The Pharma Innovation Journal 2021; 10(6): 184-190

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(6): 184-190

www.thepharmajournal.com
Received: 12-03-2021
Accepted: 21-05-2021

Nikhil Raghuvanshi
Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya, Uttar Pradesh, India

BN Singh
Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya, Uttar Pradesh, India

Vikash Kumar
Department of Agronomy, Institute Agricultural Sciences., Banaras Hindu University, Varanasi, Uttar Pradesh, India

Corresponding Author:
Nikhil Raghuvanshi
Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya, Uttar Pradesh, India

Study of growth and yield of wheat (*Triticum aestivum* L.) with different sowing method and nitrogen management under the semi-arid region of India

Nikhil Raghuvanshi, BN Singh and Vikash Kumar

Abstract
Among all the agronomical factors, sowing and nitrogen management are the most critical factors for enhancing the growth and yield of any crop. Wheat (*Triticum aestivum* L) is the first essential and strategic cereal crop for most of the world's populations. Wheat (*Triticum aestivum* L.) was planted for two consecutive seasons (2017-18 and 2018-19) in the Semi-arid Land of Agronomical research farm, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya, India. The experiment was obtained in split-plot design and comprised of four sowing methods broadcasting method (Bm), line sowing method (Lm), Furrow Irrigation Ridge Bed (FIRB) and Crisscross (20× 20 cm) (Cc), and five nitrogen managements treatments *viz.,* (N_1) Control, (N_2) 50% N as basal + 25% N after first irrigation + 25% N after second irrigation, (N_3) 50% N as basal + 50% N after first irrigation, (N_4) 25% N as basal + 25% N after second irrigation + 50% through FYM as basal, (N_5) 25% N as basal + 75% through FYM as basal was laid out with three replication on crop growth, seed yield, yield components. Statistical analysis of the obtained data presented that the FIRB and N_2 dominated other treatments for plant growth, yield and another component. Current results suggested that the FIRB sowing method and N_2 can be adopted as the best treatments for wheat cultivation under semi-arid land conditions of India.

Keywords: Growth, yield, nitrogen, sowing method, wheat

Introduction
Wheat is the dominant cereal crop of world commerce and second after rice in India. It is occupying a significant part of the daily diet of millions of people. In India, increasing the productivity of wheat becomes a must to overcome the unusual increase in population. Methods of sowing plays a significant role in providing for the proper space required by the plant for efficient utilization of air, water, solar energy, and nutrients; therefore, the crop yield and quality of the product may be improved to a great extent (Makwana and Tank, 2008) [19]. The sowing method is a significant factor determining crop vigor and yield (Khan *et al.* 2007) [15]. In India, wheat is mainly cultivated by the broadcasting method after rice, other cereals and cash crops. Broadcast sowing methods require higher seed rates and lower plant population due to undulating seed depth and spacing (Korres and Froud, 2002) [16]. Furrow irrigated raised bed (FIRB) is widely used in many countries as an improved productivity system. Due to better crop stand establishment, wheat growth and yield significantly affected by different sowing method. The crop establishment method of sowing is not popular in India.

Low soil fertility, especially nitrogen deficiency, is a significant constraint limiting wheat production in the Indo-Gangetic Plain. The crucial role of nitrogen fertilizer is in the amino compound building that improves the growth and yields wheat (Patel *et al.* 2014) [23]. However, some reports have shown that about 50% of applied nitrogen remains unavailable to a crop due to temporary immobilization in soil organic matter in winter or losses by leaching, erosion nitrification or volatilization (Zafar and Muhammad, 2007) [27]. The vital role of nitrogen in increasing crop production and its dynamic nature and property for nitrogen loss from the soil-plant system make it a unique and challenging environment for efficient management.

Crop responses to nitrogen and plant use efficiency of nitrogen vary with source, rate and timing of nitrogen application in relation to plant development and climatic conditions (Masaka 2006) [21]. Split-application of nitrogen resulted in superior quality attributes than when all nitrogen was applied as basal (Ooro *et al.* 2011) [22].

Therefore, appropriate management of nitrogen fertilizer is essential to ensure better growth and higher wheat production. The design of nitrogen application regimes should combine rate, timing, splitting, and source of the application to optimize growth and wheat yield (Borghi, 2000; Abedi *et al.* 2010) [5, 2]. In the semi-arid region of India, there is no information available about the influence of planting methods and nitrogen management on the growth and yield of wheat crop under late sown condition and their relation with each other. Therefore, the proposed investigation was executed to determine the impact of diverse sowing methods and nitrogen management on the growth and yield of wheat.

