Volume 8, No. 5, May-June 2017
ISSN No. 0976-5697
International Journal of Advanced Research in Computer Science
REVIEW ARTICLE
Available Online at www.ijarcs.info

Estimation of Phosphorus Content in Leaves of Plants using PLSRand SVMR: A Review

Sushma D Guthe
Dept. of Computer Science and IT
Dr. BabasahebAmbedkarMarathwada University,
Aurangabad, India

Ratnadeep R Deshmukh
Dept of computer science and IT
Dr. BabasahebAmbedkarMarathwada University,
Aurangabad, India

Abstract: Phosphorus is one of the foremost necessary organic chemistry elements of plant organic matter and thus, estimation of their content will facilitate monitor the metabolism method and health of plants. Spectral coefficient values of leaves obtained by visible-near infrared spectrophotometry are reported to be a robust tool for the diagnosing of plant nutritionary standing. This study aimed to match Partial least squares Regression (PLSR) method and Support Vector Machine Regression (SVMR) method ways for estimating phosphorus(CP)contents gift in leaves of numerous plants exploitation laboratory-based visible and near-infrared (Vis-NIR) coefficient qualitative analysis. This paper states the work that is done on different crops at different places to observe the phosphorus content in crop leaves.

Keywords: Vis-NIR, Fieldspec4, Spectroscopy.

1. INTRODUCTION

Phosphorus iscrucial for chemical action,the method by that plants harvest energy from the sun to supply sugar molecules, i.e. sugars. These are transported to the plants storage organs like the foundation of sugar beet or the grain of wheat, rice, maize and also the potato tuber wherever the sugars are born-again to starch. This method is important to all or any life. All inexperienced plants contribute to primary production by photosynthetic activity in leaves that play a significant role during this process. Therefore, an adequate leaf space is crucial to plant regeneration for a continuing primary production. Phosphorus is noted particularly for its role in capturing and changing the sun's energy into helpful plant compounds. The word phosphorus is combining with two words phos means light and phorus means bringing.

Thus, phosphorus is crucial for the final health and vigor of all plants. Some specific growth factors that are related to phosphorus square measure stirred root development. Increased stalk and stem strength. Better flower development and seed production. Improvements in the crop quality; increased resistance to plant diseases; it supports development throughout the whole life cycle of the crop.

Farm managers aim to identify crop phosphorus status and supply the appropriate amount of fertilizers for optimal yield and phosphorus use efficiency. Substantial amounts of phosphorus fertilizer are necessary for commercial plants production because of the large biomass produced by plants crops, but excessive amounts negatively affect cane quality and increase susceptibility to pests. Therefore, efficient estimation of plant phosphorus status and appropriate Pfertilizer management are necessary for plants production.The individual suggest fertilizer rates rang-
ing between 60 and 120 kg N/ha, relying primaryon
soil type and plants selection. Scientist advises the growers to take leaf samples for phosphorus analysis to get information about the nutritional status of their crops and to correct any kind of phosphorus insufficiency by fertilization. However, the methods used for estimating leaf phosphorus contents are laborious, costly and time-consuming. The rapid and efficient method for estimating plants phosphorus concentration is, therefore necessary.

The use of imaging spectroscopic analysis methods to estimate the nutrient status of maturing crops may save time, and scale back the value related to sampling and analysis. Imaging spectrographic analysis is a technology that result in getting data in narrow (<10 nm) and contiguous spectral bands. These narrow spectral bands allow the detection of some spectral features that masked within the broader bands of the multispectral scanner.

Researchers have evaluated the use of imaging spectroscopy techniques for estimating phosphorus status of some crops such as Corn, wheat, sorghum, Tomato, sesame, soybean, grass, cucumber by determining the appropriate combination of wavelengths to characterize phosphorus deficiency.

