Indian Journal of Agronomy **67** (2): 144—147 (June 2022)

Research Paper

Effect of nitrogen schedule and management on yield of late-sown wheat (*Triticum aestivum*) in rice–wheat system

VIPIN KUMAR[1], B.P. DHYANI[2], U.P. SHAHI[3], SATENDRA KUMAR[4], ASHOK KUMAR[5] AND AKANSHA SINGH[6]

Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut, Uttar Pradesh 250 110

Received: December 2021; Revised accepted: April 2022

ABSTRACT

A field experiment was conducted during the winter (*rabi*) season of 2016–17 at the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, to evaluate the effect of nitrogen level and its schedule on late-sown wheat (*Triticum aestivum* L.) crop. The soil of the experimental field was well-drained, sandy loam, alkaline (*p*H 7.80), low in available nitrogen, medium in available phosphorus and potassium with an electrical conductivity 0.25 d/Sm. Eleven treatments comprising control, recommended dose of nitrogen (RDN) for timely as well as late-sown wheat (variety 'PBW 226') with different application schedule were tested in randomized block design with 3 replications. Growth parameters were significantly better in the treatments where major portion of N was applied during early growth period. The highest grain yield and harvest index were recorded in T_8 treatment where 60% of recommended N in accordance to timely sown wheat was applied at sowing. This treatment was found statistically similar to T_4, [RDN for timely sown wheat 150 kg N in 2 split-50% N basal and 50% at crown-root initiation (CRI)], T_6 (RDN for timely sown wheat 150 kg N in 3 splits-60% N basal, 30% at CRI and 10% at tillering) and T_{10} (RDN for timely sown wheat 150 kg N in 3 splits-60% N basal, 34% at CRI and 2% urea spray at tillering). Growth and yield-attributing characters were comparatively higher in T_8 treatment. Available nutrients in soil after harvesting of wheat were found variable under different treatments.

Key words: Imbalanced fertilizer, Nitrogen availability, Soil health, Wheat

In India, wheat as a staple food is the second most significant crop after rice, which contributes nearly one-third of the full cereal production. Because of its wide adaptability, it may be grown under various agro-climates including extensively in North-Western and Central zones. Productivity of wheat in India is relatively low and main reason for this can be its late sowing with reduced crop duration. During the past few years, 50% sowing of wheat often gets delayed till December or early January, causing substantial loss in grain yield. This can be primarily attributed to non-availability of pre-sowing irrigation, untimely rains, delayed field conditions in waterlogged areas and adoption of upland cotton–wheat, basmati rice–wheat, potato–wheat and sugarcane–wheat rotations, where the sowing of the wheat gets delayed attributable to late harvest of preceding crop as compulsion and not by choice of the farmers. The crop under late sowing experience sub-optimal temperature at sowing which causes delayed germination by slowing down the speed of physiological activities associated with germination, viz. absorption of water, hydrolysis of nutrients inside the embryo, slow growth and development. The delayed sowing further causes supra-optimal thermal stress at reproductive phase which ends up in forced maturity (Gupta *et al*., 2002). Hot temperature stress at reproductive phase of crop results in poor yield because of reduced number of grains per spike and shrivelled grain with calibre (Sharma *et al.,* 2007). Delay in wheat sowing by 20 and 40 days from the conventional sowing date (15 November) reduced the grain yield by 23 kg/ha/day and 30 kg/ha/day respectively (Kaur and Pannu, 2008). Available literature reveals that, Indian soils have become poor in soil fertility–90% soils are deficit in N, 80% in P, 50% in K, 41% in S, 48% in Zn, 33% in B, 12% in Fe and 13% in Mo (Rattan, 2013). Level of organic matter is additionally declining in soil.

Plant nutrition plays a crucial role in growth and pro-

Based on a part of M.Sc. Thesis of the first author submitted to Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut, Uttar Pradesh in 2020 (unpublished)

[1]**Corresponding author's Email:** vipinkumar291994@gmail.com
[1,5,6]Ph.D. Scholar (Soil Science), [2,4]Professor (Soil Science), [3]Associate Professor, Department of Soil Science, Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut, Uttar Pradesh 250 110

ductivity of a crop. As wheat crop is extremely awake to applied nutrients through various sources, proper soil-fertility management is very important for optimizing the productivity 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. Nitrogen supply to plant influences the quantity of protein, protoplasm and chlorophyll formed and intern this influence cell size, leaf area and photosynthetic activity. Hence application of fertilizer nitrogen ends up in higher biomass yields and protein yield and concentration in plant part is usually increased.

Wheat is often grown as both timely or late sown. In sugarcane-dominated western Uttar Pradesh area, most of wheat is sown under late-sown conditions. The nitrogen application in timely and late-sown wheat is different and lower nitrogen is applied in late-sown condition. The reduced level of N application in the given soil fertility remains insufficient for potential production or it should be increased with change within the N application schedule. Nitrogen is applied to wheat in 3 splits i.e. half basal and rest half in 2 equal splits-after first and second irrigation. The N schedule can be thus re-examined for standardization of optimum N application at these stages.