Material and Method

Experimental site and weather

The experiment was conducted at the Agronomical research farm of the Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.), during *rabi* seasons of 2017-18 and 2018-19. Ayodhya region falls in the North Indian belt of sub-humid climate and falls in the Indo-Gangetic plains with alluvial soil and lies between latitude 26.47^0 North and at a longitude 82.12^0 East with an elevation of about 113 meters from sea level and is subjected to extremes of weather conditions. During peak summers of May and June, the temperature was around 40 to 45 ^{0}C. The temperature dropped from early November, touching a minimum of less than 5 ^{0}C during December and January. The data on climatic parameters such as rainfall, mean maximum, minimum temperature, relative humidity, sunshine, and wind speed was recorded at the Meteorological Observatory, Meteorology Research Farm, NDUA&T, Kumarganj Ayodhya have been graphically depicted in Fig.1. The total rainfall during the crop growth period in 2017-18 was 9.80 mm, while during 2018-19, it was 43.00 mm. During the crop growth period, the maximum temperature ranged from 20.5 ^{0}C to 39.2 ^{0}C during 2017-18 and from 21.2 ^{0}C to 37.2 ^{0}C during 2018-19. The minimum temperature during 2017-18 ranged from 4.7 ^{0}C to 15.1 ^{0}C, while during 2018-19, it was 5.0 ^{0}C to 22.5 ^{0}C.

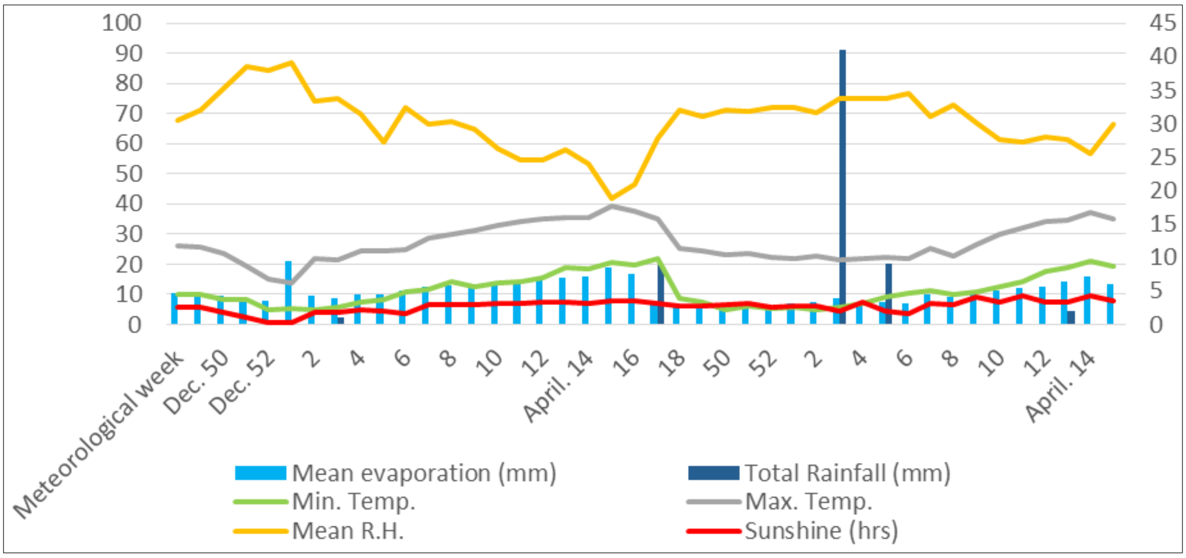

Fig 1: Weather condition of the experimental field

Description of experimental design, treatments, and agrometeorological indices

The field experiment was conducted for two consecutive years, starting from *rabi* season of 2017-18. The experiment was laid out in Split Plot Design (SPD), consisting of 20 treatments. Treatments comprised of all possible combinations of four sowing methods as main plot treatments *viz*. broadcasting method (Bm), line sowing method (Lm), Furrow Irrigation Ridge Bed (FIRB) and Crisscross sowing (20× 20 cm) (Cc) and five nitrogen managements treatments *viz*., (N_1) Control, (N_2) 50% N as basal + 25% N after first irrigation + 25% N after second irrigation, (N_3) 50% N as basal + 50% N after first irrigation, (N_4) 25% N as basal + 25% N after second irrigation + 50% through FYM as basal, (N_5) 25% N as basal + 75% through FYM as basal as subplot treatment was laid out with three replications. Nitrogen was applied as per the treatments by FYM and Urea at the rate of 120 kg ha$^{-1,}$ and other fertilizers were applied at the rate of 60 and 40 kg ha^{-1} of P_2O_5 and K_2O, respectively. Single super phosphate (SSP) and muriate of potash (MOP) were used as phosphorus and potassium sources. All doses of SSP and MOP fertilizers were applied at the time of sowing, and nitrogen applied as per the treatment. Sowing was done in the first week of December in both the years of experimentation. Six irrigations were applied in both the consequent years.

Observations and Methods of Analysis

The observations regarding various growth parameters, nutrient efficiency ratio and nutrient harvest index and yield were recorded as:

Sampling for growth parameters was done at the interval of 30 days, sowing up to maturity from each plot and ten plants selected randomly and plant height (cm), number of tillers (running m^{-1}), Dry matter accumulation (g running m^{-1}), number of leaves per running meter.

