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Nitrogen Management by Using Optical Sensor in Wheat in Jharkhand

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiment was conducted at Birsa Agricultural University during winter (*Rabi*) season of 2017-18 with the objective to evaluate the growth parameter, yield attributes, yield and economics of wheat variety HD2967 under precision nitrogen management guided by Greenseeker. The crop was sown on 25th November and was laid out in randomised block design replicated thrice. The soil of experimental plot was sandy loam in texture having low nitrogen (175.6 kg/ha), medium in phosphorous (15.38 kg/ha) and potassium (183.46 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} andT_{12} (guided by Greenseeker by NDVI technique taken at 45DAS and 65DAS) were applied with 136 kg N and 140 kg N in three split doses respectively. The two splits of nitrogen given at sowing and 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 No. Of tillers/m^2 (424.48), dry matter accumulation (1307.49 g/m^2), crop growth rate (8.14 g/m^2/day), effective tillers/m^2 (410.56), spike length (12.96 cm), spikelets per spike (21.66), filled grains per spikes (53.10), unfilled grains per spikes (2.56), thousand grain weight (42.80 g), grain yield (48.39 q/ha), straw yield (71.72 q/ha), net return (Rs 55695/ha) and B:C ratio (1.75).

Keywords: Economics; Greenseeker; NDVI; wheat; yield.

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1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is known as the king of cereal. It is the cereal crop for the majority of habitants on the earth. Wheat is the most important staple food of about 36% of the world population. It contains about 70% carbohydrate, 12% protein, 1.7% fats, 2.7% minerals and 2% fiber [1]. The cultivation of wheat has also been symbolic of the green revolution, self-sufficiency in food and sustained production. It is grown in all the continents of the world covering an area about 218.5 million hectares with a production of 713.2 million tonnes and productivity of 3,265 kg/ha during 2013. In India, it is cultivated on 30.5 million ha area with the production of 93.5 million tonnes and productivity of 3,145 kg/ha [2]. In the state of Jharkhand, wheat is grown as a second crop in sequence after *Kharif* crops. In this region, wheat is grown on 170.097 thousand ha area with the production of 335.932 thousand metric tonnes and productivity of 2123 kg/ha [3].

Nitrogen is one of the most important factors for the growth and development of plants. Nitrogen is subjected to different kinds of losses like denitrification, volatilisation and leaching which causes environmental threats. Nitrous oxide has 310 times the global warming potential of carbon dioxide, and its emissions are affected by poor nitrogen management in intensive crop production which is major source for it. The potential for enrichment of ground and surface waters with nitrates also increases with excessive N fertilizer applications causing eutrophication of aquatic ecosystem and methemoglobinemia in infants [4]. However, on the other hand, insufficient N availability to wheat plants results in low yields and significantly reduced profits compared to a properly fertilised crop.

The farmers of Jharkhand are compelled to use either an insufficient dose of N-fertilizer due to poor economic status or excessive dose of N-fertilizer because of poor knowhow. Therefore, nitrogenous fertilizers should be applied in the right quantities and at right time. To overcome this problem the concept of precision nitrogen management evolved. Precision nitrogen management provides valuable information to farmers, enabling them to make the right decisions concerning the management of crop input such as nitrogenous fertiliser. It involves the use of some tool like Greenseeker for N management through NDVI technique which helps in fulfilling the crop nitrogen requirement. The most widely known Normalized Difference Vegetation Index (NDVI) is the simple graphical indicator that can be used to analyse remote sensing measurements and is also a good indicator of biomass production. It is determined by dividing the difference of reflectance in the red (670 nm) and near-infrared (780 nm) by the sum of reflectance at these two wavebands. Green vegetation has an NDVI ranges from 0.00 to 0.99. Thus by adopting these systems, N fertilisers can be saved from 10%-80% resulting in reduced residual N in the soil by 30 -50 %, without affecting yields or influencing grain quality [5]. Keeping these points in view the concept of NDVI (Greenseeker) could be applied to manage nitrogen efficiently in the field.

