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DEMONSTRATION AND APPLICATION OF PRODUCTION AND UTILIZATION TECHNOLOGIES FOR RATTAN SUSTAINABLE DEVELOPMENT IN THE ASEAN MEMBER COUNTRIES
[ITTO-Philippines-ASEAN Rattan Project]

Technology Guide No. 03

CONTROL METHODS AGAINST POST-HARVEST PESTS OF RATTAN

CARLOS M. GARCIA and MAGDALENA Y. GIRON

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PART VII

HANDLING OF TREATED MATERIALS

- Dry the treated materials under a shed. Follow the proper piling with stickers in between layers of treated material.
- Avoid exposure of treated materials to the direct heat of the sun to avoid splitting or checking.
- Protect the treated materials from rain or splashes of water. Maintain a moisture content of below 20% to prevent fungal attack.
- Apply a second chemical treatment after processing to ensure complete protection.
- Store treated materials in a dry and well-ventilated place.
- Inspect treated materials and finished products prior to delivery to clients.
- If the treated products will be transported, wrap with kraft paper.
- Dispose treated waste materials properly in a dumping site away from water resources. Incineration or burning of treated waste rattan is not recommended because it will pose environmental problem and health hazards.

CONTROL METHODS AGAINST FUNGI AND INSECTS IN POST-HARVESTED RATTAN

C.M. Garcia and M.Y. Giron

RATIONALE

Rattan is one of the major raw materials in the manufacture of furniture and handicraft products. It plays an important role in the lives of the people living in the countryside and in the urban areas as well. The industry directly or indirectly provides a source of livelihood and contributes to their socio-economic upliftment.

Utilized as round, core, splits or wickers, rattan products have made their niche in the world market. With the current depletion of rattan resources, it is used in combination with metals, wood and other indigenous materials to enhance its aesthetic appearance. The exquisite and fine craftsmanship of Philippine rattan finished products is known the world market.

The industry however, is confronted with the problem of fungal and insect attack that degrades the quality of raw materials and finished products. Losses in millions of pesos in terms of labor and resources are incurred, prompting a need to disseminate information and demonstrate technologies on the appropriate measures to protect raw materials and finished products against biodeteriorating organisms.

It is therefore the objective of this resource book to serve as a guide for rattan gatherers, traders, manufacturers and the other stakeholders who are involved in the processing and utilization of rattan. Demonstration and application of these technologies are deemed imperative to address the problem on fungal and insect attack on freshly cut rattan and finished products.

The Plant Body of Rattan

Rattan is a climbing palm and the plant body is characterized by the presence of nodes and internodes. The length, diameter, nodes and internodes vary among species. The cross section is divided into two parts; an outer and central portion, termed as the "cortex". It contains silica, starch, water and other compounds necessary for its growth and development. The presence of starch and moisture makes it a good substrate for insects, molds and staining fungi to thrive on.

- Separate the remedially treated products from sound ones.
- Monitor and observe treated materials for beetle infestation.
- Repeat injection of chemical solution if powdery materials are observed.
- Fill up treated hole with putty and apply finishing material (Do not fill up hole with wood putty when powder material are still present. Beetles will continue to bore and destroy the material even if its filled up with putty).

C. For Raw Materials with Initial Fungal Attack

- For molds, clean the surface of the materials to remove fungal spores and hyphae of molds.
- For slightly stained or discolored rattan, scrape and burn infected portion However, this may also be decolorized by bleaching.
- For moderately stained canes, cut and burn the infected portion.
- Soak the sound portion for 8 to 24 hours. The length of soaking period depends on the degree of fungal attack.
- Air dry.

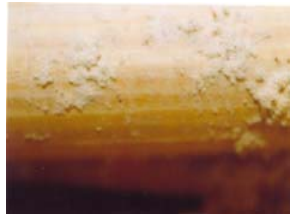
PART VI

REMEDIAL TREATMENT OF INFESTED RATTAN

Untreated rattan are subject to beetle attack during processing and while in-service. The application of the various treatment procedures discussed in the previous Chapters will serve as remedial treatment to prevent farther deterioration.

