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Frequency of Various N Levels, Lodging and Seed Quality in Wheat

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Abstract: The study was conducted to determine the frequency of various N levels, lodging and seed quality in wheat, at Malakandher Research Farms, NWFP Agricultural University, Peshawar, during 2000. Statistical analysis of the data revealed that various levels of nitrogen had a significant effect on all parameters except seed vigor. Plots fertilized with 170 kg N ha^{-1} had maximum productive tillers m^{-2}, spikelet $spike^{-1}$, grains $spike^{-1}$, grain yield and harvest index. Whereas minimum biological yield was recorded in plots fertilized with 200 kg N ha^{-1}. Nitrogen levels of 140 kg ha^{-1} significantly increased germination %age and seed size by weight. In case of nitrogen application frequencies, plots applied with nitrogen in 2 split doses i.e., 50 % at seeding time and 50 % at 2^{nd} irrigation significantly increased number of productive tillers m^{-2}, spikelets $spike^{-1}$, grains $spike^{-1}$, grain yield, harvest index, germination % age and seed size by weight. However, nitrogen applied in full at 2^{nd} irrigation recorded maximum biological yield.

Key words: Time of application, N levels, lodging, seed quality, wheat

Introduction

Wheat consumption in Pakistan is going to increase significantly in the next decade and estimated demand in year 2010 is approximately 26.4 million tons. The additional requirement will have to be met by increasing substantially the yield ha^{-1} for which there is an ample scope. The required future target can be achieved either by increasing area under cultivation or maximizing $unit^{-1}$ area. The scope for greater hectarage is limited due to competition with other crops e.g., oil seeds, pulses, sugar and fodder crops. Therefore, major emphasis to be laid on increase $hectare^{-1}$ yield, which can only be achieved when an appropriate production technology is adopted, including use of high yielding varieties, proper level of fertilizer and its time and method of application, weed control etc. Among the several factors responsible for low yield balanced fertilizer and its application time are important limited factors, for obtaining high yield. In order to get better yield, the wheat crop must be planted in rows with proper spacing and application of well-calculated amount of fertilizer.

Piech and Stankowski (1988) reported that the yield increase with higher N rates is mainly due to increase in number of grains $spike^{-1}$. Increasing levels of irrigations and N acted synergistically in increasing grain yields, N uptake and utilization of fertilizer N. Sud and Arora (1990) concluded that increasing N rate increased number of tillers $plants^{-1}$ and ears number m^{-2} but number of grains ear^{-1} and 1000 grain weight were not changed. Late sowing and higher N rates reduced 1000 grain weight, high N rates increased lodging and diseases incidence but also increased protein yield, grain protein and dry gluten content (Mazurek and Kus, 1991).

Keeping in view the importance of N in plant growth and development, the study was carried out to determine the various nitrogen levels and their frequency of application on lodging and seed quality in wheat.

Materials and Methods

Field experiment to study the frequency of various N levels, lodging and seed quality in wheat was conducted at Malakandhar Research farms of NWFP Agricultural University, Peshawar, during 1999-2000. The land was thoroughly prepared as required for wheat sowing. The experiment was laid out in Randomized Complete Block Design (RCB) with split plot arrangement using frequencies in subplot and fertilizers in main plots. Variety Tatara 96 was sown at the rate of 100 $kgha^{-1}$. The following factors and their levels were studied in the experiment.

Nitrogen levels:

N_1 = 110, N_2 = 140, N_3 =170 and N_4 = 200 kg ha^{-1}.

Application frequencies:

F_1 = All fertilizer at seeding time.
F_2 = All fertilizer at second irrigation (50 days after seeding).
F_3 = 50 % at seeding time, 50 % at second irrigation (50 days after seeding).
F_4 = 33.3 % at seeding time, 33.3 5 at second irrigation (50 days after seeding), 33.3 % at boot stage.
F_5 = 25 % at seeding time, 25 % at second irrigation (50 days after seeding), 25 % at boot stage, 25 % after anthesis.

