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Effect of Sowing Time and Nutrient Management on Physiological Parameters of Wheat

Lalita Bhayal[1], M. L. Kewat[1], Aakash[2], A. K. Jha[1], Divya Bhayal[3*] and Anamika Jain Badkul[1]

[1]Dept. of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh (482 004), India
[2]Dept. of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (221 005), India
[3]Dept. of Soil Science and Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh (482 004), India

Corresponding Author

Divya Bhayal
e-mail: divyabhayal123@gmail.com

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Abstract

An experiment was conducted during the Rabi seasons of 2020−21 and 2021−22 at Livestock farm**,** Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) to study the physiological parameters of wheat under different sowing dates and nutrient management. Twelve treatments comprised of four dates of sowing viz., 25th October, 5th November, 15th November and 25th November were assigned in main plots and these were superimposed with three nutrient management viz., Recommended dose of fertilizer, 150% RDF+FYM 15 t ha^{-1} and 150 % RDF+FYM 15 t ha^{-1}+Growth Regulators (Two spray as tank mix- Chlormequat chloride (Lihocin @ 0.2%)+Tebuconazole (Folicur @ 0.1%) as sub plots and carried out in split plot design with three replications. The results revealed that physiological parameters namely Crop growth rate, Relative growth rate, Leaf area index and Leaf area duration of wheat were significantly affected by sowing time being the maximum when wheat was sown on 5th November and proved significantly superior over delayed sowing (15th November and 25th November). The CGR, RGR, LAI and LAD were also affected by nutrient management. The values of these parameters attained maximum values when 150% RDF+FYM 15 t ha^{-1}+Growth Regulators was applied to wheat and found significantly superior over other nutrient management.

Keywords: Sowing dates, nutrient management, CGR, RGR, LAI, LAD

1. Introduction

Wheat (*Triticum aestivum* L.) is an important food grain crop of the world including India (Farooq et al., 2015). It is grown under varying climatic conditions and mostly suffer due to various abiotic stresses. Achieving higher growth of wheat is governed by sowing on suitable dates. Many studies revealed that higher temperature during vegetative or reproductive phases adversely affect the emergence and subsequent growth stages of crop (Dwivedi et al., 2015). The physiological parameters namely crop growth rate, relative growth rate, leaf area index and leaf area durationare commonlyused in crop growth analysis and these are best indicators for overall crop performance, under change in optimum temperatureand sowing time (Nataraja et al., 2006; Satter et al., 2010; Gupta and Kaur, 2022). In last two decades, marked changes in temperature have been witnessed in different parts of India and different physiological parameters require specific temperature for the production of maximum yield. Many researchers have reported that due to elevation in mean temperature (0.5°C), there is a reduction in wheat productivity by 10% (Djanaguiraman et al., 2020; Kumar et al., 2014). As temperature is increasing due to climate change and crop requires specific temperature for optimal performance. Henceforth, date of sowing is a non monetary option to synchronize temperature requirement with respect to particular physiological parameters. Therefore, it is essential and urgent need to understand wheat physiological behavior under changing temperature scenarios. Similar to this, one of the key factors affecting CGR, RGR, LAI, and LAD is nutrient management practices. However, due to most soils' low to moderate levels of both key nutrients, nitrogen and phosphorus deficiency are currently being recoded throughout India (Achakzai, 2012). The cause is likely due to an intensive cropping scheme combined with inefficient fertilizer application. Due to the large difference between nutrient addition and removal, nutrient mining poses a serious hazard to agricultural soil and is the main cause of the declining factor productivity of applied fertilizer input, particularly NPK. CGR, RGR, LAI, and LAD were all greatly improved by using NPK with FYM. (Poma et al., 2002; Singh and Agarwal, 2001; Khalil et al., 2011; Iftikhar et al., 2010). NPK nutrition is essential for

completing the life cycle of plants; without it, plants cannot survive and exhibit aberrant development. Best nutrient management strategies must therefore be evaluated in order to improve the physiological parameter of wheat crop. Keeping the above-mentioned facts in view, the present experiment entitled "Effect of sowing time and nutrient management on the physiological parameters of wheat (*Triticum aestivum* L.)" was conducted during Rabi season 2020−21 and 2021−22 with the objective to optimize physiological parameters under changing thermal regimes using different dates of sowing and nutrient management.

