The Pharma Innovation Journal 2022; 11(7): 2523-2526

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 2523-2526

www.thepharmajournal.com
Received: 06-04-2022
Accepted: 22-06-2022

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Studies on nutrients uptake by plants through the application of nitrogenous fertilizer in wheat (*Triticum durum* L.)

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Abstract
A field experiment was conducted during the Rabi season of 2021-2022 at Instructional farm AKS University, Satna. The experiment was aimed to study the effect of different levels of Nitrogen on growth, yield and uptake of nutrients. It was conducted in Randomized block design with ten treatments (0, 15, 30, 45, 60, 75, 90, 105, 120 and 140 kg N/ha) replicated thrice, with increasing levels of nitrogen significantly increased growth, yield and nutrient uptake by both seed and straw respectively over the control. Finally result conclude that Overall, the application of nitrogen @140 kg N/ha plays an important role in improving wheat yield and quality and maintaining nitrogen in the soil.

Keywords: Wheat, nitrogen uptake, nutrients uptake

Introduction
Wheat (*Triticum aestivum* L.) is the second most important food crop in India after rice (*Oryza sativa* L). It is often prioritized among grain due to its high nutritional value (70% carbohydrate, 12% protein, 1.7% fats, 2.7% minerals and 2% fiber). India's total production of wheat is 107.59 million tons which is 13.64% global production from 31.45 million hectares. Uttar Pradesh has the highest production at 32.59 million and 30.29% of all Indian production followed by Madhya Pradesh (19.61 million) and Punjab (17.51 million tons).
Nitrogen is so critical due to the fact it's far a chief aspect of chlorophyll, the compound via way of means of which plant life use daylight electricity to provide sugars from water and carbon dioxide (i.e., photosynthesis). It is likewise a chief aspect of amino acids, the constructing blocks of proteins. Without proteins, plant life wither and die. Some proteins act as structural gadgets in plant cells at the same time as others act as enzymes, making feasible a number of the biochemical reactions on which lifestyles is primarily based totally. Nitrogen is part of electricity-switch compounds, along with ATP (adenosine triphosphate). ATP lets in cells to preserve and use the electricity launched in metabolism. Finally, nitrogen is a great aspect of nucleic acids along with DNA, the genetic cloth that lets in cells (and subsequently complete plant life) to develop and reproduce. Without nitrogen, there could be no lifestyles as we recognize it. Soil nitrogen exists in three general forms: organic nitrogen compounds, ammonium (NH_4^+) ions and nitrate (NO_3^-) ions. At any given time, 95 to 99 percent of the potentially available nitrogen in the soil is in organic forms, either in plant and animal residues, in the relatively stable Soil organic matter, or in living soil organisms, mainly microbes such a bacteria. This nitrogen is not directly available to plants, but some can be converted to available forms by microorganisms. N and P fertilizers along with intercropping enhanced N uptake by Wheat while only P fertilizers and intercropping increased P acquisition by wheat. Further it was also mentioned that N uptake by border rows of wheat if intercropped with maize declined with increasing N fertilizers application rate, however that of P acquisition was not affected by P fertilizers. The amount of both N and P taken up by maize intercrop with feba bean were much higher than those by maize intercrop with wheat throughout the period of intercropping (Wenxue Li *et al*. 2003) [2]. As previously established, subsurface applications of N prove beneficial in enhancing grain N uptake, a major avenue to enhancing NUE and collecting premiums for grain protein. Rees *et al*. (1996) [1] demonstrated improved N recovery in wheat from incorporated fertilizer and subsurface bands in comparison to surface applications.

Materials and Methods

The experiments were conducted during the rabi season of 2021-2022 with wheat variety Pusa tejas. Experiments were conducted at instructional farm, AKS University, Satna (M.P.). Satna district is located in the Kymore Plateau and Satpura Hill Zone of MP-4 (Agro-climatic Zone-VIII). It is located at an elevation of 315 metres above mean sea level in the north-eastern section of Madhya Pradesh with 24.34° north latitude and 80.49° east longitude east in the Rewa division of M.P. State of India. In Satna, rainfall is moderate and low during the kharif and Rabi seasons, respectively. The soil texture of experimental plot was clay loam with pH of 7.96 which was slightly alkaline in nature, EC was 0.17, organic carbon in the plot was 0.69% the initial N: P_2O_5: K_2O was 166 kg N/ha: 10.92 kg P_2O_5/ha: 266.5 kg K_2O/ha respectively. N was applied in three split doses as per treatment, P_2O_5 and K_2O was applied in one single dose during sowing as per blanket recommendation that is 60 kg P_2O_5/ha and 40 kg K_2O/ha.

