Asian Journal of Soil Science and Plant Nutrition

Volume 10, Issue 1, Page 295-308, 2024; Article no.AJSSPN.113984
ISSN: 2456-9682

Effect of Nitrogen Management Strategies on Yield, Quality and Nitrogen Uptake by Wheat (*Triticum aestivum* L.)

Rohit Kumar [a*], Pankaj Kumar [b], Avdhesh Pratap Singh [c], Atin Kumar [d] and Sunil Kumar [e]

[a] Faculty of Agricultural Science, GLA University, Mathura UP, India.
[b] College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture and Technology Meerut, (U.P.)-250110, India.
[c] Department of Agricultural Chemistry and Soil Science, Amar Singh P.G. College, Lakhaoti, Bulandshahr, Uttar Pradesh, India.
[d] School of Agricultural Science, Uttranchal University, Dehradun, Uttarakhand, India.
[e] Department of Agriculture, Swami Vivekanand Subharti University Meerut UP, India.

Authors' contributions

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

Article Information

DOI: 10.9734/AJSSPN/2024/v10i1235

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/113984

Original Research Article

Received: 26/12/2023
Accepted: 29/02/2024
Published: 02/03/2024

ABSTRACT

There is little knowledge among farmers on the rate of nitrogen-fertilizer application. Therefore, there is a need to determine optimal rate of nitrogen-fertilizer application on growth and yield of wheat. Accordingly, an field experiment was conducted during the winter (Rabi) season at Crop Research Centre the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut,

**Corresponding author: Email: kumar.rohit@gla.ac.in;*

Uttar Pradesh, to study the impact of different nitrogen level and splitting modules on quality, yield and nitrogen uptake by wheat (*Triticum aestivum* L.) crop. The main object of investigation was to find out the optimum dose and splitting of nitrogen for wheat in irrigated system under integrated nitrogen management approach. The experiment consisting of four nitrogen levels viz. control i.e. 0 kg N ha-1 , 90 kg N ha-1, i.e 120 kg N ha-1 and 150 kg N ha-1 as main plots and four splitting modules M1- 50% N as basal through VC, + 25% at CRI + 25% booting stage through urea, M2-50 % N as basal through FYM + 25% at tillering + 25% at booting stage through urea, M3 -50% N as basal through VC+FYM (1:1), + 25% at tillering + 20% at booting stage and 5 % N as foliar spray at pre flowering stage through urea, M4 -50% N as basal through VC+FYM (1:1), rest based on SPAD reading through urea as sub-plots. The experimental results revealed that the plot which fertilized with 150 kg N ha-1 gave higher yield-attributing characters and yield (grain, straw and biological yield). The application of 150 kg N ha-1 resulted in 0.44, 15.25 and 80.8 per cent during 2016-17 and 0.41, 13.05 and 79.2 per cent during 2017-18 produced the higher grain yield over 120, 90 and 0 kg N ha-1. The content and uptake of nitrogen by grain, straw and total uptake as well as protein content and protein yield were obtained with 150 Kg N ha-1 but differences between 120 and 150 kg N ha-1 were non-significant, during both the year 2016-17 and 2017-18. Among different splitting modules M3 resulted significantly higher entire yield attributes, yield (grain and straw yield), nitrogen content and uptake by grain, straw and total uptake as well as content and yield of protein. The M3 module produced higher grain yield by 7.9, 14.7 and 24.8 per cent during 2016-17 and 8.1, 14.89 and 25.2 per cent during 2017-18 over M4, M1 and M2 splitting modules, respectively.

