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Effect of sowing dates and nitrogen levels on yield and economics of wheat (*Triticum aestivum* L.) under irrigated condition

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Abstract
The present field experiment was conducted at an Agricultural Farm Rama University, Kanpur (U.P) India. the Central Plain zone of Uttar Pradesh, during Rabi season of 2020-21. The experiment comprised of 9 treatment combinations in factorial randomized block design with three replications consisted of 3 nitrogen levels *viz.* N1: 100 kg ha^{-1}, N2: 125 kg ha^{-1} and N3: 150 kg ha^{-1} and three date of sowing *viz.* D1: 25 October, D2: 15 November and D3: 5 December. On the basis of the results emanated from present investigation, it could be concluded that crop sown on 15 November and fertilized with N @150 kg ha^{-1} have higher growth parameter i.e. plant height & dry matter accumulation and yield attributes i.e. length of spike, number of spike, number of grains per spike and test weight. Results also showed that crop sown on 15 November and fertilized with N @150 kg ha^{-1} significantly enhanced productivity parameters i.e. grain yield, straw yield. Higher values of economics *viz.*, gross return (Rs. 84398 ha^{-1}), net return (Rs. 42874 ha^{-1}) and B:C ratio (1.82) in wheat was observed in the combination of 15 November sowing time and nitrogen application rate @150 kg ha^{-1}.

Keywords: Sowing date, nitrogen level, yield, economics, wheat

Introduction

Wheat (*Triticum aestivum*), also known as "king of cereals," is the most significant staple food grain crop. India is the world's second-largest wheat-producing country. In India, wheat has been under cultivation in about 30 million hectares (14% of global area) to produce the all-time highest output of 99.70 million tonnes of wheat (13.64% of world production) with a record average productivity of 3371 kg/ha. Uttar Pradesh has largest share in area with 9.75 million hectare (32%) followed by Madhya Pradesh (18.75%), Punjab (11.48%), Rajasthan (9.74%), Haryana (8.36%) and Bihar (6.82%). Uttar Pradesh still holds the position of largest producer in the country accounting for about 28 million tonnes. (Dar *et al.*, 2018) [4].

Nitrogen is one of the most inadequate plant nutrients, especially in the semi-arid region of western Uttar Pradesh sandy loam soil. For robust vegetative development, chlorophyll synthesis, and glucose consumption, an adequate amount of nitrogen is required. The integrated N management boosted the organic carbon content of the soil as well as the availability of plant nutrients. The integration of chemical and organic sources, as well as their effective management, has yielded encouraging results in terms of not only sustaining output but also maintaining soil health. After nitrogen, phosphorus (P) is the second most important necessary nutrient for crop productivity (Venkatesh *et al.*, 2020).

Sowing time governs the phenological development, yield and effective conversion of biomass into economic yield in wheat. Timely sowing of wheat provides optimum growing period for the crop growth which can accumulate more biomass and finally results in higher grain and biological yield. In case of late sowing, the wheat crop is exposed to low temperature at the time of germination and seedling emergence while exposure to high temperature at the reproductive stage leads to force maturity and resulted in reduction of the grain yield and biological yield (Gupta *et al.*, 2017) [5]. The optimum sowing time and selection of improved cultivars play a remarkable role in exploiting the yield potential of the crop under particular agro climatic condition. It governs the crop phonological development and the efficient conversion of biomass into economic yield. Delay in sowing caused early maturity resulting drastic reduction in yield as compare to normal sowing which has a longer growth duration which consequently provides an opportunity to accumulate more biomass. Growing of suitable varieties at an appropriate time is an essential for ensuring optimum crop productivity.

Being a thermo-sensitive crop, choice of suitable variety for different seeding time further gets prime importance. (Ali *et al.*, 2011) [2].

Method and Material

Experiment site

The field experiment was conducted during *rabi* season of 2020-2021 at Agricultural Research Farm, of Rama University, Mandhana, Kanpur Nagar (U.P.) which is situated in the alluvial tract of Indo - Gangatic Plain in central part of Uttar Pradesh between $25^0$26' to $26^0$58' North latitude, $79^0$31' to $31^0$34' East longitude and on the altitude of 125.9 meters. The irrigation facilities are adequately available on this farm. The farm is situated in the main campus of the university.

Soil of Experimental Field

The experimental field is clay loam in texture, alkaline in reaction (pH 7.79), low in organic carbon (0.42%), available N (185 kg ha^{-1}), medium in available P (13 kg ha^{-1}), and high in available K (174 kg ha^{-1}).

