

[< Back to results](#) | 1 of 2 [Next >](#)[↗ Export](#) [↓ Download](#) [🖨 Print](#) [✉ E-mail](#) [📄 Save to PDF](#) [★ Add to List](#) [More... >](#)[Full Text](#) | [View at Publisher](#)**Document type**Review • [Gold Open Access](#) • [Green Open Access](#)**Source type**

Journal

ISSN

14248220

DOI

10.3390/s21093052

[View more](#) ✓[Sensors](#) • [Open Access](#) • Volume 21, Issue 9 • 1 May 2021 • Article number 3052

Ganoderma boninense disease detection by near-infrared spectroscopy classification: A review

Mohd Hilmi Tan M.I.S.^a [✉](#), Jamlos M.F.^a [✉](#), Omar A.F.^b [✉](#), Dzaharudin F.^c [✉](#),Chalermwisutkul S.^d [✉](#), Akkaraekthalin P.^e [✉](#)[📁 Save all to author list](#)^a College of Engineering, Universiti Malaysia Pahang, Gambang, 26300, Malaysia^b School of Physics, Universiti Sains Malaysia, Gelugor, 11800, Malaysia^c Department of Mechanical, Kuliyyah of Engineering, International Islamic University Malaysia, Jalan Gombak, 53100, Malaysia^d The Sirindhorn International Thai-German Graduate School of Engineering (TGGS), King Mongkut's University of Technology North Bangkok, Bangkok, 10800, Thailand[View additional affiliations](#) ✓

4

Views count [?](#)[View all metrics](#) >**Abstract**

Author keywords

Indexed keywords

SciVal Topics

Metrics

Funding details

Abstract

Ganoderma boninense (G. boninense) infection reduces the productivity of oil palms and causes a serious threat to the palm oil industry. This catastrophic disease ultimately destroys the basal tissues of oil palm, causing the eventual death of the palm. Early detection of G. boninense is vital since there is no effective treatment to stop the continuing spread of the disease. This review describes past and future prospects of integrated research of near-infrared spectroscopy (NIRS), machine learning

Cited by 0 documents

Inform me when this document is cited in Scopus:

[Set citation alert >](#)**Related documents**

Near-Infrared Spectroscopy for Ganoderma Boninense Detection: An Outlook

Tan, M.I.S.M.H. , Jamlos, M.F. , Omar, A.F. (2022) *Lecture Notes in Electrical Engineering*

Geospatial technologies for detection and monitoring of Ganoderma basal stem rot infection in oil palm plantations: a review on sensors and techniques

Khosrokhani, M. , Khairunniza-Bejo, S. , Pradhan, B. (2018) *Geocarto International*

Application of Ground-Based LiDAR for Analysing Oil Palm Canopy Properties on the Occurrence of Basal Stem Rot (BSR) Disease

Husin, N.A. , Khairunniza-Bejo, S. , Abdullah, A.F. (2020) *Scientific Reports*[View all related documents based on references](#)


Find more related documents in Scopus based on:

[Authors](#) > [Keywords](#) >

classification for predictive analytics and signal processing towards an early *G. boninense* detection system. This effort could reduce the cost of plantation management and avoid production losses. Remarkably, (i) spectroscopy techniques are more reliable than other detection techniques such as serological, molecular, biomarker-based sensor and imaging techniques in reactions with organic tissues, (ii) the NIR spectrum is more precise and sensitive to particular diseases, including *G. boninense*, compared to visible light and (iii) hand-held NIRS for in situ measurement is used to explore the efficacy of an early detection system in real time using ML classifier algorithms and a predictive analytics model. The non-destructive, environmentally friendly (no chemicals involved), mobile and sensitive leads the NIRS with ML and predictive analytics as a significant platform towards early detection of *G. boninense* in the future. © 2021 by the authors. Licensee MDPI, Basel, Switzerland.