Observation calculated by calculation:

Leaf Area Index (LAI) $\frac{Leaf\ Area}{Ground\ Area}$

Leaf Area Ratio (LAR) cm per running meter/g

$$LAR = \frac{Leaf\ area\ per\ running\ meter}{Total\ dry\ matter\ per\ running\ meter}$$

Leaf Area Duration (LAD) $LAD = \frac{LAI1+LAI2}{2} * (t2 - t1)$

Where
LAD = Leaf area duration between t2 and t1
LAI1 = Leaf area at time t1
LAI2 = Leaf area at time t2

Biomass Duration (BMD) (g days) $BMD = \frac{\text{TDM1+TDM2}}{2} * (t2 - t1)$

Where
BMD = Biomass duration between t2 and t1
TDM1 = Total dry matter at time t1
TDM2 = Total dry matter at time t2

Tiller Production Rate (TPR) $TPR = \frac{Tn2-Tn1}{(t2-t1)}$

Where
Tn1 = Numbers of tillers at times t1
Tn2 = Numbers of tillers at times t2

Result and Discussion

Growth Parameters

A perusal of the data reveals that the plant attained only a nominal growth within the first 30 days (maximum tillering stage). After that, there was a steady rise in this character, which continued till harvest. However, the rate of increase in plant growth was relatively slow after 90 days of sowing. FIRB Planting methods and nitrogen management showed a positive and significant effect on the growth character in both the years of study. The planting method plays a vital role in positive plant growth; It may be due to better sunlight absorption, better aeration, nutrient availability to wheat. The positive effect of nitrogen application on plant growth may be due to the balance of nitrogenous fertilizer and FYM with split application to crops. The supply of 100% nitrogen in three splits recorded the greater growth of the plants at all the stages of the growth in both crop seasons. This increase in plant growth may be attributed to greater availability of nutrients at all time to crops and less loss due to volatilization in alkaline soil with the application of FYM and chemical fertilizer.

The data presented in Table.1 and fig. 2 showed that in general, plant growth *viz*. emergence percentage, plant height (cm), the number of tillers per running meter, dry matter accumulation (g running meter), the number of leaves per running meter, leaf area index, biomass duration, leaf area duration and leaf area ratio increased with age and was maximum at 90 DAS except for LAI, leaf area ratio where the highest growth found at 60 DAS. The crop growth accelerated with an increasing rate during the vegetative stage from 30 to 60 DAS. The crop growth significantly varied due to different planting methods and nitrogen management. The results revealed that the maximum growth characters of wheat were recorded under FIRB compared to Lm and Cc establishment method. The least growth character found with Bs. Gupta *et al.* (2017) reported similar results, who found remarkable effects under drill sowing at 18 and 20 cm and bed planting with three rows which were better in terms of growth. El-Temsah (2017) [11] revealed that growth and productivity were recorded significantly higher under zero tillage wheat with rice residue retention than the conventional method of broadcasting. Still, it was statistically at par with zero tillage without residue and conventional method of line sowing.

Nitrogen management significantly influenced wheat crop growth, and the maximum growth was recorded under N_2 treatment at all the growth stages during both years (Table.1 and Fig.1). However, it was statistically at par with N_4 treatment during both the years of experimentation. N_1 treatment that was 0 kg N produced significantly lesser plants growth of wheat in both years. Similar results found with Soomro *et al.* (2013) reported that all growth and yield parameters were greatly affected by the sowing methods. Nakano *et al.* (2008) also suggested that the application of nitrogen in three splits helped maintain the higher level of available nitrogen in the soil at these growth phases and throughout the growing period in wheat. The results are further supported by Kumar *et al.* (2021) [18], who implies that the use of chemical fertilizers may cause adversely affect the growth attributes during the crop log phase leading to yield loses of rice. That situation could be escaped by integrated use of green manure along with judicial nitrogen fertilizer management.

