International Journal of Agricultural Sciences
Volume 12 | Issue 1 | January, 2016 | 32-37 e ISSN-0976-5670
DOI:10.15740/HAS/IJAS/12.1/32-37
Visit us : *www.researchjournal.co.in*

RESEARCH PAPER

Effect of split application of nitrogen on performance of wheat (*Triticum aestivum* L.)

R.K. SINGH*, PANKAJ KUMAR, BIRENDRA PRASAD[1], A.K. DAS AND S.B. SINGH
Krishi Vigyan Kendra, KATIHAR (BIHAR) INDIA
(Email : rksbau555@gmail.com.; mantoo555@rediffmail.com)

Abstract : A field experiment was conducted at farmer field of Katihar district during two consecutive years of 2012-13 and 2013-14 to study the yield of wheat as influenced by split application of nitrogen. The soil is non-calcareous light gray in colour flood plain belongs to the alluvial gangetic plain (Agro climatic zone II). The study was done in Randomized Block Design with four treatments and ten replications with HD 2733 wheat variety to evaluate the observation regarding growth attributes and yield components of individual plant parameters were recorded from randomly selected plants in each plot. The evaluated traits were plant population (m^{-2}), plant height (cm), bearing tillers plant^{-1} (no.), non-bearing tillers plant^{-1} (no.), spikelets spike^{-1} (no.), fertile spikelets spike^{-1} (no.) non-fertile spikelets spike^{-1} (no.), 1000-seed weight (g), seed yield (t ha^{-1}) and straw yield (t ha^{-1}). Results indicated that the use of three split N applications increased all growth and yield attributes. The best N split strategy corresponded to three N splits: at planting, crown root initiation (CRI), and panicle initiation (PI) stages.

Key Words : Wheat, Split doses, Nitrogen, Growth, Yield components

View Point Article : Singh, R.K., Kumar, Pankaj, Prasad, Birendra, Das, A.K. and Singh, S.B. (2016). Effect of split application of nitrogen on performance of wheat (*Triticum aestivum* L.). *Internat. J. agric. Sci.*, **12** (1) : 32-37.

Article History : Received : 30.06.2015; **Revised :** 14.11.2015; **Accepted :** 27.11.2015

INTRODUCTION

Wheat is an important crop for the world population and occupies a large cultivated area worldwide. Traditionally, farmers in the Indo-Gangetic Plains of India apply nitrogen uniformly as a blanket recommendation for large regions in wheat growing tracts. Many farmers often use uniform rates of N fertilizers in two times based on expected yields that could be inconsistent from field-to-field and year-to-year depending on factors that are difficult to predict prior to fertilizer application. Also, farmers often apply fertilizer N in doses much higher than the blanket recommendations to ensure high crop yields. Large temporal and field-to-field variability of soil N supply restricts efficient use of N fertilizer when broad based blanket recommendations are used. Under such situations, in season split doses of nitrogen may effectively replace the blanket fertilizer N recommendations for achieving high N-use efficiency. Nitrogen is the most important fertilizer element playing vital role in yield improvement of wheat and the element is frequently reported as deficient in agricultural soils of India (Islam, 1990). Intensive irrigated farming of high-

*** Author for correspondence :**
[1]Regional Research Station, Agwanpur, SAHARSA (BIHAR) INDIA (Email: birendragbau@gmail.com)