MATERIALS AND METHODS

The experiment was conducted during the winter (*rabi*) season of 2016–17 at Crop Research Centre of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram (29° 40′ N 77° 42′ E with an elevation of 237 m above mean sea-level) Meerut, Uttar Pradesh, to evaluate the nitrogen management for late-sown wheat variety 'PBW 226'. The soil of the experimental field was well-drained, sandy loam in texture, alkaline in reaction (*p*H 7.80), low in available nitrogen, medium in available phosphorus and potassium with an electrical conductivity 0.25 d/Sm. The details of 11 treatments are:

T_1, Control (without nitrogen); T_2, recommended dose of nitrogen (RDN) for timely sown wheat 150 kg N in 3 splits–50% N basal, 25% at crown-root initiation (CRI) and 25% at tillering; T_3, RDN for late-sown wheat, i.e. 80 kg N in 3 splits–50% N basal, 25% at CRI and 25% at tillering; T_4, RDN for timely sown wheat, i.e. 150 kg N in 2 splits–50% N as basal and 50% at CRI; T_5, RDN for late-sown wheat, i.e. 80 kg N in 2 splits–50% N as basal and 50% at CRI; T_6, RDN for timely sown wheat, i.e. 150 kg N in 3 splits–60% N basal, 30% at CRI and 10% at tillering; T_7, RDN for late-sown wheat, i.e. 80 kg N in 3 splits–60% N basal, 30% at CRI and 10% at tillering; T_8, RDN for timely sown wheat, i.e. 150 kg N in 3 splits–50% N basal, 44% at CRI and 2% urea spray at tillering; T_9, RDN for late sown wheat, i.e. 80 kg N in 3 splits–50% N basal, 44% at CRI and 2% urea spray at tillering; T_{10}, RDN for timely sown wheat, i.e. 150 kg N in 3 splits–60% N basal, 34% at CRI and 2% urea spray at tillering; and T_{11}, RDNF for late-sown wheat, i.e. 80 kg N in 3 splits–60% N basal, 34% at CRI and 2% urea spray at tillering.

The treatments were tested in randomized block design with 3 replications. Common dose of phosphorus and potassium were applied in each treatment basal, while nitrogen as per treatment description was applied basal and top-dressed/ foliar spray at CRI and tillering stage on 21 January and 11 February 2017 respectively.

RESULTS AND DISCUSSION

Crop productivity depends on genetic potential and adopted management practices. To exploit the full genetic potential of a variety, it should be given best-management practices. Nutrient management apart from other agronomic practices is most important. Poor nourishment can lead a drastic reduction in crop yield as well as crop quality. The optimum supply of essential plant nutrient from soil as well as fertilizer is mandatory for higher productivity. Data regarding the effect of different nitrogen management treatments on biological, grain, straw yield and harvest index are given Table 1. Total biological, grain and straw yields were significantly affected by different treatments. Level of N application with similar application schedule exhibited a significant effect on grain and straw yields. The maximum biological yield of 9,860 kg/ha was found statistically at par with that of T_8, T_6, T_4 treatments. It was significantly higher in T_{10} than the remaining treatments while the minimum was recorded the in control. In general, treatments receiving major portion of nitrogen at early stage accumulated more biomass. The maximum grain yield (4,180 kg/ha) statistically at par with T_6, T_{10} and T_4 was found in T_8 treatment. In all these treatments, major portion of N in accordance to timely sown wheat was applied at early growth period. Higher grain yield in these treatments may be owing to higher values of yield-attributing characters owing to better vegetative growth. Common N application schedule (50 : 25 : 25) yielded significantly lower than these treatments. Yield-attributing characters were comparatively lower in this treatment. About 9.0% yield was higher in T_8 as compared to T_2 treatment. Increment in yield with the application of higher dose of N within similar N application schedule ranged from 24.3 to 37.2%. Different treatments also significantly affected the straw yield of wheat. Maximum straw yield of 5,790 kg/ha statistically similar to T_4, T_6 and T_8 was found in T_{10} treatment. Effect of N level application at similar application schedule was significant and higher straw yield was recorded with higher N application. Higher straw yield in

Table 1. Effect of nitrogen management treatments on grain, straw and biological yields and harvest index of wheat

