

REFERENCES

- Adifaiz, A.F., Maiden, N.A., Nusaibah, S.A., Sulaiman, Z., Rafii, M.Y., 2021. Genetic variability and association of characters in the 1995 RRIM Hevea germplasm core collection for yield improvement. *J. Rubber Res.* 24, 415–422.
<https://doi.org/10.1007/s42464-021-00110-x>
- Amerik, A.Y., Martirosyan, Y.T., Gachok, I. V., 2018. Regulation of Natural Rubber Biosynthesis by Proteins Associated with Rubber Particles. *Russ. J. Bioorganic Chem.* <https://doi.org/10.1134/S106816201801003X>
- An, Z., Zhao, Y., Zhang, X., Huang, X., Hu, Y., Cheng, H., Li, X., Huang, H., 2019. A high-density genetic map and QTL mapping on growth and latex yield-related traits in *Hevea brasiliensis* Müll.Arg. *Ind. Crops Prod.* 132, 440–448.
<https://doi.org/10.1016/J.INDCROP.2019.03.002>
- Archer, B., Audley, B., Cockbain, E., McSweeney, G., 1963. The biosynthesis of rubber. Incorporation of mevalonate and isopentenyl pyrophosphate into rubber by *Hevea brasiliensis*-latex fractions. *Biochem. J.* 89.
<https://doi.org/10.1042/bj0890565>
- Archer, B.L., Audley, B.G., 1987. New aspects of rubber biosynthesis. *Bot. J. Linn. Soc.* 94. <https://doi.org/10.1111/j.1095-8339.1987.tb01045.x>
- Attanayake, A.P., Karunanayake, L., Nilmini, A.H.R.L., 2005. EFFECT OF ETHEPHON CONCENTRATION ON RUBBER YIELD THROUGH MAGNESIUM ION AND SUCROSE REGULATION IN *Hevea brasiliensis* 1–4.
- Badan Pusat Statistik, 2023. STATISTIK INDONESIA 2023. Badan Pusat Statistik/BPS-Statistics Indonesia.
- Balai Penelitian Sembawa, 2009. Pengelolaan Bahan Tanam Karet. Balai Penelitian Sembawa, Pusat Penelitian Karet, Palembang.
- Bates, D., Mächler, M., Bolker, B.M., Walker, S.C., 2015. Fitting Linear Mixed-Effects Models Using lme4. *J. Stat. Softw.* 67, 1–48.
<https://doi.org/10.18637/JSS.V067.I01>
- Besse, P., Lebrun, P., Seguin, M., Lanaud, C., 1993. DNA fingerprints in *Hevea brasiliensis* (rubber tree) using human minisatellite probes. *Heredity (Edinb.)* 70. <https://doi.org/10.1038/hdy.1993.35>
- Botstein, D., White, R.L., Skolnick, M., Davis, R.W., 1980. Construction of a genetic linkage map in man using restriction fragment length polymorphisms. *Am. J. Hum. Genet.* <https://doi.org/10.17348/era.9.0.151-162>
- Cahyo, A.N., Murti, R.H., Putra, E.T.S., Oktavia, F., Ismawanto, S., Mournet, P., Fabre, D., Montoro, P., 2022. Screening and QTLs detection for drought factor index trait in rubber (*Hevea brasiliensis* Müll. Arg.). *Ind. Crops Prod.* 190, 115894. <https://doi.org/10.1016/J.INDCROP.2022.115894>
- Chantuma, P., Thanisawanyangkura, S., Kasemsap, P., Gohet, E., Thaler, P., 2006. Distribution patterns of latex sucrose content and concurrent metabolic activity at the trunk level with different tapping systems and in latex production bark of *Hevea brasiliensis*. *Kasetsart J. - Nat. Sci.* 40, 634–642.
- Chevallier, M.-H., 1988. Genetic variability of *Hevea brasiliensis* germplasm using isozyme markers. *J. Nat. Rubber Res.*