Keywords: Yield attribute; yield; nitrogen uptake; splitting.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) crop triggered green revolution in the Indian subcontinent, is an important food grain providing nourishment nearly to 35 per cent people of the world. It is the second most important food crop after rice and has played a very vital role in increasing and stabilizing the food production of the country. It is grown on 31.45 m ha with production 107.59 million tones and average productivity of 3420 kg ha^{-1} during 2019-2020. In India, U.P having first rank in production (30.25 mt) and area (9.96 m ha) while in productivity (Anonyms, 2020). Available literature reveals that, Indian soils have become poor in soil fertility–90% soils are deficit in nitrogen [1]. In northwestern India, wheat is grown with a blanket recommended dose of 120 (in Punjab) or 150 kg N ha^{-1} (in Haryana, western Uttar Pradesh) applied in two equal splits—basal N at land preparation or planting and nitrogen topdressing at CRI stage along with first irrigation [2,3]. Nitrogen is an essential plant nutrient and constituent of many compounds of plant, such as chlorophyll, nucleotides, alkaloids, enzymes, hormones, vitamin, amino, acids protein which are considered responsible for induces the entire growth parameter and yield of wheat (Dhyani, et al, 2017). The excessive application of nitrogen may increase susceptibility of the crop to disease and increase water use early in the growing season; whereas, insufficient application may limit grain yield, grain protein and subsequent profitability. Note that grain protein content is a better indicator of sufficient nitrogen application than grain yield of bread wheat. It means that with the application of nitrogen yield will generally increase to a maximum level, whereas protein may continue to increase beyond this level with further nitrogen application. Recovery of applied nitrogen by plants is lower (30-40 %) due to inefficient splitting of nitrogen rates coupled with nitrogen applications in excess of crop requirements [4]. When managed inefficiently, a large portion of the applied nitrogen can escape (leaching, run-off, gaseous emission) from soil-plant system to reach water bodies and the atmosphere thus creating pollution problems and being an expense to the farmers also has an environmental cost [5]. As wheat crop is extremely awake to applied nitrogen through various sources, proper soil-fertility management is very important for optimizing the quality and yield of this crop. Foremost important role of nitrogen in plant is it presence within the structure of protein, the foremost important building substance from which living material or protoplasm of each cell is formed [6,7]. Nitrogen supply to plant influences the quantity of protein, protoplasm and chlorophyll formed and intern this influence cell size, leaf area and photosynthetic activity. On account of continuing world energy crisis and spiraling price of chemical fertilizer, the use of organic manure as a renewable source of nitrogen is assuming importance [8]. In this endeavor, proper blend of organic and inorganic fertilizer is important not only for enhancing yield but also for sustaining soil health [9]. For increasing production of wheat there is an urgent need to improve agronomy of this crop. Now days the researchers are interested in different alternative nitrogen management systems to cope with the limited natural resources to reassess current management practices for wheat production. The optimum application of fertilizers is important to increase the quality and yield of wheat. Keeping all above facts under consideration an attempt was made in view, the present investigation entitled "study the impact of different nitrogen level and splitting modules on quality, yield and nitrogen uptake by wheat (*Triticum aestivum* L.)" in Western Uttar Pradesh.

2. MATERIALS AND METHODS

The field experiment was conducted at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture & Technology Meerut, (U.P.) during the *Rabi* seasons of two consecutive years, 2016-17 and 2017-18. This area experiences a semiarid, subtropical climate, with extremely hot summers and freezing winters. There is gradual decrease in mean daily temperature in December reaching as low as 4.8^0C in both years and further a gradual increase is registered reaching as high as 35.3^0C and 37.6 ^{0}C in months of April during both research years, respectively. Mean relative humidity is found to be maximum in December and minimum in April, during both years. The total rainfall was occurred 93.4 mm and 37.8 mm during crop period in 2016-17 and 2017-18. The experimental field was well drained, sandy loam in texture and slightly alkaline in reaction (Soil p^H 7.88 and 7.97). It was low in organic carbon (0.48 and 0.49 %) and available nitrogen (230 and 236 kg ha^{-1}), medium in available phosphorus (13.9 and 14.2 kg ha^{-1}) and potassium (238 and 242 kg ha^{-1}) with an electrical conductivity 0.23 and 0.21 dSm^{-1} at 25^0C during 2016-17 and 2017-18, respectively.

The treatments comprised of all possible combinations of the two factors viz., four nitrogen levels *viz*. control *i.e.* 0 kg N ha^{-1} , 90 kg N ha^{-1}, recommended dose of nitrogen *i.e* 120 kg N ha^{-1} and 150 kg N ha^{-1} as main plot factor and four splitting modules M_1- 50% N as basal through VC, + 25% at CRI + 25% booting stage through urea, M_2-50 % N as basal through FYM + 25% at tillering + 25% at booting stage through urea, M_3 -50% N as basal through VC+FYM (1:1), + 25% at tillering + 20% at booting stage and 5 % N as foliar spray at pre flowering stage through urea, M_4 -50% N as basal through VC+FYM (1:1), rest based on SPAD reading through urea as sub plot factor.

The experiment consisted of sixteen treatment combinations was laid out in split-plot design (SPD) with three replications. Wheat (PBW-590) with the spacing (rows) of 20 cm was grown with recommended agronomic package of practices in 15 m^{-2} gross plot size. FYM, VC and urea, SSP, MOP were used as the source of N, P and K, respectively. The full amount of phosphorus 60 kg ha^{-1} and potassium 40 kg ha^{-1} was applied as basal while nitrogen was applied as per the treatments. The 1% nitrogen (1.5 to 2% urea foliar spray as per levels of nitrogen) solution for foliar application was prepared by mixing 13 to 17 kg N (5 % N as per levels 90-150 kg ha^{-1}) in 600liter fresh water as per levels of nitrogen. At pre flowering stage, 600liter solution was applied in one hectare. This solution was sprayed by a knapshek sprayer using flat fan nozzle till all the leaves got moistened at pre flowering stage of wheat. The plots were sprayed during late afternoon hours when wind speed slowed down to less than 10 km hr^{-1} and in SPAD meterbased plots nitrogenous fertilizers are applied as per SPAD reading. After harvesting, threshing, cleaning and drying, the grain yield of wheat was estimated at 14% moisture content. At maturity, representative and non-boarder wheat plant samples were randomly collected from each plot and partitioned into grain and straw. After oven dried at 65°C for 72 h, the samples were ground and passed through 0.5 mm sieve. The samples were analyzed for nitrogen following wet digestion using Kjedahl method as described by Subbiah and Asija, 1956. Standard procedures were used for chemical analysis of soil and plant sample.

