PLANTATION CROPS
(TANAMAN PERLADANGAN)
AGR 3501

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Selangor Darul Ehsan
PENGENALAN KURSUS

a. Maklumat Kursus

Jabatan : Jabatan Sains Tanaman
Nama Kursus: Tanaman Perkadangan
Kod Kursus : AGR3501
Jam Kredit : 2 (2+0)

Penerangan dan Ringkasan Kursus


b. Maklumat Penulis

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c. **Objektif Kursus / Hasil Pembelajaran**

Pelajar dapat:

1) Menguraikan konsep dan faktor pengeluaran tanaman perladangan (C4)
2) Merumgkai aspek pemasaran, ekonomi dan isu semasa berkaitan dengan industri perladangan (P3, CTPS, KK)
3) Membandingkan sistem pengurusan tanaman perladangan dengan mengambil kira aspek pemeliharaan alam sekitar (A4, EM)

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d. **Sinopsis Kursus**

Kursus ini meliputi prinsip pengeluaran, pengurusan, pemasaran dan ekonomi, arah aliran dan perkembangan industri tanaman perladangan utama.

(This course covers principles of production, management, marketing and economics, trends and development of major plantation crop industry).

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e. **Kandungan Kursus**

Pengenalan kepada industri peladangan
- isu-isu semasa
- cabaran

Morfologi dan sekitaran
- botani dan pengelasan spesies
- sekitaran dan iklim
- faktor pertumbuhan

Pembiakan
- pengeluaran benih/ pemiakbakaan
- semai

Pembangunan kawasan dan penanaman
- pembersihan kawasan dan pengunaan
- biomass ladang
- menanam di ladang

Penyenggaraan kawasan
- merumpai dan membaja
Pemeliharaan tanaman
- Kawalan penyakit dan makhluk perosak

Kaedah penuaan hasil dan pemprosesan
- kaedah eksploitasi hasil getah
- penuaan dan pengangkutan kelapa sawit

Integrasi temakan dan peladangan
- faedah dan kekangan
- infrastruktur dan kaedah
Kos modal dan operasi
- kos pembangunan dan infrastruktur
- kos buruh
- harga produk dan pulangan

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<td>Oil palm Industry in Malaysia, taxonomy and morphological description</td>
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<td>2</td>
<td>Oil palm seed production and nursery establishment and management</td>
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<td>7</td>
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**PART 2 : RUBBER**

<table>
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<td>2</td>
<td>Pembelajaran kendiri</td>
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<td>Sesi tutorial (jika berkenaan)</td>
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<td>Pembelajaran berkumpulan</td>
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<td>Online (email/telefon/LMS/kelas maya) antara pensyarah/pengajar dan pelajar</td>
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<td>6</td>
<td>Latihan/kuiz</td>
<td>16 jam</td>
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**Jumlah Jam Keseluruhan**: 80 jam

*Penilaian Kursus berubah dari semasa ke semasa bergantung kepada pensyarah/pengajar kursus pada semester berkenaan*

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<th>Pests and diseases of rubber and their management</th>
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<td>Harvesting of latex</td>
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**Jumlah Jam Kuliah**: 28

*Pembelajaran Maya : 1 jam kuliah bersamaan dengan 3 jam pembelajaran kendiri*
h. **Ujian Teori**

Ujian teori perlu diduduki oleh pelajar. Soalan ujian yang akan
dikemukakan adalah berdasarkan isikandungan modul, nota kuliah dan
bacaan dari buku rujukan yang diberikan. Bentuk soalan bagi Ujian
adalah berbentuk esei pendek. Maklumat mengenai peperiksaan
seperti bentuk soalan, bilangan soalan dan topik yang terlibat akan
dimaklumkan kepada pelajar semasa perjumpaan bersempura.

i. **Peperiksaan Akhir**

Soalan peperiksaan ini akan merangkumi kesemua topik dalam
modul, walau bagaimanapun penekanan diberi kepada topik-topik yang
belum dinilai. Tutor di pusat pembelajaran akan dimaklumkan
mengenai topik-topik ini, atau pelajar boleh berhubung terus dengan
ensyarah kursus untuk mendapatkan maklumat terkini.

j. **Rujukan Buku Teks**

Pelajar boleh merujuk kepada buku teks seperti disenarikan di bawah
untuk mendapatkan maklumat terperincii mengenai setiap topik
pembelajaran atau untuk tujuan tugas.

   panduan*. Kuala Lumpur: MPOB
   Getah*. Kuala Lumpur: RRIM
   Blackwell Publication.
   Science*. New York: Springer
<table>
<thead>
<tr>
<th>UNIT</th>
<th>TAJUK</th>
<th>MUKA SURAT</th>
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<td>PLANTATION MANAGEMENT PRACTICES</td>
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<td>HARVESTING AND FRUITS TRANSPORTATION</td>
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<td>INTEGRATION IN OIL PALM PRODUCTION</td>
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<td>10</td>
<td>RUBBER PLANTATION ESTABLISHMENT</td>
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<td>11</td>
<td>MANAGEMENT PRACTICES IN RUBBER PLANTATION</td>
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<tr>
<td>12</td>
<td>PESTS AND DISEASES OF RUBBER AND THEIR MANAGEMENT</td>
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<tr>
<td>13</td>
<td>HARVESTING OF LATEX</td>
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UNIT 1
OIL PALM INDUSTRY IN MALAYSIA, TAXONOMY AND MORPHOLOGICAL DESCRIPTION

TOPIC 1: INTRODUCTION TO OIL PALM

a. Oil palm, a native of West Africa, has long been known for its great economic important in West African countries. Palm oil, a vegetable oil obtained from the mesocarp of the fruits serves as a major important product of this tree, follows by palm kernel oil which is obtained from the nut after crushing the hard central shell.

b. The residue of the nut is a major ingredient in animal feed industries due to its high proteinous nature. The oil palm gives the highest yield per hectare of all oil producing oil crop.

c. The product (Palm oil) of this tree became the major raw material of lubricant use for machineries in Europe during the industrial revolution. And this later form the major raw material in the production of soap production by several companies such as Lever brothers, America palm olive.

d. The crop has been use as a source of foreign exchange earning in West-African countries such as Nigeria, Ghana since 1870s and it was later overtaken by Cocoa. The success of this industry in Africa has been limited as a result of political instability, intermittent war, and others horrible situations.

e. However, in South-east Asia, the earliest record of introduction of oil palm was four seedlings planted Buitenzorg (present Bogor) botanical garden located in Java in 1848 (known then as Dutch East Indies).

f. Two of these seedlings are taken from Amsterdam botanical garden and while the other two are from Mauritius. There is uniformity in the progeny of these palms and in 1875 the progenies from these palms were transferred to Sumatra in the present Indonesia and these became the foundation stock for oil palm industries in South-east Asia.

g. Furthermore, in 1917, the first true plantation of oil palm came into existence in Selangor district of Malaysia and by 1925 a total of 3350 ha of land was occupied by the oil palm plantation, later increased to 20,000 ha shortly before world war two. Private individuals have started taken interest in oil palm cultivation and conversion of land from other cultivated crops to oil palm plantation was increasing and this lead led to the rapid growth of the sector.

h. However in Malaysia, intensive research and development of oil palm breeding started in the 1960s after the establishment of exchange program by Malaysian
Agricultural department with West African economies and four private plantation companies established laboratory for the breeding laboratory for the improvement of oil palm. In addition to this, the government also established the Kolej Serdang which later becomes Universiti Pertanian Malaysia (UPM) with first session in July 1973 to train the people in the area of agriculture, agro industrial engineering and agro business to conduct research.

i. In addition to that, as a result of lobby by the oil palm planters, the government was able to set up a body known as Palm oil Research institute of Malaysia (PORIM) in 1979 with the support of UPM and Malaysian Agricultural Research and Development institute (MARDI).

j. Also, on 1st of May 2000, the mother research institute was incorporated by an Act of parliament (Act 582) and name Malaysia Oil palm Board (MPOB). This came up through a merger, the function of the Palm Oil Research Institute of Malaysia (PORIM) and the Palm Oil Registration and Licensing Authority (PORLA). Till date, MPOB has been a world leader in research and development of oil palm and its related product.

**TOPIC 2: SIGNIFICANT OF OIL PALM TO MALAYSIA NATIONAL DEVELOPMENT**

a. Presently in the world of fat and oil, oil palm is the most preferred and it account for about 27% of world fat consumption.

b. Oil palm is today is regarded as the golden crop of Malaysia and it is position as first in the list of Malaysia cash crop. Also, Malaysia occupies a world leader in terms of research and commercialization of oil palm.

c. At present about half of the world vegetable oil in the International market is from Malaysia. And oil palm is the most productive crop in terms of land use efficiency when compare to other oil crop.

<table>
<thead>
<tr>
<th>Total World Oils Fats Production 2008 (160 mil MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others</td>
</tr>
<tr>
<td>Laurics</td>
</tr>
<tr>
<td>Animal Fats</td>
</tr>
<tr>
<td>Sunflower oil</td>
</tr>
<tr>
<td>Rapeseed oil</td>
</tr>
<tr>
<td>Palm oil</td>
</tr>
<tr>
<td>Soybean oil</td>
</tr>
</tbody>
</table>

2
Global Palm Oil Production

Malaysia = 41.3% of world production

<table>
<thead>
<tr>
<th>Countries</th>
<th>Volume (000 tons)</th>
<th>% Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cote d'Ivoire</td>
<td>330</td>
<td>0.8</td>
</tr>
<tr>
<td>Nigeria</td>
<td>860</td>
<td>2.0</td>
</tr>
<tr>
<td>Colombia</td>
<td>800</td>
<td>1.9</td>
</tr>
<tr>
<td>Ecuador</td>
<td>420</td>
<td>0.9</td>
</tr>
<tr>
<td>Indonesia</td>
<td>19100</td>
<td>44.5</td>
</tr>
<tr>
<td>Malaysia</td>
<td>17735</td>
<td>41.3</td>
</tr>
<tr>
<td>Thailand</td>
<td>1160</td>
<td>2.7</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>400</td>
<td>0.9</td>
</tr>
<tr>
<td>Others</td>
<td>2100</td>
<td>4.9</td>
</tr>
<tr>
<td>Total</td>
<td>42904</td>
<td>100</td>
</tr>
</tbody>
</table>

(Oil World 2008)

