23

BANO BIGGYAN PATRIKA

a Journal of Forest Science
January & July 1985
Vol 14 : No 1 & 2

বন বিজ্ঞান পত্রিকা

চতুর্দশ বর্ষ : প্রথম ও দ্বিতীয় সংখ্যা

Editorial Board

Chairman :
A. ALIM

Members :
M. A. RAZZAQUE
M. A. AZIZULLAH
J. H. CHOUDHURY
M. M. HASSAN
S. A. KHAN
M. A. SATTAR
M. A. RAHMAN

Board of Management

Chairman :
DIRECTOR
FOREST RESEARCH INSTITUTE
CHITTAGONG, BANGLADESH

Members :
EDITOR
EXECUTIVE EDITOR
BANO BIGGYAN PATRIKA

Editor :
M. A. Razzaque

Executive Editor :
M. A. Azizullah

Editorial Associate :
Mrinal Sorkar

CONTENTS

* Physical strength properties of wood modified by Silane treatment
—M. A. Razzaque and W. B. Banks 1

* Rubber diseases in Thailand and their bearing on planting stocks imported to Bangladesh
—M. A. Rahman and K. S. Uddin 5

* Field identification guide to 12 species of Bangladesh Loranthaceae
—M. K. Alam 12

* Kiln drying studies on 5 cm planks of thirty timber species
—M. A. Sattar and Y. A. Talukdar 18

* Development of nursery procedure of three cane species
—A. Alim and M. Kamaluddin 26

* Effect of harvesting time and sowing interval of Garjan seeds on germination
—M. A. Haque, A.H. M.M. Rahman and J.H. Choudhury 30

* Needle cast of Pinus elliottii at Forest Research Institute campus, Chittagong
—B. Shayesta and M. A. Rahman 36

* Research trials on Ipil-Ipil in Bangladesh
—S. Das, N. Jones and M. A. Islam 42

* A study on some phenological characters of Silk Cotton tree
—M. Kamaluddin and R. L. Banik 49

* Some rubber diseases at Raozan Rubber Estate of Chittagong
—J. H. Choudhury and S. K. Khisa 52

* Short Communication 56

Editorial

UTILIZATION OF FOREST WASTES

About 40% of Latin American and 35% of Russian and North American Lands are under the cover of forest vegetation. Bangladesh is rather poorly endowed with this natural resource and has only 9% forest lands including Unclassed State Forests. Optimum utilization, thus, of the forest resource must be ensured for balanced development of the country. Due to the inaccessibility of the forest, lack of information about the end-use of a large number of lesser-known species and absence of adequate transportation facilities, full utilization cannot be made of our meagre forest wealth.

Taking per capita wood requirement in South Asian countries to be 0.42 cubic metre per annum, the estimated annual wood requirement of Bangladesh would amount to 40 million cubic metres. By all accounts only a tenth of the amount is at present available to the consumers in the country. In the face of such a bleak situation, stunning is the fact that 45% or more of the wood stock in the form of logs, cuts, limbs, branches, and tops is allowed to be left out at the forest. Add to this the industrial wood wastes in the factories a begging utilization.

In the United States systems and technology to recover forest biomass from silvicultural treatments, final harvest and site preparation are in place. Manufacturers are sufficiently interested to develop machines to capture and process biomass. Whether it will happen or not depends on the cost of production, development of market to support the system and its acceptability for fuel, fibre and feedstock. In many other developed countries, including Soviet Russia, emphasis is on the total utilization of the tree from roots to leaves.

A technology suitable for countries deficient in forest resources thus, has to be developed for economic utilization of the left-overs at the forests as well as the industrial wood wastes. If the forest wastes do not support the transportation cost to deliver them to the consumer, arrangements will then have to be made for processing the forest wastes, *in situ*. Technologies need to be developed to convert these wastes to useful articles for domestic purposes or raw-materials for industries.

Charcoal briquetting with industrial waste is common in developed countries. On destructive distillation of the wood raw materials charcoal amounting to 33 % by weight of the wood carbonised is obtained in the process. A properly built pelletizer can ensure compact briquettes for effective carbonization. The pyroligneous liquor yields a number of industrial raw materials, including power alcohol. The flue gas may be recirculated in the retorts to minimize fuel cost.

Bangladesh Forest Industries Development Corporation has reportedly introduced some charcoal plants in various felling coupes for conversion of forest residue. In the absence of the pelletizer, the charcoal produced is bound to be bulky and is likely to have limited market possibilities. Even then this step must be encouraged and the technology should be sophisticated for the preparation of compact charcoal pellets for economic transportation as well as for use in the manufacture of activated charcoal, calcium carbide, ferro-silicon and other industrial materials.

PHYSICAL STRENGTH PROPERTIES OF WOOD MODIFIED BY SILANE TREATMENT

M. A. Razzaque
W. B. Banks

A high degree of water repellency is obtained in wood modified by silanation. However, the degrading effect of HCl, formed as a by-product in the reaction, may not be fully offset by the use of acid acceptors or inert gases in the reaction. Tensile tests on microtome sections of *Pinus nigra* wood, treated variously with dimethyldichlorosilane, clearly show that chemical modification substantially decreases tensile properties of wood. Experiments with large specimens of the same species suggest that silanated zone is only superficial. As a result, most of the strength properties of the large specimens remain unimpaired.

INTRODUCTION

Wood can be dimensionally stabilized by treatment with silane. However, physical strength properties of wood are likely to be affected by silanation due to the formation of HCL in the reaction (Razzaque 1984). Acid acceptors commonly used in such reactions may be unable to totally eliminate the degrading effect (Rowell 1975, McMillin 1963). Moreover, such chemically modified wood, due to the substitution of silyl compounds for wood hydroxyl groups with consequent reduction in hydrogen bonding capacities, is likely to be more brittle than unmodified wood (Pierce 1968). It was decided, therefore, to monitor the tensile properties of silanated radial-longitudinal microtome specimens. It is also thought that wood subjected to mild silanation reactions are treated only superficially. Nominal 100 micron thick microtome specimens are, however, likely to be treated through and through. Specimens of one cm cross-sectional width were thus tested for static bending strength.

MATERIALS AND METHODS

Microtome specimens, 100 micron thick, 1 cm wide and 10 cm long were cut from the radial face of Corsican pine

blocks. These were dried under mild restraint at 20°C and 65% RH and then conditioned to constant weight over P_2O_5. They were then subjected to silanation with 1 ml and 5 ml silane vapour for 5 minutes in nitrogen atmosphere. Similarly, in the liquid phase, 1 ml and 5 ml silane in 50 ml CCl_4 were allowed to react with microtome specimens. The same experiment in liquid phase was repeated adding 10 ml Dimethyl formamide (DMF), as acid acceptor. The treated specimens after neutralizing, drying and equilibrating (at 20°C and 65% RH) were subjected to tensile tests over 2 cm span using a Universal testing machine. The load was applied using a cross-speed of 0.5 mm/min. The experiments were replicated using 20 specimens for each treatment condition.

For the static bending tests 16 cm long and 1 cm cross-sectional specimens were used. The specimens were prepared with the radial/longitudinal faces parallel to each other.

Silanation reactions were conducted both in the vapour phase and the liquid phase with dimethyldichlorosilane (DMDCS). Vapour phase reactions were done in a tall reaction vessel using a mild (2 ml silane), a medium (5 ml silane) and a severe (10 ml silane) treatment level. Another set of specimens, pre-treated with DMF, was treated in the vapour phase using 5 ml silane. A 5-minute reaction time was allowed in each case. Similar mild, medium and high level treatments were carried out in the liquid phase also using 5, 10 and 15 ml DMDCS for 5 minutes. In all cases 500 ml toluene was used as a diluent. The high level treatment was repeated with addition of 25 ml DMF in one reaction. In addition, a control reaction was carried out using solvent (toluene) and acid acceptor (DMF) only.

Liquid phase treated specimens were neutralized and equilibrated to constant weight at 20°C and 65%RH before mechanical testing. Modulus of rupture (MOR), Modulus of elasticity (MOE) and total work done (TWD) were calculated using the standard formulae.

RESULTS AND DISCUSSION

Results of tensile strength tests and static bending tests are given in Tables 1 and 2 respectively. It is evident that in microtome specimens a high degree of strength loss occurs even on mild treatment. Vapour phase reactions are rather critical. Slight loss of tensile strength occurs with mild vapour phase treatment, whereas, huge amount of strength is lost on rigorous treatment. In liquid phase reactions tensile strength properties are better retained than in rigorous vapour phase reactions. It is clear from the results that the chemical modification taking place drastically decreases tensile strength, suggesting that silanation occurs through the entire thickness of 100 microns of the specimen.

Both vapour phase and liquid phase treatments bring about loss of strength. From the limited tests carried out, it is not possible to prescribe which method of treatment is most deleterious. Even the process involving the acid acceptor does not change the results to any appreciable degree.

From the static bending tests of larger wood specimens it appears that the level of silanation achieved in these treatments

Table 1. Tensile strength of silanated microtome specimens (Mean of 40 specimens ± standard deviation)

Specimen treatment	Tensile strength Kg/mm²	Loss of strength (basis : control) %
Control	8.29 (0.67)	-
Vapour phase (mild)	5.55 (1.15)	33
Vapour phase (severe)	1.08 (0.14)	87
Liquid phase (mild)	3.14 (0.31)	62
Liquid phase (severe)	2.18 (0.19)	74
Liq. phase with DMF (mild)	3.09 (0.10)	63
Liq. phase with DMF (severe)	2.60 (0.43)	69

Table 2. Static bending tests of silanated large specimens (Mean of 12 specimens ± standard deviation)

Specimen treatment	MOR (N/mm²)	MOE (N/mm²)	TWD (Nmm/mm³)
Control	117.86 (7.72)	10,769 (837)	0.2168 (00.4)
Vapour phase (mild)	112.69 (7.27)	11,006 (496)	-
Vapour phase (medium)	104.56 (5.38)	10,453 (588)	0.1876 (0.02)
Vapour phase (severe)	99.17 (5.67)	10,752 (691)	-
Vapour phase with DMF (severe)	115.94 (6.64)	10,780 (880)	-
DMF alone	103.34 (9.88)	12,798 (1372)	-
Liquid phase (with DMF)	107.05 (4.30)	11,328 (715)	-
Liquid phase (mild)	110.12 (8.48)	12,100 (790)	
Liquid phase (medium)	107.11 (6.38)	9,166 (2869)	0.1715 (0.03)
Liquid phase (severe)	103.50 (3.99)	12,630 (1759)	-

leads to only a slight reduction in bending strength properties. However, it can be seen that as the severity of treatment is increased, a corresponding increase in strength loss is incurred. Comparison of these data with those for the thin strips suggests that the silanated zone is superficial, probably not extending to a depth greater than 1 mm or so. As a result, most of the strength properties of the large specimens remain unimpaired. The modulus of elasticity values do not change much and seem to be inconclusive. Total work done was calculated on the control, one batch of vapour phase and one batch of liquid phase specimens only

At first sight, these minimal loss of strength data appear to be quite encouraging. That is, in relatively large cross sections the loss of strength caused is less in comparison with naturally occuring strength reducing factors (relative to the strength of clear specimens) such as knots and sloping grain. However, as shown by the strength reduction caused to these sections, such reduction seems to be concentrated in a thin exposed surface zone. It is likely, therefore, that this zone may rapidly erode when exposed directly to weather, leaving unprotected wood at the surface. Under a paint film, the situation may be a little better. In this case the stresses encountered due to any differential movement of wood and paint due to change in atmospheric condition may well lead to shearing of the weak surface layer of modified wood from the underlying sound material, and effectively detaching the paint film from the wood surface. Hence, the observed strength reduction occurring as a consequence of silane treatment must impart a serious reservation on the possible utility of such wood modifying processes.

CONCLUSION

Silanation reduces the hydrogen bonding capacity of wood hydroxyl groups. Silane treatment is effected only superficially causing the thin specimens to lose most of their strength on treatment. However, most of the strength properties of large treated specimens are retained. Hence, silanation may be a practical means of imparting water repellency to wood. The long-term behaviour of modified wood needs further study.

REFERENCES

Pierce, A. E. 1968. Silylation of organic compounds. Pierce Chemical Company, Ill. U. S. A.

McMillin, C. W. 1963. Dimensional stabilization with polymerizable vapour of ethylene oxide. For. Prod. Jour. 13(2) : 56-61

Razzaque, M. A. 1984. Dimensional stabilization of wood by silanation. Bano Biggyan Patrika 13(1 & 2)

Rowell, R. M. 1975. Chemical modification of wood. Proc. Am. Wood Pres. Assoc. 71 : 41-51

M. A. Razzaque, Divisional Officer, Forest Research Institute, Chittagong, Bangladesh and W. B. Banks, Lecturer, Department of Forestry and Wood Science, University College of North Wales, Bangor, U. K.

RUBBER DISEASES IN THAILAND AND THEIR BEARING ON PLANTING STOCKS IMPORTED TO BANGLADESH

M. A. Rahman
K. S. Uddin

The status and approach for expansion of rubber cultivation in Thailand is outlined. Major diseases of rubber in Thailand, their incidence and effect in general and the role of *Phytophthora botryosa* Chee in particular, have been described. Abnormal leaf fall of rubber due to *P. botryosa* was prevalent only in some high rainfall areas in the west coast of the country. This disease was, however, found to be absent both in the plantations of seed source and in the nursery wherefrom budded stumps were imported to Bangladesh in 1984.

Details of the phytosanitary treatments and packaging of the budded stumps for shipment to Bangladesh are outlined. Survivality of the budded stumps both in the nurseries and in plantations around Khagrachhari has been found to be quite low. This is most probably due to the failure of the budded stumps to produce adequate new roots because of very late planting. Phytosanitary treatments had little or no phytotoxicity effects on the budded stumps. It is suggested that in any future programme, budded rubber stumps have to be planted in the early planting season.

INTRODUCTION

Thailand is located between 5°7′ and 20°2′N latitudes and 98° and 105°E longitudes. Amongst its 72 provinces 17 are used for commercial rubber (*Hevea brasiliensis* Muell) plantings. These plantations are in the southern and eastern regions of the country. In recent years some experimental plantations have also been raised in the northern part. About 1.6 million hectares of rubber plantations have been raised so far out of its total area of 51.4 million hectares (Lim Pholoh 1984, pers. comm.)

During mid 1984, Chittagong Hill Tracts Development Board (CHTDB) embarked to import some 0.3 million budded rubber stumps of high yielding clones from Thailand. In that connection the authors visited Thailand (i) to study the disease situations of rubber, (ii) to ensure necessary phytosanitary measures against rubber diseases in general and that of *Phytophthora botryosa* Chee in particular and (iii) to take necessary measures so that planting materials imported were in a viable condition. The budded stumps imported from 20th August to the end of September, 1984 were directly planted in the field and those received thereafter upto the 15th December, 1984, were planted in polybags and placed in a number of nurseries around Khagrachhari. In the present paper an attempt has been made to review the rubber diseases in general in Thailand and with particular reference to the disease caused by *P. botryosa* in relation to the budded stumps imported. Disease situations in the nursery where the budded stumps were grown, details of collection, phytosanitary treatments given and packing of the budded stumps for shipment to Bangladesh are also included. The budded stumps have also been examined in the nurseries and plantations of CHTDB for any probable phytotoxicity effect and also to evaluate the disease situation there.

PRESENT STATUS OF RUBBER DISEASES IN THAILAND

Some five hundred fungi have been recorded on *Hevea* or its produce, as saprophytes, epiphytes or parasites. Of these, only about twelve fungi are of importance in one rubber growing area or another, although a few are of world-wide distribution. No virus disease of *H. brasiliensis* is known. Only one report of a bacterial disease is on record (*Pseudomonas solanacearum* from Indonesia). The biology of the major pathogens has been studied in detail for finding out suitable control measures though it is not always clear at what level of disease attack such measures should be applied. Out of the twelve important pathogens of rubber *Rigidoporus lignosus* (Klotzsch) Imazeki and *Phytophthora botryosa* are of major economic importance in Thailand. The former causes a white root rot resulting death of rubber trees in patches while the latter is the cause of abnormal fall of mature leaves. The fungus usually attacks the petioles, causing the leaves to fall while they are green (Wastie 1975).

Chee (1969) recorded that in Thailand and the northern part of Peninsular Malaysia pod rot and leaf fall of rubber was associated with *Phytophthora palmivora* Buler and *P. botryosa,* particularly the latter. Wastie (1973) reported that out breaks of the abnormal leaf fall by *P. botryosa* was first noticed in 1966 in Malaysia and was restricted to high rainfall areas until 1973 when they occurred in a region of low rainfall. Defoliation was closely correlated with the duration of surface wetness and 100% relative humidity (RH) existing 7 days previously. An outbreak of leaf fall and pod rot of rubber by *P. botryosa* invariably followed a 4 day period during which the daily maximum temperature was 32.3°C with 90% RH persisting for 14 hours or more and daily rainfall 2.5 mm. (Anon. 1931). Wastie *et al* (1973) mentioned that *P. botryosa* is limited to mature leaves on trees over 6 years old. Tsao *et al* (1975) in course of a disease survey isolated and identified *P. palmivora* and *P. botryosa* from rubber in Southern Thailand.

Satisfactory control of *Phytophthora* leaf fall and pod rot was obtained by fogging a 30% copper in oil formulation (Anon 1973). Defolatan, a non-systemic fungicide, used in an oil carrier was found to be effective in controlling the disease. Tan (1983) in field trials found Ridomil 25 WP (metalaxyl) to be slightly better than Difolatan, both as protective and therapeutic fungicide against *P. palmivora* and *P. botryosa*.

Ganoderma pseudoferrum (Wakef.) van Oven and Stein causing a red disease, *Phellinus noxious* (Corner) G. H. Cunn. causing pink disease of stem and branches, chiefly on trees 3-8 years old ; *Ceratocystis fimbriata* Ell. & Holst causing mouldy rot of bark of the tapping panel, *Oidium heveae* Steinmann and *Glomerella cingulata* (Stonem.) Spauld & Schrenk (*Collectotrichum glocosporoides* Penz.) bringing about a so-called leaf fall by attacking the young leaves that develop during the short refoliation period after the annual leaf change or 'wintering', and *Drechslera heveae* (Petch) M. B. Ellis causing 'birds eye spot' on leaves have been recorded to be of minor economic importance in Thailand (Wastie 1975).