- Chiang, C.C.K., Barkakaty, B., Puskas, J.E., Xie, W., Cornish, K., Peruch, F., Deffieux, A., 2014. Unraveling the mystery of natural rubber biosynthesis. Part II: Composition and growth of in vitro natural rubber using high-resolution size exclusion chromatography. *Rubber Chem. Technol.* 87. <https://doi.org/10.5254/rct.14.87913>
- Clément-Demange, A., Priyadarshan, P.M., Thuy Hoa, T.T., Venkatachalam, P., 2007. *Hevea Rubber Breeding and Genetics*, in: *Plant Breeding Reviews*. <https://doi.org/10.1002/9780470168035.ch4>
- Cobb, J.N., DeClerck, G., Greenberg, A., Clark, R., McCouch, S., 2013. Nextgeneration phenotyping: requirements and strategies for enhancing our understanding of genotype–phenotype relationships and its relevance to crop improvement. *Theor Appl Genet* 126, 867–887.
- Cormier, F., Lawac, F., Maledon, E., Gravillon, M.C., Nudol, E., Mournet, P., Vignes, H., Chaïr, H., Arnau, G., 2019. A reference high-density genetic map of greater yam (*Dioscorea alata* L.). *Theor. Appl. Genet.* 132, 1733–1744. <https://doi.org/10.1007/S00122-019-03311-6/FIGURES/3>
- Cornish, K., 2001. Similarities and differences in rubber biochemistry among plant species. *Phytochemistry*. [https://doi.org/10.1016/S0031-9422\(01\)00097-8](https://doi.org/10.1016/S0031-9422(01)00097-8)
- Cornish, K., Siler, D.J., 1995. Effect of Different Allylic Diphosphates on the Initiation of New Rubber Molecules and on Cis-1,4-polyisoprene Biosynthesis in *Guayule* (*Parthenium argentatum* Gray). *J. Plant Physiol.* 147. [https://doi.org/10.1016/S0176-1617\(11\)82157-7](https://doi.org/10.1016/S0176-1617(11)82157-7)
- Cornish, K., Siler, D.J., Grosjean, O., Goodman, N., 1993. Fundamental similarities in rubber particle architecture and function in three evolutionarily divergent plant species. *J. Nat. Rubb. Res.* 8, 275–285.
- Cornish, K., Wood, D.F., Windle, J.J., 1999. Rubber particles from four different species, examined by transmission electron microscopy and electron-paramagnetic-resonance spin labeling, are found to consist of a homogeneous rubber core enclosed by a contiguous, monolayer biomembrane. *Planta* 210. <https://doi.org/10.1007/s004250050657>
- Cubry, P., Pujade-Renaud, V., Garcia, D., Espeout, S., Le Guen, V., Granet, F., Seguin, M., 2014. Development and characterization of a new set of 164 polymorphic EST-SSR markers for diversity and breeding studies in rubber tree (*Hevea brasiliensis* Müll. Arg.). *Plant Breed.* 133, 419–426. <https://doi.org/10.1111/PBR.12158>
- D'Auzac, J., Jacob, J.-L., Chrestin, H., 1989. *Physiology of rubber tree latex : the laticiferous cell and latex : a model of cytoplasm*. CRC Press.
- D'Auzac, J., Jacob, J.L., Prevot, J.C., Clement, A., Gallois, R., Chrestin, H., Lacote, R., Pujade-Renaud, V., 1997. The regulation of cispolyisoprène production (natural rubber) from *Hevea brasiliensis*, in: Pandalai, S.G. (Ed.), *Recent Res. Devel. in Plant Physiol.* pp. 273-332.
- Danecek, P., Auton, A., Abecasis, G., Albers, C.A., Banks, E., DePristo, M.A., Handsaker, R.E., Lunter, G., Marth, G.T., Sherry, S.T., McVean, G., Durbin, R., 2011. The variant call format and VCFtools. *Bioinformatics* 27, 2156. <https://doi.org/10.1093/BIOINFORMATICS/BTR330>
- Dijkman, M.J., 1951. *Hevea -Thirty Years of Research in the Far East*. Univ. Miami Press., Coral Gables, Florida, USA.

