

## DAFTAR PUSTAKA

- Agustiansyah, Ermawati & Suci A. 2018. The effects of foliar boron and silica through the leaves on soybean growth and yield. *Journal of Agricultural Studies*, 6 (3) : 34 – 48.
- Ahmed, S., L.H. Akhtar, S. Ahmad, N. Iqbal, & M. Nasim. 2009. Cotton (*Gossypium hirsutum* L.) varieties responded differently to foliar applied boron in terms of quality and yield. *Soil Environ.*, 28: 88-92.
- Ahmed, N. Abid, M. Ahmad, F. Ullah, M.A. Javaid, & Q. Ali, M.A. 2011. Impact of boron fertilization on dry matter production and mineral constitution of irrigated cotton. *Pakistan Journal of Botany*, 43(6) : 2903–2910.
- Aji, H. N. & Wahyuni, E. S. 2021. Pengaruh konsentrasi pupuk kalium boron dan magnesium fosfat terhadap produksi jagung manis (*Zea mays saccharata* Sturt). *Jurnal Agroplant*, 4(1) : 19 – 28.
- Badan Penelitian dan Pengembangan Pertanian. 2019. Tanah Podsolik. <http://www.litbang.pertanian.go.id/> Diakses pada 11 Januari 2023.
- Badan Pusat Statistik Indonesia. 2020. Statistik Kelapa Sawit Indonesia 2019. Jakarta.
- Basiron, Y. 2007. Palm oil production through sustainable plantations. *Eur. J. Lipid Sci. Technol.* 109:289-295.
- Balai Penelitian Tanah. 2005. Analisis Kimia Tanah, Tanaman, Air, dan Pupuk : Petunjuk Teknis Edisi 1. Balai Penelitian Tanah, Bogor.
- Balai Penelitian Tanah. 2009. Analisis Kimia Tanah, Tanaman, Air, dan Pupuk : Petunjuk Teknis Edisi 2. Balai Penelitian Tanah, Bogor.
- Baluska F, Hlavacka A, Samaj J, Palme K, Robinson D.G., & Matoh ,T. 2002. F-actin-dependent endocytosis of cell wall pectins in meristematic root cells. Insights from brefeldin A-induced compartments. *Plant Physiol.* 130:422–431.
- Banasiak, L. J. & Schafer, A. J. 2009. Removal of boron, fluoride and nitrate by electro dialysis in the presence of organic matter. *Journal of Membrane Science*, 334 : 101–109.
- Bhatt, A., Mishra, N. K., Mishra, D. S. and Singh, C. P. 2012. Foliar application of potassium, calcium, zinc and boron enhanced yield, quality and shelf life of mango. *Hort. Flora. Res. Spect.* 1(4): 300- 305
- Boldingh, H. L., Alcaraz, M. L., Thorp, T. G., Minchin, P. E. H., Gould, N., & Hormaza, J. I. 2016. Carbohydrate and boron content of styles of ‘Hass’ avocado (*Persea americana* Mill.) flowers at anthesis can affect final fruit set. *Scientia Horticulturae*, 198 : 125 – 131.
- Boroomand, N. & Grough, M. S. H. 2012. Macroelements nutrition (NPK) of medicinal plants: A review. *Journal of Medicinal Plants Research*, 6(12):2249-2255.



