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Seed Development and Maturation Studies in Ambrette (*Abelmoschus moschatus* Medic.)

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The results of the seed development and maturation studies in ambrette revealed that the pods and seeds attained physiological maturity on 35 days after anthesis as evidenced by the maximum dry weight of pod (2.694 g) and seed (12.63 mg) combined with minimum moisture content of pod (23.45%) and seed (21.64%). The change in colour of pod and seed from green to brown could be considered as a visible index of maturity. The seed quality parameters viz., germination (41%), 100 seed weight (1.468 g), seedling length (16.3 cm) and drymatter (8.0 mg) and vigour index (668) were also maximum at 35 days after anthesis.

Keywords: Ambrette, seed development, physiological maturity, drymatter accumulation

Ambrette (*Abelmoschus moschatus* Medic.) is an important medicinal and aromatic plant, which is widely distributed in the tropics and subtropics of both the hemispheres. It belongs to the family Malvaceae and the genus Abelmoschus. Ambrette is propagated through seeds. Like other crops, use of good quality seed is indispensable for the successful production of ambrette crop. However, information on seed technological aspects in ambrette is scanty, which needs to be generated. Seed maturity is the crucial and the most important factor determining its quality (Austin, 1972). In most of the crops, the duration of seed filling is a powerful yield determinant (Evans, 1975). Fixation of optimum stage of physiological as well as harvestable maturity will ensure better quality seed and reduce shattering loss. Hence, knowledge on development and maturation of seed will be useful to know the deleterious effect of environmental factors on the quality of seeds. With these backgrounds, studies were carried out with the objective to trace the pattern of seed development and maturation to fix the physiological and harvestable maturity of seeds.

Materials and Methods

Seeds collected from the Institute of Forest Genetics and Tree Breeding, Coimbatore formed the basic material for this investigation. The laboratory experiments were conducted at the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. To trace the pattern of seed development and maturation in ambrette, crop was raised in the Eastern block of Tamil Nadu Agricultural University, Coimbatore. During anthesis, a large number of fully opened flowers were individually tagged. Pods were harvested at seven days interval from the day of anthesis upto 42 days after anthesis in five replications comprising five pods per replication. At each stage of harvest, observations on pod characters *viz*., length, girth, volume, fresh weight, dry weight and moisture content (ISTA, 1999) were recorded and also physiological characters of seeds *viz*., number of seeds per pod, seed fresh weight and dry weight, moisture content (ISTA, 1999), 100 seed weight, seed germination (ISTA, 1999), root length, shoot length, hard seed content, drymatter production, vigour index (Abdul-Baki and Anderson, 1973) were recorded. Data obtained were analysed using 'F' test for significance following the methods described by Panse and Sukhatme (1999).

Results and Discussion

Seed maturation refers to the morphological, physiological and functional changes that occurred from the time of fertilization until the matured seed is ready for harvesting (Delouche, 1973). According to Harrington (1972), physiological maturity is the stage at which the seed reaches its maximum dry weight and nutrient flow from mother plant to the seed ceases. The cessation of nutrient flow is due to breakage of vascular connection to the seed by the formation of an abscission layer at physiological maturity (Eastin *et al*., 1973).

Effect of maturation stages on pod characters

In the present study the length and girth of pods were increased rapidly upto 28 days after anthesis, thereafter the change in these parameters remained non significant. Whereas, the volume of pod was rapidly increased upto 21 DAA and thereafter decreased drastically (Table 1). The rapid pod growth at initial stages might be due to more uptake of water when the intake of carbon and nitrogen was comparatively low (Patel *et al.*, 1977). The

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Table 1. Changes in ambrette pod characters during development and maturation

Stages of pod development (Days after anthesis)	Length of Pod (cm)	Girth of Pod (cm)	Volume of pod (cc pod-1)	Fresh weight of pod (g)	Dry weight of Pod (g)	Moisture content of pod (%)
7	4.54	6.58	12.10	3.364	1.160	83.13 (65.65)
14	6.10	8.67	15.40	6.732	1.959	79.43 (63.01)
21	8.15	9.77	18.51	7.725	2.236	63.41 (52.77)
28	8.47	9.83	16.00	3.896	2.587	41.36 (40.16)
35	8.40	9.70	15.40	2.830	2.694	23.45 (28.93)
42	8.38	9.65	14.41	2.810	2.583	17.46 (24.65)
Mean	7.34	9.03	15.30	4.560	2.203	51.37 (45.74)
SEd	0.082	0.163	0.249	0.163	0.082	0.938
CD (P 0.05)	0.178	0.356	0.546	0.356	0.178	2.044

Figures in parentheses indicate transformed (arcsine) values

declining trend in pod volume after 21 DAA might be due to the rapid dehydration and shrinking of matured pod as reported by Dharmalingam and Basu (1989) in mungbean. The fresh weight of pod increased with stages of development. The maximum fresh weight of pod (7.725 g) was recorded at 21 DAA and started decreasing in later stages. This might be due to quick development of seeds and high moisture content of earlier stage of development and subsequent desiccation at later stages. Similar results were also reported by Kalavathi (1996) in senna; whereas, the dry weight of pod increased rapidly upto 28 DAA (2.587 g). The increase in dry weight of pod was non significant beyond 28 DAA (Table 1). The loss of water during maturation is an inherent phase of development (McIlrath *et al*., 1963). Loss of moisture during ripening and maturation of pod and seed is a common phenomenon and has been observed in many crops (Karivaratharaju, 1974). In the present study, there is a significant difference in moisture content of pod at different stages of seed development and maturation. The moisture content of pod was maximum (83.13%) at 7 DAA. The moisture content decreased rapidly up to 42 DAA (17.46 %) in pod (Table 1).

