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Effect of sowing date and weed management on weed and yield of wheat (*Triticum aestivum* L.)

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ABSTRACT

A field experiment was conducted during the Rabi season of 2025–26 at the Agricultural Research Farm, Department of Agronomy, School of Agriculture, Suresh Gyan Vihar University, Jaipur, Rajasthan, to study the effect of sowing date and weed management on weed dynamics, growth, yield, nutrient uptake and economics of wheat (*Triticum aestivum* L.). The experiment comprised four sowing dates, viz. 10 November, 20 November, 30 November and 10 December, and four weed management treatments, viz. weedy check, carfentrazone @ 25 g ha⁻¹ at 30 DAS, clodinafop-propargyl @ 60 g ha⁻¹ + metsulfuron @ 4 g ha⁻¹, and sulfosulfuron @ 32 g ha⁻¹ + metsulfuron @ 2 g ha⁻¹. The results revealed that 20 November sowing recorded the lowest weed density and weed dry weight and the highest weed control efficiency. It also produced superior plant height, effective tillers, grains spike⁻¹, grain yield, straw yield, biological yield and nutrient uptake. Grain yield was highest under 20 November sowing (42.68 q ha⁻¹), followed by 10 November sowing (41.00 q ha⁻¹), while 10 December sowing recorded the lowest yield (36.25 q ha⁻¹). Among weed management practices, clodinafop-propargyl + metsulfuron recorded the lowest weed density and dry weight, highest weed control efficiency, and superior growth and yield attributes. It produced the highest grain yield (42.12 q ha⁻¹), straw yield (72.80 q ha⁻¹) and biological yield (114.92 q ha⁻¹). Nutrient content and uptake were also improved under timely sowing and effective weed management. Economically, 20 November sowing recorded the highest net return (₹81,766 ha⁻¹) and B ratio (3.03), while clodinafop-propargyl + metsulfuron recorded ₹77,986 ha⁻¹ net return and a B ratio of 2.81. Thus, timely sowing on 20 November combined with effective herbicide-based weed management improved wheat productivity, nutrient uptake and profitability under Jaipur conditions.

Keywords: Wheat, Sowing date, Weed management, Weed control efficiency, Grain yield

1. Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the world and plays a vital role in ensuring food and nutritional security. Its productivity is strongly influenced by agronomic practices and environmental conditions prevailing during crop growth. Among these factors, sowing time is particularly important because it determines the temperature regime, duration of vegetative growth and synchronization of crop phenology with favourable environmental conditions. Timely sowing generally promotes rapid establishment, better tillering, higher yield attributes and efficient utilization of available resources, whereas delayed sowing may shorten the crop growth period and expose the crop to unfavourable temperatures during reproductive and grain-filling stages. Sharma *et al.* (2020) [1] reported that timely sown wheat recorded lower weed density and dry weight along with higher yield attributes and grain yield than late-sown wheat. Similarly, large-scale field observations from eastern India demonstrated a substantial decline in wheat yield with progressive delay in sowing, emphasizing the importance of optimum sowing time for maintaining productivity (Dubey *et al.*, 2024) [2].

Weeds constitute another major constraint to wheat production because they compete with the crop for nutrients, moisture, light and space, particularly during the early stages of crop growth. Wheat fields are commonly infested with both grassy and broad-leaved weeds, among which *Phalaris minor* is an important grassy weed in the north-western Indo-Gangetic Plains. Weed infestation can considerably reduce crop growth, nutrient uptake and yield when effective control measures are not adopted. Chhokar *et al.* highlighted that diverse weed flora in wheat often necessitates integrated approaches and suitable herbicide combinations for effective management.

Chemical weed management remains an important component of wheat production because herbicides can provide timely and effective control of complex weed flora. Herbicide combinations containing different modes of action can improve weed suppression and reduce competition during critical crop growth stages. Singh *et al.* (2023) [3] reported that suitable herbicide combinations significantly reduced weed population and dry matter while improving grain yield and economic returns in wheat. Similarly, Ghosh *et al.* (2018) [4]

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observed that effective weed management improved crop dry matter production, nutrient uptake and grain yield compared with the weedy check.

