وزارة التعليم العالي والبحث العلمي / العراق
الجامعه التقنيه الجنوبيه
المعهد التقني شطره

حقيبة تعليمية في مادة الغابات لطلبة المعهد التفني / الشطره / قسم الانتاج النباتي / المرحلة الاولى

ا.م. خليل فرج جبر

الوحـــــدة النمطية الاولى

Training in *First modular unit*

Economical importance of Forests - Forest- Relation between forest and human – definitions of Silviculture – Stand – Seedling – Tree – Shrub.

For Students of First Stage

١ـ النظرة الشاملة (Over View)

أ- الفئة المستهدفة (Target Population)

طلبة المرحلة الاولى في قسم الانتاج النباتي / المعهد التقني / الشطره

Students of First Stage / Plant Production department

ب- مبررات الوحدة (Rationale)

بالنظر لفوائد الغطاء النباتي للبيئة والانسان ولما تشكله الغابات الجزء الاكبر من هذا الغطاء ولما للغابات من الفوائد الاقتصادية والبيئية والسياحية صممت هذه الوحدة النمطية .

ت- الفكرة المركزية (Central Ideas):-

أولاً: لغرض التعرف على اهم المصطلحات والتعاريف التي تخص علم الغابات.

ثانياً: التعرف على الفوائد الاقتصادية للغابات .

ث- أهداف الوحدة (Objectives):-

سيكون الطالب بعد دراستهِ لهذه الوحدة قادراً على أن:

1. يعرف الاهمية الاقتصادية والبيئية للغابات.
2. يعرف العلاقة الايجابية بين الانسان والغابات.
3. يعرف المصطلحات والتعاريف التي تخص الغابات

٢- الاختبار القبلي (Pre – Test):

Q1: Circle the correct answer:

A rich countries of forests like

1- Filland
2- Egypt
3- Arabia Soudia.
4- Iraq

Q2: What is the more important factor to limit the density of vegetative-life

1- light
2- winds
3- Temperature
4- rainfull

- **Note : Check the answers in key answer page7**

٣-عرض الوحدة النمطية

THE FORESTS 1-3

forest

A dense growth of trees, together with other plants, covering a large area of land. The science concerned with the study, preservation

and management of forests is **forestry.**

Economical importance of Forests

The Economic importance of forests return to being the only natural resource of wood material and other forest materials Important in the industry. Any developing country for building the growth and progress can not be dispense with wood for many reasons including that the wood enters in many industries such as papermaking, industrial silk, furniture and fuel, construction and other uses. Also, other materials produced from forest such as rubbery and cork Which are no less important than the wood which the developing countries need it

Area of forests on surface of the globe estimste to (16504) million donams (about 7.5% from worlds area and 33% from Land). The distribution of forests on the surface of globe is not equal because the edaphic and climatic conditions are different from place to other. A rich countries of forests like Filland (71% from total area), Swyeed (56%). Poor countries like Egypt, Arabia Soudia. Forest area in Iraq estimste to (7) million donams (4%) .

The important factors to control the distribution of plants are the climate with its factors (water, temperature, light….e.x.t.). The rainfull is the more important to limit the density of vegetative-life. But the difference in the temperature limits the equality of trees varieties in the world.

Forest provides multiple benefits to environment, people, and animals.

The list of benefits is as follows

1- Forest cool air temperature by release of water vapor into the air.
2- At day time trees generate oxygen and store carbon dioxide, which helps to clean air.
3- Forest attracts wild life and offer food and protection to them.
4- Forests offer privacy, reduce light reflection, offer a sound barrier and help guide wind direction and speed.
5- Well managed forests supply higher quality water with less impurity

than water from other resources.

6- Some forests raise total water stream, but this is not true for all forests.
7- Forests help in controlling the level floods.
8- Forest provides different kind of wood which are used for different purposes like making of furniture, paper, and pencils and so on.
9- Forest help in giving the direction of wind and its speed.
10- Forest helps in keeping environment healthy and beautiful.
11- Forests also minimize noise pollution.
12- Forest helps the scientist to invent new medicine as forest has different kind or plants and herbs.

