Table 1 *Per cent rot at different days of incubation at* $30 \pm 1°C$

Name of Pathogens	Mode of inoculations											
	Knife injury				Pin pricks				Spore suspension			
	PI	7 days	14 days	21 days	PI	7 days	14 days	21 days	PI	7 days	14 days	21 days
Aspergillus flavus	100	2.50	13.38	23.38	100	1.95	3.57	6.00	100	1.40	4.19	9.81
A. niger	100	2.72	15.04	25.04	100	2.23	4.89	7.42	100	1.60	3.88	7.14
A. tamarii	60	1.90	7.80	10.54	100	1.55	4.28	8.80	—	—	—	—
Cladosporium cladosporioides	100	1.65	13.47	22.47	100	1.73	5.02	10.84	100	2.53	7.10	12.52
Cephalosporium acremonium	50	0.00	3.38	8.51	—	—	—	—	—	—	—	—
Drechslera tetramera	60	0.00	3.71	7.10	—	—	—	—	—	—	—	—
Fusarium culmorum	50	0.00	5.20	10.57	—	—	—	—	—	—	—	—
F. nivale	50	0.00	4.40	9.50	—	—	—	—	—	—	—	—
F. oxysporum	60	0.82	7.10	15.20	—	—	—	—	—	—	—	—
Macrophomina phaseolina	100	2.31	18.51	26.85	100	1.73	5.02	10.84	100	2.87	9.88	14.26
Control	—	—	—	—	—	—	—	—	—	—	—	—

PI = per cent infection

rhizomes through knife injury method[2], through pin-prick injury method and through inoculation on uninjured rhizomes following dip in spore suspension (300 spores/ml). The amount of rot[3] and symptoms produced was accounted for and tabulated.

All the ten isolates reproduced rotting symptoms on healthy rhizomes through knife injury method (table 1). *Aspergillus flavus*, *A. niger*, *Cladosporium cladosporioides* and *Macrophomina phaseolina* caused 100% infection and decayed 22 to 26% rhizome tissues after 21 days of incubation. Other six isolates developed infections on 50–60% rhizomes and spoiled 7 to 15% rhizome tissues within the same period. *Aspergillus tamarii* in addition to the above four developed rots through pin pricks, but the intensity of rotting was reduced to just 6 to 10%.

Aspergillus flavus, *A. niger*, *Cladosporium cladosporioides* and *Macrophomina phaseolina* were able to penetrate and establish infection through intact host surface also showing 100% infection and decaying 7 to 14% rhizome tissues. Thus these fungi demonstrated greater virulence potentiality. The avenues created by their infections may also facilitate the infection of other weaker pathogens thereby causing greater losses to this important commodity.

Turmeric rhizome is known to be spoiled by *Sclerotium rolfsii*[1], *Pythium graminicolum*[4] and *Pythium myriotylum*[5] but except for *Aspergillus flavus*[6] the other nine pathogens reported herein have been recorded for the first time to cause rotting of turmeric rhizomes.

The authors are grateful to principal, Agra College, Agra for providing facilities and to CSIR for financial assistance.

13 February 1984; Revised 8 May 1984

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ENDOSPERM IN *HYOSCYAMUS NIGER* L.

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HYOSCYAMUS, commonly known as Henbane and a native to the Mediterranean region and temperate

Asia, is introduced into many parts of the world. The dried leaves and flowering tops constitute the drug. It is useful for relieving pain of muscle's, hysteria, cough, etc[1]. The development and structure of the endosperm in *Hyoscyamus niger* L. is reported in this communication.

The material for the present investigation was collected from Jaipur and fixed in formalin-acetic-alcohol. Usual microtome techniques were followed. The sections cut at 8–12 μm were stained in safranin-fastgreen combination.

