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FLORAL BIOLOGY IN CLOVE

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ABSTRACT

In clove, [*Eugenia caryophyllus* (Sprengel) Bullock et Harrison], anthesis takes place in the afternoon starting at 1.30 p. m. with peak between 3.30 p. m. and 4.30 p. m. Anthers dehisce longitudinally. Anther dehiscence commences 24 hr. before anthesis, peak being immediately after anthesis. Pollen grains have mean diameter of 16.1μ and are triangular in shape with three furrows and the apertures fused to form a ring. Maximum pollen germination and tube growth obtained in 1% sucrose+0.01% boric acid, germination starting 33 hr. after dusting. The stainability of pollen was 81%. Stained pollens were larger in size and gave higher percentage of germination. Stigmatic receptivity was maximum on the day of anthesis and the following day. Under artificial pollination, the maximum fruit set obtained was 30%, while under bagged conditions, it was 28%. Self pollination appeared to be more probable in clove.

INTRODUCTION

The clove, a native of Moluccas Is. is a spice crop of the humid tropics. Published literature on the floral biology of clove is limited to the description of anthesis, stigmatic receptivity, mode of pollination and fruit set (Wit, 1969; Nair, Sadanandan and Unnithan, 1974). Results of a detailed study undertaken at the UNDP/FAO Research Project of the Department of Minor Export Crops, Matale, on floral biology, pollen morphology and pollen germination of the clove plant are reported in this paper.

MATERIALS AND METHODS

For the study of anthesis, anther dehiscence and fruit set, ten clove trees were marked in Gamwasama Estate, Matale, Sri Lanka. Adequate number of mature flowers which were about to open (as evident by the larger size, dark pink calyx lobe and light pink calyx tube) were marked out. Observations on anthesis were recorded each day on 20 such flowers selected at random, for a total period of five days. For the study of anther dehiscence, 50 flowers, at random were marked and five flowers were collected at an interval of two hours starting from two days in advance of anthesis, and observed under stereo microscope for dehiscence. To find out the type of anther sac opening and its location, two mature buds about to open were collected daily between 1 p.m. and 3 p.m. for four days and 25 randomly selected anthers

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from each bud were observed under the microscope.

Pollen from freshly opened flowers was dusted on to a drop of aceto-carmine-glycerine on a slide and morphology (shape and surface pattern) studied at 10×40 magnification. Size of 50 pollen grains was measured using an ocular micrometer. Pollen grains (200 nos.) stained with acetocarmine were scored for stainability. Pollen germination was studied in cavity slides with fresh pollen. Random counts of 100 grains under microscope were made for germination and the same also used for pollen tube growth measurements.

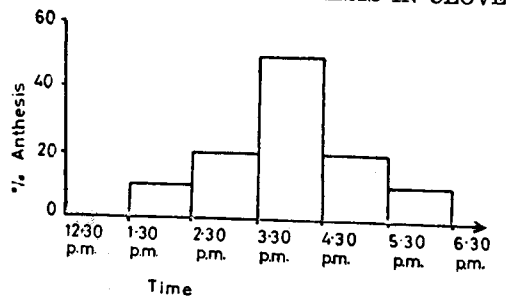
For the study of stigmatic receptivity, flowers which were likely to open the following day were selected and all other opened and unopened buds in the cluster were removed. The selected flowers were emasculated and bagged with polythene bags. Ten flowers were pollinated daily at 5 p. m. and covered again. The bags were removed five days after pollination and fruit set recorded after seven weeks. Fifty flowers from five trees which were about to open, were bagged and fruit set recorded.

RESULTS

Anthesis

During flower opening, the four connected petals separated as a cap from the hypenthium and were shed by the extending stamens. Results of observations on time and rate of anthesis are given in Fig. 1. It will be seen from the figure that the anthesis commenced at about 1. 30 p. m. and extended upto 5. 30 p. m., the peak period being between 3.30 p. m. and 4.30 p. m.

