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Response of nitrogen levels and its time of application on yield and economics on wheat (*Triticum aestivum* L.) in eastern U.P.

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ABSTRACT
A field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during Rabi season 2012-13 to study the Response of Nitrogen levels and its time of application on wheat in eastern U.P. Sixteen treatments consisted of four doses of nitrogen (40, 80, 120, and 160 kg N ha^{-1}) and four time of application (100% dose as basal, 1/2 basal + 1/2 after first irrigation, 1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation, 1/3 basal + 1/3 after first irrigation + 1/3 after second irrigation). The experiment was conducted in factorial Randomized Block Design with three replications on silt loam soils having low organic carbon (3.8%), nitrogen (185.0 kg ha^{-1}), medium in phosphorus (15.25 kg ha^{-1}) and potassium (265 kg ha^{-1}). All the yield and economics parameters increased significantly with increasing nitrogen doses up to 160 kg ha^{-1} with time of application 1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation. The yield components like no. of spikes running meter^{-1}, spike length (cm), number of grains spike^{-1}, grain weight spike^{-1}(g), grain yield (q ha^{-1}) and straw yield (q ha^{-1}) were significant higher under 160 kg N ha^{-1} and among the time of application at 1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation, which was significantly superior over rest of the treatments. Harvest index and 1000-grain weight (g) were not influenced significantly due to nitrogen levels and time of application. The maximum net return (Rs.53899 ha^{-1}) and B:C ratio (1.94) were obtained at 160 kg N ha^{-1} with 1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation. Thus it may be concluded that application of 160 kg N ha^{-1} proved suitable dose of nitrogen for exploration of the yield of wheat. The time of application at 1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation, were found most suitable schedule of nitrogen under Eastern U.P for achieving higher yield and economics.

Keywords: Wheat; Nitrogen levels; Time of application; Yield; Economic;

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is a staple food of the world and its belongs to family poaceae. India is one of the main wheat producing and consuming countries in the world. It is the most important food grain crop of the world which ranks next to rice consumed by nearly 35% of the world population. Its acreage of 223.00 million ha with the production of 687 million tonnes. In India total area under wheat is 29.40 million ha with the production of 93.90 million tonnes and productivity of 2.95 tonnes ha^{-1}. It contributes about 34% of the total food grain production of the country (Anonymous, 2011-12). In U.P. it ranks first in respect of crop coverage area 9.25 million ha and production 25.60 million tonnes but the average productivity is much lower (27.90 q ha^{-1}) than Punjab. Wheat crop in our country is grown during the winter season (Rabi). Nitrogen is one of the most essential plant nutrients which plays important role in crop production. Nitrogen utilization efficiency of soil applied nitrogenous fertilizers is very low. The leaching losses and denitrification losses of nitrogen depend upon the type of crop, cultivation practices, soil type, kind of fertilizer, application rate and time of application of fertilizer (Ramus, 1996). The response of nitrogen is not only depends upon its optimum dose but it depends upon the proper method of application of nitrogenous fertilizers. Among the major element nitrogen is most important particularly in our country because most of the Indian soils are deficient the nitrogen. Nitrogen plays a vital role in all living tissue of the plant. Nitrogen plays a vital role in increasing the yield of the crop. Application of proper amount of nitrogen is considered as key to obtain bumper crop of wheat. High nitrogen supply favours the conversion of carbohydrates into proteins, which is turn, promotes the formation of protoplasm. To get maximum benefit from the fertilizer it should not only be applied in optimum quantity but it should also be applied at right time. The timely application of nitrogenous fertilizers is considerably increased the NUE. It is now very well established that in most of the crops, the nitrogen should be applied in two or three splits dose considering stage of crop growth.