Oil Palm – the most productive oil crop

<table>
<thead>
<tr>
<th>Oil Crop</th>
<th>Production (million t)</th>
<th>% of total production</th>
<th>Total area (million ha)</th>
<th>% of total Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil palm</td>
<td>42.99</td>
<td>33.58</td>
<td>10.60</td>
<td>4.74</td>
</tr>
<tr>
<td>Soya bean</td>
<td>36.87</td>
<td>28.80</td>
<td>94.25</td>
<td>42.50</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>19.82</td>
<td>15.48</td>
<td>27.15</td>
<td>12.25</td>
</tr>
<tr>
<td>Sunflower</td>
<td>10.80</td>
<td>8.62</td>
<td>24.09</td>
<td>10.87</td>
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</tbody>
</table>

Source: Oil World Jan 30, 2009 and Oil World 2008

Source: USDA, 2011
Exercise 1

i. Using tables and figures briefly explain the role of oil palm among other oil producing crop in the world of fat and oil.

ii. Briefly describe the introduction and development, importance of oil palm to Malaysia as a country.

iii. When was MPOB established and for what purpose?

iv. When was the first oil palm plantation established in Malaysia
**TOPIC 3: TAXONOMY**

<table>
<thead>
<tr>
<th>Taxonomy class</th>
<th>Nomenclature</th>
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<tbody>
<tr>
<td>Kingdom</td>
<td>Plantae</td>
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<tr>
<td>Division</td>
<td>Magnoliophyta</td>
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<tr>
<td>Class</td>
<td>Liliopsida</td>
</tr>
<tr>
<td>Super order</td>
<td>Areicidae</td>
</tr>
<tr>
<td>Order</td>
<td>Arecales</td>
</tr>
<tr>
<td>Family</td>
<td>Arecaceae</td>
</tr>
<tr>
<td>Subfamily</td>
<td>Cocoideae</td>
</tr>
<tr>
<td>Genus</td>
<td>Elaeis</td>
</tr>
<tr>
<td>Species</td>
<td><em>Elaeis guineensis</em> Jacq. (African oil palm)</td>
</tr>
<tr>
<td></td>
<td><em>Elaeis oleifera</em> (South American oil palm)</td>
</tr>
</tbody>
</table>

**TOPIC 4: MORPHOLOGICAL DESCRIPTION OF OIL PALM TREE**

**Features of vegetative part of Oil palm tree**

a. The main components of a mature oil palm are the Leaves, trunk and the root.
b. The leaf of this plant is regarded has frond and each tree has a total of 30-50 fronds per year.
c. On average, each mature palm produces 2-3 fronds per month, while the immature young palm has a production of 3-4 fronds.
d. Each of the mature fronds has three features which are rachis, leaflets and thorns.
e. The fronds are spirally arranged on the trunk, either clockwise or anti clockwise.
f. The trunk is unbranched part of the palm tree, which serve has the link between the fronds and the roots.
g. The trunk provides the medium through which nutrient and water are supply to the leaves and other part.
h. It varies in length depending on the clones with diameter of about 45-60 cm on average.
i. The root gives stability to the tree, it absorb water and nutrient from the soil.
j. This plant has a fibrous rooting system with monocotyledon
Features of Reproductive Part of Oil Palm tree

a. The oil palm is a monoecious plant having both male and female on the same tree. The hermaphrodite inflorescence are formed at the onset of flowering period and usually located at the axil of every found.

b. The male florescence comprises of a finger-like spikelet, each has a length of about 12-20 cm, the spikelets are formed from the stock and they are up to 200 in numbers found in each of the inflorescence.

c. Each male inflorescence produces in total about 25-30 g of pollen at the tips of spikelets depending on the maturity of the palm.

d. The male flower opening with two or three days with smell of aniseed, after which the spikelets turn brown as a result of attack from fungi.

e. The female inflorescence has a shape like that of a large bud, about 24-25 in length. Present in this inflorescence are thousands of flower which originated from the spirally arrange thorny spikelets.

f. The female flowers open within three to five days. The aniseed smell flower changes its yellowish to white colour to pinkish-brown after anthesis. The flowers open one after the other in succession from top to bottom of the inflorescence.
The Features of palm fruits

a. The fruits of the palm tree ripe 5 to 6 months after pollination
b. The fruits have an average length of about 5cm and 30 of weight depending on the clone.
c. Each of the bunches has weight of about 20-30 kg and contains about 1600 fruits.
d. The fruit is a dupe with a mesocarp surrounding the seed and contains the oil while the seed contains nut from which a translucent oil known as palm kernel oil is obtained when press.
e. The fruit is divided into shell, mesocarp and kernel
Exercise 2

i. Mention the functional parts of oil palm tree and their use

ii. Differentiate between the male and female inflorescence oil palm reproductive palm.

iii. What are the features of oil palm fruits?
UNIT 2
OIL PALM SEED PRODUCTION AND NURSERY ESTABLISHMENT AND MANAGEMENT

TOPIC 1: SEED PRODUCTION AND GERMINATION

Productivity in oil palm industry have been improved through research and breeding of high quality planting material with good yield traits such as FFB, bunch number and bunch weight. Seed production is a very important part of oil palm production. Good quality seed production is one of the keys to success, it is one of determinant of yield and productivity. The best planting materials at present are the cross between the Dura and Pisifera (D×P), known as Tenera.

The best Dura and Pisifera are selected from various progeny trials material use for the evaluation. This process is done by mating several female (Dura) palm with male (pisifera) to get the best cross, it is after this is done that the best parent material are selected.

Crossing of Dura and Pisifera

![Crossing of Dura and Pisifera](image)

10
Crossing: This is an important step in seed production. It is done through control pollination.

PROCEDURE FOR CONTROL POLLINATION

A. Pollen Harvesting and preservation
   a. The selected male palm (pisifera) is cover with a plastic bag (size 46cm by 61cm) with a transparent plastic window 10 days before the maturity of the pollens. Pollens are said to mature when the flower sheath starts to split.
   b. Spray the inflorescence surface with formalin (40% formaldehyde with 10 parts of distilled water) to kill any germs and foreign pollen.
   c. Put a cotton wool soak with insecticide around the stock of the inflorescence during the period it is cover with pollination bag.
   d. Once the pollen matures, the ripe male inflorescence should be severe and take to the lab together with the pollination bag.
   e. Shake the inflorescence to release the pollen, then sieve through 70 mesh sieve and keep in the paper bag.
   f. Dry the pollen in the oven for 2 days (48hrs) at temperature of 35°c-40°c
   g. Put the pollen in air tight plastic and keep in the freezer at -5°c.

The viability of the pollen should be tested using boric acid or agar as the medium for it is use for crossing. The pollen with less than 60% viability is not advisable to be use.
B. Preparation of female (Dura palm) inflorescence

In preparing the female parent for control pollination, the following are the steps taken to ensure maximum fertility

a. The female inflorescence should be spray with formalin 10 days before the anthesis.
b. Enclose the inflorescence in a 48cm by 61cm bag made of canvas with a small transparent window made of plastic.
c. When the inflorescence has fully attained it anthesis, make a small opening on the top of the canvas bag. Anthesis can be detected when the colour changes from white to pale yellow. This occurs within the period of three to five days, i.e. 72-120 hrs.
d. Spray the purified pollen around the upper part of the inflorescence (upper space of the bag) about 5 times to ensure that pollination occur throughout the inflorescence.
e. The canvas bags should not be remove until the fruits in the bunches fully develop. This takes about six month from the date of pollination.
f. Female inflorescence covered with canvas bag with transparent plastic windown
C. Seed Harvesting and Processing

Fruit maturity and Ripening in oil palm usually takes about 5-6 month from the day pollination occurred. The product of this crossing is referred to as hybrid fruits. The following are the steps taken to harvest and process the fruits to get the seed.

a. The bunch containing the hybrid fruits are severe from the palm tree once the fruits have fully matured and ripe.

b. Follow by separation of spikelets from the bunch, then keep the spikelets in the sack bag for about 2-3 days to ease the removal of fruits from the spikelets.

c. Remove the fruits spikelets and put in the mechanical device known as depericarper for 1-2 hours in order to remove the pericarps

d. Remove the remaining pericarp by scraping the seed to ensure adequate cleaning of the seed.

e. Sorting is done to ensure only the healthy seeds are selected by excluding those seed that are too large or too small, those that have white shell and those with double seeds.

f. After, sorting the good seeds are soak in fungicide for 2 minutes

g. Dry the seed on the clean surface for 48 hours at room temperature.

h. Pack the dry seeds and store at 18°C-20°C or proceed to germinate the seeds (moisture content of seeds at this time is about 18%-19%).
D. Seed Germination process

For optimum germination of seeds, the procedures stated below are to be taken.

a. Pack the dried seeds into a plastic bag with 30cm by 45 cm dimension.
b. Put the bag containing the seed into an incubating room with temperature 38°C-
40°C for 40 days.
c. At 10 days interval check moisture content and examine the presence any fungi
infection.
d. After 40 days, take out the bag and soak the seed in water for 2-3 days to raise
the moisture content to 20%-22%.
e. Take out the seed bag and rinse them in clean water, then deep the seeds in
fungicide for not more than 2 minutes.
f. Put the wet seeds in the transparent bags at the rate of 500 seeds per bag.
g. The germination of the seeds commence after 7-10 days, and germination reach
about 90% after 30 days.
h. As from 10 -14 days after the commencement of germination, the vigorous seeds
can be planted in the polythene bags in the nursery.
Germinated seeds at various days after germination

Exercise 1

i. Is good seed important in oil palm production? Give reasons.
ii. Briefly describe the process of hand pollination in oil palm.
iii. Mention the steps involved in seed processing.
iv. What is the importance of formalin in seed pollination process?

v. Describe how you will germinate a viable seed given to you during laboratory class.
**TOPIC 2: NURSERY ESTABLISHMENT**

a. Nursery is a place where germinated seed are grown and taken care of before they are transplant to the field.

b. It plays a very important role in the production and nurturing of oil palm seedlings. Nursery offers a place where careful selection and sorting of seedlings are done to ensure healthy seed are planted.

c. Also it enables the farmer to reduce the number of causalities as a result of harsh environmental conditions by offering enabling environment to ensure full growth and adequate supervision. In addition to that nursery offers uniform treatment and care to the young seedlings.

**A. Factors consider when choosing the site for Nursery.**

a. The place meant for nursery should be close to constant and adequate source of water. Constant and sufficient water supply in nursery is very important for successful establishment. An hectare of oil palm seedlings requires about 77 000 liter of water per day.

b. Also, nearness to the field to which the seedlings are going to be planted is also very important. This will help to reduce the problem of seedling transportation and other associated problems and cost.

c. In addition, nursery site should be close to source of good soil suitable for filling of the polybags.

