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Effect of nitrogen management and plant growth regulators on growth attributes of wheat (*Triticum aestivum* L.)

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Abstract
The present investigation was conducted with the aim to know the effect of nitrogen management through organic and in-organic sources and plant growth regulators on the growth and development of the wheat cultivar HD-2968. The present study was conducted in the split plot design the treatments consist of four nutrient management, absolute control, RDF (Recommended dose of fertilizer) 150:60:40, 150% RDF. (225:90:60), 150% RDF+15 t FYM ha^{-1} in main plots and four plant growth regulators, control-two sprays of water (400 lit water ha^{-1}) at first node and flag leaf stages. two spray of Chlormequat chloride (CCC) (Lihocin @ 0.2% (800 ml ha^{-1}) of commercial product dose at First node (Around 45 DAS) and flag leaf (Around 80 DAS) using 400 lit water ha^{-1}. two sprays of Tebuconazole (Folicur 430sc) @ 0.1% at (400 ml ha^{-1}) First Node and Flag leaf with 400 lit water ha^{-1}. two spray combined application of Lihocin + Folicar in sub-plots. The application of nitrogen levels and plant growth regulators significantly influenced the plant height, number of tillers, leaf area index and dry matter accumulation at all the stages except at 30 days after sowing during both the years.

Keywords: Wheat, nitrogen, growth attributes and plant growth regulators

Introduction
Wheat (*Triticum aestivum* L.) belongs to family Poaceae, is the first important and strategic cereal crop for the majority of world population. It is the most important staple food of about two billion people (36.00% of the world population) worldwide. It provides nearly 55% of the carbohydrates and 20.00% of the food calories consumed globally and straw is a good source of feed for a large population of cattle in our country. It exceeds in acreage and production every other grain crop (including rice, maize, etc) and therefore, the most important cereal grain crop of the world, which is cultivated over a wide range of climatic conditions.
Among the different management practices, role of macro nutrients is crucial in crop nutrition for achieving higher yields (Raun & Johnson, 1999) [9]. The soils of India are deficient in nitrogen and are supplemented with chemical fertilizer for enhancing the crop productivity. Nitrogenous fertilizers play a vital role in modern farm technology, however only 20-50% of the soil applied nitrogen is recovered by the annual crops (Bajwa, 1992) [2]. The leftover nitrogen is lost from the soil system through denitrification, volatilization and leaching.
Efficient nitrogen (N) fertilization is crucial for economic wheat production and the protection of ground and surface waters (Alley *et al*., 1999) [1]. Nitrogen fertilizer rate and timing are the major tools available after planting for manipulating wheat growth and development to produce a greater grain yield per unit area (Simons 1982., Alley *et al*., 1999) [11, 1] and such as intensive management systems is to increase N fertilizer rates and control lodging with PGRs

ultimately to increase grain yields (Knapp and Harms, 1988., Van Sanford *et al*., 1989., Tripathi *et al*., 2003) [8, 14, 13].

The qualities of grain yield are influenced by fertilization treatment, environmental factors and by the genetic predispositions of a particular variety. It is commonly known that fertilization, especially nitrogen fertilization, has a fundamental position in the attainment of high yields and high quality grain. Nitrogen positively influences the leaf area and its chlorophyll concentration, thereby inducing crude protein content and the rheological properties of dough (Blandino and Rezneri, 2009) [4] and several field experiments showed that in winter wheat the number of spikes per unit area generally increases as the N rate increases while mean kernel weight usually declines (Batey and Reynish, 1976., Knapp and Harms, 1988., Alley *et al*. 1999) [3, 8, 1].

Materials and Methods

The present study was conducted in the split plot design the treatments consist of four nutrient management, absolute control, RDF (Recommended dose of fertilizer). 150:60:40, 150% RDF.(225:90:60), 150% RDF+15 t FYM ha^{-1} in main plots and four plant growth regulators, control- two sprays of water (400 lit water ha^{-1}) at first node and flag leaf stages. two spray of Chlormequat chloride (CCC) (Lihocin @ 0.2% (800 ml ha^{-1}) of commercial product dose at First node (Around 45 DAS) and flag leaf (Around 80 DAS) using 400 lit water ha^{-1}. two sprays of Tebuconazole (Folicur 430 sc) @ 0.1% at (400 ml ha^{-1}) First Node and Flag leaf with 400 lit water ha^{-1}. two spray combined application of Lihocin + Folicar in sub-plots. The treatments were replicated thrice.

