remediation*. The Chromium File from the International Chromium Development Association. 214 pp.

Jozefczak, M., Remans, T., Vangronsveld, J., and Cuypers, A. 2012. Glutathione is a key player in metal-induced oxidative stress defenses. *Int. J. Mol. Sci*. 13 : 3145-3175.

Kasim WA. 2006. Changes induced by copper and cadmium stress in the anatomy and grain yield of *Sorghum bicolor* (L.) Moench. *Int. J. Agri. Biol*. 8 : 123-128.

Karuppanapandian, T. and Manoharan, K. 2008. Uptake and translocation of tri- and hexa-valent chromium and their effects on black gram (*Vigna mungo* L. Hepper cv. Co4) roots. *J. Plant Biol*. 51 : 192-201.

_____, Sinha, P.B., Haniya, A.M.K., and Manoharan, K. 2006. Differential antioxidative responses of ascorbate-glutathione cycle enzymes and metabolites to chromium stress in green gram (*Vigna radiata* L. Wilczek) leaves. *J. Plant Biol.* 49 : 440-447.

Katz S.A., and Salem, H. 1994. *The Biological and Environmental Chemistry of Chromium*. VCH Publ, New York. pp. 20-27.

Khayatnezhad, M. and Gholamin, R. 2011. Effects of salt stress levels on five maize (*Zea mays* L.) cultivars at germination stage. *Afr. J. Biotechnol*. 10 : 12909-12915.

_____, Zaefizadeh, M., and Eimani, A. 2011. Selection of useful index for drought stress tolerance in durum wheat genotypes. *Middle East J. Sci. Res*. 9 : 189-194.

Kim, J.G., Dixon, J.B., Chusuei, C.C., and Deng, Y. 2002. Oxidation of chromium (III) to (VI) by manganese oxides. *Soil Sci. Soc. Am. J*. 66 : 306-315.

Kotas, J. and Stasicka, Z. 2000. Commentary: chromium occurrence in the environment and methods of its speciation. *Environ. Poll.* 107 : 263-283.

Komariah, I. 2008. Identifikasi varietas kedelai toleran terhadap genangan. *J. Agrivigor*. 8 : 23 – 32.

Kumar, R., Alamelu, D., Acharya, R., and Rai, A.K. 2014. Determination of concentration of chromium and other elements in soil and plant samples from leather tanning area by instrumental neutron activation analysis. *J. Radioanal. Nucl. Chem*. 300 : 213-218.

Kwak, Y.H., Lee, D.S. and Kim, H.B. 2003. Vibrio harveyi nitroreductase is also a chromate reductase. *Appl. Environ. Microbiol.* 69 : 4390-4395.

Liang, X., Zhang, L., Natarajan, S.K., and Becker, D.F. 2013. Prolin mechanisms of stress survival. *Antioxidants & Redox Signaling*. 19 : 998-1011.

Lindsay, W. L. 1979. *Chemical equilibria in soils*. John Wiley and Sons. New York. pp. 102-114.

MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS,
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Lindblom, S.D., Abdel-Ghany, S., Hanson, B.R., Hwang, S., Terry, N., and Pilon-Smits, E.A.H. 2006. Constitutive expression of a high-affinity sulfate transporter in Indian Mustard affects metal tolerance and accumulation. *J. Environ. Qual*. 35 : 726-733.

Liu, D. and Kottke, I. 2003. Subcellular localization of chromium and nickel in root cells of *Allium cepa* by EELS and ESI. *Cell Biol. Toxicol.* 19 : 299-311.

Liu, J., Duan, C.Q., Zhang, X.H., Zhu, Y.N, and Hu, C. 2009. Subcellular distribution of chromium in accumulating plant *Leersia hexandra* Swartz. *Plant Soil*. 322 : 187-195 .

_____. 2011. Characteristics of chromium(III) uptake in hyperaccumulator *Leersia hexandra* Swartz. *Environ. Exp. Bot.* 74 : 122-126.

