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Effect of nitrogen on the yield and seed quality of wheat crop under mid hill conditions of Himachal Pradesh

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ABSTRACT
Wheat (Triticum aestivum L.) is one of the most important cultivating crop of Himachal Pradesh during winter season in low and mid hills of the State. A well-balanced supply of NPK is essential for high yield and quality seed production. A field and laboratory investigation was undertaken to study the effect of different levels of nitrogen on different quality parameters of seed. The experiment with four nitrogen levels (100, 120, 140 and 160 kg/ha) was conducted during Rabi 2016 at the experimental farm of department of Seed Science and Technology. The observations recorded revealed that different levels of nitrogen resulted in significantly more plant height, leaf area index, number of spikes/m², spike length, number of spikelets per spike, number of grains per spike, biological yield, seed yield, seed recovery percentage and vigor index. No significant effect of different levels of nitrogen and phosphorus on harvest index, 1000 seed weight and germination percentage was observed. The highest seed yield was recorded with 160 kg N/ha which was statistically similar to that produced by 140 kg N/ha. These results indicated that nitrogen 140 kg/ha were appropriate for obtaining higher yield under the mid hill conditions of Himachal Pradesh.
Keywords: *Wheat, nitrogen, mid-hill, seed.*

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INTRODUCTION
Wheat (*Triticum aestivum* L.) is the most important food crop of the world and commonly known as king of cereals. It ranks first among the cereals. It is an important staple food of nearly three fourth population of India. Besides being a carbohydrate rich food (65-70% carbohydrates), wheat contain valuable protein (13-15% protein), minerals and vitamins. Much of the wheat used for livestock and poultry feed is byproduct of the flour milling industry. Industrial uses of wheat grain include starch for paste, alcohol, oil and gluten. Wheat occupies about 30 per cent of the world cropping area [6]. It is most important crop during winter season in Himachal Pradesh and is grown on an area of 371.06 thousand hectares with a production of 667.62 thousand tones in the state. The average yield of wheat in Himachal Pradesh is 15.30 q/ha [4].
The seed yield of wheat is quite low in Himachal Pradesh as compared to neighboring states of Punjab and Haryana. From seed production point of view, wheat is high volume and low profit crop. Besides the quantity, its quality is also important. Therefore, it is important to combine the high seed yields with better quality to meet the twin challenges of nutritionally superior and high quality wheat products [16-19]. Both environmental effects and the agricultural practices affect the quality of seed. Therefore, the best production practices needs to be followed to produce good quality seed. Input requirements of wheat for seed

production are supposed to be different from those recommended for grain production, as it need higher amount of inputs for production of quality seed. Numerous factors are responsible for low seed yields of wheat. Imbalance and improper use of plant nutrients is the major one [4].

Nitrogen is one of the major plant nutrients and is an essential constituent of all living cells. Importance of nitrogen in seed production of wheat is emphasized because it generally occurs in relatively low quantities in soils in the available forms and is used in large quantities. During the last few years, nitrogen consumption has touched new heights. Increase in cropping intensity and introduction of high yielding varieties have caused considerable drain of nitrogen and crops showed a positive response to added nitrogen in the soil [2, 3].

Nitrogen occupies a conspicuous place in a plant metabolism and it also increases the seed yield in cereals. In addition to the formation of proteins, nitrogen is an integral part of chlorophyll, which is the primary absorber of light energy for photosynthesis. An adequate supply of nitrogen is associated with high photosynthetic activity, vigorous vegetative growth and a dark green color and its supply influences the utilization of carbohydrates. Nitrogen is considered an indispensable element for several vital functions in plant life. Increased nitrogen levels result in increased spikes/m^2, spike length, number of spikelets/spike, number of grains/spike, 1000-seed weight and seed yield significantly (Iqtidar et al. 2006). Therefore, judicious use of nitrogenous fertilizers is of prime importance for farm profitability and environmental protection from pollution.

MATERIAL AND METHODS

The experiment was laid out in Randomized Complete Block Design (Factorial) in the field and in Completely Randomized Design in Laboratory at department of Seed Science and Technology, College of Agriculture, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *Rabi* 2016-2017. Sowing was done in a plot having size of 3.45 m x 3.45 m (11.9 m2). Crop was given variable doses of 100, 120, 140 and 160 kg N/ha as per treatments in the form of urea, half of which was applied at sowing as basal application and the remaining half was top dressed at 40 days after sowing. Other agronomic practices are done as recommended by university for Himachal Pradesh. Harvesting was done manually with sickles and crop produce was threshed with the help of a plot thresher.

