NURSERY TECHNIQUES FOR RATTAN

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FOREWORD

The International Network for Bamboo and Rattan was established in 1993 to promote collaborative research on these two non-timber forest products which are so important in large areas of the tropics.

At a planningmeetinglheld in June 1993 in Singapore, national program scientists made a series of recommendations, following detailed discussions by Working Groups of experts in different subject areas. These recommendations focused on re-orienting much ongoing research so that it becomes more strategic and more rapidly promotes technology transfer.

The Working Group on Information, Training, and Technology Transfer recommended that INBAR should issue a manual on nursery techniques for rattan.

The Forest Research Institute Malaysia (FRIM), with funds from the United Nations Development Program, had collated the results of research by many scientists to produce *A Guide to the Cultivation of Rattans.* The Director-General of FRIM, Dr. Salleh Mohd. Nor, has kindly given permission for Chapter 9 (Nursery) and Chapter 15 (Pests and Diseases of Rattans), along with relevant parts of the bibliography, to be reissued as an INBAR technical report.

Minor changes have been made to the original text to reflect information provided by the Kerala Forest Research Institute, India and the Indian Council of Forest Research and Education. Their inputs ensure that the report will be more useful to the entire INBAR network.

It should be noted that this report concentrates on propagation through seed, the normal mechanism for the major commercial species of rattans such as *Calamus manan,* C. *caesius,* and C. *trachycoleus.* Some other priority species, such as *Calamus merrillii,* produce suckers, which are also used in the nursery phase after their collection. This method is not included in this report.

For many minor rattan species (particularly for many locally important species in South India), there is little published literature about nursery practices. Some information for Indian species is available, however, from the Kerala Forest Research Institute. For species from the Philippines, information may be obtained from the Philippine Council for Agricultural, Forestry, and Natural Resources Research and Development. The addresses of both, along with FRIM and ICFRE, are included in the Bibliography section of this report.

Paul Stinson
June, 1994 *Manager, INBAR*

PREFACE

Rattans have long been used by rural folks in the making of baskets, cords, furniture, and in many other uses. The wide range of uses has boosted the rattan industry into a multimillion dollar industry with demands coming from both domestic as well as international markets. As rattans are mainly collected from the wild, this has resulted in an over utilization of the natural supply. Part of the cause of this over exploitation has been intensive logging and opening up of forest areas, resulting in easier access to previously inaccessible forests.

Many rattan species are now facing depletion and are endangered. Steps have begun to be taken by governmental and private sector agencies in the region to plant rattan in large-scale plantations, even though knowledge about the silviculture of the species is insufficient. The International Development Research Centre (IDRC) of Canada needs to be congratulated for their vision in promoting rattan research in Malaysia and in the rattan regions of Asia during the last one and a half decades. Most of the information generated through this research has been collected in Malayan Forest Record No. 35 of the Forest Research Institute Malaysia. The publication titled *A Guide to the* Cultivation *of Rattan* was funded by the United Nations Development Programme.

The IDRC has once again taken the initiative, through INBAR, to promote development in rattan and bamboo. It is now in the process of preparing manuals on several topics on rattan and bamboo. One such manual is that on rattan nursery technology - the scope of this publication.

A Guide to the Cultivation of Rattan has already dealt with this subject at great length. A decision was therefore taken that the current manual should incorporate two relevant chapters from the Guide in almost their entirety. Suggestions from a networking institute have been included in the text.

Finally, I would like to congratulate INBAR and all those individuals who have taken the effort to produce these manuals on rattan and bamboo.

Dr. Salleh Mohd. Nor
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I. NURSERY TECHNIQUES

Tan Ching-Feaw

INTRODUCTION

During the early years of rattan planting, no proper nursery techniques were adopted by the smallholder cultivators. In fact, there was no so-called "Nursery Stage". Rattan seeds or even fruits were direct seeded in the field by growers in Indonesian Kalimantan (van Tuil 1929), by the Malay villagers along the Pahang River in British Malaya (Brown 1913) and the natives in Papua New Guinea (Zieck 1972). Sometimes, wildings or seedlings found growing naturally were gathered for transplanting at the selected site. These methods of establishment were no doubt simple and primitive and cost almost nothing but the success rate was inevitably low. While these methods nevertheless served the objective then of establishing only a very small number of plants, mainly for the villagers' own use, they are definitely unsuitable for present day commercial planting. There has been a very marked improvement in nursery techniques adopted by Kalimantan rattan cultivators over the last 10 years (Tan, pers. obs.). Some of these observations are described in the sections that follow.

THE EVOLUTION OF NURSERY TECHNIQUES IN KALIMANTCIN, IN DONESIA

Besides the very early method of direct seeding reported by van Tuil (1929), the commonly adopted improved method up until probably the last 3 - 4 years was the two-stage nursery technique. This technique has also been described by van Tuil (1929). Principally, it consisted of daily watering and rubbing the rattan fruits kept in a basket made of "porun" (Lepironiu arficulafa) to remove the fleshy sarcotesta as much as possible. This was done to speed up seed sprouting. The seeds were then sown on a seed-bed where they would germinate within a few weeks. When these young seedlings were about 6 months old, they were transplanted in a larger seed-bed at a wider spacing of about 25 x 25 cm. The seedlings would be kept in the second nursery until they reached a height of 0.75 - 1 metre and had developed spines or cirri. By then they would be 12 - 15 months old, and would then be planted out in the forest.

There were good reasons for adopting this two-stage nursery technique. The first stage of closer sowing allowed a larger quantity of seeds to be sown over a smaller seed-bed, taking into consideration the possibility of a low germination rate. The second stage allowed the seedlings to grow to such a height that they could withstand the annual flooding encountered in the field as well as to become spiny enough to minimise animal damage in the forest. These nursery beds were usually sited at the growers' backyard and it was very easy for the growers to raise the seedlings properly.

The shortcomings of these methods were:

(1) First transplanting at 6 months can cause a lot of root damage to the young seedlings;

(2) Raising the seedlings to one metre height makes them very clumsy and heavy to transport to the field for planting. They may also have become too spiny and unpleasant to handle, and may be prone to breakage.

(3) Second transplanting of 12 - 15 month-old seedlings would cause further serious root damage to the seedlings and lower the survival rate after field planting. Growth of seedlings may also be impeded.

Some variations to the standard practice described above have been observed. Johari (1980) reported that germinated seeds from the "porun" baskets were transferred to wooden boxes containing earth and sawdust, at a spacing of 50 x 50 cm. These seedlings were then transplanted to the backyard nursery when they reached the four-leaf stage. In another variation, I have seen young seedlings in seed boxes and very large seedlings in large wooden trays placed on a floating platform tied to the edge of a river bank. These seedlings were fully exposed to the sun and constantly kept wet by being partially immersed in river water all the time. Other variations include haphazard sowing of seeds under the canopy of rubber trees or young seedlings planted in neat rows under jungle shade.

The most marked improvement observed in 1988 in Dadahup, Central Kalimantan (Tan, pers. obs.) was the use of polythene bags. Seeds were sown in wooden boxes and then transplanted to black polythene bags. These bags were arranged in blocks on the ground or in tiers on a wooden structure. However, how widely adopted this improved technique is, is not known. The use of polythene bags minimises root damage during transplanting, ensures higher survival rate and faster and better seedling establishment in the field. It is an important improvement.

CURRENT NURSERY PRACTICES

Recommended nursery practices for rattan have been reported by Johari & Che Aziz (1983a, 1983b, 1983c), Darus & Aminah (1985), Manokaran (1988) and Tan (1988). The techniques described are suitable mainly for raising small numbers of seedlings for research purpose or for planting by smallholders. Certain modifications or variations are required in raising very large numbers of seedlings for a sizeable commercial plantation. For example, the use of soil/sand mixture for polybags and concrete beds are not practical and are costly if thousands of seedlings are to be raised at one time. The remainder of this chapter is devoted to detailed discussions on suitable techniques for raising large numbers of seedlings for commercial planting. Costs and practicality are the most important guiding factors in deciding on which technique should be used.