FIG. 1. PATTERN OF ANTHESIS IN CLOVE



Time, period and type of anther dehiscence

Anther dehiscence in a flower started from the outer whorl and proceeded inwards. Data on the rate of anther dehiscence and anthesis are given in Fig. 2. It will be observed from this Figure that anther dehiscence preceded anthesis and was fairly prolonged. Anther dehiscence took place longitudinally either from the distal or proximal ends or from the centre, the latter occurring in 81.6% of the cases.

Pollen morphology and size

Pollen grains were light yellow in colour and triangular in shape with three furrows and the apertures fused to form a ring (Fig. 3). The mean diameter of pollen grains was 16.1μ and stainability 81.3%. The stained pollen grains were larger in diameter (18.2μ) compared to the unstained ones (14.8μ).

Pollen germination and tube growth

Pollen failed to germinate in glucose solutions, coconut water, Brewbaker's medium, higher concentration of

FIG. 2. RELATIONSHIP OF ANTHER DEHISCENCE AND ANTHESIS

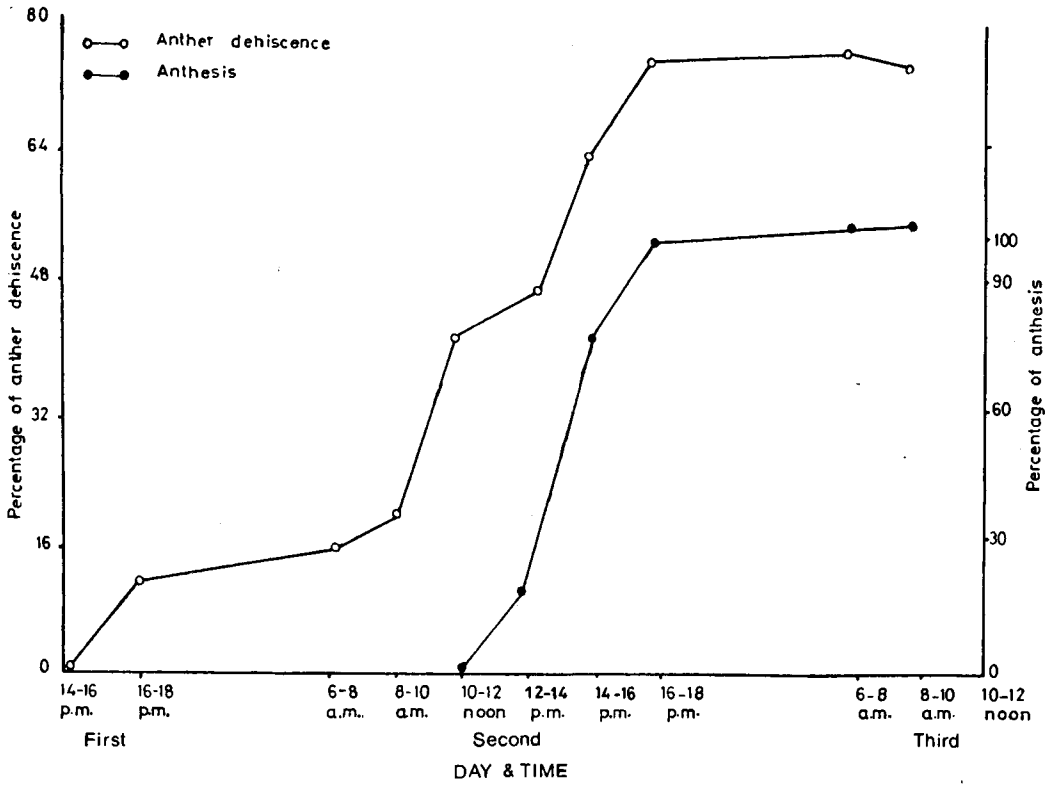
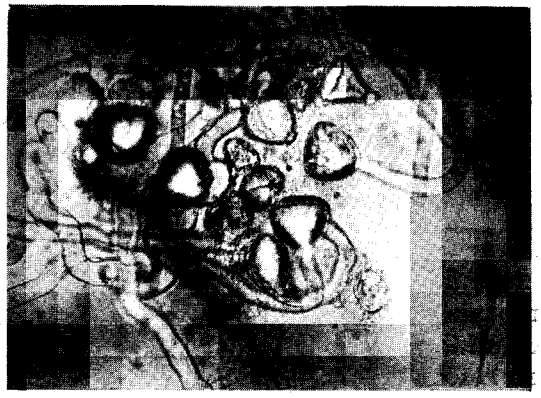


