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Studies on coconut pollen with reference to the leaf and root (wilt) diseases

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INTRODUCTION

Coconut palm is essentially monoecious having both the male and female flowers distributed in the same inflorescence although Davis *et al.*, (1954) had recorded instances where hermaphrodite flowers are produced. The male flowers occupy the distal region of the main as well as the lateral spikes, while generally more female flowers occupy the lowest region of the spikes. In a normal spadix, while there are only about 25 female flowers, the male flowers number about 12,000. The male flowers start opening as soon as the spathe covering the spadix bursts open, thereby indicating the commencement of the male phase. This phase continues for about 18 - 20 days after which no live male flower is usually seen on the spadix. A male flower is invariably shed within 24 hours of its opening. The receptivity of the female flowers begins usually from the 20th day (after the opening of the spathe), thus enabling the female phase to alternate the male phase.

A male flower has six free stamens with sabulate filaments and linear erect anthers. The anther lobes dehisce longitudinally. Accurate estimation of the number of pollen per flower has not been made, although Aldaba (1921) had estimated that each male flower carried about 272 million pollen grains. However, preliminary studies based on actual counts of individual pollen conducted at the Central Coconut Research Station, Kayangulam, India, reveal that the number of the pollen grains in a flower of a healthy tree varies from 1,11,000 to 2,21,000 per anther. However, there is a marked reduction in the number of pollen when the tree is infected with the root (wilt) disease and/or leaf disease which are rampant in the

Central Kerala, S. India. Detailed information on the root (wilt) and leaf diseases could be obtained from contributions by Menon and Nair (1949, 1951), Nagaraj and Menon (1955, 1956), Radha and Menon (1954), Sankarasubramony *et al.*, (1954), Varghese (1934) and Nagaraj *et al.*, (1954). This reduction in number of pollen increases as the disease gets aggravated.

MORPHOLOGY OF THE COCONUT POLLEN

The coconut pollen is spherical and smooth while within the anther or when soaked in water. But it shrinks rapidly on exposure to dryness and assumes an ellipsoid shape having a prominent longitudinal groove along one direction. Furtado (1923-25) suggests that this groove indicates that the coconut pollen grains belong to the type adapted to be carried by insects. Apart from this type which is easily wafted by the wind, Wodehouse (1935) is of the view that the presence of the groove or grooves in pollen grains suggests that the pollen is not meant primarily to be carried away by wind. The presence of single furrow according to Wodehouse is the sign of the monocotyledons, the primitive gymnosperms or the primitive dicotyledons. The form of the pollen grains of coconut as well as many other palms is, therefore, primitive. The only advance that it shows over those of the lower gymnosperms is in its more elongate shape permitting more complete closure of the furrow. The remarkable similarity of this form of grain to those of *Cycadales* and *Bennetitales* suggests that the palms may not be very far removed from their gymnospermous ancestors (Wodehouse). Certainly this form of grain appears to be more primitive than those of the *Typhaceae* or *Zannichelliaceae*, both of which are generally regarded as lower in the scale than the *palmaceae*. Then the primitive monocolpate pollen grains of the palms suggest that the nearest relatives may be found only among the lower gymnosperms. The coconut pollen when dried measures about 66.4 μ by 33.2 μ while when it is spherical it has a diameter of 49.8 μ.

Not all pollen grains are capable of germination or capable of effecting fertilization. There are some pollen grains which do not possess the usual form and do not appear to have the same internal structure. These are incapable of germination. Such pollen does not take a stain with potassium iodide solution and such pollen grains are termed 'sterile', 'shrunken' or 'dummy' pollen grains. According to Patel (1938), on an average, about 25 per cent. of the pollen grains are infertile although Aldaba has observed 3 per cent. to 33 per cent. of infertile pollen grains in the Philippines.

The percentage of these dummy pollen grains increases when the

tree contracts the root (wilt) disease and advances in disease condition. It has also been observed that the percentage of the apparently normal pollen from such diseased palms not only shows a numerical reduction, but also a reduction in the rate of growth of the tubes from them. When the tree shows acute disease symptoms and loses its vigour, the size of the spadices and the number of male and female flowers get reduced. Sterility of male flowers is also often noticed starting from the tip of the spikes downwards. After a stage, no spadix is produced in the tree. In order to study the degree of breakdown in the anthesis in the trees affected by the root (wilt) disease a systematic study was planned and pursued, the results of which are summarised below.

MATERIALS AND METHODS

Male flowers from apparently healthy coconut as well as those affected by the root (wilt) disease and leaf disease have been taken.

Diseased palms showing early, middle as well as acute stages were included, and 6 palms selected under each category. The history of most of these experimental trees were known for over 6 years before the commencement of the experiment. Trees over 35 years are considered adult and those below 10 years are recorded as seedlings, and the data gathered separately for the adult palms and seedlings.

In a normal spadix of a healthy tree there are about 30 spikes (average for 100 trees for one year). From each spadix, 5 spikes were selected at regular intervals representing the entire spadix and 5 flowers each were drawn at regular intervals from these spikes to represent the entire spike. Thus, in all, pollen from 25 flowers from a single spadix were studied in detail. By this process, flowers from 35 adult palms and 5 seedlings were studied, the total number of flowers studied amounting to 1000.

For distinguishing the viable pollens from the dummy ones, potassium iodide solution was used. To start with, acetocarmine solution also was tried. But with potassium iodide, quicker and better results were obtained. Hence this medium has been used throughout.