- Brown P.H., Hu H., & Roberts W.G. 1999. Occurrence of sugar alcohols determines boron toxicity symptoms of ornamental species. *J. Amer. Soc. Hort. Sci.* 124:347–352.
- Bhupenchandra, I. Basumatary, A. Singh, L. K. & Khwairkham, R. 2019. Assessment of the complex relationship of boron fractions with available soil nutrient status as influenced by boron fertilization in cauliflower. *International Journal of Chemical Studies* 2019; 7(3): 4253-4256
- CABI. 2019. *Elaeis guineensis* (African oil palm). <https://www.cabi.org/isc/datasheet/20295>. Diakses pada 17 April 2022.
- Camacho-Cristóbal JJ, Herrera-Rodríguez MB, Beato VM, Rexach J, Navarro-Gochicoa MT, & Maldonado JM. 2008. The expression of several cell wall-related genes in Arabidopsis roots is down-regulated under boron deficiency. *Env. Exp. Bot.* 63:351–358.
- Cui, J., Lamande E., & T., Guillaume. 2020. Potassium deficiency reconfigures sugar export and induces catecholamine accumulation in oil palm leaves. *Plant Science*, 300(110628):1-9.
- Corley, R. H. V. & Tinker, P. B. 2016. *The Oil Palm*, Fifth edition. Willey Blackwell Sciences. UK.
- Cosgrove, D.J. 1999. Enzymes and other agents that enhance cell wall extensibility. *Annu. Rev. Plant Physiol. Plant Mol. Biol.* 50:391– 417.
- Dannel F, Pfeffer H, & Romheld V. 2002. Update on boron in higher plant-uptake, primary translocation and compartmentation. *Plant Biol.* 4, 193–204.
- Departemen Tanah UGM. 2020. *Buku Panduan Praktikum Analisis Tanah, Air, Pupuk dan Tanaman 2020/2021*. Fakultas Pertanian Universitas Gadjah Mada, Yogyakarta.
- Du, W. Pan, Z.Y. Hussain, S.B. Han, Z.X. Peng, S.A. & Liu, Y.Z. 2020. Foliar supplied boron can be transported to roots as a boron-sucrose complex via phloem in citrus trees. *Frontiers in Plant Science*, 11(250) : 1-11.
- Fairhurst, T., Caliman JP, Hårdter R., & Witt C. 2005. *Nutrient disorders and nutrient management*. PPI, PPIC, IPI, Cirad and PRPOL editors.
- Fauziyah, B. 2010. Analisis unsur hara podzolik merah kuning sebagai rekomendasi pemupukan tanaman kakao umur 0 – 1 tahun. *Jurnal el-Qudwah*, 1 : 1 – 8.
- Ganie, M. A., Akhter, F., Bhat, M. A., Malik, A. R., Junaid, J. M., Shah, M. A., Husain Bath A., & Bhat Tauseef, A. 2013. Boron- a critical nutrient element for plant growth and productivity with reference to temperate fruits. *Current Science*, 104(1) : 76-85.
- Gardner, P. F., Pearee, BR., Mitchell, L.R. 1991. *Fisiologi Tanaman Budidaya*. UI Press. Jakarta.



- Goh., K. J., Kee, K. K., Chew, P. S., & Teoh, K. C. 2007. Boron requirement and distribution in the oil palm (*Elaeis guineensis* Jacq.) and some implications on manuring practices. *Advances in Plant and Animal Boron Nutrition*, 189 – 202.
- Goldbach, H. E. & Wimmer, M. A. 2007. Boron in plants and animals: is there a role beyond cell-wall structure?. *J.Plant Nutr. Soil Sci.*, 170 : 39 – 48.
- Gupta, Umesh C. 1968. Relationship of total and hot-water soluble boron, and fixation of added boron, to properties of podzol soils. *Soil Science Society of America Journal*, 32 (1) : 45 – 48.
- Gupta, U. & Solanki, H. 2013. Impact of boron deficiency on plant growth. *International Journal Bioassays*, 2(7) : 1048 -1050.
- Han, S. Chen, L. S. Jiang, H. X. Smith, B. R., Yang , L. T. & Xie, C. Y. 2008. Boron deficiency decreases growth and photosynthesis, and increase starch and hexoses leaves of citrus seedling. *Journal of Plant Physiology*, 165 (13) : 1331 – 1341.
- Hapuarachchi, N. S. Kämper, W. Wallace, H. M. Bai, S. H. Steven, Nichols, M. O. J. & Trueman, S. J. 2022. Boron effects on fruit set, yield, quality and paternity of hass avocado. *Agronomy*, 12 (1479) : 1 – 15.
- Hardon, J. J. Williams, C. N. & Watson, I. 1969. Leaf area and yield in the oil palm in Malaya. *Experimental Agriculture*, 5 : 25 – 32.
- Hegazi, E. S., El-motaium, R. A., Yeiha, T., & Hasim, M. E. 2018. Effect of foliar boron application on boron, chlorophyll, phenol, sugars and hormones concentration of olive (*Olea europaea* L.) buds, leaves, and fruits. *Journal of Plant Nutrition*, 7(2):1-17.
- Hu H, Penn SG, Lebrilla CB, & Brown P.H. 1997. Isolation and characterisation of soluble B-complexes in higher plants. The mechanism of phloem mobility of boron. *Plant Physiol.* 113:649–655.
- Jacquemard, J. Ch., Suryana, H. E., Kurnia, D., & Talliez, B. 2006. Expression of boron deficiency symptoms and link with the genotype in oil palm (*Elaeis guineensis* Jacq.). Communication presented at IOPC, 19 – 23 June 2006, Bali. Indonesia.
- Kastori, R., Plesnicar, M., Pankovic, D., & Sakac, Z. 1995. Photosynthesis, chlorophyll fluorescence and soluble carbohydrates in sunflower leaves as affected by boron deficiency. *J. Plant Nutr.* 18:1751–1763.
- Keren, R. & Bingham, F. T. 1958. Boron in water, soils, and plants. *Advances in Soils Science*, 229 -276.
- Khan, M. M. H., Ahmed, N., Ghafoor, U., Ali, M., Ali, M. A., Irfan, M., Hussain, S., Fahad, S., Agarwal, V., Hafez, S. H. A., Ali, R., Asdaq, S. M. B., Alabdallah, N. M., Zuan, A. T. K., Danish, S., & Datta, R. 2022. Synchronization of boron application methods and rates is