**B. Procedure for setting up Nursery**

a. Clear the site of grass, and other forms of obstruction manually using hoe or spraying with herbicide.

b. Ensure the nursery area is flat otherwise do terracing of the slope to ensure the gradient is suitable.

c. Create a deep drainage around the nursery if the nursery is sighted in the valley, this is need to prevent water logging or flooding of the nursery during heavy rainfall.

d. Construct a wire fence around the area to prevent rodent and wild predator wild boars, monkeys etc. such as from gaining entrance into the nursery.

e. Construct sprinkler irrigation system to ensure adequate and uniform water supply to all the seedling in the nursery.

f. The size of nursery depends on the number of seedling intended to be raised, however an hectare of land can accommodate 12500 seedlings.

g. The polybags to be use for nursery must be black in colour, otherwise once penetrated by the sunlight, it will spoil in less than 12 months.
C. Type of Nursery System

There are two type of nursery system in oil palm production.

1. The one stage nursery
2. The two stage nursery

**The one stage nursery:** This involves the use of large polybags sufficient enough to accommodate the growth of the seedling till it is transplanted to the field. The size of the polybags: 38 cm wide and 51 cm tall when laid on the flat surface. The thickness is 500 gauges (i.e. 0.12 mm). 5 mm holes should be made on the polybags at 8m by 8 cm spacing. This is use for spacing out, then later 46cm wide and 61cm long polybags are use for the replacement.

**The two stage nursery:** This type of nursery where the seedlings are first sowed in a small polybags of sizes of polybags of 15cm wide and 23cm length. The later they are transferred to bigger one of size 38cm x 51 cm, then replacement is done using 46cm x 61cm polybags. The size of hole which is 5mm diameter at 8cm x 8cm interval is the same for the two types of nursery systems.

**NOTE:** The only different between the one stage and two stages nursery is that seedlings are sowed directly in big polybags of size 38cm x 51 cm in one stage before replacement while in two stage nursery seedlings are first sowed in the small polybags of size 15cm wide and 23cm length before transfer into 38cm x 51 cm.

D. Soil Filling of the Polybags

a. This involves filling of polybags with soil and other materials at a certain ratio.
b. The fillings of polybags with soil are done one month before the arrival of the planting materials, the seedlings to be planted.
c. Good, fertile and top soils such as Rengam, Jerangau, Selangor or Munchong are use for this purpose.
d. Soil mixture ratio such as state below are normally use
   i. Topsoil, alluvial clay and sand = 3:1:1
   ii. Loose-texture clay, sand, organic fertilizer = 6:2:1
   iii. Top soil, sand = 3:1
E. Important Points to note during the process of filling of polybags

a. Only fine soil should be use, large and coarse soil should not be used.

b. Incase hard soil such as Durian or Briah series, the soil has to be mixed with coarse river sand at a ratio 3:2 i.e hard soil: river soil.

c. Soil with high content of organic matter should not be use because they slow down or prevent root growth. This soil type also aids the attack by *Culvularia*.

d. Insecticide should not be mix with the soil, this may have a toxic or devastating effect on the seedlings.

e. Only dry should be use, to prevent the formation of air pocket.

f. Water the filled polybags alternate days to make the soil settle. Continue this until the sand settle down to about 1 inch from the top of the polybags.

g. The polybags should be arranged in a rectangular shape, four bags wide and 25 bags long for single stage nursery while square shape arrangement for two stages nursery, 10 bags by 10 bags.

h. Spacing between the lanes on the long side of the bags should be 0.6m while for the short side is 0.3m.

i. The long side of 0.6 rows must be arranged from east to west, in order to reduce the effect of strong light.

j. Sowing can commence once the bags has been properly arranged.

k. The orientation of the bags should be changed after three month from the date the seedlings are sowed.

F. Sowing of Germinated seeds

The following precaution should be taken while sowing the germinated seeds

a. Sowing should be done on time and should not exceed four days after the seeds are received.

b. The growing seed should not be treated again with chemical to avoid damage since they have been treated earlier.

c. The sowing depth should be about 1.8cm below soil by using your finger to make about 2.5 cm wide, too deep sowing should be avoided.

d. Sow the seeds with shoot facing up with the root facing down. The root parts look hard and brown in colour while the shoot part is white and translucent.

e. On average about 1400 to 1500 seeds per day can be sowed

f. Watering should be done after the process
Exercise 2

i. Why is nursery important in oil palm production?
ii. List and state the four important nursery features
iii. Why is black colour polybags use in nursery
iv. Differentiate between two stages and one stage nursery
v. Describe how you will sow/plant the newly germinated oil palm seed in polybags
TOPIC 3: MANAGEMENT PRACTICES IN NURSERY

A. Shading
   a. This is done to prevent scorching due to excessive sunlight reaching the young seedlings.
   b. This is necessary when the seedlings are just growing and this should be done at about 70%-80%, then reduce it gradually until the seedling are about 10 weeks old or having two leaves.
   c. The could be done by erecting a pole at the four corner of the nursery to about 1.8m height together with dry palm fronds treated with insecticides to prevent attack by insect.

B. Mulching
   a. This act of using dry plant material to cover the soil surrounding the growing seedling. This is necessary when shading is absent.
   b. Mulching helps to increase soil water retention, minimize soil temperature and prevent soil erosion.
   c. Materials suitable for mulching include dry broken palm kernel shells, chopped leaves etc. and this should be applied with thickness of about 2.5 cm.

C. Watering
   a. This becomes extremely important if the rain is absent, to prevent scorching and drying up of seedling
   b. Watering should be done before 11 am and after 4 pm in the evening and avoid doing this between the stated times.
   c. Effective watering should be carried out as this affects the success of the nursery, about 0.5 liter of water per seedling per day and increase to about 2.5 at the 11 months of age.

D. Weeding
   a. This is act of keeping away an unwanted grass away from the seedling to prevent them from competing with seedlings for soil moisture, nutrients and space.
   b. Weeds in the polybags should be remove with hand
   c. The weeds present between the polybags can be remove using hoe (cangkul) Contact herbicide could also be use for these weeds.
   d. Systemic herbicide such as 2,4-D should be avoided to prevent damage to the seedlings.
E. Fertilizer Application
a. Balance fertilization is need for healthy growth of seedling
b. Fertilizer application in form of spray is needed to be done after the seedlings have grown of two leaves, before this stage the seedling can survive with the seed store nutrients.
c. Mineral fertilizer containing all the required nutrients (N, P, K, Mg) should be given the seedlings.
d. Additional fertilizers should be applied to seedlings showing a deficiency of a particular nutrient.
e. Fertilizer application should be followed by watering to prevent scorching of leaves and stems.
f. Organic fertilizer of animal origin should be avoided at the stage it may lead to uneven growth.
g. Fertilizer application in spray form should be stop when the attained three to four leaves stage or after two weeks the seedlings are moved into large polybags.

F. Pests and diseases management in oil palm nursery
a. Control and pest is one of the important managements carried out in the nursery, however this is intensified when there is manifestation of any symptoms of pest or diseases outbreak.
b. Insecticide and fungicides use for management practices in the nursery are meant to be kept around in case of any outbreak.
c. Caution should be taken during the application of these chemicals by reading through the cover notes or instructions accompany them.
d. Application or spraying of these chemical should be done during the hot midday when the leaves are dry to enhance its effectiveness.
e. Fungicides containing copper should not be use at this stage, it can result into scorching of leaves.

<table>
<thead>
<tr>
<th>Pest</th>
<th>Symptoms/Harmful effect</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caterpillars</td>
<td>Defoliation of leaves and attack of shoots</td>
<td>Spray with Dipterex</td>
</tr>
</tbody>
</table>
| Cock chafers Apogonia burn | Create small holes in the leaves, rotting around the margins of hole | 1) Place fronds of coconut around the seedling to prevent the attack.  
2)Apply Bidrin @ 200g/ 100 liter H₂O  
3)Dipteroex @ 200g/ 100 liter H₂O |
| Crickets           | All parts of the leaves are eaten         | Spray with Dieldred the net of the cricket |
Red Spider mites and Aphids
Snails and Snugs
Suck the sap of the seedling, leaving a red spot on the surface. The snails eat the shoot and other soft parts.
Spray Rogor 40 at rate of 30g/30 liter of H2O.
Apply bait containing metaldehyde such as Siputox.

Rats and Squirrel
Attack the plant base and this sometimes lead to death.
Apply poison such as warfarin, zinc phospide.

Leaf rot
(*Helminthosporium*)
This occurs inform of rotting at the base of the plant. Leaves also appear to have blackish discolouration at the edges with intersecting brown stripes.
Apply 0.1% Thibensole for severe attack. Reduce the watering rate.

Seedling-blast
(*Rhizoctonia* and *Pythium*)
Old leaves turn brown and dry from the tips downward; Root becomes soft, wet and turns dark brown.
Avoid overcrowding of the seedlings, and spray fungicide e.g. Thiram at rate of 30g/15 liters of H2O together with a stick agent such as Zineb or Captan.

Antracnose
(*Melanocarium elaeidis*)
Appearance of brown small spots between the veins at the end of the leaves.
Treat the disease as that of seedling blast.

**G. Culling/ Seedlings selection**
This is an important practice done before the transplanting of seedling to the field, to ensure that only the good and healthy seedlings are planted in the field, also to prevent the abnormal seedling and diseased seedlings transplanted.
The following sets of seedlings are culled:
- a. Grass-like leaves
- b. Twisted shoot or leaves
- c. Curled or wrinkled leaves
- d. Shrunken leaves
- e. Severe diseased seedling

**Exercise 3**

i. List and explain importance of 5 major management practices in nursery

ii. List two diseases and two pests of oil palm, their symptom and control.

iii. Why is culling/ seedling selection done in the nursery?
TOPIC 1: LAND CLEARING

a. Malaysian government is very strict on open burning.
b. Zero-burning method is applied in land clearing both in replanting and new land area.
c. This involves various land preparation involve for the establishment of a plantation, this include land clearing, layout and other related activities. This also involves the use of various machineries to do the clearing.
d. Machinery such as bulldozer and others are use all through for carrying out all the clearings activities.
e. This method is very effective as trees are uprooted completely leaving behind no obstacle on the field.
f. Large area of land can be cleared within the short period of time and it required few people to do the operations i.e. about 1.5 hectare can be cleared within five hour with one bulldozer.
g. Details stages of land preparation will be discussed in face to face classes.
TOPIC 2: AGRICULTURAL ROAD AND DRAINAGE CONSTRUCTION

A. Road construction in Oil palm plantation

a. This is very important in plantation, good road network is needed to facilitate transportation of inputs and harvest in and out of the farm.
b. The road are divided into two, the main road which link the plantation with other road within the locality at which farm is situated, while the other road is the subsidiary road which link the various section of the farm.
c. The main road is expected to be as wide as 5.5m and should stretch to about 25m per hectare connecting the other sections of the farm to the main road, also, the subsidiary road should be about 3.5m wide.
d. The road should be bulldoze to make it smooth and laterite could be added to strengthen it.
e. The road intersection should be made the right angle T-junction

