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Yumkhaibam Nargis Sultana
Department of Agriculture, Baba Farid College, Baba Farid Group of Institutions, Muktsar Road, Bathinda, Punjab, India

KH Anush Sheikh
Department of Fruit Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India

Corresponding Author:
KH Anush Sheikh
Department of Fruit Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India

Effect of different nitrogen levels on yield and its components of late sown wheat (*Triticum aestivum*) varieties

Yumkhaibam Nargis Sultana and KH Anush Sheikh

Abstract
A field experiment to investigate the effect of different nitrogen levels on yield and yield components of late wheat varieties was conducted at the Student's Demonstration and Research Field Department of Agriculture, Baba Farid College, Baba Farid Group of Institutions, Bathinda during rabi season 2018-19. The treatments consisted of three varieties (HP 3086, PBW 950 and PBW 658) and four nitrogen levels (0, 60, 120 and 180 kg N ha^{-1}). The experiment was laid out in split plot design with nitrogen levels as first factor in main plot and varieties as second factor in sub-plot with three replications. Different levels of nitrogen significantly increased the yield and yield components of wheat varieties. Yield attributing characters i.e., effective tillers m^{-2}, number of grains per ear and 1000-grain weight were maximum with 180 kg N ha^{-1}. Effective tillers m^{-2} and 1000 grain weight recorded maximum with variety PBW 590 and number of grain ear^{-1} was recorded maximum with PBW 658. Grain and straw yield were recorded maximum with nitrogen levels 180 kg N ha^{-1}. Among the varieties, maximum grain yield was recorded with PBW 590 and maximum straw yield was recorded with PBW 658. Biological yield and harvest index were recorded maximum with nitrogen levels 180 kg N ha^{-1}. Among the varieties, maximum biological yield was recorded with HD 308 and maximum harvest index was recorded with PBW 590.

Keywords: Nitrogen levels, varieties, wheat, yield

Introduction

Wheat (*Triticum aestivum* L.) is the most important and widely cultivated food crop in the world. In India, it is the 2nd most important cereal crop after rice. Wheat is primarily used as a staple food providing more protein than any other cereal crop. It is consumed in many forms like bread, cakes, biscuits, bakery products and many confectionary products. The good nutritive value of wheat flour (65-75% carbohydrates, 8-13% protein, 0.8-1.5% oil and fat, 0.3-0.5% mineral matters, 0.2% cellulose) has made the crop more valuable for human consumption.

The major wheat producing countries in the world are China, India, USA, Russia, Canada, European Union and Australia. In India, Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Maharashtra and Gujarat are the major wheat growing states. Wheat was grown in India on 305.97 lakh hectares with a total production of 98.38 million tones with an average productivity of 3,216 kg ha^{-1} (Anonymous 2018) [1].

Wheat crop bears high yield potential and responds to various agro-management practices *viz* tillage, time of sowing, crop geometry, seed rate, nutrient management etc. Low yield of wheat is attributed to many constraints, among them use of low yielding varieties and imbalance use of nitrogen which intensely and repeatedly impact resource availability are the factors of prime importance. Productivity of wheat is governed by improved varieties coupled with matching production technologies. Suitability of varieties to a particular agro-climate is the most important factor in realizing their yield potential which is further influenced by their response to application of nutrients, particularly nitrogen.

Nitrogen is the most important plant nutrient needed to obtain high wheat yields. Several investigators (Mosalem *et al*. 1997 and Sobh *et al*. 2000) [11, 15] reported a beneficial effect of nitrogen application on wheat. They reported that numbers of tillers and spikes m^{-2}, plant height, spike length, number of spikelets and grains $spike^{-1}$, grain and straw yields of wheat increased with increasing N to optimum level. In case of nitrogen deficiency, drying and firing of leaves occur, poor growth is achieved, grain becomes poorly filled and yield is severely affected.

However, high nutrient levels can also be harmful by making wheat plants more vulnerable to lodging, causing damage to the environment through leaching and nitrate volatization and economic loss to farmers. Hence it is necessary to find out the optimum dose of nitrogen for maximizing yield. The present study was therefore, designed to determine the effect of different nitrogen levels on yield and yield components of late wheat varieties.