After double fertilization, the first division of the primary endosperm nucleus has not been seen but subsequent stages clearly reveal that it results in two-celled endosperm, of which micropylar cell is much smaller than the chalazal one (figures 1A-D). The first and subsequent divisions of the nucleus in the chalazal are free nuclear forming a large number of nuclei (26–30), distributed in the peripheral portion of cytoplasm (figure 1A). The mode of division in the micropylar chamber is variable representing the following three conditions:

(i) First few divisions are all free nuclear forming 8- or more nuclei (figure 1A). (ii) The first nuclear division in the micropylar chamber is followed by a wall but further few divisions are free nuclear forming two multinucleate cells (figure 1C). (iii) All the nuclear divisions in the micropylar chamber are followed by wall formation (figures 1D, E).

Frequency-wise the last type was most common (55 %) followed by second (30 %) and first (15 %) types respectively. Eventually cell formation also occurs in the chalazal chamber and it becomes virtually impossible to distinguish the two portions of the endosperm (figure 1F). The cells of the endosperm divide rapidly and form a massive endosperm (figure 1G). Although the derivatives of the two chambers are indistinguishable yet the course of development clearly suggests that the major part of endosperm is contributed by the chalazal chamber.

Initially the cells of the developing endosperm are vacuolated (figure 1H) but during further development they start accumulating food material (figures 1I, J). The cells of endosperm in mature seed are packed with food reserves (figures 1K, L). Cells are moderately thin-walled and the epidermis is covered by a thick cuticle which is golden yellow in colour. The endosperm development in *H. niger* conforms to "Helobial type".

Three different types of endosperm—cellular, nuclear and helobial, are reported to occur in the family Solanaceae[2-9]. Cellular type is most common and recorded by the majority of the recent investigators[3-8].

Svensson[9] has described cellular as well as Helobial types of endosperm in *H. niger*. Barnard[2] also feels that probably the endosperm development is Helobial in *Dubosia leichhardtii* and *D. myoporoides*. He says, 'after fertilization the endosperm nucleus migrates to the chalazal end and divides a number of times before the division of the zygote. Several dense cytoplasmic endosperm cells "settle" at the bottom of the sac and form a base upon which a "free" nuclear endosperm develops'.

During the present study only helobial type of endosperm is observed in which the micropylar chamber is small and the chalazal one large. Three types of variations are observed in micropylar cell out of which cellular type is the most common. In *H. niger*, most of the endosperm is produced from the large chalazal chamber. Rosén[6] recognizes 6 types of endosperm in Solanaceae and has presented a scheme to show relationship between them. Saxena[7] has discussed it in detail and has proposed a modified scheme. The nuclear type of endosperm has not been observed by Saxena[7] or by us in *Datura, Atropa, Nicotiana* and *Solanum*. Our observations on *H. niger*, particularly the variations recorded during early divisions in the micropylar chamber, permit us to support the modified scheme of Saxena. This study records a new type, which occurs as a variant in *H. niger* between IV and V type in Saxena's scheme.