Effect of maturation stages on physiological characters of seeds

The changes in the colour of both pod and seed were observed during the stages of development. The pods and seeds were green in colour up to 21 DAA and gradually changed to brown colour at 35 DAA, which indicates the physiological maturity of seeds. As the seed matured, the integmentary vascular system was destroyed, which coincided with turning of seed coat colour as reported by Carlson (1973). Similar results in change of seed colour were also reported by Baruah and Paul (1997) in okra. The number of seeds per pod ranged from 105 (14 DAA) to 89 (42 DAA), but remained non significant between the stages 7 and 35 DAA (Table 2). The fresh weight of seed increased with stages of development. The maximum fresh weight of seed (31.33 mg) was recorded at 21 DAA and started decreasing in later stages. This might be due to quick development of seeds and high moisture content at earlier stages of development and subsequent desiccation at later stages. Similar results were also reported by Kalavathi (1996) in senna; whereas, the dry weight of seed increased significantly up to 35 DAA (12.63 mg). The increase in dry weight seed was non significant beyond 35 DAA (Table 2). This indicated that the large amount of reserve food materials were accumulated in the seeds till 35 DAA and the seed development continued beyond the development of pod.

Table 2. Changes during seed development and maturation in ambrette

Stages of pod development (Days after anthesis)	No. of seeds Pod^{-1}	Fresh weight of seed (mg $seed^{-1}$)	Dry weight of seed (mg $seed^{-1}$)	100 seed weight (g)	Seed Moisture content (%)
7	103	10.20	02.55	0.289	75..29 (60.13)
14	105	25.15	07.69	0.846	69.54 (56.48)
21	103	31.33	10.34	1.037	63.90 (53.07)
28	102	22.13	11.12	1.233	44 .36 (42.15)
35	101	16.12	12.63	1.468	21.64 (27.69)
42	89	15.04	12.65	1.472	19.33 (25.06)
Mean	101	19.99	9.49	1.057	49.01 (44.43)
SEd	2.40	1.59	0.61	0.070	2.638
CD (P 0.05)	5.24	3.46	1.32	0.153	5.749

Figures in parentheses indicate transformed (arcsine) values

As like that of fresh and dry weight there is a significant difference in moisture content of seed at different stages of seed development and maturation. The moisture content of seeds was maximum (75.29 %) at 7 DAA. The moisture content decreased rapidly up to 35 DAA (23.45 %) in seed. However, the decrease in seed moisture content beyond 35 DAA is non significant (Table 2). The reduction in moisture content due to advancement of maturity of pod and seed might be due to desiccation and dehydration (Abdul-Baki and Anderson, 1973). The decrease in moisture content accompanied with increase in dry weight of seeds up to 35 DAA indicated the continuous accumulation of food reserves in the developing seeds (Metha et al., 1993). Significant increase in 100 seed weight upto 35 DAA (1.468 g; Table 2) had also supported the fact that the seed development continued upto 35 DAA in ambrette. Similar trends in seed development and 100 seed weight were also observed by Kalavathi (1996) in Hibiscus sabdariffa, Gunasekaran (2003) in Solanum nigrum and Rajasekaran (2004) in brinjal.

The seeds started to germinate 28 DAA and the germination percent (20%) significantly increased with increase in seed maturity up to 35 DAA (41 %) and further increase was not significant (42 %) at 42 DAA (Table 3). The increasing trend in germination percent during the developmental stages and attainment of maximum germination might be related to the accumulation of maximum drymatter associated with decrease in seed moisture. Similar increase in germination with increase in maturity was also reported by Demir and Samit (2001) in tomato. Hard seeds were developed at 35 DAA (46 %) and increased to 51 per cent at 42 DAA and was noticed with the increase in period of retention of seeds on the mother plant (Table 3). The non occurrence of hard seeds at early stages and occurrence at full maturity stage (35 DAA) indicated that the embryo maturity preceded the development of impermeable testa. Further increase in hard seed content beyond physiological maturity stage (35 DAA) might be due to the delayed harvest, which led to the desiccation and structural changes in seed coat (Dharmalingam and Basu, 1989). The root and shoot length of the seedlings were also increased significantly upto 35 DAA (Table 3). This could be attributed to maximum drymatter accumulation of the seeds, which might have provided more energy in the growth process (Tupper, 1969). Drymatter production of seedlings was attributed as manifestation of the physiological efficiency dependent of seed vigour (Heydecker, 1973). The increase in drymatter production by the seedling and vigour index values were also exhibited the similar trend as that of germination, root length and shoot length, which indicated the attainment of physiological maturity of the seeds at 35 DAA (Table 3). Similar results were also reported by Kersting *et al.* (1961) and Suresh Babu *et al.* (2003) in brinjal and Bishnoi (1974) in triticale.

Table 3. Changes in ambrette seed attributes in development and maturation

Stages of pod development (Days after anthesis)	Germination (%)	Root length (cm)	Shoot length (cm)	Hard seed content (%)	Drymatter production (mg seedling-^{1})	Vigour index
7	00 (0.00)	00	00	00 (0.00)	00	000
14	00 (0.00)	00	00	00 (0.00)	00	000
21	00 (0.00)	00	00	00 (0.00)	00	000
28	20 (26.57)	7.0	8.6	00 (0.00)	7.2	312
35	41(39.82)	7.3	9.0	46 (42.71)	8.0	668
42	42 (40.40)	7.4	9.1	51 (45.57)	8.1	693
Mean	17 (24.35)	3.6	4.5	16 (23.58)	3.9	279
SEd	1.732	0.158	0.115	0.942	0.092	12.440
CD (P 0.05)	3.774	0.343	0.252	2.054	0.201	27.095

Figures in parentheses indicate transformed (arcsine) values

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