Materials and Methods

To evaluate the effect of different nitrogen levels on yield and yield components of late wheat varieties, an experiment was carried out at the Student's Demonstration and Research Field Department of Agriculture, Baba Farid College, Baba Farid Group of Institutions, Bathinda during rabi season 2018-19. Bathinda is situated at 30° 11' N latitude and 75° 00' E longitude at the height of 210 meters above sea level. The treatments consisted of four nitrogen levels allotted to main-plots and three wheat cultivars laid out in split-plot design with three replications. The treatment details are as follows:

Main plot treatments	**Sub plot**
Nitrogen levels (4)	Wheat cultivars (3)
N_0: 0 kg N ha^{-1}	
N_1: 60 kg N ha^{-1}	V_1 = HD-3086
N_2: 120 kg N ha^{-1}	V_2 = PBW-950
N_3: 180 kg N ha^{-1}	V_3 = PBW-658

The plot size of 2.05 m x 6 m=12.30 m^2 (row x row distance was 22.5 cm) was maintained. Wheat cultivars (HD 3086, PBW 590 and PBW 658) were sown using seed rate of 87.5 kg ha^{-1}. Wheat varieties were sown on a well-prepared seed bed in first week of Dec. in 2018. Fertilizer application was made as urea, DAP and MOP as per treatment. Nitrogen was applied at 0, 60, 120 and 180 kg ha^{-1} to different varieties. Full dose of phosphorus, potash and ½ dose of nitrogen was applied as basal through DAP, MOP and urea. The remaining half dose of nitrogen was top dressed in first irrigation. Adequate plant protection measures were made during the crop growing period. Pre sowing irrigation was applied with canal water. Total numbers of irrigations applied were 5 with respect to phenological growth stages of wheat crop. Hand weeding was done to keep the crop free of weeds. Harvesting was done manually by cutting the plants from the ground level with the help of sickles. Before harvesting, 20 spikes were taken from each plot for post-harvest studies. The crop was left in the field for one week for sun drying. After sun drying, bundle weight was taken and threshing was carried out. Produce of all the plots was threshed separately with machine and grain weight was recorded after cleaning. Straw weight was taken separately by subtracting the grain weight from bundle weight.

The following observations were recorded

- Effective tillers m^{-1} row length
- Number of grains ear^{-1}
- (iii)1000-grain weight (g)
- Straw yield (q^{-1})
- Grain yield (q^{-1})
- Biological yield (q^{-1})
- Harvest index (%)

Procedure for the Data Recording

The following procedures were adopted for recording the data on individual parameter of the crop: Number of effective tillers per meter row length from randomly selected two places in each plot was recorded at harvest and was converted to total number of tillers m^{-1} row length. Randomly ten ears were taken from each plot, ears from lodged crop were also taken on bases of percentage lodging of the plot, threshed manually, counted for number of grains ear^{-1}. One thousand grains from produce of each plot were taken and their weight was recorded and taken as 1000-grain weight. Total produce was weighed in bundles after harvesting and one week of sun drying in open. After threshing the weight of grains was subtracted from total bundle weight and remaining was straw yield, which was expressed in quintals per hectare for presentation. For calculating grain yield, bundles of wheat from each plot were threshed separately and grains were collected in separate bags for each plot. After cleaning the grains were weighed and presented in quintals per hectare. For biological yield after harvesting, the wheat crop was sun dried up to one week and then weight of net harvested area of wheat in each plot was recorded which was converted into quintals per hectare. Harvest index of each plot was calculated separately with grain yield and biological yield obtained from that plot by using the formula.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield (q/ha)}}{\text{Biological yield (q/ha)}} \times 100$$

Statistical Analysis: The data obtained on the different growth and yield components and yield were analyzed statistically by the method of analysis of variance as per the procedure outlined for split plot design given by (Gomez and Gomez, 1984) [6]. Statistical significance was tested by F–value at 0.05 level of probability and critical difference was worked out where ever the effects were significant

Result and Discussions

Table 1: Effect of nitrogen levels and varieties on yield components of wheat

Treatments	Effective tillers m^{-1} row length	Number of grains Ear^{-1}	1000-grains weight (g)
Nitrogen Levels (N)			
N_0-0 kg N ha^{-1}	66.7	45.7	42.6
N_1-60 kg N ha^{-1}	78.3	49.5	44.1
N_2-120 kg N ha^{-1}	90.2	54.2	44.9
N_3-180 kg N ha^{-1}	101.0	64.8	47.8
S.Ed±	0.92	1.02	0.24
CD (P=0.05)	2.30	2.55	0.60
Varieties (V)			
V_1-HD-308	83.0	53.1	45.1
V_2-PBW-950	87.1	52.7	44.8