Table 1: Effect of nutrient management and plant growth regulators on stand count

Treatments	Stand count at 15 DAS	
	2016-17	**2017-18**
(A) Nitrogen levels (kg ha^{-1})		
1. Absolute control.	174.00	168.50
2. RDF (150:60:40)	176.50	170.00
3. 150% RDF.(225:90:60)	173.17	167.25
4. 150% RDF + 15 t FYM ha^{-1}.	177.67	169.67
S.Em±	2.057	2.466
CD (P=0.05)	NS	NS
(B) Plant growth regulatores		
1. Control- two spray of water	175.83	168.08
2. Two spray of Lihocin @ 0.2%	177.50	172.17
3. Two sprays of Folicur @ 0.1%	173.00	165.42
4. Two spray of Lihocin + Folicur.	175.00	169.75
S.Em±	1.757	2.017
CD (P=0.05)	NS	NS

Table 2: Effect of nutrient management and plant growth regulators on plant height at various growth stages of the crop

Treatments	Plant height (cm)							
	30 DAS		60 DAS		90 DAS		At harvest	
(A) Nitrogen levels (kg ha^{-1})	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
1. Absolute control.	22.69	24.67	61.76	61.52	69.40	69.50	71.54	71.65
2. RDF (150:60:40)	22.97	24.97	75.88	77.88	85.25	87.12	87.89	89.73
3. 150% RDF.(225:90:60)	23.38	25.42	77.01	78.32	86.52	87.44	89.20	90.12
4. 150% RDF + 15 t FYM ha^{-1}	23.43	25.47	77.88	78.50	87.50	88.21	90.21	91.73
S.Em±	0.167	0.181	1.380	1.312	1.550	1.198	1.598	1.362
CD (P=0.05)	NS	NS	4.775	4.541	5.365	4.144	5.531	4.713
(B) Plant growth regulatores								
1. Control- two spray of water	23.03	25.03	76.32	77.15	85.75	86.92	88.40	89.95
2. Two spray of Lihocin @ 0.2%	23.05	25.05	72.02	72.51	80.92	81.09	83.43	83.60
3. Two sprays of Folicur @ 0.1%	23.29	25.32	74.90	76.24	84.16	84.87	86.76	87.83
4. Two spray of Lihocin + Folicur	23.11	25.12	69.29	70.33	77.85	79.39	80.26	81.85
S.Em±	0.108	0.117	1.188	1.232	1.335	1.347	1.376	1.618
CD (P=0.05)	NS	NS	3.467	3.596	3.896	3.931	4.016	4.723

Table 3: Effect of nutrient management and plant growth regulators on tillers at various growth stages of the crop

Treatments	Number of tillers (m^{-2})							
	30 DAS		60 DAS		90 DAS		At harvest	
(A) Nitrogen levels (kg ha^{-1})	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
1. Absolute control.	177.48	171.87	226.16	214.21	238.06	225.48	242.92	230.08
2. RDF (150:60:40)	180.03	173.40	341.79	361.08	359.78	380.08	367.13	387.84
3. 150% RDF.(225:90:60)	180.05	173.60	373.56	384.55	382.69	404.79	390.50	413.05
4. 150% RDF + 15 t FYM ha^{-1}.	181.22	173.06	409.64	445.06	431.20	468.48	440.00	478.04
S.Em±	2.098	2.515	5.697	4.480	5.997	4.716	6.119	4.812
CD (P=0.05)	7.261	8.704	19.714	15.502	20.752	16.318	21.175	16.651
(B) Plant growth regulators								
1. Control-two spray of water	179.35	171.45	294.43	328.31	309.93	345.59	316.25	352.64
2. Two spray of Lihocin @ 0.2%	181.05	175.61	347.77	357.92	366.07	376.76	373.54	384.45
3. Two sprays of Folicur @ 0.1%	177.83	171.73	352.77	347.17	350.35	365.44	357.50	372.90
4. Two spray of Lihocin + Folicur.	178.50	173.15	371.12	371.49	385.39	391.04	393.25	399.03
S.Em±	1.792	2.057	4.903	3.470	5.161	3.653	5.266	3.727
CD (P=0.05)	5.230	6.005	14.309	10.129	15.063	10.662	15.370	10.879

Table 4: Effect of nutrient management and plant growth regulators on Leaf area Index at various growth stages of the crop

Treatments	Leaf area Index					
	30 DAS		60 DAS		90 DAS	
(A) Nitrogen levels (kg ha^{-1})	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
1. Absolute control.	1.19	1.31	2.48	2.35	2.76	2.61
2. RDF (150:60:40)	1.46	1.62	3.75	3.97	4.17	4.41
3. 150% RDF.(225:90:60)	1.49	1.63	3.99	4.22	4.44	4.69
4. 150% RDF + 15 t FYM. ha^{-1}	1.51	1.65	4.50	4.89	5.00	5.43
S.Em±	0.027	0.017	0.063	0.049	0.070	0.055
CD (P=0.05)	NS	NS	0.217	0.170	0.241	0.189
(B) Plant growth regulatores						
1. Control- two spray of water	1.47	1.59	3.23	3.61	3.59	4.01
2. Two spray of Lihocin @ 0.2%	1.39	1.54	3.82	3.93	4.24	4.37
3. Two sprays of Folicur @ 0.1%	1.45	1.56	3.66	3.81	4.06	4.24
4. Two spray of Lihocin + Folicur	1.34	1.53	4.02	4.08	4.47	4.53
S.Em±	0.018	0.019	0.054	0.038	0.060	0.042
CD (P=0.05)	NS	NS	0.157	0.111	0.175	0.124