Therefore, optimization of sowing date along with suitable weed management is essential for achieving higher wheat productivity and profitability. Considering the close relationship between sowing time, crop competitiveness and weed infestation, the present investigation was undertaken to study the effect of sowing date and weed management on weed dynamics, growth, yield, nutrient uptake and economics of wheat (*Triticum aestivum* L.) under the agro-climatic conditions of Jaipur, Rajasthan.

2. Materials and methods

A field experiment was conducted during the Rabi season of 2025–26 at the Agricultural Research Farm, Department of Agronomy, School of Agriculture, Suresh Gyan Vihar University, Jaipur, Rajasthan, to evaluate the effect of sowing date and weed management on wheat (*Triticum aestivum* L.). The experiment was laid out in a factorial randomized block design (FRBD) with three replications. Four sowing dates, viz. 10 November, 20 November, 30 November and 10 December, were assigned as the first factor. The second factor consisted of four weed management treatments: weedy check, carfentrazone @ 25 g ha⁻¹ at 30 DAS, clodinafop-propargyl @ 60 g ha⁻¹ + metsulfuron @ 4 g ha⁻¹, and sulfosulfuron @ 32 g ha⁻¹ + metsulfuron @ 2 g ha⁻¹. The crop was raised following recommended agronomic practices for the region. Weed density and weed dry weight were recorded at 30 DAS, 60 DAS and harvest, while weed control efficiency was calculated using the standard formula. Growth parameters, yield attributes, grain and straw yield, biological yield and harvest index were recorded at appropriate stages. Grain samples were analysed for nitrogen, phosphorus and potassium content, and nutrient uptake was calculated from nutrient concentration and grain yield. Economic parameters, including gross return, net return and benefit ratio, were calculated using prevailing input and output prices. The recorded data were subjected to statistical analysis appropriate for FRBD, and treatment means were compared using the critical difference at the 5% probability level.

3. Results and discussion

3.1 Weed dynamics

The results indicated that sowing date markedly influenced weed density in wheat. The lowest weed density was recorded under 20 November sowing, whereas the highest density was observed under 10 December sowing at 30 DAS, 60 DAS and harvest. The lower weed infestation under timely sowing may be attributed to rapid crop establishment and early canopy development, which increased competition with weeds for light, moisture and nutrients. In contrast, delayed sowing probably provided favourable conditions for weed emergence and allowed weeds to compete more effectively with the crop. Similar findings were reported by Sharma *et al.* (2020) [1], who observed lower weed density under timely sown wheat than under late and very late sowing conditions.

Among weed management treatments, clodinafop-propargyl @ 60 g ha⁻¹ + metsulfuron @ 4 g ha⁻¹ recorded the lowest weed density, whereas the maximum weed population was observed in the weedy check. The superior performance of this herbicide combination may be attributed to its broad-spectrum activity against both grassy and broad-leaved weeds. Dev *et al.* (2016) [5] also reported that clodinafop + metsulfuron significantly reduced weed population and dry weight in wheat compared with other herbicidal treatments.

Weed dry weight followed a pattern similar to weed density. The minimum weed dry weight was recorded with 20 November sowing, while the maximum was observed under 10 December sowing. Timely sowing favoured rapid crop growth and canopy development, thereby suppressing weed growth and biomass accumulation. Sharma *et al.* (2020) [1] similarly reported lower weed dry matter in timely sown wheat compared with late-sown conditions.

Among weed management practices, clodinafop-propargyl + metsulfuron recorded the lowest weed dry weight, while the weedy check recorded the maximum. The reduction in weed biomass under the herbicide combination indicates effective suppression of both grassy and broad-leaved weeds. Deshmukh *et al.* (2020) [6] reported that clodinafop-propargyl + metsulfuron at 60 + 4 g ha⁻¹ provided high weed control efficiency and significantly improved wheat grain yield.