B. Drainage construction:

a. A good Drainage system is needed to control erosion and prevent flooding as a result of heavy rainfall.
b. Good drainage system is necessary for maintain soil water table. This is particularly needed in the swampy area, low lying area.
c. Types of drains present in use in the plantation
I. Main drain, this carries the main outflow of water within the estate to the rivers around the estate. The dimensions are
   i) 1.2 x 1.0 x 0.6 m or
   ii) 1.5 x 1.2 x 1.0 m

II. Secondary drainages, they are small to medium size drainage, they discharge directly into the main drain. The dimensions are
   i. 0.6 x 0.6 x 0.3 m for small size
   ii. 1.0 x 0.6 x 0.3 m for medium size.

d. For peat area, the water table here is very high, just about 0.3 m below the soil surface. The dimension is different
   i. 4.2 x 1.8 x 2.1 m - Large drains
   ii. 1.5 x 1.5 x 1.5 m - Medium drains:
   iii. 0.9 x 0.6 x 0.9 m - field drain

e. While in acid sulphate soil, the following dimensions are use
   i. 3.3 x 1.2 x 1.8 to 2.4 m - Large drains
   ii. 2.0 x 0.6 x 1.5 m - Medium drains
   iii. 1.0 x 0.45 x 0.75 m - field drain
**TOPIC 3. LINING OF PLANTATION FIELD**

a. This should commence once all the land clearing activities have been completed, at most one month before the arrival of the seedlings.
b. Lining make the field to look neat and well organized.
c. Good lining enables the movement of machineries within and between the palms in the plantation.
d. The lining orientation should be in such a way that, the row will be laid out on a north-south so that the palm will receive maximum sunlight.
e. The row should be planted parallel to the drain and harvesting path and at right angle to the road meant for transportation.
f. The recommended spacing is about 8.8 x 8.8 x 8.8 m or (29 x 29 x 29 ft) and this will result into 149 stands/ hectare

**Materials use for lining includes**

a. Measuring tape
b. White paint
c. Raffia Strings or ropes
d. Wooden poles of different sizes (i) 1.3m long and 2.3 cm wide about 118 pieces as ordinary stakes (ii) 1.5 m long and 2-3 cm wide about 30 pieces as guide stakes.

**TOPIC 4. PLANTING OF COVER CROPS**

Leguminous plants are use for this purpose. The important and significant of this practice are stated below:

a. Cover crops help to suppress or reduce weed growth
b. It helps to conserve and improve soil nutrient through addition of nitrogen
c. Also cover crops conserve soil moisture, improve soil structure and aeration
d. Cover crops help to reduce soil erosion and leaching of soil nutrients
e. some common leguminous cover crops use in the estates are as follow

*Pueraria phaseoloides*
*Mucuna cochinchenensis*
*Calopogonium caeruleum*
*Centrosema pubescense*
*Pueraria javanica*
f. The seed of the legumes could be treated with hot water at 75°C to break the dormancy.
g. The legumes seeds to be planted should be mixture of two of three different crops.
h. Fertilizer could be applied to aid the growth of the cover crops.
i. Pest should also be control using Dipterex SP80 or Sevin in case of beetle or Meta bran in case of slug and large snail infestation.

Partial overview of cover crops

Exercise 1

i. In sequential order, list all the step involve in field preparation in oil palm plantation establishment.
ii. Why do you need to cover crop in oil palm plantation?
iii. What role do drainages play in plantation?
iv. What is significant of road construction in oil palm establishment?
v. Is lining as one of preplanting operations important? Give reasons to support your answers.
TOPIC 5: PLANTING SEEDLING ON THE FIELD

Planting operation: This is also referred to as field planting operation carried out after all the pre planting activities have been. In Malaysia, this activity takes place in rainy season and this is occurs earlier in April, may, June and in the later part year which is around September, October and November. So planting is done in this month.

a. The seedling must have attained at least 11 month age before suitable for planting in the field.
b. Selection of healthy and suitable seedling and pruning must be completed three weeks before the transplanting.
c. Thorough watering should be done and treatment with insecticide.
d. Planting hole dug using mechanical driller or hoe as the case may be should be ready at least 3 week before the day to provide sufficient sunlight penetration.
e. Depth of the hole should be about 10 cm greater than the polybags to ensure adequate stability of the seedling.
f. Apply the phosphate fertilizer to the bottom of the hole, this aid quick root development. Fertilizer such as Christmas Island Rock phosphate (CIRP) is use.
g. Steadily lower the seedling in upright position into the hole, once the polybags is remove.
h. Ensure that no part of the root is damage during the process and also ensure that polybags are completely torn off.
i. Before the plant start frutting, arable crops could be planted within the rows so that it can serve as a source of income to the farmer. This practice is referred to as Intercropping.
j. The crops are planted just within the three years of planting oil palm on the field.
k. Effort should be taken to ensure that the crops do not compete with the oil palm for nutrients and other things.
l. Common crops planted include cowpea, pepper, pineapples, soybeans etc.
UNIT 4
PLANTATION MANAGEMENT PRACTICES

These are various management practices carried out after the plantation has been established. These are done to ensure good growth and yield of the planted crop. Efficient managements are essential to ensure high profit margin as a result of increased yield. The following are some of the practices carried out after the establishment and planting of the seedlings on the field.

**TOPIC 1: FERTILIZER APPLICATION**

a. Oil palm needs an additional fertilizer to supplement the soil nutrient in order to enhance the growth and productivity of the palm. Some of the needed by oil palm include Nitrogen, phosphorus, potassium, Magnesium.

b. Nitrogen is needed for chlorophyll formation for which it deficient will result into yellow colouration of the leaves in oil palm.

c. Phosphorous is essential for nucleic acid biosynthesis, root development and its deficiency of the nutrient element in soil on which oil palm is planted leads to delay in fruit ripening and reduction in fruit size.

d. Also potassium one of essential soil nutrient use for development of fruits and all its components e.g. shells, bunches, spikelles etc and absent of this in plant lead to orange spot formation on the palm leaves.

e. In addition to that, Magnesium is also required for chlorophyll formation and absent of this leads to yellow to green colour change majority at the lower part of the leaves.

Other required nutrient element is boron and deficient of this leads to bending or curling of leaves end.

a. Furthermore, the fertilizer requirement of oil palms depends on the nature and type of soil, age of tree and the nutritional status of the soil.

b. Fertilizer application should be carried out after weeding of the base of oil palm.

c. Fertilizer is application at the base should follow the shading pattern created by the palm tree of less than five years of age, because the root growth toward that direction. This will aid quick nutrient uptake roots.

d. Fertilizer is applied to oil palm two-three times per year depending on the need

e. Fertilizer application could either be carried out through manual using hand or using machinery such as fertilizer tractor.
f. Urea could be use as source of nitrogen, CIRP for phosphorous and Muriate of potash or Bunch ash as a source of potassium.
TOPIC 2: WEED CONTROL

This is another management practice carried out:

a. To maintain sanity of the field,
b. To reduce competition between weeds, leguminous plants and the palm tree
c. Aids the growth of oil palm and leguminous cover crop.
d. Prevents build up of pest and disease in the plantation by serving as host to the pathogen.
e. Weeding can be carried out manually when the oil palms are still young using hoe. It is carried out at least six times per year depending on the growth nature of the weed.
f. Weeding mature oil palm is done using herbicide at a very low concentration and the herbicide should be applied using sprayer and the person operating it should be fully dress with protective wear.
g. Spraying should be done carefully with nozzle lower to the ground and should be sprayed in the direction of the wind.
h. Care should be taken not to allow the herbicide to contact the fronds
i. Several type of sprayer can be use depending on the work load and other factors some of which are Manual Knapsack sprayer, Motorised sprayer, conventional Knapsack sprayer
j. Example of herbicide use in oil palm is Glyphosate 80% at rate of 450 liter/ hectare.
k. Weeding should be done around the base up to all the area covered by the fronds
Exercise 1

i. What are the precautions taken during planting of seedlings on the field?

ii. Is there any need for pruning of palm fronds. If Yes or No Support your answer with 3 reasons.

iii. Mention and explain the roles played by essential nutrient elements present in fertilizer that is applied to an oil palm trees?

iv. State two significant of castration in oil palm production.

v. Enumerate four importance of weeding as one of management practices in plantation.
UNIT 5
HARVESTING AND FRUITS TRANSPORTATION

These are the last set of field operations and each of these is carried out using different techniques tools and machineries.

TOPIC 1: HARVESTING

a. Good harvesting practices are aimed at ensuring minimum contamination of fruits, least damage to the fruits, harvest only ripe fruits
b. Harvesting usually starts when the oil palm have attained about 2½ - 3 years of age palm planted on the field.
c. Harvesting is carried out when the fruits on the palm trees have fully ripe. Maturity and ripening of fruits usually takes about five to six month after fertilization.
d. The frequency of harvesting is about 10-12 days interval and is done using harvesting pole.
e. Harvesting is done by cutting the stalk of the bunch of fruits using the sharp edge of knife fixed to the pole.
f. Fruits ripen when the colour changes from black to red- orange and a palm is ready for harvest when fruits begin to drop from the top of tree.
g. Only completely ripe bunches are harvested while the others remain on the tree till they ripe.

[Images of harvesting tools and methods]

Harvesting fresh fruit bunch (FFB)
**TOPIC 2: FRUITS COLLECTION AND TRANSPORTATION**

a. The bunches of fruits are collected in team by one or two men while one person harvest.
b. The fruit and bunches are pick and taken to the road side using basket or bicycle and later transfer to the tractor.
c. The stalk at the end of the bunch is cut to make least then 5 cm length to minimize oil absorption during processing.
d. The bunches of fruits and other fruits collected are taken to the factory for processing after the harvesting process is completed that same day.
TOPIC 3: PRUNING OF FRONDS

a. This is another management practices carried out on the plantation because of the following.
b. To ease the fruit harvesting and collection on the field.
c. To enable one to carry out weeding and fertilization application with ease.
d. It allow pollination and other related activities to be carry out with ease.
e. Pruning is done in young palms six month prior to harvesting by cutting the lowest frond after the inflorescence and the others are left.
f. Also pruning is carried out annually to remove the old and died front.
UNIT 6
INTEGRATION IN OIL PALM PRODUCTION

This is the incorporation of food crops and domestic animals into the plantation of oil palm.

