Effect of Date of Sowing on Yield Attribute, Yield and Profitability of Wheat (*Triticum aestivum* L.) Varieties in Central Plain Zone of Uttar Pradesh, India

Abstract

To investigate the Effect of Date of Sowing and Wheat varieties on Yield Attributes, Yield and the profitability of wheat**. A** field experiment was conducted at the Students' Instructional Farm of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Utter Pradesh (UP) during *Rabi* 2021-22 growing seasons. A split plot design with four replications was used in this study. The experimental treatments were date of sowing as main factor (D_1-15th November, D_2-30th November, D_3-10th December) and wheat varieties as sub-factor (V_1-DBW-187, V_2-K-1006, V_3-HD-2967). The result of this study showed the interaction effect of Date of Sowing and Varieties of wheat is non-significant. In the different date of sowing, the 15th November sown crop resulted in significantly higher spike length (10.67 cm), spike weight (3.147g), number of grains spike^{-1} (53.55), 1000- grain weight (42.06 g), grain yield (52.81 q ha^{-1}), gross income (INR ha^{-1} 118837.667), net income (INR ha^{-1} 49087.66) as well as B:C ratio (1.7), of wheat as compared to 30th November, 10th December. Among wheat varieties, HD-2967 resulted the highest values of Yield Attributes *viz.* spike length (10.44 cm), number of grains spike^{-1} (52.41), 1000- grain weight (40.85 g), Yield *viz.* grain yield (51.38 q ha^{-1}) and Profitability *viz.* gross income (INR ha^{-1} 115612.66), net income (INR ha^{-1} 45862.66) as well as B:C ratio (1.65), The greatest grain yield was obtained with HD-2967 variety sowed on 15th November. Thus, it is possible to maximize the Yield attributes, Yield and the Profitability of wheat by sowing HD-2967 variety on 15th November.

Keywords*- Wheat; Varieties; Date of Sowing; Yield; Profitability***;**

1. Introduction

Wheat (*Triticum aestivum* L.*)* is the king of cereals and one of the most significant staple food crops, belonging to Poaceae family is grown in at least 43 nations throughout the world (Kumar & Abraham, 2018). About 20% of the world's protein supply comes from wheat alone, and about 35% of the population depends directly or indirectly on it for nourishment (Petrusán *et al*., 2016) Humans mostly consume wheat as food. It can be easily transformed into a variety of foods, is concentrated, easy to store and transport, and is nutrient-rich. Wheat crop contributes substantially to the national food security by providing more than 50% of the calories to the people who mainly depend on it (Shiferaw *et al.*, 2013).

Wheat is a very adaptable crop and is grown under a wide range of soil and climatic condition (Kamran *et al*., 2014). The crop is most successfully grown between latitude of 30° N to 60° N and 27^{o} S to 40^{o} S in the world, with a high altitude of 5000 m. In India wheat is grown from 11° N to 30° N and from sea level up to an elevation of 3658 m in the Himalayas. In India, it is grown mostly in the plain, whereas, in the hill, it is cultivated in hill regions of North India under a wide range of climate conditions from Kashmir and other hilly regions of semi-arid regions with mild to severe winter. In India, wheat occupies second place after rice both area and production (Mahajan *et al*., 2017). The demand for wheat in the country will reach 140 million tons by 2050 (Ramadas *et al.*, 2019). Most of the demand in production can be managed by increasing productivity as the land area under wheat is not expected to expand. Efficient input management along with varietal improvement is the two basic elements that can help in achieving the target (Sharma *et al.*, 2015).

In India, wheat is generally planted as a ***Rabi*** crop during the winter months. Rabi crops in India are sown about October -November and harvested during March-April [Chowdhury et al, 1990]. It is grown in practically all of India's states, although only Uttar Pradesh, Punjab, Haryana, Bihar, and Gujarat can afford to grow it, due to environmental conditions. The majority of the nation's wheat is grown in the northern region (India) due to its favorable climatic condition. The ideal temperature range for the wheat crop during the growth season is between 20-22 ^{0}C at sowing, 16-22 ^{0}C from tillering to grain filling stage, and slowly rises to 40 ^{0}C at harvest time (Sarbaz *et al.*, 2022). Sowing takes place between the first weeks of October to the latter week of December. Due to high farming intensity, a delayed harvest of the preceding crop, or other factors, the sowing of wheat is delayed in several areas of the Uttar Pradesh (UP).