DEFINITIONS

Forest :

It is a complete life community in a certain area. It has a certain climate and density. The base of forest is a vegetative society consist of trees, shrubs, herbs, other plants like algaes and fungies besides of wild animals and micro-organis.

Seedlings :

Small plants grown from seeds till become ready to plant in nursery (age to many months to 1 year). Seedlings are the base of trees and forest.

Tree :

Woody plant with stem and crown. Less height of tree is 8m. in mature stage.

Characters of trees

1- Long-Lived :

Some of trees may lives till 4000 years like *Sequoia sempervirens*. Others : Centennials years such as *Quercus sp*.

2- Height :

50-100 m.high like some species of *Eucalyptus* and *Sequoia*.

30-50 m. high like *Pinus sp*., *Picea*, *Quercus*, *Juglans* and *Fagus sp*. 20-30 m. high like *Pinus brutia*, *Capressus sp*.,

Populus sp. No more than 10 m. : *Juniperus sp*., *Pistacia kinjuck*, *Melia sp*., *Thuja sp*. And *Tamarix sp*.

3- Diameter :

In some trees reached to 6m. like *Sequoia*. But in general (60-200) cm. at the different species.

Stand :

Piece of forest to 1 hectar of area contain one or more of species.

Silviculture :

Science care of establishment of stands and forests, continue to production and protection the old forest correspond with natural and economical conditions.

Post text

Give your answer by (True) or (False)

1- Forest area in Iraq estimste to (7) million donams .

2- Less height of tree is 10m. in mature stage.

3- Seedlings are the base of trees and forest.

4- Some of trees may lives till 4000 years like *Populus alba*.

5- Stand is a piece of forest to 4 hectar of area contain one or more of species.

- **Note : Check the answers in key answer as in the following**

key answer:

Pre text

Q1: 1

Q2: 4

Post text

1. c
2. f
3. c
4. f
5. f

Reference

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الوحـــــدة النمطية الثانية

Training in ***Second modular unit***

Geographical Distribution of forest in the word - Forest distribution and cause of spread - Tropical and sub-Tropical forests- Moderate-Cold region Forests-Moderate-Warm region Forests- Gallery and Bamboos Forests.

١ـ النظرة الشاملة (Over View):

أ- الفئة المستهدفة (Target Population)

طلبة المرحلة الاولى في قسم الانتاج النباتي / المعهد التقني / الشطره

Students of First Stage / Plant Production department

ب- مبررات الوحدة (Rationale)

بالنظر لاهمية الظروف البيئية في توزيع الغابات وكثافة الغطاء النباتي على سطح الكرة الارضية ولغرض معرفة مناطق انتشار الغابات في العالم صممت هذه الوحدة النمطية .

ت- الفكرة المركزية (Central Ideas):-

أولاً: لغرض التعرف على التوزيع الجغرافي للغابات في العالم.

ثانياً: التعرف على اسباب انتشار الغابات في العالم .

ث- أهداف الوحدة (Objectives):-

سيكون الطالب بعد دراستهِ لهذه الوحدة قادراً على أن:

1- يعرف التوزيع الجغرافي للغابات في العالم.

2- يعرف اسباب انتشار الغابات في العالم ومناطق انتشارها.

٢ـ الاختبار القبلي (Pre – Test):

Q1 : Give your answer by (True) or (False)

1- The area of these forests is about 34% from natural forests in the world.

2- Monsoon forests return to deciduous forests.

3- Deciduous forests called Broad-leaved forests.
4- *Eucalyptus spp. and Quercus* ssp. are the speciese of tropical and sub-tropical forests.
5- In coniferous forests the leaves of trees are needles-form and evergreen.

٣-عرض الوحدة النمطية

Distribution of Forest in the world 2 -3

A- Tropical and sub-tropical forests:

The area of these forests is 34.3% from natural forests in the world. It consist of :

1- Tropical rain forests

Characters :

Rate of temperature during the year : 24-28 ºC
Rainfull : 1800-10000 mm./year .
Relative Humidity : No less than 80% during the year .