Grain protein content (%): This was calculated as per American Association Cereal Chemists (2000):

Protein (%) = nitrogen % in grain × 5.78

The nutrient uptake by wheat crop at harvest had been worked out by using the following equation:

Nutrient uptake (kg ha^{-1}) = Nutrient concentration (%) in grain /straw x grain/ straw yield (kg ha-1) /100

Table 1. Physico-chemical properties of the experimental field

Particulars	Value obtained		Methods adopted
	2016-17	**2017-18**	
A. Mechanical analysis			
Sand (%)	51.72	51.77	Bouyoucos hydrometer Method (Piper,1962)
Clay (%)	19.42	18.39	
Silt (%)	28.86	29.78	
Textural class	Sandy loam	Sandy loam	Brady and Weil (1996)
B. Chemical composition			
Soil p^H (soil: water, 1:2.5)	7.88	7.97	Glass electrode pH meter Suspension method (pH meter (Jackson, 1973)
Soil EC (dSm^{-1} at 25^0C)	0.23	0.21	Conductivity meter Suspension method (Bower and Wilcox,1965)
Organic carbon (%)	0.48	0.49	Walkley and Black wet oxidation Method (Jackson, 1973)
Available N (kg ha^{-1})	230	236	Alkaline potassium permanganate method **(**Subbiah and Asija, 1956)
Available P (kg ha^{-1})	13.9	14.2	Olsen's method (Olsen *et al.,* 1954)
Available K (kg ha^{-1})	238	242	1 N NH_4OAC extraction method (Hanway and Heidal, 1952)

Table 2. Treatment details of the experiment with Symbols

A.	**Level of nitrogen (Main plot)**	**Symbol assigned**
i.	0 kg ha^{-1}	N_1
ii.	90 kg ha^{-1}	N_2
iii.	120 kg ha^{-1}	N_3
iv.	150 kg ha^{-1}	N_4
B.	**Splitting modules (Sub plot)**	
i.	50% N as basal through VC, 25% at CRI and 25% at booting stage through Urea	M_1
ii.	50 % N as basal through FYM, 25% at tillering and 25% at booting stage through Urea	M_2
iii.	50% N as basal through VC+FYM (1:1), 25% at tillering and 20% at booting stage and 5 % N as foliar spray at pre flowering stage through Urea	M_3
iv	50% N as basal through VC+FYM (1:1), rest bassed on SPAD reading through Urea	M_4

The data obtained from two year experiment were subjected to analyze statistically as outlined by. The treatment differences were tested by using "F" test and critical differences (at 5 per cent probability). The data were analyzed by using the 'Analysis of Variance Technique' as per the procedures described by Gomez and Gomes [10] and OPSTAT (HAU, Hissar). The treatment means were compared at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Yield Attributes

The application of nitrogen up to 150 kg ha^{-1} significantly increased the yield attributes, viz. number of effective tillers, spike length, number of grains spike^{-1} and test weight over the control during both the years (Table 3). However, It is clearly evident from the Table 3 that the highest values of yield attributing characters except test weight (g) were recorded With the application of nitrogen 150 kg N ha^{-1} which was statistically at par with application of nitrogen at 120 kg N ha^{-1} and significantly higher than 0 and 90 kg N ha^{-1}, during 2016-17 and 2017-18, respectively.

The application of 150 kg N ha^{-1} had highest test weight (g) which was significantly higher over all the other levels of nitrogen, during 2016-17 and 2017-18, respectively. A reduction of 10.35 % and 10.55 % was recorded in test weight over the control, during 2016-17 and 2017-18, respectively, which might be due to the no nitrogen received during the crop growth period in 2016-17 and 2017-18, The test weight is an important yield attribute which provides information regarding the efficiency with grain filling process took place and represents the development and plumpness of grains. Whereas, lowest test weight was recorded in control plot, during 2016-17 and 2017-18, respectively.

The splitting module of nitrogen had significant affect on yield attributes, viz. number of effective tillers, spike length, number of grains spike^{-1} and test weight during both study years. The results revealed that the maximum number of effective tillers, spike length, number of grains spike^{-1}, test weight (g) were counted with the application of nitrogen 50% N as basal through VC+FYM (1:1), + 25% at tillering + 20% at booting stage and 5 % N as foliar spray at pre flowering stage through urea, which remained statistically at par with M_4 module, during both study years. However, the differences among M_3 and M_4 treatments were non- significant and minimum number of yield attributes was counted in M_2 module during 2016-17 and 2017-18, respectively. This was in accordance with the findings of Inwati et al [11] and Sharma et al [12].