Details of treatments:

T1: 100 kg nitrogen/ha
T2: 120 kg nitrogen/ha
T3: 140 kg nitrogen/ha
T4: 160 kg nitrogen/ha

Data Collection:

All data were recorded on a plot basis. Plant height, Leaf area index (LAI) at heading stage, Days to 50 per cent heading, Number of tillers, Number of spikes per plant, Spike length, Number of spikelet's, Number of seeds per spike, Harvest index were determined on randomly selected 10 plants per each replication with rejecting border plants. Seeds are harvested manually and threshed to separate seeds from plant, then dried to approximately 8% moisture content, cleaned and weighed (g). Thousand seed weight was measured on a randomly selected sample of 250 counted seeds dried to < 8% moisture content and expressed as grams per 1000 seeds. 1000 seed weight, Germination percentage, Seedling length, Seedling dry weight, Seedling vigor index-I and II ware analysed on freshly harvested seed as per the ISTA guidelines. Four hundred seed from each treatment were taken at random and the test was carried out in four replication having 100 seeds in each replication. Seedling length was measured on selected ten healthy plants on last day of germination test. Later these seedlings are dried in oven at a temperature about 60^0c for 48 hrs for seedling dry weight analysed in milligrams (mg).

Germination was calculated by using the formula:

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds used}} \times 100$$

Speed of germination was calculated by using the formula.

$$\text{Speed of Germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \cdots\cdots\cdots\cdots \frac{X_n - X_{n-1}}{Y_n}$$

Where, X_1, X_2 and X_n are number of seeds germinated on first, second and n^{th} day respectively and Y_1, Y_2 and Y_n are number of days from sowing to first, second and n^{th} count respectively. Speed of germination is measured by top of paper method.

Seedling vigour index-I was calculated as per the formula given by Abdul and Anderson [1].

Seedling vigour index-I = Germination (%) × Seedling length (cm)

Seedling vigour index-II was calculated as per the formula given by Abdul-Baki and Anderson [1].

Seedling vigour index-II = Germination (%) x Seedling dry weight (mg).

Available N (kg/ha) of soil was analysed by using alkaline permanganate method [20].

Statistical analysis:

The statistical analysis for Completely Randomized Design (CRD) and Randomized Complete Block Design (RCBD) was done as per design of the experiment as suggested by Gomez and Gomez [7] using computer software OP Stat.

Result and Discussion:

The data pertaining to the effect of different doses of nitrogen on wheat crop have been presented in table.1. Plant height, number of tillers, days to 50 per cent heading, leaf area index at heading stage, number of spikes per meter row length, spike length, number of spikelets per spike, number of seeds per spike, seed yield and harvest index were significantly higher in the plants receiving nitrogen at 160 kg N/ha which was at par with 140 kg N/ha. It is due to easy and greater availability of nitrogen to the crop plants, which consequently increased the meristametic activity of the plant and improved the plant height. Increasing level of nitrogen from 120 to 150 and to 180 kg/ ha significantly increased the plant height (Mattas et al. 2011). Photosynthetic activity increased with increasing N application which led to profuse vegetative growth. Increasing level of nitrogen from 120 to 150 kg/ ha and 150 to 180 kg/ ha significantly increased the number of tillers per plant [12]. Days to 50 per cent heading maximum for 160 kg N/ha may be due to the fact that, increase in levels of nitrogen leads to excessive vegetative growth and delayed reproductive phase which results in significant increase of 50 percent heading stage. Leaf area index at heading stage maximum could be due to easy and increased availability of nutrients due to which plants are able to absorb nutrients properly and results in more photosynthesis, more transpiration and reduced rate of respiration. Increase in fertilization leads to significant increase in leaf area index of wheat [14]. Plescuta *et al.* [14] recorded that increase in fertilization leads to significant increase in leaf area index of wheat. Kumar *et al.* [11] and Arain *et al.* [4] were reported that plant height, number of tillers per meter row, number of effective tillers, spike length gave the best results by customized application of nitrogen. Increase in spike length with increases in nitrogen levels could be due to more assimilates transfer from flag leaf which increased number of spikelets and ultimately extended the spike (Kumar et al. 2016b). Significant spikelets number increase with increase with nitrogen application by extending panicle length which leads to maximum space for seed accumulation per spike [2, 12].

