Precision Nitrogen Management Through Green Seeker

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Abstract

Nitrogen is most limiting nutrient in crop production particularly in irrigated cereal-based cropping systems. Nitrogen have very important role in plant metabolism. It is essential constituent of protein, chlorophyll and other physiological processes. Now a day, we clearly know that our population increasing day by day, so food consumption is also increasing. To fulfill the demand of food, we need to produce more food. During 2015-16, total N consumption of India was 17.6mt. Fertilizers was applied as a blanket recommendation, therefore nitrogen losses occurs through depletion of weed, fixation, leaching, volatilization and denitrification etc. Beside these quality is also affected due to higher doses. So, there is need to synchronize the supply of nitrogen and demand. Under this situation precision nitrogen management is one of the best method. There are various methods of nitrogen application through real time *viz.*, leaf color chart, soil plant analysis development meter or chlorophyll meter, GreenSeeker. GreenSeeker is an integrated optical sensor based with variable rate application and mapping system which measure crop's nitrogen requirements. The sensors uses light emitting diodes (LED) to generate red light (660 nm) and near infrared light (780 nm). Red light is absorbed by plant chlorophyll as an energy source during photosynthesis. Healthy plants absorb more red light and reflects larger amounts of near infrared light NIR. The biomass produced per day as estimated through NDVI measurement using optical sensor is a reliable predictor of yield potential. GreenSeeker helps to produce the expected yield than the traditional method for application of nitrogen. It helps to reduced pollution and also helps to increase nitrogen use efficiency NUE.

Keywords: Green Seeker, Nitrogen use efficiency, NDVI.

Introduction

Precision Agriculture can defined as the application of principles and technologies to manage spatial and temporal variability associated with all the aspects of agricultural production for the purpose of improving crop performance and environmental quality (Pierce and Nowak, 1999). Precision agriculture is also known as precision farming in which in-field variability is taken into account and according to the local circumstances of a given field, seeding, nutrient management, plant protection measures etc. are taken up. Hence, there will be efficient use of resources, leading to sustainability in agriculture.

Precision farming can be defined as farming system, which enables profit to maximize and where inputs (tillage operation, seed, fertilizer and chemicals) are varied according to the yield potential of individual parts of a field. It facilitates the optimal use of inputs, resulting in increased gross margins with reduced impact on the environment. It is sometime known as variable rate technology (VRT) and site specific agriculture (Sahoo, 2010). This can be done by new emerging information technologies such as Global Positioning System (GPS), Geographical Information System (GIS), remote sensing, yield monitors etc. The data collected are to be analyzed using appropriate procedures to provide support for decision making. The inputs are to be applied properly harmonize economic, social and ecological benefits.

Thus, precision farming which is based on information and knowledge is a new combined technique for the scientific management of modern agriculture. It is a complete system that takes full advantage of available agricultural resources, reduces pollution to protect environment and promotes sustainable agriculture (Reddy and Reddy, 2015).

Nitrogen is most limiting nutrient in crop production particularly in irrigated cereal-based cropping systems. Nitrogen have very important role in plant metabolism. It is essential constituent of protein, chlorophyll and other physiological processes. Now a day, we clearly know that our population increasing day by day, so food consumption is also increasing. To fulfill the demand of food, we need to produce more food. During 2015-16, total N consumption of India was 17.6mt. Nitrogen consumption by cereals is 60% in world and 72% in India (Raun and Johnson, 1999; FAI, 2010). In Punjab and Haryana state if farmer apply

100% dose of nitrogen but only 33% nitrogen used by plants remaining 67% lost. Traditionally, farmers apply N uniformly as a blanket recommendation in wheat crop. Mostly farmers apply N much higher than the blanket recommendation to get high crop yields. But large temporal and field to field variability of soil N supply restrict efficient use of N fertilizer (Dobermann *et al.* 2003). In this situation the site-specific N management can effectively replace the blanket fertilizer N recommendations for achieving high N-use efficiency and also reduced possibility of fertilizer N related environmental pollution (Khosla and Alley, 1999). It appears that high fertilizer N-use efficiency can be improved through field-specific fertilizer N management because it deals with both spatial and transient fluctuation in soil N supply. Fruitful strategies will comprise of management options based on location-specific fertilizer N necessities of crops according to year-to-year variations in climate (especially solar radiation) and spatial as well as transient variations of indigenous soil N supplies (Giller *et al.* 2004). Precision nitrogen management is one of the best method. There are various methods of nitrogen application through real time *viz.,* leaf color chart, soil plant analysis development meter or chlorophyll meter, GreenSeeker.

GreenSeeker is an integrated optical sensor based with variable rate application and mapping system which measure crop's nitrogen requirements. The technology was developed at Oklahoma State University, USA and licensed to N Tech Industries in 2001 (www.ntechindustries.com). The sensors uses light emitting diodes (LED) to generate red light (660 nm) and near infrared light (780 nm). Red light is absorbed by plant chlorophyll as an energy source during photosynthesis. Healthy plants absorb more red light and reflects larger amounts of near infrared light NIR. The biomass produced per day as estimated through NDVI measurement using optical sensor is a reliable predictor of yield potential (Ratanoo *et al.* 2018). GreenSeeker helps to produce the expected yield than the traditional method for application of nitrogen. It helps to reduced pollution and also helps to increase nitrogen use efficiency NUE.

