Observations on the opening of flowers, dehiscense of anthers and growth of pollen tubes in *Arachis hypogaea* L.

G. G. BOLHUIS, H. D. FRINKING, J. LEEUWANGH, R. G. RENS and G. STARITSKY

Laboratory of Tropical Crop Husbandry, Wageningen, Netherlands

Summary

Examination of flower buds and flowers of three different groundnut cultivars from various origin and growing under differently controlled conditions, disclosed that flower expansion occurs at the onset of the light period.

Pollen liberation may already occur seven to eight hours before flower expansion, but even then the anthers may not have dehisced in some flowers. This throws a new light on the possibility of natural cross pollination.

From measurements of pollen-tube growth in the styles it could be computed that the tubes grow with a speed of about 4 mm per hour.

1. Introduction

Little is known as to the exact time of opening of the groundnut flowers, when pollen is liberated from the anthers and how much later fertilization of the ovule follows. In general writers on flowering and fertilization are rather vague about these questions. In the "Peanut Symposium" GREGORY *et al.* (1951) state that the petal expansion occurs at sunrise and the anthers dehisce just before or even after petal expansion. BADAMI (1935) also mentions opening of the flowers at sunrise, but pollen liberation should take place either in the early hours of the morning or at sunrise, and fertilization should be accomplished about midday. STOKES and HULL (1930) find the flowers fully opened at sunrise and the polllen already shed. According to SAUGER (1949) natural pollination occurs at about 4 a.m. and all pollen is liberated at 10 a.m. In the Philippines CAPINPIN and GUEVARA (1951) observed flower expansion already at 3 a.m., all flowers being fully expanded at 5 a.m.; dehiscence of the anthers began at 5 a.m. BOLHUIS (1959) sets the time for natural pollination between 2 a.m. and 4 a.m. KOCH (1922/30) reports opening of the flowers at sunrise, or later, according to weather conditions, cloudy weather causing an appreciable delay. DE BEER (1963) states that with his plants grown under artificial conditions anthesis occurs at the beginning of the light period. At Bambey (Sénégal) BOUFFIL (1947) finds pollination anticipating flower expansion by four hours and flowers opening at sunrise.

With the exception of CAPINPIN and GUEVARA (1951) all writers agree that flower expansion happens around sunrise but about the moment of pollen liberation the opinions differ.

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2. Materials and methods

Plants of three cultivars, *i.e. Schwarz 21, Mallorca* and *Ukraine,* were grown in Mitscherlich pots in rooms under conditions of 12-hour light, high (90 %) and low (50 %) air humidity and temperatures of 24—25° C during darkness and 27—29° C during the light period.

Illumination was provided by 24 Philips TL/55 40-Watt tubes giving a light intensity of 45.000 erg/cm²/sec. Of the cultivars used *Schwarz 21* is a tropical type from Buitenzorg (Java) about 7° lat.S, *Mallorca* originates from the sub-tropics about 37° lat.N and *Ukraine* from a typical continental climate about 51° lat.N. *Schwarz 21* belongs to the group of Spanish varieties, *Mallorca* to the Valencia group and *Ukraine* to the Small Spanish group.

Flowers were sampled at hourly intervals ranging from nine hours before to three hours after the onset of the light period. As the number of flowers sampled was generally larger than could be examined directly after sampling, they were conserved and examined afterwards. Only flowers having a style of normal length were taken into account.

The length of pollen-tube growth was determined by placing the dissected styles between an object slide and a cover glass with a drop of staining solution; a little pressure was applied. For staining the Lacmoid-Martius-Yellow solution of NEBEL (1951) was used. In the style tissue the length of the pollen tubes could be measured by means of the coloured callose lumps present in the tube.

It must be conceded that this method is not ideal, but up to now it has given the best results. Disadvantages are: a. the colouring is sometimes far from perfect, b. the pollen tube does not grow straight but winds its tortuous way through the style tissue, c. the style shows a curvature at its upper end which causes distortion under pressure. Only preparations which allowed good measurements were taken into account.

3. Results

Flower expansion generally followed the onset of the light peiod; some flowers opened somewhat earlier, others somewhat later, and very seldom flowers were found already open half an hour before that time. In the room with high humidity less variation in opening of the flowers was observed than in the low-humidity room. In the latter sometimes flower buds were found with very short hypanthia which opened either very late or not at all.

Hourly sampling and subsequent examination of dehisced anthers beginning at nine hours before the lamps were switched on up to three hours after switching on resulted in the data mentioned in the TABLE.

From these figures it is clear that flower buds with dehisced anthers can already be found about seven to eight hours before the lights are switched on.

When the lamps are switched on, however, all or nearly all flowers showed dehisced anthers. No appreciable differences between the three cultivars could be found in this respect.

After pollination the growth of the pollen tubes in the stylar canal can be followed. The very first stages were hard to detect owing to much distortion of the tissue under pressure. The first growth could only be detected about one and a half hour after pollination in flowers of the cultivar *Mallorca* in the high-humidity room; in the room with low humidity first growth could be found only about three hours before the flowers opened.

TABLE. Sampling of flowers and subsequent examination of dehisced anthers of *Arachis hypogea* L.

