

## Studies on Seed Development and Maturation in Kalmegh (*Andrographis paniculata* (Burm. F.) Wall. Ex Nees)

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**ABSTRACT:** Studies were undertaken at HC & RI, TNAU, Coimbatore in Kalmegh (*Andrographis paniculata* (Burm. F.) Wall. Ex Nees), to trace the seed development and maturation parameters for harvesting quality seeds, at the department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. The seeds registered maximum dry weight and dry matter accumulation with maximum germination and vigour in the physiological maturity stage, at 30 days after anthesis, which was associated with the change of colour of pods from light green to light brown. Beyond this stage, splitting of pods occur and resulted in shattering of seeds.

**Keywords:** Kalmegh, germination, vigour, physiological maturity

Medicinal plants are a local heritage with global importance and continue to be an important therapeutic aid for alleviating ailments of human kind. World is endowed with a rich wealth of medicinal plants. Herbs have always been the principal form of medicine in India and presently they are becoming popular in the developed world too. The demand for medicinal plants has increased globally due to the resurgence of interest in and acceptance of herbal medicine. Most of the demand is being met through collection of large quantities of medicinal plants and plant parts from wild populations.

There is thus an urgent need to develop and implement regeneration/ conservation strategies for medicinal plant species. The common means of regeneration and propagation of medicinal plants include seed-based, clonal and micro-propagation methods. It is a challenging task because less is known about their seed biology. Not much effort has been made to investigate elite specimens and their propagation.

There is a need for scientific approach for propagation of medicinal plants and to collect

relevant information regarding agro-technology, genuine planting material, economics of field cultivation etc. With these in view, an experiment was conducted in the field at HC&RI, TNAU, Coimbatore to trace the seed development and maturation stage to ensure harvest of quality seed in Kalmegh (*Andrographis paniculata*, belonging to the family Acanthaceae). It is one among the 32 medicinal plants prioritized by National Medicinal Plants Board (NMPB). This is used mainly for treating fever, liver diseases, diabetes, snake bite, common cold and bronchitis and a variety of ailments.

### MATERIALS AND METHODS

Bulk seed crop of Kalmegh was raised in the field at Horticultural College and Research Institute, TNAU, Coimbatore. About 1000 flowers were tagged soon after opening and anthesis. The pods developed from the tagged flowers were collected at 5 days interval up to 30 days after anthesis (DAA) and designated as S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub>, S<sub>4</sub>, S<sub>5</sub> and S<sub>6</sub>. The following pod and seed characters were observed.

The pod characters viz., pod length, pod width, pod area and pod perimeter were recorded by subjecting to image analysis technique with three replications of twenty five pods each. Image analysis was carried out using Delta-T (© Delta-instrument device-Cambridge, UK) Image analysis system by running custom written software 'WinDIAS' [1].

The fresh and dry weight of randomly selected pods was recorded and the mean weight of 10 pods was expressed in g pods [10]. The pod and seed moisture content were recorded [2].

With randomly selected 100 seeds, fresh and dry weight were recorded in replicates and the mean values were expressed in g/100 seeds. The following seed physiological characters were recorded viz., germination percentage [2], root and shoot lengths, dry matter production and vigour index [3]. The formula used for assessing vigour index is Germination percentage  $\times$  [Root length (cm) + Shoot length (cm)]. The biochemical characters viz., Electrical Conductivity (EC) [4], Total dissolved solids (TDS), and Alpha - amylase activity [5] were also recorded at different stages of seed development.

## RESULTS AND DISCUSSION

The pod length (1.655 cm), pod width (0.463 cm),

pod area (0.444 sq. cm) and pod perimeter (5.892 cm) increased rapidly up to 25 DAA. The fresh weight (0.526 g) and dry weight (0.3599 g) accumulation of pods reached maximum at 25 DAA. The pod moisture content of 20.8 per cent was attained at 30 DAA from 86.0 per cent at 5 DAA (Table 1). The pod length, pod width, pod area and perimeter increased up to 25 DAA, and declined thereafter. The rapid pod growth at initial stages might be due to more uptake of water with lesser intake of carbon and nitrogen, if the development of seed continues till the maturity of pod [6]. The results revealed that the seed development continued beyond the development of pod. Similar result was reported in *Abelmoschus moschatus* [7].