yielding varieties (HYV) of cereal crops and the removal of crop residue including the roots causing considerable decline in both organic matter and N content in agricultural soils of India. Generally, the agricultural soils are grossly N deficient and the crop responds to applied N. Crop response to applied N fertilizer depends on soil type, soil fertility, soil and crop management practices, crop variety, and also on the method of N application. In most crops, split application of N reported as beneficial rather than basal application of all N fertilizers. Three split application of N as top dress is a common practice for irrigated rice cultivation in India, but in case of wheat, two-thirds of nitrogen fertilizer applied as basal during final land preparation and rest one-third applied as top dressing at crown root initiation (CR1) stage reported as most efficient in improving grain yield (Razzaque *et al.*, 1980). The maximum use of N fertilizer as basal may cause less NUE thus three split applications of N *viz.*, one- third as basal, one-third as top dressing during 20-25 days after sowing (DAS) and rest one-third as top dressing during 50-55 DAS are recommended for wheat. Much works had been done to optimize N application rate (Malik, 1981; Sarker *et al.*, 1997; Rahman *et al.*, 2000 and Rahman *et al.*, 2002), method of placement and splitting of nitrogen (Razzaque *et al.*, 1980; Prasad *et al.*, 1987; Khan *et al.*, 1990; Ortiz- Monasterio *et al.*, 1994 and Rahman *et al.*, 2002). Fisher *et al.* (1993) reported that split application of N was effective in increasing wheat grain yield and especially grain protein was improved by the late application of N. Rahman *et al.* (2002) reported that N use efficiency of wheat was the maximum when nitrogen fertilizer was applied in three splits rather than two splits or applied as all basal in no-till condition However, still there are controversies in N fertilization to maximize wheat yield and that needed to elucidate for the benefit of wheat production. Therefore, the present study was undertaken to validate existing nitrogen application methods and time in order to optimize the dose of N fertilizer and recommend the most effective method of N application in wheat.

MATERIAL AND METHODS

The experiment was conducted at Farmers field of Katihar district by Krishi Vigyan Kendra, Katihar (Bihar Agricultural University, Sabour, Bhagalpur) during two consecutive years of 2012-13 and 2013-14 to study the yield of wheat as influenced by split application of nitrogen. It lies between Latitude 25'N to 26'N, Longitude 87' to 88'E with an altitude of 20 m above MSL. The climate is sub-tropical and humid having mean maximum and minimum temperature between 46^{0}C and 4^{0}C, respectively and the average annual rainfall of the district is about 1298 mm. The experimental soils are non-calcareous light gray flood plain belongs to the alluvial tract (Agro ecological zone-II) lies between three major rivers Mahananda, Kosi and Ganga. The physio-chemical properties of experimental soil have been presented in Table A. These study included with wheat variety HD 2733 with the following treatments T_1= Farmers practice (60 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 60 kg N at CRI), T_2 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 40 kg N at CRI + 35 kg N at PI), T_3 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 25 kg N at CRI + 25 kg N at PI

Table A: Initial properties of experimental soil

Treatments	pH	ECe	OC	Available nutrients (kg ha^{-1})		
	(1:2.5)	(1:2.5)	(%)	N	P	K
T_1	6.47	0.187	0.35	125.44	23.32	140.43
T_2	6.47	0.182	0.35	128.42	21.45	142.46
T_3	6.48	0.185	0.36	126.54	22.21	144.82
T_4	6.47	0.185	0.37	129.35	21.38	145.28

Table B : Final properties of experimental soil

Treatments	pH	ECe	OC	Available nutrients (kg ha^{-1})		
	(1:2.5)	(1:2.5)	(%)	N	P	K
T_1	6.51	0.242	0.41	165.27	29.52	186.21
T_2	6.55	0.265	0.43	181.36	29.86	224.54
T_3	6.54	0.261	0.42	186.53	32.84	204.36
T_4	6.56	0.264	0.42	205.24	31.34	214.82