The highest weed control efficiency among sowing dates was recorded with 20 November sowing, while the lowest was recorded under 10 December sowing. Better crop establishment and faster canopy development under timely sowing probably enhanced crop competitiveness and reduced weed growth. Similar observations were made by Sharma *et al.* (2020) [1], who reported greater weed-control efficiency and lower weed persistence under suitable sowing dates.

Among weed management treatments, clodinafop-propargyl + metsulfuron recorded the highest weed control efficiency, followed by sulfosulfuron + metsulfuron, whereas the weedy check recorded zero weed control efficiency. The effectiveness of herbicide mixtures in controlling complex weed flora has also been reported by Singh *et al.* (2022) [7], who observed higher weed-control efficiency with clodinafop-propargyl + metsulfuron and sulfosulfuron + metsulfuron compared with individual herbicides.

3.2 Crop study

3.2.1 Growth attributes

Plant population at 20 DAS and harvest was not significantly affected by either sowing date or weed management. However, numerically higher plant population was recorded under 20 November sowing, while the lowest was observed under 10 December sowing. The relatively stable plant population indicates that the treatments had limited influence on initial crop establishment. Similar variation in plant establishment with different sowing dates has been reported in wheat, although subsequent crop growth and yield were more strongly affected by sowing time (Sharma *et al.*, 2020) [1].

Plant height was significantly influenced by sowing date and weed management. The maximum plant height was recorded with 20 November sowing, whereas the minimum was observed under 10 December sowing. Timely sowing provides comparatively favourable temperature and growing conditions during vegetative development, resulting in better tillering and plant growth. Sharma *et al.* (2020) [1] also observed superior growth and yield attributes under timely sowing compared with delayed sowing.

Among weed management treatments, the maximum plant height was recorded with clodinafop-propargyl + metsulfuron, while the minimum was recorded under the weedy check. Effective weed suppression reduced competition for nutrients, moisture, light and growing space, thereby allowing better vegetative growth. Dev *et al.* (2016) [5] similarly reported improvement in plant height and dry matter accumulation following effective weed control with clodinafop + metsulfuron.

3.2.2 Yield attributes and yield

The maximum number of effective tillers was recorded with 20 November sowing, while delayed sowing on 10 December resulted in the lowest number. Better environmental conditions during the tillering phase under timely sowing probably promoted greater tiller initiation and survival. Similar improvement in yield attributes under timely sowing has been reported by Sharma *et al.* (2020) [1].

Among weed management treatments, clodinafop-propargyl + metsulfuron recorded the highest number of effective tillers, whereas the weedy check recorded the lowest. Lower weed competition under effective herbicide treatment allowed greater availability of essential resources to wheat plants, promoting tiller development. Dev *et al.* (2016) [5] also reported improved effective tillers following effective weed management in wheat.

The maximum number of grains per spike was recorded under 20 November sowing, while the minimum was observed under 10 December sowing. Timely sowing provided a favourable growth pe

riod for proper spike development and grain formation. Among weed management treatments, clodinafop-propargyl + metsulfuron recorded the highest number of grains per spike, indicating that reduced weed competition improved reproductive development. Sharma *et al.* (2020) [1] similarly reported superior yield attributes under suitable sowing dates and effective weed management.

Test weight was not significantly affected by sowing date or weed management. Although numerical differences were observed, the relatively stable test weight indicates that treatment effects were more pronounced on tiller production, grains per spike and overall biomass production than on individual grain weight.

