
Materials are the only structural components of its life cycle. Germination studies of these akinetes (the only reproductive bodies known) were accomplished by several workers\(^1\text{"}−\text{"}^5\), but *in situ* germination in *Pithophora kewensis* Wittm. was not reported.

The alga was collected in fertile condition from a temporary freshwater pond of our University campus. Clonal cultures were raised from single akinetes inoculated on nutrient agar plates made up separately with modified Chu-10 medium\(^6\), Godward medium\(^7\) and Bold's basal medium\(^8\), and subsequently incubated in thermostatically controlled culture chamber maintained at 22 ± 1°C and 16:8:12 photoperiodic with light intensity of c.2.0 klux.

Akinetes differentiated on young branches on the 18th day of inoculation of akinetes on Chu-10 nutrient agar plates. The fresh crop of akinetes developed in basipetal succession i.e. from lower portion to the upper portion of the filament.

Germination of akinetes while intact on the green vegetative filaments was an important observation of this study. It was effected by the extension of akinete wall forming a small protuberance (figure 1), later on growing into a germ tube (figures 2 and 3). The latter was generally formed at right angles to the longitudinal axes of the akinetes and grew to form a filamentous structure following cross wall formation at the base of new cells. It was also interesting to note that spore germination took place only on Chu-10 agar plates. This differential behaviour of *in situ* germination of akinetes may be attributed to variations in the nutrient constituents of the various media employed.

The authors thank UGC, New Delhi, for financial support.

24 November 1987; Revised 9 February 1988


**EMBRYOGENY IN VERBASCUM PHILOMOIDES LINN. (SCROPHULARIACEAE)**

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Cruciata type\(^4\) of embryogeny is found in nearly all the taxa of Scrophulariaceae studied except *Ellisia*...
Figure 1A–U. *Verbascum phlomoides* Linn. Stages in embryogeny. A. Zygote; B. 2-celled proembryo; C. Vertical division in terminal cell ca; D. Vertical and transverse divisions in terminal cell ca and basal cell cb, respectively; E. Quadrant stage formation in ca due to two vertical divisions at right angles to each other; the two cells, m and ci derived from cb have undergone transverse divisions; F. Octant stage formed from the original terminal cell ca; G–M. Various stages of globular embryo; N, O. Heart-shaped and torpedo stages of embryo, respectively; P–U. Cross sections of derivatives of terminal cell, ca, at various stages of embryo growth showing differentiation of layers.

*phyllum pinnatum* which follows the Solanad type. The pattern of embryogeny has been utilized as an aid in taxonomy and comparing taxa of doubtful affinities. *Celsia* Linn. has been merged with *Verbascum* Linn., but no data on embryogeny are available for the latter taxon to consider this parameter for merger or giving them an independent status. In view of this, the pattern of embryogeny in
Verbascum is being reported. Figure 1A–U gives the embryogeny and structural details of proembryo till torpedo-stage. It is seen that embryogeny in Verbascum phlomoides conforms to the Crucifer type as is also the case in Celsia coromandeliana Vahl. Based on the pattern of embryogeny, the two genera, Verbascum and Celsia may be merged into one.

5 December 1987; Revised 21 March 1988


**HETEROtic PONTENTIALS FOR SEED OIL IN Gossypium ARBOREUM L.**

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Cotton seed is the second important source of edible oil in India. There are some reports on the variability of seed oil content in cotton. However, very little information is available on the heterosis in seed oil content in cotton and that too in the upland species (Gossypium hirsutum L.). Hence 51 crosses of G. arboreum L. were screened to find out the magnitude of heterosis and inbreeding depression in seed oil content.

The 51 F₁s and their 20 parents were grown in randomized block design with 3 replications during 1987. Each entry had a single row of 10 plants spaced at 60 × 45 cm. The F₁ crossed seeds and the seeds obtained from F₁ plants (original) are genetically considered as F₂. Oil was estimated in pooled seed samples of 5 crossed bolls in F₁ and 15 bolls (5/replication) in F₂ by a non-destructive nuclear magnetic resonance (NMR) technique using Newport analyser. The heterosis over mid parent, better parent and standard variety (AKH4), and the inbreeding depression were worked out.

The range of seed oil content was higher in F₁s (19.2–26.3%) than in parents (17–24.4%). Considerable positive heterosis for seed oil content was observed over mid parent, better parent and standard variety (table 1). Of the 51 crosses evaluated, 26 exhibited positive heterosis over the mid parent in the range 0.22–20.1%. The highest mid parent heterosis (20.1%) was observed in naked-seeded × LS2, closely followed by NAS4 × LS3 (16.3%) and AC 3063 × LS2 (15.4%). Heterobeltiosis was exhibited by 18 crosses with a range of 1.3–14.8%. The highest heterobeltiosis of 14.8% was recorded in naked-seeded × LS2, followed by LS1 × LS2 (11.3%) and AC 3063 × LS2 (11.1%). The standard heterosis was exhibited by 45 crosses ranging from 0.49–29.6%. The highest standard heterosis of 29.6% was observed in naked-seeded × LS2, followed by AC 3063 × LS2 (23.6%) and NAS2 × LS2 (22.7%). Thus 2 crosses, viz. naked-seeded × LS2 and AC 3063 × LS2, exhibited high heterosis on all the 3 levels. Dani reported heterosis of up to 7.3% over mid parent and 1.6% over better parent in 12 crosses and their reciprocals in upland cotton.

The 15 superior heterotic combinations selected in F₁ showed inbreeding depression in F₂ generation ranging from −11.1 to 23.3%. This suggests that expression of seed oil content is largely governed by non-additive gene action. Dani, however, observed gain in a few crosses in F₂ ranging from 0.05 to 24.55%. This variation may be due to difference in species.

Thus in G. arboreum there was considerable heterosis in seed oil content. Expression of this trait is largely governed by non-additive gene action.

**Table 1 Range and magnitude of heterosis in seed oil content in G. arboreum L.**

<table>
<thead>
<tr>
<th>Heterosis over</th>
<th>Range of positive heterosis (%)</th>
<th>Number of crosses with positive heterosis</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0–10%</td>
<td>10–20%</td>
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<tr>
<td>Mid parent</td>
<td>0.22–20.1</td>
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<tr>
<td>Better parent</td>
<td>1.31–14.8</td>
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<tr>
<td>Standard variety</td>
<td>0.49–29.6</td>
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