10 January 1984; Revised 8 May 1984

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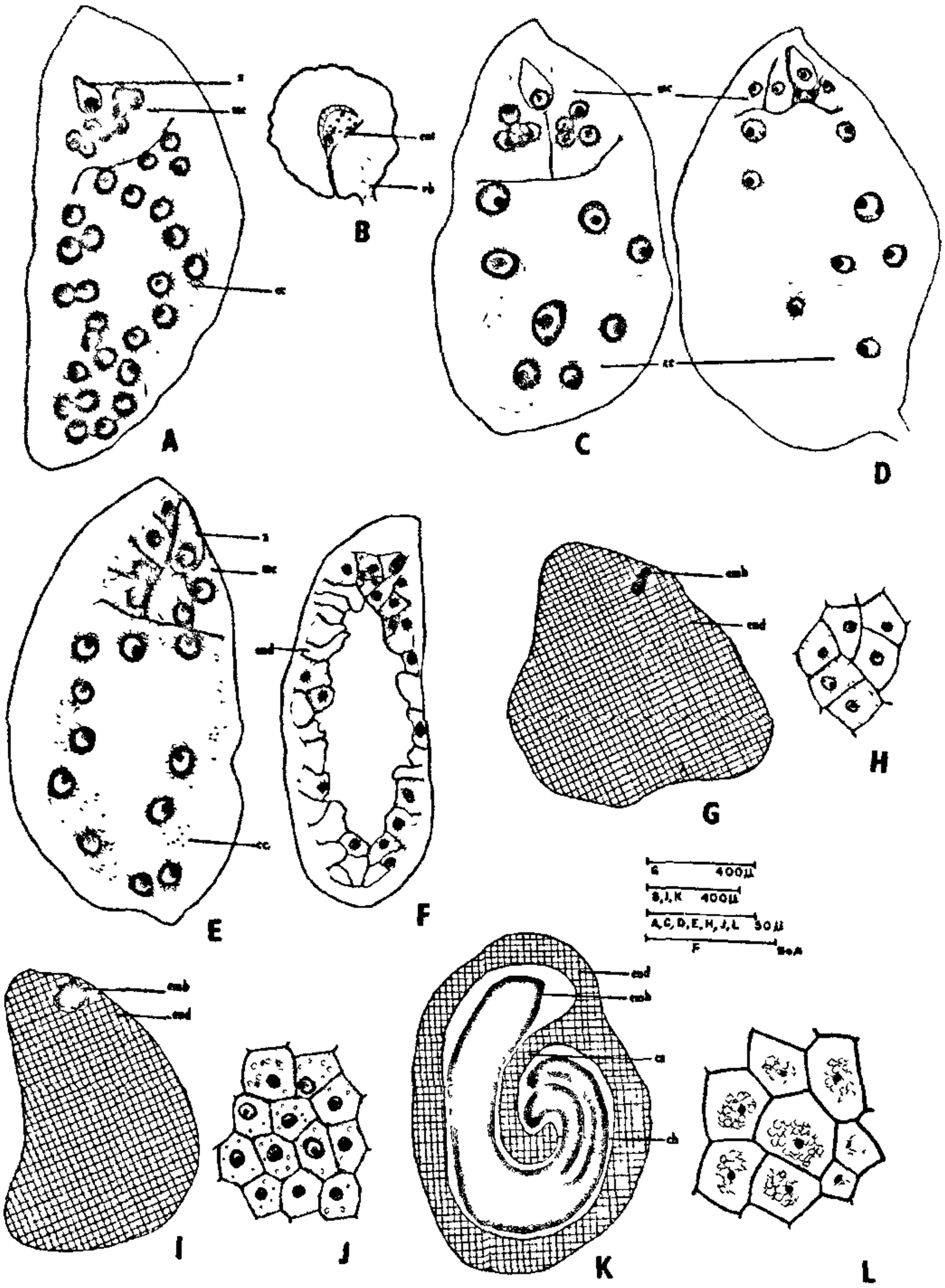

Figures 1A–L. Endosperm in *Hyoscyamus niger*. **A.** L. S. developing endosperm. Note multinucleate condition in two chambers. **B.** L. S. young seed showing endosperm and zygote. **C.** L. S. embryo sac showing free nuclei in chalazal chamber but two multinucleate cells in the micropylar chamber. **D, E.** L. S. embryo sac showing early stages in endorsperm formation. Note that the micropylar chamber is multicelled. **F.** L. S. embryo sac showing wall formation in chalazal chamber. **G, I, K.** L. S. (Semidiagrammatic) of the development of endosperm till maturity. **H, J, L.** Endosperm cells magnified from **G, I, K** to show their contents. (cc = chalazal chamber, ch = comma head, cs = comma stem, emb = embryo, end = endosperm, ent = endothelium, mc = micropylar chamber, vb = vascular bundle, z = zygote.)