Turner ard Hla Myint (1980) failed to isolate *P. botryosa* from diseased tissues of rubber in Burma, but Turner (1984) mentioned about its record from the southern part of the Tenasserim region of the country. Turner also points out that *P. botryosa* is endemic in Thailand where it is the main cause of the pod rot, leaf fall and dieback of rubber. It is also the major pathogen associated with these diseases in the north of Peninsular Malaysia. This species has not been reported from Bangladesh, India (except the Andaman Islands) or Sri Lanka where *P. palmivora* occurs.

During our recent stay in Thailand we came across hundreds of rubber plantations along the rail line from Bangkok to Hatyai through the eastern part of south Thailand, the main rubber growing region of the country, but nowhere we could see any serious damage due to abnormal leaf fall. It may, however, be noted that the disease has been prevailing only in some high rainfall areas (viz. Pangnga, Krabi, Phuket, Trang and Satun) in the west coast of south Thailand.

Mr. Pongthep Kajornchaiyakul, the Plant Pathologist on rubber diseases at the Rubber Research Centre, Hatyai mentioned that while root disease due to *R. lignosus* and pink disease due to *Corticium salmomicolor* are quite common on rubber trees in Krabi province, severe abnormal leaf fall due to *Phytophthora* spp. is found on rubber trees in Pangnga, Phuket, Krabi and Trang provinces but not so severe in Satun, except in case of very heavy rainfall. In 1976 *Phytophthora* leaf fall was found to be severe in Chanthaburi and Trat but not so severe in Rayong. Powdery mildew due to *Oidium heveae* is rather common around Yala but it has little effect on the economic importance.

SOURCE OF BUDDED RUBBER STUMPS AND DISEASE SITUATION

The budded rubber stumps which Rubber Research Institute of Thailand (RRIT) had been supplying since 17th August, 1984, to Chittagong Hill Tracts Development Board have been raised in the nursery of Chachengsao Rubber Research Centre, approximately at 11°7′ N latitude and 101°2′ longitude and at 120 km southeast of Bangkok. The centre is about 400 ha in area situted in an isolated valley.

There is no plantation either of rubber or of any other tree species in the surroundings of the centre. About 506 km away, a few small holdings of rubber (p. 1975–1976) are present. The plants were found to be quite healthy and no evidence of abnormal leaf fall or other types of disorders were reported within the area of the centre. There are some 40 ha of bud wood nursery, 2–4 year old rubber plantations and a large area of nursery for the production of budded stumps of various high yielding clones of rubber.

Fresh rubber seeds were collected from Ampur Maung in Kachat district in Rayong province, 10°8′ N lat. and 101°4′ E long., in July 1983 for raising nursery at Chachengsao. Rubber plantations in Rayong were visited on the 18th August, 1984, but nowhere symptoms of abnormal leaf fall were noticed. Only in a small number of places some trees were found to have developed 'partial wintering' effect where scattered top branches shed their leaves. This symptom is distinctly different from that of abnormal leaf fall due to attack by *Phytophthora* spp. where most of the leaves fall off even when they are green. This suggested that the seeds were collected from plantations free from *P. botryosa* damage. Seeds weighing 1250 kg were sown in rows per hectare of stock nursery. The seedlings were thinned after one month. Seedlings at 15 to 20 cm distances were retained. Such seedlings 6 to 8 months old were bud grafted, the diameter at 5 cm above the ground being not less than 1.0 cm in Feb., 1984 (Jirakorn Kosaisame, 1984, pers. comm.)

The budded seedlings, young plantations and the budwood nursery of rubber in the campus of the centre were all free from abnormal leaf fall. However, bird's eye spot on leaves caused by *Drechslera heveae* were found. These were virtually negligible and certainly had very little effect on the health and growth of the plants. It may, however, be mentioned that this fungus also occurs on seedlings and saplings of rubber in Bangladesh. *Oidium heveae*, the causal organism for powdery mildew and South American leaf blight of rubber caused by *Microcyclus ulei* (P. Henn) Arx have never been recorded in the centre. Indeed, the latter has never occurred in Malaysia, Thailand, Burma, Bangladesh, India and Sri Lanka.

From the foregoing information, it is almost certain that the budded rubber stumps from Chachengsao nursery in Thailand were free from *P. botryosa* and *Oidium heveae*. However, in consideration of the bulk importation, the conditions laid out in the import permit, the biology of *P. botryosa*, and that lest any viable propagules of *P. botryosa* or of any other unconsidered pathogen in soil particles adhering to the root surface, if any, be introduced to Bangladesh, necessary phytosanitary treatments were recommended as additional precautions.

PHYTOSANITARY TREATMENTS OF THE BUDDED STUMPS

To decide upon appropriate phytosanitary treatments careful considerations were given on the information obtained in these respects from relevant quarters.

A budded nursery was first watered sufficiently using a sprinkler of 150 HP for 8 to 10 hours before pulling of 8 to 9 months old budded rubber seedlings. Pulling

of the appropriate sized seedlings were started generally at about 7 A. M. After pulling, the seedlings were brought under shade where side roots were first trimmed and then about 15 cm of stem and 30 cm of tap root were severed from each seedling to get a budded stump. Such budded stumps were then washed and piled up in shade. These were then treated in 0.2 per cent alcoholic mercuric chloride solution for 10 minutes, washed in water and then treated for 5 minutes in either 0.1 per cent Ridomil 25 WP (200 gm in 50 litres of water) or in Difolatan, 4 Flowarble conc. solution (200 ml. in 50 litres) for 5 minutes.

PACKING FOR SHIPMENT

Wooden crates of 80 cm x 50 cm x 45 cm dimension were made by using 5 cm wide and 1 cm thick wooden planks at 5 cm distances. Such crates were chosen over solid boxes in consideration of weight of the crates, conveniences for handling in transit and aeration of the stumps. The crates and sawdusts used for packing were fumigated with methyl bromide to kill any insects, nematodes, etc at the rate of 1362 gm gas/27 cubic metre box space for 24 hours. The sawdusts were then sterilized in steam for half an hour to kill any fungal pathogens and cooled overnight. Adequate measures were taken in packing to ensure optimum survival of the budded stumps in transit.

PERFORMANCE OF THE BUDDED STUMPS IN BANGLADESH

About 1,20,000 budded stumps imported from late August through early October 1984, were directly planted over 635 acres in 13 plantations in the upland settlement area of the Rubber Planting Project of the Chittagong Hill Tract Development Board (CHTDB) in Khagrachhari Hilly District. Some 1,17,000 budded stumps received subsequently upto mid December, 1984 were planted in polybags and placed in seven nurseries.

For initial growth and development of a new shoot a budded rubber stump utilize the food reserve in the stump. But to supply the increasing demand for water and nutrients the stumps need to develop sufficient number of new roots.

In the present case, the importation and subsequent planting of the budded stumps either in the field or in polybags commenced only well after the planting season, causing the budded stumps fail to generate adequate new roots which, it seems contributed largely to the dieback and death of the stumps.

Scattered plants are still surviving in the field which will not number more than 10,000. It is estimated that out of about 95,000 there are about 51,000 of the budded stumps still alive at different stages of growth in the nurseries, excluding the 22,000 stumps which arrived on about 15th December, 1984 (Guha 1984, pers. commn).

In the nurseries, sporadic leaf spots due to *Colletorlichum gloeosporoides* and *Drechslera heveae* were found to occur, but these were not the primary cause of mortality of the budded stumps.

At Nalchara and Paranchara nurseries, a proportion of the budded stumps which were dying and which failed to flush were closely examined. Except only small sporadic lesions on the tap root over 90 percent area of the bark of root and stem including

that of the lender grafted bud patch was found to be alive. Therefore, it is obvious that the chemical treatments of the budded stumps in Thailand did not cause any phytotoxic effect on the budded stumps.

Therefore, in any future programme budded rubber stumps should be planted only early in the planting season so that before the onset of dry period the plants get well established. This will reduce the chances of mortality.

ACKNOWLEDGEMENT

The authors are indebted to International Agricultural Development Service/ Bangladesh Agricultural Research Council for providing the financial support and to the Government of the People's Republic of Bangladesh for granting necessary secondment; to the members of the Rubber Research Institute in Thailand, especially Dr. Sunnit for extending necessary co-operation in field work, and to Dr. M. M. Hassan for helpful criticism and reviewing the manuscript.

REFERENCES

Anon. 1978. Crop protection. *In*, Annual Report, 1977, Rubber Research Institute of Malaysia : 149–152 (Review of Plant Pathology, 58 : 5007 pp)

———.1981. Rubber Policy of Thailand (Editorial) : 2(2)

———.1981. Crop Protection. *In*, Annual Report, 1980, Rubber Research Institute of Malaysia : 38–41 (RPP 61 : 4324)

Chau, H. Y., Pushparajah, E., Yew, F. K. and Eusof, Z. 1975. A soil suitability technical grouping system for Hevea. Paper presented at the Third ASEAN Soils Conference, Kuala Lumpur, Malaysia, 1–5 December, 1975

Chee, K. H. 1969. Leaf fall due to *Phytophthora botryosa*. Planters' Bulletin, Rubber Research Institute, Malaya, No. 104 : 190–198 (cited in Turner and Hla Myint, 1980)

Hassan, M. M. 1983. Land suitability evaluation for rubber cultivation in Bangladesh. Rubber Berta. 1(1) : 31–36

Pushparajah, E. and Guha, M. M. 1968. Fertilizer response in *Hevea brasiliensis* in relation to soil type and soil and leaf nutrient status. Transaction of the Ninth International Congress on Soil Science. 4 : 85 (cited in Thainugul *et al* 1982)

Tan, A. M. 1983. A new fungicide for the control of black stripe. Planters' Bulletin No. 174 : 13–16 (RPP 63 : 229)

Thainugul, W. and Sinthurahas, S. 1982. The feasibility of rubber growing soil map in Thailand.

Thainugul, W. and Sinthurahas, S. 1982 (a) A map of annual rainfall of the feasible rubber growing area in Thailand.

———.and Inseance, J. 1982. The feasibility of rubber growing areas in Thailand. First International Symposium on soil, geology and land forms impact on land use planning in developing countries, Bangkok, Thailand. 1-3 April, 1982

Tsao, P. H., Tummakate, A. and Chew-Chin, N. 1975. Isolation and identities of *Phytophthora* species from rubber (*Hevea brasiliensis*) in Thailand. Plant Protection Service of Thailand Bulletin No. 25 : 9 (RPP 56 : 1713)

Turner, P. D. 1984. Import of Rubber Stumps : A letter to the Chairman, BFIDC, Dhaka, 11th July 1984

———.and Hla Myint, U. 1980. Rubber diseases in Burma. FAO Plant Protection Bulletin 28 (3) : 85–91

Wastie, R. L. 1973. Influence of weather on the incidence of *Phytophthora* leaf fall of *Hevea brasiliensis* in Malaysia. Journal of the Rubber Research Institute, Malaysia, 23(5) : 381–390 (RPP 53 : 2297)

———.1975. Diseases of rubber and their control. PANS 21(3) : 268–288

———.Chee, K. H. and Lim, T. M. 1973. Screening clones of *Hevea brasiliensis* for disease resistance – a review. Planter Kuala Lumpur. 49 : 164-169 (RPP 53 : 255)

Mohammad Abdur Rahman, Divisional Officer, Forest Research Institute, Chittagong and Kazi Shafiq Uddin, Assistant Director, Plant Protection Department. Khamarbari, Farm Gate, Dhaka, Bangladesh

FIELD IDENTIFICATION GUIDE TO 12 SPECIES OF BANGLADESH LORANTHACEAE

M. K. Alam

The paper includes a field key of 12 species of Bangladesh Loranthaceae based on their leaves and indumentum characters. Brief taxonomic notes on vegetative characters of the species, their flowering time and distribution in Bangladesh have been presented.

INTRODUCTION

The members of Loranthaceae, generally known as mistletoes, are semiparasitic shrubs (rarely erect terristrial as *Nuytsia* in Australia) growing on the host with the help of modified roots. They cause more economic loss than members of any other parasitic family of angiosperms. They mostly attack dicotyledons and gymnosperms which include forest trees, horticultural plants and plants of aesthetic value. The effects of parasites on the hosts are manifold. The hosts are subjected to reduction of vigour, growth rates, poor fruit and seed production, formation of burrs on truck or branches, reduction in foliage, drying of top, predisposition to insect and other disease attacks ultimately causing premature death. In tropical and sub-tropical forests, mistletoe infection sometimes creates havoc and damages large number of forest trees. In Bangladesh many of the important forest trees like Teak (*Tectona grandis* Linn.), Gamar (*Gmelina arborea* Roxb.) Sal (*Shorea robusta* Gaertn. f.) etc. and several fruit trees like Mango (*Mangifera indica* Linn.) Jack fruit (*Artocarpus heterophyllus* Lamk.) are attacked and damaged by mistletoes. The family, Loranthaceae, is distinguished by its usually parasitic habit, leathery leaves, cup-shaped receptacle, inferior one celled ovary, lacking in a clearly defined loculus and well defined ovules.

In Bangladesh the family is represented by 15 species under seven genera. Of them, the most common species are *Dendrophthoe falcata* (Linn. f.) Etting, *Macrosolen cochinchinensis* (Lour.) Van Teigh. *Scurrula parasitica* Linn., *S. gracilifolia* (Roxb. ex Schult.) Dans. and *Viscum monoicum* Roxb. ex DC which are widely distributed in all the districts of Bangladesh. *S. pulverulenta* (Wall. ex Roxb.) G. Don is distributed in northern districts, mainly Dinajpur, *Taxillus*

thelocarpa (Hook. f.) Alam in Chittagong and *T. umbellifer* (Scuito) Dans. in Sylhet. Species of *Helixanthera* are distributed in the forests of Sylhet and Chittagong. *D. falcata* and *V. monoicum* are two common species found in Sunderbans forest.

Loranthaceae are usually classified by their flowers. But in the field, the flowers are not always available and, therefore, foresters, biologists, pathologists and the people working with mistletoes may not find flowers during their visits. So they need some guide to identify mistletos without flowers. The present paper is an attempt to distinguish 12 species of Bangladesh Loranthaceae by their vegetative characters mainly on the characters of leaves and their indumentums. Following the vegetative key, brief taxonomic notes on vegetative characters of the species with local names ; where available, and their distribution in Bangladesh have been given. Synonyms have been given in parenthesis after the name. Flowering period has been mentioned so that one can collect the flowering materials, if needed, for critical study. The leaves of some species viz. *Dendrophthoe falcata, Scurrula gracilifolia, S. parasitica* show variation. Variation is also marked in the colour and degree of presence of indumentums in the species of *Scurrula*. So some might face some difficulties in working out some species in the key. Brief descrip tions will be helpful in cross checking the species included in the key. Any suggestion for improving the key will be appreciated.

VEGETATIVE KEY TO 12 SPECIES OF LORANTHACEAE IN BANGLADESH

1.	Leafless. Mostly trichotomously branched pendulous shrub	*Viscum articulatum*
1.	Leafy	2
2.	Parallel nerved ; main veins from the base	3
2.	Penninerved	4
3.	Leaves ovate or falcate ; acute or acuminate	*Viscum monoicum*
3.	Leaves obovate to elliptic-oblong and linear oblong ; obtuse	*Viscum orientale*
4.	Leaves glabrous	5
4.	Leaves and young shoots pubescent ; tomentose on both upper and lower surfaces	9
5.	Leaves all alternate (sometimes sub-opposite). Elliptic-lanceolate to obovate, obtuse, coriaceous ; secondary veins indistinct ; a gradual crest on the branch below the petiole base	*Dendrophthoe pentandra*
5.	Leaves opposite and alternate in the same plant	6

6. Leaves sessile (sometimes subsessile) ; tip rounded ; branches thickly lenticelled — *Dendrophthoe falcata*

6. Leaves petioled ; tip obtuse to obtuse acuminate or subacute ; branches thinly lenticelled — 7

7. Stem and branches greyish brown ; leaves elliptic or elliptic ovate ; tip mostly acuminate — *Macrosolen cochinchinensis*

7. Stem and branches blackish-grey ; leaves ovate-lanceolate, ovate-elliptic to elliptic oblong — 8

8. Leaves sub-acute at both ends ; elliptic to oblong-elliptic ; stem and old branches granular lenticelled — *Taxillus umbellifer*

8. Leaves obtuse towards the base ; tip acute ; ovate-lanceolate to ovate elliptic ; stem and older branches fissured lenticelled — *Helixanthera parasitica*

9. Branchlets and leaves beneath clothed with fine thickly cinnamon or twany, stellate tomentum ; leaves glabrous and opaque above — *Taxillus thelocarpa*

9. Branchlets and young leaves on both the surfaces covered with white, mealy grey or rusty tomentum — 10

10. Young shoots and leaves covered with scurfy white, mealy tomentum ; leaves broadly ovate or ob-ovate. Leaf margins sometimes irregularly eaten by insects ; branches pendant — *Scurrula pulverulenta*

10. Young shoots and leaves covered with scurfy greyish-brown or rusty tomentum ; leaves elliptic, elliptic-oblong to ovate-oblong — 11

11. Leaves and young twigs rusty tomentose — *Scurrula parasitica*

11. Leaves and young twigs dark brown, grey or greyish-brown —tomentose — *Scurrula gracilifolia*

BRIEF TAXONOMIC NOTES WITH DISTRIBUTION AND FLOWERING PERIOD

1. **Dendrophthoe falcata (Linn. f.) Etting.** (*Loranthus longiflorus* Linn. f.)