The pod fresh and dry weights increased upon maturation and attained maximum at 25 DAA, which declined thereafter. Similar results were reported in *Solanum nigrum* [8]. The reduction in dry weight of pod might be due to the nutrients and volatile substances in a semi fluid state which might escape along with the water when fresh weight was converted into dry weight by elimination of moisture by drying [9]. The reduction in dry weight of pod might be due to oxidation and volatilization of chemical entities [10].

The fresh weight of seed was used for

Table 1. Changes in length, width, area, perimeter, fresh weight, dry weight, moisture content and colour of pod during seed development and maturation in kalmegh

Days after anthesis (DAA)	Pod length (cm)	Pod area width (cm)	Pod perimeter (sq. cm)	Pod fresh weight (cm)	Pod dry weight (g pods <sup>-10</sup> )	Pod weight (g pods <sup>-10</sup> )	Pod moisture content (%)	Pod colour
5 (S <sub>1</sub> )	0.678	0.225	0.124	2.311	0.107	0.0149	86.0	Light green
10 (S <sub>2</sub> )	1.242	0.403	0.296	4.855	0.279	0.0594	78.7	light green
15 (S <sub>3</sub> )	1.532	0.427	0.346	5.178	0.346	0.1330	61.56	green
20 (S <sub>4</sub> )	1.553	0.441	0.396	5.267	0.452	0.2112	53.31	green
25 (S <sub>5</sub> )	1.655	0.463	0.444	5.892	0.526	0.3599	31.6	yellowish green
30 (S <sub>6</sub> )	1.646	0.452	0.433	5.775	0.364	0.2889	20.8	light brown
Mean	1.3844	0.4017	0.3398	4.8795	0.3460	0.1779	55.32	
CD (P=0.05)	0.0867	0.0249	0.0217	0.3048	0.0226	0.0130	3.643	

differentiating seed development and maturation (3) as fresh weight of seed is an important factor that determines the quality of seed [10]. It was observed that the fresh weight of seed, after reaching maximum (0.250g) on 25 DAA, started decreasing (Table 2). This could be attributed to the steady accumulation of dry matter during seed maturation phase, which are similar to results reported in *Solanum nigrum* [8].

Physiological maturity is normally depicted at the stage at which the seeds attain maximum dry weight in developing seeds. It can be employed as a criterion to assess seed maturity [11, 12]. In the present study, it was observed that the dry weight of seeds increased with increase in the maturity stages and reached the maximum (0.180g) at 30 DAA, which indicated that large amount of food reserves accumulated in the seed till 30 DAA (Table 2). These results are in line with the results in Ashwagandha [13] and in *Ocimum* [14].

The seed moisture content of 16.3 per cent was attained at 30 DAA from 57.2 per cent at 15 DAA. Loss of moisture during ripening and maturation of pod and seed is a common phenomenon and has been observed in many crops [15]. The present result is correlated with the results in ashwagandha [13], in *Abelmoschus moschatus* (7) and in periwinkle and senna [16].

Among the physiological manifestations of the seed, germination plays a significant role. The developing seed gained the germination potential 20 DAA (24%). The germination percentage increased gradually and attained maximum at 30 DAA (48%). The increasing trend in germination percentage during the development stages, which attained maximum on 30 DAA, might be attributed to the maximum dry matter content in seeds (Table 3). Similar increase in germination was evident from the results in ashwagandha [13], in *Solanum nigrum* [8], in periwinkle and senna [16] and in *Phyllanthus amarus* [17].