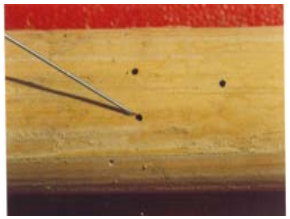
A. For Raw Materials with Initial Beetle Attack

- Segregate materials with active beetle infestation which is manifested with powdery materials falling out from the hole. Clean/cut the infested portion.
- Apply chemical solution by spraying, brushing or dipping method. The length of soaking depends on the degree of beetle attack (30 minutes or more).



- Dry and pile separately from the sound materials.
- Monitor and observe the occurrence of powdery materials. Apply a 2nd or 3rd treatment if noted.

B. For Finished Products with Initial Beetle Attack



- Inspect and mark active beetle holes.
- Inject the chemical solution directly into the beetle hole using a syringe. Apply until the hole is saturated with chemical solution..

PART I

POST-HARVEST PESTS OF RATTAN

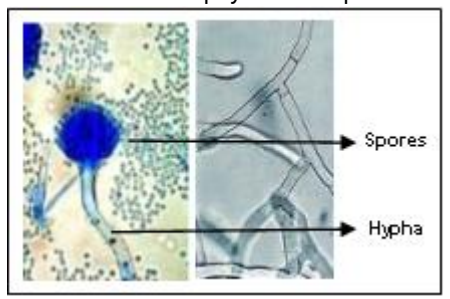
Freshly cut rattan are very susceptible to the attack of staining fungi that discolor the surface. The unsightly bluish black to black stain appears on the surface and often penetrate deep into the tissues of the cane which is difficult to remove.

On the other hand, insects like powder-post beetles attack rattan that are in storage or in service. Beetle holes and powdery masses are the manifestation of beetle attack which consequently degrade the quality of the rattan. If the materials will be stored longer in the warehouses there is a chance that these will be invaded by subterranean termites

A. Causes of Biodeterioration in Rattan

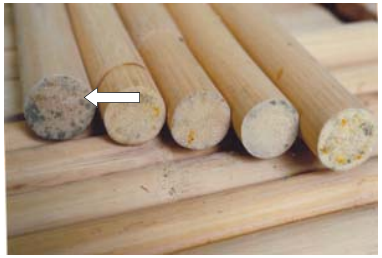
1. Fungi

Fungi are filamentous microorganisms without chlorophyll and depend on organic matter for their growth and development. The plant body is called hyphae which invade the rattan tissue and produce spores (seeds) for repro-duction. Fungal spores are disseminated by wind, water, insects, tools and other processing equipment.



There are 3 kinds of fungi that cause biodetertioration in rattan. Molds and stain fungi are the common groups of micro-organisms attacking materials after cutting. They feed on simple sugars or on complex food materials like cellulose in rattan. Decay fungi on the other hand occur on harvested rattan that are left in the forest floor for a long time.

a. *Molds* – "amag" -



- Spores may be white, bluish-gray, black green, orange, pink, bluish-gray and appear as spots or specks on the surface of infected materials.
- The hyphae or filaments may be colorless and generally found on or just a few mm beneath the surface.
- The fungi can be easily wiped off but re-appears if materials get moist or wet after drying.
- Causal organisms : *Aspergillus niger, Trichoderma viride* and *Penicillium* sp.
- Food source are simple sugars.

b. *Staining Fungi* – "mantsa"

- Spores are generally bluish gray to black in color which may be found on the surface or covered within special fruiting structures.
- Discoloration may start as a small speck or spot which later coalesce or join together to form larger or bigger specks. In severe cases, the surface is completely covered with thick mycelial growth.
- The hyphae are brown to dark brown in color that imparts the black discoloration on the surface and several mm below the surface of the affected rattan.
- Discoloration cannot be scraped off because the hyphae penetrate deep into the tissue of rattan.
- Causal organisms : *Ceratocystis* sp., *Botryodiplodia theobromae*

- Apply 50% of the total termiticidal solution (100 li) requirement into the trench by spraying or sprinkling at 4 li solution per linear meter.
- Back fill the soil into the treated dug trench and apply the remaining 50% of the total termiticidal solution (100 li).
- For drilled holes on concrete slab, pour chemical solution into the hole.
- If termite infestation is severe, drill holes also on the interior flooring along the wall and apply chemical solution.
- Likewise, spraying of chemical solution to interior walls, panels and roof space is recommended.
- Open all windows open to allow fresh air to enter and eliminate smell of chemical solution applied inside the structure.
- Re-entry period to the structure depends on the recommendation of the chemical manufacturer.

