California Avocado Society 1974 Yearbook 58: 99-102

POLLEN TUBE GROWTH IN AVOCADOS (PERSEA AMERICANA MILL)

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ABSTRACT: Under Trinidad conditions, avocado pollen tube growth was studied *in vitro* using a fluorescent technique. The pollen tube penetrated into the ovary within one hour. Great variations in the rate of growth of individual pollen tubes occurred.

Introduction

The time taken for the pollen tube to reach the ovary is a factor of considerable importance in crop production. If the rate of tube growth is slow the egg cell may not be in a proper condition for fertilization when the tube reaches the ovule.

Schroeder (1942) found that avocado pollen germinates readily on the stigma and observed in another study (Schroeder, 1954) that tubes of pollen from the 'Fuerte' cultivar penetrated the style to a distance of 0.139 mm in one hour.

In view of the fact that information about pollen tube growth of avocados is limited, a number of cross-and self-pollinations were carried out in order to study the rate of pollen tube growth in several avocado cultivars.

Materials and Methods

The avocado trees studied were at the University Field Station, St. Augustine. Four different cultivars ('Nishikawa C.,'[1] 'CRC 3-4,' 'Simmonds' and 'Nishikawa H.'[2]) **([1]*from California* [2]*from Hawaii*)** were used to see how long it takes for the pollen tube to reach the ovary. The flowers to be used for pollen and the flowers to be pollinated were always bagged before their first opening. In some instances the pollen was collected and immediately applied to the stigma, while in others it was stored either for a few hours or from morning till afternoon as it retains viability for several weeks when stored (Schroeder, 1942). Hand pollination was done immediately after emasculation of the flowers. The pistils were collected at intervals of 2, 4, 8, 16 and 24 hours after pollination and examined for pollen tube growth using a fluorescent technique developed by Martin (1959). Killing and fixing of the pistils was done in FAA solution immediately after removal from the tree. Callose fluorescence was observed with a dissecting microscope using a long wave ultraviolet lamp (UVL-22) and/or a Vickers M41 Photoplan fluorescence microscope using a HBO 200 high pressure mercury lamp with a UV filter. Later, pistils from other cultivars which were cross- and/or self-pollinated by hand (Table 1), were collected two hours after pollination and examined for pollen tube growth. The cultivars 'Simmonds,' 'Nishikawa C.' and 'CRC 3-4' were also studied

one hour after pollination.

Results

Time taken for the pollen tube to reach the ovary: In all the cross- and self-pollinations (Table 1) pollen germination and pollen tube growth occurred. The pollen tube reached the ovary within two hours after pollination. Further investigation on the cultivars 'Simmonds,' 'Nishikawa C.' and 'CRC 3-4' showed that the pollen tube penetrated into the ovary within one hour after pollination.

Schroeder (1951) pointed out that the ovule is anatropous and according to Hodgson (1930), Van Elden found that the egg cell is in a proper condition for fertilization during the first opening of the flowers. Therefore, most probably, fertilization can take place within an hour after pollination, if there is no delay because of any other reason. The distance between the stigmatic surface and the ovule is approximately 2.7 mm. in the cultivar 'Nishikawa C.'; this distance varies among cultivars with different length of pistils.

In the trees R_2T_{30}, R_2T_{32} and R_5T_{27}, cross-pollination of the Stage II flowers (flowers open for their second period), which had their stigmas receptive, indicated that the growth of the pollen tube was quite regular. The rate of growth was the same two hours after pollination, whether the flowers were pollinated during their first, or their second period of opening.

TABLE I

Hand cross- and self-pollinations carried out

Number of Rows and Number of Trees on the Row	Cultivar
R_1T_{11}(F)xR_1T_{15}	Currington (F) x Simmonds
R_1T_{15}(F)xR_1T_{11}	Simmonds (F) x Currington
R_1T_{13}(F)xR_7T_{17}	Simmonds (F) x Nishikawa H.
R_7T_{17}(F)xR_1T_{13}	Nishikawa H. (F) x Simmonds
R_1T_{13}(F)x$R_{11}T_{11}$	*Simmonds (F) x Duke*
R_7T_{27}(F)x$R_{11}T_{11}$	Nishikawa H. (F) x Duke
R_6T_{29}(F)xR_7T_{29}	CRC 4-16 (F) x Hashimoto
R_7T_{29}(F)xR_6T_{29}	Hashimoto (F) x CRC 4-16
R_6T_{29}(F)x$R_{10}T_{22}$	CRC 4-16 (F) x Fujikawa
$R_{10}T_{22}$(F)xR_6T_{29}	Fujikawa (F) x CRC 4-16
R_7T_{20}(F)xR_6T_{29}	Nishikawa C. (F) x CRC 4-16
R_5T_{27}(F)xR_7T_{20}	SR 1402-117 (F) x Nishikawa C.
R_1T_{13}(F)xR_1T_{13}	*Simmonds (F) x Simmonds*
R_7T_{17}(F)xR_7T_{17}	Nishikawa H. (F) x Nishikawa H.
R_7T_{20}(F)xR_7T_{20}	Nishikawa C. (F) x Nishikawa C.
$R_{10}T_{22}$(F)x$R_{10}T_{22}$	Fujikawa (F) x Fujikawa
R_7T_{29}(F)xR_7T_{29}	Hashimoto (F) x Hashimoto
R_2T_{32}(F)xR_1T_{13}	*SR 1402-127 (F) x Simmonds*
R_2T_{30}(F)xR_7T_{20}	SR 1402-74 (F) x Nishikawa C.
R_5T_{27}(F)xR_7T_{20}	SR 1402-117 (F) x Nishikawa C.
R_6T_{24}(F)xR_6T_{24}	CRC 3-4 (F) x CRC 3-4