These forests are the stronger and butter vegetative cover type on surface of the globe. It consist of broad leaves trees and ever green. 1 hectar from this forests contains centennials species of plants in Cameron and Jawa. Height of trees reach to (50- 70) m. These forests spread in Indonesia, India, Cameron, Brazil, Congo and Amazon. Main species : *Cassia pestula, Cedrela toona, Terminala sp., Albezzia odoratissima.*

2- Monsoon Forests

It is found in tropical countries that have a hot arid-summer and rainy winter. Leaves fall in summer. Growth period in trees happens in winter. The trees are less higher than trees of tropical rain forests. Species : Delbergia sisso, Tectona grandis, Zizyphus jujuba and Bamboo. Spread at East-Jawa and India.

3- Savana Forests

Transfer to regions with wide spaces among the groups of trees. More weeds in these regions. Spread in India, Africa, Thyland, Brazil, Australia and Pakistan. Species : Acacia sp., Prosopis sp.

4- Thorn Forests

It comes after savanna forests. Their trees have many spinules , like Prosopis sp.

B- Moderate-Cold regions Forests

It divide to 2 parts :

1- Deciduous Forest (Broad-leaved F.)

Area of these forests estimates about 15% from total forests. It Spread between tropical forest regions and coniferous forest regions. Leaves fall in winter. Contain one layer nearly. The height of trees is about (40-50)m. , Diameter is (1-2)m. It is possible to propagate by coppice system. Rainfull : (500-1750)mm/year. In these forests may be grow some species of coniferous as a single trees. And may spread some climber plants like *Hedra helix*.

Spread : Mid and south Europe, North America, North Japan and China and Mediterranean Sea Region.

Species : *Quercus sp., Fagus sp., Betula sp.*

2- Coniferous Forests

The most of leaves of trees are needles-form and evergreen except some species that their leaves fall in winter like *Larix sp*. Area of these forests estimste about 35% from total forests. The largest area of coniferous forests reached to 500000km^2 in Syperia contain many species like *Pinus, Picea sp., Larix* and other species.

C- Moderate-Warm region Forests

It combine the Mediterranean Sea Region forests . In these forests grow the broad trees and evergreen. The height of trees is medium. Species : *Eucalyptus sp., Quercus ilex, Q. suber, Cedrallus.*

D- Gallery and Bamboos Forests

Forests grow on the banks of rivers and galleries like *Salix sp. Platanus sp. Populus sp., Bamboo* and some evergreen trees besides shrub and herbs . The Bamboo forests spread in tropical regions with special soil in India, East-Asia. The propagation by rhizomes.

key answer:

Pre text

1. c
2. f
3. f
4. f
5. c

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الوحـــــدة النمطية الثالثة

Training in ***Third modular unit***

Forests in Iraq- Naturl Forests- According to density - Open Forests- Mid-density forests- Density forests- According to species- Oak forests - Pine forests - Riverine forests- Artificial Forest.

٢- الاختبار القبلي (Pre – Test)

Q1 : Give your answer by (True) or (False)

1- Forests in Iraq Present in the mountain regions of north and east-north regions.
2- Density forests in Iraq form largest area of forests.
3- Oak forests contain more than 2 species of *Quercus*.
4- The important trees in the artificial forest are *Eucalyptus* and *Calistemon*.
5- Density of the forests estimate by (0.1- 0.9)

- **Note : Check the answers in key answer** page 15

١- النظرة الشاملة (Over View)

أ- الفئة المستهدفة (Target Population)

طلبة المرحلة الاولى في قسم الانتاج النباتي / المعهد التقني / الشطره

Students of First Stage / Plant Production department

ب- مبررات الوحدة (Rationale)

بالنظر لاهمية الغابات ولغرض معرفة مناطق انتشار الغابات في العراق صممت هذه الوحدة النمطية .

ت- الفكرة المركزية (Central Ideas):-

أولا ً: لغرض التعرف على انواع الغابات في العراق .

ثانياً: التعرف على تقسيم الغابات في العراق.

ث- أهداف الوحدة (Objectives):-

سيكون الطالب بعد دراستهِ لهذه الوحدة قادراً على أن:

1- يعرف الغابات الطبيعية والاصطناعية في العراق.

2- يعرف مناطق انتشارها في العراق.