- Dinka, S.J., Campbell, M.A., Demers, T., Raizada, M.N., 2007. Predicting the size of the progeny mapping population required to positionally clone a gene. *Genetics* 176. <https://doi.org/10.1534/genetics.107.074377>
- Direktorat Jenderal Perkebunan, 2023. STATISTIK PERKEBUNAN JILID I 2022-2024. Sekretariat Direktorat Jenderal Perkebunan, Direktorat Jenderal Perkebunan, Kementerian Pertanian, Jakarta.
- Eliathe, E.A.A., Edmond, K.K., Mathurin, O.K., Justin, L.Y., Pierre, Ng.A.S., Kouadio, D., Abdourahamane, S., 2012. Detection of *Hevea brasiliensis* clones yield potential and susceptibility to tapping panel dryness in Côte d'Ivoire using the 32 and 35 KDa lutoidic proteins. *AFRICAN J. Biotechnol.* 11. <https://doi.org/10.5897/ajb11.409>
- Eschbach, J.M., Roussel, D., Van de Sype, H., Jacob, J.L., D'Auzac, J., 1984. Relationships between yield and clonal physiological characteristics of latex from *Hevea brasiliensis*. *Physiol. Veg.* 22, 295-304.
- Fang, W., Qiao, L.S., Ming, W., Jian, Q., Feng, Y.W., Hua, G.H., Zhou, X.X., 2016. Cloning and expression analysis of one gamma-glutamylcysteine synthetase gene (Hby-ECS1) in latex production in *hevea brasiliensis*. *Biomed Res. Int.* 2016. <https://doi.org/10.1155/2016/5657491>
- GAPKINDO, 2023. Natural Rubber Industry Expected to Support Earthquake-Resistant Infrastructure Industry Development [WWW Document]. URL <https://gapkindo.org/2023/02/24/ministry-of-industry-rubber-commodity-contributes-idr-110-trillion-in-foreign-exchange-and-absorbs-60000-workers-2/>
- Garsmeur, O., Droc, G., Antonise, R., Grimwood, J., Potier, B., Aitken, K., Jenkins, J., Martin, G., Charron, C., Hervouet, C., Costet, L., Yahiaoui, N., Healey, A., Sims, D., Cherukuri, Y., Sreedasyam, A., Kilian, A., Chan, A., Van Sluys, M.A., Swaminathan, K., Town, C., Bergès, H., Simmons, B., Glaszmann, J.C., Van Der Vossen, E., Henry, R., Schmutz, J., D'Hont, A., 2018. A mosaic monoploid reference sequence for the highly complex genome of sugarcane. *Nat. Commun.* 2018 91 9, 1–10. <https://doi.org/10.1038/s41467-018-05051-5>
- Gohet, E., Cauchy, T., Soumahoro, M., Kotochi, C., Chegbene, P., Njoku, A., Lesturgez, G., 2019. Meta-analysis of a large industrial latex diagnosis database provides insight on *Hevea brasiliensis* clonal adaptation and site-specific yield potential in Western Africa. *Proceeding IRRDB Rubber Conf.* 1–19.
- Gohet, E., Cavaloc, E., Cardoso, S., Cairo, I., Garcia, D., Rivano, F., Lacote, R., Lesturgez, G., 2015. A first physiological assessment of latex clonal metabolic typology and rubber yield potential of “CMS” rubber tree clones. *Proceeding Int. Rubber Conf. Ho chi Minh 2 - 3 Novemb.* 2015 287–294. <https://doi.org/10.13140/RG.2.1.3007.4328>
- Gohet, E., Chantuma, P., Lacote, R., Obouayeba, S., Dian, K., Clément Demange, A., Dadang, K., Eschbach, J.-M., 2003. Latex clonal typology of *Hevea brasiliensis*: Physiological modelling of yield potential and clonal response to ethephon stimulation. *IRRDB Work. Exploit. Technol.*
- Gohet, E., Scomparin, C., Cavaloc, E., Balerin, Y., Benites, G., Dumortier, F., Williams, H.O., Permadi, H.P., Ginting, E., De Rostolan, E., Uche, E., Chegbene, P., Hocepiéd, E., Echimane, P., Soumahoro, M., Sargeant, H.J., Suyatno, Najera, C.A., Soumahoro, B., Lacote, R., Eschbach, J.-M., 2008. Influence of ethephon stimulation on latex physiological parameters and

consequences on latex diagnosis implementation in rubber agro-industry.
Present. IRRDB Work. Latex Harvest. Technol.