environmentally friendly approach to improve quality attributes of *Mangifera indica* L. on sustainable basis. *Saudi Journal of Biological Sciences*, 29 : 1869 – 1880.

- Kusumawati, A. 2021. Buku Ajar Kesuburan Tanah dan Pemupukan, Poltek LPP Press, Yogyakarta.
- Landhi, M., D. Remorini, A. Pardossi, and L. Guidi. 2013. Boron excess affects photosynthesis and antioxidant apparatus of greenhouse Cucurbita pepo and Cucumis sativus. *Journal of Plant Research* 126 (6):775–786.
- Leghari, Shah Jahan, A. W., Niaz, Lahgari, G. M., Lahgari, A. H. Bhabhan, G. M. & Thalpur, K. H. Role of nitrogen for plant growth and development: a review." *Advances in Environmental Biology*, 10 (9) : 200 – 209.
- Legros, S. Serra, I. M. Caliman, J. P. Siregar, F. A. Vidal, A. C. & Dingkuhn, M. 2009. Phenology and growth adjustments of oil palm (*Elaeis guineensis* Jacq.) to photoperiod and climate variability. *Annals of Botany*, 104 : 1171–1182.
- Lubis, A. U. 2008. Kelapa Sawit (*Elaeis guineensis* Jacq.) di Indonesia. Pusat Penelitian Marihat Bandar Kuala Pematang Siantar, Medan.
- Mahendra, E. & Hasnelly. 2019. Respon pertumbuhan dan hasil tanaman kelapa sawit (*Elaeis guineensis* Jacq.) TM 15 dengan pemberian dosis pupuk Borat. *Jurnal Sains Agro*, 4(2): 1-7.
- Mangoensoekarjo, S. 2007. *Manajemen Tanah dan Pemupukan Budidaya Perkebunan*. Gadjah Mada University Press, Yogyakarta.
- Mangoensoekarjo, S. & A. T. Tojib. 2003. *Manajemen Budidaya Kelapa Sawit*. Gadjah Mada University Press, Yogyakarta.
- Marschner, H. 1995. *Mineral nutrition of higher plants*, Academic Press Limited, London.
- Match, T. & Ochiai K. 2005. Distribution and partitioning of newly taken up boron in sunfflower. *Plant Soil* 278:351–360.
- Meng, C., Jiang, P., Zhen, J., Zhou, G., & Xu, Q. 2014. Effect of soil and foliar application of boron on nutrion uptake, growth, and yields of red bayberry. *International Journal of Fruit Science*, 14 : 235 – 252.
- Muhlbachova, G., Cermak, P., Vavera, R., Kas, M., Pechova, M., Markhova, K., Kusa, H. Ruzek, P., Hlusek, J., & Losak, T. 2017. Boron availability and uptake under increasing phosphorus rates in a pot experiment. *Plant Soil Environment*, 63(11) : 483 – 490.
- Muliyani. 2020. Analisis kadar kalium, kalsium, dan natrium pada biskuit berbasis labu siam. Thesis, Universitas Tadulako, Palu.
- Munawar, A. 2011. *Kesuburan Tanah dan Nutrisi Tanaman*. IPB Press.



