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**Sulochna**
Research Scholar, Birsa Agricultural University Ranchi, Jharkhand, India

**Md. Parwaiz Alam**
Jr. Sci-cum-Assistant Professor, Birsa Agricultural University Ranchi, Jharkhand, India

**Md. Naiyar Ali**
Jr. Sci-cum-Assistant Professor, Birsa Agricultural University Ranchi, Jharkhand, India

**Correspondence**
**Md. Naiyar Ali**
Jr. Sci-cum-Assistant Professor, Birsa Agricultural University Ranchi, Jharkhand, India

# Effect of precision nitrogen management on protein content in grain of wheat

**Sulochna, Md. Parwaiz Alam and Md. Naiyar Ali**

**Abstract**
A field experiment was conducted at Birsa Agricultural University during winter (*Rabi*) season of 2017-18 with objective to evaluate the protein content in grain and nitrogen budgeting of soil under precision nitrogen management guided by Green Seeker. The experiment laid out in randomized block design replicated thrice. The soil of experimental plot was sandy loam in texture having low nitrogen (175.6 Kg/ha), medium in phosphorous (15.4 Kg/ha) and potassium (183.5 Kg/ha) with slightly acidic having soil pH 5.5. The twelve treatments comprised of: $T_1$- absolute control, $T_2$ to $T_4$ - application of 120 kg N in two and three split doses, $T_5$ to $T_7$ - application of 150 kg N in two and three split doses, $T_8$ to $T_{10}$ - application of 180 kg N in two and three split doses and $T_{11}$ and$T_{12}$ (guided by Green Seeker by NDVI technique taken at 45 DAS and 65 DAS) were applied with 136 kg N and 140 kg N in three spilt doses respectively. The two splits of nitrogen given at sowing and at CRI and for three splits nitrogen was applied at sowing, CRI and at tillering stage (45 DAS). Application of 140 kg N in three split doses i.e. 30 kg N as basal, 60 kg N at CRI and Greenseeker guided nitrogen application of 40 kg at 45 DAS (second irrigation) and 10 kg at 65 DAS (third irrigation) recorded the highest protein content (11.22%) and maximum utilization of nitrogenous fertilizer in treatments (-2.14 kg/ha and 0.04 kg/ha in $T_{11}$ and $T_{12}$ respectively) guided by Greenseeker.

**Keywords:** Wheat, protein content, nitrogen budgeting, Greenseeker

## Introduction
Wheat (*Triticum aestivum* L.) is second most important staple food crop of the world after rice. According to United States Department of Agriculture (USDA) advance estimates that the world wheat production 2016/17 is 735.09 million metric tons of which India shares 87 million tonnes. It occupies 18% of the world's crop acreage, feeding 1/3$^{rd}$ of the world population. India shares 36% world wheat growing area under cultivation. In the state of Jharkhand, wheat is grown as a second crop in sequence after *kharif* crops. In this region wheat is grown on 1.70 lakhs ha area with production of 3.36 lakh metric tonnes and productivity of 2123 kg/ha (SAMETI, Jharkhand, 2016) [6]. Wheat accounts for approximately 25% of worldwide protein supply and also provides micronutrients like Zn and Fe (Bhattacharjee S., 2017) [1]. Various socio-economic problems and the effect of fast changing climate depresses the yield consequences have shown the inherent difficulties in achieveing the demand on food supply (Mba *et al.*, 2012) [3].

Protein is one of the parameter of grain quality. The quality of wheat, flour and also the quality of the cereal products are mainly dependent on the protein composition. Mature wheat grains contain 8% to 20% proteins (Zilic *et al.*, 2011) [7]. Wheat protein content depends on multiple genes interacting with environmental factors, such as nitrogen availability, water, and temperature. Out of these factors nitrogen availability largely affects the protein content in wheat. Nitrogen is generally the most limiting nutrient factor for wheat production by influencing on chlorophyll production, photosynthesis process, and grain yield and quality. Increasing nitrogen supply to wheat crop can increase photosynthetic rate and consequently increase canopy biomass, grain yield and protein content. However, excessive nitrogen fertilization in cultivated land has profound environmental impacts such as nitrate leaching, soil denitrification, ammonia volatilization, and nitrous oxide emissions, which contaminate water and air and aggravate the climate change. While nitrogen losses cannot be avoided completely, they can be substantially reduced with sustainable agricultural practice such as adjusting nitrogen rate, timing and using the most appropriate fertilizer source, and adopting precision nitrogen management technologies.

