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Effect of nitrogen levels on growth and yield of different biofortified color wheat

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Abstract
A field experiment was conducted in *rabi* season of 2023-24 at Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan, Himachal Pradesh. The experiment was laid out in a split-plot design with three replications. The experiment consists of four biofortified color wheat in main plot *viz.*, (V_1) Purple wheat, (V_2) Black wheat, (V_3) Blue wheat and (V_4) Normal wheat and four nitrogen levels in (N_0) control, (N_1) 90 kg ha^{-1}, (N_2) 120 kg ha^{-1} and (N_3) 150 kg ha^{-1} in sub plot. Recommended dose of phosphorus and potassium (60:30 kg ha^{-1}) was applied through SSP and MOP as basal dose at the time of sowing. Among the biofortified color wheat, (V_4) Normal wheat recorded significantly higher growth and yield over the rest of the biofortified colour wheat. Application of 150 kg N ha^{-1} resulted significantly higher growth and yield of biofortified color wheat under mid hills of Himachal Pradesh.

Keywords: Nitrogen levels, growth, yield, biofortified color wheat

Introduction
Wheat (*Triticum aestivum*), belonging to the genus *Triticum* of the Poaceae (Gramineae) family, originates from South-West Asia and is now cultivated globally. India produces over 102.42 million tonnes of wheat on 30.31 million hectares, area with an average yield of 3314 kg ha^{-1} (Agricultural Statistics at a Glance, 2022) [2]. In Himachal Pradesh, wheat is grown on 33,148 hectares area that producing 570,378 metric tonnes with an average productivity of 1710 kg ha^{-1}. Meanwhile in Solan, Wheat is cultivated on area of 24,521 hectares with production of 58,053 metric tonnes and productivity of 2370 kg ha^{-1} (Statistical Abstract of Himachal Pradesh, 2021-22) [15].
In recent years, consumer preferences have shifted, and they now prefer a well-balanced food profile to an energy-dense diet that provides metabolic, physiological, and functional health benefits. A growing portion of the worldwide people is struggling to cope from a variety of diseases and health issues as a result of insufficient protein, vitamins, critical macro and micronutrients, including iron and zinc, in their daily diets (Balyan *et al.*, 2013) [3]. Seeing as wheat is a staple food crop in many parts of the world, it is thought that developing anthocyanin-biofortified wheat will influence human lifestyles (Sharma *et al.*, 2021) [12].
Research done by Garg *et al.* (2022) [4] demonstrated that colored wheat varieties can be adapted to various environments through breeding strategies, such as crossing exotic winter-colored wheat lines with locally adapted spring wheat cultivars. This research led to the development of colored wheat lines tailored to the Indian environment. Nitrogen significantly influences wheat yield and plays a pivotal role in determining grain baking quality. Its prominence in plant metabolism is evident as all vital plant processes are intricately associated with proteins, where nitrogen serves as an indispensable constituent. Therefore, it is imperative to assess the application of high nitrogen fertilizer rates.

Materials and Methods
The experiment was conducted during *rabi* season of 2023-24 at Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan (situated at latitude 30^0 85'67.30 N and 77^0 13'20.38 E longitude with an altitude of 1270 m above mean sea level).

The soil of the experiment field was sandy loam in texture, slightly alkaline in reaction (pH 6.65) with EC in safer range (0.25 dS m^{-1}), organic carbon (0.88%), nitrogen (292.78 kg ha^{-1}), phosphorus (24.59 kg ha^{-1}) and potassium (214.34 kg ha^{-1}). The experiment consists of four biofortified color wheat in main plot *viz.*, (V_1) Purple wheat, (V_2) Black wheat, (V_3) Blue wheat and (V_4) Normal wheat and four nitrogen levels in (N_0) control, (N_1) 90 kg ha^{-1}, (N_2) 120 kg ha^{-1} and (N_3) 150 kg ha^{-1} in sub plot. Thus a total of 16 treatment combinations were tested in the study and were replicated thrice. Recommended dose of nitrogen, phosphorus and potassium (120:60:30 kg ha^{-1}).The full dose of phosphorus and potassium and half a dose of nitrogen were applied as a basal at the time of sowing and remaining half of nitrogen was applied in two equal splits at the time of CRI and tillering stage with irrigation. The total rainfall experienced during the crop growing season was 209 mm. Blue wheat (NABIMG-9), purple wheat (NABIMG-10), black wheat (NABIMG-11) and normal wheat (PBW621) were used for sowing. Biofortified color wheat and nitrogen levels were done as per treatment.