F — Female
Nishikawa C. — Nishikawa from California
Nishikawa H. — Nishikawa from Hawaii

Differences in the rate of growth: Great variations were repeatedly observed in the rate of growth among individual pollen tubes from pollen grains of the same cultivar. For example, in the cultivar 'Nishikawa C.' one hour after pollination some pollen tubes had already reached the ovary, while others covered only a very short distance. In this cultivar the short tubes were without swollen tips. In the cultivar 'Fujikawa' two hours after pollination a similar situation was observed. in which the short tubes had swollen tips. Examination of pistils at later stages showed that more tubes grew down to the base of the style, although at this time short tubes were also observed.

Usually the pollen grains are monosiphonous, i.e. only a single pollen tube emerges from each pollen grain. However, two tubes were seen to come out from the same pollen grain in two cases. In both cases one of the tubes was short while the other had already reached the ovary; the short tube was about five times as thick as the long one. The fact that only two pollen grains have been observed indicated that polysiphonous grains very rarely occur in avocados.

Discussion

The results obtained here on the rate of pollen tube growth differ from those of

Schroeder (1954) and Van Elden (Hodgson, 1930).

In preliminary studies, Schroeder (1954) observed that 'Fuerte' pollen germinated through the style at a rate of 0.139 mm in one hour, under Los Angeles conditions. The average distance from the stigma to the egg cell was approximately 4 mm. He proposed that if a constant rate of pollen tube growth is maintained, approximately 28.5 hours would be required to effect fecundation following pollination. In another experiment, by the same author, approximately 44 hours should have been required to effect fecundation, the temperature being 26.1°C. 'Nabal' pollen appeared to germinate at a slower rate and would require about 66 hours to cover the same distance. Also in California, according to Hodgson (1930), Van Elden found much evidence that by the second opening of the avocado flower, fertilization had already occurred.

The differences in the results of this study from those previously mentioned (Schroeder, 1954; Hodgson, 1930), are probably due to different environmental conditions as, doubtless, there is a difference in temperature between California and Trinidad. During this study, the temperature was about 32.5°C(±0.8°C). That temperature greatly affects the rate of growth of pollen tube has been experimentally demonstrated by researchers in other crops. In *Datura stramonium* at 11.1° C the average rate of growth was 1.28 mm per hour, while at the optimum temperature of 33.3°C the rate was 5.86 mm per hour, or four and a half times as great (Buchholz and Blakeslee, 1927). More recently Mellenthin *et al* (1972) reported that pollen tubes of pears *(Pyrus sp.)* had grown to the base of the style within 24 hours at 21.1°C, by 72 hours at 15.5°C and 120 hours at 10°C.

The factor or factors responsible for the variation in pollen tube growth might be different in the case of short tubes without swollen tips and those short tubes which become abnormally swollen and bulbous at the tips. One possible explanation might be the presence of an inhibitor in the short-tube grains.

If pollination is adequate and many pollen grains are depositied on the stigma, the variation in pollen tube growth will not be any problem in fruit production; but in instances where only one or a few pollen grains are deposited on the stigma, because of inadequate pollination, such a variation in pollen tube growth may decrease crop production. In such instances certain tubes may have only a limited growth, so that they may never reach the ovule or, because of probable slow growth or perhaps delay in pollen germination, when they reach the ovule the egg cell may not be in a proper condition for fertilization.

ACKNOWLEDGEMENTS

I wish to thank Professor Egbert A. Tai who suggested this field of study, gave valuable guidance and reviewed the manuscript; without his encouragement this paper would not have been written. Thanks are also due to Dr. M. S. Sandhu, Mr. I. Hosein, Mr. W. B. Charles, Dr. E. J. Duncan and Miss J. Lowery for helpful discussion. I am indebted also to the Government of Trinidad and Tobago for the award of the scholarship, making this investigation possible.

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