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RESEARCH PAPER

Effect of season and spacing on flowering and yield performance of ambrette (*Abelmoschus moschatus* Medic.)

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Abstract : An investigation was undertaken to study the effect of season and spacing on flowering and yield 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 × 30 cm ; T_2 – 60 × 45 cm ; T_3 – 60 × 60 cm ; T_4 – 75 × 60 cm and T_5 – 75 × 75 cm). The design followed was Randomized Block Design with four replications. The observations on days taken for first flowering, days taken for 50 per cent flowering, number of pods per plant, pod yield per plant, pod yield per plot, pod yield per hectare, seed yield per plant, seed yield per plot and seed yield per hectare were recorded and analysed stastically. The results showed that the seeds sown during July to December (Season II) with a spacing of 60 × 60 cm recorded the highest values for all the yield characters in ambrette.

Key Words : Ambrette, Season, Spacing, Flowering, Pod yield, Seed yield

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INTRODUCTION

Ambrette *(Abelmoschus moschatus* Medic.) is an important medicinal as well as an aromatic plant, which is widely distributed in the tropics and subtropics. It is native to India and is valued for its scented seeds. Ambrette is a close relative to okra, a popular horticultural crop. The genus *Abelmoschus* has six species distributed in the south and south east Asia and in north Australia. It is universally known as ambrette and the oil extracted from the seed is called Ambrette oil (Srivastava, 1995). It is also known as musk mallow. In Tamil it is called as Vartilai kasthuri (Krishnamurthy, 1993). The area under ambrette is presently low in India but is increasing rapidly with seed exports to France, Germany, Japan, Singapore and Spain for its use as aromatic oil (Oudhia and Tripathi, 2001). The seeds yield an essential oil and give a strong musky brandy like odour of remarkable tenacity because of the presence of ambrettolide, a macro cyclic lactone in the seed coat. The oil is used as a base material for preparing high grade perfumes and cosmetics as well as creams, detergents, lotions and soaps (Misra and Mitra, 1971). In addition to their pleasant taste and flavour, the seeds possess several medicinal properties as tonic, aphrodisiac, diuretic, stomachic, demulcent and

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carminative and the roots and leaves are also used for medicinal purpose (Singh and Singh, 1992). The oil extracted from this crop has a great national and international demand. This increasing demand has motivated the farmers to cultivate this important medicinal crop in fairly large areas. The season of sowing and density of the plants (Agarwal *et al*., 2004) are two important factors which affect growth performance and yield of plants. Optimum plant population utilizes available moisture and nutrients from the soil more effectively and leads to better growth and yield of the crop (Kubsad *et al*., 2010). As the diversified response to season and spacing has been reported by many workers, there is a need to optimize these agronomic factors. In view of the above, the present investigation was undertaken to study the effect of season and spacing on flowering and yield performance of ambrette (*Abelmoschus moschatus* Medic.).

MATERIAL AND METHODS

A field experiment was conducted in the Department of Horticulture, Faculty of Agriculture, Annamalai University during two seasons *viz*., July to December 2011 (Season II) and January to June 2012 (Season I). Seeds collected from the Department of Horticulture, University of Agricutural Sciences, Bangalore were used for the study. The experiment was laid out in Randomized Block Design with four replications. Seeds were sown at different spacings *viz*., T_1 – 60 × 30 cm; T_2 – 60 × 45 cm; T_3 – 60 × 60 cm; T_4 – 75 × 60 cm and T_5 – 75 × 75 cm. The observations regarding days taken for first flowering, days taken for 50 per cent flowering, number of pods per plant, pod yield per plant, pod yield per plot, pod yield per hectare, seed yield per plant, seed yield per plot and seed yield per hectare were recorded and analysed statistically (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

The data pertaining to the days taken for first flowering and 50 per cent flowering were found to differ significantly among the various treatments (Table 1). In season I, the spacing of 60 × 60 cm took the least days (80.22 and 102.31 for first flowering and 50 % flowering, respectively) followed by the spacing of 60 × 45 cm, which recorded 83.40 days for first flowering and 105.20 days for 50 per cent flowering. The widest spacing (75 × 75 cm) took longer days (96.21 and 116.30 for first flowering and 50 per cent flowering, respectively).

In season II also, a similar trend was noticed with regard to flowering. Among the different spacing levels, it was observed that 60 × 60 cm recorded early flowering (73.50 and 95.40 days for first flowering and 50% flowering, respectively) followed by 60 × 45 cm which took 77.50 and 99.21 days for first flowering and 50 per cent flowering, respectively. The widest spacing of 75 × 75 cm recorded the maximum days (88.52 and 112.21 days for first flowering and 50 % flowering, respectively).

