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Influence of season and spacing on the growth performance of ambrette (*Abelmoschus moschatus* Medic.)

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ABSTRACT : An investigation was undertaken to study the influence of season and spacing on the growth performance of ambrette (*Abelmoschus moschatus* Medic.). The field experiment was conducted in two seasons *viz*., January to June (season I) and July to December (season II) with five spacing levels (T_1 – 60 cm × 30 cm ; T_2 – 60 cm × 45 cm ; T_3 – 60 cm × 60 cm ; T_4 – 75 cm × 60 cm; T_5 – 75 cm × 75 cm). The design followed was Randomized Block Design with four replications. The observations regarding plant height, number of branches, stem girth, internodal length, number of leaves and leaf area were recorded and analysed statistically. The results revealed that the seeds sown during July to December (season II) with a spacing of 60 cm × 60 cm recorded the highest values for the above growth characters in ambrette.

KEY WORDS : Ambrette, Season, Spacing, Plant density

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Ambrette (*Abelmoschus moschatus* Medic.) is a close relative to okra, a popular horticultural crop. It belongs to the family Malvaceae and it is popularly known as Musk mallow. The genus *Abelmoschus* has six species distributed in south–east Asia and north Australia. *Abelmoschus manihot*, *Abelmoschus esculentus* and *Abelmoschus moschatus* contain wild and cultivated forms, while *Abelmoschus ficulneus*, *Abelmoschus crinitus* and *Abelmoschus angulosus*, are only wild. Among the farmers, the popularity of the medicinal crop - Kasturi Bhindi (*Abelmoschus moschatus*) is increasing day by day. The seeds yield an essential oil and give a strong flowery musky brandy – like odour of remarkable tenacity because of the presence of ambretrolide, a macrocyclic lactone in the seed coat. Ambrette seeds are exported to Canada, France, Nepal, Spain, UAE and United Kingdom to the extent of about 116 quintals in a year because of its diversified uses. It is native to India and grows throughout the tropical regions of the country. It is found all over the Deccan in the hilly regions and at the foot hills of Himalayas. It has been introduced in Tarai area of Kumaon (Uttaranchal) and Punjab as a *Kharif* season crop. It is also cultivated as an irrigated crop in Uttar Pradesh, Andhra Pradesh, Karnataka and Gujarat.

In medicine, seeds are used as tonic, aphrodisiac, diuretic, stomachic, demulcent and carminative. They allay thirst, check vomiting and cure diseases due to Kapha and Vata and are useful in treating intestinal disorders, dyspepsia, urinary discharge, nervous debility, hysteria and skin diseases like itch and leucoderma. The leaves and roots of the plants are recommended for the cure of gonorrhoea. Aqueous and raw infusions of seeds are used for intestinal worms, snake bite, rheumatism, flu and asthma. Its seeds have absorbent capacity and inactivate snake venom. The pulverized roots are used as poultice for boils and swellings. Its seeds are mixed with coffee as a flavouring agent. Besides, seeds are also used to protect woollen garments against moth and imparts a musty odour to sachets, hair powder, pan masala, agarbatti, etc.

The oil extracted from this crop has a great national and international demand. In the national and international drug markets, the oil is known as Ambrette oil. This increasing demand has motivated the farmers to cultivate this important medicinal crop in fairly large areas. However, they often do not adopt scientific cultivation practices. The commercial cultivation of medicinal plants requires intensive care and management. The agro technologies for cultivation of medicinal plants vary and package of practices for many medicinal plants have not been studied and documented. The season of sowing and density of the plants are two important factors which affect the growth performance and behaviour of plants. As the diversified response to season and spacing has been reported by many workers, there is a need to optimize these agronomic factors. With this background in view, the present investigation was undertaken to study the influence of season and spacing on the growth performance of *Abelmoschus moschatus*.

RESEARCH METHODS

A field experiment was conducted in the Department of Horticulture, Faculty of Agriculture, Annamalai University during two seasons *viz*., January to June (season I) and July to December (season II). Seeds collected from the University of Agricutural Sciences, Bangalore were used for the study. The experiment was laid out in a Randomized Block Design with four replications. Seeds were sown at different spacings *viz*., T_1–60 cm × 30 cm; T_2–60 cm × 45 cm; T_3–60 cm × 60 cm ; T_4–75 cm × 60 cm and T_5–75 cm × 75 cm. The observations regarding growth characters *viz*., plant height, number of branches, stem girth, internodal length, number of leaves and leaf area were recorded and analysed statistically (Panse and Sukhatme, 1978).