Calculative observation

Among sowing methods, the FIRB recorded significantly higher leaf area duration and biomass duration at 60-90 days as compared to other sowing methods except for Lm (Table.2), which was statistically at par with each other during both the years. However, Bm recorded lower values of leaf area duration and biomass duration during both years. Ridge sowing provides apposite soil conditions including proper moisture availability and aeration for the emergence of seeds that lead to more leaf area duration and biomass duration than broadcasting Chatta *et al.* (2020) [6] and Bakht *et al.* (2011) [4]. Under nitrogen management, the highest leaf area duration and biomass duration was observed with N_2; however, it was statistically at par with N_4 during both years. The lowest leaf duration and biomass duration founded with N_1 during both the years of experimentation. In tiller productive rate at 60-90 DAS, similarly, Lm increased tillers higher rate at the rate of 0.29 tillers/day/running meter in 2017-18 and 0.28 tillers/day/running meter in 2018-19 followed by FIRB (0.19 tillers/day/running meter in 2017-18 and 0.20 tillers/day/running meter in 2018-19). Under nitrogen management at 60 to 90 DAS, In nitrogen management treatments N_4 and N_2 increased tillers higher rate at the rate of 0.26 tillers/day/running meter in 2017-18 and 0.26 tillers/day/running meter in 2018-19 respectively, followed by N_2 and N_4 at the rate of 0.24 tillers/day/running meter in 2017-18 and 0.19 tillers/day/running meter in 2018-19 respectively, where the lowest rate observed with N_1 and N_5 (0.03 tillers/day/running meter in 2017-18 and 0.10 tillers/day/running meter in 2018-19 respectively). Similar results reported by Somroo *et al.* (2011) reported that drill sowing of wheat increased the number of tillers/plant compared to broadcasting in standing water and normal broadcasting method. Angassa (2017) [9] The effect of the sowing method was non-significant on tiller rate and biomass duration of rice plants. The leaf area ratio at 60-90 DAS did not differ statistically under different sowing methods and nitrogen management during both years of experimentation.

Grain, straw and biological yield

Grain, straw and biological yield of wheat crop varied significantly due to different planting method and nitrogen management treatments are present in (Table. 3, Fig. 2) and the value of S. Em., C. D., are also noted in the same table. The seed, straw, and biological yield of wheat remained affected by the different planting methods during the experimentation years. Significantly higher grain yield was observed with FIRB, which was statistically at par with Lm during both years. Whereas, Cc method of planting was found to be statistically at par with Bm. The significantly lower grain, straw and biological yields were observed with Bm, and the same trend was observed in both the years of experimentation. Gupta *et al.* (2013) reported that the drill sowing at 18 and 20 cm and bed planting with three rows were better in yield. Dagash *et al.* (2013) concluded that the wheat could be grown in early and mid-November on ridge and ridge. The line with 120 kg N/ha fertilizer produced a higher yield due to absorption of higher nitrogen and consumed more heat unit. Abbas *et al.* (2009) [1] reported that the broadcast method of sowing recorded maximum grain and straw yields and was statistically at par with drill planting at 22.5 cm spacing in sandy loam soil of Pakistan. Chouhan *et al.* (2017) [7] line sowing method recorded a higher grain yield of wheat which was statistically at par with the FIRB method.

Wheat grown under different nutrient management practices showed significant variation in grain, straw, and biological yields during both years. Under nitrogen management, N_2 produced significantly higher grain, straw and biological yields compression to other treatments, which was statistically at par with N_4 during both years. The substantially lower grain, straw and biological yields were observed with the application of N_1 during both years. Similar findings were reported by Singh and Singh (2013) [24], who found that the Straw yield was influenced significantly by rates and time of nitrogen application. Dubey *et al.* (2018) [18] reported that the grain yield obtained under (1/3 at sowing and 2/3 after first irrigation) was higher by 16.53 per cent over the treatment where nitrogen was applied as ½ at sowing ½ after first irrigation. Jan *et al.* (2007) [14] suggested that application of inorganic fertilizer alone resulted in increased grain, straw and biological yield than the mixture of inorganic fertilizer and cereal residue. Kumar and Puri (2001) [17] reported that the application of 90 kg N/ha and 15 tons FYM/ha resulted in higher yields. The outcome of Aziz *et al.* (2021) [3] experiment that whenever nitrogen was applied in three equal splits producing 202% and 24.19% more grain yield over control.

Relationship between growth and yield of wheat

Data on the correlation between grain, biological yield and growth are presented in Table 4. The correlation studies between grain, biological yield, and growth had positive and significant correlations except for leaf area ratio. A negative correlation was observed between yields and LAR during the years. The study results agree with the findings of Chatta *et al.* (2020) [6] suggested that multiple regression should be used to relate growth attributes with grain yield. Trapeznikov *et al.* (1996) [26] reported that an increase of N and P fertilizer levels in band application increased the days for flowering. The results are further supported by Jacobsen *et al.* (1993) [13] reported that the banded fertilizer stimulated growth early in the growing season, and maturity increased with an increase in N concentrations. Further, Malhi and Nyborg (1990) [20] observed that the placement method has a significant effect on nitrogen fertilizer efficiency by increasing the yield.

