Modern Approaches to Nitrogen Management in Agriculture

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Introduction

Nitrogen (N) is one of the most important nutrients required for crop growth. However, inefficient use of nitrogen leads to low fertilizer use efficiency, higher production costs, and environmental pollution. Modern agriculture focuses on smart and precise nitrogen management, where the right amount of nitrogen is applied at the right time and place. Several tools and practices such as NDVI sensors, decision support software, and improved fertilizer management techniques help achieve this goal.

1. NDVI (Normalized Difference in Vegetative Index) Sensor or Green Seeker:

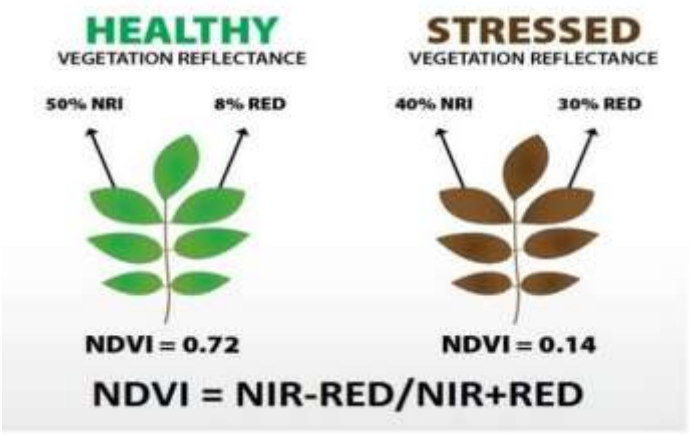
NDVI is a handheld device which uses light emitting diodes to generate red and near infrared light which are used to calculate NDVI values.

Working Principle: Green Seeker calculates NDVI using red and NIR (Near Infra-Red) light. It is based on simple principle that red light is absorbed by plant chlorophyll as an energy source during photosynthesis. Therefore, healthy plants absorbs more red light and reflect larger amounts of NIR than those that are unhealthy and thus gives higher NDVI value.

NDVI is calculated using the equation:

$$NDVI = NIR_{reflected} - Red_{reflected} / NIR_{reflected} + Red_{reflected}$$

Green Seeker is an excellent indicator of biomass (amount of living plant tissue) and is used to accurately project yield potential.



NDVI in Nitrogen Management:

NDVI is commonly used to measure plant health and vigour. By using Green Seeker, we can apply the right amount of N at the right place and at the right time thereby optimizing yield and N input. The instrument is handy and is also available through online retailers in India costing about four to five lakhs per unit. This amount seems too high for the small farmers but it will be compensated in the course of time in the form of Nitrogen saving.

2. Nutrient Expert®(NE) for Maize:

Nutrient Expert® is a computer based, easy to use, interactive decision support software for site specific nutrient management (SSNM) especially for wheat and smallholder farmers designed and developed by International Plant Nutrition Institute (IPNI), USA.

Requirements:

The software needs only the basic computer knowledge by the user and is a boon for farmers in remote areas of world where no soil testing facilities are available for the farmers.

It is a simple and easy to use software and can be used by extension personnel or the farmers itself for site specific nutrient management without undergoing any soil test or sophisticated data. The only need is previous crop management data which is not so sophisticated and the software gives the recommended doses of N as output on basis of input data. NE uses data which is simple, easily available and not so comprehensive and is as follows:

- → Growing environment: The environment plays a vital role in crop growth and health. The growing temperature (hot, cool, dry) and water availability (irrigated, fully rainfed, rainfed with supplemental irrigation) and occurrence of flooding or drought.
- → Soil fertility indicators: Soil texture (loam, sandy, and clay), soil colour (black, red, gray) and organic matter content soil test history for NPK. Historical use of organic materials (if any), soil problem (salinity, alkanality etc.).
- → Crop sequence in the farmer's cropping pattern in last 2-3 years i.e. crop taken by farmer in the field in recent past.
- → Crop residue management of previous crops: Crop residue plays an important role in soil fertility and health. Sometimes farmers burnt the whole straw to save time for early planting the next crop or to take 3-4 crops in a year. Crop residue management figures like removal of all above ground residue, retained all above ground residue, ploughed all residue, burnt all above ground residue.
- → Farmer's yield and dose of fertilizers: Current yield and dose of fertilizers and insecticides in past 2-3 months.
- → NDVI data.