Example of food crops grown in the plantation under this system includes: Pineapple, Banana, cowpea, Melon, pepper etc.

Example of domestic or farm animals use in this system includes: Cattle, sheeps, Goats, chicken, goose, ducks etc.

Advantage of integration of food crops or animal into the plantation:
  a. It increase the land use efficiency of the plantation site
  b. It increases the land and labour productivity.
  c. It increase the income of the farmer
  d. It helps to reduce the risk associated with crop failure, because the farmer can also get income from the sales of the animals or food crop.
  e. It help to control of weeds in the plantation since the animals will feed on them
  f. The waste produce by the animals helps to add organic manure to the oil palm

Factor consider when choose food crop for integration

  a. The age of oil palm
  b. The topography and soil type of the area
  c. The availability of labour
  d. The climatic condition
  e. The market availability of the crop
  f. The capital involve in the establishment
  g. The land area
  h. The agricultural system
Maturity days and labour requirement of some food crops

<table>
<thead>
<tr>
<th>Crop types</th>
<th>Maturity period</th>
<th>Labour (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>75 days</td>
<td>77</td>
</tr>
<tr>
<td>Watermelon</td>
<td>64-74 days</td>
<td>74</td>
</tr>
<tr>
<td>Potato</td>
<td>120 days</td>
<td>53</td>
</tr>
<tr>
<td>Ginger</td>
<td>8 months</td>
<td>230</td>
</tr>
<tr>
<td>Yam</td>
<td>7.5 months</td>
<td>240</td>
</tr>
<tr>
<td>Plantain</td>
<td>12 months</td>
<td>92</td>
</tr>
<tr>
<td>Pineapple</td>
<td>18 months</td>
<td>70</td>
</tr>
</tbody>
</table>

Age of oil palm and the percentage of land use for crop integration.

<table>
<thead>
<tr>
<th>Age of oil palm</th>
<th>Land area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>50-80</td>
</tr>
<tr>
<td>1-2</td>
<td>35-50</td>
</tr>
<tr>
<td>2-3</td>
<td>15-35</td>
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</tbody>
</table>

The following are the advantage of good integration on oil palm:
  a. Good integration with the Palm Plant
  b. Increasing organic matter content and soil nutrients further improve soil structure and water holding power
  c. Optimum use of land to help farmers income
  d. Disease & pest control biological
  e. Assist in weed control
Integration with watermelon (above) and upland rice (below)
Integration with banana

Factor considered when choosing the animal for integration
a. Security of farm to the animal and oil palm
b. Topography of the area
c. Size of the farm land
d. The required capital
e. The labour availability
Integration with cattle
Exercise 1

i. What are the importance of crop and animal integration in oil palm production?

ii. Mention 4 crops and 4 animals use for the integration

iii. What are the factor consider before chosen a crop or animal for integration?
UNIT 7
PALM OIL USES

a. Palm oil, a major product of oil palm is use virtually for all food products and processing.
b. Palm oil use in cooking, baking and frying
c. Palm oil is also use in the production of paint, soap and other detergents
d. Oil palm stem is use in the production of car interior decoration parts. It is use as timber and furniture products
e. Palm kernel, a product of palm fruit is use in the animal feed. It contains high amount of calcium and energy. It is use in feed formulation to enhance the animal growth.
f. Empty fruit bunch, a bye product of oil palm is use as mulch in nursery and in field. It helps to prevent excessive soil moisture lose, it helps to reduce the soil temperature and soil run off. It help to prevent wearing away of top soil around the plant. Empty fruit bunch also helps to add organic manure to the soil when it dry.
Use for production of margarine use in baking and paste making
Use in the production of sweets and other confectionaries
Use as source of oil and fat in the production of milk creamer, powdered milk, condense milk and evaporated milk
Creamer
Use in the production of soaps, detergents and other saponies

fat/oil based detergent
Use in the production of Body cream, lotion, cosmetics and other household products
Use in the production of paints, inks and other colouring products

Environment-friendly printing ink from palm oil

Economical, Good color tones & Environmentally friendly
Other uses include candles production, polymers, rubber, Biodesels, etc
UNIT 8
RUBBER INDUSTRY IN MALAYSIA, TAXONOMY AND MORPHOLOGICAL DESCRIPTION

TOPIC 1: BRIEF HISTORY OF ORIGIN AND DEVELOPMENT OF RUBBER INDUSTRY IN MALAYSIA

a. Natural rubber is one of the most important raw materials derived from rubber tree. *Hevea brasiliensis* a perennial crop with economic life span of about 30 years and member of euphorbiaceae family and one of the twelve heave group known to be producing natural rubber.

b. The tree is said to be a native of Amazonian rain forest of South America. *H. brasiliensis* been a tropical crop can strive well within the 1000km radius of north and south equator except for the extreme dry region (e.g. arid and desert region)

c. It requires about 1800-2500mm of rainfall evenly distributed and sunshine of about 25-35°C. The tree can survive at topography of about 500m above sea level.

d. *H. brasiliensis* grows well on a deep loamy soil with good drainage facility and water table of not more than 100cm from the soil surface. And it can attain an height of about 18-20 m when it is fully matured.

e. It fruits are juicy and edible, eaten by people of South America and it latex is use as a raw material for natural rubber production.

f. *H. brasiliensis* has been recognize for a very long time to be of economical important in America, Europe, however, the breakthrough in the industry occurred when the vulcanization process was discovered in 1839 and this resulted into rapid development of the many plantations and estates.

g. In 1876, about 70,000 seeds taken from Brazil were deposited at Royal botanical garden at Kew, England.

h. Later in 1877 some parts of these seedlings were sent to sri Lanka (formerly known as Ceylon), then out of these, 13 were taken to Singapore Botanical Garden and Nine from these seedling to Kuala Kangsar. Furthermore, it is from these that rubber spreads to the whole of south east Asia countries.

i. In 1888, intensification of research and development of rubber begins when HN Ridley became the director of Singapore Botanical Garden. He was able to develop excision tapping method. His finding also triggered the development in rubber in south-east Asia region.

j. In 1903, large scale planting of rubber started with establishment of rubber estate in Melaka and the year 1925 marks the beginning of research by Rubber
Research institute of Malaya (RRIM). Since then, RRIM has been pioneering R&D in rubber industry and she was further aided by Tun Abdul Razak Research centre (TARRC) in United Kindom.

k. Year 1998 marks the beginning of Malaysia Rubber Board (MRB) which came up as a result of merging Malaysia Rubber Research and Development Board (MRRDB) and Malaysia Rubber Exchange and Licensing Board (MRELB). Since then, MRB has continue to keep the ball rolling and the flag flying in the area of R&D of rubber, serving as one of the leading institute in research and development of rubber and its technologies.

l. Furthermore, economically, Rubber as a crop in Malaysia has been contributing to the growth and development of the country since 1950s. It has led to the social development of families feeding about 200,000 small holder’s families, employing about 64,000 workers.

m. The industry has contributed immensely the total export earnings of the country with about RM 5.3 Billion in 1990 it increased to about RM 25.3 Billion in 2007 through natural rubber and rubber wood.

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**Exercise 1**

i. From which family does rubber comes from?
ii. What are the environmental requirements of rubber?
iii. In which year and where was first plantation established in Malaysia?
iv. In what way has rubber contributed to Malaysian economy?
v. From which part of the world, rubber originated from?
TOPIC 2: FUNCTIONAL PART OF RUBBER TREE

Rubber tree has its part grouped into three major parts. This include the crown, stem and root:

A. Crown:
   a. This leafy part, just like other members of the euphorbiaceae family undergoes wintering as an adaptive measure to reduce water loss to the environment during harsh environmental condition.
   b. The rubber trees bear flower the male and female inflorescence on the same tree and produced fruits after pollination.
   c. The pollination is basically through insect and hand pollination is basically done during breeding programme.

B. Stem:
   a. This is also referred to as trunk, it is an unbranched part with central column referred to as medulla and it is surrounded by the bark the tree back is generally classified into three parts.
   b. The outermost layer the corky bark, this serve as the protective layer, the second layer consist of the bark stone cells, it also consist of some latex vessels.
   c. The third part is the soft layer, where several latex vessels are found. The medullary ray found at the back conduct water in one direction and food in the other direction.

C. Roots:
   a. This is the part of tree that enters the soil, it serves as the anchor for tree and it absorbs water and nutrients from the soil.
   b. The rubber has three categories of root, the tap root which is the central roots, penetrate deep down in the soil, it give anchorage to the tree, the lateral root also grows on it. The feeder roots are numerous in number, they absorb water from the soil through osmosis process. The root hair is the one responsible for nutrient absorption.
   c. Rubber tree needs to possess some characteristic for them have good productivity over live long period of time.
D. The below are some of the desired characteristic of a rubber tree

a. The tree must have a leave with broad size, shiny dark green colour to ensure adequate food production through photosynthesis.
b. The tree should have a good vigour to in order to have early maturity
c. The tree should have small side branches growing laterally to give stability.
d. The stem should be straight, smooth, cylindrical shape and upright in position.
e. The bark should be thick, smooth and quick in recovery after laceration to aid re-tapping.
f. The tree should be high yielding and little or no reduction in yield during wintering.
g. Respond to yield stimulant once it apply
h. The tree should have good latex with high dry rubber content
i. The tree should be resistant to diseases, back dryness and wind damage.