Precision nitrogen management involves the hand held Greenseeker (Trimble Navigation Limited, Sunnyvale, CA, USA) is an active optical crop canopy sensor with a red (650±10nm) and a NIR (770±15nm) is commercially available and used widely. By measuring the strength of the reflected light, the sensor shows a numeric reading of NDVI (Normalized Difference Vegetation Index) between 0.00 and 0.99. Raun *et al.*, (2001) [5] noted expected yield as determined from NDVI has strong relationship with the actual grain yield in winter wheat. Using NDVI measurements of wheat at different times during crop growth period or the application of Greenseeker fulfills the nitrogen requirement in wheat based on expected yields as well as enhances the protein content in wheat by maximum utilization of nitrogenous fertilizers. Greenseeker is a real-time application (right amount of nitrogen, at right time and at right place) of nitrogenous fertilizer helps in maximum uptake of nitrogen and reduces loss, ultimately improves the nitrogen balance in the soil.

The major objective of the present investigation was to test whether the Greenseeker based nitrogen management was appropriate in the improvement of protein content and nitrogen budgeting in irrigated wheat.

## Materials and methods

A field experiment was conducted in upland areas of research farm of the Birsa Agricultural University Farm, Kanke, Ranchi ($23^0$17' N latitude, $85^0$10' E longitude and 625 m above mean sea level), India during *Rabi* season of 2017-18 to evaluate the growth parameter, yield attributed, yield and economics of wheat variety HD2967 under precision nitrogen management guided by Greenseeker. The experiment was sown on 25th November and was laid out in randomized block design replicated three times. The soil of experimental plot was sandy loam in texture having low nitrogen (175.6 Kg/ha), medium in phosphorous (15.4 Kg/ha) and medium in potassium (183.5 Kg/ha) with slightly acidic having soil pH 5.5. The mean minimum and maximum temperature throughout the cropping season ranged from 2.0℃to 37.4℃ and average rainfall was 10.43 mm during 2017-18. Seed rate applied was 125 kg/ha and the wheat was sown in rows at 20 cm apart as per treatment scheduled. The crop received full dose of P (60kg/ha) and K (40 kg/ha) as basal, while nitrogen was applied as per treatments i.e. 120 kg/ha, 150 kg/ha, 180 kg/ha and nitrogen application as guided by Greenseeker (at 45 DAS and at 65 DAS). Nitrogenous fertilizer was applied in two (at sowing and at CRI) and three (at sowing, at CRI and at tillering) split doses. Greenseeker (NDVI technique) was applied at 45 DAS (second irrigation) and 65 DAS (third irrigation) in treatments $T_{11}$ and $T_{12}$. The sources of nutrient were urea, DAP and Muriate of potash for N, P and K, respectively. Agricultural operations and practices were applied as recommended for the crop under irrigated condition. The crop was harvested on 7th April 2018. Data on nutrient uptake and nitrogen use efficiency were recorded as per normal procedure.

## Result and discussion

***Protein content:*** Protein content varied significantly with nitrogen management practice and the highest protein content was recorded with treatments $T_{12}$ which was fertilized with 140 kg N in three split guided by Greenseeker gave the significantly higher protein content over control however remained at par with rest of the treatments. This increased in protein content in treatment $T_{12}$ might be due to the application of Greenseeker which resulted in better soil nitrogen availability and enhanced the nitrogen uptake by crop. This balanced nutrition lead or improved source-sink relation which helped in increased protein content in wheat in this treatment. This was in conformity with the finding of Mohanty *et al.*, (2016) [4].

**Table 1:** Precision nitrogen management guided by Greenseeker on protein content of wheat

| Treatments | Grain Yield (q/ha) | Nitrogen content in grain (%) | Protein content in grain (%) |
|---|---|---|---|
| $T_1$:(control) | 20.83 | 1.558 | 9.74 |
| $T_2$:(120=60+60)kg N | 39.13 | 1.637 | 10.23 |
| $T_3$:(120=60+30+30)kg N | 41.15 | 1.658 | 10.36 |
| $T_4$:(120=40+40+40)kg N | 40.49 | 1.645 | 10.28 |
| $T_5$:(150=75+75)kg N | 41.86 | 1.675 | 10.47 |
| $T_6$:(150=75+37.5+37.5)kg N | 43.11 | 1.703 | 10.64 |
| $T_7$:(150=50+50+50)kg N | 42.78 | 1.684 | 10.53 |
| $T_8$:(180=90+90)kg N | 44.34 | 1.738 | 10.86 |
| $T_9$:(180=90+45+45)kg N | 46.19 | 1.773 | 11.08 |
| $T_{10}$:(180=60+60+60)kg N | 45.60 | 1.752 | 10.95 |
| $T_{11}$:{136=30+60+GS=48(45DAS)+28(65DAS)}kg N | 47.50 | 1.786 | 11.16 |
| $T_{12}$:{140=30+60+GS=40(45DAS)+10(65DAS)}kg N | 48.39 | 1.795 | 11.22 |
| SEm± | 1.71 | 0.07 | 0.44 |
| CD (P=0.05) | 5.02 | 0.19 | 1.29 |
| CV (%) | 7.10 | 6.71 | 7.19 |

Note: GS = Greenseeker

***Nitrogen budgeting on balance sheet:*** Nitrogen management affected the budgeting of nitrogen. Budgeting is the balance sheet of the nutrient which reflects the balance of nutrients in soil after harvest of the crop. It depends on the inherent genetic potential as well as the external nutrient supplied to the crop plus soil nutrient availability besides other environmental factors directly influences the crop production.