2. Materials and Methods

The experiment was conducted at Livestock Research Farm, Department of Agronomy**,** College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during Rabi season 2020−21 and 2021−22. Jabalpur is located at with an altitude of 411.78m above mean sea level, with 23°9' North latitude and 79°58' East longitude.Twelve treatments comprised of four dates of sowing viz., D_1: 25th October, D_2: 5th November, D_3: 15th November and D_4: 25th November were assigned in main plots and these were superimposed with three nutrient management viz., N_1: Recommended dose of fertilizer, N_2: 150% RDF+FYM 15 t ha^{-1} and N_3: 150% RDF+FYM 15 t ha^{-1}+Growth Regulators (Two spray as tank mix- Chlormequat chloride (Lihocin @ 0.2%)+Tebuconazole (Folicur @ 0.1%) as sub plot and carried out in split plot design with three replications. The experimental plots received major nutrients through different fertilizers as per the treatments. Half of the nitrogen along with whole of phosphorus and potassium was drilled at the time of sowing. Remaining half of the nitrogen was top dressed in two equal splits at 28−30 and 60−62 DAS. FYM was supplied and mixed is soil before sowing as per treatments. Chloromequat Choloride and Tebuconazole growth regulator were sprayed at 45 and 70 days after sowing as per treatments. The growth parameters viz., CGR was worked out as per formula given by Watson (1958), RGR and LAI formula by Williams (1946). LAD was calculated by the formula given by Power et al. (1967) at various time intervals. The data were analyzed as per the procedure suggested by Gomez and Gomez (1984).

3. Result and Discussion

3.1. Effect on crop growth rate

It is obvious from the data given in table 1 that crop growth rate (CGR) of wheat was affected by different sowing dates and nutrient management. The value of CGR, in general, were higher during early period of crop growth but these were declined during with time being the maximum during 30-60 DAS stage due to completion of vegetative phase. But it was declined during 60−90 DAS owing to check on vegetative growth. The apparent influence of different dates of sowing was noted on CGR at all growth intervals The crop growth rate was higher when wheat was sown on 5th November (18.64 and 16.77 g m^{-2} day^{-1} during 2020-21; 19.32 and 17.67 g m^{-2} day^{-1} during 2021−22) and proved significantly superior over late sowing of wheat on 15th November and 25th November but found statistically at par with 25th October sowing of wheat during 30-60 and 60-90 DAS during both the years. The superior value of CGR under 5th November sown crop due to availability of favourable environmental conditions during different phases compared to other sowing dates. The results are in conformity with the findings of Haider (2007) and Gupta and Kaur (2022).

Nutrient management showed significant effect on crop growth rate. All the treatments varied significantly in relation to crop growth rate. The higher CGR was recorded during 30-60 DAS and 60-90 DAS in case of application of 150% RDF+FYM 15 t ha^{-1}+Growth Regulators (Chlormequat chloride+Tebuconazole @ 0.1%) (18.49 and 16.25 g m^{-2} day^{-1} during 2020−21; 19.15 and 16.77 g m^{-2} day^{-1} during 2021−22) significantly superior over rest of the treatments. The minimum value of CGR found under recommended dose of fertilizer. The application of optimal quantity of nutrients through fertilizers starting from the basal application as well as top dressing resulted in higher photosynthetic activity and consequently higher dry matter accumulation at all the time intervals. The release of nutrients, from the mineralization of added FYM, throughout the crop season also resulted in better nutrient availability to the crop and subsequently higher crop growth rate. Application of NPK+FYM significant increase in the crop growth rate was also reported by Singh and Agarwal (2001). Singh et al. (2019) also concluded that N 180 kg ha^{-1}+Chlormequat chloride + Tebuconazole increase the dry matter and CGR of wheat.