2. 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 625.22 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 crop was sown on 25th November and was laid out in randomised 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 (15.38 kg/ha) and medium in potassium (183.46 kg/ha) with slightly acidic having soil pH 5.5. The mean minimum and maximum temperature throughout the cropping season ranged from 2.0C to 37.4C 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 fertiliser 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 the first

fortnight of April. Data on growth, yield component and yield were recorded as per normal procedure. In the calculation of economics, the purchase rates of input and the selling rates of outputs were assumed as per the prevailing local market rates.

2.1 Statistical Analysis

The data were analysed statistically by applying "Analysis of Variance" (ANOVA) technique of RBD [6]. The significance of different sources of variations was tested by Error mean square of Fisher Snedecor's 'F' test at probability level 0.05. The least significant difference (LSD) at 5% level of significance was worked out for each character of the experiment.

3. RESULTS AND DISCUSSION

3.1 Growth Parameter

Application of precision nitrogen management guided by Greenseeker significantly influenced the growth character viz. plant height, total number of tillers per m^2, dry matter accumulation and crop growth rate (CGR). Significantly tallest (110.6 cm) plant height was observed with 180 kg/ha N which was at par with treatments T_{11} (105.2 cm) and T_{12} (106.6 cm) guided by Greenseeker. This might be due to the supply of higher level of nitrogen resulted in increased plant height [7]. Total tillers are the most important parameter which influences the yield of wheat. A number of tillers per m^2 was significantly higher in treatments (T_{12}) fertilised with 140 kg N guided by Greenseeker, but this treatment was at par with 150 and 180 kg nitrogen also reported by [8], [9] and [10]. Highest dry matter accumulation (1307.49 g/m^2) and crop growth rate (8.14 g/m^2/day) were recorded with T_{12} was found at par with 120 kg/ha N and 150 kg/ha N. This might be due to the fact that Greenseeker provide right amount of nitrogen at right time when crops were in demand so that maximum amount of nitrogen participated in growth of the plant which leads to higher dry matter accumulation and crop growth rate [11] and [7] respectively.

3.2 Yield Attribute, Yields and Economics

All the yield attributes and yields were significantly affected by precision nitrogen management. All the yield attributes viz. effective tillers per m^2 (410.56), 1000 grain weight (42.80 g), spikelets per spike (21.66), filled grains per spike (53.10), unfilled grains per spike (2.56), spike length (12.96 cm), grain yield (48.39 q/ha), straw yield (71.72 q/ha), net return (Rs. 55695/ha) and B:C ratio (1.75) were recorded significantly higher by Greenseeker fertilized with 140 kg N {(140=30+60+GS=40 (45DAS +10(65DAS)} with regard to precision nitrogen management which was significantly higher than 150 kg N, 120 kg N and absolute control but at par with 180 kg N. The Greenseeker is a

Table 1. Effect of precision nitrogen management on growth parameter of wheat

Treatments	Plant height (cm)	Total tillers/m^2	Dry matter accumulation (g/m^2)	Crop growth rate (g/m^2/day)
T_1(control)	83.0	233.00	864.17	4.26
T_2(120=60+60)kg N	95.60	365.41	923.70	4.30
T_3(120=60+30+30)kg N	100.2	370.78	964.35	4.53
T_4(120=40+40+40)kg N	96.2	368.00	948.74	4.44
T_5(150=75+75)kg N	101.5	381.56	1024.52	5.34
T_6(150=75+37.5+37.5)kg N	103.3	393.41	1115.84	6.55
T_7(150=50+50+50)kg N	102.0	386.59	1083.67	6.17
T_8(180=90+90)kg N	104.1	404.00	1191.06	7.17
T_9(180=90+45+45)kg N	110.6	420.08	1232.77	7.43
T_{10}(180=60+60+60)kg N	108.4	415.65	1223.00	7.40
T_{11}{136=30+60+GS=48(45DAS)+28(65DAS)}kg N	105.2	422.49	1260.30	7.64
T_{12}{140=30+60+GS=40(45DAS)+10(65DAS)}kg N	106.6	424.48	1307.49	8.14
SEm±	4.69	17.90	65.09	0.51
CD (P=0.05)	13.76	52.51	190.93	1.48
CV (%)	8.01	8.12	10.30	14.31