+25 kg N at PPI), T_4 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 20 kg N at CRI + 20 kg N at PI +20 kg N at PPI, 15 kg N at Jointing stage). The experiment was laid out in RBD with ten replications. There were altogether 40 unit plots in the experiment. The unit plot size was 4.0m × 2.5m. The land was prepared in early November and fertilizers were applied as per recommendation. All the fertilizers were applied as per treatments dose in each individual plot during the final land preparation and rest nitrogenous fertilizer were applied as per different stages recommended in different treatments. Seeds were sown by hand in 5 cm in the furrows on 18th November 2012 and 25th November 2013 at the rate of 120 kg ha^{-1} at a spacing of 20 cm/ lines. To evaluate the observation regarding growth attributes and yield components of individual plant, parameters were recorded from randomly 5 selected plants in each plot. The evaluated traits were plant population (m^{-2}), plant height (cm) bearing tillers $plant^{-1}$ (no.), non-bearing tillers $plant^{-1}$ (no.), spikelets $spike^{-1}$ (no.), fertile spikelets $spike^{-1}$ (no.) non-fertile spikelets $spike^{-1}$ (no.), 1000-seed weight (g), seed yield (t ha^{-1}) and straw yield (t ha^{-1}).

The soil samples were collected from different farmer field before start the experiment and after final harvest the crop and at each sampling site, soil samples were collected from top soil and finding are presented in Table A and B. The soil texture of the area varies from sandy loam to sandy clay with non-calcarious light gray flood plain belong to alluvial tract. In October 2012 and April 2013 and October 2013 and April 2014, surface soil samples were collected from experimental field. At each sampling point four cores (5.0 cm diameter) were randomly taken within one meter at each other to a depth of 15 cm. About 500 g composite soil samples were obtained after combining at each point. A total of 75 per cent composite soil samples were air dried and pass through 2mm sieve. Organic carbon content was determined by the Walkley and Black method (1934). Available nitrogen was determined by the alkaline $KMNO_4$ method (Subbaiah and Asija, 1956), and available phosphorus (Olsen *et al.*, 1954) and available potash were determined Flamphotometrically method (Tandon, 1993). The pH and ECe were measured in soil suspension (1:2.5) using electrode (Chopra and Kanwar, 1991). The average values of all parameters were statistically analyzed to find out the level of significance using MSTAT-C package programme. The means differences were compared by Dancan's New Multiple Range Test (DMRT) at 5 per cent level of significance.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Plant height :

The data related to plant height at harvesting stage have been presented in Table 1 and Fig 1. It is clear with observations that split applications of nitrogen had significant effect on plant height. The highest plant height (97 cm) was obtained with the treatment combination of T_2 and the lowest plant height (85 cm) was found in T_1. It is possible due to interaction effect of inorganic fertilizers, organic manure with biofertilizers. It is also the effect of split application of nitrogen doses. At every nutrients requirement stages of crop nitrogen was

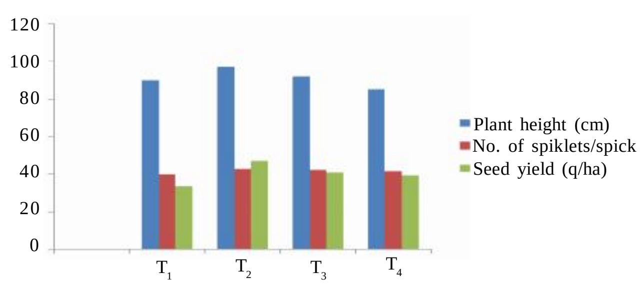

Fig 1: Effect of split application of nitrogen on plant height, number of spiklets and seed yield of wheat

Table 1: Effect of split application of nitrogen on growth attributes of wheat

Treatments	Plant height (cm)	Crop growth rate (CGR) (kg/ha/day)	No. of tiller	No. of bearing tiller	Plant population (bearing/ effective tiller/ seqmt)	No. of spiklets /spick
T_1	90	68.02	11	8	723	40.13
T_2	97	89.64	13	10	896	42.97
T_3	92	75.07	11	9	814	42.21
T_4	85	73.35	11	9	784	41.47
C.D. (P=0.05)	5	2.04	NS	NS	47	1.21

NS=Non-significant

provided with split doses of nitrogen. Due to that nitrogen use efficiency gone to maximum, therefore, crop growth rate increased. These findings are highly in conformity with the findings with Deshmukh *et al*. (1994).