3.2. Effect on relative growth rate

The relative growth rate (RGR) of wheat was affected significantly due to different dates of sowing and nutrient management during 30−60 DAS and 60-90 DAS (Table 1). Sowing of wheat on 5th November recorded significantly higher RGR during 30−60 and 60-90 DAS (0.054 and 0.036 g g^{-1} day^{-1} during 2020−21; 0.057 and 0.037 g g^{-1} day^{-1} during 2021−22) as compared to other sowing dates being the minimum under 25th November. The higher relative growth rate under 5th November sowing was due to long duration was available to crop and to overall improvement for better relative growth rate. Similar views have also been enclosed by Gupta and Kaur (2022).

Data indicate (Table 1) that application 150% RDF+FYM 15 t ha^{-1}+Chlormequat chloride+Tebuconazole was having the highest RGR (0.052 and 0.035 g g^{-1} day^{-1} during 2020−21; 0.054 and 0.036 g g^{-1} day^{-1} during 2021−22) and found significantly superior during 30−60 DAS and 60−90 DAS over recommended dose of fertilizer but found at par with 150% RDF+FYM 15 t ha^{-1} during both the years. The overall improvement in crop growth caused by optimal nutrition, which includes combining all nutrients and increasing the role of fertility levels, may

Table 1: Crop growth rate and Relative growth rate of wheat as affected by different dates of sowing and nutrient management

Treatment detail	CGR (g m^{-2} day^{-1})				RGR (g g^{-1} day^{-1})			
	30-60 DAS		60-90 DAS		30-60 DAS		60-90 DAS	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Dates of sowing								
D_1 -25 October	17.41	17.92	15.48	16.04	0.048	0.052	0.030	0.031
D_2 -05 November	18.64	19.32	16.77	17.67	0.054	0.057	0.036	0.037
D_3 -15 November	15.71	16.48	13.68	14.23	0.045	0.049	0.026	0.029
D_4 -25 November	15.58	16.42	13.43	13.38	0.040	0.042	0.024	0.025
SEm±	0.60	0.51	0.59	0.8	0.0014	0.0017	0.0019	0.0021
CD (p=0.05)	2.09	1.78	2.05	2.78	0.0048	0.0058	0.0063	0.0072
Nutrient management								
N_1- Recommended dose of fertilizer	15.78	16.23	13.68	14.46	0.041	0.045	0.024	0.025
N_2- 150% RDF+FYM 15 t ha^{-1}	16.22	17.22	14.59	14.75	0.047	0.051	0.029	0.030
N_3- 150% RDF+FYM 15 t ha^{-1}+ growth regulators	18.49	19.15	16.25	16.77	0.052	0.054	0.035	0.036
SEm±	0.61	0.64	0.54	0.59	0.0023	0.0024	0.0016	0.0017
CD (p=0.05)	1.83	1.92	1.62	1.77	0.0069	0.0073	0.0047	0.005

be attributable to their potential role in altering the soil and plant environment to promote better development of both morphological and biochemical components of the plant growth that increased efficiency of physiological processes of the plant system. Similarly, Alam (2013), Verma et al. (2017) and Mohanty et al. (2015) also observed significantly higher growth rate in wheat with under the application of higher nitrogen and organic manures in various soil types.