Table 2. Effect of precision nitrogen management on yield attribute of wheat

Treatments	Yield attributes					
	Effective tillers/ m^2	Spike length (cm)	Spikelets/ spike	Filled grains / spikes	Unfilled grains /spikes	1000 grain wt. (g)
T_1:(control)	256.50	7.23	15.45	26.20	4.73	31.33
T_2:(120=60+60)kg N	305.27	9.63	17.03	42.12	3.79	37.67
T_3:(120=60+30+30)kg N	335.39	10.23	17.46	44.27	3.48	39.00
T_4:(120=40+40+40)kg N	325.07	9.80	17.21	42.70	3.21	38.37
T_5:(150=75+75)kg N	345.11	10.80	18.20	45.20	4.07	39.60
T_6:(150=75+37.5+37.5)kg N	361.67	11.38	19.00	46.54	3.94	40.65
T_7:(150=50+50+50)kg N	353.46	11.20	18.65	45.60	3.66	40.34
T_8:(180=90+90)kg N	372.33	11.97	20.38	47.13	5.07	41.06
T_9:(180=90+45+45)kg N	385.02	12.60	20.80	49.36	4.56	41.98
T_{10}:(180=60+60+60)kg N	380.07	12.23	20.45	48.32	4.33	41.43
T_{11}:{136=30+30+GS=48 (45DAS)+28(65DAS)}kg N	395.29	12.59	21.00	50.04	2.89	42.26
T_{12}:{140=30+60+GS=40 (45DAS)+10(65DAS)}kg N	410.56	12.96	21.66	53.10	2.56	42.80
SEm±	16.60	0.52	0.87	2.15	0.23	0.710
CD (P=0.05)	48.69	1.52	2.55	6.30	0.67	2.08
CV (%)	8.16	8.11	7.96	8.26	10.30	3.10

Table 3. Effect of precision nitrogen management on yield and economics of wheat

Treatments	Grain Yield (q/ha)	Straw Yield (q/ha)	Harvest Index (%)	Net return (Rs/ha)	B:C ratio
T_1:(control)	20.83	36.50	36.61	13869	0.58
T_2:(120=60+60)kg N	39.13	57.13	40.65	40235	1.32
T_3:(120=60+30+30)kg N	41.15	59.15	40.99	43835	1.44
T_4:(120=40+40+40)kg N	40.49	58.42	40.86	42538	1.39
T_5:(150=75+75)kg N	41.86	61.86	40.31	44679	1.44
T_6:(150=75+37.5+37.5)kg N	43.11	63.11	40.58	46910	1.51
T_7:(150=50+50+50)kg N	42.78	62.78	40.53	46327	1.49
T_8:(180=90+90)kg N	44.34	65.34	40.52	48640	1.54
T_9:(180=90+45+45)kg N	46.19	68.19	40.39	51986	1.65
T_{10}:(180=60+60+60)kg N	45.60	66.60	40.65	50889	1.61
T_{11}:{136=30+30+GS=48(45DAS)+28(65DAS)}kg N	47.50	70.83	40.14	54163	1.70
T_{12}:{140=30+60+GS=40(45DAS)+10(65DAS)}kg N	48.39	71.72	40.29	55695	1.75
SEm±	1.71	2.87	1.18	2863	0.08
CD (P=0.05)	5.02	8.43	3.45	8398	0.23
CV (%)	7.10	8.05	5.07	11.03	9.32

real-time, on-the-go sensor or applicators that sense the health of the wheat crop at the time of nitrogen application and then simultaneously adds the precise amount of nitrogen that is determined to be needed by the machine. Improved yield attributes were also recorded due to better N distribution and high rate of nitrogen application. Similar results were also reported by [7] where it was revealed that all the yield attributing parameters showed beneficial effects. Highest yield and economics of wheat in treatments guided by Greenseeker was due to improved yield attributes [12].

4. CONCLUSIONS

Based on one year of experimentation it may 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 grain yield (48.39 q/ha), straw yield (71.72 q/ha), net return (Rs. 55694.82/ha) and B:C ratio (1.75).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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