A 4-5-day heat spike at any growing stage can reduce wheat output (Spiertz *et al*., 2006). For every 1-3^{o}C increase in temperature, optimal planting period will advance by 5-8 days. This development is slower in cooler regions (Kalra *et al*., 2008), and even a brief aberrant temperature rise can cause large grain losses (Alexander *et al*., 2010). Sowing timing affects wheat phenological development, yield, and biomass conversion (Dar *et al*., 2018). Timely sown wheat will develop, accumulate more biomass, and have a greater grain and biological yield. Late seeding exposes wheat to low temperatures during germination and seedling emergence, whereas high temperatures during the reproductive stage force maturity and lower grain output and biological yield (Gupta *et al*., 2017).

Early October sowing results in weak-rooted plants, due to temperatures above the optimum range cause improper germination, embryo death, and endosperm decomposition from bacterial or fungal activity. These factors affect seedling emergence and tiller quantity, lowering economic yield (Thakar and Dhaliwal, 2000). Improper variety selection impacts agricultural output since variety performance varies by genetic potential and environment. Multi-character high-yielding cultivars can boost wheat output (Hussain *et al*., 2012). Stress levels affect crop development and output. Temperature impacts winter crop yield in India, specifically. Heat unit requirement measures wheat's temperature sensitivity (Rezaei *et al*., 2015). Solar radiation impacts crop growth, blooming, and grain production in addition to temperature. Temperature and humidity are the most important elements to consider when analyzing wheat's thermal response and its requirements at different phenophases (Didal *et al*., 2022).

Using temperature units, crop maturity dates are determined. Plants must achieve a certain temperature to change phenological phases. To forecast phenology and agricultural yield across large areas, a crop model is needed. Temperature affects agricultural output during *rabi* season (Hanif *et al*., 2010). Temperature affects grain yield through phenological development. Winter crops are particularly sensitive to high temperatures during reproductive periods, and different crops respond differently to temperature change (increase).

Due of the significant inter-annual variations in production brought on by temperature variations, Central India is a good place to observe the impact of temperature on wheat productivity (Ray *et al*., 2015). The rate of temperature change has a significant impact on wheat productivity. In North India, a 10°C increase in temperature during the growing season will have no impact or hardly enhance productivity. But in most regions, a 20°C temperature increase decreased the amount of grain that could be produced (Agrawal and Sinha, 1993).

Given the foregoing information, the following goals were set for the current study which was carried out during the *Rabi* season of 2021–2022. Therefore, efforts ought to be made to minimize the effect of temperature variation caused due to changed sowing date by choosing appropriate wheat varieties which can synchronize its temperature requirement. The present study was conducted to determine the ideal timing of seeding wheat varieties in relation to weather parameters, to investigate the impact of weather parameters on the yield attributes and yield of wheat varieties and to calculate the costs and benefits of various therapies.

2. Materials and Methods

2.1 Experimental Site

The field experiments was conducted at Student's Instructional Farm (SIF) at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, and generated weather data of wheat crop during the *Rabi* season of 2021-22 from Agro-meteorological Observatory, Department of Agronomy. The experiment farm falls under the Indo-Gangetic alluvial tract of Uttar Pradesh.

2.2 Climatic Conditions

Geo-graphically, Kanpur is situated in the central part of Uttar Pradesh and the sub-tropical semi-arid tract of North India. The Kanpur-city district lies between 26^0 29' 35" North latitude and 80^0 18' 25" East longitudes and is located on an elevation of about 125.9 meters above mean sea level in Gangetic plain. Kanpur City is situated in the central plain zone of Uttar Pradesh which is located on the right bank of the holy river the Ganga and falls under the upper Indo-Gangetic plain zone of India. The average annual rainfall is about 885.6 mm out of which normally about 88.70% is received during July to September. The ranges of minimal and maximal temperature during the wheat growing period from 7.1°C to 42.2°C as compared to normal or long term means, the data was provided by metrological observatory unit of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur.