MATERIALS AND METHODS

The field experiment was conducted at Agronomy Research Farm, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj) Faizabad (U.P.), during *rabi* season of 2012-2013. The experimental site falls under sub-tropical zone in Indogangatic plains and lies between 26.47^0 North latitude, 82.12^0 East longitudes, at an attitude of about 113.0 meter from mean sea level and is subjected to extremes of weather conditions. This region average annual rainfall of around 1200 mm, which is mostly received from July to September with a few showers in winter. The total rainfall during course of experimentation was 17.2 mm. Metrological condition such as the minimum temperature (7.9^{0}C) was recorded in the month of December and January and the maximum (38^{0}C) in the month of April. The highest mean relative humidity (77.9%) was recorded in the month of January. The soil of the experiment site was found silt loam with soil available nitrogen (185.00 kg ha^{-1}), phosphorus (15.25 kg/ha), potassium (265.0 kg/ha) and ph of the soil is 8.1.

The experiment was carried out in factorial Randomized Block Design with three replications and total sixteen treatment combinations viz. four levels of nitrogen (N1-40, N2-80, N3-120, and N4-160 kg N ha^{-1}) and four time of application (T1-100% dose as basal, T2- 1/2 basal + 1/2 after first irrigation, T3-1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation, T4-1/3 basal + 1/3 after first irrigation + 1/3 after second irrigation). The wheat variety PBW-343 was sown on 12 December 2013. Land was ploughed thoroughly by tractor drawn soil turning plough followed by planking to bring the soil to a good soil tilth. Sowing was done with the help of seed drill. The nitrogen was applied as per treatment through urea, however, 60 kg P_2O_5 ha^{-1} through SSP and 40 kg K_2O ha^{-1} through muriate of potash the time of sowing as a basal dose. Five irrigations were given during the critical stages of the plant growth (like crown root initiation, tillering stage, flowering stage, milking stage) beside pre- sowing irrigation. In order to check the weeds one manual weeding was done, at 35 days after sowing. The crop was harvested at proper stage of maturity on 20 April 2013.

Numbers of spikes per running meter were counted before harvesting of crop from marked area of m^{-1} row length from five places and average value was taken. Length of five selected spikes from each plot and averaged out to get the length of single spike. The total number of grains of five selected spikes were counted and averaged to get the number of grains per spike. The number of grains of five selected spikes were measured and averaged to get the grain weight per spike and expressed in grams. One thousand grains from net plot was counted and weighed to get 1000 grains weight (g). After measuring the bundle weight of the harvested produce of each net plot, the grains were separated by threshing. The grains thus obtained were air dried to maintain 12% moisture and grain yield was recorded in kg plot^{-1} which was further multiplied with conversion factor in order to get in q ha^{-1}. The weight of the grains were substrate from the weight of total harvested produce of each net plot to get the straw yield in kg plot^{-1} which was further multiplied with the conversion factor in order to get straw yield in q ha^{-1}. The recovery of the grains in the total harvested produce expressed as harvest index. It was calculated by dividing grain yield by total biomass multiplied by 100. Cost of cultivation for different treatments were worked out by considering all the expense incurred in the cultivation of experimental crop and added with variable cost due to treatments. Gross return was worked out by multiplying the grain and straw yield separately under various treatments to their existing market price. The money value of both grain and straw yield was added together in order to achieve gross return (Rs ha^{-1}). Net return was calculated by deducting the cost of cultivation from the gross return of the individual treatment. Benefit cost ratio was calculated by dividing net return by cost of cultivation. The data recorded on different characters during the course of investigation were subjected to statistical analysis by using the analysis of variance technique for factorial randomized design as suggested by **Panse and Sukhatme (1967).**