- Destroy termite nests, if present and apply immediately with termiticidal solution.

- Use flashlight to check dark areas of the structure.
- Take note of the species of termites, point of entry and termite nests present in the area.

▶ Measure and record the perimeter and the area of the building.

▶ Estimate the total volume of chemical needed using the formula:

= Area to be treated x Dilution Rate x Application Rate

Example:

Area of warehouse to be treated = 100 sq m
Perimeter of the warehouse = 40 linear meter
Dilution Rate = 1:50
Application Rate = 4 li solution per sq m or per linear meter

Find: Total volume of chemicals needed (liters)

Solution:

= Perimeter of the warehouse (m) x Application rate (li/m) x Dilution rate (li chemical/li water)

= 40 lm x 4 li solution/lm x 1 li termiticide/40 li water

= 4 liters of termiticide (To be mixed with 200 li of water)

■ *How to apply the chemical solution as soil treatment*

- Dig a trench along the perimeter, 14 to 18 cm from the edge of exterior wall about 30 cm deep and 30 cm wide.
- For concrete slab, bore holes into the slab at 30 to 35 cm distance between holes using a rotary hammer.

c. Decay Fungi

- Generally observed in rattan that are left in the forest floor for a long time.
- Produce special fruiting structures that contain the spores.
- Whitish-grayish or yellowish filaments on the surface of affected rattan and penetrate inside the tissues utilizing the cellulose and/or lignin.

Kinds of decay fungi:

Brown rot – the infected material turns brown in color with cubical pattern of decay and crumbles when touched softly between fingers.
e.g. *Lenzites striata*

White rot – the affected rattan turns white and texture is soft and stringy.
e.g. *Fomes* sp., *Schizophyllum commune*

Soft rot. – the infected material turns black in color and soft when wet but turns tough when dry.
e.g. *Chaetomium globosum*

2. Insects

Insects are arthropods with 3 pairs of legs and 2 pairs of wings. Beetle and termites are the 2 major post-harvest pests of rattan.

a. Powder-post Beetles – "bukbok"

- Adult is brown to brownish black in color, body is cylindrical and 3 mm long.
- Larvae and adults are destructive stages that burrow and convert rattan into powdery materials.

- Powdery masses and beetle holes present on surface of rattan are signs of infestation.
- Causal insect is *Dinoderus minutus* which is also a major post-harvest insect pest of bamboo.
- Optimum temperature for development is 28 to 30°C and no stages survived at 34°C.

b. Termites – "Anay"

Social insects that live in colonies composed of a king, queen, workers and soldiers. The king and queen are responsible for the reproduction of the members of the colony while the soldiers are responsible for the defense of the colony. The workers are the food providers and responsible for the destruction of cellulosic material like rattan.

D. Fumigation — must be applied only by a certified fumigator.

- ▶ Remove dirt and foreign materials on the surface of rattan.
- ▶ Pile the materials inside the fumigation chamber with stickers between layers.
- ▶ Apply the recommended dosage of fumigant.
- ▶ Follow the recommended treatment period.
- ▶ Aerate the fumigation chamber and follow the re-entry period.
- ▶ Collect fumigant container and place the residue in a bucket with soap and water.
- ▶ Retrieve and store the fumigated materials.
- ▶ When an enclosure chamber is not available, fumigant can be applied by covering rattans with a thick plastic sheet or tarpaulin.
- ▶ Fumigation has no residual toxicity and re-infestation will occur if conditions become favorable. Apply liquid chemical for longer protection.

E. Soil Treatment (To be applied by a accredited pest control operators)

This procedure is used to create a barrier between the soil and the structure to prevent invasion or infestation by subterranean termites.

- ▶ Inspection of the warehouse
  - Visually inspect the building and vicinity for the presence of termites and termite damage.
  - Termite can be detected by probing wooden components with a screw driver/hammer or other sharp or pointed material.

