Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [2] 2017: 296-301
©2017 Academy for Environment and Life Sciences, India
Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

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

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ABSTRACT
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. . 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.
Keywords: *Wheat; Nitrogen levels; Time of application; Growth; Yield*

Received 25.07.2017 Revised 13.08.2017 Accepted 26.08.2017

INTRODUCTION

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}. 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 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.

METHODOLOGY

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 (7.9^0C) was recorded in the month of December and January and the maximum (38^0C) 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), 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 treatments 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- 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). 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 at the time of sowing as a basal dose. Five irrigations were given during the critical stage 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.

The germinated plants in one meter row length were counted randomly after 15 days of seedling. The average was taken and finally plant population was expressed in per running meter. Five plants were selected randomly in each plot and tagged for measuring height at different intervals. Height was measured at 30, 60, 90 DAS and at harvest stage with the help of meter scale from ground surface to the tip of the top most leaf before heading and up to the base of ear head after heading. The number of shoots were counted per meter row length from three places selected randomly in each plot at 30, 60, 90 DAS and at harvested stage. Then average value was worked out. The leaf area was measured at 30, 60, 90 DAS stage to calculated the leaf area index. The plants of 0.25 m row length were taken and green leaves were separated to record their surface area by automatic leaf area meter. All the leaves were grouped into three viz. small, medium and large. Five leaves from each group were taken and their surface area was measured. 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).

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RESULT AND DISCUSSION

Maximum plant height, shoots running meter^{-1}, leaf area index, dry matter running meter^{-1} in Table-1 and 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-2. There was rapid increased in height of plant from 30 to 90 days after sowing thereafter, increased in height was rather slow. Maximum plant height was recorded under 160 Kg N ha^{-1} at all the crop growth stage, which was mainly due to more availability of nitrogen. Higher nitrogen levels results in higher nitrogen uptake, which could ultimately result into increased protein synthesis, cell division and cell elongation and finally expressed morphologically on increased in height of the plant. Similar findings were reported by Khan *et. al.* (1990) and Kumar *et.al* (1995).

Plant height was affected significantly due to different time of nitrogen application at all stage of growth except 30 DAS. The height was recorded significantly higher in T_3 treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation) as compared to rest of the time of nitrogen application. The taller plant associated with T_3 treatment was due to proper availability of nitrogen throughout the crop growth coinciding with the germination, tillering and ear initiation stages. The maintenance of proper and continuous nitrogen supply to the crop helped in greater root establishment due to increased meristematic activities which contributed to rapid cell division, cell elongation and thus led to taller plant under the treatment. The lowest height at all the stages of crop growth was recorded under T_1 treatment (full dose of N applied as basal) due to poor cell division as the result of poor meristematic activities caused by un-availability of nitrogen at critical stages. The result is in close proximity to those of Seth *et al.* (1981) and Singh and Bajpai (1983).

Maximum numbers of shoots were recorded under 160 Kg N ha^{-1} at 90 days after sowing. This might be due to least plant competition for nutrient caused by sufficient supply of nitrogen which increased by better absorption of nutrient from the soil. Similar result was reported by Singh *et al.* (1980) and Singh *et al.* (1991).At all stages of crop growth the number of shoots running meter^{-1} was recorded significantly higher in T_3 treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation) over rest of the treatments except at 30 DAS. This might perhaps be ascribed to be adequate availability of nitrogen during entire grand growth period of the crop which increased the utilization and absorption of nitrogen by growing plant from the soil as the result of least competition for nitrogen. The lowest numbers of shoots were recorded under the T_1 treatment where full dose of nitrogen was applied as basal. Thereafter, it was fully ignored during the entire grand growth period resulting into lowest number of shoots production. Similar result was reported by Singh and Bajpai (1983).

Leaf area index was affected significantly due to different nitrogen levels and its time of application at all the stages of crop growth except at 30 days stage. Initially leaf area index (LAI) increased very slowly up to 30 days stage of crop growth and after that ushered in a rapid expansion up to 60 days stage. Later declining trend in LAI was observed. Slow increased in LAI at initial stage was due to less time available for growth and development of the plant. Rapid increased up to 60 days stage was possible because of increased rate of light absorption, high photosynthetic activities and increased absorption of nutrient from the soil. The reduction in LAI at 90 DAS were caused possibly due to increased senescence. The leaf area index increase with increase in nitrogen levels and was recorded maximum under 160 Kg N ha^{-1} at all the crop growth stage except 30 days stage. This may be due to increased rate of light absorption, high photosynthetic activities and increased absorption of nutrient from the soil. Leaf area index was affected significantly at all the stage of crop growth due to different time of nitrogen application. It was recorded significantly higher in T_3 treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation) as compared to rest of the treatments. The lowest LAI was recorded under T_1 treatment (full dose of N applied as basal). It was possibly due to the poor plant height, less number of leaves, low rate of light absorption, low photosynthetic activities and low absorption of nutrients from the soil.

Initially the rate of dry matter production in all the treatment was slow but it increased steadily till harvest. Different nitrogen levels had significant affect on dry matter accumulation at all the successive stages of plant growth except 30 DAS. Maximum dry matter accumulation was recorded under 160 Kg N ha^{-1} at all stages. This might be due to higher collective contribution of various growth characters like plant height, number of shoots, leaf area index and leaf of vegetative part. Similar finding were reported by Singh (1980) Hooda and Agrawal (1987). Dry matter accumulation of wheat was affected significantly due to different time of nitrogen application at all the stages of crop growth except 30 DAS. It increased successively till harvest. The rate of increase in dry matter production was slow during initial stage due to slow crop growth but it increased rapidly at later stages up to harvest due to bright sunshine and rise in temperature. Significant higher dry matter accumulation was recorded in T_3 treatment (½ basal +1/4 after first irrigation +1/4 after second irrigation) over rest of the treatments. This might be due to more assimilation and utilization of available nitrogen by the growing plant during the entire grand growth period. As the result of this more dry matter accumulation in root, stem leaves and grains which favoured to increase the dry weight under this treatment. The lowest dry matter was recorded under T_1 treatment (full dose of N applied as basal). This could be mainly due to the fact that growing plant did not achieve sufficient nitrogen at later stages leading to poorer growth of the crop which consequently resulted into lowest dry weight. Similar finding were reported by Seth *et al.* (1981).

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 spikelets 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 followed by other treatments.

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

Treatment	Plant height (cm)	Number of shoots	Leaf area index	Dry matter accumulation (g) running meter^{-1}
Nitrogen levels (kg ha^{-1})				
40	90.480	109.69	4.19	159.35
80	98.00	116.40	4.56	173.45
120	104.00	120.71	4.84	184.30
160	108.00	121.55	5.02	191.35
SEm±	2.224	2.345	0.104	3.868
CD (P=0.05)	6.480	6.772	0.301	11.171
Time of application				
T1	95.00	111.01	3.70	168.20
T2	97.00	113.45	3.78	172.18
T3	105.00	123.15	4.09	186.00
T4	103.00	120.74	4.02	182.08
SEm±	2.224	2.345	0.078	3.868
LSD 5 %	6.480	6.772	0.227	11.171

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).

Table-2 Effect of nitrogen levels and its time of application on yield and 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).

CITATION OF THIS ARTICLE

Yashwant Yadav, B.N. Singh and R.C. Tiwari. Effect of nitrogen levels and its time of application on growth, and yield on wheat (*Triticum aestivum* L.) in eastern U.P. Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue 2, 2017: 296-301