V3-PBW-658	82.0	54.8	44.5
S.Ed±	1.33	0.72	0.38
CD (P=0.05)	2.86	1.55	NS
Interaction (NxV)			
Sub at same level of main treatment			
S.Ed±	2.67	1.45	0.76
CD (P=0.05)	5.87	NS	1.66
Main treatment at same or different levels of sub treatment			
S.Ed±	2.37	1.57	0.66
CD (P=0.05)	5.20	NS	1.45
General Mean	84.05	53.5	44.8

1. Number of effective tillers meter^{-1} row length

Data pertaining to number of effective tillers meter^{-1} row length presented in table 1 revealed that differences among number of effective tillers meter^{-1} row length due to different treatments were significant. There was a significant increase in number of effective tillers meter^{-1} row length with the increase in nitrogen levels from 0 to 180 kg N ha^{-1}. The crop fertilized with 180 kg N ha^{-1} recorded significantly higher (101.0) number of effective tillers meter^{-1} row length than all other levels of nitrogen (0, 60 and 120 kg N ha^{-1}). The minimum number of effective tillers meter^{-1} row length (66.7) was obtained in control. This may be due to more number of plants unit^{-1} areas, enhanced tillering, less tiller mortality, and enhanced photosynthetic area (Patel 1991) [12], (Maqsood *et al*. 2002) [10] and (Yousaf *et al*. 2014) [19]. Among the varieties, PBW-950 recorded significantly higher number of effective tillers meter^{-1} row length (87.1) than all other varieties. The lower number of effective tillers meter^{-1} row length were obtained in PBW-658 (82.0). (Bhat *et al*. 2006) [4] Found significant differences because of different tillers producing habit and ability to maintain effective tillers meter^{-1} row length and also due to genetic makeup of particular variety.

2. Number of grains ear^{-1}

Data on number of grain ear^{-1} at harvest have been presented in table 2. A perusal of data reveals that application of 180 kg N ha^{-1} produced significantly higher number of grains ear^{-1} (64.8) followed by 0, 60 and 120 kg N ha^{-1}. The minimum number of grains ear^{-1} (45.7) was obtained in control. The nitrogen levels significantly improved the grains ear^{-1} over control treatment. This could be due to increased photosynthates with increasing nitrogen levels. The findings are in line with the data reported by (Ali *et al*. 2003) [2] who observed that increased application of nitrogen increases the number of grains yield per spike. Number of grains ear^{-1} of wheat as influenced by varieties are presented in table 2. Significantly higher number of grains ear^{-1}(54.8) was recorded in V_3 (PBW-658) followed by V_1(HD-308) and V_2(PBW-590) respectively. The probable reason for this is that different varieties have different genetic make-up.

3. Test weight (g)

Data on test weight (1000 grain weight) have been presented in table 2. The test weight increased with increasing level of nitrogen up to 180 kg N ha^{-1}. The crop fertilized with 180 kg N ha-1 recorded significantly higher (47.8) test weight than all other levels (0, 60 and 120 kg N ha^{-1}). The lowest test weight (42.6) was obtained with control. Those results are in full agreement with those observed by (Samiram *et al*. 1993) [14] who observed that the increasing levels of nitrogen not only increased the 1000 seed weight but also gave higher yield of straw, more functional leaves, high growth rate and higher net assimilation rate at all the stage of growth. These results are also similar to those reported by Abedin (1995) [3], Patel and Upadhyay (1993) [13] who concluded that higher dose of nitrogen significantly increased grain weight. The data present in Table 2 revealed that the test weight among wheat varieties did not differ significantly. Among the varieties, PBW-950 recorded higher test weight (44.8) and it was followed by PBW-658(44.5) and HD-308 (45.1) respectively. (Iqtidar *et al*. 2006) [9] Found no significant differences in the 1000-grain weight of the varieties. This corroborates with the findings of Chaudhary and Mehmood (1998) [5].

Table 2: Effect of nitrogen levels and varieties on yields and harvest index of wheat.

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Nitrogen Levels (N)				
N_0 - 0 kg N ha^{-1}	16.4	46.6	63.0	26
N_1 - 60 kg N ha^{-1}	28.3	65.3	93.7	30.1
N_2 -120 kg N ha^{-1}	32.9	64.6	97.6	33.7
N_3 -180 kg N ha^{-1}	38.3	67.7	106.1	36.1
S.Ed±	1.84	2.61	1.56	3.14
CD (P=0.05)	4.59	6.51	3.91	NS
Varieties (V)				
V_1 - HD-308	29.0	62.4	91.5	31.6
V_2 - PBW-950	30.1	59.7	89.9	33.5
V_3 - PBW-658	27.8	61.0	88.9	29.7
S.Ed±	1.12	1.39	0.87	1.94
CD (P=0.05)	NS	NS	1.86	NS
Interaction (NxV)				
Sub at same level of main treatment				
S.Ed±	2.24	6.54	1.74	3.88

