**Supplementary Table** 1 The latest related papers of chlorophyll or nitrogen quantification with spectral methods.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Species | Number of Samples | Level | Detector and spectral range | Important wavelength | Pigment | Manual measurement | R² | Chlorophyll/ nitrogen distribution | Data processing tool | Reference |
| Cyanobacteria in turbid productive water | 55 | Remote sensing | 348-1074 nmASD FieldSpec UV–VNIR spectroradiometer | 620 nm, 665 nm | Chlorophyll aphycocyanin | TD-700 Fluorometer | 0.40-0.77 | -- | -- | ([Randolph et al., 2008](#_ENREF_20)) |
| Grass and herb species | 45 | Canopy | 350-2500 nmGER 3700 spectroradiometer | --(red edge inflection point (REIP), stepwise regression and partial least squares regression) | Total chlorophyll | SPAD-502 Leaf Chlorophyll Meter | 0.25-0.69 | -- | MATLAB | ([Darvishzadeh et al., 2008](#_ENREF_3)) |
| 9 crops (garlic, alfalfa, onion, sunflower, corn, potato, sugar beet, vineyard and wheat) | 131 | Remote sensing | 400-1050 nmCHRIS (Compact High Resolution Imaging Spectrometer) | 643-795 nm | Total chlorophyll | CCM-200 Chlorophyll Content Meter | 0.83 | Yes | -- | ([Delegido et al., 2010](#_ENREF_4)) |
| Cucumber | 100 | Leaf | 400-1000 nmhyperspectral imaging system （Specim V10E） | 680-780 nm | Total chlorophyll | Spectrophotometer | 0.69 | Yes | MATLABENVI | ([Zou et al., 2011](#_ENREF_34)) |
| Cucumber | 120 | Leaf | 900-1700 nmhyperspectral imaging system （ImSpector, VI7E, Spectra Imaging） | --(PCA) | Chlorophyll aChlorophyll bTotal chlorophyll | HPLC | 0.76 | Yes | MATLABENVI | ([Shi et al., 2012](#_ENREF_21)) |
| Urban vegetation: London plane, Canary Island date palm, European nettle tree and White mul-berry | 320 | Canopy | 350-1200 nmCASI imagery | 643-795 nm | Chlorophyll aChlorophyll bTotal chlorophyll | Spectrophotometer, SPAD-502 chlorophyll meter | 0.87-0.92 | Yes | -- | ([Delegido et al., 2014](#_ENREF_5)) |
| Scots pine shoots |  | Leaf | 400-2200 nmhyperspectral LiDAR instrument | 705 nm, 750 nm | Chlorophyll aChlorophyll bTotal chlorophyll | Porra method | 0.88 | Yes | -- | ([Nevalainen et al., 2014](#_ENREF_18)) |
| Chlorophyll a in lake | 38 | Canopy | 350-1075 nmASD FieldSpec Spectrophotometer | 653 nm, 691 nm, and 748 nm | Chlorophyll a | UV-2501 spectrophotometer | 0.57-0.85 | Yes | MATLAB | ([Zhou et al., 2014](#_ENREF_32)) |
| Cotton | 193 | Canopy | 350-2500 nmASD FieldSpec FR | 515-550 nm, 715 nm, and 750 nm | Carotenoids | Spectrophotometer | 0.456-0.563 | -- | -- | ([Yi et al., 2014](#_ENREF_29)) |
| Winter wheat | 218 | Canopy | 300-1150 nmPassive spectrometer (tec5,Oberursel,Germany) | 662 nm, 682 nm | Nitrogen | -- | 0.79-0.90 | -- | MATLAB | ([Li et al., 2014](#_ENREF_14)) |
| Barley and synthetic | 294 | Canopy | 350-1800 nmQualitySpec Pro and FieldSpec 3 spectroradiometers | 505 nm, 515nm, 525 nm, 535 nm,540 nm, 555 nm, 570 nm, 615 nm, 675 nm, 700 nm, 725 nm, 730 nm, 735 nm, 785 nm | Total chlorophyll | UV–VIS spectrophotometer | 0.65-0.98 | -- | SAS | ([Yu et al., 2014](#_ENREF_30)) |