Vernacular Names : Bhanda, Phoroulla (Chittagong)

Parasitic shrub. Stem often more than 1 m long; form a burr at the point of attachment with the host tree. Bark grey, thickly lenticeolate. Leaves 5–15 x 4–10 cm; opposite or alternate, very variable in shape, ovate-oblong or elliptic, tip obtuse or rounded; emergent leaves reddish, sub-sessile to petiolate, petiole 1-5 mm long

Flowering time : October to January
Occurance : Occur throughout Bangladesh

2. **D. pentandra (Linn.) Miq.** (*L. pentandra* Linn.)

A parasite of considerable size. Branches shiny grey, lenticellate, adventitious roots running along the host of sending out haustoria at intervals. Leaves 5–15 x 3.8 cm, elliptic-lanceolate, ob-ovate, thick, veins obscure; tip obtuse or rounded, base cuneate or narrowed into a petiole of 7-10 mm. long; below the petiole base there is a gradual crest like ridge on the branch

Flowering time : December to May

Occurance : Occurs in the districts of Sylhet and Chittagong

3. **Helixanthera parasitica** (*L. pentapetatalous* Roxb.)

Large much branched parasitic shrub, quite glabrous. Adventitious roots running along the host. Leaves 5–12 x 2–5 cm ovate-lanceolate to ovate-elliptic, acute, entire, coriaceous, base rounded petiole 1–2 cm

Flowering time : February to May

Occurance : Occurs in the forests of Chittagong, Chittagong Hill Tracts and Sylhet

4. **Macrosolen cochinchinensis (Lour.) Van Teigh.** (*L. ampulaceus* Roxb. *L. globosus* Roxb.)

Vernacular Names : Chota bhanda, Pargacha, Rema (Sylhet)

Much branched, quite glabrous. Branches lenticellate, nodes swollen, base of the plant on the host swollen, the adventitious roots running along the host. Leaves 4–12 x 1.2-4.0 cm, elliptic, elliptic-lanceolate, ovate, shining above, tip obtusely acuminate, base acute or cuneate; petiole 3–10 cm long

Flowering time : January to April
A common parasite of Bangladesh.

5. **Scurrula gracilifolia (Roxb. ex Scult.) Dans.** (*L. scurrula* var. *graciliforus* Kurz.)

A large bushy wood parasite. Stem often form a burr at the point of attachment of the host plant. Branches lenticellate, all young parts densely covered with dark brown, grey or greyish brown tomentums, on maturity the upper surface of the leaves become almost glabrous. Leaves 3–8 x 1.5-4.5 cm, elliptic to ovate, tip acute to obtuse, base rounded, rarely sub-cordate; petiole 3–10 mm long

Flowering time : November to February

Occurance : Common parasite of the forests of Chittagong, Chittagong Hill Tracts and Sylhet. Also occurs in other parts of the country.

6. **S. parasitica Linn.** (*L. scurrula* Linn.)

A large bushy parasitic shrub with runner like adventitious roots. Branches lenticellate, older branches usually brown, young twigs rusty tomentose. Leaves 3-8 x 1.5-5 cm, opposite, sometimes sub-opposite, elliptic-oblong, ovate-oblong to obovate, base acute-obtuse to rounded, apex obtuse rounded, principal veins often purplish when young, scurfy or tomentose ; petioled or subsessile ; petiole upto 5 mm long

Flowering time : January to April

Occurance : Occurs in most of the districts of Bangladesh

7. **S. pulverulenta (Wall. ex Roxb.) G. Don.** (*L. pulverulentus* Wall. ex. Roxb.).

Stout, woody parasites, dark grey. Branches lenticellate, pendent, young shoots white floccose. Leaves 5-15 x 1.5-70 cm, opposite, broadly ovate to ovate-oblong, acute or obtuse, base rounded or acute ; sometimes margins irregularly eaten by insects, both sides covered with whitish grey tomentume.

Flowering time : October to December

Occurance : Occuras in the northern districts of the country.

8. **Taxillus thelocarpa** (Hook. f-) Alam (*L. thelocarpus* Hook. f.)

Woody parasite, runner like adventitious roots, Branches stout, terete, sparsely lenticellate ; bark grey, branchlets clothed with twany, scurfy tomentum ; leaves 3-7 x 2-3 cm, ovate or ovate-oblong, obtuse, base rounded, glabrous and opaque above, clothed with very fine thick rusty brown or twany, scurfy tomentum beneath.

Flowering time : September to October

Occurance : Recorded from the forest of Chittagong only

9. **T. umbellifer (Schult.) Dans.** (*L. umbellifer* Scult.)

A stout woody parasite, adventitious roots running along the host. Branches grey, lenticellate, younger parts pubescent. Leaves opposite or alternate ; 3.5—12.0 x 26.0 cm elliptic to elliptic lanceolate ; petiole 10 mm long. Veins distinct, 5-6 on either half of the mid-rib

Flowering time : November to January

Occurance : Recorded from Sylhet forest only

10. **Viscum articulatum Burm.**

A leafless, pendulous, mostly trichomously branched, green, parasitic shrub, yellow black when dry ; internodes longitudinally grooved, 1-6 cm long, 2-10 mm broad, thickend at nodes

Flowering time : January and February

Occurance : Occurs in the forests of Sylhet, Chittagong and Chittagong Hill Tracts

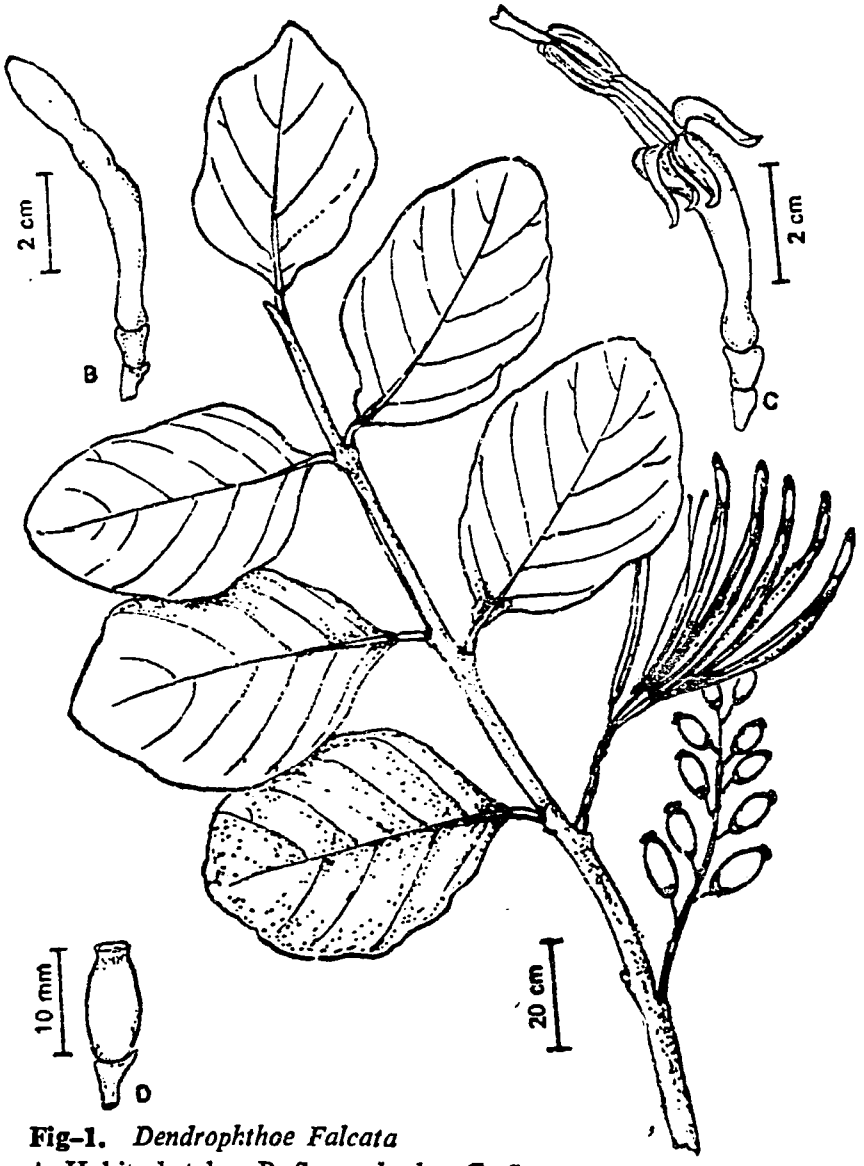

Fig-1. *Dendrophthoe Falcata*
A. Habit sketch B. flower bud C. flower
D. fruit

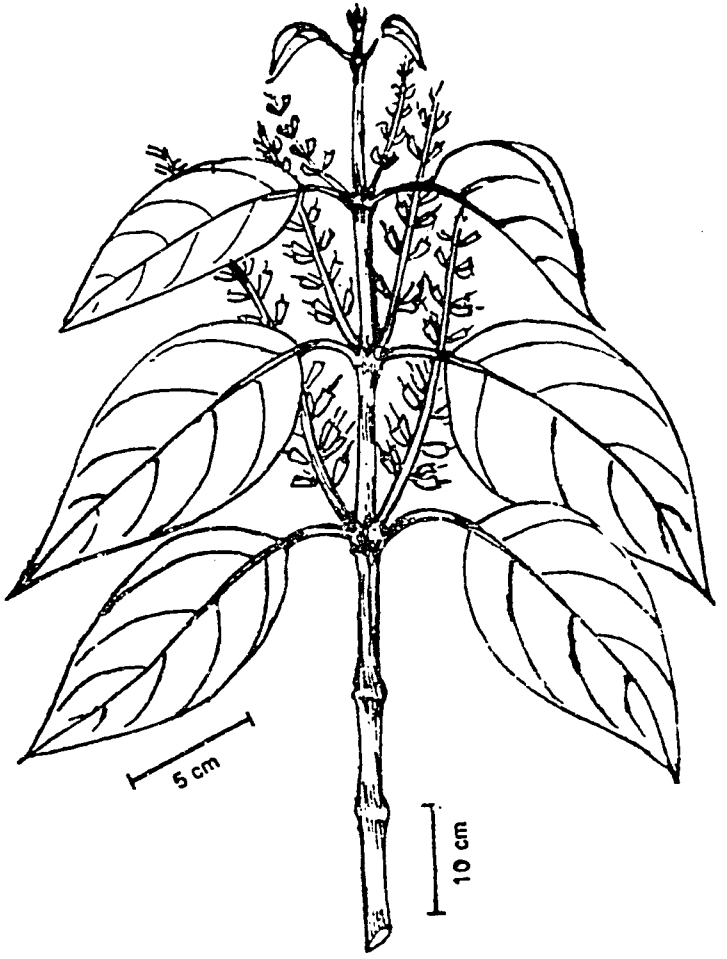

Fig-2 *Helixanthera parasitica* Habit sketch

2

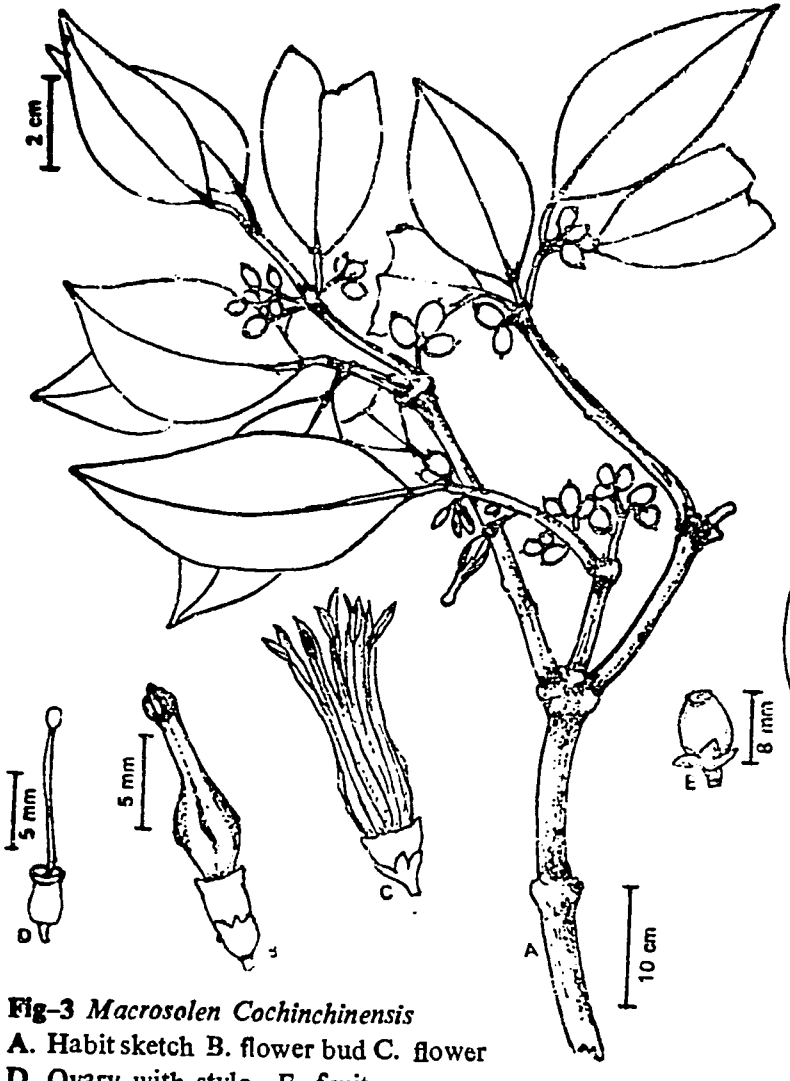

Fig-3 *Macrosolen Cochinchinensis*
A. Habit sketch **B.** flower bud **C.** flower
D. Ovary with style **E.** fruit