The highest grain yield was recorded with 20 November sowing (42.68 q ha^{-1}), followed by 10 November sowing (41.00 q ha^{-1}), whereas 10 December sowing produced the lowest grain yield (36.25 q ha^{-1}). The higher grain yield under timely sowing may be attributed to better plant establishment, greater plant height, higher effective tillers and more grains per spike. Delayed sowing shortened the effective crop growth period and exposed the crop to less favourable conditions during reproductive development. Sharma *et al.* (2020) [1] reported significantly higher wheat grain yield under timely sowing than under late and very late sowing.

Among weed management treatments, clodinafop-propargyl + metsulfuron produced the highest grain yield (42.12 q ha^{-1}), followed by sulfosulfuron + metsulfuron (40.77 q ha^{-1}), while the weedy check recorded the lowest yield (33.09 q ha^{-1}). The yield advantage under effective weed control was mainly associated with reduced weed competition and improved crop growth and yield attributes. Deshmukh *et al.* (2020) [6] reported that clodinafop-propargyl + metsulfuron provided effective weed control and higher grain yield in wheat.

The highest straw and biological yields were recorded with 20 November sowing, whereas the lowest values were obtained under 10 December sowing. Better vegetative growth and greater tiller production under timely sowing contributed to increased biomass accumulation. Among weed management practices, clodinafop-propargyl + metsulfuron recorded the highest straw and biological yields. Similar improvements in straw and biological yield following effective weed control have been reported by Dev *et al.* (2016) [5].

Harvest index was not significantly influenced by sowing date or weed management. The relatively narrow variation in harvest index suggests that treatment-induced differences in total biomass and grain yield occurred proportionately, without substantial alteration in the partitioning of assimilates towards grain production.

3.2.3 Nutrient content and uptake

Sowing date significantly affected N, P and K content in wheat grain. The highest nutrient contents were recorded with 20 November sowing, whereas the lowest values were observed under 10 December sowing. Better crop growth and nutrient availability under timely sowing may have promoted greater nutrient accumulation in the grain.

Among weed management treatments, clodinafop-propargyl + metsulfuron recorded the highest N, P and K contents, while the lowest values were recorded in the weedy check. Effective weed control reduces nutrient removal by competing weeds and consequently improves nutrient availability to the crop. Dev *et al.* (2016) [5] reported improved total N, P and K uptake by wheat with effective weed management using clodinafop + metsulfuron.

The highest N, P and K uptake was recorded with 20 November sowing, whereas 10 December sowing recorded the lowest uptake. Greater nutrient uptake under timely sowing was associated with higher grain yield and relatively higher nutrient concentration. Similarly, effective weed management with clodinafop-propargyl + metsulfuron resulted in greater nutrient uptake than the weedy check. Dev *et al.* (2016) [5] also observed increased nutrient uptake in wheat under effective weed control.

3.3 Economics

Among sowing dates, 20 November sowing recorded the highest gross return ($\text{₹}1,21,946 \text{ ha}^{-1}$) and net return ($\text{₹}81,766 \text{ ha}^{-1}$), whereas 10 December sowing recorded the lowest gross and net returns. Higher economic returns under timely sowing were primarily due to greater grain and straw production. Sharma *et al.* (2020) [1] also reported higher net returns and *B* ratio under suitable sowing dates in wheat. Among weed management practices, clodinafop-propargyl + metsulfuron recorded the highest gross return ($\text{₹}1,21,016 \text{ ha}^{-1}$) and net return ($\text{₹}77,986 \text{ ha}^{-1}$). Effective weed suppression resulted in higher grain and straw yield, which compensated for the additional cost of herbicide application. Deshmukh *et al.* (2020) [6] also reported higher net monetary returns from clodinafop-propargyl + metsulfuron in wheat.

The maximum *B* ratio among sowing dates was recorded with 20 November sowing (3.03), followed by 10 November sowing (2.94), while the minimum was recorded with 10 December sowing (2.41). Among weed management practices, clodinafop-propargyl + metsulfuron recorded the highest *B* ratio (2.81), followed by sulfosulfuron + metsulfuron (2.75). The higher profitability of effective herbicide combinations was mainly due to increased crop yield and returns relative to the cost of weed management. Similar economic advantages of clodinafop-propargyl + metsulfuron have been reported by Deshmukh *et al.* (2020) [6] and Singh *et al.* (2022) [7].