- Hao, B.Z., Wu, J.L., 2000. Laticifer differentiation in *Hevea brasiliensis*: induction by exogenous jasmonic acid and linolenic acid. *Ann. Bot.* 85, 37–43.
- Hao, X., Yang, T., Wang, Y., Liu, R., Dong, X., Zhao, J., Han, J., Zong, X., Chang, J., Liu, H., 2022. Construction of A GBS-Based High-Density Genetic Map and Flower Color-Related Loci Mapping in Grasspea (*Lathyrus sativus* L.). *Plants* 11, 2172. <https://doi.org/10.3390/PLANTS11162172/S1>
- Hardjowigeno, S., 2003. The Development of Peatlands for Agriculture an Opportunity and a Challenge. Scientific Oration Professors of Soil Science Faculty of Agriculture.
- He, J., Zhao, X., Laroche, A., Lu, Z.X., Liu, H.K., Li, Z., 2014. Genotyping-by-sequencing (GBS), an ultimate marker-assisted selection (MAS) tool to accelerate plant breeding. *Front. Plant Sci.* 5. <https://doi.org/10.3389/FPLS.2014.00484>
- Hepper, C.M., Audley, B.G., 1969. The biosynthesis of rubber from β -hydroxy- β -methylglutaryl-coenzyme A in *Hevea brasiliensis* latex. *Biochem. J.* 144, 370–386.
- Herlinawati, E., Montoro, P., Ismawanto, S., Syaafaah, A., Aji, M., Giner, M., Flori, A., Gohet, E., Oktavia, F., 2022. Dynamic analysis of Tapping Panel Dryness in *Hevea brasiliensis* reveals new insights on this physiological syndrome affecting latex production. *Heliyon* 8. <https://doi.org/10.1016/j.heliyon.2022.e10920>
- IRRDB, 1996. Manual of Biochemical and Physiological Tests for *Hevea brasiliensis*.
- Jacob, J.L., d'Auzac, J., Prevôt, J.C., 1993. The composition of natural latex from *Hevea brasiliensis*. *Clin. Rev. Allergy* 11. <https://doi.org/10.1007/BF02914415>
- Jacob, J.L., Eschbach, J.M., Prevot, J.L., Roussel, D., Lacrotte, R., Chrestin, H., D'Auzac, J., 1986. Physiological basis for latex diagnosis of the functioning of the laticiferous system in rubber trees, in: Rajarao, J.C., Amin, L.L. (Eds.), *Proceedings of International Rubber Conference*, Kuala Lumpur, Malaysia, 21–25 October 1985. Rubber Research Institute of Malaysia.
- Jacob, J.L., Prevot, J.C., Kekwick, R.G.O., 1989a. General Metabolism of *Hevea Brasiliensis* Latex (with the Exception of Isoprenic Anabolism), in: D'Auzac, J., Jacob, J.-L., Chrestin, H. (Eds.), *Physiology of Rubber Tree Latex*. CRC Press Inc, Florida, pp. 101–144.
- Jacob, J.L., Prevot, J.C., Lacrotte, R., Clement, A., Serres, E., Gohet, E., 1995. Clonal typology of laticifer functioning in *Hevea brasiliensis*. *Plant. Rech. Dev.* 43–49.
- Jacob, J.L., Prévôt, J.C., Roussel, D., Lacrotte, R., Serres, E., D'Auzac, J., Eschbach, J.M., Omont, H., 1989b. Yield-limiting factors, latex physiological parameters, latex diagnosis, and clonal typology, in: d'Auzac, J.L., Jacob, J.L., Chrestin, H. (Eds.), *Physiology of Rubber Tree Latex*. CRC Press Inc, Boca Raton, Florida., pp. 345–403.
- Jacob, J.L., Serres, E., Prévôt, J.C., Lacrotte, R., Vidal, A., Eschbach, J.M., D'Auzac, J., 1987. Development of the *Hevea* latex diagnosis. *Agritrop*, 12, 97–

118.

- Jaganathan, D., Bohra, A., Thudi, M., Varshney, R.K., 2020. Fine mapping and gene cloning in the post-NGS era: advances and prospects. *Theor. Appl. Genet.* <https://doi.org/10.1007/s00122-020-03560-w>
- Johnson, H.W., Robinson, H.F., Comstock, R.E., 1955. Estimates of Genetic and Environmental Variability in Soybeans. *Agron. J.* 47, 314–318. <https://doi.org/https://doi.org/10.2134/agronj1955.00021962004700070009x>
- Junaidi, Nuringtyas, T.R., Clément-Vidal, A., Flori, A., Syafaah, A., Oktavia, F., Ismawanto, S., Aji, M., Subandiyah, S., Montoro, P., 2022. Analysis of reduced and oxidized antioxidants in *Hevea brasiliensis* latex reveals new insights into the regulation of antioxidants in response to harvesting stress and tapping panel dryness. *Heliyon* 8, e09840. <https://doi.org/10.1016/J.HELIYON.2022.E09840>
- Kagale, S., Koh, C., Clarke, W.E., Bollina, V., Parkin, I.A.P., Sharpe, A.G., 2016. Analysis of Genotyping-by-Sequencing (GBS) Data. *Methods Mol. Biol.* 1374, 269–284. https://doi.org/10.1007/978-1-4939-3167-5_15
- Kaur, G., Pathak, M., Singla, D., Sharma, A., Chhuneja, P., Sarao, N.K., 2021. High-Density GBS-Based Genetic Linkage Map Construction and QTL Identification Associated With Yellow Mosaic Disease Resistance in Bitter Melon (*Momordica charantia* L.). *Front. Plant Sci.* 12, 986. <https://doi.org/10.3389/FPLS.2021.671620/BIBTEX>
- Kekwick, R.G.O., 1989. The formation of isoprenoids in *Hevea* latex., in: D'Auzac, J., Jacob, J.L., Chrestin, L. (Eds.), *Physiology of Rubber Tree Latex*. CRC Press, Boca Raton, FL., pp. 145-164.
- Ko, J.H., Chow, K.S., Han, K.H., 2003. Transcriptome analysis reveals novel features of the molecular events occurring in the laticifers of *Hevea brasiliensis* (para rubber tree). *Plant Mol. Biol.* 53. <https://doi.org/10.1023/B:PLAN.0000019119.66643.5d>
- Lacote, R., Doumbia, A., Obouayeba, S., Gohet, E., 2013. Sustainable rubber production through good latex harvesting practices: stimulation based on clonal latex functional typology and tapping panel management, in: *IRRDB Workshop on Latex Harvesting Technology*, Binh Duong, Vietnam, November 19th-22nd, 2013. IRRDB, Binh Duong, Viet Nam.
- Lacote, R., Gabla, O., Obouayeba, S., Eschbach, J.M., Rivano, F., Dian, K., Gohet, E., 2010. Long-term effect of ethylene stimulation on the yield of rubber trees is linked to latex cell biochemistry. *F. Crop. Res.* 115, 94–98. <https://doi.org/10.1016/J.FCR.2009.10.007>
- Le Guen, V., Garcia, D., Doaré, F., Mattos, C.R.R., Condina, V., Couturier, C., Chambon, A., Weber, C., Espéout, S., Seguin, M., 2011. A rubber tree's durable resistance to *Microcyclus ulei* is conferred by a qualitative gene and a major quantitative resistance factor. *Tree Genet. Genomes* 7. <https://doi.org/10.1007/s11295-011-0381-7>
- Le Guen, V., Lespinasse, D., Oliver, G., Rodier-Goud, M., Pinard, F., Seguin, M., 2003. Molecular mapping of genes conferring field resistance to South American Leaf Blight (*Microcyclus ulei*) in rubber tree. *Theor. Appl. Genet.* 108. <https://doi.org/10.1007/s00122-003-1407-9>
- Leclercq, J., Wu, S., Farinas, B., Pointet, S., Favreau, B., Vignes, H., Kuswanhadi,