Analysis of the pooled data revealed that 60 × 60 cm spacing recorded earlier flowering, whereas the wider spacing levels registered larger days for flowering.

The results presented in Table 2 reveal that significant differences existed among the various treatments with regard to pod characters. In season I, among the spacing levels, 60 × 60 cm (T_3) recorded the highest number of pods per plant (25.31) and pod yield per plant (48.09 g) followed by 60 × 45 cm (T_2) which registered 19.34 pods per plant and 35.01 g of pod yield per plant. The widest spacing of 75 × 75 cm (T_5) recorded the least values (11.11 pods per plant and 18.00 g of pod yield per plant) which were at par with treatment T_4.

In season II also, a similar trend was noticed with T_3 (60 × 60 cm) registering the highest values for number of pods per plant (28.22) and pod yield per plant (55.88 g). The next best values (22.02 pods per plant and 40.30 g of pod yield per plant, respectively) were recorded in

Table 1 : Effect of season and spacing on flowering of ambrette

Treatments	Days taken for first flowering			Days taken for 50 per cent flowering		
	Season I	Season II	Pooled	Season I	Season II	Pooled
T_1	88.21	80.31	84.26	109.41	103.53	106.47
T_2	83.40	77.50	80.45	105.20	99.21	102.21
T_3	80.22	73.50	76.86	102.31	95.40	98.86
T_4	93.10	84.21	88.66	112.22	109.52	110.87
T_5	96.21	88.52	92.37	116.30	112.21	114.26
S.E. ±	0.76	0.62	0.78	1.00	1.03	1.06
C.D. (P=0.05)	1.51	1.23	1.55	2.01	2.05	2.11

T_2 (60 × 45 cm). The least values for number of pods per plant (13.19) and pod yield per plant (22.09 g) were recorded at the wider spacing of 75 × 75 cm (T_5). T_5 was at par with T_4. Analysis of the pooled data revealed that 60 × 60 cm spacing recorded maximum number of pods per plant and pod yield per plant, whereas, wider spacing recorded lowest values for these traits.

With regard to pod yield per plot and pod yield per hectare significant differences were observed among the treatments (Table 2). In season I, among the spacing levels, 60 × 60 cm (T_3) recorded the highest pod yield per plot (1.586 kg) and pod yield per hectare (1321.14 kg) followed by 60 × 45 cm (T_2) which recorded 1.540 kg pod yield per plot and 1282.82 kg pod yield per hectare. The widest spacing of 75 × 75 cm (T_5) recorded the least values of 0.378 and 314.87 kg pod yield per plot and pod yield per hectare, respectively.

In season II also, the same trend was noticed with the highest values for pod yield per plot (1.844 kg) and pod yield per hectare (1536.05 kg) being recorded at the spacing of 60 × 60 cm (T_3). The next best values (1.773 and 1476.91 kg for pod yield per plot and per hectare, respectively) were recorded at the spacing of 60 cm × 45 cm (T_2). The least values for pod yield per plot (0.464 kg) and pod yield per hectare (386.51 kg) were recorded in the wider spacing of 75 × 75 cm (T_5).

Analysis of the pooled data revealed that 60 × 60 cm spacing registered highest pod yield per plot and pod yield per hectare, whereas, wider spacing recorded the least values. This might be due to the availability of food material and light per unit area to the plant, which influenced the growth of plant and ultimately increased the weight of pod and pod yield per plant. Similar findings were reported by Patil and Hulamani (1999) in *Coleus forskholi*, Sharma and Kanjilal (2000) in patchouli, Khandelwal *et al*. (2009) in *Aloe barbedensis* L. and Dev *et al*. (2013) in *Coleus barbatus*.

Seed characters differed significantly among the various treatments (Table 3). In season I, among the spacing levels, 60 × 60 cm (T_3) recorded the highest seed weight per pod (1.10 g) and seed yield per plant (27.84 g) followed by 60 × 45 cm (T_2) which registered the values of 1.02 g (seed weight per pod) and 19.73 g (seed yield per plant). The widest spacing of 75 × 75 cm (T_5) recorded the least seed weight per pod (0.81 g) and seed yield per plant (9.00 g) which was at par with T_4.

