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Nitrogen Fertilization Management in Cereal Crops Through Precision Technologies

Ajit Kumar Meena[1*], Deepak Meena[2], R.S.Meena[3]
[1*]Ph.D. Scholar, Rajasthan College of Agriculture, MPUAT, Udaipur-313001 (Raj.)
[2] Ph.D. Scholar, Rajasthan College of Agriculture, MPUAT, Udaipur -313001 (Raj.)
3. ICAR-NBSS & LUP, Regional Centre, Udaipur-313001(Raj.)

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Introduction

Cereals are the front leader in attaining self-sufficiency in food production. India is the second largest and first producer of rice, wheat and millets in the world. India is the third largest producer and second largest consumer of chemical fertilizer in the world, after China. The total production of nitrogen (N) in India was 13.43 million tons during 2017-18. However, the consumption of N was 16.96 million tons during 2017-18. So 3.43 million tones N was imported by India during 2017-18 and cereals are the maximum consumer of nitrogenous fertilizer. Cereals are the major source of food and fodder. Total cereal production of India is 251 Million tons during 2017-18. It is main source of energy for human being and animals. It play vital role for synthesis of chlorophyll and protein. Nitrogen use efficiency is very less (25-30%), because it is lost very easily through volatilization and leaching so precision nitrogen management is required. Low use efficiency of nitrogen fertilizers in agriculture contributes to different environmental impact like eutrophication of surface water bodies, acidification of agricultural soil and increased concentration of nitrous oxides in atmosphere contributing to global warming. Split application of the N fertilizer to cereal may reduce the rapid nitrous oxide emission and increase nitrogen use efficiency (NUE). Leaf Color Chart (LCC), Soil Plant Analysis Development (SPAD) meter, site specific nutrient management (SSNM), crop canopy sensor, crop stimulation models and controlled release fertilizers (CRF) are effective tools of precision N management. Around 10-25 % nitrogen can save through precision nitrogen management. According to our discussion LCC an ideal tool and eco-friendly to optimize NUE irrespective to N applied (Chaudhary *et al*., 2019).

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Nitrogen is vital element for proper growth and development of plants which significantly enhances the yield and its quality. Nitrogen use efficiency (NUE) is very less (25-30%) therefore, precision nitrogen management is required. The development of N management strategies might help to increase the efficiency NUE, reduce environmental impact and improve overall product quality. Nitrogen based fertilizers constitute nearly 60 percent of the total fertilizer material. The NUE of rice crop is only 30-40% of applied nitrogen due to various nitrogen loss mechanisms. High doses of nitrogen are responsible for dark green color leaves and excessive growth, plant lodges, and as a result yields, quality and harvest ability is reduced significantly. Besides, crop maturity is delayed and the plants become susceptible to disease and insect pest. Nitrogen management is vital for economic and environmental sustainability. Asynchrony of fertilizer application with crop demand along various nitrogen losses in Eastern India leads to low fertilizer efficiency in Kharif rice (Mohanta *et al.,* 2021). Inefficient utilization of nitrogen is considered to be the most critical one among various reasons for this low productivity. India is occupied by a large rice area, accounting for 43.7 Mha. Site-specific N management showed a positive impact in improving dry matter production in "Pratikhya" under Kharif condition rice as these treatments received more N than the remaining treatments (Kumar *et al.,* 2019). In the current study, both based on nitrogen management expressed higher growth parameters, namely, dry matter production, LAI, number of tillers m^{-2} and yield attributes (particularly, panicles m^{-2} and number of grains $panicle^{-1}$), and the impact of these characters was reflected in the productivity of rice (Goudra, *et al.*, 2019).

Such conditions require attention world over to use precision nitrogen management (PNM) techniques, which is defined as application of right rate at right time in the right place using the right source and balance. The industrialization and mechanization of the agriculture in the 20^{th} century led to an increase in productivity and efficiency and development of large-scale farms. On the other hand, farmers sacrificed the ability to manage efficiently the spatial and temporal heterogeneity of farm fields (Finger *et al.*, 2019)

Diagnostic Tools Required in PNM

a) Leaf color chart (LCC): LCC estimate plant N demand in real time for their efficient use.

Steps for LCC usage in field

- Select at least 10 disease-free plants

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- Select the topmost fully expanded leaf and compare the leaf color with the color panels of the LCC
- Measure the leaf color under the shade of your body
- Determine the average LCC reading for the selected leaves
- If more than 5 out of 10 leaves read below a set critical value apply nitrogen fertilizers immediately to avoid yield loss.

Benefits of LCC

- It is a cheaper method
- Farmers can easily use the Leaf color charts to qualitatively assess foliar nitrogen status
- It helps to improve the fertilizer NUE, and save up to 40 percent of nitrogen compared to blanket application.

b) Site-Specific Nutrient Management (SSNM): It is the dynamic, field-specific management of nutrients in a particular cropping season to optimize the supply and demand of nutrients according to their differences in cycling through soil-plant systems. SSNM approach was developed in Asian rice-producing countries through partnerships of the Irrigated Rice Research Consortium (IRRC). It emphasizes 'feeding' crop with nutrients as and when needed.

Benefits of SSNM

- Nutrient use efficiency improved.
- Increase in the profitability.
- SSNM eliminates wastage of fertilizer.
- Ensures proper ratio of the N, P and K fertilization.
- Saving in fertilizer N to a large extent.

c) Soil Plant Analysis Development (SPAD) meter: It is a simple, quick and non-destructive in situ tool for measuring relative content of chlorophyll in leaf that is directly proportional to leaf N content. The chlorophyll present in the plant is closely related to the nutritional condition of the plant. Higher SPAD value indicates a healthier plant and vice-versa.

Significance

- Improve nutrient management.

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- Study the performance and effect of fertilizer.
- Detect and study environmental stressors.
- Checking the nutritional condition of plants.
- Save up to 25 percent nitrogen as compared to fixed time N application.

d) Crop canopy sensor: It can be used to estimate crop growth in a population or community rather than individual plant or leaf. It was more efficient and suitable for large scale applications than leaf sensors.

Crop canopy sensors are Green seeker and Crop circle type.

e) Crop Simulation Models: These are quantitative tools based on scientific knowledge that can evaluate the effect of edaphic, climatic, hydrologic and agronomic factors on crop growth and yields. Examples of the crop simulation model are DSSAT models, CERES models, WOFOST models.

f) Slow-Release Nitrogen Fertilizer (SNRF): is a granulated fertilizer that releases nutrients gradually into the soil. Sometimes used synonymously as Controlled-release fertilizer or Delayed-release fertilizer.

Uncoated, SNRF: Isobutylidenediurea (IBDU).

Coated SNRF: Sulfur-coated urea, Polymer-coated (or Poly-coated) urea, Neem coated urea

Bio-inhibitors: Not really "slow-release" but inhibits microbial processes that convert N into plant available forms and slowly sparse N into soil environment like Urease and Nitrification inhibitors.

Conclusion

Around 10-25 % nitrogen can be saved through precision nitrogen management tools such as LCC, SPAD meter, SSNM, crop canopy sensor, crop stimulation models and slow-release fertilizers. Therefore, efforts must be made to popularize their use in agriculture in general and farming community in particular.

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