3- يعرف تقسيماتها حسب الكثافة والانواع .

٣-عرض الوحدة النمطية

Forests in Iraq

A- Natural Forests :

Forests grown naturally without interaction of human. Present in the mountain regions of north and east-north regions. Rainfull : 400-1200 mm./year.

Natural Forests in Iraq divid according to density to 3 groups :

1- Open forests

contain groups of trees, shrubs with extensive spaces. Area estimate to 3376400 donam (47.5% from total natural forests area). It is found : Sinjar mountain (Naynava), Bekhair (Dohok), Quiza mountain (Solaymania), Salah-Aldeen mountains (Arbil).

2- Mid-density forests

Area estimate to 1153000 donam (16.2% from total natural forests area). It is found : Swaratooka regions (Dohok),Qaradag (Solaymania), Atroosh (Naynava), Toman and Rawandoz (Arbil).

3- Density forests

High density, trees with good qualities. Area : 2581000 donam (36.3% from T.N.F.) . It is found : Kara mountain regions (Dohok), Qaradag (Solaymania), Hag-Omran (Arbil).

Natural forests in Iraq divid according to species to three groups :

1- Oak forests

These forests contain 3 species of oak are :

Quercus aegilopis
Quercus libani
Quercus infectoria

Also other species found like : Celltis sp., Juglans regia, Rhus coriaria.

2- Pine forests

The important species is Pinus brutia in Zawitta and atroosh regions. Density of these forests estimate to 0.3-0.6 (It is not high density, but open in some places).

Besides of pine trees , there are another species like Quercus , Cratagus, Pistacia, Juniperus, Celtis.

3- Riverine forests

Spread naturally on the banks of rivers and galleries.

species

Plantanus orientalis (Plantanaceae)
Fraxinus rotundifolia (Oleaceae)
Salix alba (Salicaceae)
Populus euphratica (Salicaceae)

B- Artificial Forest

It is not exist in past, but established in Iraq by the way of forestry offices. The important trees represent in these forest are :

Species	Family
Eucalyptus spp.	Myertaceae
Calistemon spp.	Myertaceae
Acacia spp.	Leguminosae
Albezzia spp.	Leguminos ae

Robinia spp.	Leguminosae
Bauhinia spp	Leguminosae
Delbergia sisso	Leguminosae
Morus alba	Moraceae
Morus nigra	Moraceae
Melia azedarash	Meliaceae
Pinus spp.	Pinaceae
Casuarina equistifolia	Casuarinaceae
Tamarix spp.	Tamaricaceae

key answer:

Pre text

1- c
2- f
3- c
4- c
5- c

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الوحـــــدة النمطية الرابعة

Training in ***Fourth modular unit***

Different divition for trees forest – According to Genus –Species – Source – Ages – Aim – Propagation methods .

٢- الاختبار القبلي (Pre – Test)

Circle the correct answer:

1- there is no variance among different regins of the world.
2- Natural Forests are forests grown naturally with interaction of Human.
3-Pure forests are forest combine many species of trees .
4-Artificial forest is a forest produce by nature.
5- High Forests are forests which produced from the seeds.

- **Note : Check the answers in key answer as in** page 18

٣-عرض الوحدة النمطية

Different divition for trees forest

As soon as there is a variance among different regins of the world, forest divide to:

1) <u>According to Species</u> It consist of :

a- Pure Forests

Forest combine one species of trees like pine forest, Oak forest ……etc.

b- Mixed Forests

Forest consist of many species of trees**,** but the quality of mix are at the form of Strips or Groups or Lineal mix

2) <u>According to Source</u>

a- Artificial Forest

Forest produce by human

b- Natural Forests

Forests grown naturally without interaction of human. Natural

Forests with no exploitation called Virgin Forests.

3) <u>According to Ages</u>

a- Even aged forests : The ages of trees in these forests are equal

b- uneven aged forests : There is a difference in the age trees which grown in the forest

4) <u>According to Aim :</u> Classify to three divisions:

1- Productive Forests

The goal of these Forests is production of Timber and others like Resin, Tanbark, ….etc.

2- Protection Forests

The purpose is the protection the soil from erosion , Rainfull and avalanches.