Liu, Z., He, X., and Chen, W. 2011. Effect of cadmium hyperaccumulation on the concentrations of four trace elements in *Lonicera japonica* Thumb. *Ecotoxicology*. 20 : 698-705.

Lopez-Luna, J., Gonzalez-Chavez, M.C., Esparza-Garcia, F.J. and Rodriguez-Vazquez, R. 2009. Toxicity assessment of soil amended with tannery sludge, trivalent chromium, and hexavalent chromium, using wheat, oat, and sorghum plants. *J. Hazard. Mater.* 163 : 829-834.

Lytle, C.M., Lytle, F.W., Yang, N., Qian, J.H., Hansen, D., Zayed, A., and Terry, N. 1998. Reduction of Cr(VI) to Cr(III) by wetland plants: potential for in situ heavy metal detoxification. *Environ.Sci. Technol*. 32 : 3087-3093.

Ma, J.F., Hiradate, S., Nomoto, K., Iwashita, T., and Mattsumoto, H. 1997. Internal detoxification mechanisms of Al^{3+} in *Hydrangea*. Identification of Al form in the leaves. *Plant Physiol.* 113 : 1033-1039.

Macnair, M.R., Tilstone, G.H., and Smith, S.E. 2000. The genetics of metal tolerance and accumulation in higher plants. In Terry, N., and Banuelos, G. (Eds.) *Phytoremediation of contaminated soil and water*. CRC Press. LLC, pp : 235-250.

Mhamdi, A., Queval, G., Chaouch, S., Vanderauwera, S., Breusegem, F.V., and Noctor, G. 2010. Catalase function in plants: a focus on Arabidopsis mutants as stress-mimic models. *J. Exp. Bot*. 3 : 1-24.

Maiti, R.K., Pinero, J.L.H., Oreja, J.A.G., and Santiago, D.L. 2004. Plant based bioremediation and mechanisms of heavy metal tolerance of plants : a review. *Proc. Indian natn. Sci. Acad*. B70. 1: 1–12.

Malmir, H.A. 2011. Comparison of antioxidant enzyme activities in leaves, stems and roots of Sorghum (*Sorghum bicolor* L.) exposed to chromium (VI). *Afr. J. Plant Sci.* 5 : 436-444.

UNIVERSITAS GADJAH MADA
MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS, BIOKIMIA DAN MOLEKULAR
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Marchiol, L., Fellet, G., Perosa, D., and Zerbi, G. 2007. Removal of trace metals by *Sorghum bicolor* and *Helianthus annuus* in a site polluted by industrial wastes: a field experience. *Plant Physiol. Biochem*. 45 : 379-387.

Maruyama-Nakashita, A., Inoue, E., Saito, K., and Takahashi, H. 2007. Sulfur-responsive promoter of sulfate transporter gene is potentially useful to detect and quantify selenat and chromate. *Plant Biotechnol.* 24 : 261-263.

McLean, J.E. and Bledsoe, B.E. 1992. *Behavior of Metals in Soils*. EPA Ground Water Issue. EPA/540/S-92/018. pp : 1-25.

McNeal, J. M. and Balistrieri. L.S. 1989. *Geochemistry and occurrence of selenium: an overview. In* L. W. Jacobs (Ed.). *Selenium in agriculture and the environment*. American Society of Agronomy. Madison, WI. Miller, W. P., D. C. Martens and L. W. Zelazny. pp : 55-72.

Memon, A.R., Ozdemir, A. and Aktoprakligil, D. 2001. Heavy metal accumulation in plants. *Biotechnol. Biotec. Eq.* 15 : 44-48.

Mendoza, J., Garrido, T., Castilo, G., and San-Martin, N. 2006. Metal availability and uptake by sorghum plants grown in soils amended with sludge from different treatments. *Chemosphere*. 65 : 2304–2312.

