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Performance of new wheat (*Triticum* spp.) varieties on different dates of sowing

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Abstract
The trials were carried out at the Research Farm, College of Agriculture, RVSKVV; Gwalior (M.P.) in the academic years 2013-14 and 2014–15. The treatments included five varieties (HD 4730, HI 8737, MPO 1215, HD 4728, and HI 8498) and two sowing dates (timely and late). Three replications of the spilt-plot design experiment were carried out. The primary plot treatments were the dates of planting, while the sub-plot treatments were the varieties. Additional sets of procedures were carried out in accordance with the recommendation for the wheat crop. Under late sowing, there were decreases in the following growth parameters: plant population/m^2, number of tillers/m^2, dry weight/25 cm row length (g), and number of spikes/m^2), physiological character (CGR), yield attributing traits (number of days to spike emergence, number of grains/spike, and grain test weight (g), and quality traits (protein content in grain (%)).When comparing late-sown crops to timely-sown ones, the greater value of grain and straw production as well as HI was noted. HD 4728 recorded the highest values for growth parameters, physiological characteristics, yield-attributing features, and quality attributes, whereas variety HI 8498 recorded the lowest values. Variety HD 4728 outperformed the other cultivars in terms of grain and straw yield as well as HI values. In comparison to the other interactions, the timely sowing condition of variety HD 4728 produced considerably better values of grain and straw yield per hectare. The variety HD 4728, when seeded on time, provided the greatest gross monetary return value and B C ratio (₹ 123876/ha and ₹4.26, respectively).followed by timely sown HI 8737.

Keywords: Date of sowing, growth characters, variety, yield attributes, yield

1. Introduction
Triticum aestivum (L.) wheat is one of India's most significant grain crops. During the Indian agricultural green revolution, this crop's acreage, productivity, and production have all increased dramatically. Winter wheat is nearly solely grown in India. Winter wheat is sown from around the first week of October to the end of December. There are several variables that contribute to the poor average wheat yield.

One of these environmental influences is late planting, which has a significant impact on wheat crop output (Saini, *et al*., 1988) [9]. The amount of time seeded has a major impact on grain and straw yields, growth, and yield qualities. Lack of improved varieties with short maturities and appropriate for late sowing conditions because of the crop's comparatively shorter growth cycle is another significant factor. New wheat varieties that have just been created may eventually take the place of the command area's long-standing, well-established types. In northern Madhya Pradesh, agronomically adjusting the planting timing using recently produced cultivars would increase wheat output.

Due to the delayed harvesting of Kharif crops, which causes a delay in the sowing of wheat, wheat is typically produced in multiple cropping systems throughout the Rabi season in the irrigated northern section of Madhya Pradesh. As a result of this Grain yield is subsequently reduced from 27 to 33%, with a mean drop of 45 kg grain/ha/day (Sardana *et al*., 2002) [10]. Wheat cultivars with a photo and thermo insensitive character often fit a larger variety of sowing times in irrigated conditions because they may retain a high level of seed output even when seeded late. In recent years, new wheat varieties have been produced that have better yield potential even under delayed planting and a higher degree of tolerance to high temperatures, as well as disease and insect pest resistance on a larger scale. Keeping the aforementioned factors in mind, the current study was done to evaluate the performance of novel wheat varieties to a broader range of planting dates in irrigated circumstances in the agro-ecosystem of Northern Central India which is Madhya Pradesh.

2. Materials and Methods

The trials were carried out at the Research Farm, College of Agriculture, RVSKVV, Gwalior (M.P.) in 2013-14 and 2014-15. The field's terrain was consistent, with a very minor slope from east to west and adequate drainage.

Gwalior is located in north Madhya Pradesh, between 26°13' North latitude and 78°14' East longitude, at an elevation of approximately 206 m above mean sea level. The climate is subtropical. Summers are long and hot. The mean monthly maximum temperature ranges from 38.5 °C to 47 °C from May to June, while the mean minimum temperature ranges from 0 °C to 4 °C from December to January. The average annual rainfall is around 751 mm, which is dispersed over a three-month period from the middle of June to the end of September.

