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Research Article

CUMIN (*CUMINUM CYMINUM* L.; UMBELLIFERAE) CULTIVATION IN WEST BENGAL PLAINS, KALYANI, NADIA

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ABSTRACT
Cumin (*Cuminum cyminum* L.; Family: Umbelliferae) is a seed spice of commercial importance as well as it is a potential medicinal herb with immense therapeutic uses not withstanding its significance in health food formulations. Seeds (fruits) yield essential oil cuminaldehyde, and it is used in perfume industry. The species is reported to be widely cultivated (major states: Rajasthan and Gujrat) in India, excepting West Bengal and Assam. Good field and viable seeds (evidenced from Scanning Electron Microscopy and viability test performed following the use of 1% tetrazolium chloride) of cumin (seed moisture content – 8.2%) collected from Zonal Adaptive Govt. Research Station, Krishnanagar, West Bengal were grown in the Experimental field plots of University of Kalyani, Nadia (latitude 22º 50´ to 24º 11´ N, longitude 88º 09´ to 88º 48´ E, elevation 48 feet above sea level; sandy loamy soil, pH – 6.8) during the months of December to April 2009-2010. Seeds of mother stock germinated (petriplate – 100.0%; field – 54.0%, survivality – 55.56%) and plants were raised and flowers started from early February. Male meiosis (2n=14; mean chromosome association/cell at metaphase- 6.80II+0.35I, chiasma/nucleus- 10.4±0.3, coefficient of chiasma terminalization– 0.66, predominance of rod bivalents at MI; 100.0% anaphase I cells were cytologically balanced) and pollen grains (assessed following 1% acetocarmine staining technique) fertility (84.8%) were nearly normal. On histological examinations of mother fruit stock it was found that it possessed distinct fruit wall layers, endosperm, embryo and oil vittae but fruits of raised plants were devoid of embryo and endosperm. The present investigation possibly provided some evidences regarding failure of cumin cultivation in West Bengal though a representative location was considered.
KEYWORDS: Cumin, Cultivation, Nadia, West Bengal plains

INTRODUCTION

Cuminum cyminum L. (Family: Umbelliferae; common name- Cumin, Safaid Jira, Zeera) is an important seed spices of commercial importance. The annual herb (seeds and essential oil) possesses potential therapeutic uses (antibacterial activity against *Pseudomonas aeruginosa*[1], antioxidant[2], anti-inflammatory[3], antidiabetic[4], anticancerous[5] amongst others) including Ayurvedic medicine (dyspepsia, diarrhea, jaundice, also considered stimulant, carminative, stomachic, astringent etc.[6]). The chief constituent of volatile oil (from dried fruit) of cumin is cuminaldehyde and is used in perfumery. Further, cumin is found potential in various health food formulations showing improved digestibility and a good nutrient composition[7,8]. The spice is widely cultivated (major states: Rajasthan and Gujrat) in India (largest producer – about 90% of the world production; area of cultivation is over 409,033 ha, production over 176,511 tons – Source: Spice Board, India) excepting Assam and West Bengal[3,9]). Considering the significant uses of cumin (*C. cyminum*), an attempt was made to grow and cultivate the spice in West Bengal plains (taking a representative location – experimental field, Department of Botany, University of Kalyani, Nadia) and the present investigation describe the consequences of the endeavor undertaken.

MATERIAL AND METHODS

Collection of seed stock

Seeds of cumin (seed moisture content – 8.2%) were obtained from Zonal Adaptive Govt. Research Station, Krishnanagar, West Bengal, India.

Seed viability

Viability of mother seed stock was tested following tetrazolium method. Test seeds were soaked in distilled water for overnight and were splitted longitudinally with a blade so that a portion of embryo was attached with each half of the seeds. One half of 50 seeds were dipped in a crucible containing 1% aqueous solution of tetrazolium chloride overnight. The seeds were properly washed to remove any superficial stain and the embryo of the seeds stained red was considered viable.

Sowing methodology

Seeds of cumin were sown in the Experimental field plots of Department of Botany, University of Kalyani (Representative location: Nadia – latitude 22º50´ to 24º11´ N, longitude 88º09´ to 88º48´ E, elevation 48 feet above sea level; soil – 9.91 p.c. sand, 2.89 p.c. silt and 87.20 p.c. clay, analyzed in Central Chemical Laboratory, Marine Wing of Geological Survey of India, Kolkata; soil pH – 6.8) during the months of mid-December to April 2009-2010. Agro meteorological data (obtained from Agro meteorological Department of Bidhan Chandra Krishi Vishavidyalay, N-24 Parganas, West Bengal) recorded during the period was – temperature: 18ºC - 30ºC max., 8.8ºC - 21ºC min.; humidity: 58.5% - 96.0% max., 44.4% - 78.6% min.; rainfall: 2.8 mm to 4.1 mm. Seeds were sown in lines keeping a distance of 25 cm between plants and 30 cm between rows. Hand weeding and irrigations were provided during early stages of growth period. No fertilizer applications were made in any growth period.