- K., Ortega-Abboud, E., Dufayard, J.F., Gao, S., Droc, G., Hu, S., Tang, C., Montoro, P., 2020. Post-transcriptional regulation of several biological processes involved in latex production in *Hevea brasiliensis*. *PeerJ* 8. <https://doi.org/10.7717/PEERJ.8932>
- Lee, D., 2018. Thailand Natural Rubber Economics [WWW Document]. URL <https://www.halcyonagri.com/en/thailand-natural-rubber-economics/>
- Lekawipat, N., Teerawatanasuk, K., Rodier-Goud, M., Seguin, M., Vanavichit, A., Toojinda, T., Tragoonrung, S., 2003. Genetic Diversity Analysis of Wild Germplasm and Cultivated Clones of *Hevea brasiliensis* Muell.Arg. by Using Microsatellite Markers. *J. Rubber Res.* 6.
- Lespinasse, D., Grivet, L., Troispoux, V., Rodier-Goud, M., Pinard, F., Seguin, M., 2000. Identification of QTLs involved in the resistance to South American leaf blight (*Microcyclus ulei*) in the rubber tree. *Theor. Appl. Genet.* 100. <https://doi.org/10.1007/s001220051379>
- LGM, 2024. Transfer of Technology [WWW Document]. URL [https://www.lgm.gov.my/webv2/coreActivities/tot/\(tot:about\)](https://www.lgm.gov.my/webv2/coreActivities/tot/(tot:about)) (accessed 12.1.24).
- Li, H., 2018. Minimap2: pairwise alignment for nucleotide sequences. *Bioinformatics* 34, 3094–3100. <https://doi.org/10.1093/BIOINFORMATICS/BTY191>
- Li, H., Vikram, P., Singh, R.P., Kilian, A., Carling, J., Song, J., Burgueno-Ferreira, J.A., Bhavani, S., Huerta-Espino, J., Payne, T., Sehgal, D., Wenzl, P., Singh, S., 2015. A high density GBS map of bread wheat and its application for dissecting complex disease resistance traits. *BMC Genomics* 16, 1–15. <https://doi.org/10.1186/S12864-015-1424-5/FIGURES/6>
- Lichtenthaler, H.K., 1999. The 1-deoxy-D-xylulose-5-phosphate pathway of isoprenoid biosynthesis in plants. *Annu. Rev. Plant Biol.* 50. <https://doi.org/10.1146/annurev.arplant.50.1.47>
- Long, X., Li, H., Yang, J., Xin, L., Fang, Y., He, B., Huang, D., Tang, C., 2019. Characterization of a vacuolar sucrose transporter, HbSUT5, from *Hevea brasiliensis*: Involvement in latex production through regulation of intracellular sucrose transport in the bark and laticifers. *BMC Plant Biol.* 19, 1–11. <https://doi.org/10.1186/S12870-019-2209-9/FIGURES/5>
- Lopez, D., 2023. PB260 draft assembly [Data set]. Zenodo. [WWW Document]. URL <https://doi.org/10.5281/zenodo.10281549>
- Martin, G., Baurens, F.C., Droc, G., Rouard, M., Cenci, A., Kilian, A., Hastie, A., Doležel, J., Aury, J.M., Alberti, A., Carreel, F., D'Hont, A., 2016. Improvement of the banana “*Musa acuminata*” reference sequence using NGS data and semi-automated bioinformatics methods. *BMC Genomics* 17, 1–12. <https://doi.org/10.1186/S12864-016-2579-4/TABLES/4>
- Martin, M., 2011. Cutadapt removes adapter sequences from high-throughput sequencing reads. *EMBnet.journal* 17, 10–12. <https://doi.org/10.14806/EJ.17.1.200>
- McMullen, A., McSweeney, G., 1966. The biosynthesis of rubber: Incorporation of isopentenyl pyrophosphate into purified rubber particles by a soluble latex-serum enzyme. *Biochem. J.* 101. <https://doi.org/10.1042/bj1010042>
- Mooibroek, H., Cornish, K., 2000. Alternative sources of natural rubber. *Appl. Microbiol. Biotechnol.* <https://doi.org/10.1007/s002530051627>

