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Effect of Different Nitrogen Doses on Growth, Yield and Economics of Wheat

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ABSTRACT

A field experiment was conducted to evaluate the effect of different nitrogen doses on growth, yield and economics of wheat. The experiment was laid out in Randomized block design (RBD) with seven treatment of nitrogen applied @ 0, 60, 90, 120,180 and 210 kg N ha^{-1} was applied in respective plots in the form of urea. Result reveled that various doses of Nitrogen showed significant impact on all parameter under study and showed significantly higher plant height was obtain at treatment 210 kg N ha^{-1} whereas, no. of tillers and dry matter accumulation were significantly higher at under treatment 180 kg N ha^{-1} and in case of all growth parameter treatment150 Kg N ha^{-1} found to be at par with the highest treatment. However, highest number of grain per spike, 1000-grain weight, grain yield and harvest index recorded significantly higher at treatment 180 Kg N ha^{-1} whereas, straw yield and biological yield were significantly higher at treatment 210 Kg N ha^{-1} and all the yield parameters were found to be at par at treatment 150 kg N ha^{-1} with the highest treatment. The highest cost of cultivation (Rs. 46810 ha^{-1}) recorded in treatment 210 kg N ha^{-1} and highest gross return and net return was (Rs.141200 ha^{-1} and Rs.95020 ha^{-1}, respectively) was recorded in the treatment 150 Kg N ha^{-1}. Highest benefit: cost ratio (2.0) was obtained from treatment 180 Kg N ha^{-1} which was similar to 150 Kg N ha^{-1}. Therefore, application of treatment 150 kg N ha^{-1} and 180 Kg N ha^{-1} could be an option to improve the growth, yield parameter and B:C ratio.

Keywords: *(Triticum aestivum* L.*)*, Spikes, Grain, Biological yield, Harvest index, Wheat

Introduction

Wheat (*Triticum aestivum* L.) belonging to Poaceae family, is an important cereal grown throughout the globe and it is one of the most extensively grown crops in the world. Wheat, with its root ramifying into the depth of human culture has an evolutionary history parallel with history of human civilization itself. Even today it decides the feast or famine for millions of people. Globally in 2021-22 wheat is cultivated on an area of 222.21 million ha, with a total production of 779.03 mtand with productivity of 3.51 mt ha^{-1} (Anonymous, 2022). India stands second among wheat production countries after China. In India, wheat is the second most important cereal crop next only to rice and a key crop of the green revolution and post green revolution era. However, it is major source of food and feed for both humans and livestock. In India during 2021-22, wheat is cultivated on an area of 31.13 mha, with total production of 109.59 mt and with productivity of 3.52 mt ha^{-1} (Anonymous, 2022).Total cultivation area of wheat in Uttarakhand was 298 hectares in 2022-23 and wheat yield was reported 2,898 kg ha^{-1} during 2022 (Anonymous, 2022).Wheat production can be improved by using better inputs, proper production

technology and by proper tillage practices. Crop yield is affected by these field operations due to their effect on chemical and physical characteristics of soil and water conservation (Bonfil *et al.*, 1999)**.**
The soils of India are deficient in nitrogen and are supplemented with chemical fertilizer for enhancing the crop productivity. Nitrogenous fertilizers play a vital role in modern farm technology, however only 20-50% of the soil applied nitrogen is recovered by the annual crops (Bajwa.,1992). Nitrogen plays a fundamental role in yield and quality (Fageria *et al.,* 2008) (Shiferaw *et al.,* 2013). Better N management is undoubtedly associated with application timings and its proper rate (Abedi *et al.,* 2010 and khan *et al.,* 2021). Optimum N at different stages of the crop until booting showed positive effects on yield and grain quality (Salim and Raza, 2020). Sufficient N in the soil for crop growth showed positive responses on grain weight, grain filling duration, and grain protein (Puga *et al*., 2020). Split application of N has controlled leaching and volatilization (Usman *et al.,* 2014).

