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Efficient Nitrogen Management Using Leaf Colour Chart for Optimizing Growth and Yield of Wheat (*Triticum aestivum L.*) Cultivars

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Abstract

A field experiment was conducted at Agricultural Research Farm, R.B.S. College, Bichpuri, Agra, during the winter (rabi) season of 2016-17, to study the efficient nitrogen management in wheat (Triticum aestivum L.) cultivars using leaf colour chart for optimizing growth and yield. Application of 150 kg N (50 kg as basal + 50 kg at crown-root initiation + 50 kg at maximum tillering followed by application of 145 kg N 50 kg as basal + 50 kg as crown root initiation + 45 kg N using leaf colour chart (LCC) at maximum tillering stage gave highest grain yield and resulted statistically similar growth and yield attributes, viz plant height, dry matter accumulation (g), no of spikes per metre^{2}, length of spike (cm), no. of grains spike^{-1}, weight of grains spike^{-1}, 1000-grain weight (g), grain yield and harvest index (%). Variety HD 2967 gave the highest grain yield (5.0 t ha^{-1}) closely followed by DPW 621-50 (4.89 th^{-1}). The highest net return of Rs. 79207 ha^{-1} and B : C ratio of Rs. 3.75 was obtained with variety HD2967 fertilized with 150 kg N ha^{-1}.

Key words *: Efficient nitrogen management, leaf colour chart, net return, wheat cultivars.*

Introduction

Nitrogen is essential, primary nutrient and limiting factor determining the yield of wheat and together with rice. A world – wide evaluation shows that the fertilizer N recovery efficiency is around 30% in wheat with current practices. The major reason of low N – use efficiency is fixed – time splitting of N applications advocated in current recommendation or N application is not synchronized with crop demand, as well as the use of nitrogen in excess to the requirement. Fertilizer N is an expensive input but farmers have tendency to apply N in large amounts to minimize yield losses due to degradation of soils and continuous cropping without investing adequately in maintaining soil quality[5].

An N requirement of wheat plant is not same throughout the growth period it is necessary to adjust fertilizer N application with the timings of plant N requirement to enhance N use efficiency in wheat. The real time N management approach can help increase N use efficiency by matching time of fertilizer application with plant need. Leaf Colour Chart (LCC) is a reliable tool for real time N management. It can be used for rapid and reliable monitoring of relative greenness of the leaf as an indicator of leaf N status.

Selection of suitable genotype plays a vital role in crop production. The choice of right genotype of wheat helps to augment crop productivity by about 20-25 per cent. Any genotype of wheat before being recommended for general cultivation for particular region must be judged for its potential, tolerance against disease in general and in particular responsiveness to added water and fertilizer and adaptability to different agro-climatic conditions. Thus, the value of stable and high yielding genotypes has been universally recogmized as an important factor for boosting crop production.

Material and Methods

A field experiment was conducted during the winter (rabi) season of 2016-17 at Agricultural Research Farm, R.B.S. College, Bichpuri, Agra (27°2 N, 77°9 E, and about 163.4 M above mean sea level). The variables involved in this study were three wheat cultivars viz. WH-1105, HD 2967 and DPW 621-50 and six nitrogen management practices including control-No., recommended 150 kg N ha^{-1} (50 kg as basal + 50 kg at crown root initiation + 50 kg at maximum tillering – N_1), 50 kg as basal + 50 kg at CRI + 25 kg at LCC 4.5, - N_2, 50 kg as basal + 50 kg CRI + 35 kg at LCC 4, 5, - N_3, 50 kg as basal + 50 kg at CRI + 45 kg at LCC 4, 5 – N_4 and 75 kg at basal + 75 kg at CRI + 75 kg at maximum tillering – N_5. The N, P and K were applied through Urea, diammonium phosphate (DAP) and muriate of potash (MOP) respectively. Thus in all 18 treatment combinations were compared in randomized block design (RBD) with four replications. The soil of experimental fields was sandy loam in texture with a pH of 8.30. The soil was low in nitrogen (174.60 kg ha^{-1}), medium in available phosophorus (26.50 kg P_2O_5 ha^{-1}) and rich in potash (220.40 kg K_2O ha^{-1}). The data relating to each character were analysed statistically. Economics of different treatments was worked out on the basis of input and output on the prevailing market prices and B : C ratio was calculated.