2. RELATED WORK

Studies of the interrelationship Phosphorus uptake, plant phosphorus concentration and growth rate are central to an understanding of the role of phosphorus within plants. It is wide accepted that improved data on the factors dominant the acquisition and utilization of phosphorus by crops can facilitate to spot the constraints to developing simpler ways of P fertilization. These in result increase the efficiency of phosphorus use to the benefit of the environment.

Vegetation monitoring is an important application of remote sensing. Many satellite missions are launched with the aim of observation changes within the vegetation cowl over the world surface. Detecting phosphorus content in leaves of crops using biological responses is difficult, so more convenient and rapid detection methods are required.

William F. Cowen studied that leaves as a source of phosphorus by using chemical analysis work is done. Oak and poplar leaves are used for experiment [1].

R. C. Menary studies the result of phosphorus nutrition and Cytokininson Flowering within the Tomato, herbaceous plant Mill. He studies the Ten days of phosphorus deficiency results in a decrease in the number of flowers that develop on the first truss of tomato plants. Bioassay method is used [2].

C.A. JONES does the literature survey of the variability in tissue nitrogen and phosphorus concentrations in maize and grain sorghum [3].

Dominique Gillon founds that there were strong relationships between the spectral characteristics of the samples and their phosphorus content, both in living and dead pine needles and in the litter. The phosphorus concentration was measured by ICP spectrometry. Two PCAs were performed, one from the entire spectrum (400±2500 nm) and one from the near-infrared region only (1100±2500 nm) [4].

S. L. Osborne detected the phosphorus and nitrogen deficiencies in corn using spectral radiance measurements. The study demonstrated hyperspectral data can be used for estimating N and P concentration, biomass, and grain yield under the presence of a combination of nutrient stresses [5].Corine C. de Groot discussed the differences and similarities in the growth response of tomato plants to N and P limitation, and to their interaction. By doing chemical analysis researcher suggest that the decrease in N concentration with increasing P limitation is also mediate by a decrease in leaf growth regulator levels and is a smaller amount doubtless as a result of decreased energy availableness at low P conditions [6].

L.K. Christensen addresses the probabilities for prediction of atomic number 7 and phosphorus content in barley plants, severally, mistreatment hyperspectral canopy reflections non-inheritable beneath natural field conditions. Partial least square (PLS) regression was used on continuous spectra within the vary of 400–750nm and also the total N and P contents were established through chemical analyses and used as references [7].

I. Bogrekci and W.S. Lee found out phosphorus content in soil and grass using diffuse reflectance method. Researcher studied that, PLS analysis results were better than SMLR results. The work is done for finding out the higher concentration of phosphorus content in soil and grass so that some remediation strategies can be planned [8].

Stephen r. delwiche explored the feasibility of near-infrared (NIR) quantitative and qualitative models for soybean inorganic phosphorus, which is complementary to phytic acid, a component of nutritional and environmental importance. Partial Least-Squares Regression (PLSR) models were individually developed for soymeal diffuse reflectance, single-bean transmittance, and averaged (24 beans/line) whole seed transmittance data [9].

Jelle G. Ferwerda demonstrates the potential of hyperspectral remote sensing to predict the chemical composition (i.e., nitrogen, phosphoric, calcium, potassium, sodium, and magnesium) of 3 tree species (i.e., willow, mopane and olive) and one woody plant species. Phosphorous was measured with a Skalar San Plus auto-analyser. The reflectance spectra were recorded using a GER 3700 spectrometer [10].

SebahattinAlbayrakdetermines the relationships between nitrogen, phosphorus, potassium, acid detergent fiber and neutral detergent fiber contents of sainfoin pasture and canopy reflectance. Canopy coefficient measurements were created by employing a portable spectroradiometer. Stepwise regression method was used [11]. Zhang and Li applied SVMR and spectral data to estimate the phosphorus content present in cucumber leaves [12].