Review of Literature

Singh *et al.* (2002) reported that the application of 30 kg N/ha each time the SPAD value fell below the critical value of 37.5 resulted in application of 90 kg N/ha, which produced rice yields equivalent to those with 120 kg N/ha applied in three splits. Wheat responded to N application at maximum tillering when SPAD value fell below 44. Wheat yield increased by 20% when 30 kg N/ha was applied at SPAD value of 42 at maximum tillering. Results show that plant need based N management through chlorophyll meter reduces N requirement of rice from 12.5 to 25%, with no loss in yield. Hence, in this study showed that we use chlorophyll meter, a reliable non destructive tool, to determine the right time for N top dressing of rice and wheat.

Khurana *et al.* (2008) reported that the performance of site-specific nutrient management (SSNM) was tested for two wheat crops. Compared with the current farmers' fertilizer practice (FFP), average grain yield increased from 4.2 to 4.8 Mg ha-1, while plant N, P, and K accumulations increased by 12–20% with SSNM. The gross return above fertilizer cost (GRF) was about 13% greater with SSNM than with FFP. The agronomic N use efficiency was 63% greater with SSNM than with FFP. SSNM has potential for improving yields and nutrient use efficiency in irrigated wheat. Hence, in this study showed that SSNM may alsocreduce pest incidence, particularly diseases that are often associated with excessive N use or unbalanced plant nutrition, and thus, further helping in augmenting crop yields.

Singh *et al.* (2011) at PAU, Ludhiana conducted seven field experiments during 2004-2006 and 2005-2007. They observed that relationships between in-season sensor-based estimates of yield at Feekes 5–6 and 7–8 stages and actual wheat yields. Response of wheat to fertilizer N defined by the sensor was highly correlated with harvest response index. Sensor-guided fertilizer N applications resulted in high yield levels and high N-use efficiency. Hence, in this study showed that GreenSeeker-guided N dose can be applied at Feekes 5–6 and Feekes 7–8 stages in wheat but with carefully designed doses of fertilizer applied at planting and crown root initiation stages of wheat crop.

Bosquet *et al.* (2011) observed that the direct use of a commercial cost-effective spectroradiometer, GreenSeeker provided with an active sensor for measuring NDVI in four genotypes of durum wheat (*Triticum turgidum* L. var. *durum*) grown in pots under a range of water and N regimes. Strong correlations were observed between NDVI measurements and dry above ground biomass, total green area, green area without spikes and aboveground N content. The models accurately predicted growth traits and N content, confirming the direct relationship between total plant biomass and spectroradiometric readings. Hence, in this study showed that the use of a portable active sensor spectroradiometer like the GreenSeeker was a

useful tool for predicting growth traits and N content in two genotypes that differed greatly in terms of plant growth and N accumulation.

Mohanty *et al.* (2016) studied that the saving of N by 9.5 and 30 kg with green seeker and SPAD, respectively while enhancement of 18.4 kg N/ha by STCR was found compared to recommended dose of fertilizers (RDF). N, P and K content and their uptake in grain, straw in wheat was significantly higher with soil-test crop response (STCR) based nutrient management applied in wheat as well as with nutrient expert based site-specific nutrient management (SSNM) applied in maize as residual effect. Hence, in this study showed that The use of some tools for in season precision N management like SPAD meter or NDVI sensor or site specific nutrient management through soil test crop response or nutrient expert helps in fulfilling the crop nutrient requirement with less environmental footprints.

Kaur (2017) at PAU, Ludhiana reported that application of 160-164 kg N ha-1 in three splits (60 kg N at sowing + 60 kg N at first irrigation + 44/40 kg N at second irrigation guided by Green Seeker) or application of 172/169 kg N ha-1 in in three splits (60 kg N at sowing + 60 kg N at first irrigation + 52/49 kg N at second irrigation) with Nutrient Expert and GreenSeeker at 2nd irrigation (120+52/49) recorded better growth characters as well as higher NDVI thus contributing to better wheat yield and quality than blanket application of 120 kg N/ha but similar to blanket application of 150 kg N/ha in different varieties and tillage options. Delayed application of 126/131 kg N ha-1 in four splits (40 kg N at sowing + 40 kg N at first irrigation + 40 kg N at second irrigation + 6/13 kg N at third irrigation guided by Green Seeker) or application of 129/142 N kg ha-1 (40 kg N at sowing + 40 kg N at first irrigation + 40 kg N at second irrigation + 9/22 kg N at third irrigation guided by Green Seeker) with combination of Nutrient Expert and GreenSeeker at 3rd irrigation (120+9/22) gave higher returns with N saving of 9-24 kg/ha and higher yield as well as net returns in comparison to 150 kg N/ha. Hence, in this study showed that GreenSeeker guided gave best result in terms of higher yield and economic returns and could be recommended to farmers field under Punjab conditions.

Some other prelimary studies at Hisar reported that NDVI values were higher in treatment having higher dose of fixed rate N at planting and CRI stage. At 65 DAS (3rd irrigation) the increase in NDVI values was more in treatment having N application at 50 DAS (2nd irrigation) with or without using GreenSeeker and it ranged from 11.7 to 22.2% as compared to treatment having no N application at 2nd irrigation where it was only 2.6 to 9.1%. Total N uptake and NDVI values were highly correlated and values of coefficient of determination were higher at middle crop growth stages as compared to early and late stages. Hence, in this study showed that most of the plant N found in chloroplast and chlorophyll protein. This is easily assessed through GreenSeeker and we can easily estimate the exact value of required N.

Conclusion

GreenSeeker is non-destructive method for accurate estimation of required amount of nitrogen on the basis of plant condition as well as site specific. A combination of prescriptive N dose at planting and crown root initiation stage and corrective N dose guided by GreenSeeker optical sensor at different stages of different crop holds promise in achieving high yield and N use efficiency. The biomass produced per day as estimated through NDVI measurement using optical sensor is a reliable predictor of yield potential. GreenSeeker helps to produce the expected yield than the traditional method for application of nitrogen.

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