SEM analysis

Fruit surfaces (mother stock) of cumin were assessed from Scanning Electron Microscopy (SEM). For SEM study, five dried and cleared fruits were fixed on a stub with double-sided tape and they were coated with gold palladium using SEM coating unit ES 100 (Polorom equipment Ltd.) and observed under SEM test (Model – JSM 5200, Tokyo, Japan) at 25 KV accelerating voltage at USIC, Jadavpur University, Kolkata. The photographs of the samples were taken at different magnifications as mentioned in the photographs. The objective of SEM analysis is to assess the fruits supplied from the Govt. Research Station in relation to its surface structures, and authenticity.

Histological studies

Histological studies were performed with fruits (mother stock as well as from the fruits of raised plants in University field plots) of cumin following the method of Johansen[10]. Microtome sections were cut at the thickness of 15 µm. Only 3 to 4 consecutive sections were taken on a slide previously smeared with Mayer's adhesive, and excess water was blotted out. The slides were then put on hot plate for fixation and subsequently passed through xylol grades (I, II and III, 10 mins. each) for dewaxing, followed by absolute alcohol (I and II, 10 mins. each) and rehydrated by passing through 90, 70 and 50 per cent alcohol keeping in each 5 to 7 mins. The sections were stained in 1% saffranin for one hour, differentiated in 50% alcohol and gradually passed through 70%, 90% and absolute alcohol I and II for 5 minutes in each, mounted in Canada balsam before observation under the microscope. Photomicrographs of the histological sections were taken at the magnification of MF- Projective K4:1×4 (objective) and subsequently enlarged. Microtome of mother fruits and fruits from raised plants were conducted to assess variations between the samples, if any.

Meiotic analysis

Meiotic analysis was performed from fixed (5 AM to 6 AM) flower buds (acetic alcohol 1:3, v/v, overnight) of appropriate sizes from the raised cumin plants (five plants scored). The fix buds were stored in 70% alcohol and kept under refrigeration (16°C ± 1°C) for further uses. PMCs and pollen grains obtained from anther squash preparations were stained in 1% acetocarmine solution. Fully and uniformly stained pollen grains were considered fertile in accordance to Marks[11]. Data were pooled over the plants and scored from metaphase I (MI) and anaphase I (AI) cells. Photomicrographs were taken from temporary preparations.

Meiotic analysis was made to study the course of microsporogenesis as the process is pivotal in understanding reproduction and fertility of the species.

RESULTS AND DISCUSSION

SEM analysis of mother fruit surfaces (Fig. 1 A-D) revealed that mericarp is oblong, ridged and furrowed, ridge continuous angled, furrow continuous, shallow; stylopodium distinctly dentate; mericarp surface (dorsal) on the furrowed region with irregular uneven thickenings of cellular appearance, cells indistinct; ridged surface with continuous cellular lines, cells elongated, narrow with thick raised walls; irregular deposition along the ridge.

Out of 50 half seeds stained in 1% tetrazolium chloride, embryos of 48 seeds (96.0%) stained red, and therefore supplied seed stock is viable and recommendable for cultivation. Under petriplate conditions (22°C ± 1°C) 100.0% germination (100 seeds given) was recorded and seedling length was measured to be 49.40 mm ± 4.44 (20 randomly taken seedlings were assessed) on the 7th day; however, 54.0% germination (100 seeds sown in 4 lines) was studied in field out of which 55.56% survived. Flowering was noted in the month of February and the plant started maturing by the end of March, harvested by mid-April.

Meiotic analysis revealed that mean chromosome association per cell at MI was 6.8 II + 0.35 I, and the bivalents formed rod (5.20 ± 0.21) and ring (0.59 ± 0.20) configurations (102 meiocytes scored). The chromosome number 2n=14 (Fig. 2 A-D) was consistent among the analyzed plants. Mean chiasma per nucleus was 10.4 ± 0.3 and the chiasma terminalization co-efficient was recorded to be 0.66. All AI cells (100.0%) were cytologically (7/7 segregation of chromosomes) balanced (100 PMC scored) with high pollen fertility (84.8%; 440 pollen grains studied). Thus, the course of microsporogenesis seems to be nearly normal for reproductive outcomes.