FIG. 3. POLLEN GRAINS IN CLOVE

FIG. 4. GERMINATION OF POLLEN GRAINS



sucrose solutions (5% and above). Pollen germination started about 32 hr. after dusting in the medium and was complete in about 20 hr. thereafter. The results of the germination tests conducted with different concentrations of sucrose and boric acids and pollen tube length are given in Table I.

It will be observed from the Table that 1% sucrose and 0.01% boric acid gave the maximum germination of 55.9%. The length of pollen tube was also highest in this medium (Fig. 4). The rate of tube elongation was observed to be faster in the beginning (Fig. 5).

Table I. *Percentage of pollen germination and pollen tube length in clove*

Culture media	Germination % (mean)	Tube length μ
Sucrose 0.5%	3.8±1.5	37.7±8.67
,, 1.0%	14.6±1.05	71.12±4.7
,, 1.5%	28.5±3.53	93.96±4.5
,, 2.0%	11.2±2.89	
Distilled water	3.2±0.57	52.12±2.74
Sucrose 0.5% + boric acid 0.01%	39.2±2.4	245.81±7.4
Sucrose 1% + boric acid 0.01%	55.9±3.66	300.45±5.2

Stigmatic receptivity and fruit set

The results of artificial pollination of emasculated flowers and fruit set obtained after seven weeks are given in Fig. 6. It will be observed that the stigma is receptive for about 48 hr. from the time of anthesis. The flowers bagged to exclude insect and wind pollination gave 28% fruit set.

DISCUSSION

The present observation on the time of anthesis largely concurred with the observations reported by Nair et al. (1974), under Andamans condition. However, Wit (1969) reported that clove flowers open usually in the early morning. It is likely that climatic conditions can influence the time of anthesis.

The floral mechanism in clove wherein the stigma is surrounded by anthers and anther dehiscence preceding stigma receptivity, appear to favour self pollination. Nair et al. (1974) observed that inbreeding is common in clove. In Indonesia (Wit, 1969) and Zanzibar (Tidbury, 1949), flying insects like bees have been reported to be responsible for pollination. Only crawling insects like black ants were found to visit clove flowers in the present investigation and the role played by these insects in pollination is yet to be assessed.

Anther dehiscence started about 24 hr. before flower opening, peak being immediately after anthesis (Fig. 2). However, the maximum dehiscence of the anthers was limited to 76%. It appears that the remaining anthers are