Time of sampling	Number of flowers		
	sampled	with dehisced anthers	%
—9	15	0	0
—8	10	1	10
—7	15	1	7
—6	15	2	13
—5	20	5	25
—4	20	8	40
—3	20	16	80
—2	20	16	80
—1	25	21	84
0 (lights on)	20	20	100
+1	20	19	95
+2	15	15	100
+3	10	10	100

Comparable data were found with the *Schwarz 21* cultivar.

From measurements of pollen tubes in flowers of the *Ukraine* cultivar in the high-humidity room a growth curve was constructed which appears to be nearly a straight line and which indicates that anther dehiscence could be placed at about seven hours before the lights were switched on (see FIG. 1). From these data a growth speed of about 4 mm per hour can be computed. The *Ukraine* cultivar was chosen because the number of pollen tubes in one style was always much larger than in the case of the other cultivars.

The first instance of pollen tubes having passed the whole length of the style and therefore being able to fertilize the ovule was found one hour after switching on the lights. In plants of the cultivar *Schwarz 21* most pollen tubes had reached the ovule between 1½ and 2½ hours after the lights were switched on. See also FIG. 2 in which the relative length of the pollen tubes is compared to the length of the style.

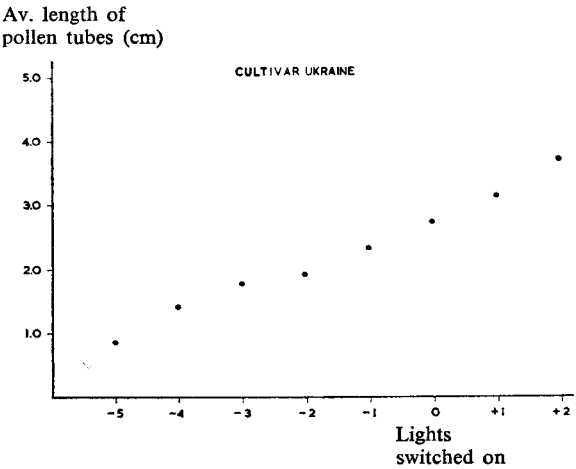

FIG. 1
Growth of pollen tubes in the stylar canal; var. *Ukraine*

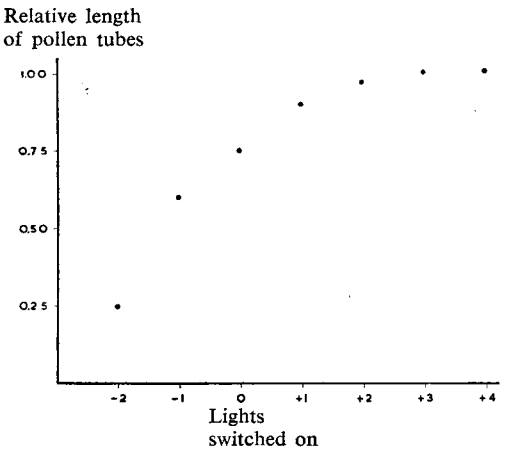

FIG. 2
Relative length of pollen tubes compared to style length

4. Discussion

By comparing the results found in our experiments concerning the time of flower expansion with those of other authors we can conclude that under field conditions and under artificial light as well the flowers generally expand about the time of sunrise or switching on the lights.

For the dehiscence time of the anthers results are more different. The statements of GREGORY *et al.* (1951), BADAMI (1935) and DE BEER (1963) that anther dehiscence takes place just before sunrise or at the moment the lights are switched on is certainly not entirely correct. According to BOUFFIL (1947) and BOLHUIS (1959) dehiscence of anthers occurs three to four hours before the opening of the flowers, which means that a difference exists of two to three hours with our present findings. This difference may, however, be partly due to lower night temperatures in the field which retards elongation of the hypanthium and the ripening of the anthers.

In his publication about natural cross pollination in the groundnut BOLHUIS (1951) reasons from the assumption that in all flowers of his experimental plants dehiscence has taken place three to four hours before sunrise and therefore their own pollen had already at least a three-hour advantage over foreign pollen. From the figures given above it is, however, clear that one hour before flower expansion about 15 % of the flowers may have undehisced anthers and even after flower expansion in some flowers anthers may have not dehisced. This throws a new light on the possibility of natural cross pollination as now the phenomenon of certation can be ruled out.

The data found for growth of pollen tubes in the styles show good agreement with the findings of BOLHUIS (1958) in his experiments. He finds that a 8.30 a.m. practically no pollen tubes had passed the base of the styles but after 10.30 a.m. practically all ovules had dbeen fertilized. His estimates of the rate of pollen-tube growth seem to have been, however, somewhat on the high side.

5. Conclusions

Flowers of groundnut plants grown under field conditions as well as those grown under artificial conditions expand at the same time, *i.e.* at the beginning of the light period.

Dehiscence of anthers may occur already at seven to eight hours before the expansion of the flowers. At the latter moment, however, a number of flowers may still contain undehisced anthers which in case of natural cross pollination excludes certation of strange pollen as a possible factor in this respect.
The growth rate of the pollen tubes in the styles can be estimated at about 4 mm per hour.

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