Statistical Analysis and Interpretation of Data

Data recorded on various parameters of the experiment was subjected to analysis by using Fisher's method of analysis of variance (ANOVA) and interpreted as outlined by Gomez and Gomez. The levels of significance used in 'F' test was found significant at a 5 percent level.

Results

Effect on crop growth parameter

Effect on plant height (cm)

The outcome of the study (Table 1) showed that significantly higher plant height (8.77 cm) was recorded with (V_4) normal wheat at 30 DAS. Simliar trend was noted at 60, 90, 120, 150 DAS and at harvest. However, least plant height (7.95 cm) was recorded with (V2) Blue wheat. A similar trend was also noted at 60, 90, 120, 150 DAS and at harvest stage.

Nitrogen levels also showed significantly variation in plant height at periodic intervals. significantly higher value was found under the application of (N_3) 150 kg ha^{-1} over rest of treatment. Interaction effect of biofortified color wheat and nitrogen levels was found to be non-significant on plant height.

Effect on chlorophyll content (SPAD value)

Chlorophyll content (Table 2) did not reach the level of significance. However, the maximum chlorophyll content (35.70) was recorded in (V_4) normal wheat at 30 DAS and the minimum chlorophyll content (34.17) was recorded in (V_2) blue wheat. A similar trend was also noted at 60, 90, 120 and 150 DAS.

Nitrogen fertilization (N_3) 150 kg ha^{-1} recorded significantly higher chlorophyll content (38.43) which was statistically at par with application of (N_2) 120 kg ha^{-1} at all the stages of crop growth. While, the lowest chlorophyll content (29.86) was recorded under the (N_0) Control treatment at all the periodic intervals. Interaction effect of biofortified color wheat and nitrogen levels was found to be nonsignificant on chlorophyll content (SPAD).

Effect on dry matter accumulation (g m^{-2})

In dry matter accumulation (Table 3) Normal wheat (V_2) recorded significantly higher (23.76 g m^{-2}) at 30 DAS. While, the least dry matter accumulation (21.17 g m^{-2}) was recorded with (V_3) Blue wheat. Similar trend was also noted at 60, 90, 120, 150 DAS and at harvest stage during course of investigation.

In case of nitrogen levels, significantly higher dry matter accumulation (23.52 g m^{-2}) was recorded with application of (N_3) 150 kg ha^{-1} at 30 DAS. However, lowest dry matter accumulation (22.19 g m^{-2}) was recorded with (N_0) Control treatment at all periodic intervals. Interaction effect was found to be non-significant.

Effect on Crop growth rate (g m^{-2} day^{-1})

Crop growth rate completely depends on dry matter accumulated by crop plants. The crop-growth rate increased progressively with advancement of crop age as presented in Table 4.

Among the biofortified color wheat, (V_4) Normal wheat exhibited a significantly higher crop growth rate (5.86 g m^{-2} day^{-1}) over rest of the color wheat at 30-60 DAS. However, least crop growth rate (2.16 g m^{-2} day^{-1}) was recorded with (V_2) Blue wheat. Similar trend was also noted at all periodic intervals.

Nitrogen fertilization of (N_3) 150 Kg ha^{-1} recorded significantly higher crop growth rate (4.28 g m^{-2} day^{-1}) at 30-60 DAS during experimentation. However, lowest crop growth rate (3.38 g m^{-2} day^{-1}) was recorded with (N_0) Control at 30-60 DAS. A similar trend was also noted at 60- 90 DAS, 90-120 DAS, 120-150 DAS and 150 DAS-at harvest of test crop. Interaction effect of biofortified color wheat and nitrogen levels was found to be non-significant on crop growth rate.

Effect on yield attribute

The scrutiny of yield attributing characters of biofortified color wheat *viz*, number of effective tillers (m^{-2}), number of grains $spike^{-1}$, spike length, and test weight are showed in Table 5.

Effect on number of effective tillers (m^{-2})

Normal wheat (V_4) recorded significantly higher number of effective tillers (183.65 m^{-2}) at harvest of biofortified color wheat. However, lesser number of effective tillers (135.99 m^{-2}) was recorded in (V_3) blue wheat at harvest.