Treatment	Yield (kg/ha)			Harvest index (%)
	Grain	Straw	Biological	
Control	2,340	3,660	6,000	39.00
RDN for timely sown wheat (50 : 25 : 25)	3,845	5,253	9,100	42.27
RDN for late-sown wheat (50 : 25 : 25)	3,043	3,906	6,969	43.66
RDN for timely sown wheat (50 : 50 : 0)	3,980	5,620	9,600	41.45
RDN for late-sown wheat (50 : 50 : 0)	3,000	4,200	7,200	41.63
RDN for timely sown wheat (60 : 30 : 10)	4,170	5,433	9,600	43.44
RDN for late-sown wheat (60 : 30 : 10)	3,093	4,190	7,283	42.47
RDN for timely sown wheat (50 : 44 : 2% urea spray)	4,180	5,403	9,580	43.63
RDN for late-sown wheat (50 : 44 : 2% urea spray)	3,123	4,360	7,483	41.73
RDN for timely sown wheat (60 : 34 : 2% urea spray)	4,070	5,790	9,860	41.28
RDN for late-sown wheat (60 : 34 : 2% urea spray)	3,030	4,400	7,430	40.78
SEm±	80.72	152.37	207.87	Not estimated
CD (P=0.05)	239.82	452.67	617.55	Not estimated

RDN, Recommended dose of nitrogen

these treatments may be attributed to better vegetative growth and higher values of yield-contributing characters. Patel *et al.,* (2008) found that, wheat variety 'PBW 373' yielded highest with 120 kg N/ha. Singh *et al.,* (2017) reported that, 150 kg N/ha proved as a most suitable practice for exploitation of the yield potential of the late-sown wheat. Kaur *et al.,* (2015) reported that, the maximum yield, yield attributes and net returns were obtained in foliar N-application treatments.The application of 150 kg N/ha in 3 splits [68 kg N at sowing + 75 kg N at 1st irrigation + 7 kg N (3 % urea spray) at anthesis] proved the best in terms of grain yield and economic net returns in case of late-sown wheat. Singh *et al.,* (2021) also reported the maximum grain yield of wheat with 2 split application of nitrogen–50% basal and 50% at first irrigation in Punjab.

Available nitrogen in soil at different stage differs significantly under the influence of different treatments. At the CRI stage, available N was significantly higher in treatments where basal N application was higher (Table 2). Available nitrogen in soil declined with the advancement in crop growth. At tillering stage available nitrogen in soil ranged from 168.76 to 217.37 kg/ha. Higher available N in different treatments may be attributed to application of N at the CRI stage. At harvesting stage, available nitrogen declined, although treatments received higher level showed higher available of N. Applied nitrogen have different fate in soil and among these fate, immobilizations is one where mineral nitrogen is converted into organic nitrogen. It is possible that a part of applied is immobilized which will be mineralized at later stage and contributed towards available N. Yadav *et al.,* (2005) reported that, with increasing N level available nitrogen in soil at harvesting was higher.

Data regarding soil organic carbon at different stages of wheat as influenced by different nitrogen treatments are given in Table 3. It is clear from the data that the organic carbon in soil at different stages was significantly affected by different treatments. At the CRI stage, the maximum organic carbon (0.521%) was significantly higher in

Table 2. Effect of nitrogen-management treatments on available soil nitrogen (kg/ha) at different stages of wheat crop

Treatment	CRI	Tillering	At harvesting
Control	186.62	168.76	148.25
RDN for timely sown wheat (50 : 25 : 25)	210.62	206.70	167.11
RDN for late-sown wheat (50 : 25 : 25)	196.58	185.00	151.58
RDN for timely sown wheat (50 : 50 : 0)	216.75	212.66	165.40
RDN for late-sown wheat (50 : 50 : 0)	195.41	179.70	148.40
RDN for timely sown wheat (60 : 30 : 10)	223.75	211.61	173.19
RDN for late-sown wheat (60 : 30 : 10)	200.41	192.79	153.28
RDN for timely sown wheat (50 : 44 : 2% urea spray)	213.33	210.40	168.23
RDN for late-sown wheat (50 : 44 : 2% urea spray)	195.83	195.40	151.30
RDN for timely sown wheat (60 : 34 : 2% urea spray)	225.00	217.37	178.85
RDN for late-sown wheat (60 : 34 : 2% urea spray)	207.91	202.37	153.00
SEm±	8.91	6.92	4.59
CD (P=0.05)	3.00	2.33	1.54

RDN, Recommended dose of nitrogen

Table 3. Effect of nitrogen-management treatments on soil organic carbon (%) at different stages of wheat crop