The experimental plot's soil was sandy clay loam. The study included 10 treatment combinations consisting of two planting dates (Timely and late) and five novel wheat varieties (HD 4730, HI 8737, MPO 1215, HD 4728, HI 8498) delivered in wheat replicated three times in split plot design. The row spacing was set at 20 cm, while the seed rate was set at 100 kg/ha. During the crop growing season, all standard packages of practices of wheat were followed.

Five crop plants were chosen at random from the net area of each plot, and they were labelled so that thorough observations could be made and all plant characteristics could be examined. The technique outlined by Panse and Sukhatme (1967) [5] was followed in the independent analysis of the data acquired on the different traits. For those characters alone, the critical difference (C.D.) value was computed at the 5% significance level.

3. Results and Discussion

The effects of the experimental variables - sowing dates (D), varieties (V), and their interaction (D x V) - are explained based on pooled data from two years, in the order that they appear in the analysis of variance tables.

3.1 Growth characters

The findings showed that the interactions between varieties, dates of sowing did not significantly affect the variations in plant population/m^2 reported at the initial and harvest phases. On the whole, nonetheless, early sowing resulted in a higher plant population than late sowing (Table 1).

Under timely seeded conditions, all growth characteristics (i.e., number of tillers/m^2 and dry weight/25 cm row length (g)) were considerably better than under late sown conditions. This might be because the temperature and other climatic factors were beneficial for plant development when the varieties were sowed on time. When a crop is late-sown, there is less time available for the expression of different phenophases, especially the process of grain filling. This is due to delayed emergence of seedlings caused by low temperature during the sowing time and early maturity due to high temperature during the reproductive phase (Randhawa, *et al*., 1992) [7]. These outcomes agree with Singh's (2010) [11] conclusions. Because of its innate qualities, variety HD 4728 recorded the highest plant height by a large margin. HD 4728 recorded the highest value of growth features (Table 1). Under HI 8498, much lower levels were observed. Their innate qualities may be the cause of the variations in growth traits caused by variants. Ranjana Suresh Kumar (2013) [8] achieved similar findings.

3.2 Physiological characters

CGR performed noticeably better when seeded on time. This might be because the temperature and other meteorological factors were advantageous for the physiological traits under the timely sowing conditions. Verma *et al*. also achieved the comparable outcomes (2003) [12].

The CGR value of variety HD 4728 was found to be substantially higher than that of the other variations (Table 1). The lowest value was noted in accordance with MPO 1215 and HI 8498.As a result of the innate qualities of the variations, we have now seen certain physiological differences between them. Ranjana Suresh Kumar (2013) [8] also achieved the similar findings.

3.3 Yield attributes

Sowing dates had a substantial impact on a variety of yield parameters, including test weight (g), number of grains/spike, number of days to spike emergence, and number of spikes/m2. When compared to late-sown crops, the timely-sown crop yielded considerably higher values of all yield parameters (Table 2). A greater temperature was experienced by the late-planted crop during the time of reproductive development. Compared to other meteorological indicators, temperature displayed a complicated association with spikelet development, ripening, and grain production (Saini, *et al*., 1988) [9].

This showed that for every 1 °C increase in temperature over a mean of 15 °C, there was a typical 3-4% drop in yield per ear. The increased amount of time available for improved resource management and potential expression throughout growth may be the cause of the yield characteristics' improvement. The late-sown crop, which stays in the milk stage during the hot weather, produced immature and wrinkled grains.

On the opposing end, the crop that was sown in a timely manner reaped several benefits. It underwent a satisfactory period of vegetative growth and eventually entered the stage of earing, where the temperature conditions were highly favorable. As the temperature gradually increased thereafter, the crop maintained an ideal balance between grain development and maturity. This synchronization between temperature and crop growth was evident from the test weight and the number of grains per spike. These outcomes align with the research findings of Singh (2010) [11], further validating the relationship between temperature and crop yield. According to Table 2, Variety HD 4728 displayed considerably higher yield attributing characteristics compared to the other varieties. This observed increase in yield could potentially be attributed to the genetic makeup of Variety HD 4728. These findings align with the research conducted by Chaudhary and Singh in 2007 [1], who also reported similar results.

