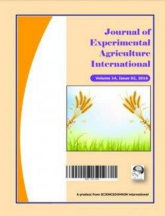

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Response of Wheat to Various Nitrogen Levels under Late Sown Condition

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Authors' contributions

This work was carried out in collaboration between both authors. Author BP designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author PKR managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment conducted during *rabi* season 2015-16 at Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar aims to evaluate the effect of different nitrogen levels on late sowing wheat. The experiment consisted of 4 nitrogen level treatments 120,135,150,165 kg N ha^{-1}. The obtained results indicated that plant height, dry matter accumulation, leaf area index (LAI), crop growth rate (CGR), number of tillers, all the yield attributes, grain yield and biological yield were significantly increased except 1000 - grain weight with increase the nitrogen dose up to 150 kg N ha^{-1}, which was at par with 165 kg N ha^{-1}.

Keywords: Wheat; nitrogen levels; biomass production; LAI; CGR, RGR; yields.

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1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the second most important cereal crop in India after rice. It is primarily used as a staple food providing more protein. Wheat sowings get delayed due to late harvesting of *kharif* crops particularly paddy and cotton; insufficient irrigation water availability and sometimes due to excess moisture and water logging as a result of heavy rainfall. Late sowing date of wheat generally experiences terminal heat stress during reproductive stage which adversely affects crop growth and yield. Though climatic conditions are not optimum and it has to complete its life cycle within a short duration but its production and productivity can be improved.
Nitrogen is one the most important mineral nutrients for poaceae plants influencing growth, development, yield, and protein content of grains [1]. Wheat yields in the semiarid regions are not only limited by inadequate water supply, but also by nitrogen shortage late in the cropping season. Nitrogen plays a vital role in all living tissues of the plant. No other element has such an effect on promoting vigorous plant growth. Abundant protein tends to increase number of the leaves, and accordingly, to bring about an increase in carbohydrate synthesis. Nitrogen plays a vital role in increasing the yield of the crop. Application of proper amount of nitrogen is considered key to obtain bumper crop of wheat. Nitrogen comprises 7% of total dry matter of plants and is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes, and photosynthetic pigments [2]. Generally, nitrogen (N) fertilization at sowing increases wheat grain yield, and late fertilization enhances grain protein concentration. The fertilizer N requirement of wheat may be related to residual N in soil, varying climatic conditions etc. Hence, present investigation was undertaken to find out the suitable rate of nitrogen for getting better yield under late sown condition.

2. MATERIALS AND METHODS

The experiment was conducted during *rabi* 2015-16 at Research Farm of Department of Agronomy, CCSHAU, Hisar, Haryana (India) using late sown wheat variety *viz.* WH 1124 using different nitrogen levels (120, 135,150, 165 kg N ha^{-1}), Phosphorus and potassium fertilizers were done at rates of 60 and 30 kg ha^{-1}. Soil of the experimental site was sandy loam in texture, slightly alkaline in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. The previous crop was Dhanicha-pearlmillet. The experiment was laid out with 3 replications in 60 plots having plot size 15 m × 2m. The full recommended dose of phosphorus, potassium fertilizers and half of the nitrogen as per treatment were applied at sowing as basal dose. Remaining half dose of nitrogen was top dressed at 1st irrigation *i.e* at crown root initiation stage.

Plant population per metre row length was recorded from each plot at 15 DAS, then multiplied by 5 to obtain plant population per square metre as the crop was sown at 20cm row spacing. For dry matter accumulation and leaf area index plants in 0.25 metre row length from the second row on either side in each plot, were harvested close to the ground at 30, 60, 90 DAS and at maturity then multiplied by four to obtain total leaf area per metre row length. Dry matter recorded were used to calculate CGR and RGR (CGR= W_2-W_1/(t_2-t_1)S and RGR= (LnW_2-LnW_1)/t_2-t_1; where W_1 and W_2 are dry weights of plants at time t_1 and t_2 respectively. t_2- t_1 is the interval of time in days, S is land area (m^2) occupied by plants).