Method and Material

High-yielding wheat varieties were planted after Paddy harvesting at the experimental farm and it is located at 29.241466°N, 79.458589°E in Fathepur, Haldwani, and Uttrakhand at an altitude of 443 m above sea level. Physio-chemical characteristics of soil type were as: 7.2 pH and EC <1(0.27 ds/m), content of nitrogen is 0.84%. The corresponding minimum and maximum temperature during the crop season ranged from 6.0^{0}C to 37.4^{0}C, respectively and average Rainfall received during crop period was 134.7 mm.
The field experiment was laid out according to randomized block design under 7 treatments each with 3 replication fertilizer application techniques for nitrogen, *viz* broadcasting with different doses viz: absolute control,60kg N ha^{-1} (50% RDN),90kg N ha^{-1} (75% RDN),120kg N ha^{-1} (100% RDN),150kg N ha^{-1} (125% RDN),180kg N ha^{-1}(150% RDN) and 210 kg N ha^{-1}(175% RDN), Phosphorus (60 kg N ha^{-1}) and potassium (40 kg N ha^{-1}) fertilizers were broadcasted uniformly in the whole experimental field. Nutrient sources were as nitrogen from urea. Two –third of nitrogen fertilizer applied as a basal dose during final land preparation. One-third applied as top dressing at crown root initiation (CRI).
The variety PBW 154 of wheat was used as the test crop. The seeds were sown by line sowing method @ 100 kg ha^{-1} and the sowing was done on 26th November, 2022. Seeds were sown at 3 to 4 cm depth, keeping row spacing of 22.5 cm. First irrigation was applied at 21 DAS and subsequent irrigations were applied as per crop requirements. Total four irrigations were applied to the crop at different stages depending upon the weather conditions.The crop was harvested manually at the maturity dated on 22 April 2023 and grain and straw yield were recorded.

Result and Discussion

Growth attributing characters

The observation studied under growth characters are Plant height (cm), Number of tillers (m^{-2}) and Dry matter accumulation(g m^{-2}) at30, 60, 90 DAS and at harvest.

Plant height (cm)

Among different nitrogen doses significantly higher plant height was recorded with treatment $T_7$where nitrogen was applied @ 175% RDN(210 Kg N ha^{-1}) (25.21, 59.36, 89.86 and 102.66 cm at 30, 60, 90 DAS and at harvest, respectively) over the rest of treatment and T_5 treatment was found to be
at par with treatment T_7 at all the growth stages.While minimum plant height was recorded with treatment $T_1$where nitrogen was not applied.. These results are similar to Ullah *et al.,* (2013) who also

reported that plant height was significantly increased by different doses of nitrogen. Increase in plant height with increasing nitrogen doses were reported by Bannori *et al.,* (2005).

Number of tillers (m^{-2})

Among different nitrogen doses significantly higher number of tillers m^{-2} were recorded under treatment T_6 where nitrogen was applied with 150% RDN (180 Kg N ha^{-1}) (197.60, 318.80, 321.66 at 30, 60 and 90 DAS, respectively) .While the treatment T_1 was recorded minimum number of tillers. However, at 30, 60 and 90 DAST$_5$ found at par with treatment T_6. Increased levels of nitrogen resulted in reduction of mortality of tillers and produced more tillers from the main stem. Similarly it also contributed in increasing tiller production up to an optimum level of nitrogen. Above optimum, the decrease in no. of tillers might be due to the competition for space. (Singh *et al.,* 2002).

Dry matter accumulation (g m^{-2})

Among different nitrogen doses significantly higher dry matter production of wheat was recorded under the application of treatment T_6 150% RDN (180 kg N ha^{-1}) (583.26 and 1001.10 g at 60and 90 DAS, respectively) over the rest of treatment and was at par with treatment T_5 125% RDN (150 kg N ha^{-1}) at both the stages. However, minimum dry matter accumulation was recorded under absolute control. As the rate of N fertilizer increase the total dry weight also increase. Nitrogen application creates a significant increase on leaf photosynthesis, leaf dry index, crop growth rate and biomass production of wheat reported by Rahman *et al.,* (2000).

Yield attributing character and yield

Yield attributing character includes effective number of grain $spikes^{-1}$ and test weight was recorded at harvesting stage of the crop.