CD (P=0.05)	5.19	2.79	4.0	NS
Main treatment at same or different levels of sub treatment				
S.Ed±	2.59	3.46	2.11	4.46
CD (P=0.05)	6.01	8.11	4.94	NS
General mean	28.9	61	90.1	31.4

4. Grain yield (q ha^{-1})

The data regarding grain yield are presented in table 2. The nitrogen levels significantly influenced the grain yield. All fertilizer treatments produced significantly higher grain yield than unfertilized control. The crop fertilized with 180 kg N ha^{-1} recorded significantly higher (38.3 q ha^{-1}) grain yield than all other levels (0, 60 and 120 kg N ha^{-1}) (Table 2). The lowest grain yield (16.4 q ha$^{-1)}$ was obtained with control. The increase in grain yield with enhanced N levels can be ascribed to better plant growth and dry matter production due to higher photosynthetic area. An increase in nitrogen supply increased all the yield attributing characters like ears m^{-2}, number of grains per spike and 1000-grain weight which ultimately contributed to increase in yields. (Hossain *et al*. 2005) [8] eported that grain yield showed significant increased with increasing nitrogen levels. Similar trends were also agreement with the results of (Tripathi *et al*. 2002 and Yadav *et al*. 2005) [17, 18]. Varieties showed non-significant differences in their grain yield. Variety V_2 (PBW-590) recorded the highest grain yield over all other varieties. Lowest grain yield was observed in V_3 (PBW-658) (Table 2).

5. Straw yield (q ha^{-1})

Data on straw yield have been presented in table 2. The nitrogen levels significantly influenced the straw yield. All fertilizer treatments produced significantly higher grain yield than unfertilized control. The crop fertilized with 180 kg N ha^{-1} recorded significantly higher (67.7 q ha^{-1}) grain yield than all other levels (0, 60 and 120 kg N ha^{-1}) (Table 2). Nitrogen is a component of porphyrins of chloroplasts and hence, increased nitrogen fertilization increased the growth and yield of crop due to increased photosynthates production. This resulted in better development in terms of plant height, number of tillers and leaf area which was reflected in higher straw yield. Similar results were also reported by Sushila and Giri (2000) [16]. Varieties showed non-significant differences in their straw yield. Variety V_1 (HD-308) recorded the highest grain yield (62.4 q ha^{-1}) over all other varieties. Lowest straw yield (27.8 q ha^{-1}) was observed in V_3 (PBW-658) (Table 2).

6. Biological Yield (q ha^{-1})

Biological yield is the total biomass produced by the plant during its life cycle. Data on biological yield have been presented in table 2. The levels of nitrogen had significant effect on biological yield which continued to increase significantly with the increase in nitrogen dose up to the highest level of 180 kg ha^{-1}. Highest biological yield (106.1 q ha^{-1}) was recorded with nitrogen level 180 kg N ha^{-1} whereas minimum biological yield (63 q ha^{-1}) was recorded from 0 kg ha^{-1}(control). More application of nitrogen gave tall plants, more grain yield, Number of tillers and total dry matter which collectively resulted in higher biological yield. There are many studies which revealed that with increasing the nitrogen rate biological yield increased (Ghobadi *et al.* 2010) [7]. The data in table 2 revealed that the biological yield was significantly influenced by different varieties. Among the varieties, highest straw yield (91.5 q ha^{-1}) was recorded in HD-3085 variety, being significantly higher than all other varieties, however, significantly lowest straw yield was obtained in PBW-658 (88.9 q ha^{-1}) (Table 2).

7. Harvest index (%)

The data of harvest index are presented in table 2. Harvest index was not significantly influenced by different nitrogen levels. Crop fertilized with 180 kg N ha^{-1} recorded significantly higher harvest index (36.1%) than all other levels of nitrogen. And lowest HI (26) was recorded in 60 kg N ha^{-1}. The data revealed that differences in harvest index were not significantly influenced by different varieties. Among the varieties, maximum harvest index (33.5%) was recorded in HD-308 however, minimum HI (%) was recorded in PBW-658 (29.7%).

Conclusion

Based on one-year study, it can be suggested that among the varieties tested, wheat variety PBW-658 may be grown for higher productivity and be fertilized with 180 kg ha^{-1} of nitrogen in agro climatic condition of Punjab.

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