B. Brushing

- Arrange canes properly on a surface lined with a plastic sheet.
- Apply the 1st coat of chemical solution using an ordinary paint brush to the cut or injured portions of the materials.

- Allow to dry for 3 minutes and apply the 2nd coating.
- Dry the treated materials.

C. By Dipping or Soaking

- Remove dirt/foreign materials on the surface, bundle the canes and place into the dipping vat.
- Put weights on top to keep canes from floating.
- Dip and retrieve bundled canes after 5 - 10 minutes.
- Keep treated materials on dripping board to allow excess solution to drip back to the dipping vat.
- Dry under shed or sun.

Two groups of termites with economic importance:

b1. Subterranean termites – build earthen tubes and the colony is in direct contact with the soil. There are four species of subterranean termites in the Philippines that destroy rattan and wood components of warehouses:

Los Banos Termites - *Microcerotermes losbanosensis* Oshima

- Shape of head of soldier is more or less rectangular.
- Nest hard, carton-like located partly above the ground.
- Tunnels are hard, narrow and cylindrical.

Mound-building termites - *Macrotermes gilvus* Hagen

- Maintains “fungus garden” inside the mound
- Queen is large.
- Earthen tubes are broad but less sturdy, easily broken and. washed by rain.

Milk termites - *Coptotermes vastator* Light

- Mode of attack is by tunneling inside and throughout the whole length of wood.
- Infested wood appear intact but hollow inside.
- Soldier exert milky substance when disturbed.

Luzon Point Headed Termites—*Nasutitermes luzonicus* Oshima

- Construct hard, semi-carton tunnels and nests which are located on trunks of trees.
- Soldiers with brownish-black pointed head.

b2. Drywood Termites

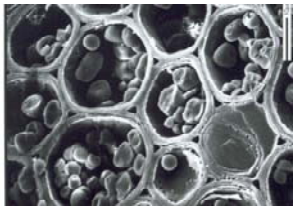
- Locally known as “unos” and soldiers with brownish-black truncated heads.
- Protection against termites is necessary in the maintenance of storage or warehouses.
- Do not build earthen tubes or earthen tunnels.
- Attack directly the wood.
- No ground contact.
- There are 2 destructive species of drywood termites.

Cyrptotermes dudleyi Banks

C. cycanocephalus Light

B. Factors for Growth and Development of Fungi and Insects

1. *Food* - From available simple sugars and starch present in the cells and tissue of rattan. Lignin and cellulose are also food sources for decay fungi and insects.



2. *Moisture* - Spores germinate in the presence of moisture or water in rattan. The optimum moisture level for fungal growth is above the fiber saturation point (30% MC). Beetles survive in rattan with 8.0% to more than 20% moisture content.

PART V

METHODS AND PROCEDURES OF CHEMICAL TREATMENT APPLICATION

The method to be used in the application of wood preservatives depends on the nature, end-use and volume of the materials to be treated. Preservatives can be applied by non-pressure and pressure methods.

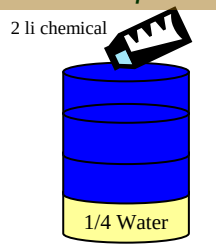
Non-pressure Treatment Method

This is a treatment method of preservatives without pressure and requires inexpensive tools and equipment. This includes spraying, brushing, dipping and soaking.

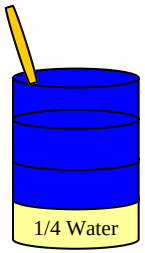
A. Spraying

- ▶ Pile rattan canes close to each other on a plastic sheet to ensure full surface coverage when spraying is applied.
- ▶ Spray the chemical solution to the surfaces and cut ends along the wind direction.
- ▶ Allow to drain and dry treated materials under shed or sun (but not under intense sunlight).

- ▶ Air-dry.
- ▶ Perform a second spraying if the treated materials will be cut into smaller dimensions.
- ▶ Collect the excess chemical solution on the plastic sheet and keep in a tightly cap container for future use.

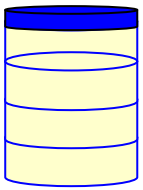


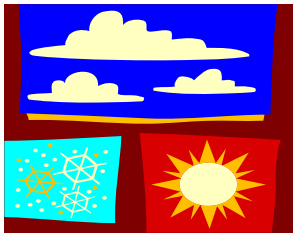
▶ Pour the 2 liters of chemical into the container with water.