FIG. 5. RELATIONSHIP BETWEEN GERMINATION RATE AND POLLEN TUBE GROWTH RATE

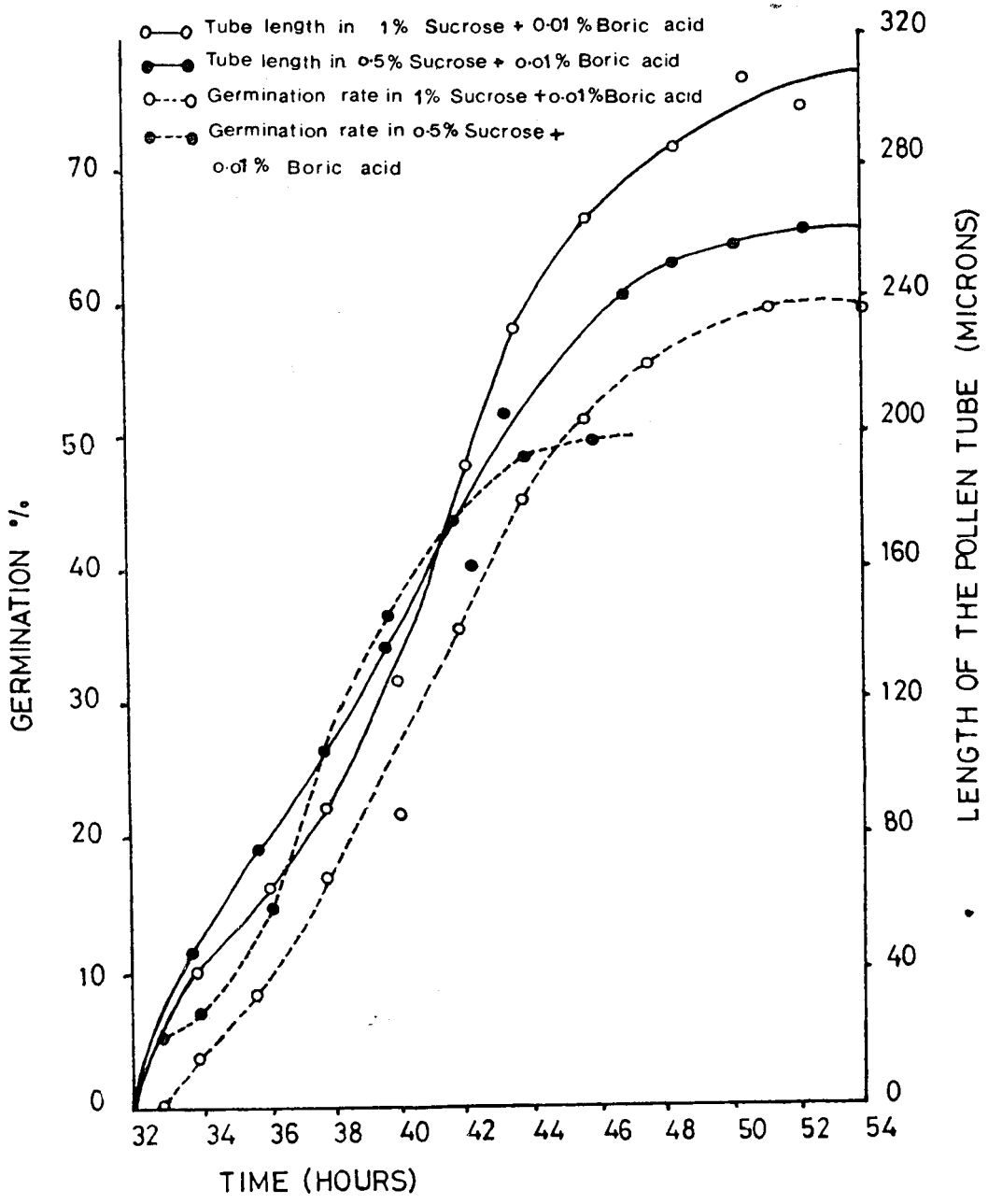
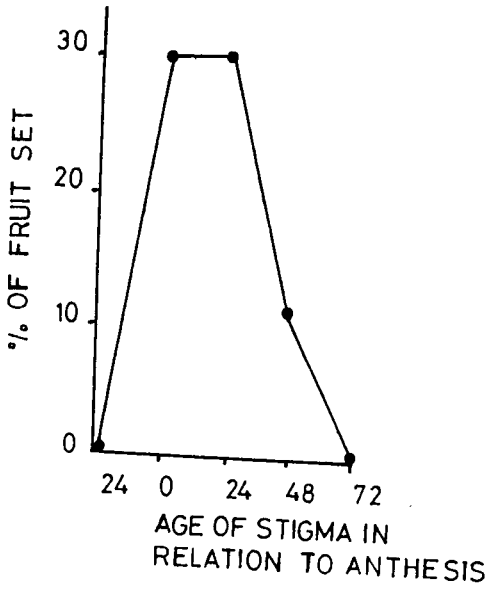