Table.1: **Effect of different doses of nitrogen on plant parameters**

Nitrogen (kg/ha)	plant height at harvest	No of tillers	Leaf area index (LAI) at heading stage	Days to 50 per cent heading	Number of tillers	Number of spikes	Spike length	Number of spikelets	Number of seeds per spike	Seed yield	Harvest index
100	85.2	48.6	3.5	113.1	48.6	44.8	11.3	15	35.4	25.7	0.38
120	88.9	51.5	4.4	119.9	51.5	46.5	12.1	15.2	37.8	30.6	0.38
140	89.7	53.6	4.8	124.6	53.6	48.5	13.4	15.5	41.1	33.9	0.38
160	90.5	54.2	5.2	127.6	54.2	51	13.8	15.8	43.8	35	0.39
SEm ±	0.44	0.26	0.09	0.82	0.26	0.18	0.04	0.13	0.34	0.24	0.002
CD 5%	1.3	0.8	0.3	2.4	0.8	0.5	0.1	0.4	1	0.7	NS

Highest grain yield was recorded at nitrogen level of 180 kg/ha and this was due to significant improvement in yield contributing characters 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 [12, 15]. Harvest index (%) expresses the physiological ability of plants to change the fraction of photo-assimilates to grain yield. Persual of data revealed that different levels of nitrogen had no significant effect on harvest index of wheat. All the given fertilizer levels did not exhibit any significant difference between and among themselves [13].

The data related to 1000 seed weight, germination percentage, seedling length, Seedling dry weight, Vigor index, as affected by nitrogen and phosphorus is presented in Table.2. The increase in thousand grains weight might be due to their genetical make-up. There was significant increase in test weight from zero level to higher doses of fertilizers but non-significant over optimal doses [16]. Different levels of nitrogen had no significant effect on germination percentage of wheat this might be due to the fact that it is only the actual process of the seed coat not the subsequent growth of the root and structure of plant [10]. Seedlings developed from seeds with high nitrogen contents showed increased water absorption and oxygen consumption during germination and produced long and heavier seedlings. Seedling length significantly increased with increased rates of increased doses of nitrogen the highest seedling length were obtained at nitrogen level of 160 kg/ha nitrogen followed by 140 kg/ha nitrogen which was significantly higher from lower doses of nitrogen. Increase in levels of nitrogen and phosphorus levels resulted in significantly higher seedling length and dry weight [8, 9]. The higher vigor index of seed from plants supplied with higher nitrogen rates might be due to more dry matter accumulation in the endosperm of seed which improved the vigor of seed lot. Increase in levels of nitrogen levels resulted in significantly higher seedling length, seedling dry weight and vigor index of wheat [8].

Table.2: **Effect of different doses of nitrogen on seed parameters**

Nitrogen (kg/ha)	Seed recovery percentage	1000 seed weight	Germination percentage	Seedling length	Seedling dry weight	Seedling vigor index-I	Seedling vigor index-II
100	78.6	41.2	94.5	15.1	180	1152	9.2
120	80	42.5	94.8	16.7	185.3	1507	10.2
140	85.6	44	95	18.9	188.1	1628.5	11.3
160	87	46.5	96.1	19.2	189.1	1879.9	12.9
SEm ±	1.03	1.44	1.01	0.11	0.64	32.06	0.12
CD 5%	3	NS	NS	0.3	1.9	94	0.4

Persual of data with respect to uptake of nitrogen revealed that increasing nitrogen levels from 100 to 160 kg/ha increased the nitrogen uptake significantly and the increase being 7.8, 13.3, 17.1 kg/ha with respectively over 100 kg/ha dose of nitrogen. At harvest, the grain nitrogen contents were higher indicated that nitrogen in other parts of wheat transferred to the grain. The uptake of nitrogen by the wheat crop is a function of content of nitrogen and biological yield. Nitrogen fertilizer significantly affected nitrogen removal with grain and straw [19].

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