3.2 Grain, Straw and Biological Yield

The levels of nitrogen had significant effect on grain, straw and biological yield which continued to increase with increasing the nitrogen levels up to the highest level of 150 kg ha^{-1} over lower levels including control, during both investigation years. The highest grain (44.96 and 45.63 q ha^{-1}), straw (65.85 and 66.83 q ha^{-1}) and biological yield (111 and 113 q ha^{-1}) was recorded with the application of 150 kg N ha^{-1} which was statistically at par with 120 kg N ha^{-1} and significantly higher than other levels of nitrogen, during both study year (Table 4). Whereas, the lowest grain yields, straw and biological yield was obtained from the control, during both investigation years. The application of 150 kg N ha^{-1} resulted in 0.44, 15.25 and 80.8 per cent during first year and 0.41, 13.05 and 79.2 per cent during second year produced the higher grain yield over 120, 90 and 0 kg N ha^{-1}, respectively. The increase in grain and straw yields which might be due to increased nitrogen availability, being constituents of chlorophyll which have direct positive effect on vegetative growth and reproductive stage due to decreased number of barren plants and increase the yield attributing characters *viz*. effective tillers, spike length, grains spike^{-1} and 1000-grain weight at 150 kg N ha^{-1} compared to lower levels of nitrogen, during both study year. In case of treatment where nitrogen was applied at 150 kg N ha^{-1} crop lodging occur due to which grain yield was increased slightly compare to previous levels of nitrogen, during both study year. The lodging of plants is generally affected by excessive nitrogen, rainfall or high wind speed. (7) reported that maximum grain yield of wheat was obtained with an application of 120 kg N ha^{-1} half through vermin-compost and half through urea. The application of 120 kg N ha^{-1} produced economically higher wheat grain yield than the 90 and 150 kg N ha^{-1}. The higher straw yield of wheat at 150 kg N ha^{-1} might be due to improved growth parameters like plant height, better root development, total number of tillers, LAI to higher growth and development as indicated by increased higher amount of dry matter production as compared to the lower levels including control, during both investigation years. Biological yield is a function of photosynthetic rate and proportion of the assimilatory surface area. The increase in biological yield with increase in rate of nitrogen might be due to better crop growth rate, LAI and accumulation of photo assimilate due to maximum days to maturity by the crop, which ultimately produced more biological yield of wheat. The harvest index was significantly increased with increasing levels of nitrogen up to 120 kg N ha^{-1} and declined at 150 kg ha^{-1}, during both study year. The highest harvest index of 41.56 and 41.57 per cent was calculated with the application of 120 kg N ha^{-1} and significantly higher than other levels of nitrogen, during 2016-17 and 2017-18, respectively. The lowest harvest index 37.65 and 37.89 per cent was calculated under the treatment of without application of nitrogen, during 2016-17 and 2017-18, respectively. Similar results were also reported by Kaur et al. [13] and Bhaduri and Gautam [14].

The splitting modules of nitrogen had also significant effect on grain, straw and biological yield (q ha^{-1}), during both year. However, the significantly highest values were recorded with application of nitrogen 50% N as basal through VC+FYM (1:1), + 25% at tillering + 20% at booting stage and 5 % N as foliar spray at pre flowering stage through urea, during both investigation year. The lowest grain, straw and biological yield (q ha^{-1}) was obtained with M_2 splitting module during experimentation year. The harvest index in wheat crop was also showed significant variation with splitting modules of nitrogen, during both investigation years.

The 5 % N as foliar spray at pre flowering stage through urea increase the chlorophyll content which increased the rate of photosynthesis and elongation of stem resulted in increase of growth attributes and yield attributes which ultimately resulted in about 24.80 and 25.17 % grain yield increased in M_3 as compared to M_2 during both year. These results are in agreement with study of Singh et al. [15].

3.3 Protein Content and Protein Yield

Protein content in gain and yield differed significantly due to different nitrogen levels and nitrogen management practices during both the years, The higher protein content (10.52 and 10.61 % in grain) and yield (474 and 484 kg ha^{-1}) was analyzed with the application of 150 kg N ha^{-1} which was statistically on par with 120 kg N ha^{-1} and significantly higher than other levels of nitrogen, during both study year (Table 5). The lowest protein content (9.10 and 9.32 %) and yield (227 and 238 kg ha^{-1}), during both years, respectively. The Protein content in grain was increased with value of 9.10 to 10.52 and 9.32 to10.60 per cent with increasing levels of nitrogen from 0 to 150 kg N ha^{-1}, during 2016-17 and 2017-18, respectively.