3.4 Yield

Under late seeding, grain yield per hectare was reduced by 23.73%. In comparison to timely seeding, late sowing resulted in a yield drop of 989 kg/ha. In a similar vein, late-planted crops showed considerably lower straw production and HI as compared to timely-planted crops (Table 3). In comparison to late sowing, stronger plant development resulting to considerably more growth and yield qualities, bold grains, and better partitioning of photosynthates may be the cause of the higher value of grain and straw yield as well as the superior

value of HI under timely sown crop. The maximum yield was similarly obtained by R. Kumar *et al*. (1994) [6] from a wheat crop that was sown on time; late-planted crops produced lower yields of grain and straw. These outcomes also support the conclusions made by Dubey *et al*. (2008) [3].

Grain and straw yield per hectare, as well as HI, were measured at a much higher value for variety HD 4728 than for variety HI 8498.

In comparison to the other interactions, the variety HD 4728's interaction under timely sowing conditions produced noticeably higher values of grain and straw production per hectare (Table 3). These outcomes also support the conclusions made by Nagarjuna *et al*. (2014) [4].

Varieties' yields varied due to notable variations in growth factors, yield features, and genetic characteristics. These outcomes also support Chaudhary and Singh's (2007) [1] findings.

3.5 Quality characters

Timely sowing of crops has been observed to have a significant impact on the protein content, resulting in a maximum protein content of 11.91% compared to late sowing. This increase in protein content can be attributed to the improved distribution and utilization of photosynthates within the plants. These findings are supported by the research conducted by Singh (2010) [11].

Variety HI 8498 had the lowest protein content value, whereas variety HD 4728 recorded a much higher value (12.38%) than the other varieties (Table 3). This might be because to the variety's genetic characteristics. These outcomes also support the conclusions made by Zende *et al*. (2005b) [13].

3.6 Economics

The results presented in Table 4 demonstrate that all the different varieties showcased a higher gross monetary return and B: C ratio when they were sown in a timely manner, as opposed to being sown late. Among the varieties, HD 4728 displayed the highest value of gross monetary return and B: C ratio (₹123,876/ha and ₹4.26, respectively) when sown on time. Following closely behind was HI 8737 when sown in a timely manner. These findings suggest that there was a more efficient distribution of photosynthates in the respective crop condition, resulting in these improved outcomes. These results further support the findings of Chourasiya *et al*. (2013) [1].

Table 1: Growth characters of wheat as influenced by sowing dates and varieties (pooled)

Treatments	Plant population/m²						Number of tillers/m²			Dry weight/25 cm row length (g)			Crop growth rate (CGR) (g/m²/day)		
	At initial			At harvest			At harvest			At harvest			60 to 90 DAS		
Date of sowing/Varieties	Timely	Late	Mean	Timely	Late	Mean	Timely	Late	Mean	Timely	Late	Mean	Timely	Late	Mean
HD 4730	119.00	117.83	118.42	116.48	114.29	115.39	359.88	343.05	351.47	284.42	235.38	259.90	120.88	92.39	106.63
HI 8737	119.66	118.67	119.16	117.24	114.98	116.11	361.08	344.50	352.79	295.15	257.66	276.41	121.15	108.94	115.05
MPO 1215	118.16	117.17	117.67	114.98	113.48	114.23	355.82	319.16	337.49	267.07	217.81	242.44	107.76	85.64	96.70
HD 4728	120.51	119.34	119.92	118.16	115.64	116.90	365.62	345.38	355.50	318.85	274.98	296.91	131.00	110.76	120.88
HI 8498	117.51	116.33	116.92	114.32	112.47	113.39	346.26	316.98	331.62	257.83	208.61	233.22	104.78	85.27	95.02
Mean	118.97	117.87		116.23	114.17		357.73	333.81		284.66	238.89		117.11	96.60	
Comparing the mean of	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)
Dates of sowing	1.64		NS	1.49		NS	5.34		14.83	7.91		21.97	3.56		9.88
Varieties	2.22		NS	2.25		NS	5.56		11.33	10.08		20.53	4.77		9.71
D x V	3.25		NS	3.21		NS	8.83		NS	15.01		NS	7.00		NS