- Nora, S., & Mual, C. D. 2018. *Budidaya Tanaman Kelapa Sawit, Buku Ajar*. Pusat Pendidikan Pertanian, hal 1 – 95. Jakarta.
- Ozturk, M., Ashraf, M., & Ahmad, M. 2010. Boron and plants. *Plant Adaptation and Phytoremediation* 477, 7(13) : 275-331.
- Pahan, I. 2006. *Panduan Lengkap Kelapa Sawit*. Penebar Swadaya, Jakarta.
- Pandin, D.S. 2009. Inbreeding depression analysis based on morphological characters in four generations of selfed mapanget tall coconut no. 32 (*Cocos nucifera* L.). *Indonesian Journal of Agriculture* 2 (2): 110-114.
- Patil, P. Briradar, P. Bhagawathi, A. U. & Hejjejar, I. S. 2018. A riview on leaf area index of horticulture crops and its importance. *International Journal of Current Microbiology and Applied Sciences*, 7 (4) : 505 – 513.
- Penaloza, P., & Toloza, P. 2018. Boron increases pollen quality, pollination, and fertility of different genetic lines of paper. *Journal of Plant Nutrition*, 41 : 969 – 979.
- Putra, E. S. T., Zakaria, W., Abdullah, N. A. P., & Saleh, G. 2010. Weak neck of *Musa* sp.cv. Rastali: A review on it's genetic, crop nutrition and post harvest. *Journal of Agronomy*, 9 (2) : 45 -51.
- Putra, E. S. T., Issukindarsyah, Taryono, Purwanto, B. H., & Indradewa, D. 2016. Induction of biochemical resistance of oil palm seedling to drought stress using boron and silicon applications. *Journal of Biological Science*, 16(5): 155-166.
- Prasad, M. V., Sarkar, A., & Jameema, J. 2010. Performance of oil palm production technologies. *Indian Res. J. Ext. Edu.*, 10(3) : 10 – 15.
- Prasetyo, B. H. & D. A. Suriadikarta. 2006. Characteristics, potential, and management of ultisols for agricultural upland development in Indonesia. *Jurnal Litbang Pertanian*, 25 : 39 – 47.
- PPKS Medan. 2020. Dosis Standar Pupuk Tanaman Kelapa Sawit Menghasilkan (TM). PPKS\_ID.
- Quddus, M. A., Anwar, M. B., Naser, H. M., Siddiky, M. A., Hussain, M. J., Aktar, S., Mondol, A. T. M. A. I., Islam, M. A., & Amin, M. R. 2020. Impact of zinc, boron, molybdenum addition in soil on mungbean productivity, nutrients uptake and economics. *Journal of Agricultural Science*, 12(9) : 115 -129.
- Rahutami, R., Sudradjat, & Yahaya, S. 2020. Respon tanaman kelapa sawit belum menghasilkan umur dua tahun terhadap pemberian pupuk mikro. *Jurnal Agrosintesa*, 3(2): 46-52.
- Rajaratnam, J. A. 1973. Application, absorption, and translocation of boron in oil palm III. Leaf analysis for diagnosing boron requirements. *Expl. Agric.*, 9 : 257 – 262.