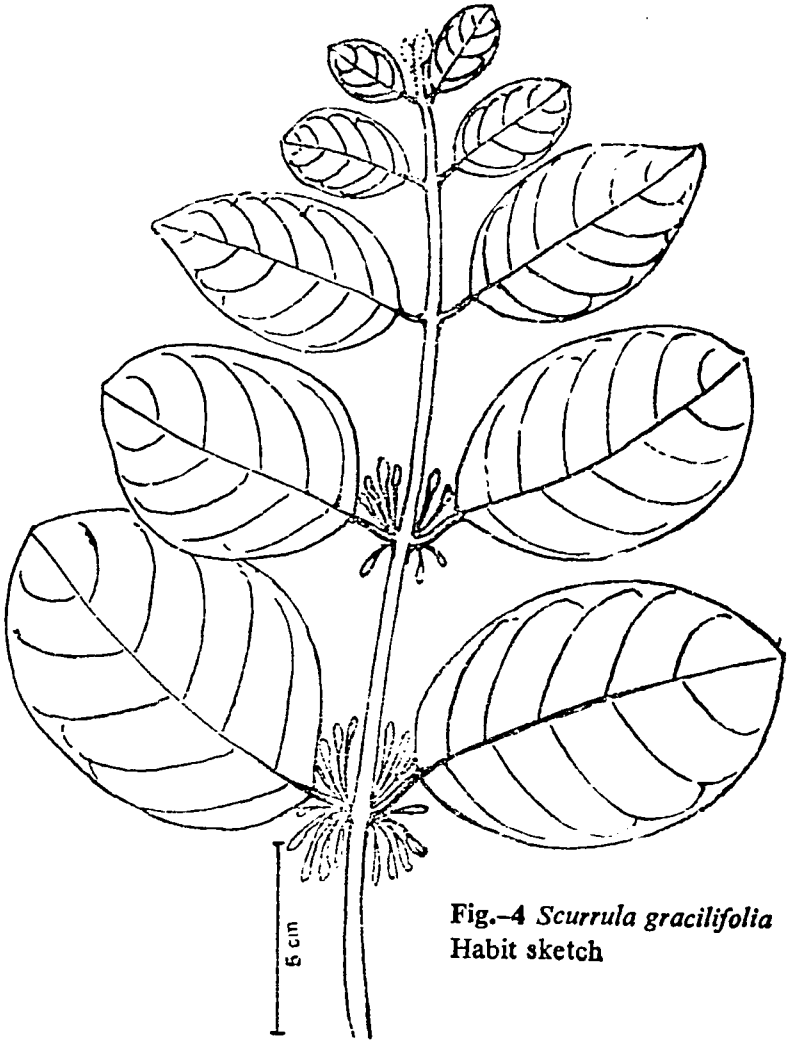

Fig.-4 *Scurrula gracilifolia*
Habit sketch

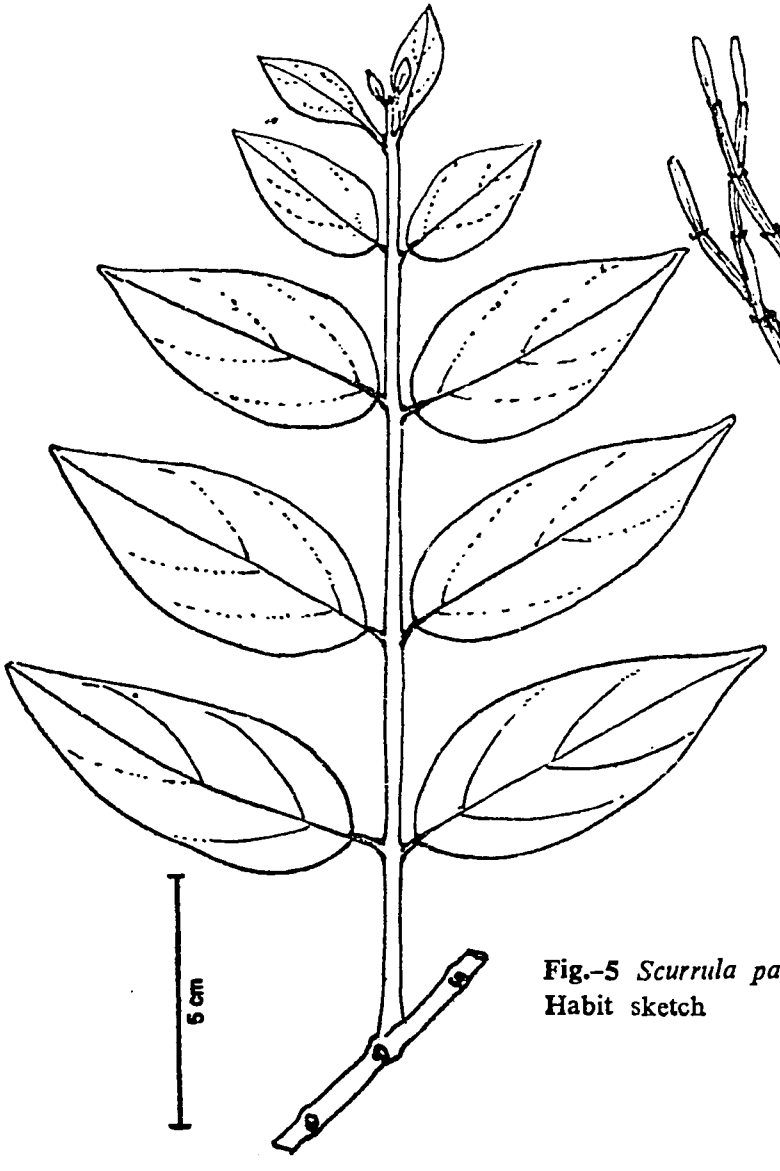

Fig.-5 *Scurrula parasitica*
Habit sketch

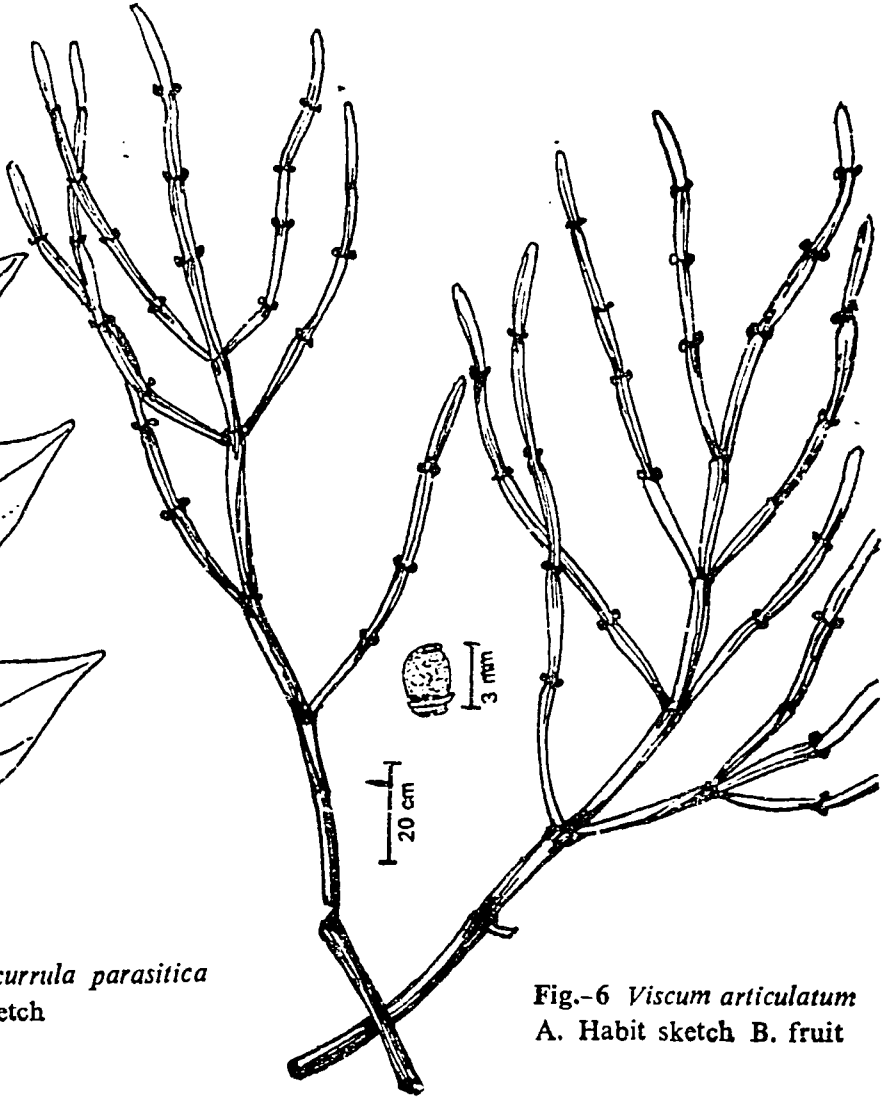

Fig.-6 *Viscum articulatum*
A. Habit sketch B. fruit

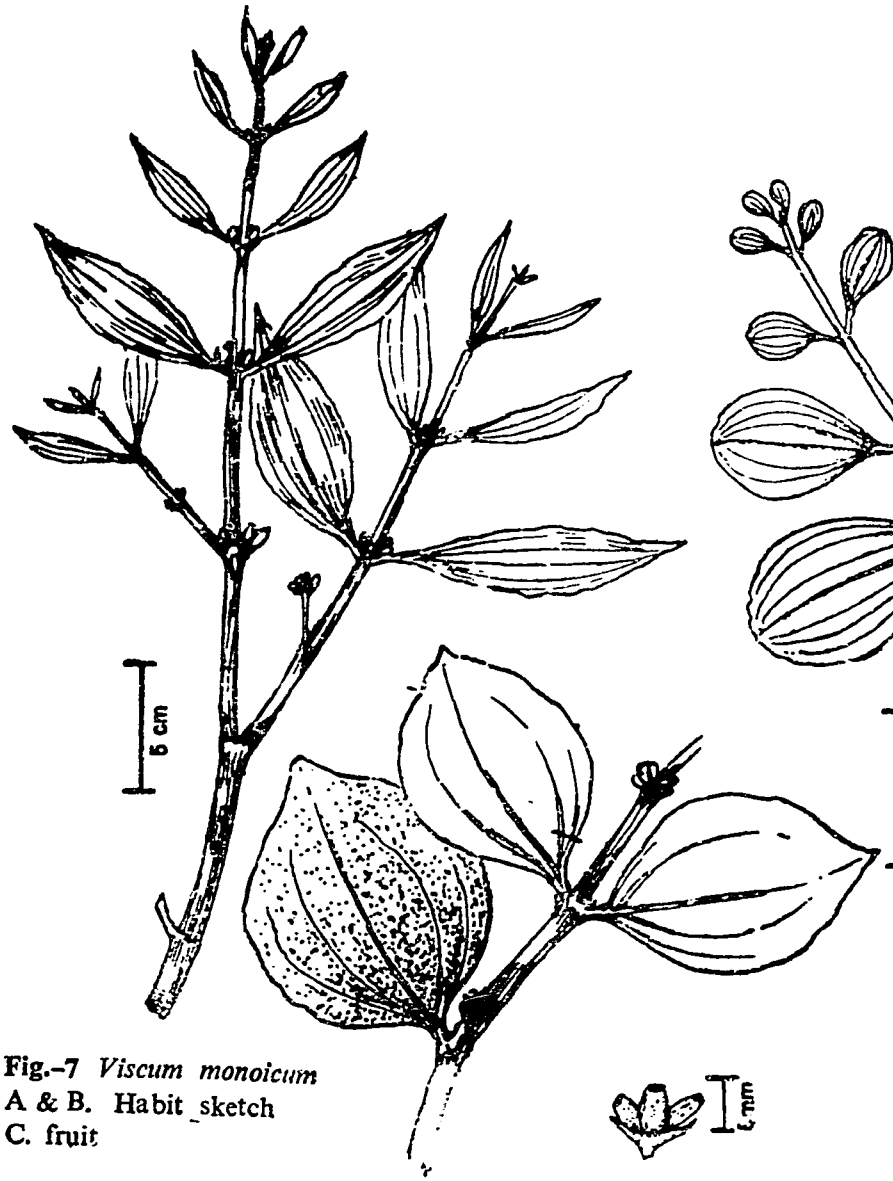

Fig.-7 *Viscum monoicum*
A & B. Habit sketch
C. fruit

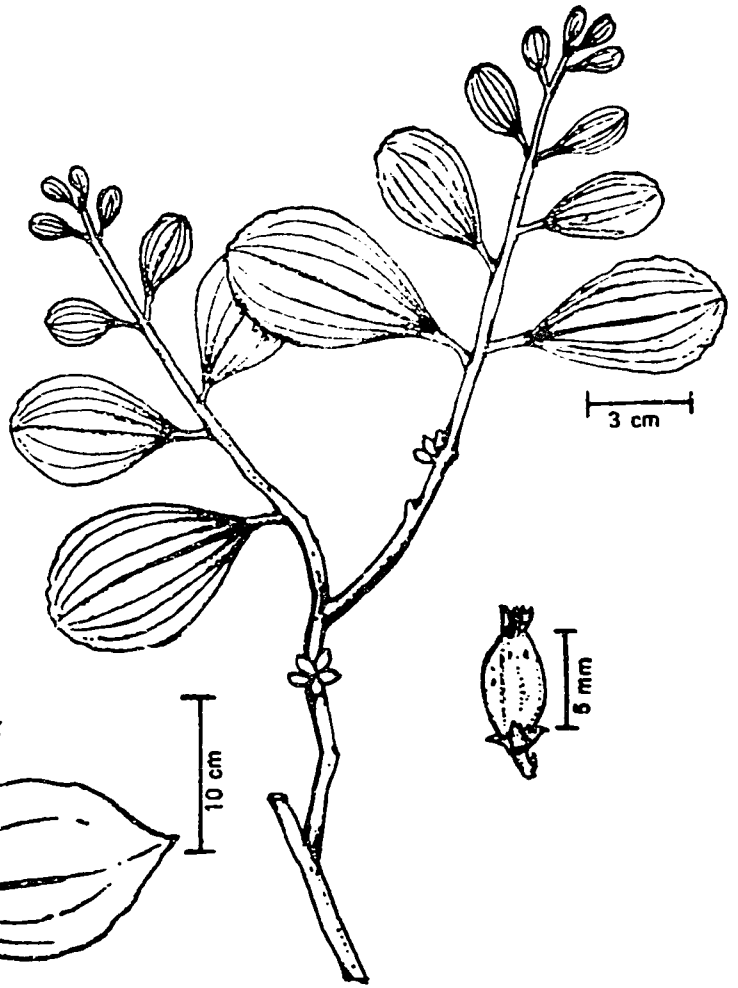

Fig.-8 *Viscum orientale*
1. Habit sketch B. fruit

11. **V. monoicum Roxb. ex DC.**

Stems 40 cm or longer, much branched, branches decussate in lower parts, dichotomous toward the apex. Leaves opposite, 2.5–10.0 X 0.6–3.5 cm, elliptic to lanceolate usually somewhat falcate, apex acute or somewhat acuminate, attenuated at base tapering into a very short petiole like structure ; usually with 5-7 longitudinal veins

Flowering time : November to February

Occurance : A common parasite occuring all over the country

12. **V. orientale Wild.**

Evergreen much branched parasitic shrub. Stems 45 cm long or more, terete with swollen node, internodes usually smooth, sometimes slightly striped. Leaves 2–6 X 1–3 cm, ovate-oblong or somewhat obovate with 3–5 longitudinal veins from the base

Flowering time : December to February

Occurance : Recorded from Banderbans and Chittagong only ; may occur in other places

ACKNOWLEDGEMENT

The author expresses his sincere gratitude to Mr. Dilip Kumar Das, Divisional Officer for his criticism and suggestions in preparing the manuscript. Thanks are due to Mrs. B. M. Rizia Khatun for varifying the key.

M. K. Alam, Senior Research Officer, Forest Research Institute, Chittagong, Bangladesh

KILN DRYING STUDIES ON 5 CM PLANKS OF THIRTY TIMBER SPECIES

M. A. Sattar
Y. A. Talukdar

The applicability of kiln drying schedules developed earlier were verified for 5 cm thick planks of thirty indigenous hardwood species. A series of charges were kiln dried covering the entire specific gravity range under four classes. It was found that the kiln schedules developed earlier for thinner stocks were equally effective in drying thicker ones. Five cm thick planks of different species having similar specific gravity range in different classes may, therefore, conveniently be kiln dried using the recommended schedules.

INTRODUCTION

Kiln drying schedules were developed at the Forest Research Institute, Chittagong for drying 3.2 cm planks of mixed hardwood species (Ali *et al* 1970, Ali *et al* 1980). These schedules were based on five specific gravity classes of timber employing linear dependancy of moisture loss on moisture content and kiln temperature. These facilitate the seasoning of a group of species having similar specific gravity range in a single charge. Experimental as well as commercial kiln drying was carried out using these schedules covering almost the entire range of the specific gravity of timbers. This schedule has provided a convenient method for efficient kiln drying of mixed hardwood species in a country like Bangladesh where the species having varied characters are numerous but their individual availability is limited in most cases. The applicability of these schedules were verified for lumber of lower thickness classes. Although the kiln drying schedules have been recommended for timber of higher thickness classes, the grouping of the species was made mainly on the basis of specific gravity without subjecting them to experiments (Sattar 1980). So the present investigation was undertaken to verify the applicability of these schedules for thicker planks with a view to recommending appropriate kiln drying schedules.

MATERIALS AND METHODS

Thirty indigenous timber species of different specific gravity ranges were used. Green timber of each species in the form of log was procured from the BFIDC timber depot at Kaptai. These logs were converted into 5 cm x 20 cm x 2.5m dimension planks.

Six full-length representative boards, three from flat-sawn and three from quarter-sawn planks were taken as test samples for each charge. Moisture sections were cut from each sample and the initial moisture contents were determined by the oven drying method. From another set, specific gravity of the species were determined based on green volume. The sample boards were end-coated with bituminous paint and their initial weights were also taken. Based on the initial moisture contents and weights, calculated oven-dry weights were found out for each sample board. During the subsequent process of drying, the daily moisture loss data were computed by simply weighing the samples.

A force-draft compartment type kiln was used for the drying. The selection of schedules was done, in the first instance, from the schedules developed for 3.2 cm thick lumber (Ali *et al* 1980) representing the specific gravity class determined by actual measurement. Then, schedules of higher specific gravity classes were tried. The schedules which offered the fastest drying rate with minimum drying degrades were considered to be the appropriate ones. The kiln schedules used are shown in Tables 1 to 5.

RESULTS

Drying times from green condition to 12 percent moisture content level were recorded for each species. The observed drying co-efficients were determined from the regressions of the rate of moisture loss on moisture content. The estimated drying co-efficients were found out with the help of the drying equation (Ali *et al* 1970). Drying degrade, on completion of drying, was assessed visually. These are presented in Table 6. Based on all these data, appropriate kiln drying schedules for 5 cm thick lumber are recommended (Table 7).

DISCUSSION AND CONCLUSION

The total periods of drying the planks from green condition to 12 percent moisture content seem to be reasonable (Table 6). These periods included the conditioning treatment of one to two days applied at the end of drying. This enabled the timber to attain a uniform distribution of moisture throughout the cross section of each piece in the charge.

In the employment of the schedules, one day was allowed for heating up the stock at the initial point of drying, and the adjustment was made thereafter as warranted by the drying rate. In the conventional schedules, temperature is normally held constant at the initial value till the fibre saturation point is reached (Torgesson 1951). But in the present approach, temperature is linearly adjusted with moisture content in order to ensure a constantly decreasing rate of drying.

It is found that 5 cm thick planks can satisfactorily be kiln dried using the schedules developed initially for planks of lower thicknesses. A comparison of observed and estimated drying co-efficients reveals that most of the species conformed

Table 1. Kiln schedule A

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Dry bulb (°C)	Wet bulb (°C)		
Steaming	134–85	37.8	35.6	86	17.5
Drying	84–53	55.6	51.1	73	12.2
–Do–	52–34	67.2	58.3	64	9.5
–Do–	33–22	73.9	56.1	22	3.2
–Do–	21–14	78.3	50.6	24	3.2
–Do–	13–8	81.1	53.3	26	3.2
Conditioning	12	82.2	77.8	83	12.2

Table 2. Kiln schedule B

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Drybulb (°C)	Wetbulb (°C)		
Steaming	116–80	37.8	35.6	86	17.5
Drying	79–54	53.3	48.9	78	13.4
–Do–	53–37	64.4	55.6	64	9.2
–Do–	36–26	71.1	53.3	41	5.5
–Do–	25–18	76.1	48.3	24	3.3
–Do–	17–12	79.4	51.7	25	3.3
–Do–	11–9	81.7	53.9	26	3.3
Conditioning	12	82.2	77.8	82	12.2

Table 3. Kiln schedule C

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Dry bulb (°C)	Wet bulb (°C)		
Steaming	98–73	37.8	35.6	86	17.5
Drying	72–54	51.1	46.7	77	13.3
-Do-	53–40	60.6	51.7	62	9.4
-Do-	39–30	67.8	50.0	39	5.6
-Do-	29–22	72.8	46.7	21	3.2
-Do-	21–17	76.7	48.9	24	3.2
-Do-	16–13	79.4	51.7	25	3.3
-Do-	12–9	81.1	53.3	26	3.3
Conditioning	12	82.2	77.8	83	12.2

Table 4. Kiln schedule D

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Dry bulb (°C)	Wet bulb (°C)		
Steaming	80–65	37.8	35.6	86	17.5
Drying	64–52	47.8	43.3	77	13.3
-Do-	51–42	56.1	47.2	60	9.4
-Do-	41–34	62.8	45.0	63	9.4
-Do-	33–27	67.8	40.0	19	3.0
-Do-	26–22	72.2	44.4	21	3.2
-Do-	21–18	75.0	47.2	24	3.2
-Do-	17–14	77.8	50.0	25	3.2
-Do-	13–12	80.6	52.8	26	3.3
Conditioning	12	82.2	77.8	83	12.2

Table 5. Kiln schedule E

Stage	Moisture content (percent)	Temperature		Relative humidity (percent)	Approximate equilibrium moisture content (percent)
		Dry bulb (°C)	Wet bulb (°C)		
Steaming	65–57	37.8	35.6	86	17.5
Drying	56–50	45.0	40.6	76	13.3
-Do-	49–43	50.6	41.7	58	9.4
-Do-	42–38	56.7	38.9	32	5.3
-Do-	37–33	60.6	32.8	14	2.6
-Do-	32–29	64.4	36.7	18	2.9
-Do-	28–25	67.8	40.0	19	3.0
-Do-	24–22	71.1	43.3	21	3.2
-Do-	21–19	73.3	45.6	22	3.2
-Do-	18–17	75.6	46.7	23	3.2
-Do-	16–15	77.2	49.4	24	3.2
-Do-	14–13	78.9	51.1	25	3.2
-Do-	12–11	80.6	52.8	26	3.3
Conditioning	12	82.2	77.8	82	12.2

to the predicted schedules. Gamar, Telsur and Jarul were found to dry slower but Teak and Nageshwar dried faster than was predicted (Table 6). Based on specific gravity, drying co-efficients and drying degrade, the thirty species under investigation have been grouped under different categories and kiln schedules have been recommended (Table 7).