Data were recorded on the Number of productive tillers m^{-2}, number of spikelets $spike^{-1}$, grains $spike^{-1}$, grain yield (kg ha^{-1}), biological yield (kg ha^{-1}), harvest index, germination test (%) of fresh seed, gain size (by weight in gram) and vigor test.

Number of productive tillers m^{-2} were recorded by counting the number of tillers in one meter length area of the three central rows in each subplot and their mean was then calculated. Number of spikelets $spike^{-1}$ was recorded by counting the number of spliklets of 10 labeled spikes in each treatment. For calculating number of grains $spike^{-1}$, five spikes treatment $^{-1}$ were randomly selected in each sub plot and then their grains were counted and divided by 5 to get the average grains $spike^{-1}$. Grain yield, biological yield and harvest index in each subplot was determined and then converted into kg ha^{-1}.

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Grain yield (kg) sub plot}^{-1}}{\text{Area sub plot}^{-1}} \times 10000$$

$$\text{Biological yield (kg ha}^{-1}) = \frac{\text{Biological yield (kg) sub plot}^{-1}}{\text{Area sub plot}^{-1}} \times 10000$$

$$\text{Harvest Index (H.I)} = \frac{\text{Grain yield}}{\text{Biological yield}^{-1}} \times 100$$

The data collected during the experiment was analyzed according to RCB design and upon obtaining significant differences Least Significant Differences (LSD) test was applied (Steel and Torrie, 1980).

Results and Discussion

Levels of nitrogen and application frequencies had a significant ($P \leq 0.05$) effect on productive tillers m^{-2}, while nitrogen levels x application frequencies (NxF) interaction had a non-significant effect (Table 1). Mean values for nitrogen levels showed that productive tillers m^{-2} increased with each increment of nitrogen levels upto 170 kg ha^{-1}, which produced 314.45 tillers m^{-2}, and statistically at par with 200 kg N ha^{-1}. While plots fertilized with 140 and 110 kg N ha^{-1} produced minimum tillers m^{-2}. These results are also confirmed by Ayoub *et al.* (1994), who reported that tillers m^{-2} increased with increasing N rate. In case of application frequencies, maximum of 339.19 tillers m^{-2} were produced by plots applied with nitrogen in 2 split doses (50 % at seeding time and 50 % at second irrigation), while minimum of 290.63 tillers m^{-2} were recorded in plots applied with nitrogen all at seeding time. Bhatti (1983) and Rehman *et al.* (1993) reported

that split application of fertilizer N has been found effective in crop yields with increasing tillers m^{-2} compared with the full application of N fertilizer at sowing time.

Analysis of the data (Table 2) showed that nitrogen levels and application frequencies had a significant ($P \leq 0.05$) affected by number of spikelets $spike^{-1}$. Mean value for nitrogen levels indicated that number of spikelets $spike^{-1}$ was higher (20.52) in plots received 170 kg N ha^{-1}. While minimum number of spikelets $spike^{-1}$ were recorded in those plots, which received 110 kg N ha^{-1}. Spikes taken from plots fertilized with nitrogen in 2 split doses produced significantly higher number of spikelets $spike^{-1}$ while nitrogen applied in full doses at seeding time recorded minimum spikelets. Similar results were also reported by Piech and Stankowski (1988).

Various nitrogen levels and their application frequencies had a significant ($P \leq 0.05$) effect on grains $spike^{-1}$ while NxF interaction had a non significant effect (Table 3). Mean values for nitrogen levels revealed that application of 170 kg N ha^{-1} produced higher 62.65 grains $spike^{-1}$ as compared with plots treated with 110 kg N ha^{-1}, which gave lesser number of 56.60 grains $spike^{-1}$. Mean values for application frequencies showed that N application in 2 doses gave maximum number of 63.06 grains $spike^{-1}$. The lowest number of 56.60 grains $spike^{-1}$ was obtained from first frequency i.e. (all fertilizer at seeding time). These results agree with the findings of Ratthi and Ramsingh (1973), who reported that the application of nitrogen increased grains $spike^{-1}$. Grain yield is one of the most important parameters and the ultimate output of any cereal crop.