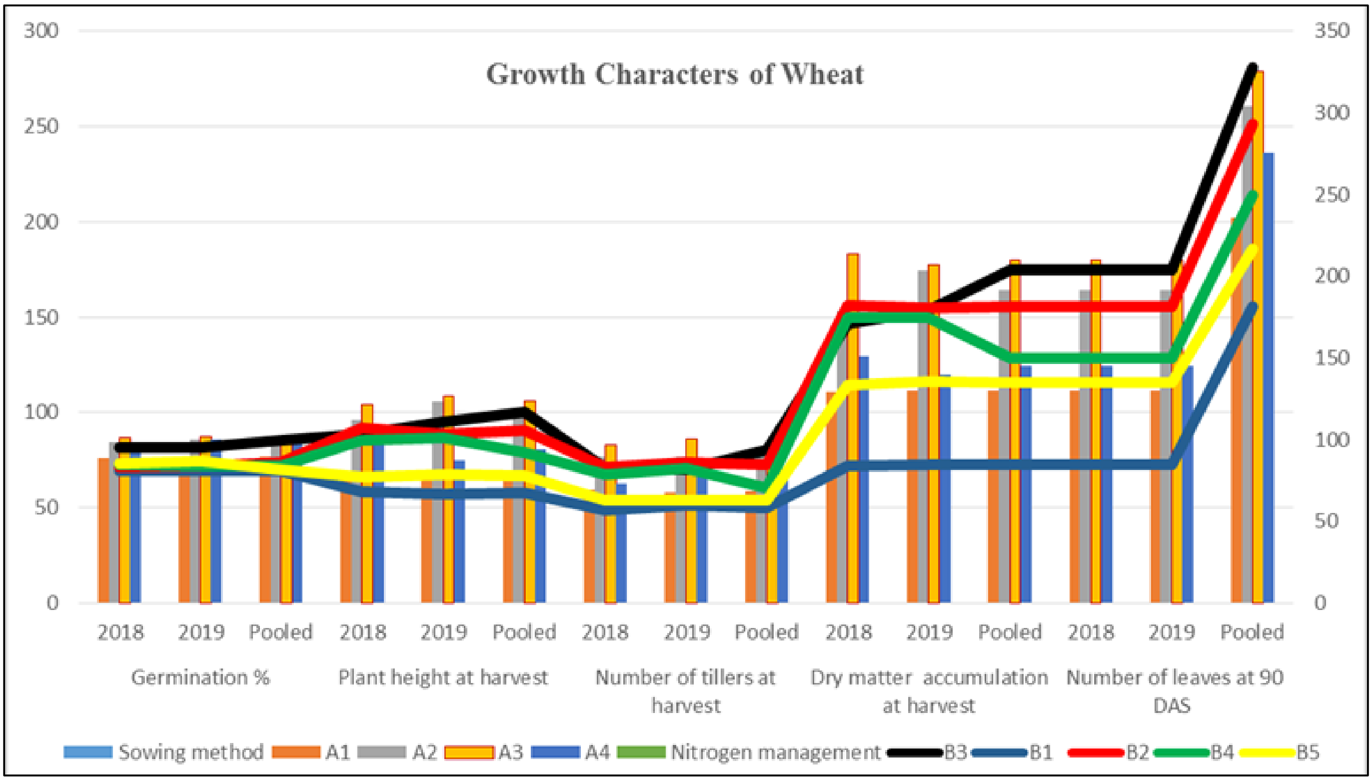

Fig 2: Effect of sowing methods and nitrogen management on growth parameters of wheat