It is apparent that kiln drying schedules based on specific gravity are equally effective in drying thicker planks. The seasoning plants of the BFIDC and some other wood based industries in the country have been using these schedules without encountering any difficulty.

Table 6. Drying times, drying co-efficients and drying defects of 30 indigenous species in 5 cm plank form

Species	Specific gravity (gr. vol.)	Initial moisture content (percent)	Drying times to 12 per-cent moisture content (days)	Drying co-efficients		Drying defects
				obser-ved.	estimated	
1	2	3	4	5	6	7
Chundul (*Tetrameles nudiflora*)	0.37	113	7	.443	.453	Minor twist
Kadam (*Anthocephalus cadamba*)	0.38	106	7	.430	.445	Minor twist
Simul (*Bombax ceiba*)	0.38	122	8	.412	.445	Nil
Pitali (*Trewia nudiflora*)	0.41	105	9	.402	.420	Nil
Narikeli (*Pterygota alata*)	0.44	104	9	.392	.396	Nil
Barta (*Artocarpus lakoocha*)	0.44	112	10	.387	.396	Nil
Gamar (*Gmelina arborea*)	0.44	127	24	.205	.396	Nil
Mahogany (*Swietenia mahogany*)	0.45	85	10	.313	.387	Minor bowing
Toon (*Toona ciliata*)	0.48	98	10	.297	.363	Tendency to distortion
Mango (*Mangifera indica*)	0.48	102	10	.292	.363	Nil
Chapalish (*Artocarpus chaplasha*)	0.48	118	9	.304	.363	Tendency to distortion
Keora (*Sonneratia apetala*)	0.50	102	11	.286	.347	Minor cupping
Uriam (*Mangifera sylvatica*)	0.51	108	12	.269	.338	Nil
Lali (*Amoora wallichii*)	0.51	112	12	.273	.338	Nil

—Contd.

1	2	3	4	5	6	7
Civit (*Swintonia floribunda*)	0.56	112	14	.213	.297	Tendency to distortion
Pitraj (*Aphanamixis polystachya*)	0.57	88	14	.221	.289	Tendency to splitting
Teak (*Tectona grandis*)	0.57	95	14	.335	.289	Nil
Telsur (*Hopea odorata*)	0.61	110	20	.169	.257	Tendency to splitting
Haldu (*Adina cordifolia*)	0.61	93	16	.238	.257	-Do-
Champa (*Michelia champaca*)	0.61	114	15	.209	.257	Tendency to distortion
Silkorai (*Albizia procera*)	0.63	85	17	.201	.240	-Do-
Bhadi (*Garuga pinnata*)	0.63	92	16	.198	.240	Tendency to distortion
Batna (*Quercus pachyphylla*)	0.63	84	18	.187	.240	-Do-
Chickrassi (*Chuckrassia velutina*)	0.64	80	18	.192	.232	Nil
Jarul (*Lagerstroemia speciosa*)	0.65	83	24	.123	.224	Nil
Jam (*Syzygium grande*)	0.65	72	21	.154	.224	Tendency to splitting
Garjan (*Dipterocarpus alatus*)	0.66	78	18	.166	.216	-Do-
Gutguttya (*Protium serratum*)	0.78	70	21	.109	.118	-Do-
Nageshwar (*Mesua ferrea*)	0.90	53	20	.182	.020	Tendency to distortion
Sundri (*Heritiera fomes*)	0.91	58	26	.035	.012	-Do-

Table 7. Recommended kiln schedules for seasoning 5 cm planks of different species

Sp. gr. range	Species	Recommended kiln schedule
0.35–0.44	Barta, Chundul, Gamar, Kadam, Narikeli, Pitali, Simul	B
0.45–0.54	Chapalish, Keora, Lali, Mango, Mahogany, Toon, Uriam	C
0.55–0.64	Batna, Bhadi, Champa, Chickrassi, Civit, Haldu, Pitraj, Silkorai, Teak, Telsur	D
0.65 and above	Garjan, Gutguttya, Jam, Jarul, Nageshwar, Sundri	E

REFERENCES

Ali, M. O. Samad, A. and Wallin, W. B. 1970. Kiln drying schedule development employing linear dependency of temperature and rate of drying on moisture content for mixed hardwoods of East Pakistan. For. Res. Inst. Bull. 2 (Wood Seasoning Series), Chittagong. 10 pp

Ali, M. O. Sattar, M. A. and Talukdar, Y. A. 1980. Kiln drying studies on 1¼" planks of Bangladesh timber species. For. Res. Inst. Bull. 6 (Wood Seasoning Series), Chittagong. 10 pp

Sattar, M. A. 1980. Kiln drying schedules for indigenous timber of Bangladesh. For. Res. Inst. Bull. 4 (Wood Seasoning Series), Chittagong. 11 pp

Torgesson, O. W. 1951. Schedules for the kiln drying of wood. For. Prod. Lab. Report No. D1791, For. Service, Madison. 15 pp

M. A. Sattar, Divisional Officer and Y. A. Talukdar, Senior Research Officer, Forest Research Institute, Chittagong, Bangladesh

DEVELOPMENT OF NURSERY PROCEDURE OF THREE CANE SPECIES

A. Alim
M. Kamaluddin

An attempt was made to develop a nursery procedure of *Calamus guruba* Buch-Ham. (Jait bet), *C. tenuis* Roxb. (Bandhari bet) and *C. latifolius* Roxb. (Korak bet) involving seed collection, pre-sowing seed treatment, media preparation, seed germination and seedling care. The plant percents obtained in *C. guruba, C. tenuis* and *C. latifolius* were 56, 58 and 62 respectively showing a good prospect for artificial regeneration of Canes.

INTRODUCTION

With the increase of human population and multiple use of Cane, the natural stands of Cane species are being used up rapidly. The faster rate of conversion of forest land for agriculture and the accessibility of human beings to further forested areas throughout the tropical forests have destroyed the natural growth of this resource to a great extent. Reforestation with some selected timber species in the high forests also causes it to diminish further.

Artificial regeneration of this valuable resource in the young plantations of different timber species and also in village groves can be considered as an effective step in conserving and replenishing the stock of this most affected resource, and at the same time to increase the opportunity cost of soil. To develop a scientific technique of artificial regeneration of Canes, the incorporation of inputs from silvicultural research on the available Cane species of the country is of considerable importance. The present paper is, however, an output of an attempt to develop a nursery procedure of *Calamus guruba, C. tenuis* and *C. latifolius* involving seed collection, presowing seed treatment, media preparation, seed germination and seedling care.

MATERIALS AND METHODS

Collection and Extraction of Seeds : Ripe fruits of *C. guruba* were collected from the natural stands of Chittagong in the last week of April. The ripe fruits of *C. tenuis* and *C. latifolius* were collected from

Chittagong Hill Tracts in the second week of May and first week of June respectively.

The fruits were opened by hand to separate the scaly layers. They were then soaked for 24 hours in a can filled with water to induce the fleshy layer of the fruit to ferment. The seeds were then separated from the fleshy layers. The clean seeds were allowed to settle at the bottom of the can and the fruit coverings to float over the settled seeds. The extracted clean seeds were then put in a basket and stored under room condition. The seeds were kept wet by watering until sowing.

Preparation of seed-bed and sowing of seeds : A seed-bed, 6.0 x 1.2 m, was prepared east to west in the nursery. The soil of the bed was worked to a depth of 30 cm. Then, 18 kg of decomposed cowdung and 9 kg of compost were thoroughly mixed with the soil.

Seeds were sown in the bed 5 cm apart in case of *C. tenuis* and 10 cm apart in case of *C. guruba* by dibbling each one just below the soil surface.

Seeds of *C. latifolius* were sown directly in the polyethylene bags of 13 x 8 cm dimension. The bags were filled up with soil mixed with decomposed cowdung at the proportion of 3 : 1 by volume.

Shading and watering : Seed-bed and sown polyethylene pots were shaded by mats made up of locally available thatch grass. Watering was done whenever necessary using a water sprinkler so as not to disturb the soil and seeds.

Pricking out and repotting of seedlings : When the seedlings of *C. guruba* and *C. tenuis* were of 2-3 leaved stage (about 3 months old), they were transferred to polyethylene bags of 29 x 15 cm size. Each seedling was planted upto root-collar region. Watering was done immediately after pricking out so as not to allow the seedling to desiccate. The potted seedlings were kept under full shade for one week and then were exposed partially to the sun.

Only the seedlings of *C. latifolius* were repotted in the polyethelene bags of 20 x 15 cm size. Repotting was done after 9 months of first germination.

Climatic condition of nursery : Throughout the period of experiment, the mean maximum temperature was 30°C and the mean minimum was 21°C. The average relative humidity was 78% and the average total rainfall was 291 cm.

OBSERVATIONS AND RESULTS

In *C. guruba,* flowering starts in August and the fruits begin to ripen in April. The fruits of *C. tenuis* and *C. latifolius* start to ripen by the first part of May and June respectively. The fruits are one-seeded and globose to oblong in shape. They remain covered with thin limbricating deplexed polished scales. Each fruit has a thin juicy pulp, the *Sarcotesta* lying over the seed. The pericarp consists of scaly epicarp with a thin layer within, and lies over the *sarcotesta.* The size of the fruit and seed, and the thickness of *sarcotesta* usually vary from species to species.

Sarcotesta of ripe fruit is fleshy and has a sweet sour taste. The thin layer of pericarp of ripe fruit dries up and the scales become easily separable. The seeds become dark in colour and hard on maturity. They are of mottled appearance, and the mottling pattern varies with the species.

During the process of germination a short plug of tissue emerges from the seed. From this plug roots emerge at the beginning and eventually an upright cylindrical outgrowth or ligule is developed. The blade of cotyledon remains within the seed as an absorptive organ, which absorbs nutrients from the endosperm. Through the ligule the first leaves emerge. Within few months several leaves develop forming a rosette structure of seedling.

All the three species tested required quite long time to start germination. The requirement of time varied with the species. The seeds of *C. guruba* started germination earlier than those of *C. tenuis*. *C. latifolius* needed longer time to start germination of its seeds in comparison to *C. tenuis*. The mortality of seedlings after germination was common in all the three species (Table 1).

DISCUSSION

Like other members of the family Palmae the species of *Calamus* need long time to start germination. Generalao (1980) reports that Cane seeds take two weeks to six months to germinate depending on the species and method of treatment. Conducting an experinment on the germination behaviour of seeds of *Calamus viminalis* var. *fasciculatus*, Banik (1979) records that the seeds sown with sarcotesta intact, require two or three months to start germination and give poor germination percentage (10–26% only). Removal of the sarcotesta is a necessary pre-treatment in order to shorten the germination period and obtain good levels of success (Manokaran and Wong 1981). The slow rate of germination in all the three species (Table 1) might be due to slow development of embryo and not due to any inherent dormancy (Mori *et al* 1980). The hard endocarp might also be a mechanical barrier for the emergence of growing embyo (Banik 1979).

Germination started after 5 to 12 weeks of sowing and the period varied from species to species (Table 1). In case of *C. latifolius*, germination started after 11 weeks and

Table 1. Germination of seeds, mortality of seedlings and plant percent of three *Calamus* species

Species	Seed sown		Days of first germination	Germination (%)		Mortality (%)			Plant (%)
	Number	Days after harvest		30 days of first germination	180 days of first germination	upto pricking out	after pricking out	upto repotting	
C. guruba	800	6	34	61	–	4.7	3.6	–	56
C. tenuis	360	5	48	63	–	4.4	2.8	–	58
C. latifolius	250	4	83	16	66	–	–	5.4	62

continued for more than 39 weeks. These findings corroborate with that of Manokaram (1978) who recorded the differential germination periods within the species as well as between different samples of the same species *of Calamus*. The variability in the rate of germination might be due to the genetic differences. The degree of ripeness of fruits might also be related with the variation of germination period. The seeds which did not germinate at all might be the unripened ones. Physiogenetical factors might also be responsible for the failure of seeds to germinate.

Sufficient moisture is likely to be important for seed germination. The process of germination starts long before the emergence of shoot above the soil surface. Drying of seed appears to stop the process and kills the germinating seeds. Direct sunlight also retards the process of germination (Generalao 1980).

The reasons of mortality of seedlings after germination might be more than one including damage to roots during weeding operation in seed-beds before pricking out and in polyethelene pots after pricking out. The mortality percentage of seedlings of *C. guruba* as well as *C. tenuis* before pricking out was found higher than that after pricking out.

CONCLUSION

The nursery procedure adapted has an important bearing in obtaining good levels of success in respect of germination of seeds and survival of seedlings. Regular watering and shading of seed-beds against direct sunlight may be considered as essential practices to obtain higher germination percentage of seeds. The mortality of seedlings, though not so high, may be further lowered by careful nursery operations particularly at the time of weeding and pricking out of seedlings so as to disturb neither the root system nor the shoot portion of the tender seedlings. The plant percent obtained in all the three species may be considered promising enough to undertake large scale plantation of these Cane species in young plantations of timber species and also in the village groves of the country. Further research to shorten the time required for starting germination and the period of germination is, of course, needed to improve the overall nursery technique of Canes.

REFERENCES

Banik R. L. 1979. A note on the flowering periodicity and the germination in Bara bet. Bano Biggyan Patrika, 8(1&2) : 52–56

Generalao, M. L. 1980. How to grow Rattan. FOR HOW-To Series No. 1. Pub. For. Res. Inst. College, Laguna Philippines. 24 pp

Manokaran N. 1970. Germination of fresh seeds of Malayasian Rattans. Malay. Forester 41 : 319–324

——————— and K. M. Wong. 1981. The Silviculture of Rattans-an overview with emphasis on experience from Malaysia. Bano Biggyan Patrika, 10(1&2) : 1–10

Mori, T., Zoilfatah bin Abd. Rahman and C. H. Tan 1980: Germination and storage of Rattan manau (*Calamus manan*) seeds, Malay. Forester 43 : 44–45

Prof. A. Alim, Director, Forest Research Institute, Chittagong and M. Kamaluddin, Assistant Professor, Institute of Forestry, University of Chittagong, Chittagong, Bangladesh

EFFECT OF HARVESTING TIME AND SOWING INTERVAL OF GARJAN SEEDS ON GERMINATION

M. A. Haque
A. H. M. M. Rahman
J. H. Choudhury

The effects of time of harvesting the seeds and the interval of sowing the same on germination was investigated in Garjan. Higher germination (95%) was obtained from the earlier harvests, as well as, early sowings. Much variation in germination was observed, even with seeds from the same collection, when the seeds were sown at different intervals of time. Only 15 to 19 percent seeds germinated when sown after 30 days of harvest.

INTRODUCTION

Garjan (*Dipterocarpus turbinatus* Gaertn. f.) is a lofty evergreen tree, attaining a height of about 46 m and a girth of about 5 m, with a long clean cylindrical bole and an elevated crown (Troup 1921). It is indigenous to Bangladesh and is also distributed throughout the greater part of Indo-Malayan region (Troup 1921, Gamble 1922). In Bangladesh, Garjan occurs in the gregarious type secondary Garjan forests of Chittagong and Chittagong Hill Tracts, bordering the Lushai and Khasia Hills of Assam and North Arakan of Burma (Champion *at al* 1965, Das 1980). In the natural habitat of Garjan, temperature varies from 40.55°C to 15.55°C and the rainfall varies from 152 cm to over 508 cm (Troup 1921, Gamble 1922, Lu 1972).

The fruits of Garjan can easily be recognized, as two of the five calyx lobes are enlarged into wings (Troup 1921, Gamble 1922). In great majority of cases the fruits ripen and fall towards the end of Summar or at the commencement of the rainy season i. e. in May or early June and germinate without delay (Troup 1921).

It is a serious problem for the foresters for raising artificial plantation of Garjan, as the seeds germinate soon after falling on the ground. The sowing of the seeds on the same day of collection is almost impossible and usually a few days elapse before sowing. A germination trial of Garjan seeds was carried out by Banik (1980). Similar work was also carried

out by Laurie (1940) with other species of the same family. But their works were limited to the sowing position and seedling behaviour. It was felt necessary to study the effects of harvesting time and sowing interval of Garjan seeds on germination and also to test the effect of time on viability in room condition.

MATERIALS AND METHODS

Garjan seeds were harvested from a selected nature tree. The ground was cleared beforehand and the seeds were collected by shaking the branches. There were 7 to 10 thousand seeds in each harvest. Collections were made approximately at about one week interval on 20th and 26th May and 2nd, 7th, 15th and 25th June. Fifty seeds were taken at random each time and were sown in vartical position with the tip flush to the ground. The first sowing was done on the same day immediately after each collection and the rest were stored under room condition for sowing subsequently after 5, 10, 15, 20, 25 and 30 days. The sowings were done in perforated polybags filled with a mixture of soil and cowdung in the proportion of 5 : 1.

RESULTS AND DISCUSSION

The results (Table 1) reveal that significant variations exist in the rate, as well as, initiation of germination. A higher percentage of germination was always obtained when the seeds were sown on the same day of collection. Regression analysis revealed that the viability of the seeds deteriorated rapidly ($Y = -2.212\ x + 83.007$) with time when stored in room condition. The germination rates were also inversely related to the time of collection, as well as, the time of sowing and was better in the earlier collections.