Table 5: Effect of nutrient management and plant growth regulators on dry matter accumulation at various growth stages of the crop

Treatments	Dry Matter Accumulation (gm/m^{-2})							
	30 DAS		60 DAS		90 DAS		At harvest	
(A) Nitrogen levels (kg ha^{-1})	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
1. Absolute control.	58.00	56.17	134.45	208.45	324.08	347.42	383.62	408.73
2. RDF (150:60:40)	58.83	55.67	578.04	595.63	963.40	992.72	1133.41	1167.90
3. 150% RDF.(225:90:60)	59.00	57.00	657.08	661.15	1095.14	1101.92	1288.40	1296.38
4. 150% RDF + 15 t FYM ha^{-1}.	59.22	56.56	762.62	701.68	1271.04	1169.46	1495.34	1375.83
S.Em±	0.686	0.822	10.981	10.655	18.302	17.759	21.532	20.893
CD (P=0.05)	2.373	2.845	38.000	36.873	63.333	61.455	74.510	72.300
(B) Plant growth regulatores								
1. Control-two spray of water	58.61	56.03	508.65	487.12	872.75	811.87	1027.35	955.14
2. Two spray of Lihocin @ 0.2%	59.17	57.39	543.18	569.93	930.29	949.88	1095.05	1117.50
3. Two sprays of Folicur @ 0.1%	58.85	56.39	519.16	509.85	890.26	849.75	1047.95	999.71
4. Two spray of Lihocin + Folicur	58.33	56.58	561.21	600.01	960.36	1000.01	1130.42	1176.48
S.Em±	0.586	0.672	9.582	8.689	15.970	14.482	18.788	17.037
CD (P=0.05)	1.709	1.963	27.968	25.361	46.613	42.269	54.838	49.728

Results and Discussion

The application of nitrogen levels and plant growth regulators significantly influenced the plant height, number of tillers, leaf area index and dry matter accumulation at all the stages except at 30 days after sowing during both the years.

While, stand count at 15 days after sowing did not influenced significantly due to the application of nitrogen levels and plant growth regulators during both the years.

Plant growth is controlled by rate of cell division, their enlargement and by supply of organic and inorganic compounds required for the synthesis of new protoplasm and cell walls. Under nutrient management application of 150% RDF+15 t FYM ha^{-1} recorded maximum plant height, numbers of tillers, leaf area index and dry matter accumulation at all growth stages during both the years. The minimum plant height, numbers of tillers, leaf area index and dry matter accumulation was recorded in control. Increasing the nutrient levels up to 150% RDF+15 t FYM ha^{-1}, resulted taller plants. This was due to demand of photosynthetic product to meet the reproductive requirements at the development stage of the plant. Better vegetative growth nitrogen being an important constitute of protein and it is associated with the activity of every living cell. Thus at higher rate of nitrogen it was observed that plants were taller than lower rates. This might be due to increase in cell size and was finally greater vertical development of plant. The observations are in conformity with the findings of Singh and Ghosh (1995), Sobh *et al.* (2000) [11], Chaturvedi *et al.* (2006) [5] and Tiwari *et al.* (2017) [12].

The effect of growth regulators on height presented in Table indicated that the maximum reduction in plant height was recorded with the application of two spray of Lihocin + Folicur as compare to the control and other growth regulators during both the years. These growth regulators are known to reduce cell division and also cell elongation particularly in the culm of cereal and causes temporary cessation or general decline of gibberellic acid synthesis rather than synthesis of a metabolic preventing stem elongation thereby reducing plant height leaf area index and dry matter accumulation. The earlier researcher Humbries *et al.* (1965) [7] also reported that use of PGR CCC can inhibit the stem elongation in wheat up to 40%. The present results also supported by the findings of Zhang *et al.* (2017) [15].

There was gradually increase in the number of tillers up to 90 days after sowing of the crop. The increase in tiller production was most probably because of greater supply of nitrogen and other nutrients to be used for cell multiplication and enlargement and also for the formation of vitally compounds in the cell sap. Similar findings were also reported by Ghosh (1995), Sobh, *et al.* (2000) [11], Chaturvedi *et al.* (2006) [5] and Tiwari *et al.* (2017) [12].

Leaf area index is the function of total leaf area, number of tillers and total canopy cover. Any factor which increases cell division and cell elongation will increase LAI. The leaf area index of plant increased with increase in nutrients levels up to 90 DAS and maximum leaf area index was produced with 150% RDF+15 t FYM ha^{-1}. The increase in leaf area index with higher nutrient doses is due to more plant height, number of tillers which resulted in more ground surface coverage these results are in conformity with the finding of Patil *et al.* (2003).

The dry matter accumulation is the combined effect of all growth characters *viz*., plant height, number of tillers and number of leaves. The adequate supply of nutrients allowed to the plant tissues to grow large and increase the chlorophyll formation and stimulated rapid rate of photosynthesis activity, consequently the application of 150% RDF+15 t FYM ha^{-1} recorded more dry matter accumulation in comparison to its lower levels. The results are in close conformity with the findings of Tiwari *et al.* (2017) [12].

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