Menezes, C.B., Ticona-Benavente, C.A., Tardin, F.D., Cardoso, M.J., Bastos, E.A., Nogueira, D.W., Portugal, A.F., Santos, C.V., and Schaffert, R.E. 2014. Selection indices to identify drought-tolerant grain sorghum cultivars. *Genet. Mol. Res.* 13 : 9817-9827.

Mei, B., Puryear, J.D., and Newton, R.J. 2002. Assessment of Cr tolerance and accumulation in selected plant species. *Plant and Soil*. 247 : 223-231.

Mishra, K., Gupta, K., and Rai, U.N. 2009. Bioconcentration and phytotoxicity of chromium in *Eichhornia crassipes*. *J. Environ. Biol.* 30 : 521-526.

Mishra, S. and Dubey, R.S. 2010. Heavy metal uptake and detoxification mechanisms in plants. *Intl. J. Agri. Res*. 5 : 482-501.

Mongkhonsin, B., Nakbanpote, W., Nakai, I., Hokur, A., and Jearanaikoon, N. 2011. Distribution and speciation of chromium accumulated in *Gynura pseudochina* (L.) DC. *Environ. Exp. Bot.* 74 : 56-64.

Mukhtar, N., Hameed, M., Ashraf, M., and Ahmed, R. 2013. Modifications in stomatal structure and function in *Cenchrus ciliaris* L. and *Cynodon dactylon* (L.) Pers. in response to cadmium stress. *Pak. J. Bot.* 45 : 351-37.

Nagajyoti, P.C., Lee, K.D., and Sreekanth, T.V.M. 2010. Heavy metals, occurrence and toxicity for plants: a review. *Environ. Chem. Lett*. 8 : 199-216

Njoku and Nweeze, 2009. Physiochemical Influence of soil minerals on the organic reduction of soil chromium. *Leb. Sci. J.* 10 : 87-98.

MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS,
BIOKIMIA DAN MOLEKULAR
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Opperman, D.J., Piater, L.A., and van Heerden, E. 2008. A novel chromate reductase from *Thermus scotoductus* SA-01 related to old yellow enzyme. *J. Bacteriol*. 190 : 3076-3082.

Panda, S.K. and Choudhury, S. 2005. Chromium stress in plants. *Braz. J. Plant. Physiol*. 17 : 95-102.

_____. and Patra, H.K. 2000. Does Cr(III) produces oxidative damage in excised wheat leaves. *J. Plant Biol.* 27 : 105–110.

_____. 2003. Heavy metal phytotoxicity induces oxidative stress in *Taxithelium* sp. *Curr. Sci.* 84 : 631–633

Park, C.H., Pandza, S., Baetens, M., Keyhan, M., and Matin, A. 2000. *Molecular and biochemical approaches to remediate Cr(VI) using chromate reductase*. Preprints of Extended Abstracts. 40 : 431-432. Symposia Papers Presented Before the Division of Environmental Chemistry American Chemical Society.

Peralta, J.R., Gardea Torresdey, J.L., Tiemann, K.J., Gomes, E., Arteaga, S., and Parsons, J.G. 2001. Uptake and effects of five heavy metals on seed germination and plant growth in alfalfa (*Medicago sativa* L.). *Bull. Environ. Contam. Toxicol*. 66 : 727-734.

Peer, W.A., Baxter, I.R. Richards, E.L. Freeman, J.L. and Murphy, A.S. 2005. *Phytoremediation and Hyperaccumulation Plants*. In Tamas, and M., Martinoia, E. (Eds.). *Molecular Biology of Metal Homeostasis and Detoxification: Topic in Current Genetics*. Springer, Berlin, Germany. pp : 299-340.

Piechalak, A., Tomaszewska, B., Baralkiewicz, D., and Malecka, A. 2002. Accumulation and detoxification of lead ions in legumes. *Phytochemistry*. 60 : 153–162.