Author keywords

ML classifier algorithms; Near - infrared spectroscopy ; NIR spectrum; Oil palms

Indexed keywords 

SciVal Topics  

Metrics 

Funding details 

References (129)

[View in search results format >](#)

All

[Export](#)  [Print](#)  [E-mail](#)  [Save to PDF](#) [Create bibliography](#)

-
- 1 (2019) *Selected Agricultural Indicators*. Cited 26 times. Department of Statistics Malaysia. Malaysia. (accessed on 27 April 2021) <https://www.statista.com/map/asia/malaysia/agriculture>
-
- 2 (2020) *Economics and Industry Development Division: Overview of Industry 2019*. Malaysian Palm Oil Board. MPOB: Bandar Baru Bangi, Malaysia
-
- 3 Flood, J., Hasan, Y., Turner, P.D., O'Grady, E.B. The spread of *Ganoderma* from infective sources in the field and its implications for management of the disease in oil palm (2000) *Ganoderma Diseases of Perennial Crops*, pp. 101-112. Cited 36 times. CABI: Egham, UK
-
- 4 Naher, L., Yusuf, U.K., Ismail, A., Tan, S.G., Mondal, M.M.A. Ecological status of *Ganoderma* and basal stem rot disease of oil palms (*Elaeis guineensis* Jacq.) (2013) *Australian Journal of Crop Science*, 7 (11), pp. 1723-1727. Cited 38 times. http://www.cropl.com/naher_7_11_2013_1723_1727.pdf
-
- 5 Singh, G. *Ganoderma*-the scourge of oil palms [*Elaeis guineensis*] in the coastal areas [Peninsular Malaysia] (1991) *Planter (Malaysia)*, 67, pp. 421-444. Cited 76 times.
-

-
- 6 Susanto, A.
Basal stem rot in Indonesia. Biology, economic importance, epidemiology, detection and control
(2009) *Proceedings of the International Workshop on Awareness, Detection and Control of Oil Palm Devastating Diseases*. Cited 20 times.
Kuala Lumpur Convention Centre, Kuala Lumpur, Malaysia, 6 November
Universiti Putra Malaysia Press: Serdang, Malaysia, 2009
-
- 7 Miller, R.N.G.
(1995) *The Characterization of Ganoderma Populations in Oil Palm Cropping Systems*. Cited 15 times.
University of Reading: Reading, UK
-
- 8 Paterson, R.R.M.
Internal amplification controls have not been employed in fungal PCR hence potential false negative results ([Open Access](#))
(2007) *Journal of Applied Microbiology*, 102 (1), pp. 1-10. Cited 34 times.
doi: 10.1111/j.1365-2672.2006.03220.x
[View at Publisher](#)
-
- 9 Horbach, R., Navarro-Quesada, A.R., Knogge, W., Deising, H.B.
When and how to kill a plant cell: Infection strategies of plant pathogenic fungi
(2011) *Journal of Plant Physiology*, 168 (1), pp. 51-62. Cited 199 times.
doi: 10.1016/j.jplph.2010.06.014
[View at Publisher](#)
-
- 10 Walton, J.D.
Deconstructing the cell wall ([Open Access](#))
(1994) *Plant Physiology*, 104 (4), pp. 1113-1118. Cited 358 times.
<http://www.plantphysiol.org/>
doi: 10.1104/pp.104.4.1113
[View at Publisher](#)
-
- 11 Nusaibah, S.A., Siti Nor Akmar, A., Idris, A.S., Sariah, M., Mohamad Pauzi, Z.
Involvement of metabolites in early defense mechanism of oil palm (*Elaeis guineensis* Jacq.) against *Ganoderma* disease
(2016) *Plant Physiology and Biochemistry*, 109, pp. 156-165. Cited 24 times.
<http://www.journals.elsevier.com/plant-physiology-and-biochemistry/>
doi: 10.1016/j.plaphy.2016.09.014
[View at Publisher](#)
-
- 12 Ho, C.-L., Tan, Y.-C.
Molecular defense response of oil palm to *Ganoderma* infection ([Open Access](#))
(2015) *Phytochemistry*, 114, pp. 160-169. Cited 24 times.
<http://www.journals.elsevier.com/phytochemistry/>
doi: 10.1016/j.phytochem.2014.10.016
[View at Publisher](#)
-

- 13 Pusztahelyi, T., Holb, I.J., Pócsi, I.
Secondary metabolites in fungus-plant interactions
(Open Access)

(2015) *Frontiers in Plant Science*, 6 (AUG), art. no. 573. Cited 210 times.
<http://journal.frontiersin.org/article/10.3389/fpls.2015.00573/pdf>
doi: 10.3389/fpls.2015.00573

View at Publisher
-
- 14 Ahuja, I., Kissen, R., Bones, A.M.
Phytoalexins in defense against pathogens

(2012) *Trends in Plant Science*, 17 (2), pp. 73-90. Cited 524 times.
doi: 10.1016/j.tplants.2011.11.002