Histological examination of mother fruits revealed the presence of distinct fruit wall, oil vittae, endosperm, cotyledons as well as embryo (Fig. 3 A-B); while, disorganized fruit wall with sporadic oil cavity and total lack of embryo and endosperm were noted in fruits of raised cumin plants (Fig. 3 C-D).

The entire procedure for cumin cultivation was reported on two subsequent (2009-10, 2010-11) years but similar results were obtained. Thus it may be suggested that cumin seeds (fruits) under the present condition germinated, plants were raised, male meiosis and pollen fertility were nearly normal but the fruits of the raised plants were devoid of embryo and endosperms causing blockage of further cultivation of the species. As reported earlier that cumin is not cultivated in West Bengal, present investigation provided some experimental basis to justify it though it was performed on a representative location. Possibly climatic factor(s) rather than soil parameters play role in abortion of embryo and endosperm in cumin thereby affecting cultivation. Robinson[12] reported that embryoless seeds or formation of rudimentary embryos in seeds in Umbelliferae affected germination frequency; however, the possible cause of it was not suggested. The author raised embryoless seeds in Umbelliferae by feeding the developing seeds with *Lygus* bug, which possibly injected toxic component(s) of its oral secretion. However, in the present context it would be relevant to suggest that cultivation of celery (*Apium graveolens*), fennel (*Foeniculum vulgare*) and ajowan (*Trachyspermum amni*) was successful in the same agro climatic conditions where cumin cultivation failed[13]. Olmo[14] found 'empty' seeds in grape varieties and internal tissues of those seeds were largely of remnants of the fatty endosperm which degenerated and left the seeds more or less hollow. The possible cause of 'empty' seed formation was maternal and exterior to the developing zygote, and the concept was reported to be applicable for sweet cherry as was suggested earlier by Tukey[15]. Grundwag[16] was of opinion that embryo and endosperm abortion were the possible causes for blankness of seeds in *Pistacia vera*; while, Mirzaie-Nodoushan and Arefi[17] reported that blankness of seeds in *P. atlantica* may be environmental like temperature effects. Wiens *et al.*[18] reported loss of reproductive fitness and population decline due to embryonic/endosperm abortion following environmental factors in *Adenostoma sparsifolium*, a rosaceous shrub endemic in fire-prone chaparral vegetation of southern California and adjacent northern Baja California, Mexico. Franz *et al.*[19] precisely pointed out that the ovule viability and embryo abortion in genotypes of *Limnanthes alba* were due to genetic background, overall nutritional status, photosynthetic capability and environmental changes.

CONCLUSION

Present investigation provided some evidences regarding failure of cumin cultivation in West Bengal though a representative location was considered (Experimental field plots of University of Kalyani, Nadia, West Bengal).

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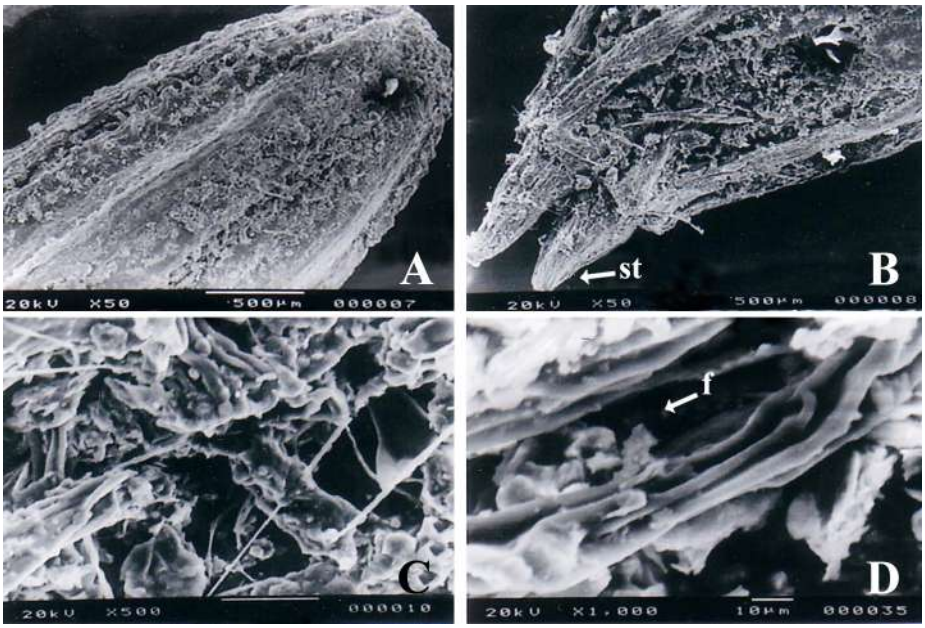


Fig 1 A-D: SEM study of seed surfaces (dorsal) of *Cuminum cyminum*. Scale bar indicated magnification. st-stylopodium, f-furrow.