▶ Mix the mixture with a wood stirrer.

- Fill up the remaining volume of water to the desired total volume of chemical solution and stir again. The chemical solution is ready to be sprayed or the materials are ready to be dipped into the vat.





3. Temperature - Favorable temperature for growth and development is 26º to 32ºC. Development of beetle is longer at lower temperature (15ºC or less) and no life stages of the insects survived at 34ºC.

4. Oxygen - Fungi and insects can tolerate low levels of oxygen but a considerable variation in tolerance exists among different species.

PART II

NON-CHEMICAL CONTROL METHODS

Fungal and insect attack in round rattan, cores or wickers can be prevented either by non-chemical or chemical methods. A single control measure is not sufficient to control biodeterioration of materials. A combination of these control measures will provide effective management to protect and maintain the quality of raw materials and finished products.

Non-chemical methods are control measures to protect rattan against post harvest pests without the use of chemicals.

A. Air-drying/Sun-drying

The process reduces the moisture content of rattan by air or sun-drying Rattan should not be dried under the intense heat of the sun to avoid splitting and cracking (Ahmad et al. 2004, Vuthy et al. 2004, Ketphanh et al. 2004, Diaz and Ramos, 2004). The method is cheap but it

takes 2-5 months) to dry and depends on the thickness, round or split form, time of the year and initial moisture content. Fungi and powder-post beetles might have colonized before rattan materials are seasoned.

» Let freshly cut rattans stand on its ends in a wigwam manner, or in vertical position against a wall or pile horizontally over a steel frame to facilitate removal of moisture.

» For split and small diameter (6 cm or less) rattans, bundle into 20 to 30 pieces and hang to enhance water loss.

B. Dipping or Soaking

Soaking of 50 to 100 pieces of rattan in running water for 1-7 days prevent fungal stain (IWiyono, 2004). These are rubbed with sand to remove dirt on the surface of rattan after soaking.

» Bundle round rattan or strips prior to soaking.

» Place the bundled rattan into the soaking vat first, provide weights on top to prevent floating and add water.

» If running water is not available, replace the water in the soaking vat every 2 days to remove polluted water and avoid stinky materials.

» Retrieve materials and drain excess water before drying.

» Air-dry/sun-dry water-soaked rattan in vertical position or wigwam pattern or bundled rattan strips by hanging.

» Proper drying of soaked-rattan materials helps prevent fungal problem.

- *Trench type* – Size of the trench depends on the length and volume of materials to be soaked. Dig a trench of desired dimension and smoothen out all sides (10 x 3 x 3 ft). Line with plastic sheet and allow 1 1/2 feet to cover the edge of the trench.

» Put weights on top to keep the plastic sheet in place.

» A trench of 10 x 3 x 3 ft can accommodate 2,500 liters of the solution.

» Recommended for materials that need immediate treatment in the harvesting site.

D. Preparation of Wood Preservative Solution (Garcia et al 2001)

▶ Read the label prior to handling and estimate the total volume of chemical and water to be mixed.

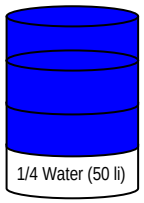
Example

Volume of chemical solution needed: 200 liters

Mixing ratio of chemical : 1 li chemical per 100 li water

Volume of chemical needed : 2 liters

▶ Wear personal protective equipment.



▶ Measure ¼ of the required volume of water (50 li) and pour into the mixing container with 200 li capacity.

C. Planning of Treatment Application

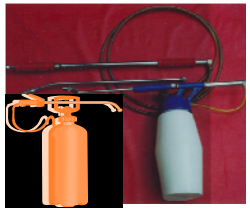
1. Check the weather.

- Schedule the application of treatment in an open area on a sunny day to avoid wash out of chemical by rain.
- If treatment application shall be done inside a warehouse, weather condition is not a problem.

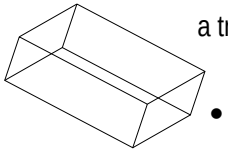
2. Prepare and check the sprayer or dipping vat.

