Chronicle of Bioresource Management 2021, 5(2):059-062

Chronicle of Bioresource Management
An International E-magazine

June 2021 | Popular Article

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Citation: Naik and Hemalatha, 2021. Precision Nitrogen Management Using Leaf Colour Chart. Chronicle of Bioresource Management 5(2), 059-062.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

Keywords:
Cereals, decision support system, leaf colour chart, nitrogen

Article History
Article ID: CBM64
Received on 07th June 2021
Received in revised form on 18th June 2021
Accepted in final form on 29th June 2021

Precision Nitrogen Management Using Leaf Colour Chart

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Abstract

Heterogeneous nature from one field to another hinders the application of broad based blanket recommendation of fertilizers to various crops. In intensive cropping system, several farmers are applying nitrogenous fertilizer either in excess or low quantity than crop requirement for higher productivity without assessing the crop requirements. The growing energy crisis in tune with overwhelming population is forcing researchers to discover possible ancillary ways to yield of field crops using numerous gadgets (LCC, SPAD meter, Green Seeker etc.) for efficient nitrogen use. Globally, cereals are major staple food crops and application of nitrogen fertilizers to cereals occupies central role in crop nutrition to augment productivity, whereas if it's used in excess quantity, pollutes the ground water through leaching losses. Nonetheless, the best remedy could be fine-tuning rate and time by various split applications in order to synchronize nitrogen demand with crop needs for higher nitrogen use efficiency and crop productivity.

1. Introduction

Cereal crops are very exhaustive and deplete soil nutrients in large quantities. In world, total more than half of the nitrogen fertilizer is consumed by cereals *viz.*, rice, wheat and maize. Among all the nutrients, nitrogen is generally the most limiting nutrient under Indian conditions and its requirement for cereal crops may vary with soil, climate, genotypes and agronomic practices. Furthermore, in intensive cropping system farmers have liability to apply nitrogen in huge quantity to curtail production losses owing to soils degradation. Whereas, in areas with high rainfall and temperature, management of nitrogen poseses a great challenge in addition to losses of nitrogen. It can be achieved by following application of need based N on intermittent evaluation of crop N level and N application till the N level goes underneath a critical level.

To obtain the nitrogen status of standing crops, we need to monitor with different techniques to answer the questions of when, where, how much of fertilizers and how to apply the fertilizers. Thereby, techniques like use of leaf-colour chart (LCC), nutrient expert, a computer-based decision support tool (Kumar et al., 2014),

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chlorophyll meter (SPAD meter) are the better options to increase nitrogen-use efficiency and productivity of crops. Nevertheless, owing to its expensive cost and lack of knowledge; chlorophyll meter, nutrient expert, computer-based decision support tool usage by the farmers in developing countries is restricted. Keeping the foregoing fact in contemplate, recent days' leaf colour chart (LCC) has been developed and it is ideal to farmers as a visible and subjective indicator of the crop N levels and can be used for precision nitrogen application (Ladha et al., 2000).

Leaf colour chart (LCC) permit an expeditious and reliable watching of leaf greenness by visual appearance of spectral properties of leaves and also it is very simple and easy to use by the farmers. It acts as a better guide to the farmers for thoughtful and right time nitrogen application. LCC is an ideal tool to optimize N use in most of the cereal crops and it consists of series of four/six green coloured shades horizontally ranging from light yellowish green to dark green colour strips fabricated with veins resembling those of leaves that are used to compare with a leaf in the same light conditions. LCC is being used successfully in crops like rice (Witt et al., 2005), wheat (Singh et al., 2014) and maize (Naik et al., 2019) to evaluate the efficient N requirement under multiple situations of soil, climate and crop variety.

2. How to Use the LCC

1. A 'four/six panel' LCC can be used to counterpart leaf colour from ten disease and pest free plants in a field with uniform plant population.

2. Observations to be taken by placing the central part of the youngest completely expanded and healthy leaf on the top of the colour strips on the chart, and compare the leaf colour with the colour panel of the LCC.

3. Don't remove and destroy the leaf/plant during observation.

4. During observation don't expose LCC directly to sunlight and leaf being measured is to be shielded from the sun. LCC readings need to be taken at same time of the day (8.00-11.00 AM).

5. LCC readings should be taken by same member at the same time of the day.

6. Determine the average LCC reading for the selected leaves. When six or more leaves read below a critical LCC value (4.0 for rice and wheat and 5.0 for maize), urea can be applied for rectifying deficiency symptoms.

7. After flowering stage, use of LCC should be stopped.

Manual usage of LCC in maize

Manual usage of LCC at threshold 5.0

Variations in maize growth due LCC threshold 4.0

Variations in maize growth due LCC threshold 5.0

3. LCC Threshold Values for Different Crops

LCC threshold values for real time nitrogen management during vegetative growth in different cereal crops for getting higher yield and nitrogen savings are LCC threshold 4.0 for rice and wheat (Singh et al., 2014), whereas LCC threshold 5.0 for maize (Naik et al., 2019; Singh et al., 2014) along with basal dose of fertilizers.

4. Quantification of Nitrogen Saved Using LCC

Matching of fertilizer nitrogen supply with crop demand using various LCC threshold values are given in Table 1. Maize crop is highly exhaustive and requirement of nitrogen is very high and productivity of maize is higher at LCC threshold 5.0 by saving 55.3 kg N ha^{-1}.

Table 1: Quantity of fertilizer N applied and saved in various LCC threshold values

LCC threshold values	Recommended dose of nitrogen (kg ha^{-1}) (a)	Nitrogen Applied (kg ha^{-1}) (b)	Nitrogen Saved (kg ha^{-1}) (a-b)
LCC 4.0	240	159.0	81
LCC 4.5	240	169.3	70.7
LCC 5.0	240	184.7	55.3

5. Effect on Economic Returns

Gross monetary returns, net monetary returns and returns per rupee invested play a major role, to persuade the farmers for acceptance of any clarified version of agro-techniques. Higher yields of maize crop with higher monetary returns were obtained with higher level of LCC threshold 5 (Table 2) and recorded significantly higher returns per rupee invested (2.32) than LCC 4.5 (2.16) and LCC 4 (2.03). These results indicated that LCC based fertilizer N management could be a perfect strategy that always gave a benefits of saving fertilizer N and producing more yield with same fertilizer. This might be due to higher yield in LCC based N application with higher dose and increased number (5) of split applications of N. Also the highest returns per rupee invested (1.94) was noticed in rice (Moharana et al., 2017).

Table 2: Gross monetary returns, net monetary returns and returns per rupee invested as influenced by various LCC threshold level

LCC threshold values	Gross monetary returns (₹ ha^{-1})	Net monetary returns (₹ ha^{-1})	Returns per rupee invested
LCC 4.0	80747	41111	2.03
LCC 4.5	86133	46366	2.16
LCC 5.0	92940	52975	2.32
SEm±	1077	1073	0.03
CD (p=0.05)	3077	3076	0.08

6. Conclusion

In most of the cereal crops application of fixed N as basal and split at one time is not sufficient for achieving more production and nitrogen use efficiency. Thereby, maximum productivity and net returns of crops like rice, wheat and maize can be obtained by precision application of N in various splits at LCC thresholds values of 4.0 for rice and wheat and 5.0 for maize. Also LCC can be used even by small or illiterate farmers as it is cheaper and farmer's friendly N management tool. Therefore, blanket application of fixed dose of nitrogen fertilizers at fixed time intervals should be restored with real time nitrogen management technology using LCC in cereals.

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