The relative lengths of root and shoot of seedlings would predict their subsequent growth and performance. In the present study, the maximum root length (3.76 cm) and shoot length (3.84 cm) of the seedlings were observed on 30 DAA. The reason might be the availability of

**Table 2. Changes in fresh weight, dry weight, moisture content and colour of seed during seed development and maturation in kalmegh**

Days after anthesis (DAA)	Seed fresh weight (g/100 seeds)	Seed dry weight (g/100 seeds)	Seed moisture content (%)	Seed colour
5 (S <sub>1</sub> )	0	0	0	-
10 (S <sub>2</sub> )	0	0	0	-
15 (S <sub>3</sub> )	0.159	0.068	57.2	Light green
20 (S <sub>4</sub> )	0.283	0.156	44.8	Yellowish brown
25 (S <sub>5</sub> )	0.250	0.172	31.2	Light brown
30 (S <sub>6</sub> )	0.215	0.180	16.3	Brown
Mean	0.1513	0.096	24.91	
CD (P=0.05) 0.01130.0075 1.999				

maximum dry matter in the seed in the above stages of seed development and maturation. This is in conformity with the findings in *Ocimum* [14] and in *Abelmoschus moschatus* [7].

The dry matter production of seedlings could be taken as a manifestation of the physiological efficiency which is dependent on seed vigour [18]. In this study, the seedling dry weight was maximum on 30 DAA (11.2 mg) (Table 3).

Vigour is the inherent ability of seed to survive, germinate and produce a seedling capable of doing well under wider range of conditions [18]. The computed vigour index values were maximum (363) at 30 DAA coinciding with the higher germination and dry matter production. Since the vigour index was the product of germination and seedling length parameters, it was highest at 30 DAA and this is in conformity with findings in ashwagandha [13], in *Solanum nigrum* [8] and in periwinkle and senna [16].

The electrical conductivity and total dissolved solids of the seed leachate were initially low, which increased towards maturity, to reach maximum at 25 DAA and was maintained up to 30 DAA. At

**Table 3.** Changes in germination, root length, shoot length, dry matter production, vigour index, electrical conductivity (EC), total dissolved solids (TDS) and alpha amylase activity during seed development and maturation in kalmegh

Days after anthesis (DAA)	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (mg seedlings <sup>-10</sup> )	Vigour index	Seed EC (dSm <sup>-1</sup> )	Seed TDS (ppm)	Alpha amylase activity (mm)
5 (S <sub>1</sub> )	0(0.5848)	0	0	0	0	0	0	0
10 (S <sub>2</sub> )	0(0.5848)	0	0	0	0	0	0	0
15 (S <sub>3</sub> )	0(0.5848)	0	0	0	0	0.008	14.56	3.4
20 (S <sub>4</sub> )	24(29.33)	3.25	3.62	10.2	165	0.011	22.34	4.2
25 (S <sub>5</sub> )	32(34.44)	3.74	3.81	10.8	243	0.026	35.87	7.3
30 (S <sub>6</sub> )	48(43.85)	3.76	3.84	11.2	363	0.026	34.27	7.9
Mean	17.3(18.23)	1.79	1.87	5.36	128	0.0117	17.83	3.80
CD (P=0.05)	0.925	0.154	0.161	0.460	11.562	0.001	1.394	0.298

(Figures in parentheses are arc-sine values)

initial stage, the seed size and the biochemical components were minimum, which increased during maturation. During the full maturation stage the seed coat become thick walled [19] which might have reduced the leach out of solutes. The maximum  $\alpha$ -amylase activity of the seeds was observed on 30 DAA, which may be due to the maximum accumulation of protein in the seed [20].

The pod colour was initially light green and it turned into yellowish green at 25 DAA and then to light brown. The seed colour was initially light green and it turned brown at 30 DAA. This might be due to chlorophyll degradation on physiological maturation and accumulation of principal chemical compounds. Similar result was observed in periwinkle and senna [16&21].

It is inferred that the physiological maturity of kalmegh seeds was attained on 30 DAA. It was associated with changes of colour of pods from green to light brown, with brown seeds and higher germination and vigour. It was important to note that beyond 30 DAA, splitting of pods and seed shattering occurred due to environmental heat and over maturity.