Crop growth rate (kg/ha/day) :

The data pertaining to the crop growth rate kg per ha per day have been presented in Table 1. It is clear from the data that the crop growth rate kg per ha per day continuouly increased (89.64) with growth progressed with T_2 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 40 kg N at CRI + 35 kg N at PI), and the lowest crop growth rate (68.02) was observed by the treatment T_1 (Farmers practice, 60 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 60 kg N at CRI) followed by T_3 (75.07) and T_4 (73.35). These findings are closely to the findings of Rajput and Verma (1994) and Selvaraj *et al*. (1993).

Plant population (Per sq. m) :

The data related to number of total tillers, bearing tiller and plant population per square meter have been presented in Table 1. It is clear from the table that the split application of nitrogen produced a significant difference of plant population per sq. meter at 5 per cent level of significance. The data showed that highest number of plant population per sq. meter (896) was found in the treatment T_2 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 40 kg N at CRI + 35 kg N at PI), and the lowest number of plant population m^{-2} (723) was observed in the treatment T_1 (Farmers practice, 60 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 60 kg N at CRI). It is also apparent from the data that plant population per sq. meter of wheat decreased with the other treatments *i.e.* T_3 (814), T_4 (784). Highest plant population m^{-2} in T_2 was due to higher no of tiller. It is possible due to the effect of variety and split application of nitrogen at requirements stages of growth period was significant for number of total tillers $plant^{-1}$, therefore, the number of plant population is going to be increased. These findings are close conformity with the findings of Gravelle *et al*. (1989).

Spikelets per spike :

Table 1 and Fig. 1 presents that the highest number of spikelets per spike (42.97) was obtained with the treatment T_2 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 40 kg N at CRI + 35 kg N at PI) that was superior to the treatment T_1 (40.13) (Farmers Practice, 60 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 60 kg N at CRI), T_4 and T_3. It is possible due to the optimum application of nitrogen at spike initiation stage. The application of nitrogen at booting stage has contributed more positively. The less spiklets and grain yield produced in treatment T_1 of course may be due to stress of N in this treatment. These findings are partly in agreement with that of Haq (1991).

1000-seed weight :

The data regarding 1000 grains weight are presented in Table 2. It is raveled from the data that 1000 grain weight was substantially affected by nitrogen application at different plant growth stages and all the treated plot produced more 1000 grain weight as compared with T_1 the control. Among the treatments, T_2 gave more 1000 grain weight as compared with the rest of the treatments. This may partially be attributed to available of nitrogen rather latter stage that is booting. The next treatments T_3, and T_4, however, did not differ when compared among themselves. Treatment T_1 was, however, logging behind. It is suggested from the data that application of nitrogen at latter stages of plant growth is necessary for the development of grain. The non-availability of nitrogen at this stage reflected a decrease in grain weight. Similar findings were documented by Pali and Sharma (1992).

Grain yield :

The mean yield of two years indicated that N splitting had the positive effect (Table 2 and Fig. 1). It is revealed from the table that the highest grain yield (47.15

Table 2: Effect of split application of nitrogen on yield attributes of wheat

Treatments	1000 seed weight (g)	seed yield (q/ha)	Straw yield (qt/ha)	Harvesting index (%)	Gross income (Rs.)	Cost of cultivation (Rs.)	B: C ratio
T_1	41.72	33.48	38.23	46.69	55947.92	22677	2.47
T_2	43.89	47.15	49.48	48.79	76603.72	22877	3.35
T_3	43.11	40.94	45.54	47.34	67806.91	23077	2.94
T_4	42.12	39.30	44.26	47.03	65361.23	23277	2.81
C.D. (P=0.05)	1.08	2.14	2.51	0.21	ND	ND	ND

