

## MIDDAY CLOSURE OF STOMATA IN THE OIL PALM IN MALAYSIA

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### Ringkasan

Penutupan setomata kelapa sawit pada waktu tengahari nampaknya telah berlaku ketika masa kemarau di Pahang dan pengairan pula menunjukkan bahawa penutupan ini berkurangan. Perulangan dan kemustahakan pelitupan itu adalah dibincangkan, begitu juga telah dirumuskan yang tegasan lembapan yang cukup guna benar-benar mengurangkan hasil kelapa sawit itu adalah kejadian di Malaysia.

### Introduction

Symptoms of water stress (drought) in the oil palm have been described by various workers in Africa. The main symptoms are: —

1. The presence of more than one fully elongated but unopened spear in the centre of the crown. Broekmans (1957) noted that the rate of opening of leaves during the dry season in Nigeria was approximately half that during the wet season, while the rate of elongation is more or less unchanged.
2. Premature dessication of the lower leaves (Rees 1961).
3. Midday closure of stomata. Rees (1961) showed that pronounced closure of stomata occurred in the afternoon during the Nigerian dry season, whereas in the wet season the stomata remained open throughout the hours of daylight.
4. Reduction in yield. Yields in Africa are generally much lower than in South East Asia; this has been attributed either to lower solar radiation, or to low rainfall in the dry season. Desmarest (1967) showed that in the Ivory Coast rainfall is the major limiting factor, since with irrigation yields of 22 tonnes fruit/ha. could be obtained, compared to 5 tons without. Irrigation appeared both to increase sex ratio and to reduce abortion rate.

In Malaysia it is often assumed that significant water stress does not occur. However, the unopened spear symptom of water stress in oil palm can certainly be observed, quite frequently in drier parts of the country, though premature dessication of leaves is probably rare except after transplanting from nursery to field. Corley (1973) suggested that abnormal peaks of male inflorescence production in Malaysia may be caused by periods of drought, but there is as yet no conclusive evidence that water stress limits oil palm yields in Malaysia.

Midday closure of oil palm stomata has not previously been observed in Malaysia, and some observations on this are presented in this note.

### Methods

Stomatal resistance to diffusion of water vapour was measured with a diffusion porometer similar to that described by Kanemasu *et al* (1969), calibrated as outlined in the same paper. Measurements were made on the lower surface of healthy, undamaged leaflets, on leaves from the lower half of the canopy (leaf number 24-36). Previous experience had shown that variation in stomatal resistance with leaf age was relatively slight. Some palms were flood-irrigated, water being channelled to the weeded circles, and allowed to flood the circle and, to a lesser extent, the surrounding soil.

All the palms involved were on a Segamat series soil, in Central Pahang.

## Results

Stomatal resistance of one leaf on each of six palms, in a 1970 D x P Planting (38 months old), was measured at frequent intervals through two consecutive days in March 1973. At this time only 5 inches of rain had fallen in the previous 10 weeks, and these palms each had two or three fully elongated but unopened spears. Closure of stomata occurred after noon on each day (fig. 1), but this closure was more pronounced on the second day. When stomatal resistance is plotted against shade temperature (fig. 2) this difference is explained, since afternoon temperatures were higher on the second day. The results in figs. 1 and 2 are very similar to those of Rees (1961) in that closure occurred soon after noon, and increased rapidly at temperatures above about 32°C.