Analysis of the data (Table 4) indicated that various nitrogen levels and their application frequencies had a significant ($P \leq 0.05$) effect on grain yield, while the effect of interaction between various nitrogen levels and their application frequencies was non significant. Maximum grain yield of 4644.00 kg ha^{-1} was obtained from plots fertilized at 170 kg N ha^{-1}, while minimum of 3740.00 kg ha^{-1} grain yield was produced in plots treated with 110 kg N ha^{-1}. Similar results were also reported by Nass *et al.* (1990) and Ayoub *et al.* (1994), who found that the grain yield increased with increasing nitrogen application. In case of application frequencies, maximum grain yield of 4762.50 kg ha^{-1} was obtained from those plots which received nitrogen in 2 split doses (i.e., 50 % at seeding, and 50 % at second irrigation) while minimum grain yield of 3937.50 kg ha^{-1} was produced by plots applied with nitrogen in full at seeding time. These results agree with those reported by Shah (1997), who concluded that split application of N fertilizer has been found effective in increasing crop yields compared with full application of N fertilizer at seeding time.

Analysis of the data (Table 5) indicated that various nitrogen levels and their application frequencies had a significant effect ($P \leq 0.05$) on biological yield, while non significant response was observed due to interaction between nitrogen levels and their application frequencies. Highest biological yield of 17799.30 kg ha^{-1} was obtained from plots fertilized at the rate of 200 kg N ha^{-1}, while the lowest biological yield of 15254.70 kg ha^{-1} was obtained from those plots, which were treated at the rate

Table 1: Productive tillers m^{-2} as affected by varying nitrogen levels and their frequency of application in wheat

Frequency of fertilizer application	Nitrogen levels (kg ha^{-1}) 110	140	170	200	Mean
F1	282.75	277.25	297.50	297.00	288.63b
F2	284.25	261.25	315.75	310.25	292.88b
F3	329.00	328.25	349.75	339.00	336.50a
F4	308.75	294.25	310.50	306.75	305.19b
F5	274.75	287.75	298.75	297.75	289.76b
Mean	295.90b	289.85b	314.45a	310.15a	

Mean of the same category followed by different letters are significantly different from one another at 5% level of probability.
LSD Values at 5% for nitrogen levels = 14.23
LSD Values at 5% for frequency of application = 16.96

Table 2: Spikelets $spike^{-1}$ as affected by varying nitrogen levels and their frequency of application in wheat

Frequency of fertilizer application	Nitrogen levels (kg ha^{-1}) 110	140	170	200	Mean
F1	19.30	19.80	20.20	20.05	19.84c
F2	19.47	20.00	20.30	20.20	19.99bc
F3	19.87	20.17	20.95	20.60	20.40a
F4	19.75	19.77	20.50	20.20	20.05bc
F5	20.00	20.10	20.65	20.30	20.27ab
Mean	19.68d	19.97c	20.52a	20.27b	

Mean of the same category followed by different letters are significantly different from one another at 5% level of probability.
LSD Values at 5% for nitrogen levels = 0.1662
LSD Values at 5% for frequency of application = 0.2905

Table 3: Grains $spike^{-1}$ as affected by varying nitrogen levels and their frequency of application in wheat

Frequency of fertilizer application	Nitrogen levels (kg ha^{-1}) 110	140	170	200	Mean
F1	54.00	57.00	61.00	60.00	58.00c
F2	56.00	58.00	59.00	60.00	58.38c
F3	59.00	61.00	66.75	65.00	63.06a
F4	55.00	58.00	63.00	61.00	59.25bc
F5	59.00	60.00	63.00	61.00	60.75b
Mean	56.60c	58.90b	62.65a	61.40b	

Mean of the same category followed by different letters are significantly different from one another at 5% level of probability.
LSD Values at 5% for nitrogen levels = 1.943
LSD Values at 5% for frequency of application = 1.734

