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Maximising the wheat (*Triticum aestivum* L.) productivity by fine tuning sowing time and fertilizers rates

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Abstract
The present research entitled ''Maximising the wheat (*Triticum aestivum* L.) productivity by fine tuning sowing time and fertilizers rates." was carried out during rabi season of 2020-21 at the Instructional Farm Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.). It was laid out in split plot design having four sowing dates i.e D_1 (25th October), D_2 (5th November), D_3 (15th November) and D_4 (25th November) taken in main plot and three nutrient management option i.e NM_1 (RFD), NM_2 (150% RFD + FYM 15 t ha^{-1}) and NM_3 (150% RFD + FYM 15 t ha^{-1}+ Growth regulators) taken in sub plot. The crop sown on 5th November gave higher grain yield 46.33 q $ha^{-1}$and straw yield 49.53 q ha^{-1}. Wheat sown on 5th November recorded higher gross, net returns and benefit cost ratio (96614.75, 65922.75 Rs ha^{-1} and 2.14), respectively followed by 15th November sowing crop. Among the nutrient management option, maximum growth and yield parameters *viz*. number of tillers (m^{-2}), dry matter production (g $plant^{-1}$), grain yield, straw yield and harvest index were recorded the treatment NM_3 (150% RFD + FYM 15 t ha^{-1}+ Growth regulators) which was at par with NM_2 (150% RFD + FYM 15 t ha^{-1}) and significantly superior to NM_1 (RFD). The highest gross return and net return was found under NM_3 (150% RFD + FYM 15 t ha^{-1}+ Growth regulators) but B: C ratio was higher in NM_1 (RFD).

Keywords: Maximising, wheat, sowing time, fertilizer rate, productivity, ear, fine tuning

Introduction
Wheat is a self-pollinated crop which belongs to poaceae family with chromosome number of 42. In India, where rice accounts for approximately one-third of the country's total production of food grains, wheat (*Triticum aestivum* L.) is the most widely consumed staple and the second-most significant food crop. India is the world's second-largest producer of wheat, accounting for around 12 percent of worldwide wheat production. India is also the world's second-largest consumer of wheat, following China, and its demand for wheat is enormous and rising. Wheat has a 217.06 mha area, a global production of 775.8 mt, and a productivity of 3.52 t ha-1. With a total production of 107.9 mt and a productivity of 3.4 t ha-1, wheat has been grown on an area of 31.35 m ha in India (USDA, 2021). In Chhattisgarh, wheat occupies an area about 101.36 (000, ha), with a production of 162.7 (000, tonnes) and average productivity of 12.89 q ha^{-1}(Anonymous, 2019-20). Sowing time is one of the most important non-monetary factors which governs the productivity of wheat crops. Late sowing reduced crop duration, which ultimately reduced the biological as well as grain yield. Wheat is basically a short-day crop native to the temperate zone, and it requires a cool environment to thrive properly. Temperature is one of the primary climatic variables that affects when to sow a crop, how long certain phenophases last, and ultimately how productive a crop is. The date of sowing is a crucial management decision to maximize wheat grain productivity.

As a result of normal sowing's extended growing period and potential to collect more biomass than with late sowing, higher grain and biological yields were produced. (Singh and Pal 2003) [12]. In any region, choosing the right cultivars can maintain higher wheat productivity. When sown late, all wheat types often experience severe temperature stress that adversely impacts phenology, growth, and ultimately yield. (Hossain and da Silva, 2012) [6].

The productivity of wheat depends upon the nutrient supplying capacity of the soil and fertilizers schedule there on. Among the major nutrient, high yielding varieties of wheat have been found highly response to nitrogen fertilization. However, in absence of phosphorus, nitrogen remain unutilized. However, the increased fertilizer and manure use for obtaining higher productivity has led to another problem of lodging in wheat, especially under irrigated conditions.