Study Design

The experiment was laid out in a factorial randomized block design (FRBD) assigning 9 treatment combinations in factorial randomized block design with three replications consisted of 3 nitrogen levels *viz*. N1: 100 kg ha^{-1}, N2: 125 kg ha^{-1} and N3: 150 kg ha^{-1} and three date of sowing *viz*. D1: 25 October, D2: 15 November and D3: 5 December. Each treatment was randomly allocated within them. The row-to-row spacing was 21 cm.

Harvest Index

The harvest index was worked out with the help of following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield (kg ha-1)}}{\text{Biological yield (kg ha-1)}} \times 100$$

Net Profit (ha-1)

The net profit from each treatment was calculated separately by using the formula given below.

Net profit (ha-1) = Gross return - Cost of cultivation Cost Benefit Ratio (C: B)

The benefit ratio for each treatment was calculated by using following formula.

$$\text{Cost Benefit Ratio} = \frac{\text{Cost of Cultivation}}{\text{Gross Return}}$$

Statistical Analysis

The data recorded during the course of the investigation were subjected to statistical analysis by "Analysis of variance technique". The significant and non-significant treatment effects were judged with the help of 'F' (variance ratio) table. The significant differences between the means were tested against the critical difference at 5% probability level. (Chandel, 1998).

Result and Discussion

Growth Parameters Plant Height

The data regarding plant height at 30, 60, 90 DAS and at harvest stage were depicted in Table-

1. Plant height was significantly influenced by the date of sowing and nitrogen levels at all growth stages. Plant height increased with the combine use of N×D but the increased were non- significant at 30 DAS and found significant at 60, 90 DAS and at harvest stage. The minimum plant height were noted 20.6, 60.2, 87.4 and 89.1 cm at 30, 60, 90 DAS and at harvest stage in N1×D3 interaction. The maximum plant height were noted 29.5, 70.1, 95.8 and 96.3 cm at 30, 60, 90 DAS and at harvest stage in N3×D2 interaction. Results were also agreement with the findings of Ullah *et al.* (2013) and Jat *et al*. (2013) [6].

Dry Matter Accumulation

The data of dry matter accumulation at 30, 60 and 90 DAS were depicted in Table-1. Dry matter accumulation was significantly influenced by the date of sowing at all growth stages. Dry matter accumulation increased with the combine use of N×D were found significant at 30, 60 and 90 DAS. The minimum dry matter accumulation were noted 54.23, 498.10 and 844.31 g m^{-2} at 30, 60 and 90 DAS respectively in N1×D3 interaction. The maximum dry matter accumulation were noted 63.44, 530.56 and 866.49 g m^{-2} at 30, 60 and 90 DAS in N3×D2 interaction. Similar findings were reported by Barthwal *et al.* (2013) [3].

Table 1: Effect of different treatment combinations on plant growth parameters.

Treatments		Plant Height (cm)				Dry Matter Accumulation		
		30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS
T1		21.3	62.1	88.6	89.8	56.58	501.70	848.23
T2		22.4	63.4	89.3	90.4	58.23	503.50	850.42
T3		20.6	60.2	87.4	89.1	54.23	498.10	844.31
T4		26.7	66.4	92.2	93.2	60.91	520.11	858.90
T5		27.1	67.3	93.0	93.8	61.22	524.28	860.10
T6		24.1	64.8	90.4	91.1	59.59	510.10	853.64
T7		28.3	68.9	94.5	95.1	62.34	526.44	863.22
T8		29.5	70.1	95.8	96.3	63.44	530.56	866.49
T9		25.3	65.2	91.5	92.0	60.10	513.20	856.70
CD at 5%	N	0.89	0.16	0.31	0.27	0.09	0.70	3.58
	D	0.89	0.16	0.31	0.27	0.09	0.70	3.58
	N×D	NS	0.28	0.54	0.48	0.16	1.22	4.22
S.E(m)±	N	0.29	0.05	0.10	0.09	0.032	0.235	1.18
	D	0.29	0.05	0.10	0.09	0.032	0.235	1.18
	N×D	0.51	0.09	0.18	0.16	0.056	0.406	2.05

Yield Attributes

A cursory glance of data revealed that that all yield attributes such as like grain per ear, ear length, 1000-grain weight and effective tillers m^{-2} were affected significantly due to nitrogen levels and date of sowing. Yield attributing characters *viz*. no. of effective tillers (m^{-2}), no. of grains ear^{-1}, length of ear (cm) and 1000 grain weight (g) increased with the combine use of N×D were found significant. The minimum no. of effective tillers (m^{-2}), no. of grains ear^{-1}, length of ear (cm) and 1000 grain weight (g) were noted 280.13, 30, 7.92 and 36.22 respectively in N1×D3 interaction. The maximum no. of effective tillers (m^{-2}), no. of grains ear^{-1}, length of ear (cm) and 1000 grain weight (g) were noted 305.94, 40, 8.41 and 43.90 in N3×D2 interaction. The consequences of the current investigation are additionally in concurrence with the investigation of Akram *et al*. (2016) Gupta *et al*. (2017) [5] and Madhu *et al*. (2018).