View at Publisher
-
- 15 Iriti, M., Faoro, F.
Chemical diversity and defence metabolism: How plants cope with pathogens and ozone pollution (Open Access)

(2009) *International Journal of Molecular Sciences*, 10 (8), pp. 3371-3399. Cited 166 times.
<http://www.mdpi.com/1422-0067/10/8/3371/pdf>
doi: 10.3390/ijms10083371

View at Publisher
-
- 16 Kandan, A., Bhaskaran, R., Samiyappan, R.
Ganoderma - a basal stem rot disease of coconut palm in south Asia and Asia pacific regions

(2010) *Archives of Phytopathology and Plant Protection*, 43 (15), pp. 1445-1449. Cited 20 times.
doi: 10.1080/03235400802536527

View at Publisher
-
- 17 Tinker, P.B.
(2008) *The Oil Palm*. Cited 761 times.
Corley, V.R.H.; John Wiley & Sons: Hoboken, NJ, USA
-
- 18 Balick, M.J., Turner, P.D.
Oil Palm Diseases and Disorders
(1982) *Brittonia*, 34, p. 364.
-
- 19 Turner, D.P., Gillbanks, R.A.
(1974) *Oil Palm Cultivation and Management*. Cited 118 times.
Incorporated Society of Planters: Kuala Lumpur, Malaysia
-
- 20 Chong, K.P., Dayou, J., Alexander, A.
Pathogenic Nature of *Ganoderma boninense* and Basal Stem Rot Disease
(2017) *Detection and Control of Ganoderma boninense in Oil Palm Crop*, pp. 5-12. Cited 19 times.
Springer: Berlin/Heidelberg, Germany
-

-
- 21 Ariffin, D., Idris, A.S.
(2002) *Progress and Research on Ganoderma Basal Stem Rot of Oil Palm*. Cited 2 times.
L-0562); MPOB: Bandar Baru Bangi, Malaysia
-
- 22 Hushiarian, R., Yusof, N.A., Dutse, S.W.
Detection and control of *Ganoderma boninense*: Strategies and perspectives ([Open Access](#))

(2013) *SpringerPlus*, 2 (1), art. no. 555, pp. 1-12. Cited 85 times.
<http://www.springerplus.com/archive>
doi: 10.1186/2193-1801-2-555

View at Publisher
-
- 23 PARKER, S.R., SHAW, M.W., ROYLE, D.J.
The reliability of visual estimates of disease severity on cereal leaves

(1995) *Plant Pathology*, 44 (5), pp. 856-864. Cited 81 times.
doi: 10.1111/j.1365-3059.1995.tb02745.x

View at Publisher
-
- 24 Wong, L.-C., Bong, C.-F.J., Idris, A.S.
Ganoderma species associated with basal stem rot disease of oil palm ([Open Access](#))

(2012) *American Journal of Applied Sciences*, 9 (6), pp. 879-885. Cited 42 times.
<http://thescpub.com/pdf/10.3844/ajassp.2012.879.885>
doi: 10.3844/ajassp.2012.879.885

View at Publisher
-
- 25 Asma, M., Noredine, K.C., Laid, D., Asma, A.K., Mounira, K.A., Philippe, T., Milet, A., (...), Kaki, A.A.
Flow cytometry approach for studying the interaction between *Bacillus mojavensis* and *Alternaria alternata*
(2016) *Afr. J. Biotechnol*, 15, pp. 1417-1428. Cited 2 times.
-
- 26 Milner, H., Ji, P., Sabula, M., Wu, T.
Quantitative polymerase chain reaction (Q-PCR) and fluorescent in situ hybridization (FISH) detection of soilborne pathogen *Sclerotium rolfsii*

(2019) *Applied Soil Ecology*, 136, pp. 86-92. Cited 5 times.
www.elsevier.com/inca/publications/store/5/2/4/5/1/8/index.html
doi: 10.1016/j.apsoil.2019.01.002

View at Publisher
-
- 27 Hu, Z., Chang, X., Dai, T., Li, L., Liu, P., Wang, G., Liu, P., (...), Liu, X.
Metabolic Profiling to Identify the Latent Infection of Strawberry by *Botrytis cinerea* ([Open Access](#))