Ping, Z., Wensheng, S., Zhian, L., Bin, L., Jintian, L., and Jingsong, S. 2009. Removal of metals by sorghum plants from contaminated land. *J. Environ. Sci.* 21: 1432-1437.

Prasad. M.N.V. 2004. Phytoremediation of metals in the environment for sustainable development. *Proc. Indian natn. Sci. Acad*. B70. 1 : 71-98.

Pulford, I.D., Watson, C., and McGregor, S.D. 2001. Uptake of chromium by trees: prospects for phytoremediation. *Environ. Geochem. Health*. 23 : 307–331.

Rai, D., Sass, B.M., and Moore, D.A.1987. Chromium (III) hydrolysis constants and solubility of chromium(III) hydroxide. *Inorg. Chem*. 26 : 345-349.

Rameshkumar, A. and Sivasudha, T. 2012. In vitro antioxidant and antibacterial activity of aqueous and methanolic extract of *Mollugo nudicaulis* Lam. Leaves. *Asian Pac. J. Trop. Biomed*. S: 895-900.

UNIVERSITAS GADJAH MADA
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Raskin I., Kumar, P.B.A., Dushenkovs, N., and Salt, D.C. 1994. Bioconcentration of heavy metals by plants. *Curr. Opin. Biotech.* 5 : 285–290.

Rastgoo, L., Alemzadeh, A., Tale, A.M., Tazangi, S.E., and Eslamzadeh, T. 2014. Effects of copper, nickel, and zinc on biochemical parameters and metal accumulation in gouan, *Aleuropus littoralis*. *Plant Knowledge Journal.* 3 : 31-38.

Revathi, K., Haribabu, T.E., and Sudha, P.N. 2010. Phytoremediation of chromium contaminated soil using Sorghum plant. *International Journal of Environmental Sciences*. 2 : 417-428.

Rejeki, A.S. 2008. Toleransi Plasma Nutfah Kacang Tunggak (*Vigna unguiculata* (L.) Walp.) Terhadap Cekaman Aluminium. *Skripsi*. Fakultas Pertanian. Universitas Brawijaya. Malang. pp. 68.

Rout, J.R. and Sahoo, S.L. 2012. Morphological and protein profile alterations in *Withania somnifera* L. with response to iron stress. *Indian J. L. Sci*. 2 : 21-25.

Ruchjaniningsih. 2009. Rejuvenasi dan karakterisasi morfologi 225 aksesi sorgum. *Prosiding Seminar Nasional Serealia*. pp. 77-81. ISBN: 978-979-8940-27-9.

Samanhudi. 2009. Prospek pengembangan energi terbarukan berbasis tanaman sorgum manis (*Sorghum bicolor* L.). Dalam: *Seminar Nasional Kluster Riset Teknik*. Surakarta, Indonesia. pp. 103-109

Samantaray S., Rout G.R., and Das, P. 1998. Role of chromium on plant growth and metabolism. *Acta Physiol. Plant*. 20 : 201–212.

_____. 2002. Biochemical responses of Cr-tolerant and Cr-sensitives mung bean cultivars grown on varying levels of chromium. *Chemosphere*. 47 : 1065-1072.

Sampanpanish, P., Tippayasak, K., and Chairat-utai, P. 2010. Chromium accumulation by phytoremediation with monocot weed plant species and a hydroponic sand culture system. *Journal of Environmental Research and Development*. 4 : 654-666.

Salt, D.E., and Rauser, W.E. 1995. MgATP-dependent transport of phytochelatins across the tonoplast of oat roots. *Plant Physiol.* 107 : 1293-1301.

Seth, C.S. 2011. A review on mechanisms of plant tolerance and role of transgenic plants in environmental clean-up. *Bot. Rev.* 78 : 32-62.