Number of grains $spike^{-1}$

Among different nitrogen doses significantly higher number of grain $spike^{-1}$ was recorded under treatment T_6 150% RDN (180 Kg N ha^{-1})*i.e.* 42.66 over the rest of treatment and was at par with treatment T_5 125% RDN (150 Kg N ha^{-1}) *i.e.*41.06. The minimum number of grain $spike^{-1}$ was observed in T_1 treatment absolute control. Increased number of grain $spike^{-1}$ might be due to optimum crop stand with better nutrition. Increase number of grain per spike with the application of higher nitrogen doses was also reported by Sabir *et al.,* (2002).

Test weight (g)

Among different nitrogen doses significantly higher test weight was found in treatment T_6 150% RDN (180 kg N ha^{-1}) (43.23 g). However, $T_4$and T_5 treatment found to be at par to the highest treatment.Minimum test weight was recorded under absolute control.

These results are similar to Ullah *et al.,* (2013) who concluded that higher dose of nitrogen significantly increased grain weight.

Grain yield (q ha^{-1})

Among different nitrogen doses significantly higher grain yield *i.e.* 53 qha^{-1} was recorded under treatment T_6 150% RDN (180 Kg N ha^{-1}). However, treatment T_5 125% RDN (150Kg N ha^{-1}) found to

be at par with treatment T_6 150% RDN (180 Kg N ha^{-1}).Minimum yield was recorded under absolute control. The possible reason of increased grain yield with adequate nitrogen supply might be the result of delayed leaf senescence, sustained leaf photosynthesis during the grain filling period and extended duration of grain fill (Frederick and Camberato, 1995 and Iqbal *et al.,* (2012).

Straw yield (q ha^{-1})

Among different nitrogen doses significantly higher straw yield was observed in treatment T_7 175% RDN (210 Kg N ha^{-1}) *i.e.* 63 q ha^{-1} .Treatment $T_5$125% RDN (150 Kg N ha^{-1}) found to be at par with highest treatment.

Biological yield (q ha^{-1})

Among different nitrogen doses significant higherbiological yield was harvested from treatment T_7 175% RDN (210 Kg N ha^{-1}) *i.e.* 111q ha^{-1} Treatment T_5 125% RDN (150 Kg N ha^{-1}) *i.e.* 110 q ha^{-1} and was found to be at par to the highest treatment 175% RDN, while minimum was recorded under treatment T_1 (control) where nitrogen was not applied. Studies revealed that with increasing the nitrogen rate biological yield increased. As a result of more biological yield a plant with its large canopy is able to intercepts more sun radiation and produce more assimilates. (Ghobadi *et al.*, 2010).

Harvest index (%)

Among different nitrogen doses significantly higher harvest index was calculated under treatment T_6 150% RDN (180 kg N ha^{-1}) i.e. 48 % was found to be at par to 125% RDN (150 kg N ha^{-1}), while minimum harvest index was calculated from control. When harvest index is low it means that there is less translocation of assimilates from the source to sink which results in less development of seeds and make them shriveled size. When harvest index is high it means that more assimilates were translocate from source to the grains which result in improved development and filling. (Uhart and Andrade, 1995).

Economics

Economics includes the cost of cultivation (ha^{-1}) gross return (Rs ha^{-1}) net return (Rs ha^{-1}) and benefit cost ratio (Rs. ha^{-1} investment).

Cost of cultivation (Rs. ha^{-1})

Among different nitrogen doses maximum cost of cultivation was (Rs.46810 ha^{-1}) recorded in 175% RDN(210 kg N ha^{-1}) due to higher cost of nitrogen fertilizer with high application doses and lowest was (Rs. 43800 ha^{-1}) with control.

Gross income (Rs. ha^{-1})

Among different nitrogen doses maximum gross return was (Rs.141200 ha^{-1}) that was recorded in 125% RDN (150 Kg N ha^{-1}) and lowest was (Rs 100818 ha^{-1}) in control.

Net income (Rs ha^{-1})

Among different nitrogen doses maximum net return was (Rs. 95020 ha^{-1}) recorded in 125% RDN (150 Kg N ha^{-1}) and lowest was (Rs. 57018 ha^{-1}) in control.

Benefit: Cost ratio

Among different nitrogen doses maximum benefit cost ratio was (2.00) recorded in 150% RDN (180 Kg N ha^{-1}) which was similar to 125% RDN and lowest was (1.3) in control.