- Rehman, ur A., Farooq, M., Nawaz, A., & Ahmad, R. 2014. Influence of boron nutrition on the rice productivity, kernel quality and biofortification in different production system. *Field Crops Research*, 169 : 123-131.
- Ryden P, Sugimoto-Shirasu K, Smith AC, Findlay K, Reiter WD, & Mc Cann, M.C.. 2003. Tensile properties of Arabidopsis cell walls depend on both a xyloglucan cross-linked microfibrillar network and rhamnogalacturonan II-borate complexes. *Plant Physiol.* 132:1033– 1040.
- Saadati, S., Moallemi, N., Mortazavi, S. M. H., & Seyyednejad, S. M. 2018. Foliar applications of zinc and boron on fruit set and some fruit quality of olive. *Vegetos*, 29(2) : 1 – 5.
- Sari, A. R., Langsa, M. H., & Sirampun, A. D. Pengaruh pemanfaatan limbah cair pabrik kelapa sawit terhadap sifat kimia dan sifat fisika tanah pada lahan perkebunan kelapa sawit milik PT. PMP Kabupaten Maybrat. *Jurnal Natural*, 15(2) : 46 – 59.
- Saputra, B., Suswati, D., & Hazriani, R. 2018. Kadar hara NPK tanaman kelapa sawit pada berbagai tingkat kematangan tanah gambut di perkebunan kelapa sawit PT. Peniti Sungai Purun Kabupaten Mempawah. *Jurnal Perkebunan dan Lahan Tropika*, 8(1) : 34 – 39.
- Shahbandeh, M. 2022. Consumption of vegetable oils worldwide from 2013/14 to 2021/2022, by oil type. <https://www.statista.com/statistics/263937/vegetable-oils-global-consumption/>. Diakses pada 4 Mei 2022.
- Shehzad, M. A. & Maqsood, M. 2015. Integrated nitrogen and boron fertilization improves the productivity and oil quality of sunflower grown in calcareous soil. *Turkish Journal of Field Crops*, 20(2) : 213-222.
- Shiddieq, D. Sudira, P. & Tohari. 2018. *Aspek Dasar Agronomi Berkelanjutan*. UGM Press, Yogyakarta.
- Siregar, H. H., Nuzul H. D., dan Iput P. 2013. Pemanfaatan data iklim untuk perkebunan kelapa sawit. *Pusat Penelitian Kelapa Sawit* 1-21.
- Sirenden, R. T. Anwar, M. & Z. Damanik. 2016. Pertumbuhan dan hasil tanaman kedelai (*Glycine Max* Merr) yang diberi pupuk nitrogen dan molibdenum pada tanah podsolik merah kuning. *Jurnal Agrium*, 13 (2) : 69 – 74.
- Sitorus, U. K. P. Siagian, B. & Rahmawati, N. 2014. Respon pertumbuhan bibit kakao (*Theobroma cacao* L.) terhadap pemberian abu boiler dan pupuk urea pada media pembibitan. *Jurnal Online Agroteknologi*, 2 (3) : 1021 – 1029.
- Souza, F.B.M., Pio, R., Tadeu, M. H., Zambon, C. R., & Reighard, G. L. 2017. Boric acid in germination of pollen grains and fruit set of peach cultivars in subtropical region. *Revista Ciencia Agronomica*, 48 : 496 – 500.



UNIVERSITAS  
GADJAH MADA

**tanggapan fisiologis, pertumbuhan dan produktivitas kelapa sawit (*Elaeis guineensis* Jacq.) terhadap pemupukan boron**

Lukas Priyo Prasetyanto, Eka Tarwaca Susila Putra, S.P., M.P., Ph.D. ; Dr. Ir. Eko Hanudin, M.S.