2.3 Soil Characteristics

The soil as a medium of plant growth is bound to affect profoundly the rate of growth of plants and ultimately the final yield through its properties. The general characteristics of experimental field were sandy clay loam, Organic Carbon (0.52%), Available nitrogen (148 kg ha^{-1}), Available P_2O_5 (22.60 kg ha^{-1}), Available K_2O (235.50 kg ha^{-1}) and pH (7.2). Nutrient concentration in soil was low to grow wheat crop to enhance production recommended dose of fertilizer was applied.

2.4 Experimental Details

The experiment was laid out in split plot design with four replications. The experimental treatments were date of sowing as main factor *viz.* 15th November (D_1), 30th November (D_2), 10th December (D_3) and wheat varieties as sub-factor *viz.* DBW-187 (V_1), K-1006 (V_2), HD-2967 (V_3). The size of each plot was (24 m^2), 6.0 long and 4.0 m width.

2.5 Crop Varieties:

(a) K-1006 (Shekhar): It was released from Chandra shekhar Azad University of Agriculture & Technology (U.P.) Kanpur in 2014. The optimum time of sowing of this variety ranges from the 1st week of November to the 2nd week of December and its yield potential is 50-60 q ha^{-1}.

(b) HD-2967: It was released from the Indian Agricultural Research Institute Pusa Delhi in 2013. The optimum time of sowing of the variety range from the 1st week of November to the 2nd week of December and its yield potential is 50-60 q ha^{-1}.

(c) DBW-187 (Karan Vandana): It was released from Indian Institute of Wheat and Barley Research, Karnal, Haryana. This variety is recommended for irrigated timely sown condition NWPZ (Punjab, Haryana, Delhi, Rajasthan and Western U.P.). Resistant to stripe and leaf rust, highly resistant to wheat blast, moderate resistance to karnal bunt and tolerance to loose smut with average yield of 61.3 q ha^{-1} and Potential Yield of 96.6 q ha^{-1}.

2.6 Agronomical Practices

The field was prepared well at proper soil moisture level after pre-sowing irrigation which was given about 10 days before the sowing date. The first ploughing was done by tractor-drawn rotavator followed by two cross ploughing with cultivator followed by planking and sowing through seed drill and planking to make the soil firm, friable, and level to ensure proper germination of seed and subsequent growth of the crop. Certified seed of wheat varieties DBW-187 (V_1), K-1006 (V_2), HD-2967 (V_3), were timely sown on 15th November (D_1), 30th November (D_2), and 10th December (D_3). Sowing was done manually at proper moisture with a uniform seed rate of 100 kg ha^{-1} and planking was done properly to cover the seeds in the furrows. The crop was fertilized uniformly at the rate of 120 kg N, 60 kg P_2O_5, and 40 kg K_2O ha^{-1}. For weed control Application of Clodinafop-propargyl (Topik) @ 60-80 g a.i. ha^{-1} & Metsulfuron-methyl @ 4-8 g a.i. ha^{-1} was applied uniformly at 30-35 DAS in each treatment. The experiment was conducted under irrigated condition and five irrigations (including one pre-sowing irrigation) were applied. The crop was first irrigated at the crown root initiation (CRI) stage (21-25 DAS) in all the treatments and the remaining three irrigations were given after 20-25 days interval to fulfillment of the crop water requirement. In general, the crop was harvested when the ear head turned golden yellow in color and leaves and stem became dry. The plants were cut close to the ground and kept for drying. Net plot of 16 m^2, leaving borders from each treatment were harvested, bundled, and tagged separately. Bundles were brought to the threshing floor and weighted after complete drying in the sunlight. Threshing was done plot-wise by thresher, yield data of grain and straw were recorded carefully.

2.7 Observations Recorded

The appropriate sampling technique implies that proper balance in sampling to achieve maximum precision at minimum cost. Following this principle, the various observations were recorded from four tagged plants in each plot. Yield and Yield attributes were recorded per plot basis and then converted to q ha^{-1}.