3.3. Effect on leaf area index

It is clear from the data presented in Table 2 that the leaf area index (LAI) of wheat at various stages at 30, 60 and 90 DAS was significantly influenced by different dates of sowing and nutrient management. The value of LAI increased with the increase of plant age. This might be due to the increase of leaf expansion at the later stages of plant growth. Sowing on 5th November was having significantly maximum leaf area index (1.17, 3.51 and 3.88 during 2020−21; 1.34, 3.53 and 3.90 during 2021−22) as compared to delayed sowing but it was statistically at par with 25th October sowing at 30, 60 and 90 DAS during both the year (2020−21 and 2021−22). Maximum leaf area index with 5th November sowing was due to availability of favourable environment for synthesis of growth favouring constituents in plant system which induced tiller and leave formation, which increased number of leaves per unit area and ultimately leaf area index. Tripathi (2003) and Pande (2009) also reported that timely sown crop was having higher LAI in comparison to late sown crop. Delay in sowing reduced LAI probably because of reduction in rate of photosynthesis and poor development of leaves. Similar finding was reported by Suleiman et al. (2014). They reported that leaf area index was reduced when sowing was delayed beyond optimum sowing date.

Leaf area index at 30, 60 and 90 days after sowing (DAS) was significantly influenced by nutrient management. At 30 DAS, maximum leaf area index was recorded (1.06, 3.40 and 3.73 during 2020−21; 1.23, 3.45 and 3.78 during 2021-22) in plots receiving 150% RDF+FYM 15 t ha^{-1}+Growth Regulators (Chlormequat chloride+Tebuconazole @ 0.1%) being significantly superior to recommended dose of fertilizer but found at par with 150% RDF+FYM 15 t ha^{-1}. At later stages 60 and 90 DAS, application of 150% RDF+FYM 15 t ha^{-1}+Growth Regulators (Chlormequat chloride+Tebuconazole @ 0.1%) recorded maximum LAI and found significantly superior over rest of the treatments. Spraying Tebuconazole and Chlormequat chloride on wheat leaves enhanced leaf area, postponed leaf senescence, and ultimately raised LAI (Mondal et al. (2020). Additionally, Yagoub et al. (2012) demonstrated that NPK+FYM had higher LAI than the control.

3.4. Effect on leaf area duration

Data on leaf area duration (LAD) of wheat as influenced by different date of sowing and nutrient management at 30−60 and 60−90 DAS have been given in Table 2. Among different dates of sowing, maximum leaf area duration (70.17 and 110.93 days during 2020-21; 75.43 and 112.96 days during 2021−22) were recorded when crop was sown on 5th November and proved significantly superior over delayed sowing i.e. 15th November and 25thNovember but found at par with 25th October. Higher Leaf Area Duration in 05th November Sowing crop due to optimum temperature (20°C) at the vegetative

Table 2: Leaf area index and Leaf area duration of wheat as affected by different dates of sowing and nutrient management

Treatment detail	Leaf area index						Leaf area duration (days)			
	30 DAS		60 DAS		90 DAS		30-60 DAS		60-90 DAS	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Dates of sowing										
D_1 -25 October	1.03	1.19	3.29	3.34	3.73	3.74	64.84	70.69	98.65	103.62
D_2 -05 November	1.17	1.34	3.51	3.53	3.88	3.90	70.17	75.43	110.93	112.96
D_3 -15 November	0.85	1.02	2.67	2.72	3.00	3.03	52.83	57.94	82.78	87.00
D_4 -25 November	0.79	0.95	2.47	2.47	2.79	2.82	48.86	51.42	76.59	75.59
SEm±	0.044	0.048	0.08	0.07	0.07	0.11	1.78	3.74	3.64	4.04
CD (p=0.05)	0.154	0.168	0.26	0.23	0.23	0.40	6.15	12.93	12.60	13.97
Nutrient management										
N_1- Recommended dose of fertilizer	0.83	0.99	2.54	2.56	2.89	2.90	50.56	56.73	77.26	77.93
N_2- 150% RDF+FYM 15 t ha^{-1}	0.99	1.16	3.01	3.05	3.43	3.45	60.11	64.20	92.54	95.95
N_3- 150% RDF+ FYM 15 t ha^{-1}+ growth regulators	1.06	1.23	3.40	3.45	3.73	3.78	66.85	70.69	106.91	110.49
SEm±	0.039	0.043	0.07	0.09	0.08	0.08	1.98	1.94	3.63	2.29
CD (p=0.05)	0.117	0.129	0.20	0.26	0.23	0.24	5.95	5.83	10.89	8.74

stage enhanced the leaf Initiation and leaf emergence for a longer period as revealed in the regular growing conditions in wheat This length was shorter due to delayed sowing and lower temperatures during the early vegetative stage than what was observed during the late growing condition. A nearly identical outcome was reported by Yadavi et al. (2015).