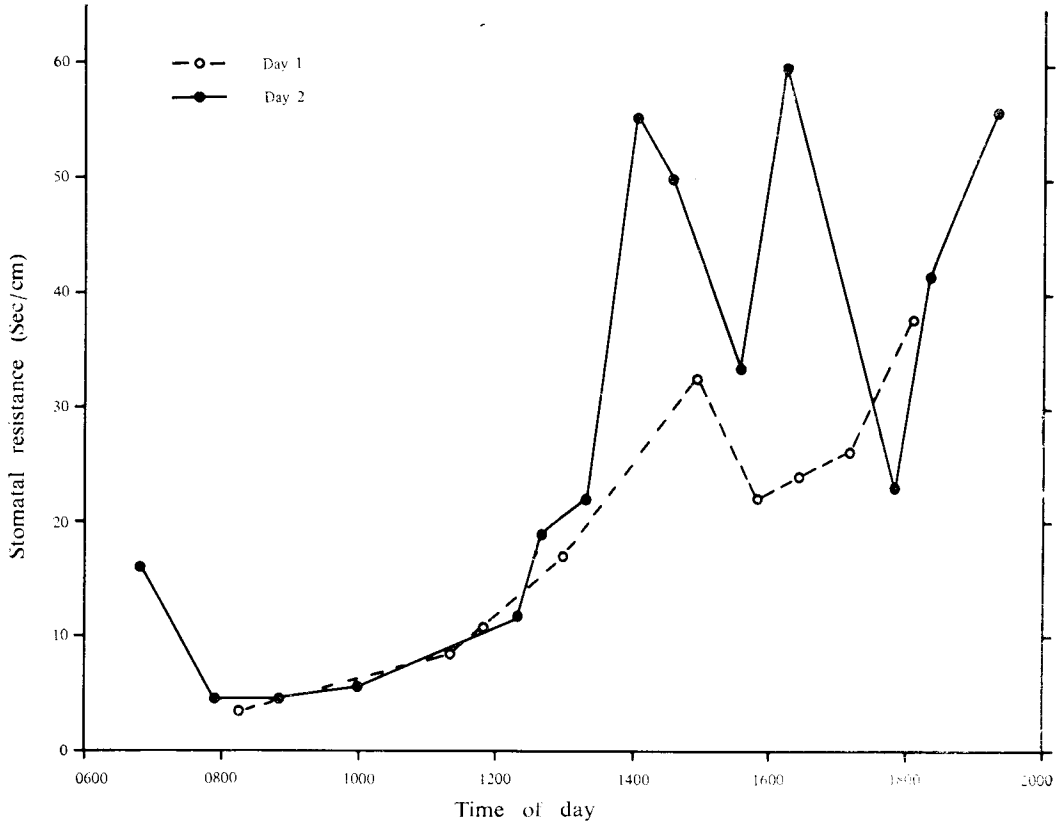


Fig. 1. Stomatal resistances during two consecutive days. Each point is the mean of 6 measurements.

Further measurements were made in an adjacent 1963 D x P planting, in which some palms had received water equivalent to about 4 ins. of rain by flood irrigation during the previous week. This was an overcast day, and at 2.30 p.m. the shade temperature was only 29°C, but nonetheless a significant difference between irrigated and unirrigated palms was observed (table 1). The stomata of the irrigated palms were fully open, with a diffusive resistance of less than 5 sec./cm, while those of the unirrigated palms were partially closed.

Table 1. Stomatal resistance of irrigated and unirrigated palms (at 2.30 p.m.)

	Stomatal resistance (sec./cm)
Irrigated	4.5 ± 1.0
Unirrigated	8.6 ± 1.4

(Each figure is the mean of 8 palms, ± standard error)