2.7.1 Yield Attributing Characteristics:

a) Length of the Ear (cm):

Length of four selected ears from each plot as measured carefully from the neck node to the tip of last grain and averaged out to get the length of a single ear.

b) Number of Grains ear^{-1}:

The total yield from randomly selected ears was threshed and seeds were counted and averaged to get the number of grains per ears.

c) Grain Weight per Spike (g):

The total yields of grain from four randomly selected tagged plants were balanced manually from each replication of variety. Average was worked out and recorded as yield (g) of grain spike.

d) Test Weight (g):

One thousand grains from a composite sample of each plot was taken, weighed separately, and recorded in grams.

2.7.2 Yield

a) Grain Yield (q ha^{-1}):

After measuring the bundle weight of the harvested produce of each plot (16 m^2), the grains were separated by threshing plot wise. The grains thus obtained after threshing the produce from each net plot were air-dried to maintain 12 % moisture and grain yield was recorded in (kg $plot^{-1}$) which was further multiplied with conversion factor in order to get in (q ha^{-1}).

2.7.3 Profitability of Treatments:

a) Gross Return (INR ha^{-1}):

Gross return was worked out based on grain and straw yield of wheat obtained under treatments considering the prevailing current year MSP of crop and local price of straw (INR ha^{-1}).

b) Net Return (INR ha^{-1}):

Net returns for individual treatment were worked out by deducting the total cost of cultivation of each treatment from gross returns of respective treatments (INR ha^{-1}).

c) Benefit: Cost ratio:

Benefit: Cost ratio of each treatment was calculated by dividing gross return by the Cost of Cultivation of the respective treatment.

$$\text{B: C ratio} = \frac{\text{Gross return (INR } ha^{-1})}{\text{Cost of cultivation (INR } ha^{-1})}$$

2.8 Statistical Analysis:

The allocation of different treatments in the plot was allotted as per design in the main plot and sub-plot. The data recorded on different Yield attributes, Yield and Profitability during the investigation was subjected to the data were analyzed statistically with the help of window-based SPSS (Statistical Product and Service Solutions) Version 10.0, SPSS, Chicago,IL software. ANOVA technique in a split-plot design and significant means were separated by least significant difference test (Gomez & Gomez, 1984).

3. Results and Discussion

The significant interaction effect was observed between date of sowing and varieties on yield attributes, yield and profitability, but the interaction effect in date of sowing and varieties were non-significant.

3.1 Yield Attribute

The perusal of the analysis results (Tables 1) reveals that on 15th November sown crop was found significantly better than 30th November and 10th December. The increment recorded under different yield attributes varied to the tune in length of ear 10.67cm (18.12 %), ear weight 3.147g (17.47%), No. grains per ear^{-1} 53.55 (17.38%), test weight 42.06g (10.00%), under 15th November sown crop compared to 10th December sowing. The better yield attributes under 15th November sowing is probably due to the good vegetation at early sowing compared to 10th December sowing. The variety HD 2967 recorded better yield attributes varied the tune in the length of the ear 10.44cm (10.88%), ear weight 3.08g (11.83%), No. grain ear^{-1} 52.41 (10.87%), and test weight 40.85g (5.85%) compared to the variety K-1006. Similar findings were also reported by (**Dwivedi *et al.*, 2015), (Kaur *et al.*, 2015**), (**Bashir *et al.*, 2016), (Hussain *et al.*, 2018), (Lal, 2019), (Ravichandran *et al.*, 2020).**

3.2 Yield

The data showed to the yield of wheat was significantly influenced by different dates of sowing and varieties. The grain yield increased to the tune of 52.81 q ha^{-1} (7.28%) and (24.05%) in the 15th November sown crop compared to 30th November and 10th December sown crop, respectively. These differences are primarily due to the differences in the environmental conditions and growth habit of the crop as evidenced from the variation in crop growth and yield parameters with date of sowing (Meena *et al*., 2017). Among the varieties, HD 2967 produced higher grain yield 51.383 q ha^{-1} (15.5%), compared to K-1006. It might be due to better genomics characters as well as better growth characteristics and yield attributes of the variety HD 2967 achieved under favorable climatic conditions. Similar findings were reported by **(Singh *et al.*, 2006), (Jat *et al.*, 2013), (Kumar *et al.*, 2018), (Mohammad *et al.*, 2019), (Lal, 2019),** (**Amarjeet *et al.*, 2020), (Tripathy *et al.*, 2020).**