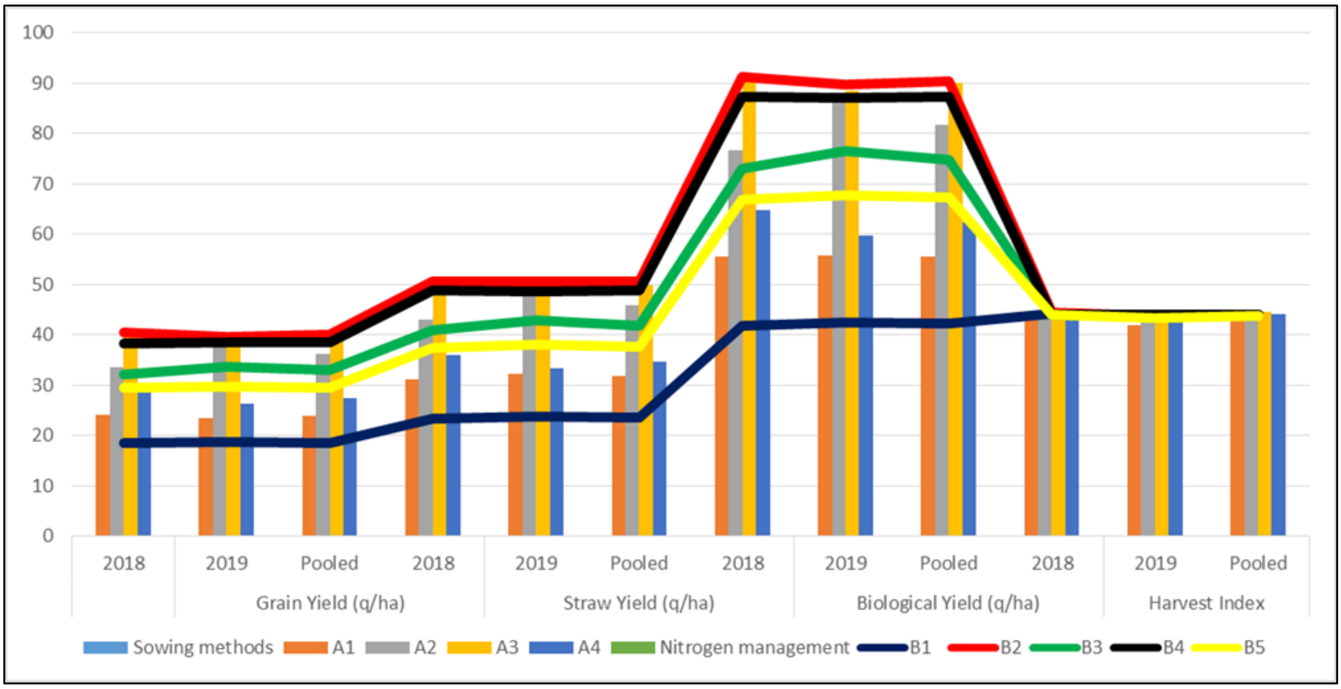

Fig 3: Effect of sowing methods and nitrogen management on grain, straw, biological yield and harvest index.

Table 1: Effect of sowing methods and nitrogen management on growth characters of wheat (*Triticum aestivum* L.) during 2017-18 and 2018-19

Treatment	Emergence%		Plant height at harvest		Number of tillers at harvest		Dry matter accumulation at harvest		Number of leaves at 90 DAS	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Sowing methods										
Bm	76.33	77.00	66.94	66.90	59.47	58.27	110.97	111.49	195.0	208.6
Lm	84.33	85.66	96.14	105.92	76.50	76.95	153.27	174.75	253.7	267.3
FIRB	86.93	87.33	103.98	108.45	83.06	86.12	182.95	177.09	284.6	273.0
Cc	84.73	85.73	85.88	74.85	62.87	67.35	129.45	119.67	230.6	241.1
S.Em ±	0.67	1.50	3.16	1.04	3.45	3.54	10.62	7.30	6.7	10.2
LSD	2.32	5.22	10.95	3.60	11.95	12.27	36.74	25.26	23.1	35.2
Nitrogen management										
B_1	80.91	81.25	68.43	66.51	56.75	59.84	83.86	85.00	179.3	184.0
B_2	83.41	84.00	107.22	103.65	83.23	86.16	182.42	180.34	288.3	297.4
B_3	81.41	81.75	88.90	95.20	70.83	69.71	146.26	153.27	243.0	256.7
B_4	84.58	84.00	99.51	100.82	78.83	82.18	174.59	174.40	275.5	285.5
B_5	85.16	86.83	77.13	78.96	62.76	62.97	133.68	135.74	218.9	213.8
S.Em ±	1.163	1.177	3.05	1.27	2.43	2.47	6.14	3.80	5.8	8.6
LSD	3.35	3.39	8.80	3.65	6.99	7.11	17.69	10.96	16.7	24.8

Table 2: Effect of sowing methods and nitrogen management on growth calculation characters of wheat *(Triticum aestivum L.)* during 2017-18 and 2018-19

Treatment	LAI at 90 DAS		Leaf Area Duration at 60-90 DAS		Leaf Area Ratio at 60 DAS		Tiller Productive Rate at 60-90 DAS		Biomass Duration at 60-90 Das	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Bm	2.17	2.04	79.47	76.34	36.70	32.35	0.13	0.09	1885.01	1880.16
Lm	2.53	2.53	103.27	100.79	41.84	37.31	0.29	0.28	2600.76	2561.85
FIRB	2.86	2.78	110.89	106.95	38.53	34.10	0.19	0.20	2850.53	2856.40
Cc	2.58	2.19	95.46	87.24	38.30	33.35	0.003	0.12	2222.60	2204.76
S.Em ±	0.13	0.09	4.90	3.28	1.07	1.25	0.08	0.07	117.07	83.26
LSD (≤0.05)	0.44	0.30	16.95	11.36	NS	NS	0.28	NS	405.10	288.11
Nitrogen management										
B_1	1.88	1.79	67.22	63.85	36.95	30.91	0.03	0.16	1735.04	1757.29
B_2	3.02	2.85	116.61	111.72	38.19	33.75	0.24	0.26	2913.63	2879.98
B_3	2.60	2.45	101.25	96.89	41.52	37.32	0.05	0.14	2340.64	2349.48
B_4	2.98	2.76	114.49	108.89	39.09	35.23	0.26	0.19	2739.81	2697.11
B_5	2.20	2.09	86.80	82.80	38.45	34.17	0.08	0.10	2219.50	2195.11
S.Em ±	0.10	0.08	2.87	2.25	1.89	1.49	0.09	0.04	83.44	73.91
LSD (≤0.05)	0.29	0.23	8.28	6.49	NS	NS	0.27	NS	240.37	212.90