RESULTS

The maximum number of spikes per running meter, length of spike, number of grains spike^{-1}**,** number of grains weight spike^{-1} was recorded under 160 Kg N ha^{-1} and among the time of application at 1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation, which was significantly superior over rest of the treatments as compared to rest of the treatments in Table-1. The data revealed that the 1000-grain weight (g) was not influenced significantly by nitrogen levels and time of application. The data revealed that yield increased successively with increased in nitrogen levels 160 kg N ha^{-1}. The yield was recorded significantly higher 41.18 q ha^{-1} under 160 kg N ha^{-1} significantly superior over the rest of the treatments. The lowest yield was recorded 34.25 q ha^{-1} under 40 kg N ha^{-1}. The grain yield of wheat was affected significantly due to different time of nitrogen application. Grain yield of wheat was observed higher 40.13 q ha^{-1} under T_3 Treatment (1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation) as compared to rest of the treatments. The straw yield was recorded significantly higher 53.50 q ha^{-1} under 160 kg N ha^{-1} significant superior over the rest of the treatments. This produced the lowest straw yield (44.43q ha^{-1}) under 40 kg N ha^{-1}. The time of nitrogen application had significant variation on straw yield as it is clear from the data presented in Table 2. Data given in table indicate that straw yield was recorded significantly higher 52.13 q ha^{-1} under T_3 Treatment (1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation) as compared to rest of the other treatments. The lowest straw yield of 47.08 q ha^{-1} was recorded under T_1 treatment. The data regarding the yield, gross return, cost of cultivation, net return and cost benefit ratio have been presented in Table 2. As data clearly revealed that cost of cultivation increased linearly with increasing nitrogen levels from 40 to 160 kg N ha^{-1} in combination to all the treatments. The maximum cost of cultivation (Rs 27723 ha^{-1}) was computed at 160 kg N ha^{-1} with T_3 Treatment (1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation). The maximum gross return (Rs 81622 ha^{-1}) was recorded with the treatment combination where 160 kg N ha^{-1} applied as T_3 Treatment (1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation). The minimum gross return (Rs 61590 ha^{-1}) was obtained under where 40 kg N ha^{-1} was applied as basal. The Highest net return (Rs 53899 ha^{-1}) was found under the treatment combination of 160 kg N ha^{-1} applied as T_3 Treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation). The lowest net return (Rs 35825 ha^{-1}) was obtained under where 40 kg N ha^{-1} was applied as basal. As regards benefit cost ratio, the maximum benefit cost ratio (1.94) was obtained from treatment combination of 160 kg N ha^{-1} applied as T_3 Treatment (1/2 basal + 1/4 after first irrigation + 1/4 after second irrigation). The lowest benefit cost ratio (1.39) was obtained under where 40 kg N ha^{-1} was applied as basal.

DISCUSSION

Wheat proved detrimental to number of ear bearing shoot. The number of ear bearing shoot was lesser than the number of shoots noted at harvest. According to Darwin's law of survival of the fittest (1956), There is competition among the shoots due to which the under developed shoot dies off and were not able to bear the spike. The number of ear bearing shoots running meter^{-1} was affected by various nitrogen levels and its time of application. The maximum ear bearing shoots were recorded under 160 Kg N ha^{-1} in comparison to lower nitrogen levels. This might be due to enhanced tillering, enhanced photosynthetic area, proper nourishment, more dry matter partitioning to sink and increased sink size at 160 Kg N ha^{-1}. Maximum length of spike, no of spikelets spike^{-1}, and test weight were recorded under 160 Kg N ha^{-1} as compared to other treatments. The lowest value of yield attributing characters were obtained under lowest nitrogen levels 40 Kg N ha^{-1} because plant were subjected to utilize the least amount of available nitrogen which resulted into reduced translocation of photosynthates from source of sink and thus led to poor growth and various yield attributes. Similar findings were reported by Singh (1980) Kumar *et al.* (1995), Singh *et al* (1990), Kumar (1985) in case of spike length, Sharma and Singh (1966), Singh *et al*. (1995) in case of no of spikelets spike^{-1} and no of grains spike^{-1} Singh *et al* (1995a) and Singh *et al* (1980) in case of test weight.