RESEARCH FINDINGS AND DISCUSSION

The data pertaining to the plant height varied significantly among the various treatments (Table 1). Plant height increased with increase in the spacing levels. In season I, wider spacing of 75 cm × 75 cm recorded the highest values (56.51 cm and 105.21 cm at 60 and 150 DAS, respectively) for this trait followed by 75 cm × 60 cm, which recorded the values of 51.90 cm and 99.50

Table 1 : Influence of season and spacing on plant height of ambrette

Treatments	Season I	Plant height (cm)				Pooled
		60 DAS			150 DAS	
		Season II	Pooled	Season I	Season II	
T_1	32.81	42.50	37.65	90.30	95.30	92.80
T_2	42.03	46.20	44.12	95.31	100.20	97.76
T_3	49.02	52.31	50.67	98.31	105.21	101.76
T_4	51.90	59.22	55.56	99.50	110.30	104.90
T_5	56.51	65.11	60.81	105.21	115.31	110.26
S.E. ±	0.55	0.56	0.58	0.65	0.75	0.86
C.D. (P= 0.05)	1.10	1.12	1.16	1.31	1.50	1.71

Table 2 : Influence of season and spacing on number of branches of ambrette

Treatments	Season I	Number of branches				Pooled
		60 DAS			150 DAS	
		Season II	Pooled	Season I	Season II	
T_1	5.00	6.00	5.50	11.00	15.21	13.10
T_2	5.12	6.85	5.98	12.25	17.25	14.75
T_3	5.35	7.95	6.65	14.25	19.35	16.80
T_4	4.50	5.12	4.81	10.25	13.87	12.06
T_5	4.00	4.56	4.28	10.11	13.00	11.55
S.E. ±	0.11	0.13	0.28	0.16	0.15	0.31
C.D. (P=0.05)	0.22	0.26	0.58	0.32	0.30	0.64

cm at 60 and 150 DAS, respectively. Closer spacing of 60 cm × 30 cm recorded the least values for plant height (32.81 cm and 90.30 cm at 60 and 150 DAS, respectively).

In season II also, a similar trend was noticed with regard to plant height. The highest values (65.11 cm and 115.31 cm at 60 and 150 DAS, respectively) for plant height was recorded at the wider spacing of 75 cm × 75 cm. The next best treatment was 75 cm × 60 cm in which the plant height was 59.22 cm and 110.30 cm at 60 and 150 DAS, respectively. The closest spacing of 60 cm × 30 cm recorded the least plant height of 42.50 cm and 95.30 cm at 60 and 150 DAS, respectively.

Analysis of the pooled data revealed that wider spacing recorded the highest values for plant height while the least values were recorded at the closest spacing of 60 cm × 30 cm. The present results are in confirmation with the findings of Singh *et al*. (2012) in *Stevia rebaudiana* and Dev *et al*. (2013) in *Coleus barbatus*. It is a well known fact that at lower plant densities good growth is observed due to the availability of greater space and lesser competition among the adjacent plants, which in turn helps the individual plants to utilize more water, nutrition, air and light as reported by Khandelwal *et al*. (2009) in Indian aloe, Singh and Singh (2006) in Kalmegh.

The number of branches was found to differ significantly among the various treatments (Table 2). In season I, the spacing of 60 cm × 60 cm recorded the highest number of branches (5.35 and 14.25 at 60 and 150 DAS, respectively) followed by the spacing of 60 cm × 45 cm, which recorded 5.12 and 12.25 branches at 60 and 150 DAS, respectively. The least number of branches (4.00 and 10.11 at 60 and 150 DAS, respectively) was recorded at the wider spacing of 75 cm × 75 cm.

In season II also a similar trend was noticed with regard to number of branches. Higher number of branches was recorded at the spacing of 60 cm x 60 cm (7.95 and 19.35 at 60 and 150 DAS, respectively), followed by the spacing of 60 cm x 45 cm which recorded the next best values (6.85 and 17.25 at 60 and 150 DAS, respectively). The wider spacing of 75 cm × 75 cm recorded the least number of branches (4.56 and 13.00 at 60 and 150 DAS, respectively).