Schiavon, M., Pilon-Smits, E.A.H., Wirtz, M. Hell, R., and Malagoli, M. 2008. Interaction between chromium and sulfur metabolism in *Brassica juncea*. *J. Environ. Qual*. 37 : 1536-1545.

Shams, K.M., Tichy, G., Fisher, A., Sager, M., Peer, T., Bashar, A., and Filip, K. 2010. Aspects of phytoremediation for chromium contaminated sites using

MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS, BIOKIMIA DAN MOLEKULAR
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common plants *Urtica dioica*, *Brassica napus* and *Zea mays*. *Plant Soil* 328 : 175-189.

Shamim, F., Saqlan, S.M., Athar, H.U.R., and Waheed, A. 2014. Screening and selection of tomato genotypes/cultivar for drought tolerance using multivariate analysis. *Pak. J. Bot*. 46 : 1165-1178.

Shanker, A.K., and Pathmanabhan, G. 2004. Speciation dependant antioxidative response in roots and leaves of sorghum (*Sorghum bicolor* (L.) Moench cv CO27) under Cr(III) and Cr(VI) stress. *Plant and Soil*. 265 : 141-151.

_____, Dianaguiraman, M., Sudhagar, R., Jayaram, K., and Pathmanabhan, G. 2004. Expression of metallothionein 3-like protein mRNA in *Sorghum* cultivars under chromium (VI) stress. *Curr. Sci.* 86 : 901-902.

_____, Cervantes, C., Loza-Tavera, H., and Avudainayagam, S. 2005. Chromium toxicity in plants. *Environ. Int.* 31 : 739-753.

Sharma, S.S. and Dietz, K. J. 2008. The relationship between metal toxicity and cellular redox imbalance. *Trends Plant Sci.* 14 : 43-50.

Sharma, D.C., Sharma, C.P., and Tripathi R.D. 2003. Phytotoxic lesions of chromium in maize. *Chemosphere*. 51 : 63–68.

Sharma, P., A. B. Jha, R.S.Dubey and M. Pessarakli. 2012. Reactive Oxygen Species, Oxidative Damage, and Antioxidative Defense Mechanism in Plant Under Stressful Conditions. *Journal of Botany*. 2012 : 1-26.

Shi, X. and Dalal, N.S. 1989. Chromium (V) and hydroxyl radical formation during the glutathione reductase – catalyzed reduction of chromium (VI). *Biochem. Biophys. Res.* 163 : 627-634.

Silva, B., Figueredo, H., Neves, I.C., and Tavares, T. 2009. The role of pH on Cr(VI) reduction and removal by *Arthrobacter viscosus*. *International Journal of Chemical and Biomolecular Engineering*. 2 : 100-103.

Sinha, V., Pakshirajan, K., and Chaturvedi, R. 2014. Chromium(VI) accumulation and tolerance by *Tradescantia pallida*: biochemical and antioxidant study. *Appl. Biochem. Biotechnol*. 173 : 2297-2306

Sirappa, M.P. 2003. Prospek pengembangan sorghum di Indonesia sebagai komoditas alternatif untuk pangan, pakan dan industri. *Jurnal Litbang Pertanian*. 22 : 133-140.

Skeffington R.A., Shewry P.R., and Peterson P.J. 1976. Chromium uptake and transport in barley seedlings (*Hordeum vulgare* L.). *Planta*. 132 : 209–214.

Srivastava, P.C. and Gupta, U.C. 1996. *Trace Elements In Crop Production*. Science Publisher Inc. USA. pp. 226-230.

Srivastava, M.M., Juneja, A., Dass, S., Srivastava, R., and Mishra, S. 1994. Studies on the uptake of trivalent and hexavalent chromium by onion (*Allium cepa*). *Chem. Speciat. Bioavailab.* 6 : 27-30.

UNIVERSITAS GADJAH MADA
MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS, BIOKIMIA DAN MOLEKULAR
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Spehar, C.R. 1994. Screening soybean germplasm for aluminium tolerance using cluster analysis. *Pesq. Agropec. Bras*. 29 : 113-122.