Crops were harvested for calculating biological and grain yield. Different yield attributes were recorded properly like the effective tillers were counted per metre row length from each plot. The spike length (cm) was measured from the base of the peduncle (lower spikelet) to the tip of the top spikelet. Grains were separated from spikelet and the number of grains was counted and the grains per spike were worked out. 1000 grains were counted at random using automatic seed counter and weighed, with the help of mini plot thresher, the grain yield was measured. Data recorded were analyzed using ANOVA technique as described by Panse and Sukhatme [3].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

In the present study plant population (Table 1a.) remained unaltered by application of nitrogen. The plant height increased significantly with each increasing nitrogen level from 120 to 150 kg N ha^{-1} in comparison to 120 and 135 kg N ha^{-1} dose at all the stages of observation. Effect of 150 and 165 kg N ha^{-1} was statistically at par with each other in respect of plant height (Table 1a.). It may be due to the fact that nitrogen plays an important role in cell division and cell elongation and thus growth in terms of height of the plant. These results are supported by the findings of

Table 1(a). Effect of nitrogen levels on growth parameters of late sown wheat

Nitrogen level (kg ha^{-1})	Plant stand at 15 DAS m^{-2}	Plant height (cm)				Leaf area (cm^2 m.r.l^{-1})			Leaf area index			Tillers no. m.r.l^{-1}	
		30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS
120	161.3	17.45	52.24	83.78	85.38	585	11074	4449	0.293	5.54	2.22	85.3	73.6
135	163.0	18.30	53.41	85.29	86.53	618	11572	5081	0.309	5.79	2.54	88.4	78.7
150	163.3	19.05	54.63	86.69	88.35	673	12579	5414	0.337	6.29	2.71	92.6	83.9
165	165.0	19.44	55.36	87.41	89.20	679	12937	5569	0.340	6.47	2.78	93.0	84.8
SEm±	2.9	0.24	0.36	0.47	0.37	4	147	71	0.002	0.07	0.04	0.7	0.9
CD at 5%	NS	0.70	1.03	1.35	1.08	11	426	207	0.006	0.21	0.10	1.9	2.7

Table 1(b)

Nitrogen level (kg ha^{-1})	Biomass accumulation (g m.r.l^{-1})				CGR (g m^{-2}day^{-1})				RGR (g g $^{-1}$ day^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest	0-30 DAS	30-60 DAS	60-90 DAS	90 DAS – Harvest	0-30 DAS	30-60 DAS	60-90 DAS	90 DAS – Harvest
120	4.49	34.21	198.43	220.65	0.74	4.95	27.37	4.45	0.050	0.068	0.059	0.004
135	4.78	36.53	220.96	244.83	0.80	5.29	30.74	4.77	0.052	0.068	0.060	0.004
150	5.33	38.46	236.52	266.16	0.89	5.52	33.01	5.92	0.056	0.066	0.060	0.005
165	5.68	39.82	241.23	269.89	0.94	5.69	33.57	5.73	0.058	0.065	0.060	0.005
SEm±	0.13	0.60	1.80	1.54	0.02	0.10	0.28	0.51	0.001	0.001	0.001	0.000
CD at 5%	0.37	1.75	5.22	4.46	0.06	0.29	0.82	NS	0.002	NS	NS	NS

(DAS= Days after sowing, CGR= Crop growth rate, RGR= Relative growth rate)

Table 2. Effect of nitrogen levels on yield attributes and yield of late sown wheat

Nitrogen level (kg ha^{-1})	Effective tillers (No. m.r.l^{-1})	Spike length (cm)	Number of grains Spike^{-1}	1000-grain weight (g)	Grain yield (qt ha^{-1})	Straw yield (qt ha^{-1})	Biological yield (qt ha^{-1})	Harvest index (%)
120	58.3	8.48	36.2	39.35	36.29	55.65	91.94	39.5
135	63.3	8.67	38.5	39.41	37.92	57.76	95.68	39.6
150	66.0	8.93	40.7	40.14	39.26	60.33	99.59	39.5
165	68.1	8.97	42.4	40.37	40.39	61.03	101.42	39.8
SEm±	0.9	0.07	0.7	0.31	0.42	0.61	0.77	0.4
CD at 5%	2.5	0.21	1.9	NS	1.21	1.76	2.22	NS

(Where, m.r.l^{-1} = Per metre row length, m^{-2} day^{-1}= per metre square per day, g^{-1} day^{-1}= per gram per day NS = Not significant)

Patel et al. [4] and Kaur et al. [5] in wheat, who reported that increasing the level of nitrogen increased the plant height.