In case of nitrogen levels, Significantly higher number of the effective tillers (163.33 m^{-2}) of biofortified color wheat at harvest was recorded under the application of (N_3) 150 Kg ha^{-1} over lesser levels of nitrogen. The lowest number of effective tillers (147.67 m^{-2}) were recorded with (N_0) Control treatment. Interaction effect of biofortified color wheat and nitrogen levels was found to be non-significant on number of effective tillers.

Effect on number of grains $spike^{-1}$

The results of study results indicate a significant variation on number of grain $spike^{-1}$ of biofortified color wheat due to nitrogen levels. Significantly higher number of grains $spike^{-1}$ (48.50) was recorded with (V_4) Normal wheat, and lower number of grains $spike^{-1}$ (36.83) was recorded in (V_3) Blue wheat during the course of study.

Application of (N_3) 150 kg N ha^{-1} recorded significantly higher number of grains $spike^{1}$ (43.83) over rest of the treatments. However, application of (N_2) 120 kg N ha^{-1} was statistically at par with (N_3) 150 kg N ha^{-1}. While, lesser number of grains $spike^{-1}$ (39.62) was recorded with (N_0) Control during course of study. Interaction effect of biofortified color wheat and nitrogen levels was found to be non-significant on number of the effective tillers.

Effect on spike length (cm)

Normal wheat (V_4) recorded significantly higher spike length (7.98 cm) over the rest of treatments. However, (V_2) Black wheat (7.38 cm) was statistically at par with (V_4) Normal wheat. While lowest spike length (6.40 cm) was recorded in (V_3) Blue wheat at harvest.

In case of nitrogen levels, the spike length did not reach the level of significance. However, the maximum spike length (7.51 cm) was recorded under the application of (N_3) 150 kg ha^{-1} and the minimum spike length (6.96 cm) was recorded under the (N_0) control treatment.

Interaction effect was found to be non-significant

Effect on Test weight (g)

Normal wheat (V_4) recorded significantly higher test weight (41.50 g).While, lowest test weight (36.98 g) was recorded in (V_2) Black wheat during the course of study.

In case of nitrogen levels, the test weight did not reach the level of significance. The maximum test weight (39.90 g) was recorded with the application of (N_3) 150 kg ha^{-1} and the minimum test weight (38.67 g) was recorded with the (N_0) Control treatment.

Interaction effect of biofortified color wheat and nitrogen levels was found to be nonsignificant on test weight.

Effect on yield

The investigational data relating to yield like grain yield, straw yield, biological yield and
harvest index are presented in Table 6.

Effect on grain yield (kg ha^{-1})

Among the biofortified color wheat, significantly higher grain yield (3060 kg ha^{-1}) was observed under the (V_4) Normal wheat. However, the lower grain yield (1488 kg ha^{-1}) was recorded in (V_3) Blue wheat.

Nitrogen fertilization of (N_3) 150 Kg ha^{-1} recorded significantly higher grain yield (2370 kg ha^{-1}). However, the lowest grain yield (1794 kg ha^{-1}) was recorded with (N_0) Control treatment. Interaction effect was found to be non-significant.

Effect on straw yield (kg ha^{-1})

Straw yield of biofortified color wheat was significantly influenced by different nitrogen levels.

The results from the experimental field among the color wheat, a significantly higher straw yield (6704 kg ha^{-1}) was observed under the (V_4) Normal wheat. While, lower straw yield (3734 kg ha^{-1}) was recorded in (V_3) Blue wheat during course of investigation.

In case of nitrogen levels, a significantly higher straw yield (5571 kg ha^{-1}) was recorded with the application of (N_3) 150 Kg ha^{-1}. However, the lowest straw yield (4630 kg ha^{-1}) was recorded with the (N_0) control treatment.

Interaction effect was found to be non-significant.

Effect on biological yield (kg ha^{-1})

The data revealed that biological yield of biofortified color wheat followed a similar trend as that observed with respect to grain yield and straw yield with different nitrogen levels.

The experimental result showed that among the color wheat, a significantly higher biological yield (9764 kg ha^{-1}) was observed under the (V_4) Normal wheat, and the lower (5222 kg ha^{-1}) was recorded in (V_3) Blue wheat during course of study.