(2019) *Evolutionary Bioinformatics*, 15. Cited 6 times.
http://www.la-press.com/journal.php?journal_id=17&issue_id=416&tab=volume&order_by=volume&max_results=50
doi: 10.1177/1176934319838518

View at Publisher
-

- 28 Bachika, N.A., Hashima, N., Wayayoka, A., Mana, H.C., Alia, M.M.
Optical imaging techniques for rice diseases detection: A review
(2020) *J. Agric. Food Eng*, 2, p. 1.
-
- 29 Webster, C.G., Turechek, W.W., Li, W., Kousik, C.S., Adkins, S.
Development and evaluation of ELISA and qRT-PCR for
identification of squash vein yellowing virus in cucurbits
([Open Access](#))

(2017) *Plant Disease*, 101 (1), pp. 178-185. Cited 3 times.
<http://apsjournals.apsnet.org/doi/pdfplus/10.1094/PDIS-06-16-0872-RE>
doi: 10.1094/PDIS-06-16-0872-RE

View at Publisher
-
- 30 Migliorini, D., Ghelardini, L., Luchi, N., Capretti, P., Onorari, M., Santini, A.
Temporal patterns of airborne *Phytophthora* spp. in a woody
plant nursery area detected using real-time PCR

(2019) *Aerobiologia*, 35 (2), pp. 201-214. Cited 5 times.
www.wkap.nl/journalhome.htm/0393-5965
doi: 10.1007/s10453-018-09551-1

View at Publisher
-
- 31 Suharti, W.S., Nose, A., Zheng, S.-H.
Metabolite profiling of sheath blight disease resistance in rice:
In the case of positive ion mode analysis by CE/TOF-MS
([Open Access](#))

(2016) *Plant Production Science*, 19 (2), pp. 279-290. Cited 11 times.
<http://www.tandfonline.com/doi/pdf/10.1080/1343943X.2016.1140006>
doi: 10.1080/1343943X.2016.1140006

View at Publisher
-
- 32 Khaled, A.Y., Abd Aziz, S., Bejo, S.K., Nawi, N.M., Seman, I.A., Onwude, D.I.
Early detection of diseases in plant tissue using spectroscopy–
applications and limitations ([Open Access](#))

(2018) *Applied Spectroscopy Reviews*, 53 (1), pp. 36-64. Cited 43 times.
www.tandf.co.uk/journals/titles/05704928.asp
doi: 10.1080/05704928.2017.1352510

View at Publisher
-
- 33 Zeng, H., Zhang, D., Zhai, X., Wang, S., Liu, Q.
Enhancing the immunofluorescent sensitivity for detection of
Acidovorax citrulli using fluorescein isothiocyanate labeled
antigen and antibody

(2018) *Analytical and Bioanalytical Chemistry*, 410 (1), pp. 71-77. Cited 11
times.
link.springer.de/link/service/journals/00216/index.htm
doi: 10.1007/s00216-017-0690-2

View at Publisher
-
- 34 Krawczyk, K., Uszczyńska-Ratajczak, B., Majewska, A., Borodynko-Filas, N.
DNA microarray-based detection and identification of
bacterial and viral pathogens of maize

(2017) *Journal of Plant Diseases and Protection*, 124 (6), pp. 577-583. Cited 6
times.
<http://link.springer.com/journal/41348>
doi: 10.1007/s41348-017-0098-4

View at Publisher

- 35 Darmono, T.W.
Detection of basal stem rot disease of oil palm using polyclonal antibody
(1999) *Menara Perkeb*, 67, pp. 32-39. Cited 3 times.
-
- 36 Ananthanarayanan, V.T., Reddy, M.K.
Serological test for the diagnosis of *Ganoderma lucidum*
(1984) *Curr. Sci*, 53, pp. 97-98. Cited 2 times.
-
- 37 Ariffin, D., Idris, S., Khairudin, H.
Conformation of ganoderma infected palm by drilling technique
(1995) *PORIM International Palm Oil Congress (No. L-0314)*. Cited 2 times.
PORIM: Kuala Lumpur, Malaysia
-
- 38 Idris, A.S., Rajinder, S., Madihah, A.Z., Wahid, M.B.
Multiplex PCR-DNA kit for early detection and identification of *Ganoderma*
species in oil palm
(2010) *MPOB Information Series TS*, 531. Cited 15 times.
MPOB: Bandar Baru Bangi, Malaysia
-
- 39 Idris, A.S., Mazliham, M.S., Loonis, P., Wahid, M.B.
GanoSken for early detection of *Ganoderma* infection in oil palm
(2010) *MPOB Information Series TT*, 442. Cited 10 times.
MPOB: Bandar Baru Bangi, Malaysia
-
- 40 Dutse, S.W., Yusof, N.A., Ahmad, H., Hussein, M.Z., Zainal, Z.
An electrochemical DNA biosensor for ganoderma boninense
pathogen of the oil palm utilizing a new ruthenium complex,
[ru(dppz)₂(qtpy)]Cl₂