FRUIT COLLECTION

With the establishment of about 10,000 hectares of commercial rattan plantations with the three most important commercial species, viz. "manau" (Calamus manan), "sega" *(Culumus cuesius)* and "irit" (Calamus trachycoleus), by SAFODA and two private plantations in Sabah alone, adequate rattan fruit/seed supply has been assured. Also, quite a number of small trial plots and seed gardens have been established in Peninsular Malaysia over the last 10 years. These also have the potential to supplyconsiderable quantities of seeds (Tan 1989):Desperate and tedious efforts to hunt for rattan fruits in the wild for commercial planting should be a thing of the past. There can now be planned seed production from commercial plantations and government seed gardens. Predictable adequate supplies of good quality fruits/ seeds can be assured.

Past experience has shown that "manau" fruits usually ripen from February to May in Peninsular Malaysia (Darus & Aminah 1985; Nur Supardi, pers. comm.), whereas "sega" fruits ripen from October to January of the following year and "irit" fruits ripen from March to June. Therefore, timing of fruit collection and seed sowing can be planned accordingly.

In the SAFODA plantation in Sabah, "manau" fruits also ripen during April/May whereas "irit" and "sega" fruits usually mature towards the end of the year until early part of the following year.

After the fruit-bearing branches (infructescences) are cut from the rattanplant, fruits should be separated from the branches and packed in sacks made from "mengkuang" (Pandunus sp.) or "porun" *(Lepironia articdutu).* Fruits should be kept cool and moist at all times in order to maintain seed viability. These sacks provide good aeration and hence prevent undesirable heat build-up among the fruits. The sacks can be kept moist or wet by watering without becoming easily torn like a gunny sack does. Although Mori et al. (1980) have shown that "manau" fruits stored in closed plastic bags could still maintain a high germination rate of 81 percent after one month under room temperature of 21°C - 28°C, I consider it a high risk practice for handling large quantities of fruits. The logistics would be too demanding to ensure the temperature in the plastic bags does not rise above 21°C - 28°C during transport and storage prior to being processed.

Since future rattan fruit supply is expected to be mainly from plantations or seed gardens, collection and transport should be faster and easier and long storage may not be required except perhaps for research purposes.

After the sacks of fruits have been delivered to the nursery site, they should be spread out on gunny sacks laid flat on the ground under shelter at a cool site. Too much heat build-up in the sacks may either kill the embryos or stimulate early sprouting of the "buttons" which might then be rubbed off during the process of sarcotesta removal. The fruits should be kept moist by regular watering and sheltered from any direct sunlight.

FRUIT PROCESSING

It is a standard practice to remove the fruit scales (pericarp) and the fleshy sarcotesta, the outer seed-coat, before seeds are sown.

For Calamus manan, Darus & Aminah (1985), obtained germination rates of 80 percent and 67percent for complete and partial removal of sarcotesta respectively. However, they cautioned about possible damage to the embryo during the sarcotesta cleaning process. Moriet al. (1980) found that complete sarcotesta removal of C. munun seeds resulted in germination rates of 90 - 100 percent. Bagaloyos (1988) has reported that removal of the hilar cover gave the best germination rates of 78 percent and 87 percent respectively for C. *merrilli* and C. *ornutus* var. *philippinensis.* Though the hilar cover removal techniques gave very encouraging results, it cannot be practised on a commercial scale for large quantities of seeds since it is a very tedious and risky process. Sumantakul(l989) has reported a low germination rate of 16 percent for C. *latifolius* when the pericarp and sarcotesta were removed completely. Sowing the whole fruit as well as fruit with only the pericarp removed surprisingly gave 54.5 and 32.0 percent germination rates respectively. The unusual low germination rate for clean removal of pericarp and sarcotesta probably confirmed the reservation expressed by Darus & Aminah (1985) that the embryos can be damaged during the cleaning process. Sumantakul(1989) also found that for C. latifolius, seed seasoning at 40°C for 24 - 48 hours gave a significantly higher germination rate of about 70 percent than in controls. Soaking seeds in water did not improve germination.The pretreatment with heat at40°C appears promising for large scale application, but more trials need to be carried out to confirm the usefulness of the technique. Moreover, this technique can only be carried out by specialist seed supply companies willing to invest in facilities and equipment required to carry out the heat treatment. For the smallholder cultivator and for commercial projects where the treatment would only be carried out once, it would not be economical.

In the absence of any suitable mechanical processor, large - scale fruit processing still has to be carried out manually. As practised in the large-scale planting project in Sabah, the pericarp is first crushed, and the sarcotesta then rubbed by hand against a gunny sack laid flat before being washed off with water. Repeated rubbing and washing is carried out until the seeds are practically free from sarcotesta. For processing small quantities of fruits, a whirling blender may be used.

In a variation in the method in fruit processing, fruits are depulped after being soaked in water for about 24-48 hours. The pericarp and sarcotesta are removed by rubbing the presoaked fruits with hand. Seeds are cleaned by repeated washing in water. To prevent any moisture loss before sowing, the seeds are kept mixed with moist sawdust.

The processed seeds should be sown immediately wherever possible. Should there be any delay in sowing, the processed seeds should be spread out on gunny sacks laid flat, and kept moist and cool as is done for fruits before processing begins.

SOWING TECHNIQUES

At present, the recommended sowing technique is to sow processed seeds in a raised seed-bed. Seedlings emerging from the seed-bed are then transplanted to black polythene bags.

In the SAFODA rattan project in Sabah, I tried other sowing techniques such as using seed trays and direct seeding in poly-bags. In the seed tray technique, wooden trays of the size of 1.5 x 1.0 m with a fine wire mesh as a base were used to hold seeds until they germinated. The trays were stacked in tiers under a cool shed to save space. Seeds had to be watered at least three times a day to keep them moist since they were exposed to the atmosphere all the time. Once seeds had sprouted, they were then transferred either to the seed-beds or direct to polythene bags. These techniques were tried in order to maximise utilisation of seed-bed space by sowing only pregerminated seeds. This technique was however, found to be very tedious because every germinated seed had to be picked out from the tray and sown in the seed-bed. If the seed was too advanced in its germination stage, sowing became even more troublesome. Subsequently, this technique was abandoned. Sowing pregerminated seeds directly into polybags created additional maintenance problems similar to those in direct sowing of ungerminated seeds into polythene bags, although there was the advantage of knowing that the seed sown was viable.

These maintenance problems are discussed in the following paragraphs.

Direct sowing of ungerminated seed in polythene bags was tried with the aim of eliminating the need to transplant seedlings from seed-bed to polythene bags since transplanting incurred additional time, labour and costs as well as resulting in a certain amount of seedling casualty. However, experience has shown that direct seeding is not advisable because of the following disadvantages:

(1) Unless a seed lot used is assured of a high germination rate, a lot of polythene bags will be left vacant. Since

rattan seed lots collected from the forest usually have unpredictable germination rates which seldom exceed 75 percent, about 25 percent of the bags could be left vacant and wasted unless these vacant bags are resown with seeds. This would mean additional labour and costs for resowing and rearranging thousands of polythene bags.

(2) Rain splash tends to expose the rattan seeds, especially the smaller seeds of "sega" and "irit". Unless these seeds are covered again with soil, they remain exposed to sunlight, becoming dehydrated and dying especially if germination has already started. Repeated covering the seeds with soil incurs extra labour and costs.

(3) Maintaining the newly emerged seedlings in individual bags is also more troublesome than maintaining them in the seed-bed since a much bigger area needs to be covered. One might be maintaining many scattered empty bags unnecessarily. Moreover, young developing seedlings can easily be disturbed by either reckless watering or heavy rain, with the result that the young root system of the seedlings will become exposed and killed by direct sunlight if not covered up immediately.