Table 3: Effect of sowing methods and nitrogen management on yield of wheat (*Triticum aestivum* L.) during 2017-18 and 2018-19

Treatments	Grain Yield (q/ha)		Straw Yield (q/ha)		Biological Yield (q/ha)		Harvest Index	
	2018	2019	2018	2019	2018	2019	2018	2019
Sowing methods								
Bm	24.23	23.50	31.25	32.24	55.48	55.74	43.99	41.98
Lm	33.60	38.83	43.04	48.55	76.64	86.97	44.02	44.36
FIRB	40.74	39.54	50.74	49.01	91.48	88.55	44.49	44.64
Cc	28.66	26.40	36.07	33.43	64.73	59.83	44.32	44.12
S.Em ±	2.49	2.00	2.85	1.69	5.31	3.46	0.51	0.65
LSD (≤0.05)	8.63	6.93	9.86	5.84	18.37	11.99	NS	NS
Nitrogen management								
B_1	18.48	18.69	23.45	23.81	41.93	42.50	44.35	43.83
B_2	40.49	39.64	50.73	50.53	91.21	89.67	44.43	43.75
B_3	32.16	33.77	40.97	42.86	73.13	76.63	44.06	43.79
B_4	38.41	38.50	48.89	48.70	87.30	87.20	44.07	44.06
B_5	29.50	29.73	37.33	38.14	66.84	67.87	44.13	43.45
S.Em ±	1.39	0.95	1.76	1.06	3.07	1.98	0.41	0.53
LSD (≤0.05)	3.99	2.74	5.07	3.04	8.85	5.70	NS	NS

Table 4: Correlation between grain and biological yield for various growth characteristics obtained from different sowing methods and nitrogen management on wheat during 2017-18 and 2018-19.

Parameters		Emergence%	Plant Height (cm)	Number of tillers at harvest	Dry matter accumulation at harvest	Number of leaves at 90 DAS	LAI at 90 DAS	Leaf Area Duration at 60-90 DAS	LAR at 90 DAS	TPR at 60-90 DAS	Biomass Duration at 60-90 DAS
Grain Yield (q/ha)	2017-18	0.456**	0.862**	0.864**	0.918**	0.880**	0.785**	0.873**	-0.365*	0.556**	0.887**
	2018-19	0.650**	0.885**	0.794**	0.949**	0.848**	0.829**	0.895**	-0.348*	0.571**	0.898**
Biological yield (q/ha)	2017-18	0.542**	0.862**	0.866**	0.918**	0.880**	0.788**	0.876**	-0.559*	0.562**	0.887**
	2018-19	0.624**	0.880**	0.787**	0.952**	0.848**	0.830**	0.895**	-0.327*	0.571**	0.890**

Conclusion

In these two-year studies, the maximum plant height, number of tillers, dry matter accumulation at harvest stage observed with (FIRB) sowing method and (B2) 50% N as basal + 25% N after first irrigation + 25% N after second irrigation. The maximum LAI and number of leaves at 60 DAS found with (FIRB) sowing method and (B2) 50% N as basal + 25% N after first irrigation + 25% N after second irrigation. The yield obtained with (FIRB) sowing method and (B2) 50% N as basal + 25% N after first irrigation + 25% N after second irrigation. The interaction between the sowing method and nitrogen management were found non-significant. In conclusion, it could be suggested that (FIRB) sowing method and (B2) 50% N as basal + 25% N after first irrigation + 25% N after second irrigation proved to be more remunerative and economical.