There were total 10 treatments that were T_1 =control, T_2=15, T_3=30, T_4=45, T_5 =60, T_6= 75, T_7= 90, T_8=105, T_9=120, T_{10}=140 kg N/ha, seeds were sown at a spacing of 22.5 cm between rows and 10 cm between plants. Sowing was taken on 13th of November 2021. Plants growth parameters such as plant height and number of tillers were taken. Plant height was measured from base to top at 30, 60 and 90 DAS and number of tillers were counted at 30 and 60 DAS. The average of 5 plants were considered for final plant height and number of tillers. Yield parameters such as spike length, no. of spikelets per spike, 1000 grain weight and yield were taken individually from each plots after harvest. Primary nutrients uptake by wheat was analysed in the lab, nitrogen uptake was estimated using kjeldahl method (Subbiah and Asija, 1956) [3], phosphorus uptake was estimated using spectrophotometer by Olsen's method (Olsen *et al.*, 1954) [5] and potassium uptake was estimated using flame photometric method (Jackson, 1974) [4].

Results and Discussion

The result of different levels of nitrogen on growth characteristics such as plant height and number of tillers was found significant and given in table 1 and it was observed that plant height and number of tillers increased significantly with higher levels of nitrogen. The application of the application of 140 Kg N/ha + 60 kg P_2O_5/ha + 40 kg K_2O/ha resulted in significantly higher plant height and maximum number of tillers followed by application of 120 Kg N/ha + 60 kg P_2O_2/ha + 40 kg K_2O/ha, as per the research. This increase in wheat plant height and number of tillers could be attributable to enhanced nutrient availability through nitrogenous fertilizer throughout the crop growth stages, where nitrogen was delivered at the beginning and later stages by a slow and consistent release of nitrogen. These findings are consistent with those of Kumar *et al*. (2017) [7], Chaturvedi (2006) [8] and Singh *et al*. (2012) [12].

The key factors of a crop's eventual yield are yield characteristics such as spike length, number of spikeletes per spike, Grain yield and Test weight (1000 seed weight) was found significant and given in table 2, which were found to be increasing with increased levels of nitrogen the application of 140 kg N/ha + 60 kg P_2O_5/ha + 40 kg K_2O/ha resulted in significantly higher numbers of spikes per plant, spike length, grain weight and test weight followed by the application of 120 kg N/ha + 60 kg P_2O_5/ha + 40 kg K_2O/ha. The rise in yield characteristics wheat could be attributed to better nutrient availability during the crop's development and reproductive stages, which supplied more photosynthates from sink to source and raised the number of spikelets per spike, spike length, yield and test weight. These findings are consistent with those of Patel *et al*. (2018) [10], Langer *et al*. (1973) [11] and Singh *et al*. (2016) [6].

The maximum nutrients uptake was found to be increasing with increased nitrogen levels and given in table 3 the application of 140 kg N/ha + 60 kg P_2O_5/ha + 40 kg K_2O/ha, followed by 120 kg N/ha + 60 kg P_2O_5/ha + 40 kg K_2O/ha, resulted in considerably increased nitrogen, phosphorus and potassium uptake by grain and straw of wheat among the treatments. The enhanced nitrogen, phosphorus and potassium uptake of wheat with these treatments was due to more nitrogen being available in sufficient amounts, which was supplied through chemical fertilizer throughout active growth stages of the crop during development and reproductive stages of the crop. These findings are consistent with those of Vandana *et al*. (2008) [12], Singh *et al* (2016) [6] and Singh and Sharma (2016) [13].