Universitas Gadjah Mada, 2023 | Diunduh dari <http://etd.repository.ugm.ac.id/>

- Srisook, N., Oramon, T., Danphitsanuparn, P., Pattana-anake, V., & Joseph, S. J. J. 2022. Convolutional neural network based nutrient deficiency classification in leaves of *Elaeis guineensis* Jacq. *International Journal of Computer Information Systems and Industrial Management Applications*, 14 : 19 – 27.
- Statista Research Departement. 2022. Vegetable oils consumption per capita in Indonesia from 2010 to 2020, with estimates until 2030.  
<https://www.statista.com/statistics/1225403/indonesia-vegetable-oils-consumption-per-capita/>. Diakses pada 4 Mei 2022.
- Stephanus, D., Supriadi, & Sarifuddin. 2013. Survei dan pemetaan status hara tembaga dan boron perkebunan kelapa sawit rakyat hutabayu raja. *Journal Agroekoteknologi*, 2(1), 6471.
- Sunarko. 2014. *Budidaya Kelapa Sawit di Berbagai Jenis Lahan*. Agromedia Pustaka, Jakarta.
- Sutarta, E. S. & Syarovy, M. 2019. Kesuburan tanah dan laju fotosintesis tanaman kelapa sawit yang menunjukkan gejala white stripe pada lahan gambut di labuhan batu.. *Jurnal Penelitian Kelapa Sawit*, 27(2): 127-140.
- Takano J, Noguchi K, Yasumori M, Kobayashi M, Gajdos Z, & Miwa, K. 2002. Arabidopsis boron transporter for xylem loading. *Nature*. 420:337–340.
- Tariq, M. Akbar, A. Haq, L.u. & Khan, A. 2010. Comparing application methods for boron fertilizer on the yield and quality of tobacco (*Nicotiana tabacum*. L.). *Communications in Soil Science and Plants Analysis*, 41 (13) : 1525 – 1537.
- Tinto, Rio. 2022. *Boron dalam Tanah dan Nutrisi Tanaman*. United State Borax, Chicago. US.
- Trivedi, N. Singh, D. Bahadur, V. Prasad, V. M. & Collis, J. P. 2012. Effect of foliar application of zinc and boron on yield and fruit quality of guava (*Psidium guajava* L.). *Horti Flora Research Spectrum*, 1 (3) : 281 – 283.
- Tsadilas, C. D., Kassioti, T., & Mitosios, I. K. 2005. Influence of liming and nitrogen forms on boron uptake by tobacco. *Communications in Soil Science and Plants Analysis*, 36 (4) : 701 -708.
- Uexkull, H. R. & Fairhurst, T. H. 1999. *Oil palm nutrition management*. Better Crops International, 13 (1) : 1 – 56.
- Urry, L. Cain, M. Wasserman, S. Minorsky, P. & Reece, J. 2017. *Campbell Biology* 11<sup>th</sup> Edition. New York: Pearson Higher Education.
- Wasaya, A., Shabir, M. S., Hussain, M., Ansar, M., Aziz, A., Hassan, W., & Ahmad, I. 2017. Foliar application of zinc and boron improved the productivity and net returns of maize ground under rainfed conditions of Pothwar plateau. *Journal of Soil Science and Plant Nutrition*, 17(1) : 33-45.



UNIVERSITAS  
GADJAH MADA

**tanggapan fisiologis, pertumbuhan dan produktivitas kelapa sawit (*Elaeis guineensis* Jacq.) terhadap pemupukan boron**

Lukas Priyo Prasetyanto, Eka Tarwaca Susila Putra, S.P., M.P., Ph.D. ; Dr. Ir. Eko Hanudin, M.S.

Universitas Gadjah Mada, 2023 | Diunduh dari <http://etd.repository.ugm.ac.id/>

- Warsito, J., Sabang, S. M., & Mustapa, K. 2016. Pembuatan pupuk organik dari limbah tandan kosong kelapa sawit. *Jurnal Akademika Kimia*, 5(1) : 8 – 15.
- Williams, J. H. & Reese, J. B. 2019. Evolution of development of pollen performance. *Current Topics in Developmental Biologi*, 131 : 299 – 336.
- Xu, F., Goh, K. J., Gan, H. H., Kee, K. K., Chew, P. S., & Teoh, K. C. 2007. Boron requirement and distribution in the oil palm (*Elaeis guineensis* Jacq.) and some implications on manuring practices. *Advances in Plant and Animal Boron Nutrition*, 1 : 189 – 202.
- Yu, Q., Hlavacka, A., Match, T., Volkmann, D., Menzel, D., Goldbach, H. E., & Baluska, F. 2002. Short-term boron deprivation inhibits endocytosis of cell wall pectins in meristematic cells of maize and wheat root apices. *Plant Physiol.* 130:415–421.