Exercise 2

i. Mention the three major parts of a rubber tree
ii. List the 3 categories of rubber roots.
iii. What are the importance of root to the plant
iv. List five desired characteristics a rubber tree should have
UNIT 9
RUBBER PROPAGATION AND NURSERY ESTABLISHMENT

TOPIC 1: RUBBER PROPAGATION

a. Propagation is the multiplication or reproduction of planting material so as to ensure their quantity and availability.
b. Propagation is necessary to ensure the existence of rubber tree.
c. Majorly, there are two ways of propagation. This includes the Sexual and the Vegetative ways
d. Sexual Propagation is the production through sowing of seed that came up as a result of fertilization between the two sex gametes. The outcome of sexual propagation is usually characterized with little or no uniformity. This process occurs naturally with the aid of insect and it also carried out by human during breeding program.
e. Vegetative propagation involves using of plant vegetative parts to multiply the plant. This method of propagation is very fast and the outcome is very uniform, with short regeneration period. The seedlings produced from this method are true to type the parent tree.
f. Techniques uses under vegetative methods such as Green budding and Young budding. For the green budding the seedling for root stock is raised in the polybags must have attained age of six month before the budding process take place, while in the case of young budding the seedling for root stock is just about 10 weeks of age. The root stock is raise by planting the rubber seed

TOPIC 2: NURSERY ESTABLISHMENT

A. Germination Of Rubber Seeds For Root Stocks

a. Rubber seed, a dycotyledon seed with semi hard seed coat with five sides namely frontal, sides, dorsal, ventral and micropyler.
b. A hole known as micropyle is present at one end of the seed coat, where plumule and radical appear during germination.
c. The seed originates from the fruits formed from the pollination between female and male flowers.
d. Fresh seed of rubber are use for planting as they easily lose their viability once they are expose to direct sunlight. The percentage viability decreases from 95% at the first day of exposure to 1% after four days.

e. The root stock originate from the seed has a great effect on the yield and growth of rubber in the later stage in the life of the tree.

f. For rubber seed to be viable, it must have the following
   i. It must be fresh and fell not more than two days
   ii. It must have a shiny appearance
   iii. Did not expose to direct sunlight
   iv. It should not be damage
   v. Has a big mass
   vi. Fall during the seeding season

B. Germination process

a. The fresh collected seed are place in the germination box prepare using 15 cm height and 100cm (depending on the number of seeds to be germinated) of loose soil, river sand or saw dust.

b. The seeds are place with their germination bed and press into it, cover it light with soil or saw dust of about 1.5 cm.

c. Germination begins from 10 days and it last till 14-28 days. The seeds are lifted and transfer to polybags when the radicals have fully appear while the plumules are just appearing using a piece of wood with flat hedge.

d. The germinated seeds are then taken to the nursery for further growing.
C. Nursery Establishment In Rubber Production

Nurseries are places set up to nurture and raise the young growing seedling over the large scale. The germinated seedlings are transfer into the polybags to allow adequate spacing and good root growth.

The following factors are consider and preferred when choosing a site for nursery.

a. The topography of the land should be flat
b. The place should be close to source of water and preferable water table should be below 75 cm to ensure good water intake.
c. The place to be use for nursery should be free from disease and harmful pest
d. The nursery site should have a well drain and fine texture soil.

In establishing rubber nursery, the following steps are taken.

a. The site is cleared and all the tree or other vegetation consider not useful are remove.
b. The area is plough ones for polybags nursery through harrowing and rotivation and twice for ground nursery.
c. For ground nursery, 250 kg/ha of magnesium lime stone as basal fertilizer is spread on the site before second ploughing and 625kg/ha of phosphate fertilizer is added and thereafter, rotavate the site.

Types of Rubber Nursery

a. high budding
b. Budstick multiplication nursery
c. Young budding
d. Budded stump nursery
e. Core stump nursery
TOPIC 2: NURSERY MAINTENANCE PRACTICES

a. Adequate water must be supplied using sprinkler irrigation system for large number of seedling at least twice daily morning and evening.

b. Weeding should be done regularly to prevent the overcrowding and competition with seedling for nutrient, water etc.

c. Paracol may be use at rate of 2liter to 450 liter of water for one hectare when the seedlings have attained two months of age.

d. Culling and thinning out of defected seedling should be done regularly.

e. Fertilizer application should be done as recommended using the below scheduled.

f. For Bud stick, 42g of equivalent mixture Magnesium x (Mag x) should be applied at 2, 3, 4, 5, 7, 9, 11, 13 and 15 months.

g. Manuring schedule for budded stump is 60g of equivalent mixture Magnesium x should be applied at 2, 3, 4, 5 and for polybags budded stump is Mag x at rate of 28g for the 1st and 3rd month.

h. Young budding at the age of 1-8 week, foliar fertilizer together with fungicides mixtures are sprayed (Baytolan, Dithane M-45, Daconil and H2O) at rate of 15ml, 10g, 12g and 4.5 liters respectively at two times per week.

i. Also for young budding, mixture of NPKMg at ratio of 15:15:6:4 together with 56g of soluble phosphate and 4.5 liters of H2O is added at dosage of 40-60ml per polybags or 7g per polybags of kokei or Nurseryace, a slow release fertilizer incase of shortage of labour.

j. As from the 4weeks of age, only mixture of NPKMg at ratio of 15:15:6:4 together with 56g of soluble phosphate and 4.5 liters of H2O is added at dosage of 40-60ml per polybags or 7g per polybags of kokei or Nurseryace should be apply weekly.

k. For core stump, 2 pellets of 14g Nurseryace should be applied at six month interval.

l. Rooting hormone such as Indolebutyric acid (IBA) may be apply to budded stump just before transplanting to the field.

Exercise 1

i. Lists 5 maintenance practices in a rubber nursery.
ii. Mention the 4 types of rubber nurseries
iii. What are the factors considered when choosing a nursery site?
iv. What are the fertilizers used in nursery and what are the time they are use?
v. How can you recognize a good and viable seeds?

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Rubber plantation establishment involve various operations which are aimed at making a site conducive for planting of rubber. It involves the use for different types of machineries and huge man power to control the operation and drive the equipments. Rubber plantation establishment can be divided into two categories.

These are (1) New planting (2) Replanting.

1) New planting is the planting of rubber where it has not been previously planted. This usually takes place in the jungle full of big trees and series of vegetation existing naturally or on a land previously use for the cultivation of other crops. This operation here is usually very time consuming and energy demanding.

2) Replanting operation is the planting of rubber at a place where it was previously planted with rubber. This practice usually occurs at the end of economic life span of a rubber tree. The operation is easy when compare to that of new planting.

The followings are the operations carried out during the establishment in a sequential order.

A. Land Clearing

This is the clearing of site of all form so of vegetation and trees. Clearing becomes necessary to get rid of all forms of vegetation present of the site that can create obstacle to the rubber or serve as a competitor with rubber for nutrient, water and space. This operation begins by brushing of the ground vegetation. This is followed by felling of tree using manual felling method or machinery such as bulldozer to uproot the trees and later the trees are pile up in a roll at interval of about 10-20m. The felled trees are take elsewhere for other economical use or shredding as thin as possible according zero burn technique recommendation.
B. Drainage:

This is necessary to remove the excess water from the site, prevent erosion, prevent disease outbreak as a result of stagnant water in the plantation, ensure optimum water table level and ensure good and healthy growth of crop.

a) The drainage is of three types (1) the main drain (2) the subsidiary drain (3) the intermediate drain.
b) The main drain is about 150cm deep dug at interval of about 100 -200m and this drains into a river.
c) The subsidiary drain has a depth of 120cm at dug at 50m interval towards the main drain.
d) The intermediate drain is dug between the subsidiary drain with depth of 100 cm.
e) A drop of 30cm is done at every 300m length of drain to ensure the flow is fast

d. Road Construction: A good road system is very important in plantation.

a) This is necessary to ensure, fast and easy communication, easy access to all part of the estate, reduce the time taken to travel within the estate, and maximize the efficiency with which activities are done.
b) Agricultural road is categorized into 3 types (1) Main road (2) Subsidiary road (3) Minor road.
c) The main road link the rubber estate's head office to the main road and publics' lane.
d) The subsidiary roads join the head office to the various section of the estate.
e) While the minor roads link the different block in the plantation to the subsidiary road leading to the main office. The presence of minor road depends on the size of plantation among other things.
e. **Tilling:** Tilling of agricultural roads with plantation is done if necessary to strengthen it and to prevent the impact of direct rainfall and erosion from destroying the road. It is also done to road durable and last longer. The main road is tilled, however the other may not tilled to reduce the cost of production.

f. **Terracing:** Terracing is done if the area to be planted is located on a hilly area. It is done to reduce the impact of erosion and to make the use of machineries on the site possible. Terracing helps to make use of to ensure the plant are firmly rooted by creating adequate environment to enable root growth.

g. **Lining of Field:** This is the field layout which is aimed at optimum planting without compromising the crop nutritional and space requirement. 

In rubber plantation, lining is either done in a straight on a flat surface or in a contour in case of a hilly site.
In one hectare of land, 400-500 trees of rubber can be planted. And planting density is the amount of seedling stands per given area of land. It has unit of tree or seedling/ hectare.

Planting density of rubber  

\[
\frac{\text{Area per one hectare of land (m}^2\text{)}}{\text{Area occupy by one tree (m}^2\text{)}}
\]

Rubber spacing for square planting i.e.
Distance between the row and distance between the trees in the same role:
5m by 4m = 20 m
One hectare of land = 10,000 m
Therefore planting density of square planting per hectare
\[
= \frac{10000 \text{ m}}{20 \text{ m}^2} \times 500 \text{ trees}
\]

For double hedge planting
The formula is planting density:
\[
\frac{\text{Area per one hectare of land (m}^2\text{)}}{\text{Area occupy by one tree (m}^2\text{)}} \times 2
\]

Rubber spacing for square planting i.e.
Distance between the row and distance between the trees in the same role:
5m by 4m = 20 m
One hectare of land = 10,000 m

\[
\frac{10000}{20} \times 2
\]
400 trees/ hectare

Furthermore, the table below shows the planting distance and number of trees per hectare:

<table>
<thead>
<tr>
<th>Type of Design</th>
<th>Btw the rows (m)</th>
<th>Btw the trees (m)</th>
<th>No of tree/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hegde</td>
<td>10</td>
<td>2</td>
<td>500</td>
</tr>
<tr>
<td>Double Hedge</td>
<td>25</td>
<td>2</td>
<td>400</td>
</tr>
<tr>
<td>Avenue</td>
<td>8</td>
<td>2.5</td>
<td>500</td>
</tr>
<tr>
<td>Rectangular</td>
<td>6.75</td>
<td>3</td>
<td>494</td>
</tr>
<tr>
<td>Square</td>
<td>5</td>
<td>4</td>
<td>500</td>
</tr>
</tbody>
</table>
Single avenue planting system

Triple avenue planting system
V) **Fencing:** This is the erecting of barrier around the plantation.

a. This is done by erecting barb wire supported by pole as a form of demarcation along the plantation boundary.
b. This fencing is with the aim of harmful animal and human from entering the plantation.
c. Perimeter fencing is also to prevent damage to the newly transplanted seedlings as a result intrusion by grazing animals.