An analysis of variance (Table 3) showed that the variations of the germination percentage depending on the date of sowing was highly significant ($p \gg 0.01$). Similar significant results have also been obtained in case of time of collection ($p > 0.01$). The critical differences at 0.01 level was found to be 2.387 for all the dates of sowing.

Initiation of germination, on the other hand, was found to be directly related to the time of seed collection and time of sowing (Table 1). Collection made between 20.5.78 and 2.6.78 and sown within 15 days of collection resulted in early initiation of germination. The analysis of variance (Table 2) which was done on average initiation-time of germination revealed that both the time of seed collection and the time of sowing were highly significant ($p \gg 0.01$). Storage in room condition resulted in delay of germination and increased loss of viability.

Some seeds, a negligible percentage, germinate even in storage. It occurs due to the fact that these seeds do not have any dormancy period under the favourable environmental conditions present during maturity. Such characteristics of Garjan seeds create problem in raising artificial plantation. In this experiment it has become obvious that more than 84% seeds germinated when sown on the same day of collection. However, the viability deteriorates very rapidly and comes down to about 15% at the end of 30 days when kept under room condition (Table 1). The time of collection, too, has some effect on

Table 1. Germination percentage and days required for initiation of germination in Garjan on various dates of collection and sown.

Date of Collection	Sowing interval of seeds (days)	Average time required for initiation of germination (days)	Germination percentage
20-5-78	0	4.50	95.00
	5	5.00	83.50
	10	5.00	77.50
	15	7.50	52.00
	20	9.00	41.00
	25	8.50	25.00
	30	12.00	18.00
26-5-78	0	5.00	93.19
	5	7.00	73.00
	10	7.00	59.00
	15	9.00	48.50
	20	10.50	41.00
	25	12.00	36.00
	30	14.50	19.00
2-6-78	0	7.00	92.38
	5	7.00	76.00
	10	8.50	68.00
	15	9.00	53.00
	20	11.00	45.00
	25	12.50	31.00
	30	15.00	17.00

—Contd.

1	2	3	4
7-6-78	0	6.50	79.73
	5	8.00	69.50
	10	9.00	58.00
	15	12.00	43.00
	20	12.50	37.00
	25	16.00	23.00
	30	18.50	18.50
15-6-78	0	8.00	73.50
	5	8.00	59.00
	10	9.50	51.00
	15	10.00	44.50
	20	13.00	46.00
	25	16.00	18.00
	30	16.00	16.50
25-6-78	0	7.50	72.00
	5	8.00	61.50
	10	8.50	53.00
	15	11.00	50.00
	20	15.50	38.00
	25	17.00	21.50
	30	17.00	15.00

Table 2. Analysis of Variance on the days required for the initiation of germination of Garjan seeds

Source of variation	df	SS	MSS	'F' ratio
Time of Sowing (Row)	6	431.16	71.86	68.93
Time of Collection (Block)	5	115.90	23.18	22.33**
Error	30	30.77	1.03	
Total	41	577.83		

** *Significant at 1% level, Critical difference 1.21 at the same level*

the germination. It has been found in the experiment that earlier collections resulted in higher percentage of germination (>52%).

However, moisture content of the seeds, temperature and relative humidity of the atmosphere play vital roles in the germination process. This is more true for Garjan seeds, as the time for the maturity of seeds coincides with the time of the year when both the temperature and the relative humidity are adequate. Tang and Tamari (1973) also reported the increase of germination of *Hopea* sp., a Dipterocarp, after storing for two months at 15°C. It is worthwhile to investigate the effect of storage of Garjan seeds at lower temperature and at low relative humidity on the germination rate. A positive response will certainly be helpful in solving problems faced in plantation programmes of Garjan.

On that basis it may be suggested that the collected seeds may be kept in a cool and well ventilated room upto ten days prior to sowing under unavoidable circumstances.

CONCLUSION

It is concluded that for raising a successful plantation of Garjan in Bangladesh seeds should be collected between last week of May and 1st week of June and should be sown within 10 days of collection. It may be mentioned that Garjan seeds should be kept in a well ventilated dry and cool place if the situation demands the seeds to be stored.

REFERENCES

Banik, R. L. 1980. Studies on sowing position of Garjan seeds on their germination and seedling behaviour. Bano Biggyan Patrika, 9(1 & 2) : 43-52

Table 3. Analysis of Variance on the percentage of germination of Garjan seeds

Source of Variation	df	SS	MSS	'F' ratio
Time of sowing (Row)	6	20658.37	3443.06	119.97**
Time of Collection (Block)	5	978.67	195.67	6.82**
Error	30	861.11	28.70	
Total	41	22497.83		

** *Significant at 1% level, Critical difference 2.387 at the same level*

A regression analysis done on the average germination percentage of all the dates of collection over the dates of sowing revealed that, on an average, 60% germination could be obtained if the seeds were sown even after 10 days of collection.

Barnett, J. O. 1972. Southern Pine seeds germinate after forty years storage. Journal of Forestry 70(10) : 629

Champion, H. G. ; Seth, S. K. and Khattak, G. M. 1965. Forest types of Pakistan. Forest Institute, Peshawar. 238

Das, S. 1980. Dipterocarp Forests of Bangladesh and their management. Bano Biggyan Patrika, 9(1 & 2) : 71-86

Gamble, J. S. 1922. A manual of Indian Timber. An account of the growth, distribution and uses of the trees and shrubs of India and Ceylon with description of their wood structure. Sampson Low, Marston and Company Limited, London 1981, Rept. 1922 : 69-73

Ghani, Q. 1962. Common Timbers of Pakistan. Pakistan Co-operative Book Society Ltd. (Press Section). 125, Motijheel, Dhaka-2 : 63-64

Latif, M. A. 1979. Treatment of green Garjan sleepers with oil-borne preservative. Bano Biggyan Patrika, 8(1 & 2) : 27-33

Laurie, M. V. 1940. Notes on the germination of Scaphula (*Anisoptera glabra*). Ind. For., 66 : 653-654

Lu, T. H. 1972. The classification and distribution of Dipterocarpaceous timber plants. Quarterly Journal of Chinese Forestry. 6(1) : 174-185

Tang, H. T. and Tamari, G. 1973. Seed description and storage tests of some Dipterocarps., Malayan Forester. 36 (2) : 38-53

Troup, R. S. 1921. The Silviculture of Indian Trees. Vol. 1 Clarendon Press, Oxford. 30-135

Urgenc, S. and Oddbasi, T. A. 1971. Comparative results of long term storage of *Pinus brutia* seeds and cones by different methods. Istanbul Universitesi Orman *Fakiiltesi* Dergisi 21(2) : 82-93

M. A. Haque, Senior Research Officer, A. H. M. Mujibur Rahman, Ex-Divisional Officer and J. H. Choudhury, Divisional Officer, Forest Research Institute, Chittagong, Bangladesh

NEEDLE CAST OF PINUS ELLIOTTII AT FOREST RESEARCH INSTITUTE CAMPUS, CHITTAGONG

B. Shayesta
M. A. Rahman

Tropical pines have been under introduction trials in Bangladesh since 1961-62 with a view to building up a source of long-fibred pulp. Pathological observations in respect of planted Pines at Forest Research Institute Campus, Chittagong are reported. The etiology and symptoms of needle cast disease of *Pinus elliottii* Engelm. have been described.

Botryodiplodia theobremae Pat. and *Pestalotia macrotricha* Kl. were mainly isolated from the infected needles. Pathogenicity tests were carried out. The results indicated that both the fungi were responsible for the development of needle cast of *P. elliotti,* the former having a dominant role. The disease, however, was not a serious threat to the crop and has not been recorded on other species of Pines in the campus.

INTRODUCTION

Trials on introduction of tropical Pines have been undertaken in Bangladesh with a view to building up a source of longfibred pulp. *Pinus caribaea, P. oocarpa* and *P. elliottii* have been experimentally planted over the last 15-20 years at the Bangladesh Forest Research Institute Campus.

Needle cost is a general term used to describe diseases in which needles are shed from diseased trees. Specific needle cast differs with respect to age of needles attacked and time of year affected, depending on the species of fungus and the infected host. However, most needle casts have some common characteristics (Blanchard and Tattar 1981). They occur on Pines, Spruces, Firs, Larches and various Ceders. Defoliation is rarely severe enough to kill any trees except young seedlings (Baxter 1952, Boyce 1961). In some needle casts infection is mostly restricted to the newly developing needles, and sporulation is timed to coincide in spring, when new needles develop (Smith 1978). The disease

is mainly caused by certain genera of the Ascomycetes (Hypodermataceae) and the Fungi Imperfecti, by environmental factors or a combination of fungi and adverse conditions.

During 1977–78 an investigation was made to observe the pathological conditions of planted Pines at Forest Research Institute Campus. It was observed that some of the *P. elliottii* trees showed defoliation of current year's needles. The present paper deals with the study of the symptoms and causal organism of needle cast.

MATERIALS AND METHODS

Affected needles and apparently healthy needles were collected from severely affected shoots of *P. elliottii* trees. One, two, and three year-old healthy and affected needles were collected at random from sixteen trees. Collected samples were compared with each other and the types of infection noted. Infected needles bearing mature spots, and apparently healthy needles of different ages were also selected for isolation of fungi.

The samples under last were washed in running tap water and then in dilute soap water to remove the adhering dirt and subsequently washed with several aliquots of distilled water. The needles were then surface sterilized using 0.1% mercuric chloride solution for 2 minutes (Booth 1971). The needles were finally treated with Streptomycin and Penicillin solution for 3 minutes (Anon. 1968). The samples were then cut aseptically into 1–2 mm small pieces. Infected and healthy needles were planted on 2% Malt Extract Agar (MA) and Potato Sucrose Agar (PSA) media (Anon. 1968). Plates were incubated at 25°C for 15 days and observed regularly. When sufficient mycelial growth became visible, the fungi were grouped visually, isolated and identified.

To find out the extent of incidence of infection on healthy and infected needles, about 500 needles of each of the types were collected at random from sixteen affected trees.

Newly flushed needles on shoots of sixteen *P. elliottii* trees were inoculated by spraying with mycelial suspension with a sterilized syringe and then each individual shoot was covered with a polyethylene bag to maintain high relative humidity for three days. Equal number of untreated shoots on all the trees were covered with polyethylene bag in the same as controls. Thereafter, observations were taken at weekly intervals.

RESULTS

Symptoms of the disease : Generally the trees exhibited reduced growth and degenerated look. Two and three year old needles, mainly the latter, dropped in large numbers and were hanging amidst green needles. Such dead needles and a proportion of apparently healthy ones showed reddish-brown lesions on the needles within the sheath region. Besides such necrotic areas, scattered brown spots developed on the three year old needles.

Reduced current year's shoot growth was observed. Some of the shoots failed to flush while others flushed partially. When such needles were about 1–2 cm, necrotic lesions, as above, were found to occur on a small proportion of needles. Incidence of symptoms on the diseased needles was

significantly high ($P=0.001$) as compared to that on the apparently healthy ones (Table 1). Examination of apparently dying shoots and roots of affected trees did not reveal either shoot dieback or root rot diseases.

Isolation of fungi : The results of isolation of fungi, as presented in Table 2, show that basically two fungi, identified as *Botryodiplodia theobromae* Pat. (Type-b) and *Pestalotia macrotricha* Kl. (Type-a), were obtained. The former was dominant of the two.

growing mycelial culture of *B. theobromae* and *P. macrotricha*, presented in Table 2, revealed that both the fungi were able to infect uninjured needles significantly ($P > 0.001$) as compared to the controls. Symptoms, as found to occur naturally, continued to develop from 7 to 35 days. It may, therefore, be mentioned that in case of an insignificantly small number of the controls slight infection symptoms developed by 35 days while significantly ($P=0.001$) higher number of the inoculated branches developed severe to moderate levels of infection by 28 days (Table 3).

Table 1. Incidence of disease symptoms on needles of *P. elliottii*

Needles Types (3 age classes)	No. of needles assessed	Needles infected (%)
Diseased	8000	63.25***
Healthy (apparently)	8000	36.75

***Signifies $P=0.001$

Table 2. Isolation of fungi from infected and healthy young needles of *P. elliottii*

Age of needles	Needles Types	No. of needle pieces plated	Percent isolation	
			a	b
1	Infected	50	40	60
	Healthy	50	0	0
2	Infected	50	44	56
	Healthy	50	0	0
3	Infected	50	44	56
	Healthy	50	0	0

Pathogenicity tests : Results of artificial inoculation of young twigs of *P. elliottii* by 20 days old actively

It is evident from Table 3 that *B. theobromae* could be consistently reisolated from the infected needles. Reisolation of

Table 3. Extent of infection on artificial inoculation of *P. elliottii* and result of reisolation of fungi

Fungi	No. of trees	No. of branch inoculated	No. of branch with symptoms	Level of infection				Reisolation	
				+++ (servere)	++ (moderated)	+ (slight)	– Nil	No. of inocula plated	% isolation
B. theobromae	16	48	30	15	15	0	0	260	73***
P. macrotricha	16	48	30	12	12	6	0	260	28**
Control	16	48	12	0	0	12	36	130	4

***=0.001, **P=0.01

this fungus was significantly higher (P=0.001) as compared to either of the controls or the *P. macrotricha* while the latter was also reisolated significantly (P=0.01) as compared to the controls. This also confirms the dominant role of *B. theobromae*.

DISCUSSION

Infection took place most frequently on one year old needles, but also occurred on 2 year old needles being most prevalent on 3 year old needles. Affected needles usually shed in the late spring but before defoliation was noticed in the early summer.

Review of literature indicates that *B. theobromae* was the first reported needle can fungus on *P. elliottii* tree in Bangladesh. This is a wide spread saprophyte and a facultative wound parasite in the tropics and subtropics causing diseases in living plants. It also causes preharvest and storage rots of fruits, dieback, canker, staining of timber and damping off. This fungus caused dieback of Albizia *falcata A. sumatrana* and *A. julibrissin* in Indonesia, India, U. S. A. and Iran (D' Angremond 1948, Venkata Ram 1960, Browne 1968, Spaudling 1956, 1958, 1961, Scharif 1964). This also causes dieback of *Artocarpus integrifolia* (Kathal) in Bangladesh (Rahman *et al* 1984, Unpub. data) and *Hevea brasiliensis* in Sri Lanka (Murrey 1930). *B. theobromae* caused cankers on young *P. elliottii* and *P. taeda* in Australia (Young 1936, Browne 1968) and root rot of *P. caribaea* in Sabah, Malaysia (Liu 1977).

Even though *P. macrotricha* was isolated from infected needles and produced symptoms on the trees after inoculation could be less consistently reisolated as compared to *B. theobromae*. This fungus is often listed as a pathogen (Gibson 1975, 1979).

B. theobromae is transmitted by wind and water (Meredith 1961). So it was suspected that some of the controls became contaminated by air-borne or water transmitted spores of the fungus occurring naturally. Both the fungi were also reisolated

from the infected controls. Though *B. theobromae* played a dominant role as needle cast of *P. elliottii* tree at Forest Research Institute Campus, it did not pose any serious threat to other planted Pines there.

REFERENCES

Anon. 1968. Plant Pathologist's Pocket Book, Commonwealth Mycological Institute, Kew. 267 pp

Baxter, D. V. 1952. Pathology in Forest Practice, 2nd Edition, John Wiley and Sons, Inc. N. Y. ; Chapman & Hall, Ltd., London. 601 pp

Boyce, J. S. 1961. Forest Pathology, 3rd Edition, McGraw-Hill Book Company, Inc. London. 572 pp

Browne, F. G. 1968. Pests and Diseases of Forest Plantation Trees. Oxford University Press, London. 1330 pp

Booth, C. 1971. Methods in Microbiology, Vol. 4. Academic Press, London. 795 pp

Blanchard, R. O. & Tattar, T. A. 1981. Field and laboratory guide to tree pathology, Academic Press, London. 285 pp

D'Angremond, A. 1948. Iverslag van der Directeur van het Algemeen Proefstation der A. V. R. O. S. Over het tyjdvak 1 Januari 1940–31 December 1940). Meded. alg. Proefst. Avros. Alg. Ser. 60, 59 pp (Cited in Gibson, 1975)

Gibson I. A. S. 1975. Diseases of forest trees widely planted as exotics in the tropics and Southern Hemisphere Part-1. Commonwealth Agricultural Bureaux, London 51 pp

————————1979. Diseases of forest trees widely planted as exotics in tropic and Southern hemisphere Part-II. The Genus Pinus. Commonwealth Mycological Institute, Kew, Surrey. 135 pp

Liu, P. S. W. 1977. A supplement to a host list of plant disease in Sabah, Malaysia. Commonwealth Mycological Institute. Phytopathological Paper No. 21 (Cited in Gibson, 1979)

Murray, R. K. S. 1930. Diseases of rubber in Ceylon, Rubber Research Scheme (Ceylon)

Meredith, D. S. 1961. *Botryodiplodia theobromae* Pat. and *Nigrospora* sp. in the air of a Jamaican banana plantation. Nature, U. K. 190 : 555–557

Rahman, M. A., Mohiuddin, M. and Mridha, A. U. 1984. Study of the dieback disease of Kathal (*Artocarpus integrifolia* L.) at Dulahazara, Chittagong (Manuscript in preparation).