Because of the above-mentioned disadvantages, the practice of direct seeding in polythene bags was also abandoned in the SAFODA rattan project.

At the Kerala Forest Research Institute in India, the practice is to sow seeds in moist clean sawdust placed in re-usable aluminium trays or wooden boxes. Seedlings of a month or so in age are removed from the moist sawdust and potted.

SEED-BED PREPARATION

The use of raised seed-beds is recommended for seed sowing (Fig. 1). The raised bed should consist of a layer of sandy loam 7-10 cm in thickness overlain by a 3 cm thick layer of old sawdust, the whole surrounded by planks to maintain the height of the bed.

FIGURE 1. A typical seed-bed

The beds should be rectangular in shape, about one metre wide and of any convenient length. The site chosen for the seed-bed should be flat or gently sloping, and in an area where good top soil (loam, sandy loam or sandy clay-loam) is available in situ for construction of the beds. Proximity to a reliable water source is of paramount importance. Beds adjacent to the polythene bag nursery facilitate easier transplanting work later.

Shelter needs to be built over the seed-bed to protect the seeds from heavy rain and direct sunlight. A sloping wooden frame overlain with palm fronds makes reasonable shelter. Palm fronds may last up to only two sowings. They are good for keeping out strong sunlight and light rain. Heavy water seepage from heavy rain will churn up the seed-bed and expose the seeds. This could create a lot of extra work when thousands of seeds are being handled because disturbed seed-beds need to be smoothened and exposed seeds covered up again.

More lasting zinc sheets may be used if seed-beds are constructed under light forest shade. In exposed conditions, zinc sheets tend to become very hot. Use of zinc sheets avoids the rain water leak problem experienced with the use of palm fronds. However, lighting will be poorer. Costs will also be higher. Plastic shading sheet providing about 50 percent shade, though convenient to use and lasting, is expensive and cannot keep the rain out. Palm fronds, though not ideal, are the most suitable material available at present. They are relatively cheap and usually available locally. Plastic shading sheet should be hung around the edges of the seed-bed to protect emerging seedlings from sun-scorching.

SEED SOWING AND AFTER-CARE

Processed seeds should be treated with fungicide (e.g. 1 gram fungicide to 300 grams of seeds) before sowing to minimise fungal attack on the seeds and developing seedlings. Since seeds of "sega" and "irit" are small, being about the size of a small peanut, they can be broadcast over the seed-bed, and then spread out by hand to be about 2-3 cm apart. They are then pressed into the soil until they are buried or alternatively be covered with l-2 cm of soil and subsequently overlain with about 3 cm of seasoned sawdust. "Manau" seeds which are much larger need to be sown in rows about 4 cm apart with 2 cm distance within the rows. They should also be covered with soil and sawdust in a similar way. During sowing of "manau" seeds, their germination pores should face upwards to hasten the germination process (Johari & Che Aziz 1981). Darus (1983) found that "manau" seeds preferred a medium with high water-holding capacity such as sawdust or a 3:l forest topsoil and sand mixture, while "sega" seeds did not show any preference to sawdust or different mixtures of topsoil and sand. Daily watering is required to keep seeds moist all the time. While a rubber or plastic hose may be used, a rose head should be fitted to ensure only fine spray will reach the seed-beds and hence not churn up the seeds. Any exposed seeds should be covered up immediately.

Fertilizer application is considered unnecessary since seedlings are transplanted soon after they have emerged. They are not expected to suffer from any nutrient deficiency at this early stage.

If seeds are mature and vigorous and germinate early, there is no need for any pest and disease control. Weeding of the seed bed should be carried out as often as necessary.

THE POLYBAG NURSERY

As elaborated in the early sections of this chapter, the polybag nursery technique has evolved from various less efficient methods and is now recommended as the standard technique. It is by far the most efficient and reasonably cheap method for handling very large number of seedlings for a commercial plantation.

Choice of Site

The site for the polybag nursery should be near the nursery beds for ease of operation. It should be flat or gently sloping and fertile topsoil should be available in situ for bag filling. Rivers or ponds with reliable and unpolluted water supply should be nearby for efficient irrigation. The selected site should be easily accessible and centrally located within the plantation area.

Shade Shelter for the Polythene Bag Nursery

Seedlings raised in polybags need shade to grow well. Shade can be provided by manipulating the forest canopy or by constructing a shelter using a timber frame and plastic shading sheet. The optimum shade for raising young seedlings is about 50 percent. Forest canopy is more or less ready made except for the need to manipulate tree canopy to provide optimum combination of shade and light. It is relatively cheap to use and takes little time to prepare for use. It has, however, serious disadvantages, as follows:

(1) Seedlings are often damaged or killed by falling tree branches.

(2) Leaf litter often covers up the seedlings and needs to be cleared frequently so that seedling growth is not adversely affected.

(3) Even with canopy manipulation, it is difficult to achieve uniform shade/light conditions for the whole nursery.

(4) The forest floor tends to be uneven; it is therefore difficult to arrange neat rows and blocks of polybags which do not topple, thereby giving rise to more management problems.

(5) Surface roots of some trees can start to grow into polybags and compete for water and nutrients with the young seedlings and thereby affect their growth.

In view of the above-mentioned disadvantages, use of jungle shade for a polybag nursery should be avoided.

It is feasible, however, to establish a polythene bag nursery under a forest plantation (Fig. 2).

For example, SAFODA successfully established a large nursery under an *Acacia mangium* plantation. The nursery site was flat and there were no obstructing bulging root systems on the ground surface to prevent neat bag arrangement. Light was adequate and more uniform thaninnatural forest. However, leaf fall and broken branches continued to cause problems.

The use of plastic shading sheet (Fig. 3) supported with a wooden frame does not have the above disadvantages, although the initial capital outlay is higher. Shading sheet needs to be imported. A timber frame can be made from small tree trunks extracted from the nearby forest, if secondary forest is to be the site for the rattan plantation.

Before constructing the frame, the site should be clear-felled. Logs, tree stumps, and big branches should be removed and the remaining litter burnt off. Where necessary, levelling should be carried out and some mechanical cultivation in compacted areas would be neccesary to loosen the top soils for easy bag filling.

FIGURE 2. Polybag nursery with plantation trees as shde

FIGURE 3. Polybag nursery with polythene netting as shade

FIGURE 4. Polybag nursery with palm leaves as shade

FIGURE 5. Polybag nursery with bamboo strps as shade

Only small tree trunks or large branches that could last for 12-15 months should be used for constructing the main frame. The height of the frame should be about two metres to allow easy movement of workers under the shelter. If large numbers of seedlings are to be raised, a continuous shelter is preferred to small individual shelters, to minimise timber use and to provide more uniform shade.

Palm fronds (Fig. 4) can also be used as shading materials placed over the wooden frame. They should be suitably spaced to achieve about 50-60 percent shade. Crushed bamboo strips, (Fig. 5) about l0-15 cm in width, are also cheap local materials, if available. These strips are also placed over the wooden frame. Palm fronds and the bamboo strips can be shifted to increase light intensity gradually as seedlings grow older.

Size of Polythene Bags and their Arrangement

Polythene bags of various sizes ranging from 3 x 6 cm to 40 x 50 cm (laid flat) have been used by different growers. The bags are usually black in colour. Bags of 3 x 6 cm in size have been used to raise "sega" seedlings for six months before planting out in the field. These small bags were used to avoid transporting large seedlings in large bags in a plantation where a road network was lacking and roads were difficult to construct. From experience, however, six-month old seedlings were too young to establish well in the field. Furthermore, in case of delay in field planting, seedlings would outgrow the bag and become stunted.