This has resulted in reduced wheat yield as well as lowered the quality of the final produce. In an area of India where crops are grown intensively, a high annual output of crops causes significant nutrient losses, which are then not adequately replenished by chemical fertilizers and manures, leading to poor soil health. According to Mandal *et al*. (1992) [9], wheat is a significant cereal crop that needs a good supply of nutrients, particularly nitrogen, to grow. Under these circumstances, integrating the use of chemical and organic fertilizers and manures can be crucial in maintaining soil fertility and crop productivity.

Material and Method

Field experiment was carried out during *rabi* season 2020-21 at the Instructional cum Research Farm of BTC College of Agriculture and Research Station, Bilaspur, (Chhattisgarh) during rabi 2020-21. The treatment consisting of four dates of sowing as main plot *viz*. D_1 (25th October), D_2 (5th November), D_3 (15th November) and D_4 (25th November) with three nutrient management sub plot *viz.* NM_1 (RFD), NM_2 (150% RFD + FYM 15 t ha^{-1}) and NM_3 (150% RFD + FYM 15 t ha^{-1}+ Growth regulators) were laid out in split plot design with three replications. The crop was sown as per treatments using 100 kg seeds ha^{-1} at 20 cm rows apart. The soil of the experimental site was neutral in reaction (6.9) and clay in texture, the soil was slightly alkaline in reaction medium in organic carbon (0.60%) and low in available nitrogen (138 kg ha^{-1}), medium in phosphorus (12.18 kg ha^{-1}) and potash (186.14 kg ha^{-1}) and variety GW-366 A recommended fertilizer dose of 120:60:40:20 N:P:K kg ha^{-1} was applied through urea, Single super phosphate, murate of potash respectively. 50% nitrogen with full dose P and K was applied as basal dose at sowing time and remaining 50% nitrogen was applied in two equal split i.e. ¼ at after first irrigation (CRI) and second dose at second irrigation in all the treatments.

Results and Discussion

Effect on Grain yield

Data on grain yield of wheat which were recorded after harvest has been presented table 1. from the result, it was clearly shown the different date of sowing and nutrient management treatment made on effective and note worthily influences on the production of wheat. The average yield varied from 37.20 to 46.33 q ha^{-1} in different date of sowing treatment 5th November (D_2) produced appreciably higher seed yield (46.33q ha), as compare to 25th October (D_1) and 25th November (D_4), but significantly at par with 15th November (D_3) (44.28 q ha).

Among different nutrient managements grain yield was higher under treatment150% RFD + FYM 15 t ha^{-1}+ Growth regulators (NM_3) (44.83 q ha) followed by 150% RFD + FYM 15 t ha^{-1} (NM_2) (43.46 q ha^{-1}) the lowest grain yield was obtained under RFD (NM_1) (37.36 q ha^{-1}). Kushwaha and Singh (2002) found that the while 25% increase in the recommended level of fertilizer significantly increased the grain yield.

Interaction effect of date of sowing and nutrient management had non-significant.

Straw yield

Table 2 shows that straw yield of wheat followed the trend of variations similar to that of seed yield for different date of sowing treatment. Among nutrient management practices the treatment 150% RFD + FYM 15 t ha^{-1}+ Growth regulators (NM_3) recorded higher straw yield which was significantly superior then RFD (NM_1) and 150% RFD + FYM 15 t ha^{-1} (NM_2) under study. Thus the result confirms by Saikia and Kalita (2021) [14].

However, interaction effect between date of sowing and nutrient management has non-significant.

Harvest index

Data on harvest index of wheat which were recorded at harvest has been presented table 1. Among different date of sowing 5th November (D_2) recorded higher harvest index and 25th October (D_1) date of sowing treatment had the lower harvest index. However, the nutrient management practices could not bring about any significant difference for harvest index.

Non-significant interaction effect between sowing date and nutrient management for the harvest index was observed at harvest.

