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Effect of different sowing dates and irrigation schedule on yield attributes of wheat varieties under Allahabad conditions

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Abstract
A field experiment was conducted at the Forestry Nursery and Research Farm of Department of Environmental Sciences & Natural Resource Management, College of forestry, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad during Rabi 2016-17 to study the interaction effects of different sowing dates and irrigation schedule on yield attributes of wheat varieties. The results revealed that spike length and grains per spike of wheat crop were significantly influenced by different dates of sowing, varieties and irrigation schedules. Among different varieties, sowing dates and irrigation schedules, the maximum number of spikelet per spike, grains per spike and grain yield was recorded with variety PBW-343, sowing of wheat on 25th Nov and 4 irrigations respectively while spike length was observed maximum with variety HD-2967, 25th Nov sowing and 4 irrigations. Sowing of wheat variety PBW-343 on 25th Nov along with 4 irrigations resulted in maximum spike length (15.04 cm), grains per spike (52.17) and grain yield (42.51 q/ha). Interaction effect of date of sowing, varieties and irrigation schedules was non-significant on spikelet per spike.

Keywords: Wheat, irrigation schedule, sowing date and variety.

Introduction
Wheat is the world's largest grown cereal crop, belonging to family *Graminae* and genus *Triticum*. It is the 3rd most produced cereal after maize and rice in world. The total production of wheat is 713 million tones. (FAO stat). India ranks second in terms of area, production & productivity next to China. Wheat is an important food crop of the world as it provides food to 36 % of the global population. Wheat contains about 10-14% protein, 1-2% total fat, 0.3-0.5% carbohydrates (DWR, annual report 2015) [1]. Wheat is an important rabi crop, which is grown in between September & December & harvested between February & May. It is grown in diverse agro-climatic conditions from 11 ^{0}N -35 ^{0}N latitude and 72 ^{0}E-92 ^{0}E longitudes. It is mainly cultivated in Indo - Gangetic plains which accounts for roughly 20 million hectares covering states like Punjab, Uttar Pradesh, Madhya Pradesh, Haryana, Bihar and West Bengal.
The total area under wheat crop is 29.8 mha in India. Uttar Pradesh is the maximum wheat producing state in India with an area of 9.64 mha, production 30 million metric tones, with a productivity of 31.13 quintals per hectare. India is blessed with both the rich land and extremely suitable weather climate for crops production. Therefore, the rate of wheat production is second highest in the world. There are still many factors, which are responsible for low average yield of wheat in this country. One of such environmental factors is untimely planting which affects the yield of wheat crop considerably (Saini *et al.*, 1988) [5]. Another important aspect is lack of improved varieties which are having short maturity and suitable under late sown condition due to relatively shorter growing period available to the crop. Moreover, varieties also vary both in yield and nutrient uptake under late sown condition (Singh *et al.*, 1997) [6]. Earlier it was reported that wheat crop, apart from being governed by genetic characters depend largely on a number of environmental factors, which vary under different sowing dates (Saini *et al.* 1988) [5].
The sowing of wheat is delayed either to fit it in multiple or relay crop sequence, where wheat is sown after very short duration winter (rabi) crop or after long duration rice crop or Sugarcane ratoon. Thus, the yield of wheat decreases with delayed sowing though the magnitude of reduction varies with the varieties. The sowing time is the most important factor determining the yield of wheat. There are many factors responsible for low yield of wheat but poor irrigation and use of varieties with low yield potential are most important (Mehta and Mathur, 1979) [4]. Earlier researchers showed that irrigation consistently increased wheat yields in Pakistan (Hussain *et al.*, 1997 and Rahim *et al.*, 2007).

Moreover, Wajid *et al.* (2002) reported that wheat crop produced highest grain yield by applying irrigation at all definable growth stages. Because irrigation is an expensive input, so farmer, agronomist and economist need to know the response of yield to irrigation. Keeping in view of the aforesaid facts, the present study was undertaken to evaluate the performance and adaptability of newly developed varieties of wheat to a wider range of sowing dates in irrigated conditions under Allahabad conditions.

Materials & Methods

The field experiment was conducted during Rabi 2016-17 at the Forestry Nursery and Research Farm of Department of Environmental Sciences & Natural Resource Management, College of forestry, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad. Soil of this region is sandy loam and slightly alkaline. The site of experiment was located at 25º.57' N latitude, 81º.51' E longitude and 90 meters above the sea level. This region has sub-tropical climate with extremes of summer and winter. The experiment was laid out using three factors Randomized Block Design, replicated thrice. There were 27 treatment combinations comprised of three dates of sowing (D_1 = 25th Oct., D_2 =10th Nov., D_3 = 25th Nov.), three varieties (V_1 = HD-2967, V_2 = PBW-343, V_3 = PBW-502) and three irrigation schedules (I_1 = 3 irrigations, I_2 = 4 irrigations, I_3 = 5 irrigations). Observations of different yield attributes including spike length was counted separately which were obtained randomly from five tagged plants and their averages were recorded. For determining number of spikelet per spike and number of grains per spike, five spikes were selected at random from each plot and the number of grains in each spike was counted and their mean was recorded. The data were analyzed statistically using standard tools**.**