Initial nitrogen in soil, nitrogen added in soil, nitrogen uptake by crop and soil nitrogen after harvest were regarded as (A), (B), (C) and (D) respectively. Actual gain or loss over initial was calculated by subtracting initial available nitrogen in soil (A) from soil nitrogen after harvest (D). Finally available nitrogen balance was obtained by subtracting the sum of nitrogen uptake by crop (C) and soil nitrogen after harvest (D) from the sum of initial available nitrogen in soil (A) and nitrogen added in soil (B). This balance reflects the actual change in nitrogen status of soil. Nitrogen balance in soil was indicated by positive value. As the nitrogen level increased the nitrogen balance was increased. Available nitrogen balance was maximum in treatments fertilized with 180 kg N

in two splits i.e. 90 kg N as basal and 90 kg N at CRI, might be due to higher dose of nitrogen level. Control treatment recoded the minimum nitrogen balance because control treatment was not fertilized with nitrogenous fertilizer. Treatments guided by Greenseeker recorded the lower balance of available nitrogen due to splitting and need based nitrogen application in comparison to other treatments except control. This might be due to maximum content and uptake of nitrogen in grain and straw in these treatments (Kantilal, B.V. 2016) [2].

**Table 2:** Precision nitrogen management on nitrogen budgeting of wheat

| Treatment | Initialavailable N insoil (kg/ha) | N added in soil (kg/ha) | N uptake by crop (kg/ha | Soil N statusafter harvest (kg/ha) | Actual gain/loss over initial (kg/ha) | Available N balance (kg/ha) |
|---|---|---|---|---|---|---|
| | (A) | (B) | (C) | (D) | (D-A) | {(A+B)-(C+D)} |
| $T_1$:(control) | 175.6 | 0 | 51.59 | 169.26 | -6.34 | -45.25 |
| $T_2$:(120=60+60)kg N | 175.6 | 120 | 93.40 | 176.43 | 0.83 | 25.77 |
| $T_3$:(120=60+30+30)kg N | 175.6 | 120 | 99.63 | 178.24 | 2.64 | 17.73 |
| $T_4$:(120=40+40+40)kg N | 175.6 | 120 | 96.71 | 177.18 | 1.58 | 21.71 |
| $T_5$:(150=75+75)kg N | 175.6 | 150 | 103.75 | 179.96 | 4.36 | 41.90 |
| $T_6$:(150=75+37.5+37.5)kg N | 175.6 | 150 | 106.70 | 183.14 | 7.54 | 35.76 |
| $T_7$:(150=50+50+50)kg N | 175.6 | 150 | 105.16 | 181.20 | 5.60 | 39.24 |
| $T_8$:(180=90+90)kg N | 175.6 | 180 | 112.31 | 187.72 | 12.12 | 55.57 |
| $T_9$:(180=90+45+45)kg N | 175.6 | 180 | 118.76 | 195.23 | 19.63 | 41.61 |
| $T_{10}$:(180=60+60+60)kg N | 175.6 | 180 | 115.73 | 192.62 | 17.02 | 47.25 |
| $T_{11}$:{136=30+30+GS=48(45DAS+ 28(65DAS)}kg N | 175.6 | 136 | 123.75 | 190.02 | 14.42 | -2.17 |
| $T_{12}$:{140=30+60+GS=40(45DAS)+ 10(65DAS)}kg N | 175.6 | 140 | 126.44 | 189.12 | 13.52 | 0.04 |

Note: GS = Greenseeker

## Conclusion

On the basis of one year of experimentation, it can be concluded that application of 140 kg N in three split doses i.e. 30 kg N as basal, 60 kg N at CRI and Greenseeker guided nitrogen application of 40 kg at 45 DAS (second irrigation) and 10 kg at 65 DAS (third irrigation) recorded the highest protein content (11.22%) and maximum utilization of nitrogenous fertilizer in treatments (-2.14 kg/ha and 0.04 kg/ha in $T_{11}$ and $T_{12}$ respectively) guided by Greeenseeker.

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