Conclusion

The study revealed that 20 November sowing was most suitable for obtaining higher growth, yield, nutrient uptake and profitability in wheat under Jaipur conditions. Among weed management practices, clodinafop-propargyl @ 60 g ha^{-1} + metsulfuron @ 4 g ha^{-1} provided effective weed suppression and resulted in higher grain yield and economic returns. Thus, timely sowing combined with effective weed management can improve wheat productivity and profitability under the agro-climatic conditions of Rajasthan.

Table 1. Effect of sowing date and weed management on weed study

Sr. no.	Treatments	Weed dynamics (m^2)			Weed dry weight (g/m^2)			Weed control efficiency (%)		
		30 DAS	60 DAS	60 DAS	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
A.	Date of sowing									
1.	S ₁	5.23 (27.78)	6.15 (38.02)	6.63 (44.03)	6.55 (43.89)	7.46 (56.27)	7.60 (57.29)	66.24	58.91	55.94
2.	S ₂	5.19 (27.42)	6.09 (37.32)	6.57 (40.33)	6.50 (43.32)	7.39 (55.23)	7.54 (57.19)	66.69	59.68	56.04
3.	S ₃	6.87(48.86)	7.59 (58.35)	8.07 (64.36)	8.61(76.01)	9.31 (86.36)	9.17 (84.96)	41.56	36.93	34.70
4.	S ₄	7.48 (56.92)	8.15 (67.16)	8.52 (73.17)	9.39 (89.93)	9.90 (99.40)	9.78 (96.58)	30.85	27.44	25.76
	S.Em.±	0.13	0.15	0.18	0.14	0.19	0.20	1.03	0.90	0.86

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Sr. no.	Treatments	Weed dynamics (m ²)			Weed dry weight (g/m ²)			Weed control efficiency (%)		
	CD	0.37	0.44	0.51	0.41	0.54	0.58	2.97	2.61	2.48
B.	Weed management									
1.	W ₁	7.82 (62.49)	8.46 (71.98)	8.81 (77.99)	9.82 (97.54)	10.28 (106.52)	10.12 (102.94)	0.00	0.00	0.00
2.	W ₂	6.42 (42.67)	7.20 (52.91)	7.62 (58.92)	8.06 (67.42)	8.75 (78.31)	8.75 (77.78)	48.16	42.83	40.22
3.	W ₃	5.04 (25.59)	6.00 (35.94)	6.49 (41.95)	6.32 (40.42)	7.28 (53.19)	7.44 (55.38)	68.91	61.16	57.43
4.	W ₄	5.48 (30.24)	6.32 (40.02)	6.87 (46.03)	6.86 (47.77)	7.75 (59.23)	7.78 (59.92)	63.27	56.76	53.92
	S.Em.±	0.13	0.15	0.18	0.16	0.19	0.20	1.03	1.16	1.22
	CD	0.37	0.44	0.51	0.46	0.54	0.58	2.97	3.35	3.52
	CV%	7.24	7.53	8.22	7.05	7.60	8.13	6.94	7.06	7.08

Table 2. Effect of sowing date and weed management on growth attributes of wheat

Sr. no.	Treatments	Plant population per m row length		Plant height (cm)		
		20 DAS	At harvest	30 DAS	60 DAS	At harvest
A.	Date of sowing					
1	S ₁	9.84	9.02	25.95	53.97	95.01
2.	S ₂	9.94	9.19	26.77	55.68	98.33
3.	S ₃	9.10	8.52	23.98	49.87	88.07
4.	S ₄	8.96	8.33	23.32	48.50	85.66
	S.Em.±	0.29	0.29	0.47	1.23	1.71
	CD	NS	NS	1.34	3.55	4.94
B.	Weed management					
1.	W ₁	8.88	7.75	22.79	47.40	83.41
2.	W ₂	8.41	8.16	24.62	51.20	90.43
3.	W ₃	9.75	8.67	26.59	55.31	97.68
4.	W ₄	9.62	8.54	26.01	54.11	95.56
	S.Em.±	0.29	0.29	0.47	1.23	1.71
	CD	NS	NS	1.34	3.55	4.94
	CV%	11.46	12.19	6.45	7.61	6.48