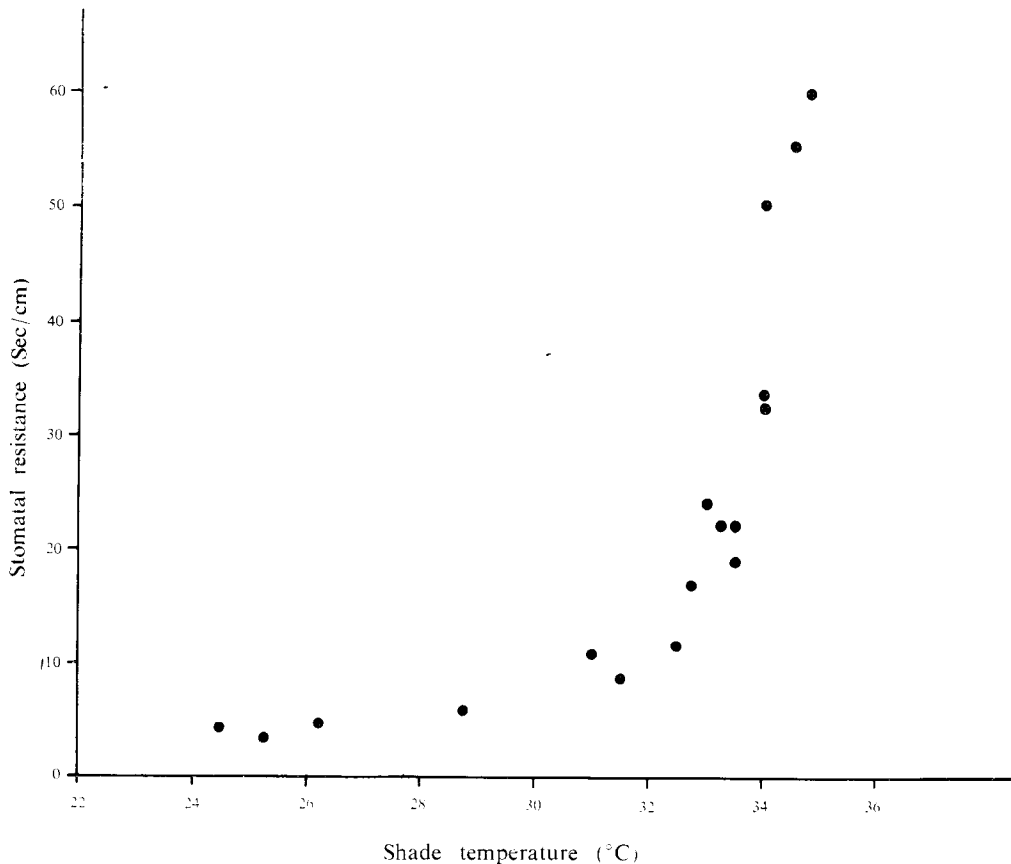


Fig. 2. Stomatal resistances in relation to shade temperature. Early morning and evening measurements are omitted, since low light intensity also causes stomatal closure.

### Discussion

The importance of these observations lies in the fact that, while the closure of stomata reduces water loss, it also reduces the rate of uptake of carbon dioxide for photosynthesis. Other work in our laboratory shows that the light-saturated rate of photosynthesis is reduced by over 75% when the stomatal resistance exceeds 20 sec./cm. Photosynthesis at low light intensities (in leaves shaded by other leaves, or in overcast conditions) will be less affected, but will also be reduced. Thus, from fig. 1, the rate of photosynthesis would be considerably reduced for at least half of each day. A lower rate of photosynthesis will lead to a reduction in yield, even if water stress has no other effects on the oil palm.

Several questions arise from this work. First, how often does such midday closure occur in Malaysia? At the time these measurements were made, soil moisture deficit was probably of the order 4—6 ins. (that is, 4—6 ins. of rain would be necessary to bring the soil up to saturation). As a rough estimate, deficits of 4 ins. and over may occur as often as 40 days/year in South Johore, and up to 100 days/year in drier districts, so stomatal closure may also occur with this frequency.

How much reduction in yield will result from such midday closure? Stomatal closure such as is shown in fig. 1 may reduce daily total photosynthesis by nearly 50%. Since

about 50% of the dry matter produced in photosynthesis is required for vegetative growth, we may assume that negligible dry matter would be available for yield on such days. Thus if such midday stomatal closure occurred on 40 days/year, yield might be reduced by over 10%.

Does water stress have any other important effects on the oil palm, or does reduced photosynthesis alone account for the effect on yield? We cannot answer this yet, but we may note that, during a "severe" dry season in Nigeria, Rees (1961) observed stomatal closure on about 80 days. On the basis of the above paragraph, this would account for a yield reduction of about 22%, whereas even the best yields in Africa are over 30% below reasonable Malaysian yields. Thus we can perhaps expect that water stress has other effects on the oil palm, over and above that of reducing photosynthesis.

Lastly, how much irrigation water would be required to prevent water stress occurring? The irrigated palms referred to in table 1 had received about 4 ins. of water, but irrigation was only started after 10 weeks of dry weather, when the soil was already very dry. If irrigation were started earlier, probably little more than one inch per week would be required, since pan evaporation rarely exceeds one inch per week, at least in Johore.

Further work on the effects and importance of water stress is in progress. Meanwhile, we may conclude that water stress, sufficient to affect oil palm yields, does occur in Malaysia, perhaps for as much as three months per year in some districts. Irrigation at the rate of one inch of water per week might well be sufficient to eliminate this water stress.

### Acknowledgements

I am grateful to Derek Nesbit for his cooperation, and for carrying out the irrigation.

### Summary

Midday closure of oil palm stomata was observed to occur during a dry period in Pahang and irrigation was shown to reduce this closure. The likely frequency and importance of such closure is discussed, and it is concluded that water stress sufficient to significantly reduce oil palm yields does occur in Malaysia.

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