Treatments	Plant height (cm)				Number of tillers (m^{-2})				Dry Matter (g m^{-2})	
	30 Das	60 Das	90 Das	At harvest	30 Das	60 Das	90 Das	At harvest	60 Das	90 Das
Control	12.58	47.13	77.60	88.26	183.52	226.00	240.90	183.52	345.52	670.56
60 kg N ha^{-1} (50% RDN)	17.79	51.90	81.70	91.60	186.70	241.86	259.53	186.70	447.23	781.56
90 kg N ha^{-1} (75% RDN)	19.41	53.16	83.26	92.63	189.98	256.46	279.50	189.98	492.41	857.16
120 kg N ha^{-1} (100% RDN)	21.28	54.50	85.20	94.06	192.80	282.43	292.43	192.80	509.33	917.50
150 kg N ha^{-1} (125% RDN)	24.27	57.10	88.30	99.66	197.18	316.73	320.73	197.18	553.94	988.73
180 kg N ha^{-1} (150% RDN)	23.27	55.56	87.73	96.36	197.60	318.80	321.66	197.60	583.26	1001.10
210 kg N ha^{-1} (175% RDN)	25.21	59.36	89.86	102.66	195.79	302.40	308.36	195.79	528.54	943.23
SEm ±	0.27	0.89	0.87	1.05	1.013	4.135	2.302	1.013	10.82	6.34
CD at 5%	0.85	2.79	2.71	3.28	3.156	12.88	7.172	3.156	33.72	19.76

Table–1. Growth attributing characters

Treatment	No. of grains $spikes^{-1}$	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Control	35.20	33.83	36	47	88	42
60 kg N ha^{-1} (50% RDN)	37.56	36.33	42	52	95	43
90 kg N ha^{-1} (75% RDN)	38.20	38.93	43	54	98	44
120 kg N ha^{-1} (100% RDN)	38.63	40.10	46	57	103	44
150 kg N ha^{-1} (125% RDN)	41.06	42.56	52	62	110	47
180 kg N ha^{-1} (150% RDN)	42.66	43.23	53	56	110	48

210 kg N ha^{-1} (175% RDN)	39.60	39.90	48	63	111	43
SEm ±	0.92	1.47	0.61	0.46	1.71	0.79
CD at 5%	2.86	4.58	1.92	1.43	5.35	2.48

Table – 2.yield attributing characters

Treatment	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	Benefit : Cost ratio
Control	43800	100818	57018	1.3
60 kg N ha^{-1} (50% RDN)	45235	116638	71403	1.5
90 kg N ha^{-1} (75% RDN)	45550	119498	73948	1.6
120 kg N ha^{-1} (100% RDN)	45865	126716	80851	1.7
150 kg N ha^{-1} (125% RDN)	46180	141200	95020	2.0
180 kg N ha^{-1} (150% RDN)	46495	139600	93105	2.0
210 kg N ha^{-1} (175% RDN)	46810	133800	86990	1.8

Table -3. Economics characters

Conclusion

The scrutiny of data on growth yield attributes clearly reveals that the application of 150% RDN (180 kg N ha^{-1}) significantly the high values of growth except plant heightwhich was higher at 175% RDN (210 kg N ha^{-1}).The yield attributing characters and yields was significantly higher at T_6 150% RDN (180 kg N ha^{-1}) which was found to be at par with T_5 treatment 125% RDN (150 kg N ha^{-1}). Harvest index was higher at T_6 150% RDN (180 kg N ha^{-1}) and was to be at par in T_5.The highest cost of cultivation of (Rs.46810) per ha^{-1} was incurred under treatment 175% RDN (210 kg N ha^{-1}) followed by 150% RDN (180 kg N ha^{-1}) (Rs.46495). The highest gross return (Rs.141200) was obtained with 125% RDN (150 kg N ha^{-1}). The highest net return (Rs. 95020) was obtained under 125% RDN (150 kg N ha^{-1}). The highest benefit: cost ratio (2.0) was obtained with 150% RDN (180 kg N ha^{-1}) similar to 125% RDN (150 kg N ha^{-1}).Thus 150% and 125% RDN with 180 kg N ha^{-1} and 150 kg N ha^{-1}, respectively may be recommended for obtaining maximum yield of wheat grown under foot hills of Uttrakhand.

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