Analysis of the pooled data revealed that the spacing of 60 cm × 60 cm recorded the highest values for number of branches while the least values were recorded at the wider spacing of 75 cm × 75 cm. This might be attributed to favourable weather conditions, which influenced the plants to put on the maximum growth, ultimately resulting in the maximum number of branches as reported by Meena *et al*. (2012) in *Nigella sativa*. Similar results

Table 3 : Influence of season and spacing on stem girth (cm) of ambrette

Treatments	Stem girth (cm)					
	60 DAS			150 DAS		
	Season I	Season II	Pooled	Season I	Season II	Pooled
T_1	2.11	2.85	2.48	4.10	5.55	4.88
T_2	2.55	3.00	2.77	4.53	6.00	5.27
T_3	3.02	3.51	3.26	5.32	6.95	6.13
T_4	1.90	2.33	1.67	3.12	5.01	4.07
T_5	1.82	2.05	1.93	3.05	4.65	3.85
S.E. ±	0.15	0.16	0.16	0.18	0.19	0.12
C.D. (P=0.05)	0.30	0.33	0.33	0.36	0.40	0.24

Table 4 : Influence of season and spacing on internodal length (cm) of ambrette

Treatments	Internodal length (cm)					
	60 DAS			150 DAS		
	Season I	Season II	Pooled	Season I	Season II	Pooled
T_1	2.85	3.00	2.93	4.65	5.00	4.83
T_2	3.00	3.25	3.13	5.00	5.55	5.28
T_3	3.32	3.63	3.48	5.50	5.92	5.71
T_4	3.76	4.00	3.88	5.75	6.15	5.95
T_5	4.10	4.21	4.16	6.25	6.45	6.35
S.E. ±	0.09	0.10	0.11	0.14	0.15	0.16
C.D. (P=0.05)	0.19	0.20	0.22	0.28	0.30	0.33

were reported by Kubsad *et al*. (2010) in Aswagandha and Singh *et al*. (2012) in *Stevia rebaudiana*.

Significant differences were noticed among the various treatments with regard to stem girth (Table 3). In season I, the spacing of 60 cm × 60 cm recorded the highest values (3.02 cm and 5.32 cm at 60 and 150 DAS, respectively) for stem girth followed by the spacing of 60 cm × 45 cm, (2.55 cm and 4.53 cm at 60 and 150 DAS, respectively). Wider spacing of 75 cm × 75 cm recorded the least values for stem girth (1.82 cm and 3.05 cm at 60 and 150 DAS, respectively).

In season II also the highest values (3.51 cm and 6.95 cm at 60 and 150 DAS, respectively) for stem girth were recorded at the spacing of 60 cm × 60 cm. The spacing of 60 cm × 45 cm was found to be the next best treatment in which the stem girth was 3.00 cm and 6.00 cm at 60 and 150 DAS, respectively. The least values (2.05 cm and 4.65 cm at 60 and 150 DAS, respectively) for stem girth were recorded in the widest spacing of 75 cm × 75 cm.

With regard to the pooled data analysis, the results revealed that the spacing of 60 cm × 60 cm recorded the highest values for stem girth, while the least values were recorded at the widest spacing of 75 cm × 75 cm.

The data pertaining to the internodal length was found to differ significantly among the various treatments (Table 4). In season I, wider spacing of 75 cm × 75 cm recorded the highest values (4.10 cm and 6.25 cm at 60 and 150 DAS, respectively) for internodal length followed by the spacing of 75 cm × 60 cm, which recorded the values of 3.76 cm and 5.75 cm at 60 and 150 DAS, respectively. The least values (2.85 cm and 4.65 cm at 60 and 150 DAS, respectively) for internodal length were recorded at the closest spacing of 60 cm × 30 cm.

In season II also, wider spacing of 75 cm × 75 cm recorded the highest values (4.21 cm and 6.45 cm at 60 and 150 DAS, respectively) for internodal length. The spacing of 75 cm × 60 cm registered the next best values of 4.00 cm and 6.15 cm at 60 and 150 DAS, respectively. Closer spacing of 60 cm × 30 cm recorded the least values (3.00 cm and 5.00 cm at 60 and 150 DAS, respectively) for internodal length. Similar findings were reported by Singh and Singh (2006) in Kalmegh and Khandelwal *et al*. (2009) in Indian aloe. Pooled data analysis revealed that the spacing of 75 cm × 75 cm recorded the highest values for internodal length, while the least values were recorded at the closest spacing of 60 cm × 30 cm.