- Check the sprayer or vat for any leak by pouring half of the total volume of water required and repair any leak, if any.

a. Sprayer types - handheld type, knapsack or a power sprayer. The type of sprayer needed depends on the volume of materials to be treated.



b. Dipping vats - stainless steel, concrete, drum or a trench dug lined with plastic sheet.



- *Stainless steel type* - resistant to corrosion and can be transported.

- *Concrete type* - permanent type of dipping vat with a gate valve for easy cleaning and transfer of remaining chemical solutions into a container.

- *Drum type* - A 200-liter steel drum is cut and welded together lengthwise to make a longer dipping vat.

C. Kiln-drying

The process of reducing the moisture content of canes by kiln dryer where the temperature and relative humidity are regulated. Rattan are placed in a kiln dryer and a drying schedule is applied.

» Prepare materials into desired dimensions and air-dry initially.

» Pile the materials inside the kiln with a sticker to allow heat to pass thru between layers of materials.

» Kiln-dry materials according to species and portion of the canes. Butt portions are slower to dry than top portions.

» Follow the recommended kiln-drying schedule.

» Retrieve kiln-dried materials and store in a covered building/warehouse to avoid re-absorption of moisture from rain or soil.

» Dried rattans are subject to re-infestation and application of chemical solution is necessary to provide longer protection.

D. Smoking

Smoking is the process of exposing rattan to the smoke emitted by sulphur gas until the rind or skin becomes yellow. The treatment makes rattan resistant to fungal attack (Wiyono and Santos 2004, Ketphan et al. 2004, Myint 2004, Vuthy et al. 2004).

» For large diameter rattan, wash canes to remove dirt.

» For small diameter rattan and scrape the nodes.

» Pile properly in an enclosed shed or chamber.

» Apply smoke by burning sulphur dioxide.

F. Boiling in Oil

The process is done by boiling rattan in diesel solutions for 10 to 30 minutes at a temperature of 60 to 150°C (Raja 2004, Kethpanh et al 2004, Wiyono 2004, Bich 2004). The process will remove moisture, waxy materials, resins and gums, improve color, texture and flexibility; and prevent insect and fungal attack (Raza 2004).

» Prepare the boiling vat. A drum cut into half can be used.

» For large diameter rattan, bundle into 8 -10 pieces per bundle; for small diameter rattan into 15-20 pieces per bundle.

» Dip the bundled canes into the vat with diesel oil with a temperature of 60°C for 10 to 30 minutes. Canes boiled for 30 minutes turned darker in color.

» Retrieve treated rattan and drain oil.

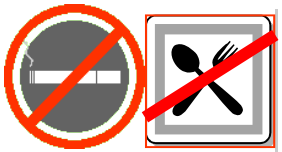
» Scrub the rind with the use of rag or sand or sawdust until the dirt and oil are removed. Pressurized water may also be used.

» Lean oil-treated rattan on wooden frame to dry.

» Loosen the bundled large diameter rattan at one end and place on a wigwam-like structure.

» Hang small diameter rattan over a wooden frame. Turn around rattan after the 3rd and 5th day to obtain uniform drying.

» Boiled rattan are dry when canes are lightweight, the rind turns yellowish and high pitched sound when beaten on a hard surface.



▶ Do not eat, drink or smoke when handling wood preservatives .

▶ Wash hands and feet, or take a shower after handling the chemicals and change work clothes. Wash work clothes separately from normal clothing.

▶ Avoid chemical solution to get into your gloves. Wash outside of gloves, turn inside out, wash inside and let it dry before using.

▶ Spray along the wind direction. Do not blow clogged nozzles with your mouth.

▶ Dispose used chemical solutions properly. Allow water to evaporate or dispose in dumping grounds for chemicals. Dumping grounds must be away from river or water source.

▶ Dispose chemical container following the triple rinse technique. Drain the concentrate from the container into the spray tank for at least 30 seconds and rinse it three times.

▶ Store chemicals with proper label in a storage room with a safety padlock.