F. J. Ponzoni studied the spectral signature related to gas, phosphorus, and metallic element deficiencies in Eucalyptus saligna seed plant leaves. Researcher used simple and multiple regression techniques. Leaves of those seedlings were measured radiometrically so as to characterize spectrally the symptoms [13]. Agustin Pimstein Exploring remotely sensed technologies for monitoring wheat potassium and phosphorus using field spectroscopy. Israel. Traditional and recently developed vegetation indices, along with Partial least squares (PLS) regression models, were calculated so as to predict metallic element and phosphorus contents from the wheat cover spectral information [14].

Adebusoye O. Onanuga studied that Phosphorus, Potassium and Phytohormones Promote Chlorophyll Production Differently in Two Cotton Varieties Grown in Hydroponic Nutrient Solution [15].YanfangZhai concluded that the SVMR method combined with Vis-NIR reflectance has the potential to estimate the contents of biochemical components of different plants.. The Partial Least Square Regression and Support Vector Machine Regression methods were calibrated to estimate the Nitrogen, Phosphorus and potassium contents of the obtained samples from spectral reflectance [16].

Y. Özyigit determines the nitrogen, phosphorus, and potassium contents of rangeland plants using spectral reflectance value by using the portable spectroradiometer. Stepwise linear regression was wont to choose wavelengths to research relationships between laboratory analysis results and spectral information [17].G. R. Mahajan used regressive models for vegetation indices. The results of experiment suggest that radiometric measurements are often used for observance of N, P, S and K standing in an exceedingly wheat crop. Correlation analysis of nutrient status with leaf and canopy reflectance showed presence of responsive wavelengths to variable N, P, S and K status in wheat [18]

Liu Yanli studied that upper side or lower side of leaves give the better spectral signature. The linear of PLS model and nonlinear of LS-SVM model fit better with spectral data of the upper side and lower side of leaves, respectively [19].

Jagadeeswaran detect the nitrogen, phosphorus, potassium deficiencies in maize through hyperspectral remote sensing technique. GER1500 model was used to take the spectra. Detection of nutrient deficiency through Hyperspectral remote sensing is possible for nitrogen [20].

3. METHODOLOGY

L.K. Christensen used partial PLS for predicting nitrogen and phosphorus. Partial least-squares (PLS) regression modelling (Wold et al., 1984) was allotted on the filtered, scatter corrected, plant spectra at intervals every of the 3 growth stages and across all growth stages. The determination of the optimal number of principal components in the PLS regression was carried out based on the lowest root mean square error of prediction (RMSEP).C. Petisco used MLR and PLSR. Multiple linear regression and PLSR were used for developing NIR calibrations, using IDAS (InfraAlyzer Data Analysis System) and SESAME 3.10 (Bran&Luebbe, Germany) software, respectively.

Zhang, X. J was conducted the analysis between the phosphorus content of the cucumber leaf and therefore the computation of spectrum for every sample. The coefficients were improved. However, it was not high enough to

establish an estimation model. It shows that nonlinear model is required to estimate the phosphorus content of the crop leaf supported spectral coefficient of reflection. Artificial neural network (ANN) and support vector machine (SVM), the modern algorithm for modeling and estimating, were used to establish the nonlinear models.

Agustin Pimstein was used traditional vegetation indices to evaluate nutrient content in wheat crop. For the multivariate data analysis procedure, the Unscrambler 9.7 software was used to define different models and to predict biophysical data. Partial Least Squares (PLS) regression was used to find the best prediction of the biophysical variables.

Yanfang Zhai Estimation of nitrogen, phosphorus, and potassium contents in the leaves of different plants using laboratory-based visible and near-infrared reflectance spectroscopy. The PLSR and SVMR methods were calibrated to estimate the nitrogen, phosphorus, and potassium contents of the obtained samples from spectral reflectance. Cross-validation with an freelance knowledge set was used to assess the performance of the label models.