| Mosses and vascular plants | 26 | Leaf | 325-1075 nmCompact Airborne Spectrographic Imager 2 (CASI-2) | 705 nm and red edge | Total chlorophyllNitrogen | Elemental analyzer | 0.29-0.32 | Yes | -- | ([Kalacska et al., 2015](#_ENREF_12)) |
| Black spruce and trembling aspen | 600 | Leaf Canopy | 400-2500 nmASD spectroradiometer Fieldspec Pro FR | --PROSPECT model: Blue 456-475 nm, Green 544-564 nm, Red 620-670 nm, NIR 837-876 nm, SWIR 1616-1644 nm | Total chlorophyll | Cary-1 Spectrophotometer | 0.75-0.99 | Yes | GeoDa software package | ([Croft et al., 2015](#_ENREF_2)) |
| Potato | 270 | Leaf | 401-982 nmAirborne Imaging Spectrometer for Applications (AISA Eagle) | 713 nm, 751 nm | Nitrogen | Combustion analyzer | 0.77-0.79 | -- | ENVI | ([Nigon et al., 2015](#_ENREF_19)) |
| Rice | 150 | Canopy | 350-1000 nmASD Field Spec Pro spectrometer | 640 nm, 732 nm and 752 nm | Total chlorophyll | SPAD-502 | 0.89 | Yes | -- | ([Li et al., 2015](#_ENREF_16)) |
| Maple, Chestnut, Beech | 90 | Leaf | 400-800 nmHitachi 150–20 spectrophotometer, 2101 PC spectrophotometer | --(NN and PLS) | Total chlorophyllCarotenoids | Reflectance measurement | 0.70-0.97 | -- | -- | ([Kira et al., 2015](#_ENREF_13)) |
| Lettuce | 140 | Leaf | 380-1012 nmA-Series VNIR Micro-Hyperspec Sensor(Headwall Photonics, Fitchburg, MA, USA) | 677 nm, 744 nm, 904 nm | Total chlorophyll | PCSTestr 35 | 0.92 | -- | -- | ([Simko et al., 2015](#_ENREF_22)) |
| Winter wheat | 407 | Remote sensing | 325-1075 nmASD FieldSpec Handheld spectrometer (Analytical Spectral Devices Inc., USA) | 419 nm, 742 nm and 759 nm | Total chlorophyllNitrogen | Micro-Kjeldahl method | 0.788-0.813 | -- | MATLAB | ([Feng et al., 2015](#_ENREF_7)) |
| Ponds (surface water) | 120 | Canopy | 400-1000 nmAn imaging spectrograph (Imspector V10E, SpectralImagingLtd., Oulu,Finland) | 666 nm, 702 nm | Chlorophyll a | Spectrophotometer | 0.82-0.96 | Yes | -- | ([Wang et al., 2016](#_ENREF_26)) |
| Winter oilseed rape |  | Canopy | 350-2500 nmAnalytical Spectral Devices Field Spec Pro spectrometer (ASD, Boulder, CO, USA) | 680-760 nm | Total chlorophyll | UV-5200 spectrophotometer | 0.88 | -- | -- | ([Li et al., 2016](#_ENREF_15)) |
| Rice | 24 | CanopyRemote sensing | 350-1050 nm400-2500 nmportable spectroradiometers (FieldSpec-FR, ASD)EO-1 Satellite of Hyperion sensor | 491 nm, 574 nm, 681 nm, 695 nm, 705 nm, 709 nm, 717 nm, 740 nm, 750 nm, 800 nm | Chlorophyll aChlorophyll bTotal chlorophyllNitrogen | Spectrophotometer, titration | 0.69-0.82 | Yes | ENVI | ([Moharana and Dutta, 2016](#_ENREF_17)) |
| Rice | 30 | Leaf | 300-920 nma photosensitive APD array | --(SVM) | Nitrogen | Kjeldahl analysis | 0.51-0.75 | -- | -- | ([Du et al., 2016](#_ENREF_6)) |
| Winter wheat | 237 | Canopy | 325-1075 nmASD FieldSpec HandHeld data-logger (Analytical Spectral Devices, Boulder, CO, USA) | Red-edge VIs (e.g., mND705, GND [750,550], NDRE, RI-1dB) | Nitrogen | Kjeldahl apparatus | 0.74-0.87 | -- | MATLAB | ([He et al., 2016a](#_ENREF_10)) |