FIG. 6. RECEPTIVITY OF STIGMA



not functional. A more or less similar situation in respect of anther dehiscence and anthesis was observed in nutmeg by Bavappa and Heen Banda (1981). In majority of the cases, a slit appeared in the centre of the anther sacs which gradually extended both distally and proximally leading to anther dehiscence. Similar dehiscence mechanism has been reported in *Cajanus* (Subramaniam, 1950) and *Cardamomum* (Parameswar and Venugopal, 1974). Wit (1969) observed that in clove, stigma was receptive for about 2-3 days from anthesis. In the present study, the maximum receptivity of 30% was observed to be on the day of anthesis and the day following that. By second day, it was 10%. However, the report of Nair et al. (1974) is at variance with these observations. They obtained highest receptivity on the fifth day after anthesis.

The addition of boric acid to sucrose medium increased the pollen germination as well as the tube length (Table I). It was also observed that the pollen tubes had typically sigmoid curves (Fig. 4). A similar effect of boron on pollen germination and tube growth was observed in Cucurbitaceae (Vasil, 1960) and *Scilla* and *Vinca* (Brink, 1924, a, b).

The highest germination of 55.9% was obtained in 1% sucrose and 0.01% boric acid, though the stainability with acetocarmine was 81%. It appears that pollen stainability need not necessarily indicate pollen viability in clove.

When individual flowers were protected by covering with polythene bags, 28% fruit set was obtained. The fruit set did not increase significantly when the flowers were artificially pollinated. The absence of flying insects visiting the clove flowers, the mode of anther dehiscence and anthesis, the narrow range of stigmatic receptivity and equal fruit set by self and cross pollination suggest that under situations prevailing in Sri Lanka, self pollination is most probable in clove.

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REFERENCES

BAVAPPA, K. V. A. and HEEN BANDA, Y. M. 1981. Anthesis and pollen studies in nutmeg. *J. Plant. Crops.* **9** (1): 42–45.

BRINK, R. A. 1924a. The physiology of pollen: I. The requirements for growth. *Amer. J. Bot.* **11**: 218–288.

BRINK, R. A. 1924b. The physiology of pollen: II. Further consideration regarding the requirements for growth. *Amer. J. Bot.* **11**: 283-296.

NAIR, R.B., SADANANDAN, A.K. and UNNITHAN, K. R. G. 1974. Floral biology and breeding of clove. pp. 28–29. In *Proceedings of First National Symposium on Plantation Crops.* (Ed. N. M. Nayar). Indian Society for Plantation Crops, Kasaragod, India.

PARAMESWAR, N. S. and VENUGOPAL, R. 1974. Capsule setting studies in *Elettaria cardamomum* Maton. *Curr. Sci.* **3** (5): 97–58.

SUBRAMANIAM, K. 1950. Anthesis in *Cajanus indicus.* Cited by Parameswar et al. *Mysore J. Agric. Sci.* **8**: 356–361.

TIDBURY, C. K. 1949. *The clove tree* 1st ed. Crosby Lock Wood and Son Ltd., London. pp. 212.

VASIL, I. K. 1960. Studies on pollen germination of certain Cucurbitaceae. *Amer. J. Bot.* **47**: 239–247.

WIT, F. 1969. The clove tree *Eugenia caryophyllus* (Sprengel) Bullock *et* Harrison. In *Outlines of perennial crop breeding in the tropics,* pp. 163–175. (Eds.) Ferwerda, F. P. and Wit, F. Veenman and Zonen, N. V. Wageningen.