Results and Discussion

Spike length (cm)

The data on spike length of wheat which was affected by date of sowing, varieties and irrigation schedule was presented in table (1 & 2). Among different varieties, maximum spike length was found in variety HD-2967 (12.65 cm) and minimum was found in PBW-502 (10.04 cm). Maximum spike length was recorded in wheat sown on 25th Nov (12.75 cm) whereas minimum spike length was found in wheat sown on 10th Nov (11.15 cm). Among irrigation schedules, maximum number of spikes was found with 4 irrigations (12.81 cm) and minimum was found in 3 irrigations (10.82 cm). The interaction effect of date of sowing, varieties and irrigation schedule on spike length (cm) was also found significant. Spike length was found maximum with treatments D_3V_2 (13cm), D_3I_2 (14.01cm) and V_2I_2 (13.81cm). The data in table 2 revealed that the treatment D_3V_2 I_2 recorded significantly maximum spike length (15.04 cm) which was statistically at par with $D_3V_1I_2$ and significantly higher as compared to other treatments.

Table 1: Effect of different dates of sowing, varieties and irrigation schedule on spike length (cm) of wheat crop

T/C	V_1	V_2	V_3	Mean		I_1	I_2	I_3	Mean		I_1	I_2	I_3	Mean
D_1	13.53	11.72	9.04	11.43	D1	10.92	11.99	11.39	11.43	V1	12.00	13.30	12.67	12.65
D_2	11.40	12.39	9.66	11.15	D2	9.97	12.42	11.05	11.15	V2	11.61	13.81	12.50	12.64
D_3	13.03	13.81	11.41	12.75	D3	11.57	14.01	12.67	12.75	V3	8.85	11.31	9.95	10.04
Mean	12.65	12.64	10.04		Mean	10.82	12.81	11.70		Mean	10.82	12.81	11.70	
CD				0.54					0.54				0.54	

Table 2: Interaction effect of different dates of sowing, varieties and irrigation schedule on spike length (cm) of wheat crop.

T/C	D_1			D_2			D_3		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
I_1	13.97	11.10	7.70	10.15	11.19	8.57	11.87	12.54	10.29
I_2	12.87	12.75	10.36	12.75	13.65	10.86	14.27	15.04	12.72
I_3	13.77	11.32	9.07	11.29	12.33	9.54	12.95	13.85	11.23
CD	0.93								

Spikelet per spike

The number of spikelet per spike (table 3 & 4) did not vary significantly due to different dates of sowing, varieties and irrigation schedule. The interaction effect of sowing, varieties and irrigation scheduling was also found non- significant.

Table 3: Effect of different dates of sowing, varieties and irrigation schedule on spikelet/spike of wheat crop

T/C	V_1	V_2	V_3	Mean		I_1	I_2	I_3	Mean		I_1	I_2	I_3	Mean
D_1	18.04	18.90	16.06	17.67	D1	16.35	19.76	16.89	17.67	V1	18.29	21.55	18.98	19.61
D_2	19.47	20.60	18.08	19.38	D2	18.15	21.24	18.75	19.38	V2	19.46	22.51	19.85	20.61
D_3	21.31	22.33	19.90	21.18	D3	20.07	22.94	20.53	21.18	V3	16.83	19.88	17.34	18.01
Mean	19.61	20.61	18.01		Mean	18.19	21.32	18.72		Mean	18.19	21.32	18.72	
CD				NS					NS					NS

Table 4: Interaction effect of different dates of sowing, varieties and irrigation schedule on spikelet/spike of wheat crop

T/C	D_1			D_2			D_3		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
I_1	16.46	17.98	14.61	18.28	19.27	16.89	20.12	21.12	18.98
I_2	20.13	21.14	18.01	21.29	22.24	20.20	23.23	24.15	21.44
I_3	17.54	17.58	15.56	18.84	20.27	17.15	20.58	21.71	19.29
CD									NS

Grain/spike

The results presented in tables (5 & 6) showed that the date of sowing, varieties and irrigation schedule significantly affected the grain/spike. Among different varieties, maximum grain/spike was found in PBW-343(50.02) and minimum was found in PBW-502(48.23). Maximum grain/spike was recorded in wheat sown on 25th Nov (50.05) whereas minimum grain/spike was found in wheat sown on 25th Oct (48.34). Among irrigation schedules, maximum number of grain/ spikes was found in 4 Irrigation (50.48) and minimum was found in 3 Irrigation (47.38).

The interaction effect between date of sowing and varieties was found significant and maximum grain/spike was found in D_3V_2 (51.35) and minimum was found in the in D_1V_1 (48.07) similarly interaction effect of varieties and irrigation on grain/spike was also significant with maximum grain/spike was found in V_2I_2 (51.1) but interaction effect between of date of sowing and irrigation on grain/spike was not significant. The data in table 6 revealed that maximum grain/spike (52.17) was recorded with D_3 V_2 I_2 treatment which was significantly higher as compared to other treatments Grains per spike were less in late sowing due to less production of photosynthates due to shorter growing period. Similar results were also reported by Shahzad *et al*., (2002). Genetic variability among different varieties results to differences in number of grains per spike. These results are in line with those reported by Haider (2004) [3]. The optimum sowing resulted in better development of the grains due to good growing period. These findings are strongly supported by those of Spink *et al*., (2000) [7].