Reference

1. Abbas G, Ali MA, Abbas G, Azam M, Hussain I. Impact of planting methods on wheat grain yield and yield contributing parameters, The J of Animal & Plant Sci 2009;19(1):30-33
2. Abedi T, Alemzadeh A, Kazemeini SA. Effect of organic and inorganic fertilizers on grain yield and protein banding pattern of wheat. Aust. J Crop Sci 2010;4:384-389.
3. Aziz Md, Patra PS, Saha R, Ahmed AS. Productivity and use efficiencies of maize (*Zea mays* L.) in response to split application of nitrogen. Biological Forum – An International Journal 2021;13(1):429-434.
4. Bakht J, Shafi M, Rehman H, Uddin R, Anwar S. Effect of planting methods on growth, phenology and yield of maize varieties. Pak. J Bot 2011;43:1629-1633.
5. Borghi B. Nitrogen as determinant of wheat growth and yield. In: Satorre, E.H., Slafer, G.A. (Eds.), Wheat Ecology and Physiology of Yield Determination. *Food* Products Press, New York 2000, 67-84.
6. Chattha MU, Hassan MU, Khan1 I, Chattha MB, Aamer, M, Nawaz M *et al*. Impact of planting methods on biomass production, chemical composition and methane yield of sorghum cultivars, Pak. J Agri. Sci 2020;57(1):43-51.
7. Chouhan BS, Kaushik MK, Napelia V, Solanki NS, Singh B, Devra NS *et al*. Effect of sowing methods, scheduling of irrigation based on IW/CPE ratio and chemical weed control on plant height, dry matter accumulation and yield of wheat, J of Pharm. and Phyto 2017;6(3):169-172
8. Dagash YMI, Ahmed SIMM, Khalil NA. Effect of nitrogen fertilization, sowing methods and sowing dates on yield and yield attributes of wheat (*Triticum aestivum* L). Universal J of Plant Sci 2014;2(6):108-113. DOI: 10.13189/ujps.2014.020603
9. Delessa Angassa D. Effect of sowing method and seeding rate on yield and yield components of rainfed rice (*Oryza sativa* L.) Varieties in Woliso, South-West Shoa Zone, Ethiopia, Int. J of Appl. Agri. Sci 2017;3(5):104-110.
10. Dubey S, Tiwari A, Singh V, Pandey VK, Singh G. Effect of nitrogen levels and its time of application on yield attributes, yield and economics of barley (*Hordeum vulgare* L.). Inter. J of Cur. Micro. and Appl. Sci., 2018;7(01):1695-1705. https://doi.org/10.20546/ijcmas.2018.701.205
11. El-Temsah ME. Response of wheat yield, its components and technological characteristics to different nitrogen rates and planting methods. Egypt. J Agron 2017;39(3):421-429
12. Gupta G, Hooda VS, Thakral SK, Kumar N, Kumar V, Dwivedi A. Effect of different crop establishment methods and nitrogen levels on growth attributes, dry matter partitioning and radiation characteristics of wheat (*Triticum aestivum* L.). Int. J Pure App. Biosci 2017;

5(1):617-623.
13. Jacobsen JS, Taneka DL, Bander JW. Spring wheat response to fertilizer placement and nitrogen rate with limited moisture. Comm. Soil Sci. Plant Anal 1993;24:187-195.
14. Jan T, Jan MT, Arif M, Akbar H, Ali S. Response of wheat to source, type and time of nitrogen application. Sarhad J. Agric 2007;23(4):871-879.
15. Khan A, Muhammad A, Shah A, Ali S, Hussain Z, Khan S. Evaluation of planting methods for grain yield and yield components of wheat. Sarhad J Agri 2007;23(3):561-564.
16. Korres FF. The influence of different establishment methods on performance of early drilled winter wheat. HGCA- Project Report 2002;375:24.
17. Kumar P, Puri UK. Effect of nitrogen and farmyard manure application on maize (*Zea mays* L.) varieties. Indian J. Agron 2001;46(2):255-259.
18. Kumar V, Singh MK, Raghuvanshi N, Sahoo M. Response of summer green manuring and nutrient management on log phase of growth in unpuddled transplanted hybrid rice (*Oryza sativa* L.). Biological Forum – An International Journal 2021;13(1):122-127.
19. Makwana CF, Tank DA. Effect of methods of sowing and seed rate on yield and quality of irrigated durum wheat (*Triticum durum Desf.*) Variety GW- 1139. Res. Crops, 2008;9(2):494-497.
20. Malhi SS, Nyborg M. Effect of tillage and straw on yield and N uptake of barley grown under different N fertility regimes. Soil Tillage Res 1990;17:115-124.
21. Masaka J. The Effect of N fertilizer placement and timing on the aboveground biometric characteristics of spring wheat (*Triticum aestivum* L. cv. Spectrum) on Leached Chernozem. Inter. J of Agri. Res 2006;1:68-75.
22. Ooro PA, Malinga JN, Tanner DG, Payne TS. Implication of rate and time of nitrogen application on wheat (*Triticum aestivum* L.) yield and quality in Kenya. J. of Animal and Pl. Sci 2011;9(2):1141-1146.
23. Patel UK, Sahu RL, Kumar S. Effect of organic and inorganic fertilizer on macronutrients content and uptake of wheat crop under rice-wheat cropping system. Advanced Res. J of crop impr 2014;5(2):200-203.
24. Singh J, Singh A. Productivity and quality of malt barley (*Hordeum vulgare*) as affected by sowing date, rate and stage of nitrogen application. Indian J of Agro 2013;58(1):72-80.
25. Soomro UM, Rahman MU, Odhano EA, Gul S, Tareen AQ. Effects of sowing method and seed rate on growth and yield of wheat (*Triticum aestivum*), World J of Agri. Sci 2009;5(2):159-162.
26. Trapenznikov VK, Sereda NA, Shkil AV. The background nitrogen of a leached chernozem with different methods of fertilizer application. Agrokhiniya 1996;5:3-7.
27. Zafar J, Muhammad FC. Effects of soil and foliar application of different concentrations of NPK and foliar application of $(NH_4)_2SO_4$ on growth and yield attributes in wheat (*Triticum aestivum* L.). Paki. J of Plant Sci 2007; 13(2):119-128.