Table 1: Grain and straw yield (q ha^{-1}) and harvest index % of wheat as influenced by sowing dates and nutrient management

Treatment	Grain Yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest Index (%)
Date of sowing			
D_1 (25th Oct)	37.20	42.27	46.82
D_2 (5th Nov)	46.33	49.53	48.44
D_3 (15th Nov)	44.28	48.84	48.05
D_4 (25th Nov)	39.72	43.49	47.68
S.Em ±	1.13	0.87	0.38
C.D.(P=0.05)	3.90	3.01	NS
Nutrient Management			
NM_1 (RFD)	37.36	41.45	47.84
NM_2 (150%RFD+FYM 15t ha^{-1})	43.46	46.83	48.07
NM_3 (150%RFD+FYM 15t ha^{-1}+GR)	44.83	49.83	47.33
S.Em ±	0.85	0.96	0.47
C.D.(P=0.05)	2.55	2.88	NS
Interaction (A × B)			
S.Em ±	1.70	1.92	0.94
C.D.(P=0.05)	NS	NS	NS

Effect on Economics

Cost of cultivation (Rs ha^{-1})

The cost of cultivation among all the date of sowing treatment was same among all the date of sowing treatment (Rs 30,692) the cast of cultivation varies Rs 30692 to 41093 among nutrient management practices. the highest cast of cultivation is under 150% RFD + FYM 15 t ha^{-1}+ Growth regulators (NM_3) Rs 41,093 which was Rs 3000 higher than 150% RFD + FYM 15 t ha^{-1} (NM_2), this might be due to include of rates of growth regulators. The nutrient management RFD (NM_1) cast of cultivation was equal to cast of cultivation of date of sowing. (Table 2)

Gross return (Rs ha^{-1})

The higher gross return was observed under 5th November (D_2) (Rs 96614.75) next to 15th November (D_3) and lowest grass return was found under 25th October (D_1). Among nutrient management the treatment 150% RFD + FYM 15 t ha^{-1}+ Growth regulators (NM_3) recorded highest grass return (Rs 93,772.25) next to 150% RFD + FYM 15 t ha^{-1} (NM_2) (Rs 90,684) the lowest grass return was found under RFD (NM_1) (Rs 78,135.50).(Table 2)

Net return (Rs ha^{-1})

Among different date of sowing treatment 5th November (D_2) recorded highest net return (Rs 65922.75) as compare to 15th November (D_3) and 25th November (D_4) the lowest net return was registered under 25th October (D_1). The application of 150% RFD + FYM 15 t ha^{-1}+ Growth regulators (NM_3) fond higher return Rs 52,697 which was Rs 5,253.50 higher than RFD (NM_1) (Rs 47443.50). (Table 2)

Benefit: cost ratio

The higher B:C ratio was observed under 5th November (D_2) (2.14) next to 15th November (D_3) (2.01), lowest B:C ratio was under 25th October (D_1) among different date of sowing. The application of RFD (NM_1) recorded higher B:C ratio 1.54 then 150% RFD + FYM 15 t ha^{-1} (NM_2) and 150% RFD + FYM 15 t ha^{-1}+ Growth regulators (NM_3) these might be due to higher cost of cultivation under 150% RFD + FYM 15 t ha^{-1} (NM_2) and 150% RFD + FYM 15 t ha^{-1}+ Growth regulators (NM_3).

Table 2: Cost of cultivation (Rs. ha^{-1}), Gross return (Rs. ha^{-1}), Net return (Rs. ha^{-1}) and B:C ratio of wheat as influenced by sowing dates and nutrient management

Treatment	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Date of sowing				
D_1 (25th Oct)	30,692.00	77,950.50	47,258.50	1.53
D_2 (5th Nov)	30,692.00	96,614.75	65,922.75	2.14
D_3 (15th Nov)	30,692.00	92,565.00	61,873.00	2.01
D_4 (25th Nov)	30,692.00	82,984.50	52292.50	1.70
Nutrient Management				
NM_1 (RFD)	30,692.00	78,135.50	47,443.50	1.54
NM_2 (150% RFD+FYM 15t ha^{-1})	38,093.00	90,684.00	52,592.00	1.38
NM_3 (150% RFD+FYM 15t ha^{-1}+GR)	41,093.00	93,772.25	52,697.00	1.28

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