**VII) Planting of Leguminous Cover Crop**

Leguminous plants are use for this purpose. The important and significant of this practice are stated below:

a. Cover crops help to suppress or reduce weed growth
b. It helps to conserve and improve soil nutrient through addition of nitrogen
c. Also cover crops conserve soil moisture, improve soil structure and aeration
d. Cover crops help to reduce soil erosion and leaching of soil nutrients
   a. Some common leguminous cover crops use in the estates are as follows
   b. *Pueraria phaseoloides*
   c. *Mucuna cochinensis*
   d. *Calopogonium caeruleum*
   e. *Centrosema pubescence*
   f. *Pueraria javanica*

e. The seed of the legumes could be treated with hot water at 75°C to break the dormancy
f. The legumes seeds to be planted should be mixture of two of three different crops
g. Fertilizer could be applied to aid the growth of the cover crops.
h. Pest should also be control using Dipterex SP80 or Sevin in case of beetle or Meta bran in case of slug and large snail infestation.
h. **Digging of Hole:** This is the preparation of planting hole.
   a) A spacious hole is dug to enable optimum root growth by losing the soil, breaking the hard underlining rock, easy weathering of parent materials and facilitate release of basal fertilizer.
   b) The hole is dug using mechanical digger or manual using digging chisel.
   c) Manually, hole of 60x60x60 cm can be dug or cylindrical hole of 45cm diameter with 45 cm depth can be dug using mechanical digger.
i. Planting Operation
   This is the operation mark the end of lengthy field operations.
   a) The planting is carried out about two weeks after the planting hole is dug.
   b) Planting is carried out very early in the morning to avoid transplanting shock.
   c) The polybag with which the seedlings are raise is cut off.
   d) Basal fertilizer is added to the hole to ensure rapid root development and the seedling is gently lowered into the hole together with the ball of earth.
   e) Only healthy and good looking seedlings are planted on the field.
Field planting of rubber seedlings

Exercise 1

i. Mention 7 activities carried out during plantation establishment.
ii. What is the importance of drainage and road construction in the plantation?
iii. List 3 types of cover crops planted in plantation
iv. What is the planting density of 1 hectare of land when a spacing of 5m x 4m is used per plant?
v. Why is leguminous cover crop planted in rubber plantation?
UNIT 11
MANAGEMENT PRACTICES IN RUBBER PLANTATION

TOPIC 1: MULCHING

a. This act of using dry plant material to cover the soil base of the newly transplanted seedling.
b. Mulching helps to increase soil water retention, minimize soil temperature and prevent soil erosion, encourage the development of root feeder and serve as manure to the soil
c. Materials suitable for mulching include dry broken palm kernel shells, chopped leaves etc. and this should be applied with thickness of about 2.5 cm.

TOPIC 2: FERTILIZER APPLICATION

This is the provision of required nutrient to the seedling to aid its growth and establishment.

a. Optimum fertilizer application will aid rapid growth and early maturity.
b. It aid quick recovery of bark and other incisions
c. Increase yield of latex and wood
d. Finally it helps to protect against disease infestation through resistance.
e. Fertilizer is applied broadcasted at the base, following the canopy formation, because this is where the feeder roots are present. It aid easy absorption.
f. Fertilizer is applied after the plant recover from wintering (after the plant regain its leaves) this is around February to march and May to June.
g. Strait fertilizer or compound fertilizer could be use for rubber tree.
h. Nitrogen, important component of protein, helps in leaf development and photosynthesis. It deficiency lead to pale green to yellow of leave colour.
i. Phosphorous is important for root and meristematic tissue development, use during cell division. It deficiency leads to brown colour formation starting from the tips.
j. Potassium is important for growth and plant metabolism, it deficiency shows yellow colour on the leaf margin.
k. Magnesium is one of the constituent of chlorophyll and is important for photosynthesis. It deficiency leads to pale to yellow colouration of leaf vein.
l. Sulphur is another important nutrient element, it's one of the constituents of protein and it use during chlorophyll formation. It deficiency lead to stunted leaf growth, pale green colouration and necrosis of margin and tips of leaf.
m. Calcium is another component of cell, and is also use during root development.
n. There are different types of fertilizer. This include

i. **Straits fertilizer**: It contain one nutrient element, it is use when plant is deficient of one nutrient element. Examples of this include CRiP, Lime stone. Ammonium sulphate.

ii. **Mixture fertilizer**: is a fertilizer types that contains more than one types of straits fertilizer. It contains material that contains each of the nutrient elements. The fertilizer is physically mixed together. It does not involve any chemical process. Example of this includes NPKMg. Mag X (8.4% N, 14.5% P₂O₅, 7.2% K₂O and 2.1% MgO) and Mag Y (10.7% N, 10.4% P₂O₅, 7.2% K₂O and 2.1% MgO)

iii. **Compound Fertilizer**: This fertilizer type contains two or more strait fertilizer materials and is mix together through chemical process. Examples include Behn Meyer, Complasel.

iv. **Slow Release fertilizer**: This is a type of fertilizer use for a special purpose, it is use to reduce the frequency of fertilizer application and also to ensure the steady release of nutrient to the tree over a long period of time.

![Fertilizer application](image)
TOPIC 3: REPLACEMENT, THINNING, PRUNING AND BRANCH INDUCTION

a. REPLACEMENT: This involves the replanting of the seedling that die at few days or weeks after they are transplanted to the field. The dead seedlings are replaced with the seedling of the same age so that they can attained the maturity age together with those seedlings that have fully established themselves.

b. THINNING OUT: This is the removal of some selected rubber seedling from the plantation as a result of poor growth, diseases and damage.

c. PRUNING: This is the cutting of branches of the growing seedling with the aim of given its tree a perfect shape, in order to enhance the growth, stabilize the tree, reduce the wind damage and to obtain a straight for good tapping and timber later when it is harvested. The rubber seedling is trimmed in such a way that there will be three whorls of branches on a straight stem known as leader.
d. **BRANCH INDUCTION:** This is done on tree to ensure that have enough leaves for adequate photosynthesis through provision of number large leaf area. It is also done in a clone with late branch formation. It is done through folding of the three apex leaves of the rubber seedling on the field.

**TOPIC 4: WEED CONTROL**

This is act of keeping away an unwanted grass away from the seedling to prevent them from competing with seedlings for soil moisture, nutrients and space. Weeds serve has a host to pathogen. Weed is control manually using hoe on a small area of land. However, on an estate or large plantation weeding is done using chemical called herbicides. The herbicide is sprayed using knapsack sprayer around the tree, but caution is taken not allow the herbicide to touch the leaves or the stem.

a. In immature rubber, different kind of herbicides are used for different type of weeds
b. Pure grass weeds like *Elicine inidica* and mixture of grass and broad leaves weed s, 3.0 litres of Round up or 3.3 litres Basta 15.
c. Broad leaves weed, 3.3 litres of Basta or 30 litres of 2,4-D Amin is applied per hectare.
d. For Noxious and stubborn weeds like *Imperata cylindrical* 6.0 liters of Round up or Touchdown is use for one hectare infected.
e. In case of ferns infestation, 6.0 litres/hectare of Basta 15 is use to control
f. For woody weeds like *Chromolaena odorata*, 2.0 liters/ hectare of Tordon 101 or Banvel 400 are used on this weed.
g. In matured rubber plantation, 3.0 litres of Round up or Hat- Trick is used to control weed which are mix of grass and broad leaves.
h. Also for mature rubber, infestation by Noxious and stubborn weeds like *Imperata cylindrical* 6.0 liters/hectare of Round up or Touchdown is use for controlling them
Exercise 1

i. Give the functions of macro and micro nutrient elements for rubber tree.

ii. Why do we control weed?

iii. Mention three groups of weed found in rubber plantation and herbicide we use in controlling them.

iv. Mention 5 management operations carried out in rubber plantation.

v. Fertilizer use in rubber plantation are of different types, mention them?
UNIT 12
PESTS AND DISEASES OF RUBBER AND THEIR MANAGEMENT

Diseases in rubber plantation can be grouped into three categories. Root disease, Stem disease and Leaves disease

**TOPIC 1: ROOT DISEASES**

This is diseases that affect the root of the rubber tree. It is taken to be the more severe disease of rubber. It is caused by fungi and it spread very fast to the entire tree present around by penetrating the wood tissue thereby causing rot and later death of the tree.

<table>
<thead>
<tr>
<th>Name</th>
<th>Symptoms</th>
<th>Prevention and treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>White root</td>
<td>Cause by <em>Rigidoporus lignosus</em>. Rhizomorphs are attached to the root</td>
<td>Prevention through Maintain good sanitation and</td>
</tr>
<tr>
<td></td>
<td>white upper side orange yellow and underside is having brown or red colour.</td>
<td>Plant cover crop. Detrenching or Isolation of root then apply Bayleton 25WP (10g + 1litre of H₂O) Poisoning 0</td>
</tr>
<tr>
<td></td>
<td>Spread very fast</td>
<td></td>
</tr>
<tr>
<td>Red root</td>
<td>Cause by <em>Ganoderma philippi</em>. Mycelium skin I covering the root surface</td>
<td>Prevent and treat like white rot</td>
</tr>
<tr>
<td></td>
<td>with dark red and the underside ash grey colour.</td>
<td></td>
</tr>
<tr>
<td>Brown root</td>
<td>Cause by <em>Phellinus noxius</em> The honey comb fruiting body has dark brown</td>
<td>Prevent and treat like white rot</td>
</tr>
<tr>
<td></td>
<td>upper part and grey under side. Rough root surface.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zig zag line on the wood tissue</td>
<td></td>
</tr>
</tbody>
</table>
Root disease control
**TOPIC 2: LEAVES DISEASES**

The symptoms of this diseases manifest on the leaves and lead to falling of the leaves. Some of them affect rubber in the nurseries while some showed up when the rubber is planted in the estate. The names, symptoms and treatments of these diseases are tabulated below.

