Bangladesh J. Bot. **52**(2): 277-282, 2023 (June) DOI: https://doi.org/10.3329/bjb.v52i2.67024

REAL TIME NITROGEN MANAGEMENT THROUGH LEAF COLOUR CHART AND CHLOROPHYLL METER IN WHEAT (*TRITICUM AESTIVUM* L.) OF JAMMU

Neetu Sharma*, Aaina Sharma, AP Singh, Vikas Sharma, Rohit Sharma, Rakesh Kumar, Akhil Verma and Joysamuel Mecarty

Division of Agronomy, FOA, Main Campus SKUAST- J, Chatha-180009, Jammu, India

Keywords: Leaf color chart, Nitrogen use efficiency, Sufficiency index, Wheat yield

Abstract

A field experiment was conducted to assess the effect of real time nitrogen management through leaf colour chart and chlorophyll meter in wheat. The experimental results revealed that Leaf color chart ≤5 based nitrogen application recorded significantly higher growth, yield and yield attributes, which was statistically at par with leaf color chart ≤ 4, sufficiency index and leaf color chart ≤3. However, recommended nitrogen application recorded significantly highest agro physiological efficiency. Sufficiency index recorded highest benefit cost ratio (B:C) which was followed by leaf color chart ≤ 4 and leaf color chart ≤ 5.

Introduction

Wheat (*Triticum aestivum* L.) is a crop of global significance and second most important crop of India. It is grown in diversified environment and serves as staple food for millions of people. The productivity and quality of wheat crop depends on the environmental conditions and improved agronomic practices especially the nutrient management, which plays a significant role in achieving higher productivity (Singh and Sandhu 2020). Among the primary nutrients, nitrogen is very important nutrient as it is intimately involved in the process of photosynthesis and thus directly related to total dry matter production. An adequate supply of nitrogen can increase the yield as much as 60 per cent (Singh *et al*. 2017). Top dressing through split application of nitrogen is needed when the crop has a great need for nitrogen and when the rate of nitrogen uptake is large (Zobermann and Fairhurst 2016). Crop-demand based nitrogen application is one of the important options to reduce nitrogen losses and to increase nitrogen use efficiency of a crop. Some Modern gadgets or tools like Leaf colour chart (LCC) based on spectral properties of leaf and chlorophyll meter or Soil Plant Analysis Determination (SPAD) meter based on light transmittance through leaves has been reported by several researchers as precision tools to increase nitrogen use efficiency in wheat. These regulate the timing of nitrogen application (Singh and Sharma 2016). Leaf color chart and chlorophyll meter are reliable, quite simple and useful tools to assist farmers in decision making regarding top dressing of nitrogenous fertilizers to crops (Singh *et al*. 2016). LCC and SPAD can be used to monitor plant nitrogen status *in situ* in the field and to determine the right time of nitrogen top dressing to crop and can save up to 50 and 60 kg N/ha, respectively, without yield decrement in wheat over blanket application of nitrogen (Singh *et al*. 2014, Maiti and Das 2016). Hence, keeping the above under consideration the study was planned to work out need based management of nitrogen using leaf color chart and SPAD for wheat in sub-tropics of Jammu.

Materials and Methods

A field experiment was conducted during rabi season of 2018-19 and 2019-20 at the research farm of Division of Agronomy, SKUAST-J (32-40^o N latitude and 74-58^o E longitude and an altitude of 332 m above mean sea level). The experimental soil was sandy clay loam in texture,

*Author for correspondence: <hanshunitu77@rediffmail.com>.