- Mournet, P., de Albuquerque, P.S.B., Alves, R.M., Silva-Werneck, J.O., Rivallan, R., Marcellino, L.H., Clément, D., 2020. A reference high-density genetic map of *Theobroma grandiflorum* (Willd. ex Spreng) and QTL detection for resistance to witches' broom disease (*Moniliophthora perniciosa*). *Tree Genet. Genomes* 16, 89. <https://doi.org/10.1007/s11295-020-01479-3>
- Munyengwa, N., Le Guen, V., Bille, H.N., Souza, L.M., Clément-Demange, A., Mournet, P., Masson, A., Soumahoro, M., Kouassi, D., Cros, D., 2021. Optimizing imputation of marker data from genotyping-by-sequencing (GBS) for genomic selection in non-model species: Rubber tree (*Hevea brasiliensis*) as a case study. *Genomics* 113, 655–668. <https://doi.org/10.1016/J.YGENO.2021.01.012>
- Narayanan, C., Mydin, K.K., 2011. Heritability of yield and secondary traits in two populations of para rubber tree (*Hevea brasiliensis*). *Silvae Genet.* 60, 132–139. <https://doi.org/10.1515/sg-2011-0018>
- Piyatrakul, P., Yang, M., Putranto, R.A., Pirrello, J., Dessailly, F., Hu, S., Summo, M., Theeravatanasuk, K., Leclercq, J., Kuswanhadi, Montoro, P., 2014. Sequence and expression analyses of ethylene response factors highly expressed in latex cells from *Hevea brasiliensis*. *PLoS One* 9. <https://doi.org/10.1371/journal.pone.0099367>
- Poland, J.A., Brown, P.J., Sorrells, M.E., Jannink, J.L., 2012. Development of High-Density Genetic Maps for Barley and Wheat Using a Novel Two-Enzyme Genotyping-by-Sequencing Approach. *PLoS One* 7, e32253. <https://doi.org/10.1371/JOURNAL.PONE.0032253>
- Pootakham, W., Ruang-Areerate, P., Jomchai, N., Sonthirod, C., Sangsakru, D., Yoocha, T., Theerawattanasuk, K., Nirapathpongorn, K., Romruensukharom, P., Tragoonrung, S., Tangphatsornruang, S., 2015. Construction of a high-density integrated genetic linkage map of rubber tree (*Hevea brasiliensis*) using genotyping-by-sequencing (GBS). *Front. Plant Sci.* 6, 1–12. <https://doi.org/10.3389/FPLS.2015.00367/ABSTRACT>
- Price, A.H., Cairns, J.E., Horton, P., Jones, H.G., Griffiths, H., 2002. Linking drought-resistance mechanisms to drought avoidance in upland rice using a QTL approach: Progress and new opportunities to integrate stomatal and mesophyll responses. *J. Exp. Bot.* <https://doi.org/10.1093/jexbot/53.371.989>
- Puskas, J.E., Gautriaud, E., Deffieux, A., Kennedy, J.P., 2006. Natural rubber biosynthesis-A living carbocationic polymerization? *Prog. Polym. Sci.* <https://doi.org/10.1016/j.progpolymsci.2006.05.002>
- Putranto, R.A., Herlinawati, E., Rio, M., Leclercq, J., Piyatrakul, P., Gohet, E., Sanier, C., Oktavia, F., Pirrello, J., Kuswanhadi, Montoro, P., 2015. Involvement of ethylene in the latex metabolism and tapping panel dryness of *Hevea brasiliensis*. *Int. J. Mol. Sci.* 16. <https://doi.org/10.3390/ijms160817885>
- Pütter, K.M., van Deenen, N., Unland, K., Prüfer, D., Schulze Gronover, C., 2017. Isoprenoid biosynthesis in dandelion latex is enhanced by the overexpression of three key enzymes involved in the mevalonate pathway. *BMC Plant Biol.* 17. <https://doi.org/10.1186/s12870-017-1036-0>
- Qin, Y., Wang, J., Fang, Y., Lu, J., Shi, X., Yang, J., Xiao, X., Luo, X., Long, X., 2022. Anaerobic metabolism in *Hevea brasiliensis* laticifers is relevant to rubber synthesis when tapping is initiated. *Ind. Crops Prod.* 178, 114663. <https://doi.org/10.1016/j.indcrop.2022.114663>