"Manau" seedlings have also been raised in giant bags (40 x 50 cm) usually used for raising oil palm seedlings. It has been claimed that higher survival rate and faster growth rate could be achieved by using these huge bags. This advantage should be weighed against the additional costs incurred in purchasing larger bags, more soil filling, transporting and planting the much larger seedlings in the field.

Based on my experience, the minimum bag size is 15 x 23cm (laid flat) for raising seedlings up to 9 months, an optimum field

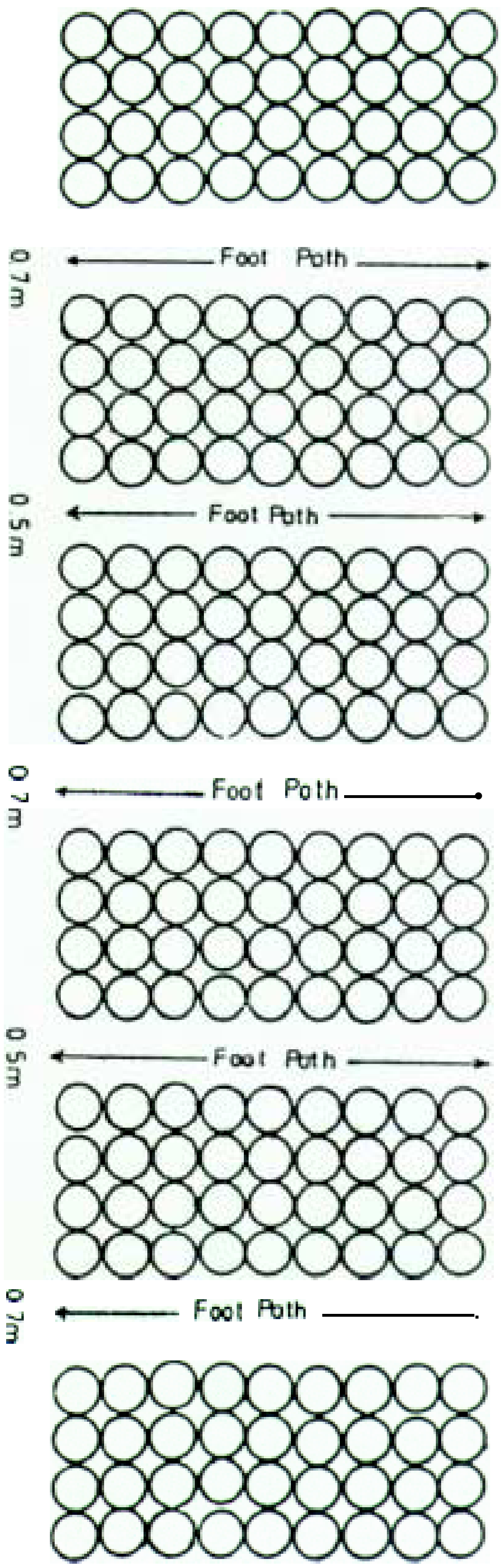

FIGURE 6. Arrangement of polythene bags in nursery

planting age. If seedlings are to be maintained for more than 9 months, then bags of 20 x 25 cm (laid flat) in size are recommended. Only black polythene bags of 0.1 mm in thickness should be used. Bag filling should be carried out in situ under the shade shelter already constructed. This is to minimise or even eliminate the need to move around hundreds or thousands of filled bags. Labour saving can be quite considerable if logistics are planned well ahead.

Bag filling is carried out manually. Only loam, sandy loam, sandy clay loam or clay loam should be used for bag filling. The choice of a site with good topsoils is extremely important. It is impractical and simply too costly to mix soils and sand to obtain the ideal soil texture for thousands of bags.

The filled polythene bags should be arranged in neat 4-bag wide blocks. The length of the block can be adjusted to suit the size and shape of the nursery. From experience, the 4-bag width is found to be ideal because it allows enough space for optimum seedling growth without wasting nursery area. If bags are arranged more than four in width, it can result in overcrowding,overshading, more rapid spread of pests and diseases, and interference in carrying out routine weeding, fertilizing and watering. The 4-bag wide blocks should be separated by 0.5-0.7 metre wide footpaths to allow easy access for seedling maintenance and to provide space for optimum seedling growth (Fig. 6).

Transplanting

As rattan seeds germinate, the first sign is the emergence of spear-like protuberances after which the seedling leaves expand. Seedlings are generally ready for transplanting when the first seedling leaves are fully expanded (Fig. 7).

Before transplanting, the seed-bed should be thoroughly watered to loosen the sowing medium so that seedlings can be pricked out easily with minimum damage to the root system. In the soil medium of the polybag to which the seedling is to be transplanted, a hole deep enough to accommodate the seedling

FIGURE 7. Rattan seedlings in seedbed ready for transplanting into polybags

roots should be made. During transplanting, the seedling should be held between the fingers with its roots suspended in the hole. The hole should then be filled with soil before the seedling is released so that the roots are not compressed and crumpled. All these seemingly simple and unimportant steps will ensure successful transplanting when followed diligently. The soil around the newly filled hole should be gently compacted to ensure close contact between the soil medium and the seedling roots. Immediately after transplanting, seedlings should be watered thoroughly. Rattan seedlings are generally quite hardy and can easily be transplanted. The success rate of transplanting should not be less than 90 percent. Within a week or so, success or failure of transplanting should be known and any casualties should be replaced as soon as possible so that the polybags and nursery space are not left vacant and wasted.

At the Kerala Forest Research Institute, the seedlings are potted when they attain a height of 4-6 cm about a month or so (depending on the species) after germination. At this stage, they can be very easily pulled out from the moist sawdust without damaging the root system. Potting is done in 20 x 26 cm size perforated polythene bags of 250 mm gauge thickness. These bags are arranged on a thick polythene sheet spread over the nursery ground. The bags are rearranged once in three months to prevent the roots from striking the ground. Out-planting is done only when the seedlings are one-year-old in order to ensure improved survival rates and better height growth in the field.

Maintenance of Seedlings in Polybags

The after-care of seedlings in polybags consists of replacing weak and dead seedlings, watering regularly, weeding, fertilizing, pest and disease control.

Any dead or weak seedlings should be replaced as soon as possible to ensure uniformity in the size of living seedlings. Empty bags not replanted with good seedlings will be wasted. Before field planting, weak and diseased seedlings should be culled and only healthy and vigorous seedlings are planted. Culling should be as severe as practicable at the nursery stage. I believe this is an effective and practical way to minimise the uneven growth so commonly encountered in the field.

Depending on weather conditions, watering should be carried out as often as necessary to keep the soil medium moist. On a hot day, two waterings (one in the morning and one in the early evening) may be necessary. A plastic or rubber hose with a rose head attachment to give out a fine spray may be used. For a large nursery handling many thousands of seedlings at a time, a sprinkler system will be necessary to provide timely and efficient watering. Hand-watering tends to be uneven since it depends solely on the judgement and skill of a particular worker. Over-watering or under-watering is commonly encountered. During hand-watering more water tends to be wasted since the application rate is more difficult to control and is usually faster than the soil infiltration rate of the medium. Constant watering may cause soil compaction, resulting in a hard crust being formed on the soil surface in the bag. This hard crust should be broken up every now and then.

Manual weeding should be carried out as often as necessary, perhaps once a month, to rid the polythene bags of weeds. Weeding and breaking of soil crust can be done together, and should be carried out before fertiliser application.

About two weeks after transplanting, fertiliser application can commence with 8-10 granules of compound fertiliser (15N: 15P: 15K in composition) per seedling. The amount can be increased gradually to 15-20 granules per application when seedlings reach an age of 9-10 months. Fertilisation can be carried out once a month.

Pest and Disease Control

For pest and disease control, see Section II.