slightly alkaline (pH 7.82), low organic carbon (4.8g/kg) and available nitrogen (224.60 kg/ha) but medium in available phosphorus (19.60 kg/ha) and potassium (149.60 kg/ha). The experiment was conducted in randomized block design with four replications. The treatments consisted of control**,** nitrogen application based on leaf color chart ≤3**,** leaf color, chart ≤ 4**,** leaf color chart ≤5**,** sufficiency index based nitrogen application and recommended dose of nutrients. A well fertilized reference plot with 50% higher than recommended nitrogen was also laid out at the experimental site for calculating sufficiency index. Wheat cultivar "HD-3086" was sown at row to row spacing of 20 cm. The application of fertilizers was done in accordance with the requirement of the treatments as per technical programme of the experiment. The recommended dose of nutrients for wheat crop was 100 kg/ha nitrogen (N), 50 kg/ha phosphorus (P_2O_5), 25 kg/ha potassium (K_2O) besides 37.5 kg/ha sulphur (S) which was applied to all the treatments in addition to have uniformity in the nutrients applied to the crop. These nutrients were supplied in form of urea, diamonium phosphate (DAP), single super phosphate (SSP), muriate of potash (MOP) and gypsum. Nitrogen was applied in split doses and entire dose of phosphorus, potassium and sulphur were applied as basal dose in all the treatments except for phosphorus which was applied through single super phosphate in control. However, in treatments with LCC and sufficiency index based nitrogen application, 60 kg N/ha was applied in two equal splits in all the treatments. Soil plant analysis development meter was used to assess chlorophyll content for deriving sufficiency index value (Singh *et al.* 2014).Minolta-502 Soil plant analysis development meter was used to assess chlorophyll content. The soil plant analysis development meter readings were taken periodically under clear weather conditions from 11 am to 2 pm. Soil plant analysis development meter readings were collected from youngest first fully expanded flag leaf from the top of the plant. The threshold value of sufficiency index for determining nitrogen status was 95%. Leaf color chart readings were determined using six panel leaf color chart for wheat developed by PAU-Ludhiana. Leaf color chart was compared with the mid portion of fully opened top most leaf. The 15 kg/ha nitrogen was applied when leaf color chart reading was ≤ 3, ≤ 4 and ≤ 5 in respective treatments.The crop was grown under assured irrigation. For plant height, five plants were selected randomly and tagged in each plot while for the parameters like leaf area index and dry matter accumulation, plants from border rows were selected for recording observations. Data pertaining to yield and yield attributes were obtained at harvest. The leaf area index of the leaves was calculated as per the formulae given by Radford (1967). The increase in plant material per unit time or cumulative absolute growth rate (AGR) was calculated as per the formula given by Radford (1967). Different nitrogen efficiency indices were calculated by using the formula given below .

$$\text{Nitrogen use efficiency} = \frac{\text{Grain yield in treated plot (kg/ha) - grain yield in control plot (kg/ha)}}{\text{Amount of nitrogen applied (kg/ha)}}$$

$$\text{Apparent recovery (\%)} = \frac{\text{N uptake in treated plot (kg/ha) – N uptake in control plot (kg/ha)}}{\text{Amount of nitrogen applied (kg/ha)}}$$

$$\text{Agro-physiological efficiency} = \frac{\text{Grain yield produced (kg/ha)}}{\text{N uptake in above dry matter at harvest (kg/ha)}}$$

Among economic parameters, net return per ha was calculated by deducting cultivation cost from gross returns. Benefit cost ratio (B: C) was calculated by dividing net returns with total cost of cultivation to evaluate the economic viability of treatments. The observations recorded during the course of investigation were tabulated and subjected to analysis of variance techniques as described by Gomez and Gomez (1984). The key for degree of freedom used in analysis of variance is given below:

Source of variation	Degree of freedom
Replications (r-1)	4-1 = 3
Treatment (t-1)	6-1 = 5
Error (r-1) (t-1)	(4-1) (6-1) = 15
Total (rt-1)	24-1 = 23