Spaudling, P. 1956. Diseases of North American forest trees planted abroad. U. S. D. A. Agriculture Handbook No. 100

———1958. Diseases of foreign forest trees growing in the United States, U. S. D. A. Agriculture HandBook No. 139

———1961. Foreign diseases of forest trees of the world. U. S. D. A. Agriculture Handbook No. 197

Scharif, G. 1964. Report on forest diseases in near and Middle East. FAO/ IUFRO Symp. Int. dang. For. Dis. Insects, Oxford. 7 pp

Smith, R. S. Jr. 1978. Diseases of Pacific Coast conifers. U. S. D. A. Agriculture Handbook No. 521

Vankata Ram, C. S. 1960. Report of the Plant Pathologist. 1959-60. Rep. Tea Sci. Dep. Un. pl. Ass. S. India, 1959-60 : 19-32

Young, H. E. 1936. The species of *Diplodia* affecting forest trees in Queensland. Agricultural Journal 46 : 310-327 (Cited in Gibson, 1979)

B. Shayesta, Junior Research Officer, and M. A. Rahman, Divisional Officer, Forest Research Institute, Chittagong, Bangladesh

RESEARCH TRIALS ON IPIL-IPIL IN BANGLADESH

S. Das
N. Jones
M. A. Isiam

Seeds of Ipil-Ipil imported from the Philippines were experimentally tried at Charaljani (Tangail) and Keochia (Chittagong) to compare the growth performance of the cultivars.

Survival percentages of the three cultivars, K8, K27 and K67 at Charaljani were 96, 94 and 93 respectively, whereas at Keochia they were 89, 75 and 80 respectively. Height growth at Charaljani was almost double that at Keochia. The height growth after 140 days at Charaljani was 63.5 cm, 35.5 cm and 38 cm for K8, K27 and K67 respectively. The above-ground biomass (green weight basis) in 9 month old trees was 11.34 Kg for K8, 9.97 Kg for K27 and 9.0 Kg. for K67 at Charaljani. These figures were better than those at Keochia. The plots at Keochia were, therefore, abandoned later.

The second assessment was done 5 years later. The average green weights of all the cultivars together were 10 Kg per tree and 52 metric tons per ha with survival of 68%. An MAI/ha of 10.0 metric tons was recorded. The corresponding air-dry weights were 7.3 Kg. 39 metric tons and 7.8 tons respectively. The oven-dry weights were 5.8 Kg, 30 tons and 6.1 tons. The biomass production for K8 was 15.4 tons/ha/yr., which was significantly higher than those of other two cultivars.

INTRODUCTION

Ipil-Ipil is indigenous to Central and South America and naturalised in the Pacific Islands. Since it is found in Peru, El Salvader and also in Mexico its natural range can be considered as extending from approximately latitudes 27°N to 19°S. It has been introduced into many tropical and sub-tropical countries, but the records

of these introductions are incomplete. Barge (1976) suggests that Spanish priests took the species to the Philippines from either Mexico or Central America. It is naturalised in tropical Queensland and New Guinea presumably originating from Hawaii (Anon. 1975).

According to Brewbaker (1975), there are two distinct growth forms of Ipil-Ipil. One is a low shrub known as the "Hawaiian Type" (not to be confused with the "Hawaiian Giant"). The other is a tall, arboreal form, growing to 16 m in height known as the "Salvador Type". Probably the early introductions to Bangladesh were of the "Hawaiian Type".

Breeding studies in Hawaii and in Australia have led to development of cultivars for their own purposes. In Australia Cv PERU and Cv SALVADOR were developed as fodder trees while in Hawaii K8, K28 and K67 initially yielded fodder but continued growth to fuelwood sizes. Hutton (1977) reports on further work in Australia and the development of Cv CUNNINGHAM (K-500) which arose as a cross between cultivars PERU and GUATAMALA. It has a desirable low branching habit for browsing and greater wood production than Cv. PERU.

The Hawaiian breeding programme produced the "Hawaiian Giant"—a cultivar with an outstanding growth performance. On good soils Brewbaker (1975) records height growth of 16 m in 6 years, average basal trunk diameters of 21.5 cm in 6 years, fodder yields of 32.6 metric tons/ha and a fertilizer equivalent, as a green manure crop, of 563 Kg P and 563 Kg K per ha. This cultivar was developed from seed imported in 1963 from Mexico. This seedlot was designated K8 in Hawaii. Although it was called *L. esculenta* by the collector, it has proved to be the arboreal form of *L. leucocephala*. Two other varieties were found to closely resemble the general habit of K8; they are K28 and K67. The former was collected from Mexico and the latter from El Salvador,

Ipil-Ipil is the common name used in the Philippines for the exotic leguminous species *Leucaenea leucocephala*, which is also exotic to Bangladesh. The original sources of introduction here are not recorded. In Bangladesh the species is frequently found in coastal areas where it is known as Teli Kadam (Presumably because the flowers are similar to those of *Anthocephalus Cadamba*). It grows as a shrub about 5 m to 6.5 m tall. The species has been extensively planted on the coastal embankments in Chittagong and Noakhali districts.

The plants are usually bushy and probably of the "Hawaiian Type". In 1963, some seeds were obtained from the Philippines and were planted at Charaljani Silviculture Research Station. A small number of individuals were planted near the Forest Office at Rasulpur; seeds from these were collected in 1968 and planted on a 0.4 ha plot at Charaljani. This plot was assessed in 1977. Only 13 of the 1210 trees planted had survived and the mean height of these was 6 m.

MATERIALS AND METHODS

Seed sources: Further small quantities of seeds of varieties K8 (called the "Hawaiian

Giant"), K28 and K67 were obtained by the Bangladesh Forest Department in August 1977 from the Philippines. These were sown at two of the Forest Research Institute field stations, Charaljani (Tangail) and Keochia (Chittagong). By mid-September 1977 the potted seedlings were sturdy, but not large enough for field planting. Since these cultivars were reported to be extremely fast-growing it was considered that delaying field planting until June, 1978 would have been harmful. An experiment to compare growth of the cultivars was planned, involving intensive care throughout the dry season. The trials were eventually made at Keochia and at Charaljani in September 23 and 29, 1977 respectively.

Sites studied : Many site factors have to be taken into consideration when introducing a species or provenance to a country. A useful indicator is the latitude of the parent source compared with that in the sites on which the progeny are established. Keochia Research Station is 22° 22′ N and Charaljani Research Station is 24° 40′ N. The parent stock of the three cultivars on trial, K8, K28 and K67, originated from latitudes 26° 40′ N and 21°N and 14°N respectively. However, the cultivars were further developed at the Oahu Experimental Station, Hawaii which is 21° 34′ N. Seed was imported from the Philippines lying between latitudes 5°N and 20°N. The actual location was not known but was probably in the vicinity of Manila (between 14°N and 15°N). Sites chosen for the trial were therefore comparable in respect of latitude.

L. leucocephala requires rainfall in excess of 760 mm per annum and temperatures above 10°C (Anon. 1975). The mean annual rainfall at Keochia is 2700 mm and at Charaljani 2300 mm. The coldest temperature ever recorded at Keochia is 10°C and at Charaljani 8°C. Once again these compare quite well with the minimum requirements of the species.

The Soil pH is 5.2 at Keochia and 5.5 at Charaljani. These acid soils were expected to be the severest constraint since *L. leucocephala* grows best on soils with pH above 6.5.

Experimental design : It was decided to establish randomised blocks for the three populations, each with four replications. At Keochia 49 plants per plot were established, but owing to shortage of seedlings K8 cultivar was replicated three times only, while K67 was replicated five times. At Charaljani there were four replicates of each, with only 28 plants per plot.

Establishment : Planting was carried out very late in the wet season and it was known that the plants would survive only if they could be watered during the dry season. It was, therefore, decided to locate the plots near the office at each station and minimize the area of the plots. A 0.6 x 0.6 m planting espacement was selected and site preparation included complete removal of weeds. The seedlings were mulched after planting. When the weather became drier, each plant was given five litres of water in two separate days each week. By the second week in February 1978 it was noted that the plots appeared desiccated and the treatment was changed to 1 litre per plant per day until the rains came.

RESULTS AND DISCUSSION

Percentage of survival and height growth : Charaljani appears to be a much better site than Keochia. Height and survival were assessed at the former 140 days after planting. At Keochia a similar assessment was made 170 days after planting. No statistical comparisions were made between sites because there were different number of plants per plot and a discrepancy of 30 days between assessments. However, the differences were undoubtedly noteworthy.

Survival at Charaljani for the K8, K28 and K67 cultivars was 96%, 94% and 93% respectively ; while at Keochia it was 89%, 75% and 80% respectively.

Height growth at Charaljani was at most double that at Keochia despite the shorter growth period. The means for the respective cultivars were 63.5 cm, 35.5 cm and 38 cm on the former site and 25.5 cm, 22.8 cm and 20.3 cm on the later. Analysis of variance performed on the Charaljani data revealed that the K8 height growth was significantly better than the other two cultivars. The three complete blocks at Keochia were similarly assessed but there was no significant difference in growth.

Growth and the general appearance of the crop at Keochia was much more variable than at Charaljani and significant between-block differences were detected there. On this site Block III, of the four blocks established was made up of two K67 plots and one K28. Therefore, the analysis was for Bocks I, II and IV. The mean height growth, pooling data from the three cultivars, was 28 cm, 25.4 cm and 20.3 cm respectively for these three blocks and survival 89%, 87% and 68%. In both cases, Block IV was significantly poorer than Blocks I and II. At Charaljani an assessment of block means showed no significance between block differences.

Assessment of biomass production in 1978 : The first assessment of biomass was done on 29-6-78. The plants were cut back to a height of 25 cm above ground. The production of biomass from the three cultivars, at the end of 2 months is indicated below (Table 1) :

Assessment of biomass production in 1983 : (Das *et al* 1985) After the first assessment of biomass in 1978, only eight stumps were kept in each plot at a spacing of 1.3m x 1.3m at Charaljani. The trial plots at Keochia after first assessment were abandoned due to poor performance of the species there.

(i) **Estimation of growth :** The mean survival percentage, mean height and mean

Table 1. Showing the average green weight and air-dry weight per plot

Variety	Keochia		Charaljani	
	Green Wt. (Kg.)	Air-Dry Wt. (Kg.)	Green Wt. (Kg.)	Air-Dry Wt. (Kg.)
K8	0.86	0.32	11.34	4.53
K28	0.68	0.22	9.97	4.43
K67	0.40	0.18	9.0	2.27

diameter of all the cultivars were recorded to be 68%, 8.2m and 5.1 cm respectively. No volume growth was calculated. One tree from each plot was selected randomly and was felled 10 cm above the ground. Then the total green weight, weight of leaves and branches and wood samples were taken in the field.

(ii) **Estimation of above ground biomass :** Samples of leaves, twigs and small wood sample were taken, weighed and transported to FRI, Chittagong for airdrying and, later, oven drying and weighing again to determine the biomass on air-dry and also on oven-dry basis. These green air-dry and oven-dry weights were plotted against the dbh of the sample trees. The average green air-dry and oven-dry weights of the different cultivars were determined from the plotted curves using mean diameter as the entry point. Accordingly, the total biomass production after 5 years and the production per ha and per year were also calculated.

The average green weight of all the cultivars together were 10 kg per tree and 52 metric tons per ha. An MAI/ha/yr of 10.6 metric tons were found. The corresponding air-dry weights were 7.3 Kg. 39 tons and 7.8 tons respectively. The oven-dry weights was 5.8 Kg. per tree and 30 tons per ha. The oven dry MAI/ha/year was 6.1 tons.

(iii) **Ratio of stem wood to leaves and branches (green weight) :** This ratio for Ipil-Ipil was found to be 2 : 1. The range of the total green weights of the range of the total green weights of the individual trees varied from 1 Kg to 138 Kg. The average green weight of stem wood of all the felled trees was 26.6 Kg and that of leaves and branches was 13.0 Kg.

A comparison has also been made among the three cultivars separately (K8, K28 and K67) with respect to their diameter and height growth and the production of biomass. It has been found that the cultivar K8 has the best performance, i. e., survival 98%, mean diameter 6.57 cm ; mean height 10.5 m and oven-dry biomass 15.4 tons/ha/yr. The worst performance has been recorded for the cultivar K67 i.e., survival 44%, mean diameter 3.5 cm, mean height 5 m and ovendry biomass of 1.4 tons/ha/yr. One important factor of Ipil-Ipil is the soil reaction. This plant does not grow well in acid soils. It requires alkaline or neutral soils. The growth of K8 at Charaljani was more than double that at Keochia, due, at least partly, to the slightly less acid soil. It also achieved nearly twice the height of the K28 and K67 cultivars on the same site. This cultivar will probably be the best to use especially in the initial stage in Bangladesh. The increment recorded was that put on during the dry season and indicates the response of the plants to watering and to soil fertility rather than other site factors. It appears that fertility at Charaljani is much better than at Keochia and a soil analysis is needed on both sites to determine the reason.

As regards biomass production all three cultivars have produced more biomass at Charaljani at the end of 9 months than at Keochia in 1978. The plots at Charaljani station were retained and only 8 stumps were left per plot at a spacing of 1.3 m x 1.3 m. Coppice was allowed to

grow without any interference but some stumps out of the eight died from natural causes in some plots.

The biomass assessment done after another five years revealed that the highest biomass production had been obtained from the cultivar K8 and the lowest from K67, 15.4 and 1.4 tons/ha/yr (O. D.) respectively. However, even the production of biomass by cultivar K8 is lower than the biomass reported from other countries, such as, India (Chakravorty 1984). This can be explained probably from the soil reaction and soil fertility points of view.

It is expected that when these cultivars are tried on farmers' land or in the coastal areas of Bangladesh, they will produce more biomass than what has been found in the forest areas of Madhupur Forest Tract (Charaljani).

Therefore, the following recommnedations are made concerning further study :

1. Further source-identified seed should be imported and trials established on a range of pre-classified sites. These should include new cultivars adapted to acid soils.

2. The nursery handling techniques should be closely examined, so that the best possible stock is made available for field planting.

3. Contact with scientists in other countries working on this species is needed so that the most up-to-date establishment, management and utilisation techniques are adopted.

4. Biomass production should be studied on the farmers' land especially in the tobacco-growing areas of Bangladesh.

5. Production of biomass should be compared to *Eucalyptus camaldulensis* where soils are acid. In most of these cases *Eucalyptus* and *Acacia* are viable alternatives where growth of *Leucaena* is expected to be poor.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the help afforded by the Statistics Section of the Forest Research Institute, Chittagong. The efforts of the staff at the Charaljani and Keochia Field Stations are also acknowledged.

REFERENCES

Anon. 1975. Better Pastures for the Tropics, Arthur Yates & Co. Pvt. Ltd., Revesby NSW, Aust., 1st Ed. : 41-42

Berge, M. D. 1976. Banyani (Giant Ipil-Ipil *Leucaena leucocephala*) : a source of fertilizer, feed and energy for the Philippines. USAID Agric. Dev. Ser., E76-012(30). 22 pp

Brewbaker, J. L. 1975. 'Hawaiian Giant' Koa Haole. Coll. of Trop. Ag., Haw, Ag. Expt. St. Misc. Publ. No. 125. 4 pp

Das, S. et al 1985. Research on biomass production in Bangladesh with special reference to tree crops. Submitted to SARC. Seminar on biomass to be held in April, 1985 at Dhaka

Chakraborty, K. 1984. Experiments on forest biomass and energy plantations in West Bengal—An Appraisal. Indian Forester. Vol. 110, No. 8

Hutton, M. E. 1977. Breeding, Genetics and General Uses of Ipil-Ipil. Proc. Int. Conslt. on Ipil-Ipil Res., Phil. Coun. Ag. and Res. Research/U. S. Nat. Ac. Sc. : 13-14

S. Das, Chief Research Officer, N. Jones, UNDP/FAO Consultant and M. A. Islam, Divisional Forest Officer, C/o Forest Research Institute, Chittagong, Bangladesh.

A STUDY ON SOME PHENOLOGICAL CHARACTERS OF SILK COTTON TREE

M. Kamaluddin
Ratan Lal Banik

A study on phenological characters of Silk Cotton tree revealed that the species commenced to shed leaves in December and became almost leafless in January, when it flowered. Fruits ripened in March-April and after shedding of fruits, new leaves and shoots appeared. Out of total dry matter of fruits, 21.1% was cotton-fibre (floss) and 12.6% was seed by weight. The average yield of cotton-fibre was 5.67 kg per tree per annum and the reproductive capacity of the species was found to be 33251.

INTRODUCTION

Silk Cotton tree (*Ceiba pentandra* Gaertn.) is a fast-growing deciduous species of family *Banibacaceae*, growing to a height of 25 m to 30 m with a diameter of 1.5 m to 1.8 m. It occurs mainly in the tropics, where it is a component of secondary forest. The tree has been introduced from Burma to the Southern part of Chittagong. In the villages of Chittagong, it is often planted for its fruit. The fruit gives silk cotton (floss) which is the true 'Kapok' of commerce. This floss is superior in quality than that obtained from the fruit of Simul (*Bombax* Spp.) (Gamble 1972). Being elastic, the floss is mostly used for filling and stuffing cushions, pillows, mattresses and saddles. As it is light and impervious to water, the floss is eminently suitable for use in life-boats and life-preservers. Mixing with other types of fibres, it is also used in the manufacture of textiles (Cobley 1970). Oil of seed is suitable for lubrication and soap manufacture and after purification, for cooking. The residual cake after expression of the oil is a good cattle food. The wood of the tree is used in making packing cases and boxes, and also for other purposes requiring a soft and easily worked wood.

Information regarding phenological characters of a species is of great importance for its scientific cultivation and proper management. The paper presents certain phenological characters of Silk Cotton tree like leaf-shedding, flowering, fruit-setting and reproductive capacity.

MATERIALS AND METHODS

The phenological behaviour that occurred with the changes of seasons were recorded from 8 trees of 13 years old growing at the Forest Research Institute campus, Chittagong.

In recording other parameters, sample fruits were collected from all the trees, when they were just beginning to dehisce. Length, diameter and fresh weight of the fruits were recored. Diameter was measured at the middle part of the fruit by taking two readings perpendicular to each other. The fruits were then dried in trays in the sun. The fruit-wall, the floss and the seeds were separated from the dried fruit for taking their weights. In all the cases, 25 observations were taken for each parameter.

For germination test, 50 seeds were drawn at random from the freshly collected lot and sown on moist blotting papers inside petridishes. The petridishes were placed at room condition (22–26°C) and the test was replicated thrice.