In season II also, a similar trend was noticed. The highest values for seed weight per pod (1.21 g) and seed yield per plant (34.15 g) were recorded in the spacing of 60 × 60 cm (T_3). The next best values (1.05 and 23.12 g for seed weight per pod and seed yield per plant, respectively) were recorded at the spacing of 60 × 45 cm (T_2). The least values for seed weight per pod (0.83 g) and seed yield per plant (11.25 g) were recorded at the wider spacing of 75 × 75 cm (T_5). T_5 was at par with T_4. Analysis of the pooled data revealed that 60 × 60 cm

Table 2 : Effect of season and spacing on pod characters of ambrette

Treatments	Number of pods per plant			Pod yield per plant (g)			Pod yield per plot(g)			Pod yield per hectare (kg)		
	Season I	Season II	Pooled	Season I	Season II	Pooled	Season I	Season II	Pooled	Season I	Season II	Pooled
T_1	13.22	15.01	14.12	22.08	25.52	23.80	1457	1684	1571	1213.68	1402.77	1308.64
T_2	19.34	22.02	20.68	35.01	40.30	37.66	1540	1773	1657	1282.82	1476.91	1380.28
T_3	25.31	28.22	26.77	48.09	55.88	51.99	1586	1844	1715	1321.14	1536.05	1428.60
T_4	11.44	14.02	12.73	18.65	23.13	20.89	485	601	543	404.01	500.63	452.32
T_5	11.11	13.19	12.33	18.00	22.09	20.05	378	464	421	314.87	386.51	350.69
S.E. ±	0.44	0.43	0.31	0.55	0.58	0.60	11.07	11.81	11.84	15.13	17.61	16.67
C.D. (P=0.05)	0.88	0.86	0.62	1.11	1.17	1.21	22.13	23.61	23.67	30.25	35.21	33.33

Table 3 : Effect of season and spacing on seed characters of ambrette

Treatments	Seed weight per pod (g)			Seed yield per plant (g)			Seed yield per plot (kg)			Seed yield per hectare (kg)		
	Season I	Season II	Pooled	Season I	Season II	Pooled	Season I	Season II	Pooled	Season I	Season II	Pooled
T_1	0.85	0.88	0.87	11.24	13.06	12.15	0.742	0.862	0.802	618.09	718.05	668.07
T_2	1.02	1.05	1.04	19.73	23.12	21.43	0.868	1.017	0.943	723.04	847.16	785.53
T_3	1.10	1.21	1.16	27.84	34.15	31.17	0.919	1.127	1.029	765.53	938.79	857.16
T_4	0.83	0.85	0.84	9.50	11.92	10.71	0.247	0.310	0.279	205.75	258.23	232.41
T_5	0.81	0.83	0.82	9.00	11.25	10.13	0.189	0.236	0.213	157.44	196.59	177.43
S.E. ±	0.01	0.01	0.02	0.8	0.9	1.0	0.015	0.018	0.017	12.16	14.85	14.00
C.D. (P=0.05)	0.02	0.02	0.03	1.6	1.9	2.0	0.029	0.036	0.033	24.32	29.69	27.19

spacing recorded the maximum values for seed characters, whereas, wider spacing recorded the least values.

Significant differences were observed with regard to seed yield per plot and seed yield per hectare (Table 3). In season I, among the different spacing levels, 60 × 60 cm (T_3) recorded the highest seed yield per plot (0.919 kg) and seed yield per hectare (765.53 kg) followed by 60 × 45 cm (T_2) which recorded 0.868 and 723.04 kg seed yield per plot and per hectare, respectively. The widest spacing of 75 × 75 cm (T_5) recorded the least values (0.189 and 157.44 kg seed yield per plot and per hectare, respectively.

In season II, also a similar trend was noticed with the highest values for seed yield per plot (1.127 kg) and seed yield per hectare (938.79 kg) being recorded at the spacing of 60 × 60 cm (T_3). The next best values (1.017 and 847.16 kg for seed yield per plot and per hectare, respectively) were recorded at the spacing of 60 × 45 cm (T_2). The least values for seed yield per plot (0.236 kg) and seed yield per hectare (196.59 kg) were recorded at the wider spacing of 75 × 75 cm (T_5).

Analysis of the pooled data revealed that 60 × 60 cm spacing recorded the highest values for both seed yield per plot and per hectare, whereas, wider spacing recorded the least values. Similar findings were reported by Singh and Chauhan (2001) in isabgol, Balasubramaniam *et al*. (2006) in kalmegh, Sivakumari *et al*. (2006) and Khajuria *et al.* (2012) in ambrette.

The increased seed yield at optimum spacing might be due to the availability of optimum space for growth and development of individual plants as compared to closer spacing, where severe competition for light, nutrient and water might have resulted in drastic reduction in seed yield per plant that may not be compensated with higher plant population. Similar findings were reported by Singh *et al*. (2002) and Meena *et al*. (2012) in nigella. Moreover, the favourable weather conditions influenced the plants to put on the maximum growth, ultimately resulting in the maximum yield of plant. This is in accordance with the findings of Meena *et al*. (2006) in coriander and Singh and Singh (2006) in kalmegh.

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 × 60 cm recorded a better performance with regard to the flowering and yield characters when compared to the other treatments.

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