II. PESTS AND DISEASES

Maziah Zakaria, Azmi Mahyudin and Laurence G. Kirton

INTRODUCTON

Rattan has for decades been extracted commercially from the forest. Little attention has been paid towards pests and diseases which affect it, since no maintenance of the plants was required and damaged canes could be rejected. With the cultivation of rattan, however, the issue of pests and diseases becomes an important one. The growing of any tree species on a plantation basis is bound to increase pest and disease problems because monocultures provide a uniform host population. Rattan cultivation, however, is a very new field in Peninsular Malaysia and most other places and it is difficult to predict whether or not pests and diseases will become significant. The experience of pest-free plantations of Calamus trnchycoletls and C. caesius in Central Kalimantan (Dransfield 1979) is encouraging. However, as Norani *et* al. (1985) point out, plantations of other palm trees, namely coconut and oil palm, have not been spared from major pest and disease problems. On the other hand, rattan underplanting in rubber plantations and especially in production forests, is not essentially a monoculture, but rather an intercropping system. This may possibly work in favour of reduced pest and disease incidence and enhanced natural control.

The information on pests and disease organisms in this chapter is obviously based on recent experiences with existing plantations and nurseries. Compared with other plantation systems, these experiences are therefore limited and doubtless will expand only in time. The treatment given here is thus an initial guide, based on existing knowledge, for diagnosing and solving possible pest and disease problems.

Some suggestions are given for the control of the more important pests and diseases mentioned. The concept of managing pests and diseases in plantation systems should not, however, be viewed purely as practising control measures. The basic principle is to manage pest and disease organism populations below a threshold that causes economic damage. The importance accorded to a pest or disease must relate to its effect on the growth of the rattan plants for quality cane production. A number of leaf feeding pests may normally, for example, have little effect on the cane or on plant growth, and would therefore require no intervention to suppress their populations. A rattan cane borer, however, would cause severe reduction in cane quality even at low pest population levels and thus, should be considered a significant pest. The stage of growth of the rattan plant should also be considered. Death of seedlings in nurseries as a result of pests or diseases can be considered less of an economic loss than the death of plants already established for a number of years in plantations.

Maintaining pest and disease organism levels below a level that causes economic damage is best achieved by integrating existing natural control with good cultural practices that help reduce the incidence of pests and diseases, and incorporating chemical control only when these fail. In large-scale plantations, it is usually necessary to develop monitoring programmes for target pests and diseases to determine when chemical control becomesnecessary.Forthesamereason,rattanplantationmanagers will need to be able to recognise and assess pest and disease incidence. This chapter provides the basis for recognising as well as understanding the mode of attack and biology of these organisms.

PESTS

Recent literature on the pests associated with rattans has been reviewed by Aminuddin (1990a). Early reports by Kalshoven (1951; 1955) cited the moth *Artona* catoxantha (Zygaenidae) and the beetles Botryonopa sanguinea (Hispinae), *Protocerius colossus* and Rhabdocnemis *Ieprosa* (Curculionidae) as insects associated with natural stands of rattan in Indonesia. *Artona catoxunthu* was then already an established and occasionally serious pest of coconut palms. Corbet and Pendlebury (1978) mentioned that the butterflies *Elymnias,* Suastus gremius and Telicota sp. feed on Calumus.

When plantations of rattan species were established in Sabah, Khamis (1981) reported and described damage by a Hesperiid, Gunguru thrysis and a Tarsonemid mite, Hemitarsomemus latus. Newly transplanted and young rattans planted near forest or secondary growth were occasionally uprooted by elephants or gnawed through by rats. In Sri Lanka, the young shoots and rhizomes of planted rattans were eaten by porcupines (de Zoysa & Vivekandan 1987).

In Peninsular Malaysia, Norani et al. (1985) reported that rattan under cultivation was affected by a number of Lepidopteran leaf feeders. Additionally, they noted the presence of an unidentified beetle larva that damaged the basal part of the stem, and a Cerambycid cane borer. These beetles have since been identified as Rhynchophorus *schuch* and possibly a *Mesosu* sp. respectively. Occasional damage to the unripe fruits of rattans by beetles has recently been noted by Aminuddin (1990a).

The account presented here is based on the authors' experiences of pests associated with rattans in Peninsular Malaysia. Information from other sources has, however, been used to supplement descriptions of the pests and their biology. Pests are described in relation to the plant part that they affect, that is the stem, leaves or roots.

The stem borers are beetles (Coleoptera) and the only other important insect pest known to affect the stems of rattan plants are crickets that sever young seedlings at the base. Mealy bugs (Pseudococcidae) have, however, been observed just below the soil at the stem base of young seedings of *Calamus trachycoleus* when these were uprooted (Tan C.F. pers. comm.).

Termites (Isoptera) affect the roots, while the leaf feeders are predominantly butterflies (Lepidoptera) of the families Satyridae and Hesperiidae. The Satyrids and most Hesperiids feed on monocotyledonous plants including many species of palms. Besides these, grasshoppers have been found to feed on Calamus trachycoleus seedlings in nurseries and spider mites can cause severe damage to the leaves (Tan C.F. pers. comm.). The latter is discussed below under leaf feeding pests based on reports by Khamis (1981) in Sabah.

STEM FEEDING INSECTS

Genus near *Mesosa (Coleoptera: Cerambycidae)*

This beetle, the larva of which causes surface damage to canes of Calamus manan, belongs to subfamily Lamiinae of the Cerambycidae. Damage by the beetle larva occurs on growing rattan canes but results in black streaks accompanied by surface damage on the internodes of rattan canes after they have been harvested and processed. The borer has been found to affect rattan planted under forest cover.

The adult beetle, shown in Figure 1, is about 1.2 - 1.6 cm long and, like most Cerambycids, has antennae that are almost as long as the body. The body is greyish brown with fine grey dots and darkbrown markings on the elytra. The larva is elongated (about 2.0 - 2.5 cm long), legless, has an enlarged head and is bright yellow in colour.

FIGURE 1. Adult Cerambycid cane borer, possibly Mesosa species

Infestation by this beetle occurs under yellowing and drying leaf sheaths of fronds, but not under green leaf sheaths of younger fronds, nor under leaf sheaths that have fully dried. Development is synchronised with drying and yellowing of the sheath. The adult beetle lays eggs singly in crevices on yellowing leaf sheaths and the young larvae upon hatching burrow and feed on the soft and moist inner layer of the sheath and the outer layer of the cane under it. Feeding activities of the larva cause the formation of a tunnel between the sheath and the cane, thus causing significant surface damage to both the sheath (Fig. 2) and the cane. In more severe cases, the larva bores right into the cane. The tunnels are packed with particles of leaf sheath and cane material generated during the burrowing and feeding activities of the larva. The pre-pupal larva, however, is usually found in a gallery in the sheath free from these particles. Larvae, pupae or freshly emerged adults can be readily seen when the leaf sheath is removed.

FIGURE 2. Damage to the cane sheath of *Calamus manan* bv the Cerambvcld cane borer

Attack by this pest usually occurs under the lowest leaf sheath and the larva completes development under one sheath or connected sheaths. Adult beetles that emerge may lay eggs on freshly yellowing areas of the same sheath or on other yellowing sheaths. Each palm sheath supports the development of several beetles whichmaybe staggered over a period of time. Round exit holes made by emerging adult beetles are a characteristic symptom of attack by this beetle.

Rhynchophorus schach(Coleoptera: Curculionidae)

This beetle is commonly called the "Red Stripe Weevil" and breeds in a variety of palms, especially when they are still young. It is a well known pest of coconut and oil palm. It rarely attacks healthy palms, usually affecting them only when they are wounded and diseased. The larva feeds on the tissue in wounded petioles and eventually in the main stem causing stunted growth and ultimately death. It has in one instance caused loss to planting stock in 3-year old Calamtls manan grown under rubber and has been reported as a pest of the rattan Calamus *merrillii* in the Philippines (Braza 1988). Symptoms of attack by this pest are the death of central shoots leading to stunted growth and ultimately death of the entire plant, and the presence of the beetle larva inside the core of the plant stem (Fig. 3).