Table 4: Grain yield (kg ha^{-1}) as affected by varying nitrogen levels and their frequency of application in wheat

Frequency of fertilizer application	Nitrogen levels (kg ha^{-1}) 110	140	170	200	Mean
F1	3525.00	3700.00	4300.00	4225.00	3937.50c
F2	3750.00	3900.00	4500.00	4300.00	4112.50c
F3	4125.00	4600.00	5325.00	5000.00	4762.5a
F4	3700.00	4850.00	4750.00	4325.00	4406.25b
F5	3600.00	4000.00	4345.00	4123.75	4017.19c
Mean	3740.00c	4210.00b	4644.00a	4394.75b	

Mean of the same category followed by different letters are significantly different from one another at 5% level of probability
LSD Values at 5% for nitrogen levels = 247.70 LSD Values at 5% for frequency of application = 252.10

Table 5: Biological yield (kg ha^{-1}) as affected by varying nitrogen levels and their frequency of application in wheat

Frequency of fertilizer application	Nitrogen levels (kg ha^{-1}) 110	140	170	200	Mean
F1	14291.50	15666.00	16358.00	17500.00	15953.88bc
F2	16666.00	17333.25	18333.00	19666.00	17999.56a
F3	14500.00	15333.00	15500.00	17500.00	15708.25c
F4	15666.00	16000.00	16500.00	17330.00	16374.13b
F5	15150.00	16000.00	16333.00	17000.00	16120.75bc
Mean	15254.70d	16066.45c	16604.80d	17799.30a	

Mean of the same category followed by different letters are significantly different from one another at 5% level of probability using LSD test
LSD Values at 5% for nitrogen levels = 376.10 LSD Values at 5% for nitrogen levels = 376.10

Table 6: Harvest index (%)as affected by varying nitrogen levels and their frequency of application in wheat

Frequency of fertilizer application	Nitrogen levels (kg ha^{-1}) 110	140	170	200	Mean
F1	24.85	23.83	26.32	21.90	24.79c
F2	22.52	22.56	24.64	28.55	22.88d
F3	28.50	30.39	34.34	24.95	30.37a
F4	23.65	30.31	28.82	24.95	26.93b
F5	23.74	25.02	24.18	24.25	24.91c
Mean	24.65c	26.36b	28.13a	24.76c	

Mean of the same category followed by different letters are significantly different from one another at 5% level of probability.
LSD Values at 5% for nitrogen levels = 1.392
LSD Values at 5% for frequency of application = 1.823

Table 7: Germination % age as affected by varying nitrogen levels and their frequency of application in wheat

Frequency of fertilizer application	Nitrogen levels (kg ha^{-1}) 110	140	170	200	Mean
F1	87.00	90.00	85.00	81.00	85.75b
F2	86.00	88.75	83.00	82.00	84.94b
F3	89.00	90.00	87.00	83.00	87.75a
F4	87.00	90.00	84.00	81.00	85.50b
F5	86.00	89.00	84.00	81.00	85.00b
Mean	87.00b	89.95a	84.60c	81.60d	

Mean of the same category followed by different letters are significantly different from one another at 5% level of probability.
LSD Values at 5% for nitrogen levels = 1.264
LSD Values at 5% for frequency of application = 1.190

Table 8: Grain size (mg) as affected by varying nitrogen levels and their frequency of application in wheat

Frequency of fertilizer application	Nitrogen levels (kg ha^{-1}) 110	140	170	200	Mean
F1	237.00	245.00	230.00	215.00	231.80ab
F2	228.00	239.00	215.00	208.00	222.70c
F3	240.00	248.00	236.00	223.00	236.80a
F4	235.00	246.00	227.00	217.00	231.30ab
F5	234.00	243.00	223.00	213.00	228.30bc
Mean	234.80ab	244.30a	226.20bc	215.30c	