- Quinlan, A.R., Hall, I.M., 2010. BEDTools: a flexible suite of utilities for comparing genomic features. *Bioinformatics* 26, 841–842.
<https://doi.org/10.1093/BIOINFORMATICS/BTQ033>
- Rao, P.S., Saraswathyamma, C.K., Sethuraj, M.R., 1998. Studies on the relationship between yield and meteorological parameters of para rubber tree (*Hevea brasiliensis*). *Agric. For. Meteorol.* 90, 235–245.
- Rastas, P., 2017. Lep-MAP3: robust linkage mapping even for low-coverage whole genome sequencing data. *Bioinformatics* 33, 3726–3732.
<https://doi.org/10.1093/BIOINFORMATICS/BTX494>
- Rattanawong, R., 2012. QTL mapping in *Hevea brasiliensis* for analysing the genetic determinism of growth, latex production, and the macromolecular structure of natural rubber. Kasetsart University.
- Sando, T., Takaoka, C., Mukai, Y., Yamashita, A., Hattori, M., Ogasawara, N., Fukusaki, E., Kobayashi, A., 2008. Cloning and characterization of mevalonate pathway genes in a natural rubber producing plant, *hevea brasiliensis*. *Biosci. Biotechnol. Biochem.* 72. <https://doi.org/10.1271/bbb.80165>
- Sayurandi, S., Wirnas, D., Woelan, S., 2016. Analisis Daya Hasil Lateks Dan Heritabilitas Karakter Kuantitatif Dari Beberapa Genotipe Karet Pp/07/04. *J. Penelit. Karet* 7, 1–12. <https://doi.org/10.22302/ppk.jpk.v34i1.226>
- Seguin, M., Rodier-Goud, M., Lespinasse, D., 1997. Mapping SSR markers in rubber tree (*Hevea brasiliensis*) facilitated and enhanced by heteroduplex formation and template mixing, in: *Plant and Animal Genomes V Conference*. San Diego, USA, p. 66.
- Sethuraj, M.R., 1981. Yield components in *Hevea brasiliensis*— theoretical considerations. *Plant. Cell Environ.* 4, 81–83. <https://doi.org/10.1111/j.1365-3040.1981.tb00838.x>
- Shearman, J.R., Sangsrakru, D., Jomchai, N., Ruangareerate, P., Sonthirod, C., Naktang, C., Theerawattanasuk, K., Tragoonrung, S., Tangphatsornruang, S., 2015. SNP Identification from RNA Sequencing and Linkage Map Construction of Rubber Tree for Anchoring the Draft Genome. *PLoS One* 10, e0121961.
<https://doi.org/10.1371/JOURNAL.PONE.0121961>
- Solichin, M., Suwardin, D., Raswil, R., Santosa, A.M., Anwar, A., 2006. Pengolahan Bahan Olah Karet Rakyat, in: Wijaya, T., Boerhendhy, I., Suryaningtyas, H., Suwardin, D., Nancy, C. (Eds.), *Sapta Bina Usahatani Karet Rakyat*. Balai Penelitian Sembawa, Palembang, pp. 111–124.
- Souza, L.M., Gazaffi, R., Mantello, C.C., Silva, C.C., Garcia, D., Le Guen, V., Cardoso, S.E.A., Garcia, A.A.F., Souza, A.P., 2013. QTL Mapping of Growth-Related Traits in a Full-Sib Family of Rubber Tree (*Hevea brasiliensis*) Evaluated in a Sub-Tropical Climate. *PLoS One* 8.
<https://doi.org/10.1371/journal.pone.0061238>
- Statista, 2024. Average yield of natural rubber in India from financial year 2006 to 2019, with an estimate for 2020 [WWW Document]. URL <https://www.statista.com/statistics/1056259/india-natural-rubber-average-yield/> (accessed 12.1.24).
- Tang, C., Yang, M., Fang, Y., Luo, Y., Gao, S., Xiao, X., An, Z., Zhou, B., Zhang, B., Tan, X., Yeang, H.Y., Qin, Y., Yang, Jianghua, Lin, Q., Mei, H., Montoro, P., Long, X., Qi, J., Hua, Y., He, Z., Sun, M., Li, W., Zeng, X., Cheng, H., Liu, Y.,