Table 3. Effect of sowing date and weed management on yield attributes and yield of wheat

Sr. no.	Treatments	Number of effective tillers	Number of grains per spike	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
A.	Date of sowing							
1	S ₁	84.74	45.12	39.57	41.00	69.99	110.99	36.91
2.	S ₂	89.02	46.37	39.92	42.68	73.16	115.84	36.82
3.	S ₃	74.91	43.05	38.73	38.45	61.64	97.98	37.28
4.	S ₄	72.34	40.47	38.32	36.25	58.77	92.27	36.34
	S.Em.±	1.81	0.80	0.72	0.84	0.21	2.38	0.83
	CD	5.21	2.34	NS	2.44	0.63	6.87	NS
B.	Weed management							
1.	W ₁	75.54	38.64	38.05	33.09	56.53	89.62	36.94
2.	W ₂	77.01	42.62	38.93	37.55	63.97	101.51	37.16
3.	W ₃	85.91	46.24	39.95	42.12	72.80	114.92	36.57
4.	W ₄	82.54	45.40	39.65	40.77	70.27	111.04	36.68
	S.Em.±	1.81	0.80	0.72	0.84	0.21	2.38	0.83
	CD	5.21	2.34	NS	2.44	0.63	6.87	NS
	CV%	7.79	6.37	6.38	7.61	7.26	7.90	7.81

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Table 4. Effect of sowing date and weed management on nutrient content in grain of wheat

Sr. no.	Treatments	Nitrogen content in grain (%)	Phosphorus content in grain (%)	Potassium content in grain (%)	Nitrogen uptake by grain (kg/ha)	Phosphorus uptake by grain (kg/ha)	Potassium uptake by grain (kg/ha)
A. Date of sowing							
1.	S ₁	1.75	0.433	0.450	72.33	18.19	18.87
2.	S ₂	1.78	0.444	0.456	76.32	19.28	19.76
3.	S ₃	1.71	0.413	0.432	62.02	15.11	15.78
4.	S ₄	1.69	0.403	0.425	56.57	13.86	14.62
	S.Em.±	0.02	0.003	0.003	1.35	0.25	0.33
	CD	0.05	0.008	0.008	3.91	0.71	0.94
B. Weed management							
1.	W ₁	1.66	0.398	0.420	54.99	13.37	14.15
2.	W ₂	1.72	0.416	0.437	64.84	15.80	16.60
3.	W ₃	1.79	0.445	0.455	75.31	19.10	19.54
4.	W ₄	1.76	0.436	0.451	72.11	18.17	18.75
	S.Em.±	0.02	0.003	0.003	1.35	0.36	0.37
	CD	0.05	0.008	0.008	3.91	1.04	1.07
	CV%	2.69	2.33	2.17	7.01	7.49	7.42

Table 5. Effect of sowing date and weed management on economics

Sr. no.	Treatments	Gross return (RS/ha)	Net return (Rs/ha)	B:C ratio
A. Date of sowing				
1.	S ₁	118058	77878	2.94
2.	S ₂	121946	81766	3.03
3.	S ₃	102794	62614	2.56
4.	S ₄	96989	56809	2.41
B. Weed management				
1.	W ₁	94773	54593	2.36
2.	W ₂	106713	65033	2.56
3.	W ₃	121016	77986	2.81
4.	W ₄	117312	74632	2.75

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