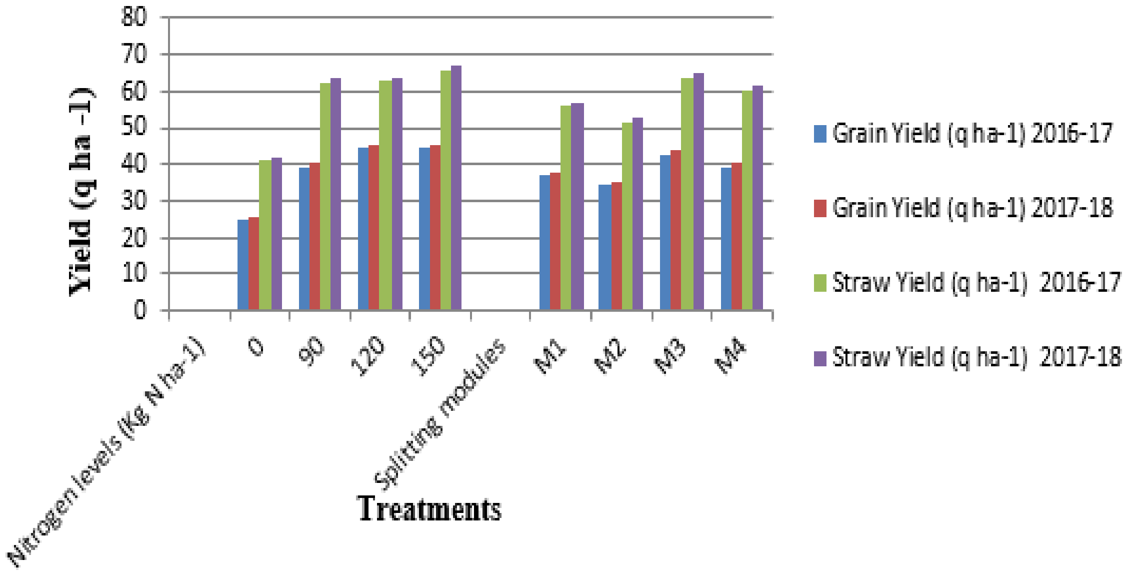

Fig. 1. Effect of different levels and splitting modules of nitrogen on grain and straw, of wheat, during 2016-17 and 2017-18

Table 3. Effect of different levels and splitting modules of nitrogen on number of effective tillers, spike length, No. of grain spike^{-1} and test weight of wheat, during 2016-17 and 2017-18

Treatment	Yield attributes							
	No. of eff. Tillers m^{-2}		Spike length (cm)		No. of grains spike^{-1}		Test weight (g)	
	2016-17	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
Nitrogen levels (kg ha^{-1})								
0	254	259	8.35	8.43	29	31	35.66	36.11
90	276	282	10.82	10.99	38	39	37.59	38.12
120	291	296	11.95	12.17	40	42	38.95	39.55
150	293	298	12.03	12.26	41	44	39.78	40.37
SEm(±)	1.75	1.90	0.09	0.10	0.16	0.18	0.16	0.18
C.D. (P=0.05)	6.16	6.70	0.33	0.35	0.56	0.64	0.56	0.63
Splitting modules								
M_1	277	282	10.62	10.79	36	38	37.84	38.39
M_2	274	280	10.33	10.50	34	36	37.55	38.09
M_3	282	287	11.41	11.60	40	42	38.41	38.94
M_4	280	285	11.14	11.32	38	40	38.18	38.72
SEm(±)	1.07	1.16	0.06	0.06	0.09	0.11	0.10	0.11
C.D. (P=0.05)	3.15	3.41	0.16	0.18	0.28	0.32	0.29	0.32

Note: Significant differences at<0.05 level was taken from three replicates for each treatment's (mean values): Critical Deference, SEm; Standard Error of the Mean, NS; Non-Significant

Table 4. Effect of different levels and splitting modules of nitrogen on grain, straw, biological yield and harvest index of wheat, during 2016-17 and 2017-18

Treatment	Yield (q ha^{-1}) Grain		Straw		Biological		Harvest index (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Nitrogen levels (Kg N ha^{-1})								
0	24.86	25.46	41.10	41.67	66	67	37.65	37.89
90	39.01	40.36	62.17	63.67	101	104	38.54	38.78
120	44.76	45.44	62.92	63.88	108	109	41.56	41.57
150	44.96	45.63	65.84	66.83	111	113	40.61	40.62
SEm(±)	0.67	0.69	0.83	0.87	1.28	1.35	0.24	0.26
C.D. (P=0.05)	2.37	2.43	2.94	3.07	4.52	4.77	0.86	0.93
Splitting modules								
M_1	37.21	37.99	56.12	57.06	93	95	39.63	39.75
M_2	34.19	34.87	51.66	52.48	86	87	39.53	39.65
M_3	42.67	43.65	63.68	64.87	106	109	39.95	40.07
M_4	39.53	40.38	60.57	61.63	100	102	39.25	39.37
SEm(±)	0.40	0.41	0.47	0.49	0.74	0.78	0.15	0.16
C.D. (P=0.05)	1.17	1.19	1.39	1.45	2.17	2.28	0.45	0.48

