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Effect of sowing time, seed rate and harvesting duration on growth of Ashwagandha (*Withania somnifera*)

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Abstract
A field investigation was carried out during the 2009-10growing season at the Herbal garden, Rajendra nagar, Hyderabad. To study the influence of sowing date, seed rate and harvesting time on vegetative growth of ashwagandha (*Withania somnifera*). The experiment was arranged in a factorial randomized block design comprising eighteen treatment combinations with three replications. Treatments included two sowing dates (August 15th and August 30th), three seed rates (10,12 and 14 kg/ha) and three harvesting stages (150,180 and 210 days after sowing. Early sowing significantly enhanced plant height and leaf area compared to late sowing. A seed rate of 14 kg/ha resulted in greater plant height and branching, while the largest leaf area was observed at 10 kg/ha. Although interaction effects were, the combination of early sowing with a higher seed rate and harvesting at 180 days produced superior growth.

Keywords: Ashwagandha, sowing time, seed rate, harvesting duration, plant height, leaf area

Introduction
Ashwagandha (*Withania somnifera*), a medicinal plant of the Solanaceae family, is widely valued for its therapeutic properties and economic importance. It is predominantly cultivated under rainfed conditions in semi-arid and dry regions of India. The medicinal values of ashwagandha is attributed to bioactive compounds such as withanolides and alkaloids present mainly in roots. Vegetative growth characteristics including plant height, branching pattern and leaf area directly influence photosynthetic efficiency and biomass accumulation. Agronomic factors like sowing time, plant population and harvesting stage play a crucial role in determining crop performance. Hence, this study was undertaken to evaluate the combined effect of sowing time, seed rate and harvesting duration on the growth behavior of Ashwagandha.
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In Madhya Pradesh, it is cultivated in about 4000 hectares. (Nigam *et al.*,1984) [6]. The drug is mainly used in ayurvedic and unani preparations. The alkaloid withaferine-A which is present in roots having antibiotic and anti-tumour properties (Farooqui *et al.*, 2001) [3].

Materials and Methods
This experiment was conducted at the Herbal garden, Rajendra nagar, Hyderabad, from August 2009 to 2010.Two sowing dates, three seed rates and three harvesting durations were arranged in a factorial randomized block design with three replications. The field was prepared to affine tilth and plots measuring 2m x 3m were laid out. Seeds were mixed with sand in equal proportion and broadcast uniformly. Five healthy plants from each plot were selected for recording plant height, number of branches and area at 180 days after sowing. The data were statistically analyzed using analysis of variance (ANOVA). The data were analyzed using computer software programmed by the method of variance outlined by Panse and Sukhatme (1985) [7].

Results and Discussion
Early sowing significantly improved plant height and leaf area compared to late sowing. A higher seed rate resulted in increased plant height and branching, while leaf area was at a lower

seed rate. Harvesting duration were largely non-significant; however, early sowing combined with a higher seed rate and harvesting at 180 days resulted in superior growth performance.

Table 1: Effect of sowing time, seed rate and harvesting duration on plant height (cm) at 180 DAS in Ashwagandha.

	Seed rate(S)			
Sowing date(D)	**S_1(10kg/ha)**	**S_2 (12 kg/ha)**	**S_3 (14 kg/ha)**	**Mean**
D_1 (August 15th)	44.65	44.05	46.56	45.08
D_2 (August 30th)	41.67	40.75	40.35	40.93
Mean	43.16	42.40	43.46	
Harvesting duration(H)				
H_1 (150 DAS)	42.50	42.55	42.98	42.67
H_2 (180DAS)	41.67	42.43	44.56	42.89
H_3 (210DAS)	45.30	42.23	42.83	43.45
Mean	43.16	42.40	43.46	

Harvesting duration (H)	**Seed rates (S)**					
	S_1 (10 kg/ha)		**S_2 (12 kg/ha)**		**S_3 (14 kg/ha)**	
	Sowing dates (D)	**D_1 (Aug 15th)**	**D_2 (Aug30th)**	**D_1 (Aug15th)**	**D_2 (Aug 30th)**	**D_1 (Aug15th)**	**D_2 (Aug30th)**
H_1 (150DAS)	44.50		40.50	44.50	40.60	46.03	39.93
H_2 (180DAS)	41.56		41.80	42.96	41.90	49.00	40.13
H_3 (210DAS)	47.86		42.73	44.70	39.76	44.66	41.00

Factors	**S.E m ±**	**CD (5%)**	**Interaction**	**S.E m ±**	**CD (5%)**
Sowing date (D)	0.52	1.52	DXS	0.91	NS
Seed rate (S)	0.64	NS	DXH	0.91	NS
Harvesting duration (H)	0.64	NS	SXH	1.12	NS
			DXSXH	1.58	NS

Table 2: Effect of sowing time, seed rate and harvesting duration on number of branches at 180 DAS in Ashwagandha.