<table>
<thead>
<tr>
<th>Name</th>
<th>Symptoms</th>
<th>Prevention and treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bird's eye spot</td>
<td>Cause by <em>Bipolaris heveae</em>. Attack the nursery seedling. Refoliation and growth retardation. Cause small dark spots in older leaves while in younger leaves forms yellow halos around the shot holes</td>
<td>Apply week Antracol and Dithane M-45</td>
</tr>
<tr>
<td>Corynespora leaf disease</td>
<td>Cause by fungus <em>Corynespora cassiicola</em>. It affects leaves along the vein Shows grayish dark spot and this enlarge to form circular or irregular. Later the leaves turn yellow and drop</td>
<td>Spray 0.3% of Benlate</td>
</tr>
<tr>
<td>Phytophthora (Abnormal leaf fall)</td>
<td>Cause by fungus <em>Phytophthora botryose</em>. Tree shield their three leaflets attached to petiole having white spot of coagulated latex in the middle white one white and many black spot</td>
<td>Spray with mist blower for four weeks at the beginning of rainy season with copper oxichloride together with oil at 1.2kg a.i per hectare.</td>
</tr>
<tr>
<td>Oidium (powdery mildew)</td>
<td>Cause by fungus <em>Oidium heveae</em>. It affects young shoot that are regaining their leave after wintering. Cause a lot of leaves fall and more if the tree is slightly shaken The unfold leaves of about 5cm shriveled and blacken gradually starting from the tip and later fall with petioles attaching to the branch.</td>
<td>Spray with 0.5 a.i/ hectare of Calixin 75EC. Sulphor can also be use to dust the leaves during the period of refoliation after wintering</td>
</tr>
<tr>
<td>Colletotrichum</td>
<td>Colletotrichum gloeosporioides . Falling of old leaves Shriveled of leaves margins especially tips, It later shows small spot having yellow halos on the narrow brown margin. It can also lead to dieback of green shoots</td>
<td>Treat with 0.2% Daconil and antracol added to water in young rubber plant and nursery seedlings</td>
</tr>
</tbody>
</table>
### TOPIC 3: STEM DISEASES

These diseases affect the tapping panel, branches and fork

<table>
<thead>
<tr>
<th>Name</th>
<th>Symptoms</th>
<th>Prevention and treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pink disease</td>
<td>Cause by <em>Corticium salmonicolor</em>. Spread by air current. Affect mature tree's branches, and fork. Shows cobweb-like films of silky white mycelium mostly near the fork of branch. The mycelium later turn pink. Drying branches with black streaks of coagulated latex.</td>
<td>Treat with fungicide Bordeaux mixture (1kg of CuSO₄+ 25litres of H₂O) &amp; 2kg of hydrated lime+ 75litres of H₂O. For mature rubber Daconil F500 or Calixin at 3litres/ 97 litres of H₂O.</td>
</tr>
<tr>
<td>Pathogenic Die back</td>
<td>Cause by <em>Colletotrichum gloeosporioides</em>. Terminal leaves turns brown. Stem die up.</td>
<td>Pruned of the infected part. Treat the wound with fungicide.</td>
</tr>
<tr>
<td>Ustulina stem rot</td>
<td>Cause by <em>Ustulina deusta</em>. Bleeding of latex from infected part, followed by coagulation and foul smell. Development of grayish white fruiting body form of sheet and later turns grey black.</td>
<td>Pruned the infected part and dress the wound with fungicide.</td>
</tr>
<tr>
<td>Mistletoes</td>
<td>Semi parasitic plant, connect to the tree through the sucker.</td>
<td>Pruned of the infected branch and treat the wound</td>
</tr>
<tr>
<td>Bark Necrosis</td>
<td>Brownish necrotic spot on the tapping cut. Spread very fast dueing rain season. Bleeding of latex if the infection is severe and tree may finally die.</td>
<td>Treat with 2% Difolatan. Don't tap the tree for 6 months.</td>
</tr>
<tr>
<td>Panel Necrosis</td>
<td>Cause by <em>Fusarium solani</em>. Spread during weather and infect tapping and panel boundary.</td>
<td>Don’t open new pane during wet season. Slight sunken lesions Apply 2% difolatan.</td>
</tr>
<tr>
<td>Black stripe</td>
<td><em>Phytophthora palmivora</em> Development of sunken area and discoloured area above the panel, Underlying tissues change to brown or black colour when the bar is removed.</td>
<td>Treat with 2% of Difolatan or apply 0.8% three times per week Ridomil.</td>
</tr>
<tr>
<td>Brown Bast or tree dryness</td>
<td>Brown bast at the bark to partial and total dryness</td>
<td>Terminate the spreading along the latex vessel. Isolate the tree.</td>
</tr>
<tr>
<td>Mouldy rot</td>
<td>Cause by <em>Ceratocystis fimbriata</em>. Spread by tapping knives Sunken discoloured spot present immediately above the tapping cut, later change colour to dark and then grey.</td>
<td>Disinfect the tapping knives regularly. Treat with Difolatan at 2% or Benzilate at 0.5%</td>
</tr>
</tbody>
</table>
**TOPIC 4: PEST OF RUBBER**

a. Treat the Grasshoppers infestation with Tamaron 600 at rate of 1ml to 1 litre of water or Malathion LV at rate of one kg per hectare.

b. Termite should be control with Dursban EC at rate of 20 ml or 330ml of steadfast or 25 ml Lorsban 40. Each of these should be use with 5 liter of water.

c. For cricket, 2.5 ml of Lindane 20 with 1 litre of water or 5ml of Tamaron 600 plus one litre of water or 1kg/ha of Malathion LV.

d. Also Caterpillars are controlled with Sevin 85S 10g to 1 liter water or 10g + 5 litre of water Dipterex sp.

**Exercise 1**

i. Mention the 3 categories of diseases in rubber plantation

ii. List 2 types of root diseases, symptoms and treatment

iii. Mention and explain the symptoms and treatments of 3 stem diseases.

iv. Phptophthora, Oidium and colletotrichum are diseases of rubber leaves, mention their symptoms and treatments.

v. Mention two types of rubber pests and their treatments
UNIT 13
HAVESTING OF LATEX

TOPIC 1: LATEX AND RUBBER TAPPING

a. Latex is one of the important product of rubber, the latex vessel arrange spirally move from lower left to the upper right at an angle of about 3.5°-5.0°. Once a cut is severely and skillfully made on the bark of the rubber tree, the latex begins to flow out.
b. Tapping Direction: Tapping is made but cutting in the opposite direction of the latex vessel at an angle that ensures maximum flow of latex. For budding, tapping cut is at angle 30° while 25° for clonal seedlings.

c. Height of Tapping: The tapping cut height for budding is 150 cm from the ground while for clonal seedlings is 75 cm from the ground.

d. Time of Tapping: Tapping is carried out very early in the morning once the tapping panel is visible to the naked eyes. This is due to the fact that the cells are fully turgid in the morning and transpiration is still very low or zero, this allows maximum flow of latex.

e. Tapping depth: Tapping is done to ensure optimum flow of latex without causing much damage to the tree physiology. Cut is made up to the soft layer which is the third layer from the cork and closest to the cambium. This is because largest concentrations of latex vessels are found here. Tapping of 0.2 mm distance from the cambium is found to be optimum.

f. A tapping knife is used to create the incisions. It has one side blunt while the other side is very sharp. There are two types of knives use for tapping. (1) Gouge: The one that is cut by pushing (2) Jebong: It cut through pulling.

g. Rain guard is fit above the tapping pane to prevent interference and upset of latex flow by rain. It also prevents the panel from getting wet.

h. For opening of panel, Beroti (a wooden stick of 150 cm height, 1 cm thickness and 4 cm wide) and a wire at the top of 45 cm diameter is used to measure the height and girth of the tree.

i. The latex dripped in the cut attached to the tree are collected and taken after the latex has stop dripping, this is pour into the collection tank and carried away for processing.

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**Exercise 1**

1. Using tapping angel and tapping height the differences clonal seedling tapping and budding tapping.
2. In what direction is tapping carried out in latex harvesting.
3. How can you prevent rain from interfering and upsetting latex flow.
4. What time of the day is tapping carried out and why?
TOPIC 2: INTERNATIONAL NOTATION FOR TAPPING SYSTEM

a. These are symbols and number use to describe the tapping cut and the frequency in certain period of time in the rubber tapping system.
b. This is unique worldwide to solve the problems associated with the use of different symbols in different regions.
c. The tapping notation can be classified into three based on the area of application. Vis stimulation, panel notation and tapping methods
d. Tapping methods are generally classified into the following group.
   a. Symbol of cut
   b. Number of cut
   c. Length of cut
   d. Direction of tapping
   e. Frequency of tapping
   f. Change of cut
   g. Tapping intensity
   h. Combination tapping

Symbol of cut
The symbol of cut is represented by capital letter
   e.g.
   S= spiral cut
   V= v cut
   M= Mini cut

Length of Cut
The length is denoted by fraction written before the cut
   e.g.
   S= one full spiral cut
   V= one full v cut
   1/2S= one half spiral cut
   1/4S= one quarter spiral cut

Number of cuts
This is represented by a number before the length of cut notation and a multiplication sign is inserted in between.
   e.g.
   2 x 1/2S = two half spiral cuts
   2 x 1/4S = two one quarter spiral cut
Direction of Tapping
Most tapping is downward, it might be upward in some case. The notation is written using (↑) for upward and (↓) tapping.

E.g.

- 1/2S↓ = one half spiral cuts tapped downward
- 1/4S↑ = one quarter spiral cut tapped upward
- 2 x 1/2S↑↓ = two half spiral cuts tapped upward and downward.

Frequency of tapping
This shows the frequency at which tapping is done. It is represented by a fraction or series of fractions. Days is represented by d; w for weeks; m for month and y for years.

E.g.

- d/1 = daily tapping (once everyday)
- d/2 = alternate daily (once every two days)
- d/3 = third daily (once every three days)
- d/4 = forth daily (once every four days)
- d/6 = six daily (once every six days)
- 2w/4 two weeks in four weeks (tap two weeks rest for two weeks)
- 9m/12 nine months tapping and 3 month of rest

Combination tapping
This denote the use of different length and type of cut carried out on the same day (+) or alternate day (,).

E.g.

- 1/2S↓ + 1/4S↑ = one half spiral cuts tapped downward together with one quarter spiral cut tapped upward one the same day
- 1/4S↑, 1/2S↓ = one quarter spiral cut upward, tapped on alternate tapping day with half spiral tapped downward.

Change – over system
This represents the number of successive period, panel and cycle of change. This is put in fraction and brackets.

E.g.

- (t,t) = two cut each, tapped alternately at every tapping.
- (5m, 5m) = two cuts each, tapped alternately at every five tapping
- (10t, M) = two cuts, the first cut tapped in ten tappings and then second cut tapping in one month.
Panel Notation
This notation represent the panel location and renew succession of tapping panels. The panel situated above the height of the first opening of tapping cut is referred to as high panel and it is represented by capital letter H, while the panel formed below the first tapping opening is called based panel and it is represented by capital letter B, while the other cuts are represented by number.

e.g.
0= virgin bark
1= first renewed bark
11= second renewed bark
1= first cut
2= second cut

Method of application
These are symbol telling the planter how to apply the stimulant.
e.g
Pa= Panel application
Ba= Bark application
La= Lace application
Ga= Groove application

The amount of formulation applied at a one application is presented by its weight (g) or its volume (ml)
The size of band on which the stimulant is applied is measured in centimeter (cm)
The frequency of application is expressed in weeks (w) or month (m)
The number of application in a particular period usually a year
e.g
9/w= nine application per year
10/y (m) = nine application per year applied at monthly interval.

Stimulant
Active ingredient and concentration

e.g
ET 8.0% = stimulate with 8.0% Ethephon
ED 3.0% stimulate with 3.0% Ethad.

Exercise 2

i. Briefly explain important of international notation tapping system
ii. List the different 3 groups of tapping notation.
iii. Mention five out of eight tapping methods.
iv. List two type of panel notation and 3 types of stimulant application