The maximum leaf area duration (66.85 and 106.91 days during 2020−21; 70.69 and 110.49 days during 2021−22) was recorded with the application of 150% RDF+15 t FYM ha^{-1}+Growth Regulators (Chlormequat chloride and Tebuconazole) and proved significantly superior over other nutrient management treatments. The minimum leaf area duration was recorded under recommended dose of fertilizer. According to Alam (2013), N 160 kg ha^{-1} increases leaf area and leafiness during the growth period.

4. Conclusion

Wheat on 5th November and application of 150% RDF+FYM 15 t ha^{-1}+Growth Regulators (Chlormequat chloride @ 0.2%+Tebuconazole @ 0.1%) was found more productive as wheat attained maximum values of CGR, RGR, LAI and LAD.

5. References

Achakzai, A.K.K., 2012. Effect of various levels of nitrogen fertilizer on some vegetative growth attributes of Pea (*Pisum Sativum* L.) cultivars. Pakistan Journal of Botony 44(2), 655−659.

Alam, M.S., 2013. Growth and yield potentials of wheat as affected by management practices. African Journal of Agricultural Research 8(47), 6068−6072.

Djanaguiraman, M., Narayanan, S., Erdayani, E., Prasad, P.V.V., 2020. Effects of high temperature stress during anthesis and grain filling periods on photosynthesis, lipids and grain yield in wheat. BMC Plant Biology 20, 2−12.

Dwivedi, S.K., Kumar, S., Prakash, V., 2015. Effect of late sowing on yield and yield attributes of wheat genotypes in Eastern Indo Gangetic Plains (EGIP). Journal of Agricultural Search 2(4), 304–306.

Farooq, O., Ali, M.,Naeem, M., Abdul, S., Ijaz, M., Sher, A., Yasir, T.A., Iqbal, M.M., 2015. Impact of sowing time and planting method on the quality traits of wheat. Journal of Global Innovations Agricultural and Social Sciences 3(1), 8−11.

Gomez, K.A., Gomez, A.A., 1984. Statistical procedure for Agricultural Res. second edition, John Willey and sons New York, 680.

Gupta, N., Kaur, H., 2022. Wheat response to foliar application of salicylic acid at different sowing dates. Journal of Crop Improvement 36, 271−274

Haider, S.A., 2007. Growth analysis in relation to sowing dates in four varieties of wheat: A functional approach. Journal of Life and Earth Science 2(2), 17−25.

Iftikhar, T., Babar, L.K., Zahoor, S., Khan, N.G., 2010. Impact of land pattern and hydrological properties of soil on cotton yield. Pakistan Journal of Botony 42(5), 3023−3028.

Khalil, S.K., Khan, F., Rehman, A., Muhammad, F., Ammanullah, Khan, A.Z., Wahab, S., Akhtar,S., Zubair, M., Khalil, I.H., Kalan S.M., Khan, H., 2011. Dual purpose wheat for A forage and grain yield in response to cutting, seed rate and nitrogen. Pakistan Journal of Botony 43(2), 937−947.

Kumar, S.N., Aggarwal, P.K., Swaroopa, R.D.N., Saxena, R., Chauhan, N., Jain, S., 2014. Vulnerability of wheat production to climate change in India. Climate Research 59, 173−187.