Strati, S., Paoletti, E., Barbolani, E., and Pirazzi, R. 1999. Root length and distribution of chromium in *Corylus avellana* with tuber albidum mycorrhizas. *Water, Air, and Soil Pollut.* 113 : 33-41.

Strlic, M., Kolar, J., Selih, V.S., Kocar, D., and Pihlar, B. 2003. A comparative study of several transition metals in Fenton-like reaction system at circum-neutral pH. *Acta Chim. Slov*. 50 : 619-632.

Sunkar, R. 2010. *Plant Stress Tolerance, Methods and Protocols*. Human Press. Springer. New York.

Sundari, T., Soemartono, Tohari, dan Mangoendidjoyo, W. 2005. Keragaan hasil dan toleransi genotip kacang hijau terhadap penaungan. *Ilmu Pertanian*. 12 : 12-19.

Supena, N., Soegianto, A., dan Soetopo, L. 2014. Response of oil palm varieties to aluminium stress. *The Journal of Tropical Life Science*. 4 : 51-60.

Swietlik, R. 1998. Review: Speciation analysis of chromium in waters. *Pol. J. Environ. Stud*. 7 : 257-266.

Talukdar, D. 2011. Effect of arsenic-induced toxicity on morphological traits of *Trigonella foenum-graecum* L. and *Lathyrus sativus* L. during germination and early seedling growth. *Curr. Res. J. Biol. Sci*. 3 : 116-123.

Tigabu, E., Andargie, M., and Tesfaye, K. 2013. Genotypic variation for salinity tolerance in Sorghum (*Sorghum bicolor* (L.) Moench) genotypes at early growth stages. *J. Stress Physiol. Biochem.* 9 : 253-262.

Tripathi, D.K., Singh, V. P., Kumar, D., and Chauhan, D.K. 2011. Impact of exogenous silicon addition on chromium uptake, growth, mineral elements, oxidative stress, antioxidant capacity, and leaf and root structures in rice seedlings exposed to hexavalent chromium. *Acta Physiol. Plant.* 34 : 279-289.

Trivedi, D., Gill, S., Yadav, S., and Tuteja N. 2013. Genome-wide analysis of glutathione reductase (GR) genes from rice and *Arabidopsis*. *Plant Signal Behav*. 8 : 1-7.

Trustinah, Kasno, A., dan Wijanarko, A. 2009. Toleransi genotip kacang tanah terhadap lahan masam. *Penelitian Pertanian Tanaman Pangan*. 28 : 183-191.

Vajpayee, P., Tripathi, R.D., Rai, U.N., Ali, M.B., and Singh, S.N. 2000. Chromium (VI) accumulation reduces chlorophyll biosynthesis, nitrate reductase activity and protein content in *Nymphaea alba* L. *Chemosphere*. 41 : 1075– 1082.

UNIVERSITAS GADJAH MADA
MEKANISME TOLERANSI Sorghum bicolor (L.) Moench. TERHADAP CEKAMAN KROM: KAJIAN FISIOLOGIS, ANATOMIS, BIOKIMIA DAN MOLEKULAR
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Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

Vaisi, Z., and Farshadfar, E. 2011. Correlation between field and laboratory indicators of drought tolerance in wheay-barley disomic addition lines. *Ann. Biol. Res.* 2 : 546-553.

Vatamaniuk, O.K., S. Mari, Y.U. Lu, and P.A. Rea. 2000. Mechanism of heavy metal ion activation of phytochelatin (PC) synthase. *J. Biol. Chem*. 275: 31451-31459.

Vazquez, M.D., Poschenrieder, CH., and Barcello, J. 1987. Chromium VI induced structural and ultrastructural changes in bush bean plants (*Phaseolus vulgaris* L.). *Ann. Bot.* 59 : 427-438.