Note: Significant differences at<0.05 level was taken from three replicates for each treatment's (mean values): Critical Deference, SEm; Standard Error of the Mean, NS; Non-Significant

Significant differences in protein content and protein yield of wheat were also observed due to different splitting modules of nitrogen, during both study years. The highest protein content (10.19 and 10.25%) and protein yield (439 and 451 kg ha^{-1}) was recorded in M_3 module and being on par with M_4, during 2016-17 and 2017-18, respectively. The difference between M_3 and M_4 was no significant, during both study year. The lowest protein content 9.79 and 9.96 per cent was recorded in M_2 module, during 2016-17 and 2017-18, respectively. The application of 5 % N as foliar spray at pre flowering stage through urea, resulted in 29.49 and 28.49 % higher protein yield than the M_2 module, during both the years. Similar results were also reported by Rawluk et al. [16].

Data regarding nitrogen content in grain and straw, nitrogen uptake (by grain and straw) and total uptake by wheat as significantly influenced by different nitrogen treatments, during both the year (Table 6). The highest nitrogen content 1.84, 1.86 % and 0.60, 0.61 % in grain and straw, 82.93, 39.10 and 84.83, 40.29 kg ha-1 by grain and straw and total nitrogen uptake 123 and 125 kg ha^{-1} was recorded with the application of nitrogen at 150 kg N ha^{-1} which was statistically on par with 120 kg N ha^{-1}, during 2016-17 and 2017-18, respectively. The lowest content 1.59, 1.63 % and 0.37, 0.37 % in grain and straw, 39.68, 25.47 and 41.60, 26.26 kg ha^{-1} by grain and straw and total nitrogen uptake 55 and 57 kg ha^{-1} was observed in control plot, during 2016-17 and 2017-18, respectively. The different splitting modules of nitrogen exhibited a significant effect on nitrogen content in grain and straw, nitrogen uptake by grain and straw and total uptake by wheat during both investigation years. The maximum nitrogen content 1.79, 1.79 % and 0.53, 0.54 % in grain and straw, 76.90, 34.30 and 79.05, 35.46 kg ha^{-1} by grains as well as straw and total nitrogen uptake 111 and 115 kg ha^{-1} was recorded in M_3 modules, during both study years, respectively. The lowest content 1.59, 1.63 % and 0.37, 0.37 % in grain and straw, 39.68, 25.47 and 41.60, 26.26 kg ha^{-1} by grain and straw and total nitrogen uptake 55 and 57 kg ha^{-1} was observed in control plot, during 2016-17 and 2017-18, respectively. However respective increment in total nitrogen uptake by crop at 150 kg N ha^{-1} over control, 90 and 120 kg N ha^{-1} was 68, 23 and 9 kg ha^{-1} during first year and 68, 20 and 8 kg ha-1, during second year, respectively. The minimum nitrogen content 1.72 1.74 % and 0.48, 0.49 % in grain and straw, 58.40,25.47 and 61.46 , 26.26 kg ha^{-1} and 85 and 88 kg ha^{-1} was obtained with M_2 splitting module, during 2016-17 and 2017-18, respectively. The total nitrogen uptake was increased 30.6, 20 and 10.6 per cent during first year and 30.7, 20.5 and 10.2 per cent, during second year due to M3, M4 and M1 over M2, respectively. Higher nitrogen content in grain due to application of nitrogen might be due to the fact that initial dose of nitrogen could boost the root development, tillering through adequate nitrogen available to plant for vegetative and reproductive growth 'and ultimately yield and more nitrogen content in grain due to more mobilization of nitrogen from vegetative parts to grain. Since, total nitrogen uptake is a function of respective yield and its content in grain and straw, therefore, higher grain and straw yield together with the higher values of its nutrient content has resulted in higher total nitrogen uptake, further nitrogen improves the cation exchange capacity (CEC) of the roots, which helped in better nitrogen uptake which ultimately resulted in total nitrogen uptake by wheat and directly proportional to total nitrogen levels. These results are in agreement with those reported by Arora et al [17]. Singh et al. [18] and Mattas et al. [19].