Results and Discussion

Data on growth parameters of wheat revealed that the growth characters of wheat were significantly influenced by different treatments of nitrogen management (Table 1). Leaf color chart $\leq$ 5 based nitrogen application recorded significantly higher plant height which was at par with leaf color chart $\leq$ 4, sufficiency index and leaf color chart $\leq$ 3.This might be due to favorable effect of nitrogen on cell division and tissue organization that ultimately led to significant improvement in plant height (Reena *et al.* 2017a).Dry matter production and absolute growth rate increased significantly with leaf colour chart $\leq$ 5 based nitrogen application which was found to be statistically at par with nitrogen application based on leaf colour chart $\leq$ 4, sufficiency index based nitrogen application and leaf colour chart $\leq$ 3 (Table 1). This caused favourable effect of nitrogen on cell-division, tissue organization and better synchronization of nitrogen supply with crop nitrogen demand which led to rapid cell elongation, higher dry matter accumulation and absolute growth rate. These results are in close conformity with findings of Barad *et al.* (2018) and Nayak and Patra (2016). Significantly higher number of tillers/m^2 was observed with leaf color chart $\leq$ 5 based nitrogen application which was found statistically at par with nitrogen application based on leaf color chart $\leq$ 4, sufficiency index based nitrogen application and leaf color chart $\leq$ 3. This might be attributed to efficient nitrogen management with application of higher quantum of nitrogen which indirectly aids in enhancing the nutrient status of plant as per crop need. Similar findings were also reported by Duttarganvi *et al*. (2014) and Maiti and Das (2016). Likewise, significantly higher leaf area index was recorded with leaf color chart $\leq$ 5 based nitrogen application which was found statistically at par with nitrogen application based on leaf color chart $\leq$ 4, sufficiency index based nitrogen application and leaf color chart $\leq$ 3.These results are in close agreement with those reported by Jing *et al. (*2017)

Leaf color chart based nitrogen application significantly influenced yield attributes (Table 1). Leaf color chart $\leq$ 5 recorded significantly higher numbers of spikes/m^2, number of grains/spike and 1000-grain weight which was at par with leaf color chart $\leq$ 4, sufficiency index based nitrogen application and leaf color chart $\leq$ 3. This might be due to adequate nitrogen supply during reproductive growth phase and availability of nitrogen as per crop need resulted in significant increase in yield attributes of wheat crop. These results are in close conformity with the findings of Murdock *et al.* (2014).

Leaf color chart based nitrogen application significantly influenced grain yield, straw yield and biological yield (Table 1). Leaf color chart $\leq$ 5 based nitrogen application recorded significantly highest grain yield, straw yield and biological yield which was found to be statistically at par with the nitrogen application based on leaf color chart $\leq$ 4, sufficiency index based nitrogen application and leaf color chart $\leq$ 3. These treatments registered 147.22, 144.17,

Table 1. Effect of leaf color chart and SPAD based application of nitrogen on growth, yield attributes and yield of wheat (Pooled data of two years).

Treatment	Growth				Yield attributes				Yield		
	Plant height (cm)	Leaf area index	Dry matter accumulation (g m^{-2}) (60 das)	Absolute growth rate (g m^{-2} day^{-1}) (60-90 das)	No. of tillers M^{-2}	No. of spikes M^{-2}	No. of grains $spike^{-1}$	1000-grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Control	27.39	0.43	72.37	7.27	312.88	310.90	26.81	29.85	2005.5	2976.0	4981.50
Nitrogen application based on leaf color chart ≤ 3	35.68	1.26	161.85	17.15	369.00	363.50	36.01	37.73	4670.5	6027.0	10697.50
Nitrogen application based on leaf color chart ≤ 4	37.77	1.35	166.01	17.80	379.13	374.50	36.84	38.67	4897.0	6194.0	11091.00
Nitrogen application based on leaf color chart ≤ 5	38.94	1.47	170.47	18.45	382.63	377.50	37.54	38.77	4958.0	6225.0	11183.00
Sufficiency index based nitrogen application	37.24	1.31	164.66	17.58	374.88	370.13	36.52	38.38	4855.5	6153.0	11008.50
Recommended dose of fertilizer	33.00	1.07	152.36	16.03	350.75	347.38	34.72	36.75	4313.0	5631.0	9944.00
Se (±)	1.39	0.08	3.69	0.45	7.38	6.61	0.58	0.53	168.22	171.89	283.45
Cd (5%)	4.19	0.22	11.14	1.36	22.12	19.82	1.75	1.58	504.67	515.66	850.40
Well fertilized reference plot (150% of rdn)	40.62	1.51	172.90	18.77	387.51	383.10	37.98	38.96	5335.5	6554.0	11889.50