The number of leaves and leaf area (Table 5 and 6) exhibited significant differences among the various treatments. In season I, the spacing of 60 cm × 60 cm recorded the highest values for number of leaves (40.23

Table 5 : Influence of season and spacing on number of leaves of ambrette

Treatments	Number of leaves					
	60 DAS			150 DAS		
	Season I	Season II	Pooled	Season I	Season II	Pooled
T_1	30.25	32.56	31.41	60.25	80.56	70.41
T_2	35.25	40.03	37.64	65.23	90.23	77.43
T_3	40.23	45.10	42.66	78.35	105.23	91.79
T_4	23.35	28.56	25.95	53.25	75.00	64.13
T_5	20.35	25.55	22.95	50.55	70.35	61.45
S.E. ±	0.58	0.66	0.81	1.01	1.15	1.30
C.D. (P=0.05)	1.17	1.33	1.63	2.02	2.31	2.71

Table 6 : Influence of season and spacing on leaf area (cm^2) of ambrette

Treatments	Leaf area (cm^2)					
	60 DAS			150 DAS		
	Season I	Season II	Pooled	Season I	Season II	Pooled
T_1	122.31	125.32	123.82	239.10	250.12	244.61
T_2	129.25	132.32	130.79	255.31	263.23	259.27
T_3	138.23	140.21	139.22	274.22	285.31	279.77
T_4	120.21	123.21	121.71	230.20	242.21	236.21
T_5	119.21	120.25	119.73	225.25	235.01	230.13
S.E. ±	1.26	1.32	1.33	1.06	1.19	1.32
C.D. (P=0.05)	2.58	2.63	2.65	2.11	2.38	2.63

and 78.35 at 60 and 150 DAS, respectively) and leaf area (138.23 cm^2 and 274.22 cm^2 at 60 and 150 DAS, respectively) followed by the spacing of 60 cm × 45 cm, which recorded 35.25 and 65.23 leaves at 60 and 150 DAS, respectively and leaf area of 129.25 cm^2 and 255.31 cm^2 at 60 and 150 DAS, respectively. Wider spacing of 75 cm × 75 cm recorded the least number of leaves (20.35 and 50.55 at 60 and 150 DAS, respectively) and leaf area (119.21 cm^2 and 225.25 cm^2 at 60 and 150 DAS, respectively) (Arumugam and Rajeswari (2009); Bharathipriyan (2007) and Mahabaleswar (1984).

In season II also, a similar trend was noticed with regard to number of leaves and leaf area. The highest number of leaves (45.10 and 105.23 at 60 and 150 DAS, respectively) and leaf area (140.21 cm^2 and 285.31 cm^2 at 60 and 150 DAS, respectively) were recorded at the spacing of 60 cm × 60 cm. The spacing of 60 cm x 45 cm was found to be the next best treatment in which the number of leaves was 40.03 and 90.23 at 60 and 150 DAS, respectively and leaf area was 132.32 cm^2 and 263.23 cm^2 at 60 and 150 DAS, respectively. The widest spacing of 75 cm × 75 cm recorded the least number of leaves (25.55 and 70.35 at 60 and 150 DAS, respectively) and leaf area (120.25 cm^2 and 235.01 cm^2 at 60 and 150 DAS, respectively). Analysis of the pooled data revealed that the spacing of 60 cm × 60 cm recorded the highest values for number of leaves and leaf area while the least values for these traits were recorded at the widest spacing of 75 cm × 75 cm. The present results are in confirmation with findings of Umesha *et al*. (1990) in *Clocimum* and Dev *et al*. (2013) in *Coleus barbatus*. The reason for the production of more number of leaves with greater leaf area might be due to the availability of space and nutrients to the individual plants as reported by Kubsad *et al.* (2010) and Agarwal *et al*. (2004) in Ashwagandha. Further Saravanan *et al*. (2009) reported that the canopy coverage at wider spacings will be sparse and plants will not be able to produce enough number of leaves.

Based on the results of the present study, it can be concluded that ambrette seeds sown during July to December (season II) with a spacing of 60 cm × 60 cm recorded a better performance with regard to the growth characters when compared to the other treatments.

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