Yield attributing characters are the resultant of vegetative growth of the plants. All the attributes viz number of ear bearing shoots running meter^{-1} spike length, number of spikelets spike^{-1} and no of grains spike^{-} and 1000- grains weight were affected significantly due to different time of nitrogen application. Highest value of all the yield attributes except number of spikelet and grain spike^{-1} was recorded in T_3 treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation) as compare to other treatments. This could possibly be due to continuous availability of nitrogen in plant at all the critical stages might have resulted in enhanced photosynthetic activities of leaves which increased the translocation of photosynthates from source of leaves and stem to the sink, leading to highest yield attributes under the T_1 treatment, on the contrary, full dose of N applied as basal gave lower indices of all the yield attributes as the un-availability of nitrogen on later stages after germination under this treatment, has led to the poorer and lowest yield attributes. Similar results were obtained by Agrawal and Moolani (1987) in case of number of ear bearing shoots running meter^{-1} and Agrawal and Moolani (1987) in case of number of spikelet's spike^{-1}.

Different nitrogen levels and its time of application had influences on grain yield. In general average yield of wheat under timely sown condition is poor due to less exploitation of potentialities of the crop. Reduction in yield is caused due to delayed emergence of ear head. Delayed emergence of crop and premature drying due to high temperature and hot desiccating winds during grain filling stage cause the forced maturity of timely sown crop which ultimately results in the heavy reduction in whole biomass.

The yield was recorded significantly higher under 160 Kg N ha^{-1} as compared to other treatments. This might be due to adequate nitrogen availability which contributed to increase dry matter accumulation. Productivity of a crop is collectively determined by vigour of the vegetative growth, development as well as yield attributes which is the result of better translocation of photosynthates from source of leaves and stem of the grains. Better vegetative growth coupled with higher yield attributes resulted into higher grain yield as 160 Kg N ha^{-1}. Dhuka *et al (*1992*)* Singh *et al* (1995) Grain yield of wheat was significantly influenced by various time of nitrogen application. Highest yield was obtained under T_3 treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation).The increase in grain yield under this treatment was mainly due to production of more number of effective shoots running meter^{-1} which had direct bearing on the production of grain yield as the result of favourable growth and development through efficient assimilation and utilization of available nitrogen by the growing plants during the entire grand growth period. Growth in vegetative phase and development in reproductive phase determines the yield. Thus yield is the function of complex inter relation of various yield components which is determined from the growth in vegetative phase and from its subsequent reflection in reproductive phase and hence productivity of a crop determined collectively by vigor of the yield attributes and plant population per unit area. The lowest yield were recorded under the T_1 treatment, (full dose of N applied as basal) which was possibly due to reduced translocation of carbohydrates from source leaves and stem of sink, similar findings were reported by singh and singh (1991) Dhuka *et al* (1992).

Straw yield was influenced significantly by rates and time of nitrogen application. Maximum straw yield was recorded under160 Kg N ha^{-1}. This may be probably due to higher density of tiller and increased rate of dry matter production. Similar finding were reported by Dhuka *et al* (1992). Straw yield was also noted higher under T_3 treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation) which was mainly due to more dry matter accumulation per unit area as a result of better performance of vegetative growth caused due to efficient assimilation and absorption of nitrogen from the soil during entire period of growth, unlike the lowest straw yield was recorded in the T_1 treatment, (full dose of N applied as basal). The lowest yield in the T_1 treatment may be due to reduced translocation of carbohydrates from source leaves and stem of sink, which ultimately resulted into poor dry matter accumulation. Similar finding were reported by singh and Singh (1991) Dhuka *et al* (1992).

Harvest index of wheat was not affected significantly due to different nitrogen levels and time of nitrogen application. However the performance was better in T_3 treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation).

The highest gross return of Rs 81,622 was obtained in N_4T_3 treatment under 160 Kg N ha^{-1} which was applied as T_3 treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation) as compared to other treatments. Which may be due to maximum grain and straw yield. The lowest gross return Rs 61,590 ha^{-1} was recorded in N_1T_1 treatment due to lowest yields, where 40 Kg N ha^{-1} was applied as basal. Maximum cost of cultivation Rs. 27,722 ha^{-1} was recorded under N_4T_3 as compared to other treatment. Highest net return of Rs 53,899 ha^{-1} was recorded under N_4T_3 fallowed by other treatments. The lowest net return of Rs.35825 ha^{-1} was recorded in N_1T_1 treatment due to lowest gross return.