(2012) *International Journal of Electrochemical Science*, 7 (9), pp. 8105-
8115. Cited 18 times.
<http://www.electrochemsci.org/papers/vol7/7098105.pdf>
-
- 41 Yeong, T.J., Jern, K.P., Yao, L.K., Hannan, M.A., Hoon, H.T.G.
Applications of photonics in agriculture sector: A review
(Open Access)

(2019) *Molecules*, 24 (10), art. no. 24. Cited 10 times.
<https://www.mdpi.com/1420-3049/24/10/2025/pdf>
doi: 10.3390/molecules24102025

View at Publisher
-
- 42 López, M.M., Bertolini, E., Olmos, A., Caruso, P., Gorris, M.T., Llop,
P., Penyalver, R., (...), Cambra, M.
Innovative tools for detection of plant pathogenic viruses and
bacteria (Open Access)

(2003) *International Microbiology*, 6 (4), pp. 233-243. Cited 192 times.
<http://www.im.microbios.org/>
doi: 10.1007/s10123-003-0143-y

View at Publisher
-

- 43 Ray, M., Ray, A., Dash, S., Mishra, A., Achary, K.G., Nayak, S., Singh, S.
Fungal disease detection in plants: Traditional assays, novel diagnostic techniques and biosensors
(2017) *Biosensors and Bioelectronics*, 87, pp. 708-723. Cited 68 times.
www.elsevier.com/locate/bios
doi: 10.1016/j.bios.2016.09.032
View at Publisher
-
- 44 García-Sánchez, F., Galvez-Sola, L., Nicolás, J., Muelas-Domingo, R., Nieves, M.
Using Near-Infrared Spectroscopy in Agricultural Systems
(2017) *Dev. Near-Infrared Spectrosc.* Cited 15 times.
J.M
-
- 45 Blanco, M., Villarroya, I.
NIR spectroscopy: A rapid-response analytical tool
(2002) *TrAC - Trends in Analytical Chemistry*, 21 (4), pp. 240-250. Cited 569 times.
doi: 10.1016/S0165-9936(02)00404-1
View at Publisher
-
- 46 Liaghat, S., Ehsani, R., Mansor, S., Shafri, H.Z.M., Meon, S., Sankaran, S., Azam, S.H.M.N.
Early detection of basal stem rot disease (Ganoderma) in oil palms based on hyperspectral reflectance data using pattern recognition algorithms (Open Access)
(2014) *International Journal of Remote Sensing*, 35 (10), pp. 3427-3439. Cited 47 times.
<https://www.tandfonline.com/loi/tres20>
doi: 10.1080/01431161.2014.903353
View at Publisher
-
- 47 Wu, D., Feng, L., Zhang, C., He, Y.
Early detection of Botrytis cinerea on eggplant leaves based on visible and near-infrared spectroscopy
(2008) *Transactions of the ASABE*, 51 (3), pp. 1133-1139. Cited 59 times.
-
- 48 Manley, M.
Near-infrared spectroscopy and hyperspectral imaging: Non-destructive analysis of biological materials (Open Access)
(2014) *Chemical Society Reviews*, 43 (24), pp. 8200-8214. Cited 270 times.
<http://pubs.rsc.org/en/journals/journal/cs>
doi: 10.1039/c4cs00062e
View at Publisher
-
- 49 De Beer, T., Burggraave, A., Fonteyne, M., Saerens, L., Remon, J.P., Vervaet, C.
Near infrared and Raman spectroscopy for the in-process monitoring of pharmaceutical production processes (Open Access)
(2011) *International Journal of Pharmaceutics*, 417 (1-2), pp. 32-47. Cited 366 times.
www.elsevier.com/locate/ijpharm
doi: 10.1016/j.ijpharm.2010.12.012
View at Publisher