| Winter wheat | 17463 | Canopy | 325-1075 nmASD FieldSpec HandHeld(Analytical Spectral Devices, Boulder, CO, USA) | 478 nm, 538 nm, 634 nm, 768 nm | Nitrogen | Micro-Kjeldahl method | 0.819-0.897 | -- | MATLAB | ([He et al., 2016b](#_ENREF_11)) |
| Winter wheat | 602 | Canopy | 325-1075 nmASD FieldSpec Handheld spec-trometer (Analytical Spectral Devices Inc., USA) | 680 nm, 700 nm, 725 nm, 756 nm | Nitrogen | Micro-Kjeldahl method | 0.831 | -- | MATLAB | ([Guo et al., 2016](#_ENREF_9)) |
| Winter wheat | 402 | Remote sensing | 325-1075 nmASD Field Spec Pro spectrometer (Analytical Spectral Devices, USA) | WRNI: [(R735 −R720)\*R900]/[Rmin(R930 −R980)\*(R735 + R720)] | Nitrogen | Dumas Elementary Analyser | 0.818-0.843 | -- | MATLAB | ([Feng et al., 2016](#_ENREF_8)) |
| Water (Microcystis algae blooms) | 29 | Remote sensing | 371-1042 nmA CASI-1500 VNIR airborne hyperspectral imaging system | 686 nm, 714 nm | Chlorophyll a | 10200H-2.b: Spectrophotometric | 0.12-0.84 | Yes | ENVI | ([Beck et al., 2016](#_ENREF_1)) |
| Corn | 66 | Leaf | 400-1000 nmSpectrometer | --(PLS) | Total chlorophyll | SPAD-502 meter | 0.612 | -- | MATLABENVI | ([Wu et al., 2016](#_ENREF_28)) |
| sunlit leaves, shaded leaves | 551 | Leaf | 400-2500 nmFieldSpec spectrometer | 550 nm, 672 nm, 708 nm | Total chlorophyll | UV-VIS spectrophotometer | 0.23-0.71 | -- | -- | ([Sonobe and Wang, 2016](#_ENREF_23)) |
| Winter wheat | 59 | Remote sensing | 350-2500 nmASD FieldSpec Pro spectrometer (Analytical Spectral Devices, Boulder, CO, USA) | 705 nm and red edge | Nitrogen | Kjeldahl method | 0.77-0.96 | -- | -- | ([Zhou et al., 2016](#_ENREF_33)) |
| Durum wheat | 2103 | Canopy | 268-1095 nmportable field spectroradiometer (GER 1500, Spectra Vista Corp., Poughkeepsie, New York) | 583-722 nm | Nitrogen | Carlo Erba elemental analyzer | 19.3%≤RMSECV≤ 36.3%. | -- | R | ([Thorp et al., 2017](#_ENREF_24)) |
| Spinach | 180 | Leaf | 874-1734 nmimaging spectrograph (ImSpector N17E; Spectral Imaging Ltd., Oulu, Finland) | --(PLS) | Chlorophyll aChlorophyll bTotal chlorophyllCarotenoids | Spectrophotometer | 0.660.660.710.79 | Yes | -- | ([Zhang et al., 2017](#_ENREF_31)) |
| Pure broadleaf, pure needle leaf, and mixed forest | 26 | Remote sensing | 400-2500 nmTwo imaging spectrometers | --(continuous wavelet analysis (CWA), PLSR) | Nitrogen | Measured in the laboratory | 0.65 | -- | MATLAB | ([Wang et al., 2017](#_ENREF_27)) |
| Grasses, forbs, and shrubs | 128 | leaf and canopy | 405-950 nmAnalytical Spectral Devices (ASD) FieldSpec 3 Max field portable spectroradiometer (Analytical Spectral Devices, Inc., Boulder, Colorado, USA) and an ASD Pro Lamp (Analytical Spectral Devices, Inc., Boulder, Colorado, USA) | 690-750 nm | Chlorophyll aChlorophyll bTotal chlorophyll | Spectrophotometer | 0.24-0.67 | Yes | -- | ([Tong and He, 2017](#_ENREF_25)) |
| Rice | 300 | Leaf | 400-1000 nmhyperspectral imaging spectrometers (HyperspecTM VNIR, Headwall Photonics, USA) | 700-760 nm | Chlorophyll aChlorophyll bTotal chlorophyllCarotenoid | Spectrophotometer | 0.654-0.928 | Yes | Image pipeline with LabVIEW | This present work in this article |

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