Table 5: Effect of different dates of sowing, varieties and irrigation schedule on grain/spike of wheat crop

T/C	V_1	V_2	V_3	Mean		I_1	I_2	I_3	Mean		I_1	I_2	I_3	Mean
D_1	48.07	48.72	48.22	48.34	D1	46.71	49.87	48.43	48.34	V1	47.1	50.1	48.8	48.7
D_2	48.43	49.97	47.20	48.53	D2	46.59	50.19	48.82	48.53	V2	49.1	51.1	49.8	50.0
D_3	49.55	51.35	49.27	50.05	D3	48.84	51.37	49.95	50.05	V3	45.9	50.2	48.6	48.2
Mean	48.68	50.02	48.23		Mean	47.38	50.48	49.07		Mean	47.4	50.5	49.1	
F-test				S					N/A					S
CD				0.82					N/A					0.82
S. Em.				0.29					0.29					0.29

Table 6: Interaction effect of different dates of sowing, varieties and irrigation schedule on grain/spike of wheat crop

T/C	D_1			D_2			D_3		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
I_1	46.08	48.22	45.85	46.60	47.74	45.42	48.72	51.36	46.45
I_2	49.66	49.49	50.45	50.06	51.72	48.79	50.53	52.17	51.40
I_3	48.47	48.46	48.36	48.63	50.46	47.38	49.41	50.51	49.94
F-test									S
CD									0.82
S. Em.									0.29

Grain yield (q/ha)

The result of experiment in presented in tables (7 & 8) Showed that the effect of date of sowing, varieties and irrigation schedule significantly affected the grain yield. Among different varieties, maximum grain yield was found in PBW-343 (40.46 q/ha) and minimum was found in PBW-502(38.70 q/ha). Among date of sowing, the maximum grain yield was recorded in wheat sown on 25th Nov (40.29 q/ha) and minimum was found in wheat sown on 25th Oct (38.63 q/ha). Among irrigation schedules, maximum grain yield was found in 4 Irrigation (40.88 q/ha) and minimum was found in 3 Irrigation (38.28 q/ha). The interaction effect of date of sowing, varieties and irrigation schedule on grain yield was also found significant. Maximum grain yield was found in interaction of D_3V_2 (41.16 q/ha), D_3 I_2 (41.59 q/ha) and V_2I_2 (42.38 q/ha) and minimum was found in the in D_1V_3 (37.69 q/ha) D_1I_1 (37.48 q/ha) and V_3I_1 (37.27 q/ha). The maximum grain yield was recorded in D_3 V_2 I_2 (42.51q/ha) and minimum was found in D_1V_3 (36.31q/ha). From the above result it was concluded that PBW-343 cultivar had produced more grain yield than the HD-2967 & PBW-502 respectively. Lower grain yield in late sowing was mainly due to lower germination count, less number of tillers, less number of grains per spike and lower 1000-grain weight. These results are in accordance with those of Spink *et al.,* (2000) [7] and Aslam *et al.,* (2003). They also reported that late sowing results in less grain yield per hectare. Higher grain yield was mainly due to higher number of tillers and higher 1000-grain weight. These results are similar to Shahzad *et al.,* (2002). Grain yield of wheat crop is the result of combined effect of various yield contributing components. It is evident from the above data that sowing date & varieties affected significantly the grain yield. These results are in line with Joshi *et al* (2016) [9].

Table 7: Effect of different dates of sowing, varieties and irrigation schedule on grain yield (q/ha) of wheat crop

T/C	V_1	V_2	V_3	Mean		I_1	I_2	I_3	Mean		I_1	I_2	I_3	Mean
D_1	38.65	39.56	37.69	38.63	D1	37.48	39.90	38.51	38.63	V1	38.26	40.74	39.37	39.45
D_2	39.67	40.65	38.75	39.69	D2	38.38	41.14	39.56	39.69	V2	39.31	41.74	40.31	40.46
D_3	40.05	41.16	39.66	40.29	D3	38.99	41.59	40.28	40.29	V3	37.27	40.16	38.67	38.70
Mean	39.45	40.46	38.70		Mean I	38.28	40.88	39.45		Mean I	38.28	40.88	39.45	
CD				0.19					NS					0.19

Table 8: Interaction effect of different dates of sowing, varieties and irrigation schedule on grain yield (q/ha) of wheat crop

T/C	D_1			D_2			D_3		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
I_1	37.43	38.70	36.31	38.41	39.29	37.42	38.93	39.94	38.08
I_2	39.99	40.57	39.13	40.92	42.13	40.37	41.30	42.51	40.97
I_3	38.52	39.40	37.61	39.68	40.53	38.47	39.91	41.01	39.92
CD									0.33

Conclusion

From this study it can be concluded that for producing higher grain per spike, spike length (cm) and grain yield (q/ha), it is advocated to sowing of PBW-343 wheat variety on 25 November with providing 4 irrigations.

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