Beeson (1941) describes this pest as well as its biology and mode of attack. The adult beetle varies in size from 25 to 50 mm long. It is black in colour with a red median streak on the thorax. The mouth parts are elongated into a snout or rostrum as is typical in the Curculionidae. The egg is yellowish white in colour and cylindrical in shape with rounded ends. The "C" shaped grub-like legless larva, shown in Figure 5, is white with a brown head and its body is thickest across the middle, corrugated and bluntly tapering posteriorly.

The adult female lays eggs in wounds or soft areas of the plant tissue such as the new shoots of living palms. Sometimes, a hole is bored with the snout and the eggs are then oviposited in it. Braza (1988) noted that in Calamus *merrillii,* the adults girdle-cut

FIGURE 3. *Calamus manan* seedling killed by a larva of *Rhynchophorus schach* which can be seen within the opened stem

the petiole of the youngest opened fronds and the female lays eggs in the tissue of the cut end of the petiole. After about 4 days, the egg hatches and the larva bores into and feeds on the interior of the palm stem. The larva matures within about a month to a size of about 30 to 45 mm long and 15 to 19 mm wide and subsequently constructs a strong blunt elliptical cocoon made of twisted palm fibres. Within the cocoon, the larva then becomes inactive and pupates. The pupal stage lasts 2 to 3 weeks and the immature beetle remains for another week in the cocoon before emerging. The total life-cycle takes about 50 to 80 days.

Crickets: *Brachytypes* & *Gryllulus* spp. (Orthoptera: Gryllidac)

Crickets of these genera are destructive when they cut young seedlings or low shoots of young rattan plants to feed on. They are believed to have caused such damage to 2-year old *Calamus manan* seedlings grown under rubber. Seedlings or shoots damaged or severed at the base are an indication of possible cricket damage. The severed parts may be hollowed out or missing. The presence of crickets can often be identified by their “singing” in the early morning and they may also be noticed in crevices on the ground or among cover crops.

Crickets are generally herbivorous, some being injurious to seedlings in nurseries and seedlings sown in the open. Beeson (1941) describes the habits of crickets of these two genera. *Brachytrypes* cuts young seedlings or low shoots at night, dragging them into its tunnels to feed on. Cricket species in this genus are blackish brown in colour, and about 5 cm long. They make a deep tunnel in the ground which opens to the surface through a large conspicuous hole surrounded by ejected earth. Gryllullus is the black-headed cricket, which is omnivorous and is destructive when it feeds on sown seeds or germinating seedlings or when it cuts the stems and leaves of older plants.

LEAF FEEDING PESTS

Lepidopteran Leaf Feeders

There are at least five species of butterflies, the larvae of which feed on the leaves of rattans, but defoliation does not appear to be severe. Corbet and Pendlebury (1978) provide a general account of these butterflies and some of their life-histories. The following is a more detailed account of their early stages.

Family *Sa tyridae*

Amathusia ochraceofusca Honrath

The larvae feed on Calamus manan. They are greyish green when young and become brownish when mature. They are densely covered in long fine hairs and when disturbed raise their thorax to expose black nacreous areas folded under the thoracic segments (Fig. 4). Further agitation usually causes them to release their grip and drop to the ground. The larvae are

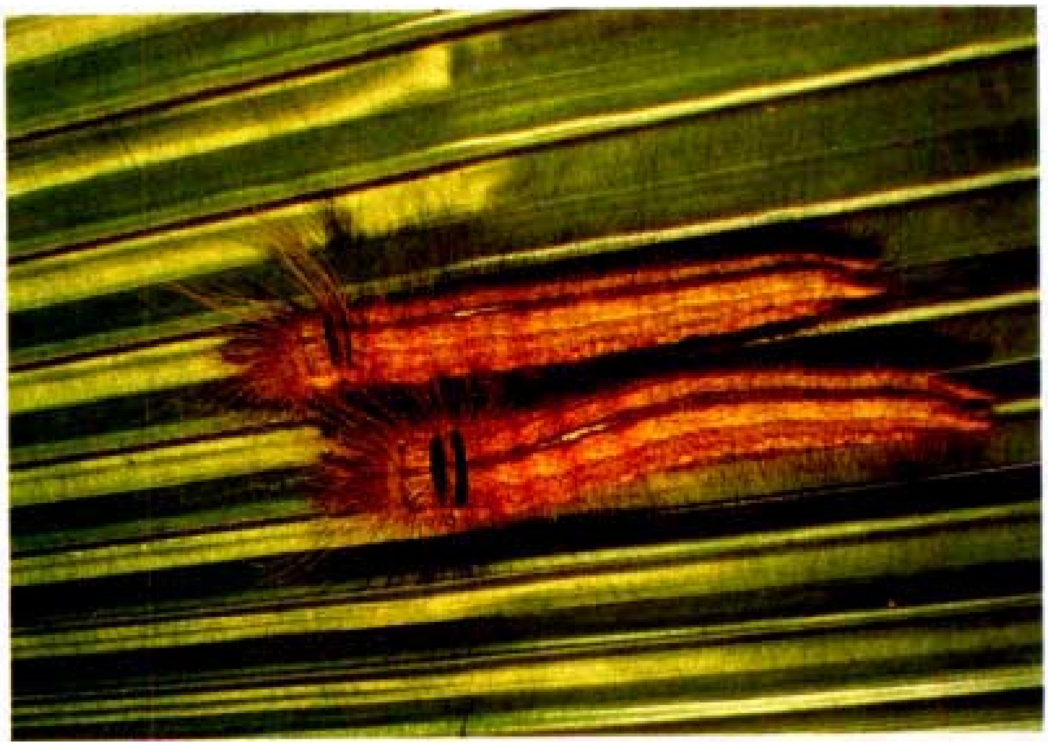

FIGURE. 4 Larvae of *Amnthusia ochractwfirsca*

gregarious, moving closely in a group, feeding in the late evening or night and remaining dormant throughout the day near the base of the rattan. They may remain on the cane, on hanging dry rattan leaves or under a large green frond, moving up the tree to feed at night. Generally, leaves are consumed one by one. The pupae are dimorphic, being either green or brown and the pupal period is, 15 to 17 days. The species has been found feeding on rattan leaves in plantations close to the forest. It has not been recorded fromnurseries. Tan (1988) reported this species feeding on the cultivated palm, Licuala grandis.

Family *Hesperiidae*

Gangara thyrsis Fabricius

The adult butterfly is known as "The Giant Redeye". The larva, which feeds on Calamus manan, C. *trmhycolrus* and C.cuesius, is also known to feed on the leaves of various other

FIGURE 5. Larva of *Gangara thrysis*

FIGURE6. Pupal chamber of *Gangara thrysis* made from a rolled leaf of Calamus *manan*

palms (Beeson 1941). It measures about 3.5 to 5.0 cm in length and is blood-red in colour, with its entire body covered by a loose filamentous whitish waxy material (Fig. 5) which, when handled, is rubbed off. It remains in a rolled leaf of the food-plant. The pupal head region is darkly coloured whereas the thorax and wing cases are light green and the abdominal region is light yellowish brown. Pupation takes place within a rolled leaf of the food-plant (Fig. 6) and the pupa makes a rattling noise inside the shelter when disturbed. The pupal period is about 15 to 20 days. The butterfly is confined to the lowlands and flies at dusk.