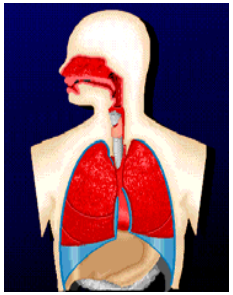
PART IV

PREPARATION OF CHEMICALS AND DIPPING VATS

Wood preservatives are formulated to eliminate wood destroying organisms and if not properly handled will pose danger to human health, animals and the environment. Knowledge of the safety measures in handling of these chemicals is very important. Everyone should understand these measure in order to avoid the potential risks posed by wood preservatives.

A. Entry Routes of Chemicals into the Body

The toxic substance can enter the body through the following routes:



- Thru inhalation - dust, mist, fume or vapor can pass through the nose or mouth and into the lungs.
- Thru oral - can enter through the mouth to the stomach and bloodstream and can be transferred by touching the mouth, face, lips or food which is later eaten with contaminated hands.
- Thru dermal - wood preservatives can penetrate through the skin pores, particularly to the wounded portion.

The face, eyes, ears, lips, wrists and forearms are sensitive to chemicals. Skin contamination can occur during loading and unloading, transporting, mixing preservatives and during treatment application.

B. Precautionary Measures and Health and Safety

All personnel particularly in the treating area must be familiar of the precautionary and safety measures in handling chemicals.

- Wear Personal Protective Equipment (PPE): long sleeves, visor hardcap, gloves, respirator and safety shoes.

G. Other Non-chemical Methods

1. Proper storage and stacking
   - Proper storing and piling will keep harvested and processed rattan from biological attack.
   - After cutting, do not leave harvested rattan in contact with the ground for a long time.
   - Transport harvested rattan immediately to the processing Plant, cut into desired length and piled vertically to facilitate drying.

PART III

CHEMICAL METHODS ON THE CONTROL OF FUNGI AND INSECTS

Chemical methods are control measures that use chemicals or preservatives on materials to prevent insect and fungal attack. The hazards pose by these chemicals warrants a judicious and wise use of the toxic substances in any application procedures.

A. Wood Preservatives

- Chemicals that are applied to wood and non-wood forest products (NWFP) to kill, prevent and mitigate fungal and insect attack.
- Fungicides and insecticides are wood preservatives used against fungi and insects, respectively.
- Termiticides are chemicals used to control termites and are restricted for soil treatment.

B. Advantages in Using Wood Preservatives:

- Highly effective
- Rapid control
- Easy to prepare and apply
- Readily available

C. Commercially Available Wood Preservatives

- Fungicides - 2-thiocyanomethylthio-benzothiozole (TCMTB), propiconazole, Disodium Octatetraborate (DOT)
- Insecticides (wood preservatives) – deltamethrin, permethrin
- Termiticides (for soil treatment only) - chlorpyrifos, fenvalerate, fipronil, bifenthrin
- Fumigants - methyl bromide, hydrogen phosphide (phosphine)

D. Criteria in the Selection of Wood Preservatives

- Identity of the pest to be controlled.
- Highly effective to control existing pest problem.
- Environment-friendly
- Permanence in rattan with simple disposal system.
- Does not affect the properties of materials.
- Economical
- Comply with government regulations

E. Classification of Treatment Applications of Preservatives

The application of wood preservatives can be classified according to the condition of materials to be treated.

1. Prophylactic treatment

- Application of wood preservatives to freshly cut rattan to provide temporary protection against insect or fungal attack prior to processing.
- Protection is limited to a short period of time.
- Examples of wood preservatives: Propiconazole, deltamethrin, DOT to protect freshly cut rattan from fungal attack or deltametrhin against beetle damage. If the problem are both insects and fungi, deltamethrin and propiconazole or TCMTB can be tank mixed.

2. Preventive treatment

- Application of preservatives to conditioned rattan to prevent attack in conditioned rattan with long lasting efficacy.
- Keep treated rattan from rain to prolong its service life.
- Examples of wood preservatives: Deltamethrin or permethrin to protect conditioned rattans from beetle infestation. Application of fungicides to conditioned rattans is not necessary because MC is below 30%.

3. For Remedial/Curative Treatment

- Application of preservatives on rattan with existing fungal or insect attack .
- Example of wood preservatives: Propiconazole, TCMTB or DOT for fungi and deltamethrin or permethrin against powder-post beetles.