Table 2: Effect of different treatment combinations on yield attributing characters.

Treatments		Yield Attributing Characters			
		No. of effective tillers (m-2)	No. of grains ear-1	Length of ear (cm)	1000 grain weight (g)
T1		282.52	31	7.97	36.98
T2		284.34	31	8.01	37.34
T3		280.13	30	7.92	36.22
T4		294.81	34	8.20	40.12
T5		298.43	35	8.26	41.56
T6		287.67	32	8.08	38.49
T7		302.15	37	8.33	42.68
T8		305.94	40	8.41	43.90
T9		291.70	33	8.14	39.58
C.D. at 5%	N	0.349	0.118	0.004	0.138
	D	0.349	0.118	0.004	0.138
	N×D	0.605	0.205	0.006	0.238
S.E(m)±	N	0.116	0.039	0.001	0.045
	D	0.116	0.039	0.001	0.045
	N×D	0.200	0.068	0.002	0.079

Productivity Parameters

Data presented in Tbale-3 shows that all the productivity parameters *viz*. grain yield, straw yield and biological yield except harvest index was significantly influenced by the date of sowing and nitrogen levels at harvest stage. Productivity parameters *viz*. grain yield, straw yield, biological yield and harvest index increased with the combine use of N×D were found significant. The minimum grain yield, straw yield, biological yield and harvest index were noted 27.23, 33.74, 60.97 and 44.66 respectively in N1×D3 interaction. The maximum grain yield, straw yield, biological yield and harvest index were noted 35.21, 53.80, 89.01 and 39.55 in N3×D2 interaction. Comparative findings were detailed by and Kamrozzaman *et al*. (2016).

Table 3: Effect of different treatment combinations on productivity parameters.

Treatments		Grain Yield (q ha-1)	Straw Yield (q ha-1)	Biological Yield (q ha-1)	Harvest Index (%)
T1		28.35	35.22	63.57	44.59
T2		29.41	38.35	67.76	43.41
T3		27.23	33.74	60.97	44.66
T4		32.92	44.76	77.68	42.37
T5		33.78	47.24	81.02	41.69
T6		30.67	40.41	71.08	43.14
T7		34.56	50.34	84.90	40.70
T8		35.21	53.80	89.01	39.55
T9		31.88	42.52	74.40	42.84
C.D. at 5%	N	1.47	1.68	1.21	1.95
	D	1.47	1.68	1.21	1.95
	N×D	2.56	1.92	1.30	2.16
S.E(m)±	N	0.49	0.56	0.40	0.65
	D	0.49	0.56	0.40	0.65
	N×D	0.85	0.64	0.43	0.72

Economics

The data revealed that effect of different combination of date of sowing and nitrogen levels significantly affect the economics of wheat crop. In order to assured profitability net return and B: C ratio was worked out. The highest net return (Rs.42874 ha^{-1}) and benefit: cost ratio (1.82) was obtained from treatment when crop sowing at 15th November and fertilized with N @ 150 kg ha^{-1}. Similar finding were reported by Barthwal *et al.* (2013) [3].

Table 4: Effect of different treatment combinations on economics of wheat crop

Treatments	Total cost of Cultivation (Rs./ha)	Gross Return (Rs./ha)	Net Return (Rs./ha)	B:C Ratio
N1DI	40876	65930	25054	1.63
N1D2	40876	68848	27972	1.46
N1D3	40876	63303	22427	1.82
N2D1	41200	77523	36323	1.13
N2D2	41200	79876	38676	1.06
N2D3	41200	71902	30702	1.34
N3D1	41524	82223	40699	1.02
N3D2	41524	84398	42874	0.96
N3D3	41524	74868	33344	1.24

Conclusion

On the basis of result emanated from present investigation it can be concluded that sowing of wheat crop at 15th November with the application of nitrogen @ 150 kg ha^{-1} produces higher growth, yields, maximum net income and benefit: cost ratio under eastern-plain zone condition of U.P. Farmers Should be suggested to this area that sowing of wheat at 15th November and nitrogen use @ 150 kg ha^{-1} gives them better yield and profit.

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