Mohanty, S.K., Singh, A.K., Jat, S.L., Parihar, C.M., Pooniya, V., Sharma, S., Chaudhary, V., Singh, B., 2015. Precision nitrogen-management practices influences growth and yield of wheat (*Triticum aestivum*) under conservation agriculture. Indian Journal of Agronomy 60(4), 617−621.

Mondal, T.B., Mitra, A., Chowdhury, R., Das, S., 2020. Yield maximization through higher fertilization and lodging management in irrigated timely sown wheat (*Triticum aestivum* L.) under eastern sub-Himalayan plains. Journal of Crop and Weed 16(3), 173−178

Nataraja, T.H., Halepyati, A.S. Pujari, B.T. Desai, B.K., 2006. Influence of phosphorus levels and micronutrients on physiological parameters of wheat, Karnataka. Journal of Agricultural Science 19(3), 685−687.

Pande, P., 2009. Physiological basis of yield differences among wheat varieties under timely and late sown conditions. Thesis, Ph.D. (Agronomy), G.B. Pant University of Agriculture and Technology, Pantnagar.

Poma, I., Venezia, G., Saladino, S., Gristina, G., Ferrotti F., Mirabile, C., 2002. Durum growth analysis in semi arid environment in relation to crop rotation and nitrogen rate. Science of Agrochemical. Italy, 209−212.

Power, J.E., Wills, W.O., Granes, D.L., Reichman, G.A., 1967. Effect of soil temperature, phosphorus and plant age on growth analysis of barley. Agronomy Journal 9, 231−234.

Satter, A., Cheema, M.A., Farooq, M., Wahid, M.A., Wahid, A., Babar, B.H., 2010. Evaluating the performance of wheat cultivars under late sown conditions. International Journal of Agriculture and Biology 12, 561−565.

Singh, R., Agarwal, S.K., 2001. Growth and yield of wheat (*Triticum aestivum*) as influenced by levels of farmyard manure and nitrogen. Indian Journal of Agronomy 46, 462−467

Singh, S., Singh, T., Singh, A.K., Singh, R.K., 2019. Effect of nitrogen levels and plant growth regulators on growth, lodging, yield and economics of wheat (*Triticum aestivam* L.). Journal of Pharmacognosy and Phytochemistry 8(4), 665−671.

Suleiman, A.A., Nganya, J.F., Ashraf, M.A., 2014. Effect of variety and sowing date on growth and yield of wheat (*Triticum aestivum* L.) in Khartoum, Sudan. Journal of Forest Products Industries 3, 198−203.

Tripathi, N., 2003. Studies on physiological parameters in relation to heat tolerance in eight wheat varieties. Thesis, M.Sc. Ag. (Agronomy), G.B. Pant University of Agriculture and Technology, Pantnagar

Verma, P., Yadav, A.N., Kumar, V., Singh, D.P., Saxena, A.K., 2017. Beneficial plant-microbes' interactions: biodiversity of microbes from diverse extreme environments and its impact for crop improvement. In Plant-microbe interactions in agro-ecological perspectives.Springer, Singapore, 543−580.

Watson, D.J., 1958. The physiological basis of variation in yield. In Advances in agronomy Academic Press, 4, 101−145

Williams, S.R.F., 1946. Methods of growth analysis. In: Sestak, Z., Catasky, J., Jouris, P.J. (Eds), Plant photosynthetic production manual methods. Drow, Jenk N.U. Publishers. The Hague, 348-391.

Yadavi, A., Kiani, M., Dehnavi M.M., Khajeeyan, R., 2015. Sowing date and weed competition effects on growth, phenology and yield of three white bean (*Phaseolus vulgaris* L.) cultivars. International Journal of Biological Sciences 2, 80−89.

Yagoub, S.O., Elkhalil, A.E., Balasio, E.D., 2012. Effect of different watering regimes on growth of two wheat (*Triticum aestivum* L.) cultivars at high terraces of North Sudan. International Journal of Agricultural Science, 2(8), 684−695.