3- Multiple aims forests

These forests consider important to protect wild animals and river pools. Also used as recreational and tourist.

<u>5) According to Propagation Methods</u> divide to:

1- Low Forests : Forests are produced from coppice**.**

2- High Forests : Forests which produced from the seeds**.**

3- Combined Forests : It consist of low trees produced from coppice and high trees produced from seeds**.**

key answer:

Pre text

1- f
2- f
3- f
4- f
5- c

References

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الوحـــــدة النمطية الخامسة

Training in ***Fifth modular unit***

Advantages of Forests – Productional advantages- Protectional

advantages- Recreational advantages. Basic advantages- Secondary advantages.

٢- الاختبار القبلي (Pre – Test)

Give your answer by (True) or (False)

1- The wood of *Eucalyptus* and *Casuarina* are concedered from the hard-wood.
2- Soft-wood used in mobilia anf furniture.
3- Bark used in tannage such as *Casuarina*.
4- Alcoholic production extract from *Juniperus communis*
5- Perfume, drug, medicine extract from *Pinus brutia*.

- **Note : Check the answers in key answer** page 21

٣-عرض الوحدة النمطية

Advantages of Forests

1- Productional advantages
2- Protectional advantages
3- Recreational advantages (Sociological and Tourist adv.)

1- Productional advantages
a- Basic advantages
Wood :
1- **Hard-wood :** Manifacture, mobilia, furniture, cabinet work, ships,

instruments….e.t.c.
Species : *Tectona grandis , Quercus, Juglans, Fagus*…. e.t.c.

2- **Soft-wood :** Coal, fuel, distillation, paste of papers, extraction of acetone, chloroform, methylene….. e.t.c.
Species : *Eucalyptus, Casuarina, Pinus*…. e.t.c.

3- Rubber (caoutchouc) : *Hayphea sp.*

B- Secondary advantages

1- Bark (peels) : Used in tannage such as Quercus infectoria.

2- Production suberine (cork) : such as Quercus suber

3- Insulator (Non conductor) : such as Sequoia sempervirens

4- For nutrition (Seeds and Fruits) : *Pinus pinea, Castanea vesca, Juglans sp., Quercus spp.Prunus spp., Crataegus azarolus, Corylus sp.*

5- For animal nutrition (Forage) : *Robinia pseudoacacia, Acacia spp., Ceratonia siliqua.*

6- Alcoholic production : *Juniperus communis.*

7- Aromatic, Perfume, drug, medicine, soap extraction from leaves and branches of Salix, *Laurus nobilis, Ceratonia siliqua.*

Volatile oils : *Eucalyptus spp*

8- Gumes : *Acacia sinigalensis*

9- Resin and glues : *Pinus brutia*

10- Juice : Extraction sugary juice from *Acer saccharium* that has a nutrition and economic value.

11- Festival : Some species of coniferous trees used in chrismas such as : *Cedrus spp., Pinus spp., Abies spp., Picea spp*. Others used as ornamental trees in Parks and general gardens.

key answer:

Pre text

1- f
2- f
3- f
4- c
5- f

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2- الالوسي ، يونس محمد وعلي محي التلال . الغابات العامة . الطبعة الاولى . وزارة التعليم العالي والبحث العلمي. هيئة التعليم التقني . دار التقني للطباعة والنشر. بغداد/ العراق.

الوحـــدة النمطية السادسة

Training in *Sixth modular unit*

Scientific visit to one of the forest nurseries

الوحـــــدة النمطية السابعة

Training in ***Seventh modular unit***

Vegetative Cover- Forest- Maquious- Tundra- Savana- Steppe- Desert. Developmental stages of trees- Seedling stage- Saplings stage- Pole stage –Young Timber stage- Mature stage- Over mature stage.

٢- الاختبار القبلي (Pre – Test)

Give your answer by (True) or (False)

1- Maquious are shrubs grown under vertical spread-regions of natural forests.
2- The vegetative cover in the globe contains the forests only.
3- Tundra is the short trees or shrubs which replaced of forest-trees in the north regions of Asia, Europ, America.
4- Desert formed due to little humidity (rainfall) and increase of temperature only.
5- Over mature stage is the more important developmental Stages of Trees.