Voland, S., Lutz, C., Michalke, B., and Lutz-Meindl, U. 2012. Intracellular chromium localization and cell physiological response in the unicellular alga *Micrasterias*. *Aquat. Toxicol.* 109 : 59–69.

Wang, R., Gao, F., Guo, B.Q., Huang, J.C., Wang, L., and Zhou, J. 2013. Short-term chromium-stress- induced alterations in the maize leaf proteome. *Int. J. Mol. Sci.* 14 : 11125-11144.

Wellburn, A.R. 1994. The spectral determination of chlorophylls a and b, as well as total carotenoid, using various solvents with spectrophotometers of different resolution. *J. Plant Physiol*. 144 : 307-313.

Werck-Reichhart, D., Hehn, A., and Didierjean, L. 2000. Cytochromes P450 for engineering herbicide tolerance. *Trends Plant Sci*. 5 : 116-123.

Yadav, S.K. 2010. Heavy metals toxicity in plants: An overview on the role of gluthatione and phytochelatins in heavy metal stress tolerance of plants. *S. Afr. J. Bot*. 76 : 167–179.

Yildiz, M., Terzi, H., Cenkci, S., and Yildiz, B. 2012. Chromium (VI)-induced alterations in 2-D protein profiles and antioxidant defence systems of barley cultivars. *Hacettepe J. Biol. & Chem.* 40 : 257–265.

Yu, X.Z. and Gu, J.D. 2007. Accumulation and distribution of trivalent chromium and effects on hybrid willow (*Salix matsudana* Koidz x *S.alba* L.) metabolism. *Arch. Environ. Contam. Toxicol*. 52 : 503-511.

Yu, X.Z., Gu, J.D., and Xing, L.Q. 2008. Differences in uptake and translocation of hexavalent and trivalent chromium by two species of willows. *Ecotoxicology*. 17 : 747-755.

_____, and Huang, S.Z. 2007. Hexavalent chromium induced stress and metabolic responses in hybrid willows. *Ecotoxicology*. 16 : 299–309.

Yusro, 2001. Pengelompokan varietas/galur sorgum (*Sorghum bicolor* L. Moench) berdasarkan ciri-ciri morfologinya. *Skripsi.* Jurusan Statistika Fakultas Matematika dan Ilmu Pengetahuan, IPB, Bogor.

Zayed, A.M., Lytle, C. M., Qian, J., and Terry, N. 1998. Chromium Accumulation, Translocation and Chemical Speciation in Vegetable Crops. *Planta*. 206 : 293-299.

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GADJAH MADA
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_____ and Terry, N. 2003. Chromium in the environment: factor affecting biological remediation. *Plant and Soil*, 249 : 139-156.

Zeng, L., Shannon, M.C., and Grieve, C.M. 2002. Evaluation of salt tolerance in rice genotypes by multiple agronomic parameters. *Euphytica*. 127 : 235-245.

_____, 2005. Exploration of relationships between physiological parameters and growth performance of rice (Oryza sativa L.) seedlings under salinity stress using multivariate analysis. *Plant and Soil*. 268: 51-59.

Zhang, X., Liu, J., Wang, D., Zhu, Y., Hu, C., and Sun, J. 2009. Bioaccumulation and chemical form of chromium in *Leersia hexandra* Swartz. *Bull. Environ. Contam. Toxicol*. 82 : 358-362.

Zou, J., Wang, M., Jiang, W., and Liu, D. 2006. Chromium accumulation and its effects on other mineral elements in *Amaranthus viridis*. *Acta Biol.Cracov. Ser. Bot.* 48(1): 7-12.

_____, Yu, K., Zhang, Z., Jiang, W., and Liu, D. 2009. Antioxidant response system and chlorophyll fluorescence in chromium (VI)-treated *Zea mays* L. seedlings. *Acta Biol.Cracov. Ser. Bot.* 51 : 23-33.