To germinate the pollen, different media such as 3 per cent. cane sugar solution; 2 per cent. cane sugar and 2 per cent. gelatin; 10 per cent. cane sugar and 2 per cent. gelatin; 5 per cent. cane sugar and 2 per cent. gelatin; 3 per cent. cane sugar and 2 per cent gelatin and 5 per cent. cane sugar and 0.75 per cent. agar; 2 per cent. gelatin; 0.75 per cent. agar; distilled water; tender nut water; water of matured nut, fresh as well as stored; bee honey; nectar from female flower glands and stigmatic secretion were tried. Out of these, the natural medium, i. e. stigmatic secretion gave the maximum germination. Next best

was the medium 5 per cent. cane sugar and 2 per cent. gelatin which was used for these experiments.

PROCEDURE

Representative spikes from selected trees were collected as soon as the inflorescence opened. Five fully matured male flowers whose anthers just start to dehisce were picked out and the pollen from them studied separately.

Dry pollen spread on microscopic slides was measured (length and maximum width) with the help of micrometer eye-piece. Measurements are taken of 25 pollen grains randomly selected on the slide and the average calculated.

When the measurements of the dry pollen were over, a few drops of potassium iodide solution were added to the slide in order to soak the pollen grains. Within a very short time the ellipsoidal pollen grains assume a globular form. Then the diameter is also measured and the average for at least 25 randomly selected pollen was taken. However, for this selection the shrivelled ones, deformed ones and the pygmy ones are excluded. By the application of the potassium iodide solution the majority of the pollen grains take up a maroon colour which represents the well formed normal pollen grains. There are also a number of almost transparent or empty pollen grains as well as those with irregular or shrivelled grains. Percentage of the normal pollen grains and the remainder were calculated separately after counting the entire pollen in 5 separate microscopic fields.

In order to study the percentage of germination of the pollen, pollen grains were taken in cavity slides. The medium, 5 per cent. cane sugar and 2 per cent. gelatin, was dropped into the cavity just sufficient to soak the pollen grains. With a pointed needle the pollen grains were spread and thinned for convenient observation. With a cover-slip the cavity position of the slide enclosing the pollen grains was covered. At regular intervals of 15 minutes the germination of the pollen was counted and the percentage calculated. Since it was seen that almost the entire germination was recorded within 2 hours, for recording of the maximum percentage germination, the counts were taken uniformly after 2 hours from the time of the pollen being soaked in the medium. A pollen is considered to have germinated even when the entine just forms a lump beak after rupturing the exine. In the course of these studies for germination, several pollen grains were observed to have burst open and the inner contents purged out. Such pollen were considered to be ungerminated ones.

To find out the rate of growth of the pollen tube of both the healthy and the diseased palms the average length of the tubes of the germinated pollen of the entire pollen in the cavity (at a time 100-200 pollen grains were deposited in that cavity) was calculated for both these categories.

RESULTS

From the perusal of the data gathered it has been observed that

there is a distinct difference in size and behaviour of the pollen from diseased and healthy ones. However, there is not much difference between the pollen of healthy adults and the seedlings. A summary of the observations made is given in Table 1.

TABLE I

Condition of trees	Number of trees	Dry pollen		Soaked pollen	Germinating pollen			
		Length in microns	Breadth in microns	Diameter in microns	Percentage of dummy	Percentage of germination	Length of pollen tube within ½ hour in microns	Rate of growth in microns per minute
Healthy	Average of 9 trees	66.4	33.2	49.8	9.75	75.5	23.9	0.78
Root (wilt) disease early	,,	,,	,,	,,	12.06	51.62	22.5	0.75
Root disease middle	Average of 4 trees	65.16	,,	,,	13.29	49.43	11.2	0.37
Root disease advanced	,,	64.29	,,	,,	22.31	33.46	13.7	0.43
Leaf (rot) disease early	Average of 3 trees	65.8	,,	,,	11.55	58.46	14.27	0.47
Leaf disease middle	,,	64.06	,,	,,	12.25	46.5	12.94	0.43
Leaf disease advanced	,,	65.4	,,	,,	13.54	36.1	11.62	0.38
Seedlings	Average of 5 seedlings	66.4	,,	,,	10.6	54.1	23.8	0.61

It may be seen from the table that while there is difference in the length of the pollen between healthy and diseased trees, the difference is not appreciable when the grains are soaked. The percentage of dummy pollen is higher for the root diseased trees than the leaf diseased ones. The difference is significant. There is also material difference in the percentage of germination between healthy and diseased palms. It may also be stated that the percentage of germination of the pollen of the seedlings is also comparatively less (54 per cent).

SUMMARY

The number, size, percentage germination etc. of the coconut pollen in relation to the root (wilt) disease were studied at the Central Coconut Research Station, Kayangulam, Kerala.

The dry pollen of a healthy coconut palm is ellipsoidal measuring about 66.4 μ. by 33.2 μ. and when it gets soaked with water, it assumes a spherical shape measuring about 49.8 along the diameter. However, the pollen from diseased palms measure less. Dimunitive ones and pollen having irregular shape are at their maximum in the case of diseased trees in the acute condition. Even where the tree produces only a few male flowers on account of its exhaustion due to disease, the flowers were observed to have numerous normal looking pollen grains capable of germination and presumably fertilisation.

The percentage of dummy pollen is higher in diseased palms and there is a correlation between the percentage and the stage of infection. It was also seen that the dummy pollen was more in the case of root (wilt) diseased palms than in the leaf diseased ones of the same stage of infection.

It was also seen that the percentage of germination of the pollen dwindles as the tree gets aggravated with the diseases. In the case of very young palms (healthy ones), the percentage germination of pollen was found to be much lower than that of healthy adult palms.

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