All other growth parameters like biomass accumulation, no of tillers (Table 1(a&b)) were also improved significantly up to 150 kg N ha^{-1}. The LAI increased significantly by nitrogen levels at all the crop growth stages. LAI at 135 kg N ha^{-1} was significantly more over 120 kg N ha^{-1}. The maximum LAI was recorded with 165 kg N ha^{-1} which was statistically at par with 150 kg N ha^{-1} and both these treatments have significantly higher LAI than 120 and 135 kg N ha^{-1} at 30, 60 and 90 DAS. Crop growth rate increased with each successive increase in nitrogen dose up to 150 kg N ha^{-1}. Numerically highest CGR observed during 60-90 DAS with 165 kg N ha^{-1} which was at par with 150 kg N ha^{-1}. At 90 DAS–harvest stage all the nitrogen treatments had no significant difference in improving CGR. At 0-30 DAS, RGR was increased significantly with each increase in N up to 150 kg ha^{-1}. However, at other stages, nitrogen levels were statistically at par in respect of RGR. Numerically highest CGR observed during 60-90 DAS with 165 kg N ha^{-1} which was at par with 150 kg N ha^{-1}. At 90 DAS–harvest stage all the nitrogen treatments had no significant difference in improving CGR. Highest no. of tillers (93.0) were recorded with 165 Kg N level which was at par with 150 kg N ha^{-1} (92.6). Both these levels were statistically at par with each other in term of total number of tillers at both the growth stages. This occurred due to the fact that application of nitrogen resulted in increasing the proportion of protoplasm of cell wall material which caused an increase in the size of cell, ultimately increased growth parameters. This is closely correlated with the interception of more solar radiation through photosynthesis with increased in LAI due to increase in N fertility. These findings are supported by Hussain et al. [6], Patel et al. [4], Kaur et al. [5], Kachroo and Razdan [7] and Kumar et al. [8] in wheat.

3.2 Yield Attributes and Yield Studies

The spike length, number of grains per spike increased significantly with increasing nitrogen up to 150 kg N ha^{-1}. The response of nitrogen was significant up to 150 kg ha^{-1} and further increase in N dose to 165 kg ha^{-1} failed to cause an appreciable increase in effective tillers. Both these treatments were significantly superior than 120 and 135 kg N ha^{-1} in respect of effective tillers. The length of spike improved significantly by application of both 150 and 165 kg N ha^{-1} over 120 and 135 kg N ha^{-1} treatment. Among different nitrogen levels, highest spike length (8.97 cm) was recorded with 165 kg N ha^{-1} which was statistically at par with 150 kg N ha^{-1} (8.93 cm). However, 1000 - grain weight did not significantly increased with increasing N levels (Table 2). Similar results were reported by Jakhar [9]. Increased yield attributes due to increasing level of N were due to better growth parameters with the increasing level of N. These findings substantiate the results of Patel et al. [4] and Pandey et al. [10].

Grain, straw and biological yields were improved significantly with increase in N dose up to 150 kg ha^{-1} which was statistically at par with 165 kg N dose (Table 2). The higher grain yield obtained with increasing nitrogen levels could be ascribed to its favorable effect on yield attributing characters. The biological yield of wheat varied significantly among different nitrogen levels. The maximum biological yield was recorded with 165 kg N ha^{-1} (101.42 qt ha^{-1}) which was closely followed by 150 kg N ha^{-1} (99.59 qt ha^{-1}). Both these levels produced significantly higher biological yield than 120 (91.94 qt ha^{-1}) and 135 (95.68 qt ha^{-1}) kg N ha^{-1}. Increase in straw and biological yields of wheat with successive increase in N levels probably came through favorable influence of increasing N levels on growth parameters in terms of plant height, number of tillers, dry matter production and LAI. Corroborative findings have been reported by Beheraa and Rautaray [11], Patel et al. [4], Pandey et al. [10], Narolia et al. [12] and Nishant et al. [13] in wheat crop. The harvest index was not influenced significantly by nitrogen application treatments.

4. CONCLUSION

On the basis of one year study, it can be concluded that in late sown wheat all the growth parameters (height, dry matter accumulation, Leaf area index (LAI)), yield attributes and yield has been increased significantly with increasing nitrogen levels up to 150 kg ha^{-1}. Thus we can use up to 150 kg N ha^{-1} under late sown condition to improve yield.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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