Nitrogen fertilization (N_3) 150 Kg ha^{-1} recorded significantly higher biological yield (5571 kg ha^{-1}). However, lowest biological yield (4630 kg ha^{-1}) was recorded under the (N_0) control.

Discussion

Effect of biofortified color wheat on growth characters

A significantly increase in plant height, chlorophyll content, dry matter accumulation, crop growth rate were observed in (V_4) Normal wheat over the rest of treatments. It may be attributed to inherent variation caused by the superior genetic makeup. Result were inline with Garg *et al.* (2018) [4], where they found significant variation in growth characters of biofortified color wheat**.**

Effect of nitrogen levels on growth characters

Growth parameters like plant height, chlorophyll content, dry matter accumulation and crop growth rate differed significantly of biofortified color wheat due to nitrogen levels. Among the treatments, significantly higher were value found under the application of (N_3) 150 kg ha^{-1} over rest of treatment.

Improvement in growth parameters like plant height and chlorophyll content due to the soil application and top dressing of nitrogen fertilizer with the dose of 150 kg ha^{-1} resulted in higher dry matter accumulation and crop growth rate in reproductive plant parts. The role of nitrogen due to the potential involvement in altering the soil and plant environment helpful for the development of both morphological and biochemical components of growth, plant height of biofortified color wheat under various nitrogen levels might be ascribed. It is commonly known that nitrogen plays a crucial role in the creation of protein, chlorophyll, and other organic compounds with physiological importance. It is well known that, similar to environment factors, mineral nutrition, especially nitrogen, plays a significantly regulatory functional role in plant systems through the synthesis and translocation of growth hormones, which typically act as a stimuli for specific crop growth and development stages. Similar results were observed by Guarda *et al.* (2004) [7]; Kachroo and Razdan (2006) [8]; Yadav *et al.* (2011) [16]; and Sharma *et al.* (2016) [11].

Effect of biofortified color wheat on yield attributes

The data showed that higher value of yield attributes like number of grains $spike^{-1}$, number of effective tillers, test weight were significantly higher in (V_4) Normal wheat followed by (V_2) which was statistically at par with (V_4) Normal wheat in case of spike length. Test weight was recorded significantly higher in (V_4) Normal wheat followed by (V_1) Purple wheat (V_3), Blue wheat and (V_2) Black wheat, respectively. This might be due to better growth characters of (V_4) Normal wheat which enhances the spike length and, number of effective tillers which resulted in better grains $spike^{-1}$. Test weight was higher in (V_4) Normal wheat due to superior genetic characters. These findings are consistent with those made public by Garg *et al.* (2018) [4].

Effect of nitrogen levels on yield attributes

The data showed that higher yield attributes like number of grains $spike^{-1}$ and number of effective tillers were recorded with application of (N_3) 150 kg N ha^{-1} which was statistically at par with (N_2) 120 kg N ha^{-1}. This might be because of an adequate supply of nitrogen, which led to higher dry matter accumulation and, as a result, higher tiller density and effective tiller density. The presence of nitrogen contributed to optimum nourishment, which led to spike length and thus additional grains ear^{-1}. Spike length and test weight could not react the level of significance. These findings are consistent with those made public by Khan *et al.* (2022) [9] and Sikarwar *et al.* (2022) [13].

Effect of biofortified color wheat on yield

Grain yield is the economic part of harvest, which mirrors the resultant effect of all different biofortified color wheat. Different biofortified color wheat positively influenced crop growth parameter and yield attribute resulting in better yield. It is the function of like number of grains $spike^{-1}$, number of effective tillers, spike length.

The data showed that significantly higher yield (grain, straw and biological yield) was recorded in (V_4) Normal wheat. This might be due to that yield of crop is the result of different yield attributes like number of grains $spike^{-1}$, number of effective tillers, and spike length which directly influence the grain and straw yield. Higher the yield attributes, higher the yield. This matches the results from Garg *et al.* (2018) [4].

Effect of nitrogen levels on yield

Grain yield is the economic part of harvest, which mirrors the resultant effect of all factors that are influenced by different treatments. Different treatments positively influenced crop growth parameter and yield attribute resulting in better yield. It is the function of like number of grains spike^{-1}, number of effective tillers and spike length.