- **Note : Check the answers in key answer** page 26

٣.عرض الوحدة النمطية

Vegetative Cover

Groups of plants cover a certain area like forest contains trees, shrubs, herbs….e.t.c. May be swamps consist of different plants or may contains plants live in arid-zones like thorn-plants or succulents. Schimper (1935) divided the Vegetative societies in every region of natural-spread regions to 2 parts :

First : Depend on climatic conditions like Savana, Tundra and Rain's forest.

Second : Depend on soil factors like soil-water, origin. For example sandy-hills, swamps forests…. e.t.c.

The vegetative cover in the globe contains :

1- Forest

2- Maquious

Shrubs grown under vertical spread-regions of natural forests (Coasts of Mediterranean sea under natural forests region) .

3- Tundra

Tundra is the Short trees or shrubs which replaced of forest-trees in the North regions of Asia, Europ, America.

4- Savana, Steppe

5- Desert

Sahara formed due to little humidity (rainfall) and increase of temperature or decrease of temperature. In the first case contains of anti-arid plants with long pivotal roots or thorn-plants, succulents, these regions called **prairie.** In the second case forest called (Freeze-

desert) like plants of Tundra. It is found in Ciperia and cold regions of north Europe and America .

Developmental Stages of Trees

It is possible to recognize 6 stages of growing and Development of trees :

1- Seedlings Stage : small plants after germination till 90cm. of height.

2- Saplings stage : Divid to 2 parts :
a- Small Saplings : 90cm. to 3m. high.
b- large Saplings : More than 3m. high and 10cm. in diameter at d.b.h. (diameter breast high).

3- Pole stages : Divid to 2 parts :
a- Small poles : 10 to 20 cm. in diameter at d.b.h.
b- Large poles : 20 to 30 cm. in diameter at d.b.h.

4- Young Timber Stages (standards) : 30-60 cm. in diameter at d.b.h. This stage begin with relative decreasing of longitudinal growing in trees and end with total decreasing.

5- Mature stage : Over 60 cm. in diameter at d.b.h. Begining when the longitudinal growing is stopped. Tree has a good diameter for commercial.

6- Over mature stage : Depretion of production. The longitudinal growing is zero.

key answer:

Pre text

1- c
2- f
3- c
4- f
5- f

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الوحـــــدة النمطية الثامنة

Training in ***Eighth modular unit***

Planning of forest – Artificial regeneration – System of planting .

٢- الاختبار القبلي (Pre – Test)

Give your answer by (True) or (False)

1-The good planning of road networks is the planning which ensure connecting most the parts of forest .

2- There are three types of planting.

3- Not required to be natural regeneration from seed, but may be from other sources .

4- Artificial regeneration in the forest is used for two purposes.

5- From the conditions necessary for natural regeneration is the presence of trees that bear seeds.

- **Note : Check the answers in key answer as in** page 32

٣.عرض الوحدة النمطية

Planning of forest

In the different phases of planning forest road networks and single roads there are multiple needs, besides wood transport, that must be taken into consideration. These are, for example, biodiversity, key biotopes, endangered species, entity of wilderness and protection areas, hunting, fishing, other local recreational and socio-economic needs and landscaping. In road planning, as well as in forestry generally, there are always three major subjects to be optimized: economics, ecology and aesthetics.

forest road planning

The good planning of road networks is the planning which ensure connecting most the parts of forest .

Types of road forest :

1- Main roads

2- contour roads

3- valley roads

4- connecting roads

natural regeneration in forest :

A seedling growth after the fall of seeds from trees naturally in the forest or stand. And without human intervention. Not required to be natural regeneration from seed, but may be from other sources such as :

1- Coppice
2 – Layering
3 – Offsets and Suckers

The conditions necessary for natural regeneration

1- The presence of trees that bear seeds
2- Provide the conditions of germination
3- Trees safety from disease and insects

Artificial regeneration

Artificial regeneration in the forest is used for three purposes are

1- Productional purpose

2- Protectional purpose

3- Recreational purpose

There are secondary uses of Artificial regeneration :

1- Sand dunes fixation

2- Wind Buffers

3- Roadsides

4- Drying of the marshes

5- Improve the viability of soil productivity

6- Burned areas within forests that are difficult to renew a normal

Advantages of artificial regeneration

1- The artificial regeneration is not dependent on seed production year.