Liu Yanli predicts the content of nitrogen and phosphorus content in citrus leaves. Both the linear and the nonlinear calibration methods were used to retrieve the relationships between spectral data (X-variables) and nitrogen and phosphorus content (Y-variables). PLS analysis was used for linear calibrations and LS-SVM was used for nonlinear calibrations.

4. RESULT AND DISCUSSION

C. Petisco found that higher calibrations were obtained with PLSR than with MLR for the 3 components studied. Stephen R. Delwiche demonstrates that NIR reflectance of soybean meal are often used to give a gross estimate of Phosphorus concentration and as a method for classifying breeders' lines into classes of low and high Phosphorus. Zhang XJ found that non-linear model area unit sensible than the linear.

Stephen R. Delwiche demonstrates that NIR reflection factor of soy flour is wont to provide a gross estimate of Phosphorus concentration and as a method for classifying breeders' lines into classes of low and high Phosphorus. Agustin Pimstein confirms the robust result of the biomass within the spectral response of crop canopies. Yanfang Zhai founds that estimations of organic chemistry contents a lot of advanced at cover level than at leaf level and SVM technique prompt.

Liu Yanli found that victimization the hyperspectral information grouping and process system to handle upside of leaves will with success get nutrition standing of citrus leaves. Y. Özyigit study results, important relationships were determined between NPK levels and reflection factor values in spectral reflection factor measurements of Doyran land set in urban center.

5. CONCLUSION

Monitoring of Phosphorus levels in plants is a lot of essential for plant growth therefore field experiment showed a sensitivity of the spectral measurement to phosphorus application has in several levels of various plants. Phosphorus content gives stimulation to photosynthesis process. After statistical analysis of spectral knowledge we created a comparison with the results of leaf structure and nutrition analysis to relative spectral vegetation indices with the agronomical necessary crop characteristics.

5. ACKNOWLEDGEMENT

This work is supported by Dept. of Computer Science and Information Technology under the funds for Infrastructure under science and Technology (DST-FIST) with sanction no. SR/FST/ETI- 340/2013 to Dept. of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India. The authors would like to thank Department and University Authorities for providing the infrastructure and necessary support for carrying out the research.

REFERENCES

[1] William F. Cowen and G. Fred Lee"Leaves as a source of phosphorus" Environmental Science and Technology Volume 7, Number 9, September 1973.

[2] R. C. Menary and J. van Staden "Effect of Phosphorus Nutrition and Cytokinins on Flowering in the Tomato, Lycopersicon esculentum Mill." Australian Journal of Plant Physiology 3(2) 201 - 205, 1976.

[3] C.A. JONES "a survey of the variability in tissue nitrogen and phosphorus concentrations in maize and grain sorghum"Elsevier Scientific Publishing Company, Amsterdam Field Crops Research, Volume 6,pages 133—147,1983.

[4] Dominique Gillon, ClaudieHoussard, Richard Jo€re"Using near-infrared reflectance spectroscopy to predict carbon, nitrogen and phosphorus content in heterogeneous plant material"©Springer-Verlag, Oecologia, Volume 118, Issue 2, pp 173–182, February 1999.

[5] S. L. Osborne, J. S. Schepers, D. D. Francis, and M. R. Schlemmer"detection of phosphorus and nitrogen deficiencies in corn using spectral radiance measurements" Agronomy Journal,Volume 94, No. 6, p. 1215-1221, November–December 2002.

[6] CorineC. de Groot, Leo F. M. Marcelis, Riki van den Boogaard, WernerM. Kaiser andHansLambers"Interaction Of Nitrogen And Phosphorus Nutrition In Determining Growth" Plant and Soil Volume 248, Issue 1, pp 257–268, January 2003.

[7] L.K. Christensen1,B.S. Bennedsen; R.N. Jørgensen; H. Nielsen "Modelling Nitrogen and Phosphorus Content at Early Growth Stages in Spring Barley using Hyperspectral Line Scanning" Biosystems Engineering,Volume 88, Issue 1, Pages 19–24, May 2004.