***Erionota* torus Evans**

The larva is pale green covered with short silky hairs and a whitish powdery substance and has a dark brown head capsule (Fig. 7). It rolls up the leaf from the tip parallel to the veins and lives and feeds from one end of the leaf in this shelter. The larval

FIGURE 7. Larva of *Erionota torus*

period is about 20 to 29 days. Pupation takes place in the rolled leaf. The pupa is long, slender and also covered with the same whitish powdery substance present on the larva. When disturbed, the pupa wriggles violently in the shelter. The pupal period ranges from 8 to 14 days and the complete life-cycle takes about 35 to 47 days. The adult butterfly flies at dusk. The larva feeds on Calamus manan but is also known to feed on a large variety of other palms (Corbet & Pendlebury 1978).

Quedara monteithi Wood-Mason & de Niceville

The larva of this species feeds on Calamus manan. It is 2.5 to 3.0 cm long, light green in colour and covered with a thin layer of a white powdery substance. Its head capsule is greyish but dark brown medially. The larva rests in a depression or shallow groove which it forms on the top of the leaf with the help of silken threads which span across it. This groove runs parallel to the veins of the leaf. The larva feeds on the leaf area surrounding it, always retaining its resting point which eventually becomes long and narrow. When the entire surrounding area of the leaf is eaten, it then moves to a new leaf to feed on, forming a new groove on it. The pupa is light green with white longitudinal stripes and gradually turns to dark brown, partly variegated with yellow nearer emergence of the adult. It is attached to the leaf by a silken girdle and at the cremaster. The pupal period is about 12 to 14 days.

Spider Mites

Damage by these mites has been observed to be occasionally serious on Calamus truchycoleus. Khamis (1981) identified Hemitarsonemus latus as a species that damages Culumus *cuesius* in Sabah. They are minute mites belonging to the family Tarsonemidae, measuring about 0.5 mm or less in length. The adult mites are white to pale yellow in colour. They remain on the underside of leaves where they feed on the sap of the leaves which initially develop numerous small yellowish or greyish spots. The mites multiply rapidly and cause the leaves to become scorched in appearance and eventually curl and dry up.

ROOT FEEDING INSECTS

Termites *(Isoptera)*

Termites are often found in association with the stems and roots of rattan plants. Their presence becomes noticeable when they make earth covered trails on the stem. Not all termites are destructive and in fact their presence can be beneficial when they feed on dead remains of plants such as dead rattan fronds or sheaths and eventually enrich the soil in doing so. Coptotermes curvignathus, however, has been known to cause the death of recently transplanted seedlings of Calamus manan. These become susceptible to attack by the termite because of the stress of transplanting and the possibility of root injury. Cracks or abrasions on the palm-sheath, or other wounds on the stems may also predispose rattan seedlings to infestationby this termite species. Plants which show signs of general yellowing should be checked for the presence of this termite in the soil at the base of the plant. The termite soldiers of this genus exude a white latex from the front of their head when disturbed and if this is found to be so, attack by *Coptotermes* curvignathus is almost certain. This species kills many other tree species of economic importance in forestry and agriculture.

The much larger termites of the genus *Macrotermes* are believed to have caused the death of young Calamus manan seedlings in polythene bags left on the forest floor.

CONTROL OF PESTS

Very little control of rattan pests has been necessary in existing plantation experience. However, this does not mean that no serious pest problems will ever occur and so a knowledge of potential pest problems is essential in the event that pest outbreaks occur.

Application of insecticides may be necessary when the rattan plants are young if crickets, grasshoppers, mites or termites are suspected to be a problem. The base of the plants can be sprayed with malathion (0.7 grams active ingredient per litre water), for example, to control crickets or a similar foliar application can be used to control grasshoppers. Amitraz can be applied as a foliar spray in nurseries at a dilution rate of 0.2 grams active ingredient per litre water if spider mite infestation is serious. This is a fairly selective acaricide and is less likely to affect natural enemies of the mite than a broad spectrum insecticide such as malathion. A soil drench of an insecticide can be used to prevent attack by termites. About one litre or more, depending on the size of the plant, at the manufacturer's recommended concentration, should be applied to the soil at the base of each plant.

Care in handling young rattan plants will help prevent injuries and so minimise the risk of infestations by Rhynchophorus schach. Although the Cerambycid Mesosa has so far only been found infesting rattan planted under forest cover, it may yet cause problems in plantations and should be considered a serious threat to the plants since it causes direct damage to the canes. One possibility for control of this pest when the rattan plants are still low is to remove yellowing leaf sheaths before the beetle has an opportunity to infest them. This, however, would be difficult when the plants grow higher. Chemical control of the insect would be difficult because of the burrowing habits of the larvae.

DISEASES

Most of the diseases that affect rattan are leaf diseases, as has been pointed out by Khamis (1981) and Norani *et* al. (1985). Thus far, the only serious outbreak of a disease on rattan in Peninsular Malaysia was leaf blight of C. *trachycoleus* which occurred in 1985. In Sabah, where rattan has been planted on a large scale, there has been no report of any serious outbreak. In Thailand, where research on diseases of rattan has just begun, leaf spots and leaf blight have been reported as a commonly encountered disease (Vongkaluang 1989). Besides leaf diseases, another commonly encountered disease of rattan seedlings is collar rot. This disease has been observed in Malaysia both by Khamis (1981) and Norani et *al. (1985).*

Disease occurrence on plants is generally more prevalent during or after prolonged wet weather which favours the survival and dispersal of many micro-organism, especially fungi. The fungi survive in diseased materials and trash, and are dispersed by water splash, air currents, physical contact or insects.

The account presented here on diseases of rattan is based on studies in Peninsular Malaysia and is arranged in relation to the plant parts that the disease organisms infect and the symptoms they produce. Fungal diseases, however, are recorded as common in nurseries in India. These include seedling blight *(Guignardia calami)* and seedling steminfection (Fusarium). Other diseases recorded are caused by *Corynespora cassiicola, Collestrichumgloeosporioides, Sclerotium rolfsii,* and *Bipolaris ellisii.*

LEAF DISEASES

Leaf diseases are the most prevalent and they occur throughout the year. Although disease symptoms differ on different hosts, the causal organisms are usually the same. Conversely, more than one species of fungus can be associated with one disease symptom. The fungi commonly associated with leaf diseases are *Colletotrichum* spp., *Glomerella cingulata, Pestalotiopsis* spp., *Dreschlera* sp., *Helminthosporium* sp. and *Cercospora* sp. (Norani & Maziah 1988). Apart from *G. cingulata,* which is an ascomycete, the rest of these fungi are Fungi Imperfecti.

Disease symptoms range from being very mild to very severe. In heavily infected plants, the lesions often coalesce and spread throughout the plant, in some cases causing the death of seedlings. Leaf diseases can occur throughout the life of the plant.

Three main types of leaf disease can be distinguished based on the symptoms they produce.

Leaf spots

As far as is known, all species of rattan are susceptible to leaf spot infection to varying degrees. The severity of the disease depends on three maininteracting factors, i.e. host susceptibility, fungus pathogenicity and the environmental conditions.

The disease starts as tiny necrotic spots on the leaf surface. Later these spots enlarge into discrete, rounded or angular spots. Under humid or wet conditions, these spots coalesce to form larger, irregular lesions (Fig. 8).

FIGURE 8. Leaf spots coalesce to form lesions in Calamus caecius

Results from isolation experiments revealed that more than one fungus is responsible for this disease. Four types of fungi frequently isolated are Colletotrichum spp., *Pestalotiopsis* spp., Curvularia sp. and Phomopsis sp.

Leaf blight

The most significant leaf disease of rattan thus far experienced is leaf blight in Calamus truchycoleus. This disease resulted in 30 percent mortality of the growing stock during an outbreak in the Forest Research Institute Malaysia.

The disease starts with the development of brown spots which later turn into brown lesions with 80 percent of the leaf area infected. The disease spreads rapidly from seedling to seedling and within a span of a few weeks, more than a quarter of the seedlings can become infected.