Table 1: Effect of different levels of nitrogen on growth parameters such as plant height @30, 60 and 90 DAS and number of tillers per running meter @30 and 60 DAS

Treatments	Plant height (cm)			Number of tillers	
	30 DAS	60 DAS	90 DAS	30 DAS	90 DAS
Control	23.42	42.27	55.47	2.53	12.66
15 kg N/ha	26.6	44.56	57.56	2.66	15.46
30 kg N/ha	29.51	47.36	60.64	2.66	18.13
45 kg N/ha	31.34	50.54	63.45	2.86	21.26
60 kg N/ha	33.64	53.53	65.54	3.33	24.40
75 kg N/ha	36.86	55.92	68.38	3.60	26.20
90 kg N/ha	38.45	57.81	72.30	3.80	28.60
105 kg N/ha	40.69	59.32	77.50	4.40	29.06
120 kg N/ha	43.53	62.23	80.10	4.80	33.86
140 kg N/ha	46.56	66.24	84.52	5.53	34.16
S. Em ±	2.54	2.46	3.647	0.332	2.432
CD (p=0.5)	7.63	7.38	10.919	0.993	7.282

Table 2: Effect of different levels of nitrogen on yield characteristics such as spike length, number of spikelets per spike, grain yield and test weight.

Treatments	Spike Length (cm)	Number of spikelets per spike	Grain yield (kg)	Test weight (g)
Control	5.66	10.67	1583	33.43
15 kg N/ha	5.84	13.47	2250	33.49
30 kg N/ha	5.96	16.53	2916	36.37
45 kg N/ha	6.06	19.60	3216	37.80
60 kg N/ha	6.35	21.33	3716	37.88
75 kg N/ha	6.65	25.40	4216	37.92
90 kg N/ha	6.88	27.73	4691	39.33
105 kg N/ha	7.07	29.67	4883	41.35
120 kg N/ha	7.50	32.40	5236	43.83
140 kg N/ha	7.62	35.47	5364	45.13
S. Em ±	0.237	3.604	0.589	3.672
CD (p=0.5)	0.709	10.792	1.763	10.994

Table 3: Effect of different levels of nitrogen on nutrients uptake in seed and straw i.e., nitrogen uptake, phosphorus uptake and potassium uptake in seed and straw.

Treatments	Nitrogen uptake (kg/ ha)		Phosphorus uptake kg/ha		Potassium uptake (kg/ha)	
	Seed	Straw	Seed	Straw	Seed	Straw
Control	50.75	16.72	16.36	8.16	24.08	66.13
15 kg N/ha	55.11	20.68	17.11	8.45	27.43	69.37
30 kg N/ha	61.70	23.26	17.86	8.79	29.30	71.17
45 kg N/ha	67.84	26.45	18.19	9.08	32.85	74.83
60 kg N/ha	72.84	29.29	18.84	9.32	35.37	77.25
75 kg N/ha	77.42	32.92	19.95	9.92	38.83	80.86
90 kg N/ha	82.24	35.10	20.17	11.17	41.18	83.27
105 kg N/ha	88.32	38.92	20.94	11.74	45.20	86.16
120 kg N/ha	96.90	47.91	22.71	13.09	47.32	90.79
140 kg N/ha	101.29	50.89	23.76	13.89	50.11	93.22
S. Em ±	4.902	3.822	1.077	0.905	3.654	3.647
CD (p=0.5)	14.678	11.444	3.224	2.709	10.94	10.921

Conclusions

Nitrogen one of the most important nutrients required for crops growth and development and it effects wheat significantly in growth, yield and nutrients uptake by wheat plants. Increasing levels of nitrogen increased wheat growth characteristics such as plant height (cm) and number of tillers, yield characteristics such as spike length (cm), number of spikelets per spike, grain yield (kg/ha), test weight (g) and nutrients uptake i.e. nitrogen uptake in seed and straw, phosphorus uptake in seed and straw and potassium uptake in seed and straw. It was found that application of 140 kg N/ha + 60 kg P_2O_5 + 40 kg K_2O recorded maximum growth characteristics, yield characteristics and nutrients uptake in wheat followed by 120 kg N/ha+ 60 kg P_2O_5 + 40 kg K_2O. The final yield may not have reached the total yield potential due to sudden increase in temperature in the month of March which lead to early maturity of wheat. Application of 140 kg N/ha + 60 kg P_2O_5 + 40 kg K_2O is statistically at par with 120 kg N/ha+ 60 kg P_2O_5 + 40 kg K_2O in terms of yield and grain quality.

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