- 50 Sun, Y.
(2013) *Comparison and Combination of Near-Infrared and Raman Spectra for PLS and NAS Quantitation of Glucose, Urea and Lactate*. Cited 4 times.
ProQuest LLC.: Ann Arbor, MI, USA
-
- 51 Beć, K.B., Grabska, J., Huck, C.W.
Near-infrared spectroscopy in bio-applications (Open Access)
(2020) *Molecules*, 25 (12), art. no. 25122948. Cited 25 times.
<https://www.mdpi.com/1420-3049/25/12/2948/pdf>
doi: 10.3390/molecules25122948
View at Publisher
-
- 52 Isha, A., Yusof, N.A., Shaari, K., Osman, R., Abdullah, S.N.A., Wong, M.-Y.
Metabolites identification of oil palm roots infected with *Ganoderma boninense* using GC–MS-based metabolomics (Open Access)
(2020) *Arabian Journal of Chemistry*, 13 (7), pp. 6191-6200. Cited 3 times.
<http://colleges.ksu.edu.sa/Arabic%20Colleges/CollegeOfScience/ChemicalDept/AJC/default.aspx> (ScienceDirect)
<http://www.sciencedirect.com/science/journal/18785352>
doi: 10.1016/j.arabjc.2020.05.026
View at Publisher
-
- 53 Isha, A., Akanbi, F.S., Yusof, N.A., Osman, R., Mui-Yun, W., Abdullah, S.N.A.
An NMR metabolomics approach and detection of *ganoderma boninense*-infected oil palm leaves using MWCNT-based electrochemical sensor (Open Access)
(2019) *Journal of Nanomaterials*, 2019, art. no. 4729706. Cited 5 times.
<http://www.hindawi.com/journals/jnm/>
doi: 10.1155/2019/4729706
View at Publisher
-
- 54 Khaled, A.Y., Abd Aziz, S., Bejo, S.K., Nawi, N.M., Abu Seman, I.
Spectral features selection and classification of oil palm leaves infected by Basal stem rot (BSR) disease using dielectric spectroscopy (Open Access)
(2018) *Computers and Electronics in Agriculture*, 144, pp. 297-309. Cited 23 times.
www.elsevier.com/inca/publications/store/5/0/3/3/0/4
doi: 10.1016/j.compag.2017.11.012
View at Publisher
-
- 55 Khaled, A.Y., Abd Aziz, S., Khairunniza Bejo, S., Mat Nawi, N., Abu Seman, I., Izzuddin, M.A.
Development of classification models for basal stem rot (BSR) disease in oil palm using dielectric spectroscopy (Open Access)
(2018) *Industrial Crops and Products*, 124, pp. 99-107. Cited 17 times.
www.elsevier.com/inca/publications/store/5/2/2/8/2/5
doi: 10.1016/j.indcrop.2018.07.050
View at Publisher
-
- 56 Dayou, J., Alexander, A., Sipaut, C.S., Phin, C.K., Chin, L.P.
On the possibility of using FTIR for detection of *Ganoderma boninense* in infected oil palm tree
(2014) *Int. J. Adv. Agric. Environ. Eng.*, 1, pp. 161-163. Cited 6 times.

- 57 Alexander, A.
Sensitivity analysis of the detection of *Ganoderma boninense* infection in oil palm using FTIR
(2014) *Trans. Sci. Technol*, 1, pp. 1-5. Cited 3 times.
-
- 58 Abdullah, A.H., Shakaff, A.Y.M., Adom, A.H., Ahmad, M.N., Zakaria, A., Ghani, S.A., Samsudin, N.M., (...), Hamid, N.H.
P2.1.7 Exploring MIP Sensor of Basal Stem Rot (BSR) Disease in Palm Oil Plantation
Proceedings of the Proceedings IMCS 2012, pp. 1348-1351. Cited 3 times.
Nuremberg, Germany, 20–23 May 2012
-
- 59 Liaghat, S., Mansor, S., Ehsani, R., Shafri, H.Z.M., Meon, S., Sankaran, S.
Mid-infrared spectroscopy for early detection of basal stem rot disease in oil palm

(2014) *Computers and Electronics in Agriculture*, 101, pp. 48-54. Cited 32 times.
www.elsevier.com/inca/publications/store/5/0/3/3/0/4
doi: 10.1016/j.compag.2013.12.012

View at Publisher
-
- 60 Shafri, H.Z.M., Anuar, M.I., Seman, I.A., Noor, N.M.
Spectral discrimination of healthy and ganoderma-infected oil palms from hyperspectral data ([Open Access](#))