2- You can change species found in the forest or the region.

3- Improve soil state in the case of mixing species.

Sources of artificial regeneration

1- Seedlings : It come from two sources

a- Cultured seedlings in the nursery

b- Seedlings collected from the areas under natural regeneration of forests (wildplants)

2- Direct sowing : Try using this method in the north of Iraq in 1972 in the Zawita when sowed the seeds of pine by plane.

3- The cuttings : Specializes in fast-growing species only. It need to land a light or any kind sedimentary

Methods of planting

Divide to :

1- Compression method

used in sandy soil Which compresses the soil by Karak many times and then place Seedling and press the soil about it. This method needs to rainfall throughout the year. This way can not be used in Iraq because of their need to much moisture.

2- Dug- Hole Method

Summed up this method to dig a hole and put soil aside, then put seedling and returned the amount of soil to the hole. The seedling planted in the center of the pit or on the side of the hole and called here Side hole method.

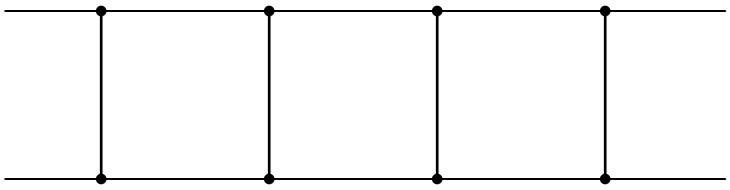
Should be planting on the shoulders of canals and the size of the hole when planting is 30 X 30 cm and used this method in plain areas and roadsides in Iraq. The usual way in the mountainous areas where agriculture is the contour lines.

3- French-method italic

are used in mountain areas and areas where moisture is available throughout the year. Used in the case of conifers which breeding with bare-roots. here the seedling be in italic form and then take its normal form.

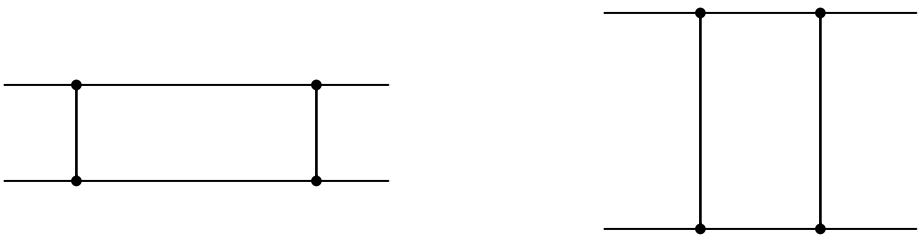
Types of planting

1- Planting in the form square : here, the distance between the seedling and the other and between the line and another be equal and as shown in the shape1. It's the easiest types of planting in terms application.



shape1

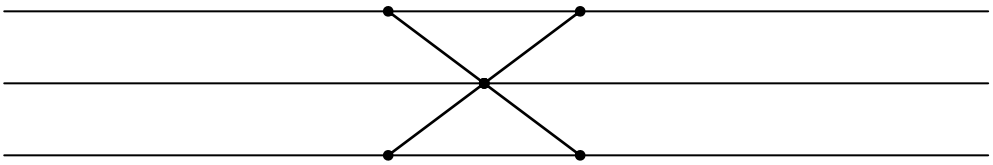
2- Planting in the form rectangle : Here, the distance between the seedlings and the other is greater than the distance between the line and another as in Figure 2



Shape2

3- Planting in the form triangle : This type is used in planting roadside and windbreaks, as well as is used in sand dune fixation. the

number of trees per hectare more than in other types of planting. Percentage increase in the number of trees, 15% more than in the square metod. Here, the distance between the seedling and the other and between the line and another be equal and as shown in the shape3



shape3

key answer:

Pre text

1- c
2- c
3- c
4- f
5- c

References

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الوحـــــدة النمطية التاسعة

Training in ***Ninth modular unit***

Pure Forests - Naturally cases to form Pure Forest- Caracteristics of Pure Forest.