138.65 and 132.88 per cent higher grain yield of wheat over that of control. Further, it was also apparent from the Table 2 that LCC ≤ 3 based nitrogen application was found statistically at par with recommended dose of fertilizers whereas, significantly lowest grain yield was observed in control. This might have happened due to greater availability of photosynthates, metabolites and nutrients to develop reproductive structures which resulted in increased number of productive plants and ultimately increased crop yield. Similar results were also reported by Barad *et al.* (2018). Increased yield of wheat with right dose of N coupled with right time of application by need based N management using leaf color chart and temporal variation in nitrogen supply to plant which led to higher grain yield than blanket recommendation. These results are in agreement with the findings of Singh *et al.* (2016).

Table 2. Effect of leaf color chart based application of nitrogen on various nitrogen efficiency indices and relative economics of wheat crop (pooled data of two years).

Treatment	Agronomic NItrogen use efficiency (kg/kg)	Apparent recovery efficiency (%)	Agro physiological efficiency (kg/kg)	Net return (Rs. ha^{-1})	B:C ratio (Re. $Re.^{-1}$)
Control	0.00	0.00	0.00	27031	1.24
Nitrogen application based on leaf color chart ≤ 3	25.38	66.07	38.43	83021	3.07
Nitrogen application based on leaf color chart ≤ 4	24.10	65.09	36.99	87338	3.18
Nitrogen application based on leaf color chart ≤ 5	21.87	59.18	36.93	88089	3.15
Sufficiency index based nitrogen application	27.14	73.27	37.01	86929	3.22
Recommended dose of fertilizer	23.08	57.49	40.19	75561	2.87
SE (±)	1.01	0.36	0.53	-	-
CD (5%)	3.04	1.10	1.58	-	-

Efficiencies of nitrogen use is presented in Table 2, which revealed that sufficiency index recorded significantly highest nitrogen use efficiency which was at par with leaf color chart ≤ 3 and leaf color chart ≤ 4. However, sufficiency index based nitrogen application recorded significantly highest apparent recovery of nitrogen and recommended dose of fertilizers recorded significantly highest agro physiological efficiency. Similar findings were also reported by Maiti and Das (2016) and Bhat *et al.* (2015) who suggested that synchronizing crop nitrogen demand with fertilizer nitrogen supply using leaf color chart based nitrogen management strategy lead to apparent recovery of nitrogen and agro physiological efficiency.

Nitrogen application based on leaf color chart ≤ 5 resulted in higher net returns which was closely followed by leaf color chart ≤ 4 (Table 2). The higher net returns due to leaf color chart based nitrogen application resulted in improvement in crop yield (Table 2). These results are in close conformity with the findings of Kumar *et al.* (2017). However, maximum B:C ratio was recorded with sufficiency index based nitrogen application which was closely followed by nitrogen application based on leaf color chart ≤ 4 and leaf color chart ≤ 5. This might be due to reduced dose of nitrogen application with minimum number of splits and statistically similar yield with leaf color chart ≤ 5 based nitrogen application.These results are in conformity with the findings of Reena *et al.* (2017b).

From the above findings, it may be concluded that leaf color chart ≤ 5 based nitrogen application was suitable for yield maximization and higher net returns irrespective of B:C ratio.. Thus, need based N management based on leaf color chart ≤ 5 would help farmer community to utilize the nitrogenous fertilizers efficiently and optimally.

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(Manuscript received on 04 April, 2022; revised on 09 May, 2023)