(2011) *International Journal of Remote Sensing*, 32 (22), pp. 7111-7129. Cited 43 times.
<https://www.tandfonline.com/loi/tres20>
doi: 10.1080/01431161.2010.519003

View at Publisher
-
- 61 Ahmadi, P., Muharam, F.M., Ahmad, K., Mansor, S., Seman, I.A.
Early detection of ganoderma basal stem rot of oil palms using artificial neural network spectral analysis ([Open Access](#))

(2017) *Plant Disease*, 101 (6), pp. 1009-1016. Cited 41 times.
<http://apsjournals.apsnet.org/doi/pdf/10.1094/PDIS-12-16-1699-RE>
doi: 10.1094/PDIS-12-16-1699-RE

View at Publisher
-
- 62 Deshmukh, K., Sankaran, S., Ahamed, B., Sadasivuni, K.K., Pasha, K.S.K., Ponnamma, D., Rama Sreekanth, P.S., (...), Chidambaram, K.
Dielectric Spectroscopy

(2017) *Spectroscopic Methods for Nanomaterials Characterization*, 2, pp. 237-299. Cited 21 times.
<http://www.sciencedirect.com/book/9780323461405>
ISBN: 978-032346146-7; 978-032346140-5
doi: 10.1016/B978-0-323-46140-5.00010-8

View at Publisher
-
- 63 Brandl, H.
Detection of fungal infection in *Lolium perenne* by Fourier transform infrared spectroscopy ([Open Access](#))

(2013) *Journal of Plant Ecology*, 6 (4), pp. 265-269. Cited 7 times.
doi: 10.1093/jpe/rts043

View at Publisher
-

- 64 Alexander, A., Dayou, J., Sipaut, C.S., Phin, C.K., Chin, L.P.
Some interpretations on FTIR results for the detection of *Ganoderma boninense* in oil palm tissue
(2014) *Advances in Environmental Biology*, 8 (14), pp. 30-32. Cited 5 times.
<http://www.aensiweb.com/old/aeb/Special%207%20ICEBS%202014/30-32.pdf>
-
- 65 Lelong, C.C.D., Roger, J.-M., Brégand, S., Dubertret, F., Lanore, M., Sitorus, N.A., Raharjo, D.A., (...), Caliman, J.-P.
Evaluation of oil-palm fungal disease infestation with canopy hyperspectral reflectance data (Open Access)
(2010) *Sensors*, 10 (1), pp. 734-747. Cited 53 times.
<http://www.mdpi.com/1424-8220/10/1/734/pdf>
doi: 10.3390/s100100734
View at Publisher
-
- 66 Knipling, E.B.
Physical and physiological basis for the reflectance of visible and near-infrared radiation from vegetation
(1970) *Remote Sensing of Environment*, 1 (3), pp. 155-159. Cited 762 times.
doi: 10.1016/S0034-4257(70)80021-9
View at Publisher
-
- 67 Liang, P.-S., Slaughter, D.C., Ortega-Beltran, A., Michailides, T.J.
Detection of fungal infection in almond kernels using near-infrared reflectance spectroscopy
(2015) *Biosystems Engineering*, 137, pp. 64-72. Cited 25 times.
<http://www.elsevier.com/inca/publications/store/6/2/2/7/9/5/index.htm>
doi: 10.1016/j.biosystemseng.2015.07.010
View at Publisher
-
- 68 *A Guide to Near-Infrared Spectroscopic Analysis of Industrial Manufacturing Processes*. Cited 3 times.
8.108.5026EN, M.M. British Grassland Society: Herisau, Switzerland
-
- 69 Murray, I.
Forage analysis by near infrared spectroscopy
(1993) *Sward Measurement Handbook*, pp. 285-312. Cited 120 times.
British Grassland Society: Kenilworth, UK
-
- 70 Gurrapu, S., Soucek, M.
(2015) *Innovate in Industrial and Optical Sensing Applications Using Award-Winning DLP® Technology*
Texas Instruments: Dallas, TX, USA
-
- 71 Givens, D.I., De Boever, J.L., Deaville, E.R.
The principles, practices and some future applications of near infrared spectroscopy for predicting the nutritive value of foods for animals and humans (Open Access)
(1997) *Nutrition Research Reviews*, 10, pp. 83-114. Cited 96 times.
<http://journals.cambridge.org/NRR>
doi: 10.1079/NRR19970006
View at Publisher