3.4 Soil p^H and Organic Carbon After Harvest of Crop

The highest organic carbon content in soil (0.54 and 0.56 %) was analyzed where 150 kg N ha^{-1} was applied and being statistically at par with 120 kg N ha^{-1}. Whereas, lowest organic carbon content 0.47 and 0.48% was analyzed in soil after harvesting of wheat where no nitrogen was applied during both experimentation year (Table 7). The differences in organic carbon content among different splitting modules of nitrogen were found to be non-significant during both the years of study. The pH of soil exhibited non significant effect to different levels of nitrogen and the pH of soil was decreased with increasing the levels of nitrogen, during both study years. The pH of soil ranged from 7.44 to 7.88 and 7.53 to 7.97 in different levels of nitrogen including control, during both study years. The different splitting modules of nitrogen did not exhibit any significant change in pH of soil after harvesting of wheat crop, during 2016-17 and 2017-18, respectively. Similar results were also reported by Kumar et al. [20].

Table 5. Effect of different levels and splitting modules of nitrogen on protein content (%) and protein yield of wheat, during 2016-17 and 2017-18

Treatments	Protein			
	Content (%)		Yield (kg ha^{-1})	
	2016-17	2017-18	2016-17	2017-18
Nitrogen levels (kg ha^{-1})				
0	9.09	9.32	227	238
90	10.14	10.21	396	413
120	10.25	10.31	459	469
150	10.52	10.61	474	484
SEm(±)	0.07	0.09	4.32	4.64
C.D. (P=0.05)	0.28	0.30	15.2	16.37
Splitting modules				
M_1	9.94	10.06	374	386
M_2	9.79	9.96	339	351
M_3	10.19	10.25	439	451
M_4	10.08	10.18	403	415
SEm(±)	0.04	0.05	2.53	2.70
C.D. (P=0.05)	0.11	0.15	7.43	7.94

Note: Significant differences at<0.05 level was taken from three replicates for each treatment's (mean values): Critical Deference, SEm; Standard Error of the Mean, NS; Non-Significant

Table 6. Effect of different levels and splitting modules of nitroge on nitrogen content, uptake and total uptake by wheat, during 2016-17 and 2017 -18

Treatment	Nitrogen									
	Content (%)				Uptake (Kg ha^{-1})					
	Grain		Straw		Grain		Straw		Total	
Nitrogen levels (kg ha^{-1})	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
0	1.59	1.63	0.37	0.37	39.68	41.60	15.12	15.56	55	57
90	1.78	1.79	0.51	0.52	69.31	72.26	31.60	32.85	100	105
120	1.80	1.81	0.53	0.55	80.44	82.08	34.04	35.08	114	117
150	1.84	1.86	0.60	0.61	82.93	84.83	39.10	40.29	123	125
SEm(±)	0.01	0.02	0.01	0.01	0.76	0.84	0.62	0.64	2.42	2.50
C.D. (P=0.05)	0.05	0.06	0.06	0.07	2.66	2.97	2.19	2.27	9.10	9.12
Splitting modules										
M_1	1.74	1.76	0.49	0.50	64.48	67.58	28.41	29.31	94	97
M_2	1.72	1.74	0.48	0.49	58.40	61.46	25.47	26.26	85	88
M_3	1.79	1.79	0.53	0.54	76.90	79.05	34.30	35.46	111	115
M_4	1.77	1.78	0.51	0.51	70.57	72.69	31.69	32.73	102	106
SEm(±)	0.01	0.01	0.01	0.01	0.44	0.49	0.35	0.36	1.40	1.44
C.D. (P=0.05)	0.02	0.02	0.02	0.03	1.30	1.44	1.03	1.06	4.12	4.24

Note: Significant differences at<0.05 level was taken from three replicates for each treatment's (mean values): Critical Deference, SEm; Standard Error of the Mean, NS; Non-Significant

Table 7. Effect of different levels and splitting modules of nitrogen on organic carbon content and p^H of soil after harvest wheat, during 2016-17 and 2017-18

Treatments	Organic carbon (%)		p^H	
	2016-17	**2017-18**	**2016-17**	**2017-18**
Nitrogen levels (kg ha^{-1})				
0	0.47	0.48	7.88	7.97
90	0.50	0.51	7.72	7.81
120	0.52	0.54	7.52	7.61
150	0.54	0.56	7.44	7.53
SEm(±)	0.004	0.004	0.13	0.13
C.D. (P=0.05)	0.02	0.02	NS	NS
Splitting modules				
M_1	0.51	0.52	7.59	7.61
M_2	0.50	0.51	7.50	7.52
M_3	0.53	0.54	7.76	7.78
M_4	0.52	0.53	7.71	7.73
SEm(±)	0.002	0.002	0.079	0.08
C.D. (P=0.05)	NS	NS	NS	NS

Note: Significant differences at<0.05 level was taken from three replicates for each treatment's (mean values): Critical Deference, SEm; Standard Error of the Mean, NS; Non-Significant

4. CONCLUSION

Based on the findings of two year present investigations, it can be inferred that the application of 150 kg N ha^{-1} as 50% N basal through VC+FYM (1:1), + 25% at tillering + 20% at booting stage and 5 % N as foliar spray at pre flowering stage through urea), proved effective in enhancing the yield attributes, yield, protein content and nitrogen uptake by wheat crop, during both investigation year. The addition of Vermicompost, FYM and chemical nitrogen fertilization played an important role in improving nitrogen uptake by wheat. For developing effective nitrogen management, these finding might be helped in Western Uttar Pradesh and other place of same climate. Thus, it may be concluded that the management of optimize nitrogen plays a significant role in optimizing wheat production. Since, the result is based on two year study, it require further investigation to find out optimum dose and appropriate management practices of nitrogen for wheat production and ensuring food security.