Results and Discussion

Growth and yield attributes:

All the growth parameters and yield attributes like number of shoots per m^2, plant height (cm), Dry matter accumulation (g) per 25 cm row length, length of spike (cm), number of grains $spike^{-1}$, weight of grains $spike^{-1}$ and 1000 grain weight (g) were significantly influenced by different nitrogen management practices and wheat cultivars (Table 1). The maximum growth and yield attributes were found in recommended nitrogen (150 kg N ha^{-1}) management; However, they were at par with nitrogen management including application of 50 N kg as basal + 50 kg N at CRI and 35 kg at maximum tillering stage by LCC 4, 5 (total 135 kg N ha^{-1}). This might be because of nitrogen application based on LCC was done as per the crop need rather than at fixed dose. This cause favaurable effect of N on cell-division and tissue organization that ultimately improved tiller formation and dry matter accumulation[1,3].

The highest values of yield contributing characters like length of spike (cm), number of spike per m^2, number of grains per spike, weight of grains $spike^{-1}$ and 1000 grain weights were recorded in recommended nitrogen management which was at par with treatments having a total application rate of 135 kg N. This trend was similar to what observed earlier in number of shoots per m^2 and dry matter accumulation and might be owing to synchronization of nitrogen supply with demand of crop leads to statistically similar growth and biomass production. Higher photosynthetic rate reflected in better reproductive growth too. Application of 225 kg N ha^{-1} did not differ appreciably with 150 kg N ha^{-1}, but both the rates of nitrogen increased significantly growth and yield attributes in this respect. No-N control treatment recorded significantly less yield attributes due to reduced dry-matter accumulation and later on the poor grain filling too. The data presented in Table 1 revealed that different varieties of wheat had significant effects on growth and yield contributing characters such as number of spikes per m^2, length of spike weight of grains $spike^{-1}$ and 1000–grain weight were also improved appreciably with cultivar HD2967 closely followed by DPW 621-50 than WH 1105, respectively. These results confirm the findings of earlier investigators[2, 4].

Grain and Straw yield

The biological, grain and straw yield was significantly affected due to different nitrogen management practices and wheat cultivar's (Table 2). All the nitrogen management practices resulted conspicuously higher grain yield as compared to no nitrogen (No). The maximum grain (5.58 t ha^{-1}) was found with 150 N ha^{-1} closely followed with 135 kg N ha^{-1} by LCC 4, 5. Application of 225 kg N ha^{-1} did not differ appreciably with 150 kg N ha^{-1}. Grain yield is the joint effect of number of spikes per m^2, length of spike, number and weight of grains $spike^{-1}$ and 1000-grain weight. Straw yield also significantly increased due to nitrogen management practices. The highest straw yield was recorded with the application of 225 kg N ha^{-1} closely followed by 150 kg N ha^{-1} and 145 kg N ha^{-1}. Better plant growth might be held responsible for higher straw yield ha^{-1}. Harvest index was increased significantly with 150 kg N ha^{-1} and 135 kg N ha^{-1} by LCC 4, 5 over rest of the treatments. This is probably the results of increased translocation of synthesized material from the stem and leaves of spike as well as greater the developing capacity of plants. The maximum grain and straw yield was found with the variety HD 2967 closely followed by DPW 621-50 than WH 1105. Variety HD 2967 also had highest harvest index and it was significantly higher than DPW 621-50 and WH1105 which were not appreciable in this respect.