Mean of the same category followed by different letters are significantly different from one another at 5% level of probability.
LSD Values at 5% for nitrogen levels = 11.46
LSD Values at 5% for frequency of application = 5.601

Table 9: Seed vigor (Seedlings dry weight, mg) as affected by varying nitrogen levels and their frequency of application in wheat

Frequency of fertilizer application	Nitrogen levels (kg ha^{-1}) 110	140	170	200	Mean (NS)
F1	14.86	15.79	14.69	15.68	15.25
F2	15.61	15.48	15.28	14.98	15.34
F3	15.48	15.38	14.93	15.13	15.23
F4	14.82	15.32	14.76	14.96	14.97
F5	15.09	15.54	15.81	15.46	15.47
Mean (NS)	15.17	15.50	15.09	15.24	

NS = Non significant.

F_1 = All fertilizer at seeding time.
F_2 = All fertilizer at second irrigation (50 days after seeding).
F_3 = 50 % at seeding time, 50 % at second irrigation (50 days after seeding).
F_4 = 33.3 5 at seeding time, 33.3 5 at second irrigation (50 days after seeding), 33.3 % at boot stage.
F_5 = 25 % at seeding time, 25 % at second irrigation (50 days after seeding), 25 % at boot stage, 25 % after anthesis.

of 100 kg N ha^{-1}. Mean values for application frequencies revealed that all fertilizer at second irrigation (i.e., 50 days after seeding) gave higher biological yield of 17999.56 kg ha^{-1}. The lowest biological yield of 15708.25 kg ha^{-1} was obtained from plots treated with N at 50% at seeding, 50% at second irrigation. Similar results were also reported by Graham *et al.* (1983), who revealed that grain yield and straw yield were increased with increase in nitrogen levels. Harvest index was significantly ($P \leq 0.05$) different due to various nitrogen levels, their application frequencies whereas NxF (interaction) showed a non significant effect.

Plots treated with highest doses of N i.e., 170 kg ha^{-1} had high harvest index (28.13%), followed by nitrogen levels of 110 kg ha^{-1}) with a harvest index value of 24.65% (Table 6). In case of application frequencies highest harvest index value of 30.37% was recorded in treatments applied with nitrogen in 2 split doses (i.e., 50 % at seeding and 50 % at second irrigation), while lowest harvest index (22.88 %) was recorded in treatments applied with full dose of N at 2nd irrigation. Percent germination was significantly ($P \leq 0.05$) affected by N levels and application frequencies, whereas interaction was non significant. The data (Table 7) showed that highest germination (89.95 %) was observed in plots applied with nitrogen at the rate of 140 kg ha^{-1}, whereas minimum germination (81.60 %) was recorded in plots applied with nitrogen at the rate of 200 kg ha^{-1}. In case of application frequencies maximum germination percentage (87.75) was recorded for F_3 i.e., (50 % at seeding and 50 % at second irrigation).

Data (Table 8) revealed that grain size was significantly ($P \leq 0.05$) affected by nitrogen levels and application frequencies, while their interaction was non significant. Mean values for nitrogen levels indicated that maximum grade recovery of 244.30 kg ha^{-1} (which revealed 81.40% bigger and 18.60 % smaller seed size) was obtained from 140 kg N ha^{-1}, while minimum of 215.30 kg ha^{-1} (which revealed 71.80% bigger and 28.20% smaller seed size) was recorded in plots received 200 kg N ha^{-1}. In case of application frequencies maximum grade recovery of 236.80 kg ha^{-1} (which revealed 78.90 % bigger and 21.10 % smaller seed size) was recorded in those treatments applied with nitrogen in 2 split doses (i.e., 50% at seeding and 50% at second irrigation) while lowest seed grade recovery 222.70 kg ha^{-1} (which revealed 74.20 % bigger and 25.80% smaller seed size) was recorded in those treatments applied with nitrogen all at second irrigation. Statistical analysis of the data (Table 9) showed that nitrogen levels, their application frequencies and also NxF interaction did not significantly affect seed vigor.

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