- Yang, Jin, Tian, W., Zhuang, N., Zeng, R., Li, D., He, P., Li, Z., Zou, Z., Li, S., Li, C., Wang, J., Wei, D., Lai, C.Q., Luo, W., Yu, J., Hu, S., Huang, H., 2016. The rubber tree genome reveals new insights into rubber production and species adaptation. *Nat. Plants* 2, 1–10. <https://doi.org/10.1038/nplants.2016.73>
- Tang, C.R., Huang, D.B., Yang, J.H., Liu, S.J., Sakr, S., Li, H.P., Zhou, Y.H., Qin, Y.X., 2010. The sucrose transporter HbSUT3 plays an active role in sucrose loading to laticifer and rubber productivity in exploited trees of *Hevea brasiliensis* (para rubber tree). *Plant, Cell Environ.* 33, 1708–1720. <https://doi.org/10.1111/j.1365-3040.2010.02175.x>
- Taussky, H.H., Shorr, E., 1953. A Microcolorimetric Method for the Determination of Inorganic Phosphorus. *J. Biol. Chem.* 202, 675–685. [https://doi.org/10.1016/s0021-9258\(18\)66180-0](https://doi.org/10.1016/s0021-9258(18)66180-0)
- Tupy, J., 1989. Sucrose supply and utilization for latex production., in: D'Auzac, J., Jacob, J.L., Chrestin, H. (Eds.), *Physiology of Rubber Tree Latex*. CRC Press Inc., Boca Raton, FL, USA, pp. 179–218.
- Van Ooijen, J.W., 2009. MapQTL 6. Software for the mapping of quantitative trait loci in experimental populations of diploid species. *Kyazma B. V.*, Wageningen, Netherlands.
- Varghese, Y.A., 1992. Germplasm resources and genetic improvement, in: Sethuraj, Mathew (Eds.), *Natural Rubber: Biology, Cultivation and Technology*. Elsevier, pp. 88-115.
- Varghese, Y.A., Mydin, K.K., 2000. Genetic Improvement, in: George, P.J., Jacob, C.K. (Eds.), *Natural Rubber : Agromanagement and Crop Processing*. Rubber Research Institute of India, Rubber Board, Kottayam, India, pp. 36–46.
- Venkatachalam, P., Geetha, N., Sangeetha, P., And, Thulaseedharan, A., 2013. Natural rubber producing plants: An overview. *African J. Biotechnol.* 12. <https://doi.org/10.4314/ajb.v12i12>.
- Verma, S., Gupta, S., Bandhiwal, N., Kumar, T., Bharadwaj, C., Bhatia, S., 2015. High-density linkage map construction and mapping of seed trait QTLs in chickpea (*Cicer arietinum* L.) using Genotyping-by-Sequencing (GBS). *Sci. Reports* 2015 51 5, 1–14. <https://doi.org/10.1038/srep17512>
- Vijayakumar, K.R., Gohet, E., Thomas, K.U., Xiaodi, W., Sumarmadji, Rodrigo, L., Thanh, D.K., Sopchoke, P., Karunaichamy, K., Said, M.A.M., 2009. Special communication: Revised international notation for latex harvest technology. *J. Rubber Res.* 12, 103–115.
- Wickland, D.P., Battu, G., Hudson, K.A., Diers, B.W., Hudson, M.E., 2017. A comparison of genotyping-by-sequencing analysis methods on low-coverage crop datasets shows advantages of a new workflow, GB-eaSy. *BMC Bioinformatics* 18, 1–12. <https://doi.org/10.1186/S12859-017-2000-6/TABLES/5>
- Wu, W., Zhang, X., Deng, Z., An, Z., Huang, H., Li, W., Cheng, H., 2022. Ultrahigh-density genetic map construction and identification of quantitative trait loci for growth in rubber tree (*Hevea brasiliensis*). *Ind. Crops Prod.* 178, 114560. <https://doi.org/10.1016/J.INDCROP.2022.114560>
- Xia, Z., Liu, K., Zhang, S., Yu, W., Zou, M., He, L., Wang, W., 2018. An ultra-high density map allowed for mapping QTL and candidate genes controlling dry latex yield in rubber tree. *Ind. Crops Prod.* 120, 351–356.

<https://doi.org/10.1016/J.INDCROP.2018.04.057>

Yao, X., Chen, X., Wang, J., Zhou, J., Cai, M., Lin, W., 2017. Effect of clonal rootstocks on the growth and yield of hevea rubber. *J. Rubber Res.* 20, 203–212. <https://doi.org/10.1007/BF03449152/METRICS>

Zhang, L., Guo, D., Guo, L., Guo, Q., Wang, H., Hou, X., 2019. Construction of a high-density genetic map and QTLs mapping with GBS from the interspecific F1 population of *P. ostii* 'Fengdan Bai' and *P. suffruticosa* 'Xin Riyuejin.' *Sci. Hortic. (Amsterdam)*. 246, 190–200. <https://doi.org/10.1016/J.SCIENTA.2018.10.039>

Zuraina, W.K., Pudjianto, E., Udin, A., Kurniawati, N., Magdalena, E., Damarjati, S.N., 2022. Statistical of national leading estate crops commodity 2021-2023. Secretariate of Directorate General of Estates, Directorate General of Estates, Ministry of Agriculture, Jakarta.