-
- 72 Kuda-Malwathumullage, C.P.
(2013) *Applications of Near-Infrared Spectroscopy in Temperature Modeling of Aqueous-Based Samples and Polymer Characterization*
University of Iowa: Iowa, IA, USA
-
- 73 Vranic, B.Z.
(2015) *Design of Experiments Methodology in Studying Near-Infrared Spectral Information of Model Intact Tablets, in Simultaneous Determination of Metoprolol Tartrate and Hydrochlorothiazide in Solid Dosage Forms and Powder Compressibility Assessment Using Near-Infrared Spectroscopy*
University of Basel: Basel, Switzerland
-
- 74 Davies, A.M.C.
An introduction to near infrared (NIR) spectroscopy
(2014) *J. Near Infrared Spectrosc.* Cited 2 times.
(accessed on 24 June 2020)
<https://www.impopen.com/introduction-near-infrared-nir-spectroscopy>.
-
- 75 Deaville, E.R., Flinn, P.C.
Near-infrared (NIR) spectroscopy: An alternative approach for the estimation of forage quality and voluntary intake
(2009) *Forage Eval. Rumin. Nutr.*, pp. 301-320. Cited 114 times.
-
- 76 Gislum, R., Micklander, E., Nielsen, J.P.
Quantification of nitrogen concentration in perennial ryegrass and red fescue using near-infrared reflectance spectroscopy (NIRS) and chemometrics

(2004) *Field Crops Research*, 88 (2-3), pp. 269-277. Cited 55 times.
doi: 10.1016/j.fcr.2004.01.021

View at Publisher
-
- 77 Zhang, Y., Li, M., Zheng, L., Zhao, Y., Pei, X.
Soil nitrogen content forecasting based on real-time NIR spectroscopy

(2016) *Computers and Electronics in Agriculture*, 124, pp. 29-36. Cited 39 times.
www.elsevier.com/inca/publications/store/5/0/3/3/0/4
doi: 10.1016/j.compag.2016.03.016

View at Publisher
-
- 78 Omar, A.F., Atan, H., Matjafri, M.Z.
Peak response identification through near-infrared spectroscopy analysis on aqueous sucrose, glucose, and fructose solution

(2012) *Spectroscopy Letters*, 45 (3), pp. 190-201. Cited 30 times.
doi: 10.1080/00387010.2011.604065

View at Publisher
-

□ 79 Haq, Q.M.I., Mabood, F., Naureen, Z., Al-Harrasi, A., Gilani, S.A., Hussain, J., Jabeen, F., (...), Al-Bahaisi, I.M.
Application of reflectance spectroscopies (FTIR-ATR & FT-NIR) coupled with multivariate methods for robust in vivo detection of begomovirus infection in papaya leaves
(2018) *Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy*, 198, pp. 27-32. Cited 4 times.
doi: 10.1016/j.saa.2018.02.065

[View at Publisher](#)

□ 80 Lim, J., Kim, G., Mo, C., Oh, K., Yoo, H., Ham, H., Kim, M.S.
Classification of Fusarium-infected korean hulled barley using near-infrared reflectance spectroscopy and partial least squares discriminant analysis ([Open Access](#))
(2017) *Sensors (Switzerland)*, 17 (10), art. no. 2258. Cited 7 times.
<http://www.mdpi.com/1424-8220/17/10/2258/pdf>
doi: 10.3390/s17102258

[View at Publisher](#)

🔍 Jamlos, M.F.; College of Engineering, Universiti Malaysia Pahang, Gambang, Malaysia; email:mohdfaizaljamlos@gmail.com

© Copyright 2021 Elsevier B.V., All rights reserved.

[< Back to results](#) | 1 of 2 [Next >](#)

[^ Top of page](#)

About Scopus

[What is Scopus](#)
[Content coverage](#)
[Scopus blog](#)
[Scopus API](#)
[Privacy matters](#)

Language

[日本語に切り替える](#)
[切换到简体中文](#)
[切换到繁體中文](#)
[Русский язык](#)

Customer Service

[Help](#)
[Contact us](#)

ELSEVIER

[Terms and conditions ↗](#) [Privacy policy ↗](#)

Copyright © Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.

We use cookies to help provide and enhance our service and tailor content. By continuing, you agree to the use of cookies.

 RELX