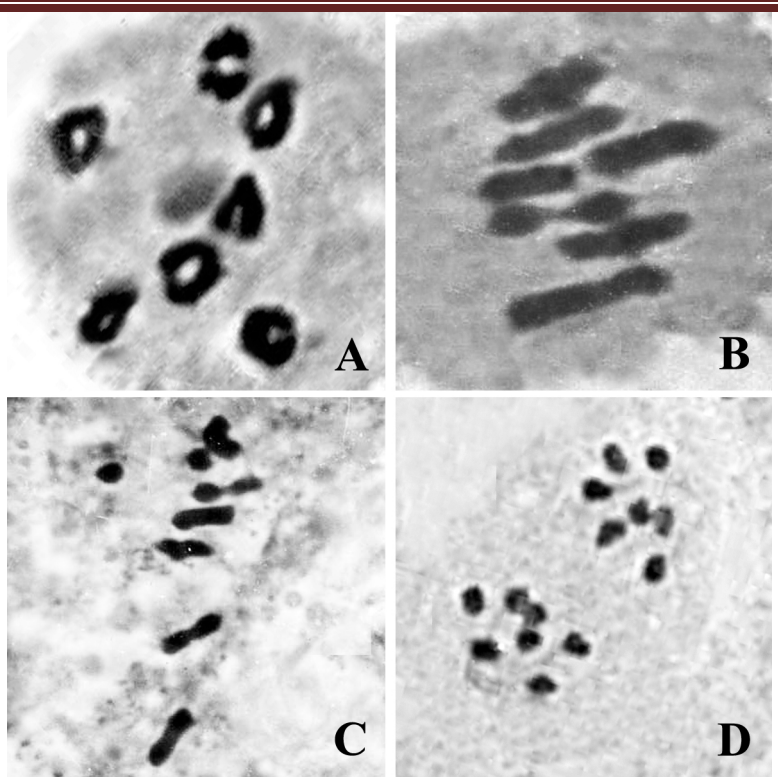


Fig 2 A-D: Meiotic configurations (2n=14) in *C. cyminum*. A- Diplotene with ring and rod configurations of chromosomes; B- 7II at MI; C- 6II+2I at MI; D- 7/7 separation of chromosomes at AI.

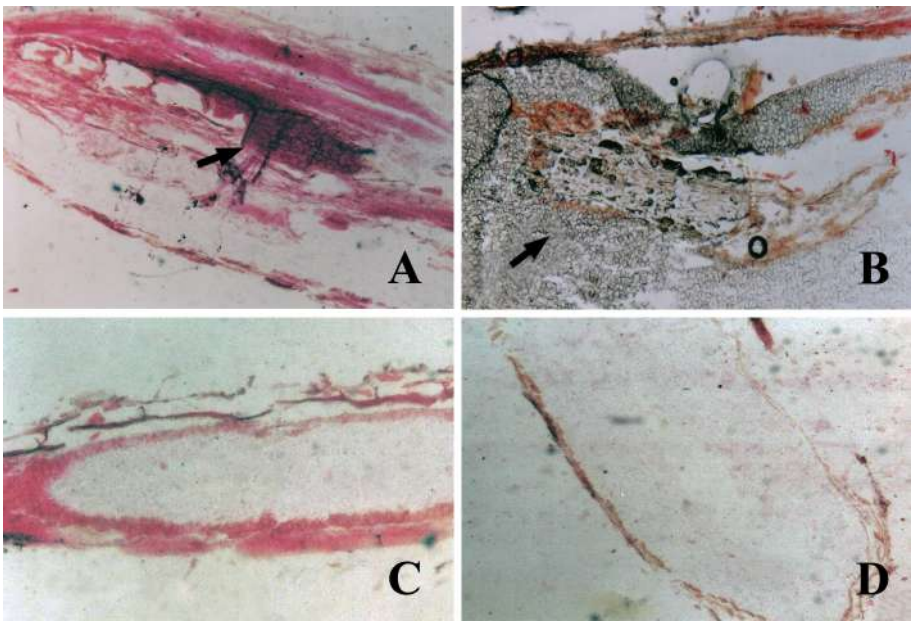


Fig 3 A-D: L.S. through cumin seeds. A-B- L.S. of seeds from mother stock showing embryo (A) and cellular endosperm (B). C-D- L.S. through seeds of raised plants where embryo and endosperms are both lacking.

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