The highest net profit of Rs. 79207 ha^{-1} and B : C ratio of Rs. 3.75 was obtained from variety HD 2967 fertilized with recommended 150 kg N ha^{-1} closely followed by variety DPW 621-50 with 150 kg N ha^{-1}, which gave net return of 78781 ha^{-1} and B : C ratio of Rs. 3.74.

On the basis of this study it is concluded that variety HD 2967 fertilized with 50 kg N as basal + 50 kg N at CRI and 35 kg LCC 4-5 (135 kg ha^{-1}) resulted in at par grain yield as compared to recommended N (150 kg N ha^{-1}), although higher net return and benefit : cost ratio were obtained in the recommended N practice. There can be substantial fertilizer saving with use of real time N management.

Table 1 Effect of nitrogen management using leaf colour chart and wheat cultivars on growth and yield attributes

Treatments	No. of shoots per m^2 at harvest	Plant height (cm) at harvest	DMA (g) at harvest	No. of spike per m^2	Length of spike (cm)	No. of grains $spike^{-1}$	Weight of grains (g) $spike^{-1}$	1000 grain weight (g)
Varieties								
WH-1105	448.34	105.56	108.45	444.07	6.04	52.26	2.06	39.05
HD-2967	473.06	113.52	118.28	466.81	6.78	57.13	2.38	41.23
DPW 621-50	469.06	110.56	114.12	463.49	6.23	56.93	2.31	40.95
SEM ±	5.75	1.40	1.34	5.51	0.08	0.72	0.04	0.54
CD (P = 0.05)	19.88	4.86	4.65	19.06	0.28	2.50	0.15	1.88
Nitrogen Management								
No Nitrogen (No)	400.12	87.25	76.40	391.09	5.72	46.64	1.88	37.86
150 Kg N ha^{-1}	483.25	116.04	125.78	478.63	6.48	62.42	2.60	41.91
125 kg N ha^{-1} by LCC (N_2)	460.95	106.78	106.90	461.19	6.24	51.01	2.00	39.64
135 kg N ha^{-1} by LCC (N_3)	475.65	109.35	122.34	466.78	6.26	58.14	2.40	40.34
145 kg N ha^{-1} by LCC (N_4)	465.23	108.12	125.10	461.19	6.40	57.38	2.52	41.48
225 kg N ha^{-1} (N_5)	470.12	120.70	123.52	470.10	6.52	57.14	2.50	41.02
SEm ±	7.61	1.80	1.72	7.27	0.10	0.87	0.05	0.70
CD (P = 0.05)	16.24	3.84	3.67	15.52	0.21	1.86	0.12	1.49

LCC = Live colour chart, DMA – Dry matter accumulation

Table 2 Effect of nitrogen management using leaf colour chart and wheat cultivars on biological, grain, straw yield, harvest index and B:C ratio.

Treatments	Biological Yield (t ha^{-1})	Grain Yield (t ha^{-1})	Straw Field (t ha^{-1})	Harvest Index (%)	B:C ratio
Cultivar's					
WH-1105	11.58	4.62	6.80	39.47	3.28
HD-2967	12.10	5.01	7.45	41.74	3.63
DPW 621-50	11.84	4.89	7.20	39.64	3.56
SEm ±	1.34	0.62	0.88	0.45	
CD (P = 0.05)	4.62	2.15	3.05	1.56	
Nitrogen Management					
No Nitrogen (No)	6.88	2.56	3.72	37.20	2.75
150 Kg N ha^{-1}	13.11	5.58	7.52	42.58	3.75
125 kg N ha^{-1} by LCC (N_2)	12.05	4.91	7.14	40.79	3.58
135 kg N ha^{-1} by LCC (N_3)	12.05	5.10	7.41	40.41	3.64
145 kg N ha^{-1} by LCC (N_4)	12.85	5.42	7.43	42.19	3.68
225 kg N ha^{-1} (N_5)	13.10	4.95	8.51	37.78	3.60
SEm ±	1.74	0.80	1.13	0.51	
CD (P = 0.05)	3.71	1.72	2.42	1.0	

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