#### REFERENCES

1. NICK WEBB AND DICK JENKINS (2000). In: WinDIAS user manual, Delta-T Devices Ltd., Cambridge, U.K.
2. ANONYMOUS (2008). International Rules for Seed Testing. *Seed Sci. Technol.*, Zurich, Switzerland.
3. ABDUL-BAKI AA AND JD ANDERSON (1973). Vigor determination of Soybean seed by multiple criteria. *Crop Sci.*, 13: 630-633.
4. PRESLEY JT (1958). Relation of protoplast permeability to cotton seed viability and predisposition to seedling disease. *Plant Disease Reporter*, 42: 852.
5. SIMPSON GM AND JM NAYLOR (1962). Dormancy studies in seeds of *Avena fatua* - A relationship between maltose, amylose and gibberellin. *Can. J. Bot.*, 40: 1599-1673.
6. PATEL JS, PJ SHARKEY AND CA ATKINS (1977). Nutrition of developing legume fruit. *Plant Physiol.*, 59: 506-510.
7. SIVAKUMAR D (2005). Seed Technological studies in Ambrette (*Abelmoschus moschatus* Medic.). M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
8. GUNASEKARAN S (2003). Seed development and

- maturation, extraction methods, germination test and storage in *Solanum nigrum* Linn. *M.Sc. (Ag.) Thesis*, Tamil Nadu Agricultural University, Coimbatore.
9. RAO KVM AND GR RAO (1975). Growth, respiration and endogenous auxins of developing and germinating seeds of pigeon pea. *Seed Res.*, 3(1): 1-10.
  10. HARRINGTON JF (1972). Seed storage and longevity. In: *Seed Biology (III)*. (Ed. T.T. Kozlowski), Academic Press, New York, pp. 145-245.
  11. CHANDRASEKARAN M (1979). Studies on maturation, storability and quality of seeds of bottlegourd. *M.Sc. (Ag.) Thesis*, Tamil Nadu Agricultural University, Coimbatore.
  12. VARATHARAJAN A (1979). Studies on maturation and quality of seeds in ribbed gourd and bitter gourd. *M.Sc. (Ag.) Thesis*, Tamil Nadu Agricultural University, Coimbatore.
  13. VAKESWARAN V (2001). Investigations on certain aspects of True seeds and synthetic seed development in Ashwagandha (*Withania somnifera* Dunal). *Ph.D. Thesis*, Tamil Nadu Agricultural University, Coimbatore.
  14. SWAPNA M (2003). Tracing seed maturation pattern and development of seed testing procedure for *Ocimum spp.*, *M.Sc. (Ag.) Thesis*, Tamil Nadu Agricultural University, Coimbatore.
  15. KARIVARATHARAJU TV (1974). Studies on seed maturation aspects for fixing maximum physiological maturity to achieve maximum vigour and dry weight. *Annual Progress Report*, 1973-74. Tamil Nadu Agricultural University, Coimbatore.
  16. RAMASAMY V (2006). Seed technological studies in periwinkle (*Catharanthus roseus* (L.) G. Don cv. *roseus*) and senna (*Cassia angustifolia* Vahl). *M.Sc. (Ag.) Thesis*, Tamil Nadu Agricultural University, Coimbatore.
  17. HIPPARAGI SS, DM VENKATA REDDY, RAME GOWDA AND K VISHWANATH (2007). Studies on physiological maturity in *Phyllanthus amarus* Schum and Thonn. *Seed Res.*, 35(2): 202-204.
  18. HEYDECKER W (1972). Vigour. In: *Viability of seeds* (ed. E.H. Roberts), Chapman and Hall London, pp. 209-252.
  20. BHOJWANI SS AND SP BHATNAGAR (2005). Seed development. In: *The embryology of Angiosperms*. Vikas Publishing House Pvt. Ltd., New Delhi, pp. 268-280.
  21. KALAVATHI D (1996). Seed production, processing, testing and storage studies in medicinal plants of Senna, Periwinkle and Roselle. *Ph.D. Thesis*, Tamil Nadu Agricultural University, Coimbatore.