3.3 Profitability

The overall effect of date of showing on 15th November sown crop found excellent in terms of profitability over other date of sowing *viz.* 30th November, 10th December (Table 2). The 15th November sown crop, recorded more gross return (INR ha^{-1} 118837.66), net return (INR ha^{-1} 49087.66) and B: C ratio (1.7) as compared to 10th December sown crop. Among the wheat varieties, HD-2967 recorded more grass return (INR ha^{-1} 115612.66), net income (INR ha^{-1} 45862.66) and B: C ratio (1.65) compared to K-1006 variety. The above findings are matched with findings of **(Bachhao *et al.*, 2018), (Maurya *et al.*, 2014) and (Mukherjee, 2012), (Netam *et al.*, 2020).**

Table 1: Effect of Date of Sowing and Varieties on Yield Attribute and Yield of Wheat

Treatments	Yield Attributes				Yield
	Spike Length(cm)	Spike Weight (g)	Number of Grains/Spike	Test Weight(g)	Grain Yield (q ha^{-1})
Date of Sowing					
D_1-15th Nov	10.673	3.147	53.553	42.060	52.817
D_2-30th Nov	9.937	2.930	49.857	39.660	48.970
D_3-10th Dec	8.817	2.597	44.240	37.150	43.857
SE(d)±	0.162	0.051	0.539	0.244	0.509
C.D. (P=0.05)	0.396	0.124	1.316	0.595	1.242
Varieties					
V_1-DBW187	9.670	2.850	48.523	39.553	47.933
V_2-K1006	9.310	2.743	46.710	38.467	46.327
V_3-HD2967	10.447	3.080	52.417	40.850	51.383
SE(d)±	0.162	0.051	0.556	0.250	0.566

C.D. (P=0.05)	0.396	0.119	1.169	0.526	1.190
Interaction					
V x D					
SE(d)±	0.301	0.098	0.964	0.434	0.981
C.D. (P=0.05)	NS	NS	NS	NS	NS
D x V					
SE(d)±	0.291	0.094	0.949	0.428	0.932
C.D. (P=0.05)	NS	NS	NS	NS	NS

Table 2: Effect of Date of Sowing and Varieties on Profitability of wheat

Treatments	**Gross return (INR ha^{-1})**	**Net return (INR ha^{-1})**	**B:C ratio**
Date of sowing			
D_1-15th Nov	118837.667	49087.667	1.703
D_2-30th Nov	110183.000	40433.000	1.580
D_3-10th Dec	98677.667	28927.667	1.417
SE(d)±	757.258	335.110	0.044
C.D. (P=0.05)	1848.071	704.172	0.108
Varieties			
V_1-DBW187	107850.333	38100.333	1.547
V_2-K1006	104235.333	34485.333	1.497
V_3-HD2967	115612.667	45862.667	1.657
SE(d)±	779.567	335.110	0.050
C.D. (P=0.05)	1848.071	704.172	0.105
Interaction			
V x D			
SE(d)±	1350.250	580.427	0.087
C.D. (P=0.05)	NS	NS	NS

D x V			
SE(d)±	1330.869	565.449	0.082
C.D. (P=0.05)	NS	NS	NS

4. Conclusion

The 15th November sown crop recorded better yield attributes and grain yield (52.817 q ha^{-1}) of wheat. Among wheat varieties, HD-2967 exhibited maximum yield attributes and grain yield (51.383 q ha^{-1}) compared to other varieties *viz.* K-1006, DBW-187. The economic parameters of 15th November sown crop recorded maximum gross income (INR ha^{-1} 118837.66), Net income (INR ha^{-1} 49087.667) and B:C ratio (1.703). Among varieties, HD-2967 recorded maximum gross income (INR ha^{-1} 115612.66), net income (INR ha^{-1} 45862.667) and B: C ratio (1.65) compared to varieties *viz.*K-1006, DBW-187. As the results of the experiment are based on one year data. To get a more accurate result, one more experiment needs to be done on the same land and under the same weather conditions.

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