Treatment	CRI	Tillering	At harvesting
Control	0.480	0.472	0.441
RDN for timely sown wheat (50 : 25 : 25)	0.521	0.531	0.502
RDN for late-sown wheat (50 : 25 : 25)	0.492	0.504	0.470
RDN for timely sown wheat (50 : 50 : 0)	0.513	0.552	0.523
RDN for late-sown wheat (50 : 50 : 0)	0.491	0.515	0.481
RDN for timely sown wheat (60 : 30 : 10)	0.515	0.531	0.502
RDN for late-sown wheat (60 : 30 : 10)	0.492	0.513	0.475
RDN for timely sown wheat (50 : 44 : 2% urea spray)	0.521	0.530	0.503
RDN for late-sown wheat (50 : 44 : 2% urea spray)	0.490	0.490	0.484
RDN for timely sown wheat (60 : 34 : 2% urea spray)	0.510	0.542	0.510
RDN for late-sown wheat (60 : 34 : 2% urea spray)	0.493	0.511	0.492
SEm±	0.006	0.005	0.007
CD (P=0.05)	0.018	0.015	0.022

RDN, Recommended dose of nitrogen; CRI, crown-root initiation

treatment T_2 & T_8. Author please give than T_1, T_3, T_5, T_7 and T_9 treatments. Organic carbon in soil was almost similar in the treatment receiving higher basal N application. Minimum soil organic carbon of 0.480% recorded in T_1 treatment was significantly lower than the remaining treatments. At tillering stage, soil organic carbon varied from 0.472 to 0.552%. The maximum per cent organic carbon (0.552%) recorded in T_4 treatment was statistically at par to T_2, T_6, T_8, T_{10} and significantly higher than the remaining treatments. The minimum soil organic carbon (0.472%) was significantly lower in the control compared with the remaining treatments. It was also noticed that organic carbon was comparatively higher in those treatments that received higher N application by CRI stage. Organic carbon estimated at harvesting declined from the values recorded at tillering in different treatments. At harvesting stage, soil organic carbon differed from 0.441 to 0.523%. the maximum organic carbon of 0.523% was significantly higher than the organic carbon found in T_1, T_3, T_5, T_7, T_9 and T_{11} treatments. Organic carbon content at this stage seems to be related with the biomass production. Possibly more residue left in soil with the application of maximum amount of nitrogen for timely sown wheat at early part of crop growth may be the reason of higher organic carbon content in soil. Decline in organic carbon in soil at harvesting stage may be supposed due to increased mineralization with favourable condition for microbial activity.

From the results obtained in the present study it may be concluded that, the nitrogen recommendation of 80 kg/ha for late-sown wheat is not sufficient for higher productivity in the present soil condition. The maximum yield of wheat was obtained with the application of nitrogen in accordance to timely sown wheat in rice–wheat system that is 150 kg N/ha. For late sown wheat, application of major portion of recommended nitrogen in accordance to timely sown wheat at early growth seems better; however, this effect was not noticed in case of late-sown recommendation. Since, the result is based on 1-year study, it require further investigation to find out optimum dose of nitrogen for late-sown wheat and appropriate N application schedule.

REFERENCES

Gupta, N.K., Gupta, S. and Kumar, A. 2002. Exogenous cytokinin application increases cell membrane and chlorophyll stability in wheat (*Triticum aestivum* L.). *Cereal Research Communication* **28**: 287–291.

Kaur, A. and Pannu, R.K. 2008. Effect of sowing time and nitrogen schedules on phenology, yield and thermal use efficiency of wheat (*Triticum aestivum* L). *Indian Journal of Agricultural Sciences* **78**(4): 366–369.

Kaur, G., Asthir, B. and Bains, N.S. 2015.Nitrogen levels effect on wheat nitrogen use efficiency and yield under field conditions. *African Journal of Agricultural Research*. DOI:10.5897/AJAR2015. 9668.

Patel, K.P., Patel, A.K., Patel, A.M., Patel, K.C. and Ramani, V.P. 2008. Response of wheat to micronutrient application. *Asian Journal of Soil Science* **3**(1): 84–88.

Rattan, R. K. 2013. Soil Science and Society. *Journal of Indian Society of Soil Science* **61**: 6–18.

Sharma-Natu, P., Sumesh, K.V., Lohot, V.D. and Ghildiyal, M.C. 2007. High temperature effect on grain growth in wheat cultivars an evaluation of responses. *Indian Journal of Plant Physiology* **11**: 239–245.

Singh, Mandeep, Singh, Kanwaljit and Bimbraw, Avtar Singh. 2021. Evaluation of bread wheat (*Triticum aestivum*) under semi-arid conditions of Punjab. *Indian Journal of Agronomy* **66**(4): 413–418.

Singh, Shivendra, Singh, Avanish, Raghuvanshi, Nikhil and Singh, R.A. 2017. Effect of nitrogen management practices on the productivity of late-sown wheat (*Triticum aestivum* L.) varieties. *International Journal of Current Microbiology and Applied Sciences* **6**(7): 878–887.

Yadav, M.P., Aslam, M. and Kushwaha, S.P. 2005. Effect of integrated nutrient management on rice (*Oryza sativa*)–wheat (*Triticum aestivum*) cropping system in Central Plain Zone of Uttar Pradesh. *Indian Journal of Agronomy* **50**(2): 89–93.