Calamus trachycoleus seedlings are very susceptible to this disease. It is worth noting that seedlings of C. manan and C. *cuesius* were not infected when the outbreak occurred and a pathogenicity test confirmed their resistance to this disease (Norani A., pers. comm.).

The causal organism of this disease is primarily *Colletotrichum gloeosporioides* and its perfect stage, *Glomerella cingulata.* Both stages have been observed on infected leaves and hence they are both important in perpetuating the disease cycle. The infective propagules of these pathogens are their conidia and ascospores, both of which require high humidity for infection of host tissue. During the rainy season, conidia are dispersed by water splash. They are also dispersed by wind and insects.

Shot hole

Shot holes have been observed on C. *trachycoleus* (Fig. 9) and C. *caesius* (Fig. 10). The disease usually starts with small brown spots which later enlarge to form grey lesions. During the dry season, the lesions dry up and peel off, resulting in what is termed “shot holes”.

Three types of fungi commonly found associated with this disease are *Curvularia* sp., *Pesfalofiopsis* spp. and *Phomopsis* sp.

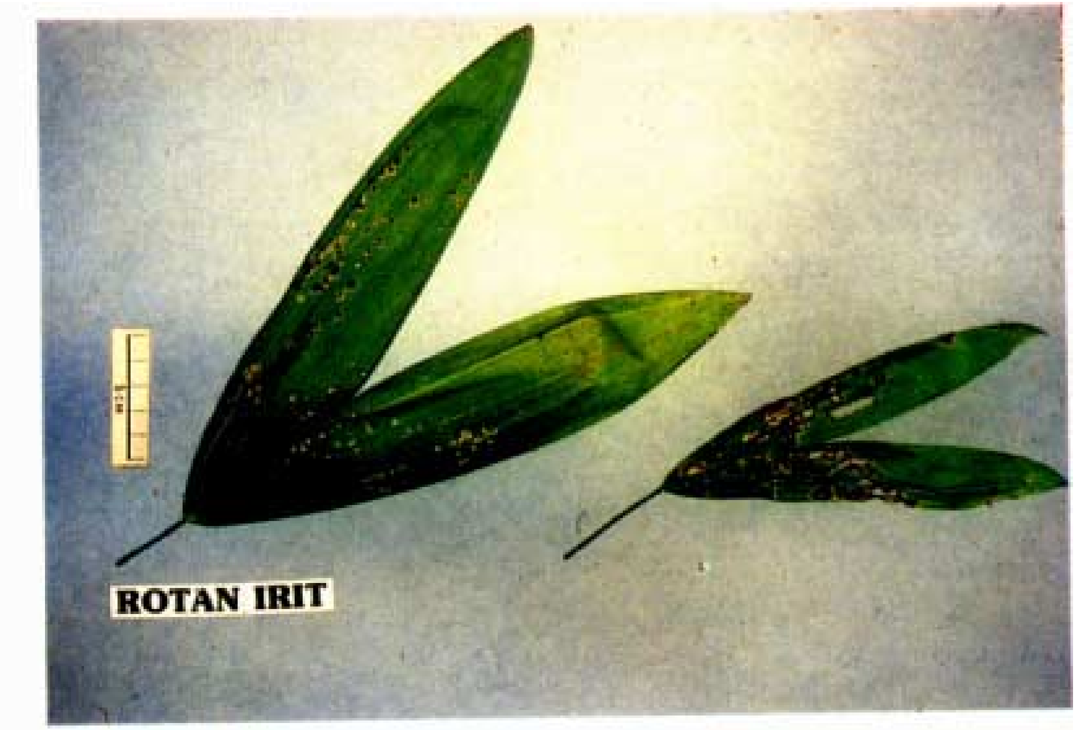

FIGURE 9. Shot hole symptoms of Calamus trachycoleus

FIGURE 10. Shot hole symptoms of Calamus caesius

COLLAR DISEASE

Apart from leaf diseases, another common disease of rattan is collar rot (Fig. 11). This disease occurs either during the seedling stage while plants are still in pots, or in the field. Collar rot is also very common in tissue-cultured seedlings when they have been transferred from a sterile environment to the soil. In the field, collar rot is usually observed following excessive rainfall.

FIGURE 11. Collar rot disease symptoms

Collar Rot Disease of Rattan in the Field

The first signs of occurrence of this disease are always observed following over-watering or when environmental humidity is very high, such as when rattan is planted under rubber in plantations. A major outbreak of collar rot was observed in a study plot established in Bukit Belata Forest Reserve (Norani et al. 1985).

Infection occurred at or above ground level, that is at the collar region of the rattan. Infected tissue appeared soft and water-soaked. As the disease advanced, the infected tissue began to rot and this was followed by wilting of the leaves.

Rhizoctonia solani is a soil-borne fungus associated with this disease. The fungus is strongly aerobic and thus, high soil moisture levels associated with prolonged rain inhibit activity of the fungus in the soil. In response, the fungus then grows over the soil surface whence it may attack the collar region of plants. Infection by this fungus is therefore generally confined to the upper 1 to 2 cm of plant stems.

Collar Rot Disease of Tissue Culture Plantlets

This problem is encountered when tissue-cultured plantlets of rattan are transferred into unsterile soil. More than 60 percent mortality has been recorded when conventional transferring methods were used. Improved methods recently developed have, however, reduced the percentage of mortality to less than 20 percent (Maziah Z., unpublished).

The obvious symptom of this disease is rotting at the collar region followed by wilting and finally drying of the entire plant. Superficial fungal mycelium can be seen at the collar region, usually as a white cottony mass (Maziah 1986).

Isolation revealed the presence of two species of *Fusarium,* namely, F. *oxysporum* and *F. solani,* both of which are soil borne. *Fusariurn* spp. produce two kinds of conidia, that is macroconidia and microconidia. They also withstand adverse environmental conditions by producing thick-walled chlamydospores which act as dissemination propagules.

The fungi cause the plant to wilt by blocking the vascular system and also by the production of the toxin fusaric acid.

CONTROL OF DISEASES

Diseases of rattan are best controlled by integrating good sanitary practices with appropriate chemical control. Optimum fertilizing and weeding are also recommended as they promote better growth, making the plants less susceptible to diseases.

Leaf spots and also shot-holes can be controlled using any dithiocarbamate fungicide such as Mancozeb or Maneb, or by using benzimidazole fungicides, such as Benomyl. Nursery hygiene practices also ensure successful eradication of these diseases. This includes avoiding overcrowding and overshading that result in humid conditions, which are conducive to the spread of the pathogens.

The leaf blight causal organism, Colletotrichum *gloeosporioides* can be effectively controlled by means of chemicals. Many chemicals such as Maneb, Mancozeb, Bavistin, Bropineb, Zineb, Chlorothalonil, Captofol, Captan, Benomyl, Thiophanatemethyl and copper fungicide give varying degrees of control. Strict sanitation practices should be followed, such as culling of severely infected leaves, providing adequate spacing between seedlings to avoid over-crowding and avoidance of excessive watering.

Prevention of collar rot disease is much more effective than control. The disease can be avoided by adopting good nursery techniques. Excessive watering of seedlings should be avoided. The potting mixture should not be too high in clay as this tends to retain excessive moisture in the pot. A mixture of systemic fungicides such as Metalaxyl with Mancozeb is effective but can be costly.

CONCLUSIONS

Although there have so far not been any serious pest or disease outbreaks on rattan under cultivation in Peninsular Malaysia, the potential always exists. It should be noted that a number of pest and disease organisms found affecting rattans are occasionally serious pests and diseases on other plantation palms. Rattan cultivators should therefore be continually alert to pest and disease problems in their plantations. There is also a need for continuous documentation of the pests and diseases associated with rattan, since rattan silviculture is a relatively recent development and there will doubtless be further important findings.

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