qha^{-1}) was obtained by the application of treatment T_2 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 40 kg N at CRI + 35 kg N at PI). The lowest grain yield (33.48 qha^{-1}) was achieved in the treatment T_1 (Farmers practice, 60 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 60 kg N at CRI) where the splitting of nitrogen was delayed from CRI to PPI. Similarly Deshmukh *et al.* (1994) reported that nitrogen application in three splits at sowing, CRI and jointing (1:2:1) produce higher grain and straw yield than the other splits is in partial conformity with the present study. N splitting had significant positive effect and three split applications gave higher yield over all basal or other split applications. Rahman *et al*. (1999) found that wheat yield was increased with N rate up to 160 kg/ha. In present study under the experimental soil conditions, N application of 150 kg/ha applied as 75 basal, 40kg top dress at CRI stage and 35 kg top dress at first node stage performed the maximum yield for both the years.

Straw yield :

Straw yield varied significantly due to the application of nitrogen in split. From the Table 2 it can be seen that the lowest straw yield (38.23 qha^{-1}) was produced by the treatment T_1 (Farmers Practice, 60 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 60 kg N at CRI) compared to other treatments of split application of nitrogen. The highest straw yield (49.48 qha^{-1}) was produced by the treatment T_2 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 40 kg N at CRI + 35 kg N at PI). These increased straw yield is attributed to the more tillers per unit area. Similar findings were reported by Gill and Sandhu (1963) and Shakir (1970).

Harvest index :

The data related to harvest index have been presented in Table 2. Harvest index showed significantly variation for different split application of nitrogen. The highest value (48.79%) was obtained by the treatment T_2 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 40 kg N at CRI + 35 kg N at PI) and the lowest value (46.68%) was obtained from the treatment T_1. These findings are similar to that of Sadat *et al*. (2008).

Economics :

The gross return showed considerable differences in various treatments. Higher gross income was realized with split application of nitrogen. Three split application of nitrogen with treatment T_2 (75 kg N + 60 kg P_2O_5 + 40 kg K_2O at land preparation + 40 kg N at CRI + 35 kg N at PI) recoded higher B:C ratio (3.35) due to increased gross return. It is possible due to higher number of tillers, grains in per spiklets, test weight ultimately higher total production of wheat compared to other treatments. These finding are closely in confirmation to the findings of Gobi *et al.* (2006).

REFERENCES

Chopra, C.L. and Kanwar, J.S. (1991). *Analytical agricultural chemistry*, Kalyani Publication, NEW DELHI, INDIA.

Deshmukh, S.C., Tahtore, A.S. and Sinha, N.K. (1994). Effect of split application of nitrogen and phosphorus in irrigated wheat. *Crop Res.* (*Hisar*), **8** (3): 493-498.

Fisher, R.A., Howe, G. N. and Ibrahim, Z. (1993). Irrigated spring wheat and timing and amount of nitrogen fertilizer. I. Grain yield and protein content. *Field Crops Res.,* **33**:37-56.

Gill, M.S. and Sandhu, G.R. (1963). Study of some agronomic factors affecting the maximum yield of wheat under Lyallpur conditions West Pakistan. *J.Agric. Res.,* **1**(3):5-11.

Gobi, Ramesh, S., Pandian, B.J., Chandrasekaran, B. and Sampathkumar, T. (2006). Evaluation of crop establishments and split application of N and K on growth, yield attributes, yield and economics of hybrid rice CoRH2. *Asian J. Plant Sci.,* **5** (6): 1022-1026.

Gravelle, W. D., Alley, M. M., Braun, D. E. and Jesepth, K. D. S. (1989). Split sprig nitrogen application effects on yield, lodging and nutrient uptake of soft red winter wheat. *USA J. Prod. Agric.,* **1**(3): 249-256.

Haq (1991). Effect and planting geometry and time of application of nitrogen on growth and yield and late sown wheat. M.Sc. (Hons) Thesis, Department of Agronomy, University of Agriculture, FAISALABAD, PAKISTAN.

Islam, M.S. (1990). Nutrient status of some soils of Bangladesh. In: Proc. International symposium on paddy soil fertility. Bangladesh Agric. Res. Council, Dhaka, (BANGLADESH) .