A close perusal of the data under different nitrogen levels revealed that significantly higher yield (grain, straw and biological) was observed with application of (N_3) 150 kg N ha^{-1}. This might be due to that yield of crop is the result of different yield attributes like number of grains spike^{-1}, number of effective tillers, spike length which directly influence the grain and straw yield. Higher the yield attributes, higher the yield. Similar observations were also made by several earlier workers in wheat Singh and Agarwal, 2003 [14]; Kachroo and Razdan 2006 [8]; Abedi *et al*., 2013 [1]; Chauhan *et al.*, 2014; Shah *et al*., 2016 [10] and Khan *et al.*, 2022 [9].

Table 1: Effect of nitrogen levels on plant height (cm) at periodic intervals of biofortified color wheat

Treatments	Plant height (cm)					
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
Main plot (Color wheat)						
V1 : Purple Wheat	8.77	13.05	20.47	59.09	72.56	71.19
V2 : Black Wheat	9.16	14.00	21.37	64.10	74.31	72.86
V3 : Blue Wheat	7.95	12.72	19.15	49.24	71.29	69.92
V4 : Normal Wheat	10.64	15.97	23.31	69.48	82.30	81.01
SEm±	0.23	0.35	0.55	1.44	2.10	2.08
LSD (*p*=0.05)	0.79	1.22	1.89	4.99	7.28	7.21
Sub plot (Nitrogen levels)						
N0 :0 kg ha^{-1} (Control)	6.91	11.55	18.62	55.92	68.84	67.47
N1 :90 kg ha^{-1}	9.45	13.76	21.14	60.11	74.10	72.73
N2 :120 kg ha^{-1}	9.60	14.28	21.81	62.88	77.50	76.13
N3 :150 kg ha^{-1}	10.56	16.15	22.71	62.99	80.02	78.65
SEm±	0.21	0.35	0.53	0.97	2.03	2.02
LSD (*p*=0.05)	0.61	1.02	1.54	2.85	5.91	5.90
Interaction (Vx N)	NS	NS	NS	NS	NS	NS

Table 2: Effect of nitrogen levels on SPAD value (chlorophyll content) at periodic intervals of biofortified color wheat

Treatments	SPAD value (Chlorophyll content)				
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
Main plot (Color wheat)					
V1 : Purple Wheat	34.59	43.23	53.74	55.69	53.56
V2 : Black Wheat	34.62	43.24	54.61	56.56	54.44
V3 : Blue Wheat	34.17	43.20	53.65	55.57	53.44
V4 : Normal Wheat	35.70	44.25	55.91	57.70	55.58
SEm±	0.86	1.02	1.04	1.07	0.98
LSD (*p*=0.05)	NS	NS	NS	NS	NS
Sub plot (Nitrogen levels)					
N0 :0 kg ha^{-1} (Control)	29.86	39.78	50.69	53.97	49.78
N1 :90 kg ha^{-1}	33.93	43.06	53.74	55.43	54.33
N2 :120 kg ha^{-1}	36.86	44.62	55.39	57.56	55.71
N3 :150 kg ha^{-1}	38.43	46.44	58.11	58.56	57.20
SEm±	0.75	0.92	0.99	1.06	0.96
LSD (*p*=0.05)	2.18	2.69	2.89	3.11	2.80
Interaction (Vx N)	NS	NS	NS	NS	NS

Table 3: Effect of nitrogen levels on dry matter accumulation (g m^{-2}) at periodic intervals of biofortified color wheat

Treatments	Dry matter accumulation (g m^{-2})					
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
Main plot (Color wheat)						
V1 : Purple Wheat	22.09	131.35	208.24	327.82	516.80	565.93
V2 : Black Wheat	23.67	112.24	182.25	300.41	505.74	579.98
V3 : Blue Wheat	21.17	85.85	138.92	229.28	396.51	443.75
V4 : Normal Wheat	23.76	199.46	316.47	488.20	720.09	829.82
SEm±	0.31	3.40	5.37	6.97	10.12	14.80
LSD (*p*=0.05)	1.06	11.76	18.57	24.11	35.02	51.23
Sub plot (Nitrogen levels)						
N0 :0 kg ha^{-1} (Control)	22.19	123.58	196.98	317.04	501.92	546.03
N1 :90 kg ha^{-1}	22.41	126.56	201.33	323.46	524.24	587.50
N2 :120 kg ha^{-1}	22.58	126.86	204.98	324.59	526.99	611.00
N3 :150 kg ha^{-1}	23.52	151.90	242.60	380.61	585.98	674.95
SEm±	0.30	3.31	5.35	6.78	8.53	11.43
LSD (*p*=0.05)	0.90	9.66	15.62	19.78	24.90	33.35
Interaction (Vx N)	NS	NS	NS	NS	NS	NS