Based on input data; the software gives the recommended dose and time of fertilizers (organic, inorganic or micronutrient) applications for the specific crop or field.

Besides these tools there are many other management practices which are helpful in precise N management and are discussed below:

1. **Leaf Color Chart (LCC):**

The leaf colour chart (LCC) primarily developed for rice, is a tool to rapidly assess leaf N status at crop growth stages and thereby guide the application of fertilizer N to maintain optimal leaf N content, which is vital for achieving higher yields.

LCC for wheat is under development and being standardized for a number of varietiesby Punjab Agricultural University, Ludhiana. By matching the leaf color of their crop from 10-12 randomized sites in their field (bypassing the diseased plants) with the colour of chart; farmers can find the required dose of fertilizers application at specific site or plant. By using standard leaf colour chart we can predict the amount of N required in the field or the individual plant. This will have a check on the undue use of urea in the field.

2. Neem coated urea & slow releasing urea:

By using neem coated urea we can reduce the cost on urea input and also reduce the input cost of insecticides as neem is a natural insecticide. Hence, we can reduce the import of urea as it reduces the leaching of N in the soil and denitrification process. We can also use the synthetic polymers which reduces leaching as the water has to go through the small pores of polymer to reach the urea granules and also decreases the volatile nature of urea.

3. Using inhibitors: Urease is the compound which enhances the denitrification process.

$$CO(NH_2)_2 + H_2O + \text{urease} \rightarrow 2NH_3 + CO_2$$

This ammonia is a gas and readily escapes into environment causing N losses. Urease inhibitors are one class of compounds that prevents this conversion. Hydroquinone is one such Urease inhibitor which reduces the Methane and Nitrous Oxide gas emission in water logged conditions.

4. Split application of fertilizer

Split application of Nitrogen fertilizer to meet the immediate crop growth stage specific N needs is recommended for maximum N use efficiency with reduced losses. Splitting the total N into two doses, half as basal dose and rest as top-dressing in case of heavy soil types is recommended.

5. Fertigation

Recent methods of application like fertigation would help in increasing the nutrient use efficiency along with reducing the losses. Fertigation is a method of fertilizer application in which fertilizer is incorporated within the irrigation water by the drip system. In this system fertilizer solution is distributed evenly in irrigation. The availability of nutrients is very high therefore the efficiency is more. In this method liquid fertilizer as well as water soluble fertilizers are used. By this method, fertilizer use efficiency is increased from 80 to 90 per cent. Practicing fertigation is beneficial to farmers in timely and site-specific application of nutrients. Application of exact quantity of fertilizers according to soil nutrient status based on soil tests will not only result in

proper supply of deficient nutrient elements essential for profitable crop production but also saves cost by supply of precise amount of nutrients as per the nutrient supplying capacity of the soil.

6. New Initiatives

New schemes like Soil health cards (launched in February, 2015) by Govt. of India to improve the soil health of the individual farmer's land. Under the scheme a detailed analysis of samples of soil collected from land held by individual farmers is done in various soil testing labs across nation for water content, presence of elements such as potassium, nitrogen, phosphorous, copper, iron and zinc, as well as pH and salinity levels, clay content and water retention capacity. Advice on handling particular kinds of soil are then handed over in form of soil health cards to the farmers to serve as a guiding tool to apply fertilizers for various crops. Mobile van soil testing facility is also available under the scheme.

Conclusion

Smart nitrogen management combines modern tools like NDVI sensors and decision support software with improved agronomic practices such as LCC, fertigation, and split fertilizer application. For agriculture students, understanding these technologies is essential for promoting sustainable, profitable, and environmentally friendly crop production in the future.

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