Khan, R.A., Tomar, S. S., Yadav, N.S., Sharma, R.B., Kushwah, P.S. and Jain, M.P. (1990). Response of wheat to irrigation and nitrogen. *Indian J. Agron.,* **35** (4): 414-416.

Malik, C.V. S. (1981). Response of wheat varieties to different levels of nitrogen. *Indian J. Agron.,* **26** (1): 93-96

Olsen, S.R., Cole, C.V., Watanable, F.S. and Dean, L.A. (1954). Estimation of available phosphorous in soils by extraction with sodium bicarbonate. *U.S. Dept. Agri. Cire*. 939.

Ortiz-Monasterio, I., Sayre, K.D., Pena, J. and Fisher, R.A. (1994). Improving the nitrogen use efficiency of irrigated spring wheat in the Yaqui Valley of Mexico. *Trans. 15th World Congr. Soil Sci.,* **5** (b): 348-349

Pali and Sharma, R.S. (1992). A note on response of semi irrigated dwarf wheat to varying rates and methods of nitrogen application. *Haryana J. Agron.*, **6** (1): 87:88.

Prasad, U.K., Pandey, R.D., Prasad, T. N. and Jah, A.K. (1987). Effect of irrigation and nitrogen on wheat. *Indian J. Agron.*, **32** : 310-313.

Rahman, M.A., Karim, A. J. M. S., Haque, M. M. and Saifuddin, K.M. (1999). Water use, yield and yield component of wheat under irrigation and nitrogen application in terrace soil of Bangladesh. *Ann. Bangladesh. Agric.*, **9**(2): 191-204.

Rahman, M.A., Karim, A. J. M. S., Shaheed, M.A. and Samad, M.A. (2000). A study on the effect of irrigation and nitrigen fertilization on uptake and efficiency of nitrogen in wheat. *Bangladesh. J. Agric. Res.,* **25**(4): 578-583.

Rahman, M.A., Sufian, M.A., Saifuzzaman, M. and Chikushi, J. (2002). Nitrogen management in rice-wheat alternating cropping system and wheat genotype identification preferable to surface seeding condition. *J. Fac. Agric. Kyushu Univ.,* **46**: 295-301.

Rajput, R.L. and Verma, O. P. (1994). Effect of split and modified source of urea on the yield of irrigated wheat. *Indian J. Agron.,* **39** (3): 403-405.

Razzaque, M.A., Hossain, A.B.S. and Hossain, M.A. (1980). Effect of nitrogen rates and their time of application on HYV wheat. *Bangladesh J. Agric. Res.,* **1**: 33-40.

Sadat, M.N., Rahman, M.A., Miah, M.N.A., Ara, M. I. and Al Azad, M.A.K. (2008). Effect of split application of nitrogen on yield and grain protein content of wheat. *B.R.P. J.,* **4** : 285-296.

Sarker, M.A. Z., Miah, M. G., Hamid, A., Haider, J. and Hashem, A. (1997). Effect of nitrogen level and duration of weed competition on weed biomass, yield and yield attributes of wheat. *Ann. Bangladesh Agric.,* **7**(1): 1-7.

Selvaraj, N., Irulappan, I. and Vedamuthu, P.G.B. (1993). Effect of organic and inorganic fertilizers on foliage and bulb characteristics in garlic (*Allium sativum* L.). *South Indian Hort.,* **41**: 350-354.

Shakir, M.Y. (1970). Effect of the time of application of nitrogenous fertilizers on the yield of wheat. *J. Agric. Res*., **8** (4) : 356-359.

Subbaiah, B.V. and Asija, G.L. (1956). A rapid method for the estimation of available nitrogenin soil. *Curr. Sci*., **25**:259-260.

Tandon, H.L.S. (1993). *Methods of analysis of soil, plants, waters and fertilizers*. Fertilizers Development and consultation organization, NEW DELHI, INDIA.

12th Year
★★★★★ of Excellence ★★★★★