	Seed rate(S)			
Sowing date(D)	**S_1(10kg/ha)**	**S_2 (12 kg/ha)**	**S_3 (14 kg/ha)**	**Mean**
D_1 (August 15th)	10.48	10.63	10.92	10.67
D_2 (August 30th)	10.82	11.28	11.80	11.30
Mean	10.65	10.96	11.36	
Harvesting duration(H)				
H_1 (150 DAS)	10.16	10.83	10.95	10.65
H_2 (180DAS)	11.12	10.31	11.38	10.94
H_3 (210DAS)	10.66	11.73	11.75	11.38
Mean	10.65	10.96	11.36	

Harvesting duration (H)	**Seed rates (S)**					
	S_1 (10 kg/ha)		**S_2 (12 kg/ha)**		**S_3 (14 kg/ha)**	
	Sowing dates (D)	**D_1 (Aug 15th)**	**D_2 (Aug30th)**	**D_1 (Aug15th)**	**D_2 (Aug 30th)**	**D_1 (Aug15th)**	**D_2 (Aug30th)**
H_1 (150DAS)	9.80		10.53	10.60	11.06	11.53	10.36
H_2 (180DAS)	11.81		10.43	8.86	11.76	10.73	12.03
H_3 (210DAS)	9.83		11.50	12.43	11.03	10.50	13.00

Factors	**S.E m ±**	**CD (5%)**	**Interactions**	**S.E m ±**	**CD (5%)**
Sowing date (D)	0.36	NS	DXS	0.63	NS
Seed rate (S)	0.44	NS	DXH	0.63	NS
Harvesting duration (H)	0.44	NS	SXH	0.77	NS
			DXSXH	1.10	NS

Table 3: Effect of sowing time, seed rate and harvesting duration on leaf area (cm^2) at 180 DAS in Ashwagandha.

	Seed rate(S)			
Sowing date(D)	**S_1(10kg/ha)**	**S_2 (12 kg/ha)**	**S_3 (14 kg/ha)**	**Mean**
D_1 (August 15th)	1689.41	1672.53	1768.88	1710.27
D_2 (August 30th)	1723.13	1605.29	1588.57	1638.99
Mean	1706.27	1638.91	1678.73	
Harvesting duration(H)				
H_1 (150 DAS)	1693.93	1635.69	1635.83	1655.15
H_2 (180DAS)	1679.87	1666.79	1740.15	1695.60
H_3 (210DAS)	1745.00	1614.25	1660.21	1673.15
Mean	1706.27	1638.91	1678.73	

Harvesting duration (H)	Seed rates (S)						
	S_1 (10 kg/ha)			S_2 (12 kg/ha)		S_3 (14 kg/ha)	
	Sowing dates (D)	D_1 (Aug 15th)	D_2 (Aug30th)	D_1 (Aug15th)	D_2 (Aug 30th)	D_1 (Aug15th)	D_2 (Aug30th)
H_1 (150DAS)	1675.34		1712.52	1635.25	1636.14	1768.18	1503.48
H_2 (180DAS)	1633.14		1726.59	1679.34	1658.25	1801.94	1678.35
H_3 (210DAS)	1759.74		1730.27	1706.99	1521.50	1736.53	1583.88

Factors	S.E m ±	CD (5%)	Interactions	S.E m ±	CD (5%)
Sowing date (D)	18.65	53.62	DXS 3	2.32	92.88
Seed rate (S)	22.85	NS	DXH	32.32	NS
Harvesting duration (H)	22.85	NS	SXH	39.58	NS
			DXSXH	55.97	NS

Conclusion

The study concludes that early sowing with an optimum seed rate enhances vegetative growth in ashwagandha. Sowing on August 15 with a seed rate of 14 kg/ha and harvesting at 180 days was identified as the most effective treatment combination under the experimental conditions.

Interactions

The data on interaction between dates of sowing and seed rates (DXS), seed rates and harvesting durations (SXH), dates of sowing and harvesting durations (DXH) as well as the three way interaction between sowing times, seed rates and harvesting durations (DXSXH) on plant height at 180 DAS were found to be no significant (Table 1). A treatment combination of $D_1S_3H_2$ (sowing on August 15th, with seed rate of 14 kg/ha and harvesting duration of 180 DAS) recorded significantly higher plant height (49.00) followed by $D_1S_1H_3$ (47.86) and $D_1S_1H_1$ (46.03). The data on interaction between dates of sowing and seed rates (DXS), seed rates and harvesting durations (SXH), dates of sowing and harvesting durations (DXH) as well as the three way interaction between sowing times, seed rates and harvesting durations (DXSXH) on number of branches at 180 DAS were found to be non- significant (Table 2). The data on interaction between dates of sowing and seed rates (DXS) was significant (Table 3). Where a combination of August 15th and 14 kg/ha (D_1S_3) recorded maximum leaf area (1768.88 cm^2) followed by D_2S_1 (1723.13 cm^2) and D_1S_1 (1689.41 cm^2). Seed rates and harvesting durations (SXH), dates of sowing and harvesting durations (DXH) as well as the threeway interaction between sowing times, seed rates and harvesting durations (DXSXH) on leaf area at 180 DAS were found to be non - significant

Though interaction treatments were not significant, a combination of August 15th sown crop with a seed rate of 14 kg/ha and harvesting duration of 180 DAS ($D_1S_3H_2$) recorded maximum plant height (49.00 cm) whereas highest number of branches (13.00) recorded with August 30th sown crop with a seed rate of 14 kg/ha and harvesting duration of 210 DAS ($D_2S_3H_3$).

Though interaction treatments were not significant, highest leaf area (1966.90 cm^2) was recorded with date of sowing AugusT_{15}th, combination of 14 kg/ha seed rate and harvesting duration of 180 DAS ($D_1S_3H_2$).

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