The reproductive capacity was calculated with the formula (Salisbury 1946) given below :

$$\text{Reproductive capacity} = \frac{\text{Average seed output} \times \text{Percentage germination}}{100}$$

RESULTS AND DISCUSSION

Leaf-shedding, flowering and fruit-setting : The leaves turned yellow and commenced to fall in the beginning of December. Flower buds appeared in January when the trees were almost leafless. By the end of January, trees were covered with masses of creamy white blossom. Fruit-setting took place in Fabruary. During the period of fruit-setting, flocks of bats visited the trees at every night. Licking the nectar and distributing the pollens on their fur, they brought about pollination in flowers. Baker and Harris (1959) also recorded the bat-pollination in the species. The successful mating was likely to be dependent on the visits of the bats at the time of fruit-setting.

Young fruits were green in colour and developed very rapidly. The colour remained green till maturity. Ripening of fruits started from the mid of March and the fruit fall was completed within mid April. At this time, new leaves and shoots appeared. The young leaves were reddish in colour and soon turned pale green. Dried matured fruits were brown in colour and dehisced longitudinally.

Fruit and its components : The fruit was a capsule, pendulous, not truly cylindrical but bulged in the middle and tapered at both ends. On average, the fruit was 17.2 cm long with a mid diameter of 5.4 cm. Green fruits were about four times heavier than dry fruits. In a dry fruit, fruit-wall was 47.3%, floss was 21.1%, and the total seed content was 12'6% of its total weight (Table 1). The fruit contained brownish black seeds embedded in tight ball of silky floss derived from the epidermal cells of the inner capsule wall. On average, the seed was 0.61 cm in diameter and 0.076 g in weight.

Yield of floss : A Silk Cotton tree produced on average 1031 fruits per annum and

Table 1. Measurements of fruit and its components

Green fruit (g)	Dry fruit (g)	Fruit wall (g)	Floss (g)	Seed content	
				(g)	(no.)
99.1±22.8	26.0±8.3	12.3±3.8	5.5±1.3	3.3±0.9	44±13

± *Standard deviation*

the average dry weight of floss per fruit was found to be 5.5 g (Table 1). Therefore, the yield of floss per tree might be expected as 5.67 kg per annum. These findings corraborate with that of Record and Hass (1949).

Seed germination and reproductive capacity : Seeds started germinating after 4 days of sowing and continued for more 6 days. The average germination percentage was 73 3. As on average, a fruit contained 44 seeds (Table 1) and the number of fruits produced per tree was 1031, the seed output of the species could be around 45364. So, the reproductive capacity was calculated as 33251.

CONCLUSION

The study reveals that the number of fruits produced per tree and the floss production per fruit are quite good. The seed output and seed germination are also promising in terms of supply of seeds and seedlings for plantations. These information may also be considered useful in commercial exploitation of the species.

REFERENCES

Baker, H. G. and B. J. Harris. 1959. Bat-pollination of the Silk-cotton tree, *Ceiba pentandra* (L.) Gaertn. in Ghana, J. W. Afr. Sci. Ass. S : 1-9

Gamble, J. S. 1972. A Manual of Indian Timbers, 2nd Repri., Intern. Distributors, 318–A, Onkar road, Dehra Dun, India. 868 pp

Cobley, L. S. 1970. An introduction to the Botany of Tropical Crops, But. & Tann. Ltd. London. 357 pp

Record, S. J. and R. W. Hess. 1949. Timbers of the New World, New Haven, Yale Uni. Press, London. 640 pp

Salisbury, E. J. 1946. In Sympo. on 'the ecology of closely allied species', J. Ecol. 33 : 115–116

M. Kamaluddin, Assistant Professor, Institute of Forestry, University of Chittagong and Ratan Lal Banik, Divisional Officer, Forest Research Institute, Chittagong, Bangladesh

SOME RUBBER DISEASES AT RAOZAN RUBBER ESTATE OF CHITTAGONG

J. H. Choudhury
S. K. Khisa

Rubber tree (*Hevea brasiliensis* Muel. Arg.) is being raised commercially by the BFIDC to attain self-sufficiency in natural rubber in Banglaoesh. Symptoms of panel-burrs and nodules, cankers, galls, secondary die-back and patch canker have been described. A brief review of their causes has been made. Preventive and/or control measures have been suggested for each of the diseases.

INTRODUCTION

Rubber tree, *Hevea brasiliensis* Muel. Arg. is indigenous to Brazil. It yields latex which is commercially the most important source of natural rubber (NR). It was first introduced in Bangladesh in the year 1970 in tea gardens. The commercial introduction of this species was done by Bangladesh Forest Industries Development Corporation (BFIDC) in 1962. Since then an area of 5512 ha in eight different estates of Chittagong and Sylhet has been covered with rubber plantation, mostly on unproductive waste land and scrub forest land. It has been decided to raise 24280 ha of plantation to achieve self-sufficiency in rubber in the country. Of this 19187 ha would be raised in the public sector and the rest through private participation (Amin 1977, Hussein 1982).

Plantation forestry particularly with exotic species usually suffers from the attacks of pest and diseases (Boyce 1963), even though a few species acclimatize with the natural condition of the country. As an exotic species, rubber is no exception. Raozan Rubber Estate, the oldest in the country, comprising of about 486 ha, suffered many setbacks from the silvicultural point of view during the establishment of the plantation. It has been experiencing many disorders and diseases in the tapping stage.

In November, 1980 the authors visited Raozan Rubber Estate and closely examined some of the existing diseases. From those observations, the present note has been prepared for those involved directly in rubber cultivation.

MATERIALS AND METHODS

Close and thorough observations of the affected trees were carried out at different sites of Raozan Rubber Estate. Diseased samples and some fruit bodies of wood rotting fungi occuring on the dying branches were collected. Isolation of fungi was done from the diseased samples. Small pieces (1 mm) from the inner core of tissue were directly transferred aseptically on Bean Meal Agar, Corn Meal Agar and Malt Agar. The wood rotting basidiomycetous fungi were recognized from the appearance of their fruit bodies. Mainly from these observations, symptoms of a number of diseases and disorders have been described. From the available literature, known preventive and/or control measures have been noted under each of the diseases for convenience of the users.

OBSERVATIONS

The following disorders and diseases of rubber trees were observed and control measures suggested.

A. Panel-burrs and nodules : Varying sizes of pronounced burrs and protuberances were observed in the tapping regions of the trunk, rendering retapping of the renewed bark difficult. Nodules (hard, more or less spherical balls of wood, about the size of a pea, buried in the cortex with one or more pointed ends) were also observed.

Cause : Burrs are formed from increased meristematic activity which produces an excessive amount of wood if normal healing process of panel wounds, caused by careless tapping, is delayed due to some panel disease. During normal healing of wounds nodules and some thickenings of callus edges are formed. Large burrs are usually formed due to injuries in the region of dormant buds in the stem (Rao 1975).

Preventive and control measures : Injury to cambium layer should be avoided by careful tapping. Prompt control of panel diseases is also necessary to prevent the formation of burrs and nodules. Panel diseases can effectively be controlled by 2 to 4 weekly sprays or brushings with 0.5% Benlate, 2% Difolatan, 0.5% Antimuein WBR or any other modern fungicide (Khan 1980, Rao 1975). Larger burrs, when formed, should be removed neatly and the resultant wound should be treated with Petrolatum (Khan 1980) or Cerano (containing 8 parts Glycerol, 2 parts anhydrous Lanolin and 0.3% Phenyl mercuric acetate) or other suitable wound dressings (Shurtleff 1966). Nodules can be removed easily by the tip of a knife and may have a wound dressing in case of any injury (Rao 1975).

B. Cankers and Galls : Canker was found on the stem and branches. Necrosis of bark tissues or cambium resulted in an open wound exposing the wood. They increased in size with the growth of the tree.

Rough surfaced, hard, swollen tumours or galls upto 20 cm or more in diameter were found on the trunk. Trees with galls and cankers were found to be stunted and weak.

Cause : Larger open wound exposing the wood may be formed due to severe injury

to cambium layer or other wound of various causes. This may also happen when normal process of healing of wounds is disturbed due to irritation by insects, mites, bacteria, fungi, viruses and nematodes (Shurtleft 1966). Galls arise from abnormal meristematic activity resulting in the formation of excessive wood tissue.

Preventive and control measures : Wounding of plants while transporting and transplanting should be avoided. Grafting and pruning knives should be dipped in a suitable disinfectant (70% alcohol) between cuts. Large cankers should be cut and sterilized with household disinfectant or 1 : 1000 solution of mercuric chloride in water and then painted with a tree wound dressing like petrolatum (Khan 1980) or Cerano (Shurtleff 1966). Cankered twigs and branches should be pruned and burned in dry weather.

Outer gall tissue should be excavated and chiseled off, the gall and its surrounding margins should be painted with a mixture of 1 part of Elgetol (19% sodium dinitro-o-cresol) and 4 parts of methanol (Shurtleff 1966). The damaged areas should then be painted with a tree wound dressing.

C. Secondary die-back : Die-back is a progressive death of shoots and branches starting at the extremeties and extending downwards along the branches and main stem until the whole tree is killed (Rao 1975). Rots or progressive decays proceeding downwards through the broken ends of the branches of living trees were found causing, ultimately, the death of some branches. Three polypores with white or brown thick skin like fruit bodies were found growing on and around the dead leafless woody twigs. They were identified as *Irpex* sp., *Poria* sp. and *Hexagonia* sp.

Cause : It may be caused by facultative parasites entering through damaged or weakened tissues. Tissues damaged by pruning, wind breakage, etc. offer entry to the common wound parasites–mostly the species of the fungi *Botryodiplodia, Collectoriclum, Phyllostictus* and *Phomopsis.* The fungi responsible are spread by wind borne spores (Rao 1975).

Preventive and control measures : Fungal fruit bodies and all the affected parts with a portion of the healthy tissues should be removed and burnt. The cut ends should be sterilized with a disinfectant and finally painted with Petrolatum or Cerano or other suitable tree paints. A good tree paint can be prepared by melting and stirring together 10 parts by weight of lanolin, 2 parts of rosin and 3 parts of crude gum (Shurtleff 1966).

D. Patch-canker : A patch-canker diseaes was detected appearing on the main stem above the tapping panel, but just below the forked branches. Infection was detected with the symptom of oozing out of amber coloured liquid from the diseased and swelled up areas. The bark was found to be mois't rotted, and of reddish brown colour. A coagulated rubber pad with a foul smell was found under the bark where latex coagulated.

Cause : *Phytophthora* sp. was consistently isolated on Bean Meal Agar which probably might have caused the disease. *Phytophthora palmivora* (Butl), *P. meadii* McRae, *Pythium vexans,* de Bary (Bakshi

1976) and *Ustilina deusta* Holtm ex Fr (Rao 1975) are reported to cause the same disease.

Preventive and control measures: The diseased bark with a little healthy portion should be dressed with an organo-mercurial fungicide like 'Aretan' and 'Cersan' (Anon. 1975) or with other suitable fungicides like Benlate (0.5%), Antimucin WBR (0.5%) or 2% Difolatan (Khan 1980). The cut area of the bark with the surrounding portion should also be sterilized and dressed with a tree wound dressing mentioned earlier.

ACKNOWLEDGEMENT

The authors are grateful to the Estate Manager and his staff, Raozan Rubber Estate for their assistance during the field work and to Dr. M. A. Rahman, Divisional Officer, Forest Research Institute for his suggestions and critical review of the manuscript.

REFERENCES

Amin, S. M. R. 1977. Rubber plantation in Bangladesh. Proc. Ist. Bangladesh Nat. Conf. For. : 133-139

Anon. 1975. Rubber and its cultivation. Rubber Board, India. 110 pp

Bakshi, B. K. 1976. Forest Pathology, Principles and Practice in Forestry. FRI, Dehra Dun. 400 pp

Boyce, J. S. 1963. Principles of forest disease control. ISDA For. Ser., Misc. Publ. No. 939 : 117-118

Hussein, M. N. 1982. Development of rubber plantation in Bangladesh. Proc. 2nd Bangladesh Nat. Conf. For. : 194-197

Khan, A. M. 1980. A short note on panel disease of rubber trees. unpubl. rept., 11 pp

Rao, B. S. 1975. Maladies of Hevea in Malaysia. RRIM, Kuala . mpur. Malaysia. 108 pp

Shurtleff, M. C. 1966. How to control plant diseases in home and garden (2nd ed.), Iowa State Univ. Press, Ames, Amex Ames, Iowa. 649 pp

Jahangir Haider Choudhury, Divisional Officer and Sudibya Kanti Khisa, Junior Research Officer, Forest Research Institute, Chittagong, Bangladesh

Short Communication

EFFECT OF SOWING ORIENTATION ON GERMINATION OF SAL SEED

Sal seeds generally mature between the months of April and May. It may vary according to location. The seeds fall as soon as they mature. The germination of seed starts soon after maturity and it may germinate even on the tree (Troup 1921). When germination starts, the tip (apex) of the fruits splits longitudinally (at right angle to the pedicel of the seed) and the radicle emerges from the apex of the seed.

Germination percentage is influenced by various factors. Cockburn and Wong (1969) stated that germination percentage of Sal depended on the size of seed trees and collection of seeds from the tree rather than from ground. Troup (1921) reported that sound fresh seed had a high germinative capacity. Sal seed, however, rapidly loses its viability. Depth of sowing is also an important factor in germination. Cayford and Waldron (1969) found that germination depended on sowing methods and depth of sowing. Defective sowing of Sal seed in nursery in India had led to low germination percentage (Singh et al. 1975). The present investigation was, thus, undertaken to determine the effect of sowing orientation of seed on germination.

Sal seeds were collected from four locations, viz. Salna (Dhaka), Burshijura (Sylhet), Charaljani (Mymensingh) and Hyakhoo (Chittagong). The experiment was carried out in the month of May, 1978. The seeds were collected from 30 selected mother trees. The seeds were dewinged and kept under cold water for 5-10 minutes. Then the seeds were sown in 25 cm dia round plastic sieves filled with a mixture of soil and cowdung in the ratio of 3 : 1.

Four hundred fifty seeds were taken from each mother three. Fifty seeds were sown in plastic sieves in each of the three sowing orientations with three replications of each between 1.0-1.5 cm deep in the soil. Observations were recorded everyday until germination had ceased.

Hodgkins (1966) investigated the effect of depth of sowing. He observed that better germination was found at a depth of 1.0 to 1.6. cm. Present investigations corroborate the observation.

From Table 1 it can be seen that the germination percentage of Sal Seed was higher in upward and horizontal orientations

Table 1. Germination percentages of sal seed in three sowing orientation of four locations

Seed source	Sowing Orientation	Seed germination percentages of mother trees								Mean Germination per cent
		1	2	3	4	5	6	7	8	
Hyakhoo	Upward	50.0	52.0	62.0	54.6	60.0	52.0	53.3	62.0	55.6**
	Horizontal	52.6	56.0	61.3	61.3	56.6	54.6	62.6	57.3	57.7**
	Downward	10.0	8.6	12.0	10.0	8.0	10.0	10.6	14.0	10.4
Charaljani	Upward	58.6	64.6	57.3	53.3	58.0	60.0	59.3	61.3	59.0%*
	Horizontal	67.3	60.0	54.6	56.0	54.0	63.0	56.0	66.0	59.6**
	Downward	16.0	17.3	12.6	11.3	12.0	14.0	14.6	13.3	13.8
Salna	Upward	60.0	26.9	75.0	43.3	37.1	53.8	52.3	–	49.7**
	Horizontal	60.0	34.6	70.0	50.0	28.5	76.4	57.1	–	53.8**
	Downward	15.0	15.3	20.0	10.0	14.2	7.6	19.0	–	14.4
Burshijura	Upward	61.3	50.0	64.6	54.6	62.0	70.6	60.0	–	60.5**
	Horizontal	56.0	64.6	46.0	52.6	63.3	61.3	61.3	–	57.8**
	Downward	11.3	14.6	12.0	12.0	11.3	12.0	12.0	–	12.1

***means significant at $P=0.01$*

than in downward. Zerebecor (1969) working with sprouting Acorns obtained the best germination in horizontal orientation. In the present study germination percentage in upward orientation sowing of all the four collections varied from 26.9 to 75.0 and it was almost similar with that of the horizontal sowing which varied from 28.5 to 76.4%. But in downward orientation sowing it was 7.6% to 20.0%. When the seeds were sown in downward orientation, the radicle remained in the soil but the plumule did not emerge normally. It ran in different directions producing abnormal seedling. Banik (1980) also reported that defective sowing method produced abnormal seedling in Garjan. Moreover, analysis showed that the downward sowing orientation is significantly inferior to the upward and horizontal sowing orientation, the latter two being statistically similar.

REFERENCES

Banik, R. L. 1980. Studies on sowing position of Garjan seeds on their germination and seedling behaviour. Bano Biggyan Patrika Vol. 9 : No. 1 & 2: 43–52.

Cockburn, P. F. and Wong, S. M. 1969. Germination in *Shorea curtisii* Dyer (Seraya) Malay. Forester. 32(3) : 266–268

Cayford, J. H. and Waldron, R. M. 1967. Effect of Captan on germination of White spruce, Red Pine Seed. For chron. 43(4) : 301-384.

Hodgkins. E. J. 1966. A study of direct seeding depth for loblolly pine Jor. For. Vol. 64(5) : 317-319.

Singh, R. V. Chandra, J. R. and Sarma, R. K. 1975. Effect of depth of sowing of Spruce seeds. The Indian Forester. Vol. 101(3) : 170-175.

Troup, R. S. 1921. The Silviculture of Indian Trees. Vol. 1. Clarendon Press. Oxford

Zerebcor, V. G. 1969. Importance of condition and position of Acorns, when sown. Lesnz, Arhangel Sk. Vol. 12(4) : 144-146

Vidyarthi, R. D. 1962. Text book of Botany. Vol. 1. The Indian Press, Allahabad, India

Md. Serajuddoula
Senior Research Officer
A. H. M. Mojibur Rahman
Ex. Divisional Officer
Forest Research Institute
Chittagong, Bangladesh