Table 2: Yield attributes of wheat as influenced by sowing dates and varieties (pooled)

Treatments	Number of days to spike emergence			Number of grains/spike			Grain test weight (g)			Number of spikes/m²		
Date of sowing / Varieties	Timely	Late	Mean	Timely	Late	Mean	Timely	Late	Mean	Timely	Late	Mean
HD 4730	85.32	80.86	83.09	41.16	37.98	39.57	36.98	33.11	35.05	325.62	313.23	319.43
HI 8737	87.49	81.83	84.66	43.18	39.03	41.11	38.28	34.99	36.64	333.22	319.45	326.33
MPO 1215	81.82	79.33	80.58	37.58	34.84	36.21	33.60	30.42	32.01	318.68	307.12	312.90
HD 4728	88.67	84.17	86.42	46.66	39.84	43.25	39.54	37.43	38.48	339.20	320.35	329.78
HI 8498	79.67	78.33	79.00	35.73	33.50	34.62	32.83	30.97	31.90	315.28	288.03	301.66
Mean	84.59	80.91		40.86	37.04		36.24	33.38		326.40	309.64	
Comparing the mean of	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)
Dates of sowing	0.81		2.25	0.58		1.61	0.48		1.34	2.04		5.65
Varieties	1.71		3.49	1.06		2.16	1.32		2.69	7.31		14.89
D x V	2.31		NS	1.46		NS	1.74		NS	9.47		NS

Table 3: Yield and quality parameters of wheat as influenced by sowing dates and varieties

Treatments	Grain yield (kg/ha)			Straw yield (kg/ha)			Harvest Index (%)			Protein content in grain (%)		
Date of sowing / Varieties	**Timely**	**Late**	**Mean**	**Timely**	**Late**	**Mean**	**Timely**	**Late**	**Mean**	**Timely**	**Late**	**Mean**
HD 4730	5817	4638	5228	8060	6533	7296	41.92	41.53	41.73	11.91	11.04	11.47
HI 8737	5874	4858	5366	8268	6382	7325	41.53	43.22	42.38	12.00	11.47	11.73
MPO 1215	4169	3051	3610	5637	3971	4804	42.53	43.45	42.99	11.61	10.62	11.11
HD 4728	5961	5392	5677	8616	7536	8076	40.88	41.72	41.30	12.99	11.77	12.38
HI 8498	3965	2902	3433	5237	3748	4493	43.08	43.67	43.37	11.01	10.48	10.75
Mean	5157	4168		7163	5634		41.99	42.72		11.91	11.07	
Comparing the mean of	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)	S.E. (m) ±		C.D. (at 5%)
Dates of sowing	40		112	64		177	0.11		0.31	0.13		0.36
Varieties	84		171	123		250	0.52		1.07	0.16		0.33
D x V	113		241	168		360	0.67		NS	0.24		NS

Table 4: Economics of different treatments as influenced by interaction of sowing dates and varieties of wheat

S. No.	Treatment combination	Cost of Cultivation (₹/ha)	Gross monetary return (₹/ha)	B: C Ratio (₹)
1.	Timely x HD 4730	29109	119497	4.11
2.	Timely x HI 8737	29109	121175	4.17
3.	Timely x MPO 1215	29109	85084	2.93
4.	Timely x HD 4728	29109	123876	4.26
5.	Timely x HI 8498	29109	80428	2.77
6.	Late x HD 4730	29109	95706	3.29
7.	Late x HI 8737	29109	98390	3.39
8.	Late x MPO 1215	29109	61650	2.13
9.	Late x HD 4728	29109	111028	3.82
10.	Late x HI 8498	29109	58517	2.02

Note: Grain price @ 1500/q and Straw price @ 400/q

4. Conclusion

In late sown conditions, the weight of the grain was significantly affected compared to other factors that contribute to yield. This can be attributed to a decrease in the duration of grain growth. On the other hand, when the crop was sown at the appropriate time, it exhibited superior growth, yielded favorable results in terms of yield and quality, and ultimately achieved the highest yield. Specifically, the variety HD 4728, when sown at the right time, recorded the highest grain yield and also generated the highest income, as reflected in the gross income, along with a favorable benefit-cost ratio.

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