ACKNOWLEDGEMENTS

We are grateful to the authorities of the Sardar Vallabhbhai Patel University of agriculture & Technology, Meerut, U.P., India for all support in execution of this experiment. We also acknowledge the technical support from all authors. Moreover, we would like to express our great respect for the editors and anonymous reviewers to improve the manuscript quality.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Rattan RK. Soil Science and society. Journal of Indian Society of Soil Science. 2013;61:6–18.
2. American association cereal chemists. Approved methods of the America Association Cereal Chemists. St. Paul, Minnesota; 2000.
3. Bouyoucos GJ. Hydrometer Method Improved for Making Particle Size Analysis of Soils.
4. Fageria NK, Baligar VC. Enhancing nitrogen use efficiency in crop plants. Advance Agronomy. 2005;88:97-185.
5. Basso BD, Carnrnarano A, Troeeoli D, Chen, Ritchie IT. Long-terni Wheat responses to nitrogen in rainfed Mediterranean environment: Field data and simulation analysis. European Journal of Agronomy. 2010;33:132-138.
6. Agronomy Journal. 1962;54:464-465.
7. Brady NC, Weil RR. Organisms and ecology of the soil. The Nature and Properties of Soil. 1996;11:328-360.
8. Subbiah BV, Asija GL. A rapid procedure for determination of vailable nitrogen in soil. Current Science. 1956;25:259-260.
9. Pullicinoa DS, Massaccesia L, Dixonb L, Bolb R, Gigliottia G. Organic matter dynamics in a compostamended anthropogenic landfill capping-soil. European Journal of Soil Science. 2009; 61:35–47.
10. Gomez KA, Gomez AA. Statistical procedures for agricultural research, 2nd edition. A Wiley-Inter Science Publication, New York (USA). 1984;196-211.
11. Inwati Kumar, Devendra, Yadav, Janardan, Yadav, Jay shankar giriraj and pandey astha. Effect of different levels, sources and methods of application of nitrogen on growth and yield of wheat (*Triticum aestivum* L.). International Journal of Current Microbiology and Applied Sciences. 2018;7(2):2398-2407.
12. Sharma PK, Yadav GL, Sharma BL, Kumar S. Response of wheat (*Triticum aestivum*) to nitrogen and zinc fertilization. Indian Journal of Agronomy. 2000;45:124-27.
13. Kaur G, Asthir B, Bains NS. Nitrogen levels effect on wheat nitrogen use efficiency and yield under field conditions. African Journal of Agricultural Research; 2015.
DOI: 10.5897/AJAR; 2015. 9668
14. Bhaduri Bebarati, Poonam, Gautam. Balanced use of fertilizers and FYM to enhance nutrient recovery and productivity of wheat (*Triticum aestivum* cv UP - 2382) in a Mollisol of Uttarakhand. International Journal Agriculture Environmental Biotechnolog. 2012;5(4):435-439.
15. Singh Shivendra, Singh Avanish, Raghuvanshi, Nikhil, Singh, RA. Effect of nitrogen management practices on the productivity of late-sown wheat (*Triticum aestivum* L.) varieties. International Journal of Current Microbiology and Applied Sciences. 2017;6(7):878–887.
16. Rawluk CDL,.Racz GJ, Grant CA. Uptake of foliar or soil application of 15 N labelled

urea solution at anthesis and its effect on wheat grain yield and protein. Canadian Journal of Plant Science. 2000;(80):331-334.

17. Arora VK, Sidhu AS, Sandhu KS, Thind SS. Effects of tillage intensity, planting time and nitrogen rate on wheat yield following rice. Experimental Agriculture. 2010;46: 267-75.
18. Singh RK, Singh Kumar, Sandip, Singh LB. Integrated nitrogen management in wheat (*Triticum aestivum*), Indian Journal of Agronomy. 2007;52(2):124-126.
19. Mattas, K.K. Uppal, R.S. and Singh, R.P. Effect of varieties and nitrogen management on the growth, yield and nitrogen uptake of durum wheat. Research Journal Agriculture Science. 2011;2:376-80.
20. Kumar Vipin, Dhyani BP, Shahi UP, Kumar Satendra, Kumar Ashok, Singh Akansha. Effect of nitrogen schedule and management on yield of late-sown wheat (*Triticum aestivum*) in rice–wheat system. Indian Journal of Agronomy. 2022;67(2): 144-147.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/113984