Maximum benefit cost ratio Rs. 1.94 was obtained in N_4T_3 treatment, where 160 Kg N ha^{-1} was applied ½ basal +1/4 after first irrigation +1/4 after second irrigation fallowed

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Table-1 Response of nitrogen levels and its time of application on yield attributes on wheat (*Triticum aestivum* L.) in eastern U.P.

Treatments	Number of spikes per running meter	Spike length (cm)$^{-1}$	Number of grains spike^{-1}	Grain weight spike^{-1}	1000-grain weight	Grain Yield (q/ha^{-1})	Straw Yield (q/ha^{-1})
Nitrogen levels (kg ha^{-1})							
40	84.20	8.40	36.03	1.49	41.30	34.25	44.43
80	91.72	9.26	39.19	1.64	41.58	37.33	48.40
120	97.34	9.95	41.59	1.75	42.13	38.05	50.10
160	98.84	10.39	43.20	1.83	42.25	41.18	53.50
SEm±	2.077	0.192	0.823	0.032	0.859	0.787	1.017
CD (P=0.05)	5.998	0.555	2.378	0.093	NS	2.273	2.937
Time of application							
T1	87.58	8.94	37.99	1.58	41.50	36.28	47.08
T2	89.51	9.16	38.81	1.63	41.88	37.04	48.30
T3	99.92	10.06	42.01	1.77	42.13	40.13	52.13
T4	95.10	9.84	41.19	1.73	42.06	37.36	48.93
SEm±	2.077	0.192	0.823	0.032	0.859	0.787	1.017
CD (P=0.05)	5.998	0.555	2.378	0.093	NS	2.273	2.937

Note- Time of application (T1-100% dose as basal, T2- ½ basal + ½ after first irrigation, T3-½ basal + ¼ after first irrigation +¼ after second irrigation, T4-1/3 basal + 1/3 after first irrigation +1/3 after second irrigation).

Table-2 Economics of various treatment combinations

Treatment combination	Grain yield (qha^{-1})	Straw yield (qha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs.ha^{-1})	Net return (Rs.ha^{-1})	B:C (Rs. rupee^{-1} invested)
N_1T_1	33.00	42.60	25764.63	61590	35825.37	1.39
N_1T_2	33.70	43.80	25864.63	63015	37150.37	1.43
N_1T_3	36.50	47.30	25964.63	68192	42227.37	1.62
N_1T_4	33.80	44.00	25964.63	63230	37265.37	1.43
N_2T_1	35.95	46.40	26350.71	67092	40741.29	1.54
N_2T_2	36.70	47.70	26450.71	68625	42174.29	1.59
N_2T_3	39.70	51.40	26550.71	74155	47604.29	1.79
N_2T_4	36.95	48.10	26550.71	69122	42571.29	1.60
N_3T_1	36.55	48.00	26936.79	68542	41605.21	1.54
N_3T_2	37.35	49.20	27036.79	70102	43065.21	1.59
N_3T_3	40.55	53.00	27136.79	75942	48805.21	1.79
N_3T_4	37.75	50.20	27136.79	71042	43905.21	1.61
N_4T_1	39.60	51.30	27522.87	73980	46457.13	1.68
N_4T_2	40.40	52.50	27622.87	75540	47917.13	1.73
N_4T_3	43.75	56.80	27722.87	81622	53899.13	1.94
N_4T_4	40.95	53.40	27722.87	76642	48919.13	1.76

Note- Nitrogen levels (N1-40, N2-80, N3-120, and N4-160 kg N ha^{-1}) and time of application (T1-100% dose as basal, T2- ½ basal + ½ after first irrigation, T3-½ basal + ¼ after first irrigation +¼ after second irrigation, T4-1/3 basal + 1/3 after first irrigation +1/3 after second irrigation).

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