Table 4: Effect of nitrogen levels on crop growth rate (g m^{-2} day^{-1}) at periodic intervals of biofortified color wheat

Treatments	Crop growth rate (g m^{-2} day^{-1})				
	30 - 60 DAS	60-90 DAS	90-120 DAS	120-150 DAS	150 DAS- at harvest
Main plot (Color wheat)					
V1 : Purple Wheat	3.64	2.56	3.99	6.30	1.40
V2 : Black Wheat	2.95	2.33	3.94	6.84	2.12
V3 : Blue Wheat	2.16	1.77	3.01	5.49	1.35
V4 : Normal Wheat	5.86	3.90	5.56	7.73	3.47
SEm±	0.11	0.08	0.10	0.22	0.43
LSD (*p*=0.05)	0.39	0.28	0.35	0.77	1.29
Sub plot (Nitrogen levels)					
N0 :0 kg ha^{-1} (Control)	3.38	2.45	4.00	6.08	1.26
N1 :90 kg ha^{-1}	3.47	2.49	4.07	6.69	1.86
N2 :120 kg ha^{-1}	3.48	2.60	3.99	6.75	2.40
N3 :150 kg ha^{-1}	4.28	3.02	4.60	6.85	2.54
SEm±	0.10	0.08	0.08	0.20	0.18
LSD (*p*=0.05)	0.32	0.22	0.32	0.58	0.54
Interaction (Vx N)	NS	NS	NS	NS	NS

Table 5: Effect of nitrogen levels on yield attributes of biofortified color wheat at harvest

Treatments	Yield attributes			
	Spike length (cm)	Test weight (g)	No. of grains $spike^{-1}$	No. of effective tillers (m^{-2})
Main plot (Color wheat)				
V1 : Purple Wheat	6.95	40.17	38.92	146.99
V2 : Black Wheat	7.38	36.98	43.67	152.04
V3 : Blue Wheat	6.40	38.29	36.83	135.99
V4 : Normal Wheat	7.93	41.50	48.50	183.65
SEm±	0.19	0.87	0.69	4.02
LSD (*p*=0.05)	0.67	3.00	2.39	13.90
Sub plot (Nitrogen levels)				
N0 :0 kg ha^{-1} (Control)	6.96	38.67	39.92	147.67
N1 :90 kg ha^{-1}	7.08	39.36	41.33	152.27
N2 :120 kg ha^{-1}	7.12	39.00	42.83	155.39
N3 :150 kg ha^{-1}	7.51	39.90	43.83	163.33
SEm±	0.17	0.69	0.63	3.70
LSD (*p*=0.05)	NS	NS	1.82	10.80
Interaction (Vx N)	NS	NS	NS	NS

Table 6: Effect of nitrogen levels on yield (kg ha^{-1}) of biofortified color wheat at harvest

Treatments	Yield (kg ha^{-1})			Harvest Index (%)
	Grain Yield	Straw Yield	Biological Yield	
Main plot (Color wheat)				
V1 : Purple Wheat	1847	4808	6655	27.75
V2 : Black Wheat	1912	4913	6825	28.01
V3 : Blue Wheat	1488	3734	5222	28.49
V4 : Normal Wheat	3060	6704	9764	31.34
SEm±	51	127	128	0.94
LSD (*p*=0.05)	176	440	27442	NS
Sub plot (Nitrogen levels)				
N0 :0 kg ha^{-1} (Control)	1794	4630	6424	27.92
N1 :90 kg ha^{-1}	2040	4872	6912	29.51
N2 :120 kg ha^{-1}	2103	5086	7188	29.25
N3 :150 kg ha^{-1}	2370	5571	7941	29.84
SEm±	45	120	120	0.88
LSD (*p*=0.05)	130	351	350	NS
Interaction (Vx N)	NS	NS	NS	NS

Conclusion

On the basis of one year experiment it is to be concluded that application of 150 kg N ha^{-1} with normal wheat recorded significantly higher growth and yield under mid hills of Himachal Pradesh.

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