[8] I. Bogrekci , W.S. Lee"Spectral Phosphorus Mapping using Diffuse Reflectance of Soils and Grass" Biosystems Engineering, Volume 91, Issue 3, Pages 305–312, July 2005.

[9] Stephen r. delwiche, Lester o. pordesimo, Andrew m. scaboo, and Vincent r. pantalone "measurement of inorganic phosphorus in soybeans with near-infrared spectroscopy" J. Agric. Food Chem., 54 (19), pp 6951–6956, 2006.

[10] Jelle G. Ferwerda, Andrew K. Skidmore "Can nutrient status of four woody plant species be predicted using field spectrometry?" ISPRS Journal of Photogrammetry & Remote Sensing Volume 62, Issue 6, Pages 406–414December 2007.

[11] Sebahattin Albayrak "Use of Reflectance Measurements for the Detection of N, P, K, ADF and NDF Contents in Sainfoin Pasture"SensorsVolume8, Issue 11, 7275-7286, 2008.

[12] Zhang, X. J, M. Z. Li"Analysis and Estimation of the Phosphorus Content in Cucumber Leaf in Greenhouse by

Spectroscopy." Spectroscopy and Spectral Analysis 28(10), 2404–8 , Oct 2008.

[13] F. J. Ponzoni, J. L. De & M. Goncalves"Spectral features associated with nitrogen,phosphorus, and potassium deficiencies in Eucalyptus saligna seedling leaves" int. j. remote sensing, vol. 20,Issue 11, 2249- 2264, 1999.

[14] Agustin Pimstein, ArnonKarnieli, Surinder K. Bansal, David J. Bonfil "Exploring remotely sensed technologies for monitoring wheat potassium and phosphorus using field spectroscopy" Field Crops Research Volume 121, Issue 1, Pages 125–135, February 2011,

[15] Adebusoye O. Onanuga, Ping'an Jiang, SinaAdl"Phosphorus, Potassium and Phytohormones Promote Chlorophyll Production Differently in Two Cotton (Gossypiumhirsutum) Varieties Grown in Hydroponic Nutrient Solution" Journal of Agricultural Science Vol. 4, No. 2, 2012.

[16] Yanfang Zhai ,Lijuan Cui , Xin Zhou , Yin Gao , TengFei and WenxiuGao"Estimation of nitrogen, phosphorus, and potassium in the leaves of different plants using laboratory-based visible and near-infrared reflectance spectroscopy: comparison of partial least-square regression and support vector machine regression methods" International Journal of Remote SensingVol. 34, Issue 7, 2502–2518, 10 April 2013.

[17] Y. Ozyigit, and M. Bilgen"Use of Spectral Reflectance Values for Determining Nitrogen, Phosphorus, and Potassium Contents of Rangeland Plants" J. Agr. Sci. Tech. Vol. 15: 1537-1545, December 2013.

[18] G. R. Mahajan, R. N. Sahoo, R. N. Pandey, V. K. Gupta, Dinesh Kumar "Using hyperspectral remote sensing techniquesto monitor nitrogen, phosphorus, sulphur and potassium in wheat (Triticumaestivum L.)" Precision Agric, Volume 15, Issue 5, pp 499–522, October 2014.

[19] Liu Yanli, LyuQiang, He Shaolan, Yi Shilai, Liu Xuefeng, XieRangjin, ZhengYongqiang, Deng Lie "Prediction of nitrogen and phosphorus contents in citrus leaves based on hyperspectral imaging." Int J Agric&BiolEng, Vol. 8,Issue 2 80－88, April 2015.

[20] Jagadeeswaran, BalajiKannan and Sivasamy"Prediction of Nutrient Deficiencies in Maize through Hyperspectral Remote Sensing Technique" Department of Science and Technology, Government of India – Dec 4-8, 2015.