٢- الاختبار القبلي (Pre – Test)

Circle the correct answer :

1- When the edaphic and climatic conditions are very hard, Pure forest form naturally.

2- After first and hard storms, the forest transform to regions with bad environments.

3- All operations like pruning and thinning are easier.

4- The intolerant species can not grow well with the presence of tolerant species .

5- Natural pruning is not clair in pure forest.

- **Note : Check the answers in key answer as in** page 35

٣-عرض الوحدة النمطية

Pure Forest :

Forest combine one species of trees inorder to be dominant as 95% such as forest of oak or Eucalyptus ….e.t.c.

Pure Forest form naturally in follow cases :

1- When the edaphic and climatic conditions are very hard, so that allow to one species to grow and form a pure forest. Like Alpes and polar regions, forest of Tamarix in the cold swamp regions and Mangrof forest in the Tropical regions which have a salinity soil.

2- After first and hard storms the forest transform to regions with bad environments, it become unsuitable except some of pioneer species, that aid to form pure forest for certain period, then change to mixed forest.

3- In some times pure forest form by the result of competition among the species on light or humidity….e.t.c. The stronger species dominate the others species.

4- Tolerant species make a shadow, therefore the intolerant species can not grow well. But when the trees face freezing and violent storms, the tops and some branches will break to open the crown and light will enter inside of forest to grow the intolerants species.

Characteristics of pure forest

1- All operations like pruning, thinning and others are easier and there is no need to more technical operations.
2- Natural pruning is clair.
3- Pure forest is more economic than mixed forest, specially when the species is desirable in the region.

key answer:

Pre text

1- c
2- c
3- c
4- c
5- f

References

الالوسي ، يونس محمد وعلي محي التلال . الغابات العامة . الطبعة الاولى . وزارة التعليم العالي والبحث العلمي. هيئة التعليم التقني . دار التقني للطباعة والنشر. بغداد/ العراق.

الوحـــــدة النمطية العاشرة

Training in *Tenth modular unit*

Mixed Forest - Equality of mix (Blend)- Rules for establishment of mixed forest- Cayer Rule- Forms of mix - Equal mix- Lineal mix – Strips mix- Groups mix .

٢- الاختبار القبلي (Pre – Test)

Circle the correct answer :

1- Mixed Forest consist of many species of trees with certain proportions.

2- In mixed forest with one layer , the crowns of trees are not at the same height.

3-The selected species must be decrease the productional capacity of soil.

4- The production of wood in mixed forests is more than pure forest.

5- In equal mix each species is surrounded by other species of all sides.

Note : Check the answers in key answer as in page 38

٣.عرض الوحدة النمطية

Mixed Forest : Forest consist of many species of trees with certain proportions. These forests naturally formed in moderate, tropical and sub- tropical regions and in the rich soils and unarid soils.

Mixed forest divide according to equality of mix (blend) to 3 divisions

1- Mixed forest with one layer : The crowns of trees are nearly at the same height. There is no gradual at crown‘s umbrella.

2- Mixed forest with 2 layers : Two species participate in crown‘s umbrella, one under other like Quercus over and Fagus is down. Fagus is tolerant tree to shade , but Quercus is intolerant.

3- Mixed forest with many layers : Such as rain tropical forests.

The production of wood in mixed forests is more than pure forest. A research conducted in Germany showed that the trees of Picea gave $3m^3$ of wood in the pure forest as yearly growth whereas was $8m^3$ in mixed fprest.

Rules for establishment of mixed forest

Specialists put many ruls to establish the artificial mixed forest such as Cayer Rule at 1898 and Heyer and Hess at 1906.

Cayer Rule :

1- The selected species for establish artificial mixed forest must be more suitable for edaphic and climatic conditions and have the ability to grow well.

2- The selected species must not be decrease the productional capacity of soil.

3- It is necessary to limit certain place and surface for each species in order to take advantages of light, temperature and humidity to grow well.

Forms of mix :

1- Equal mix :
Each species is surrounded by other species of all sides.

2- Lineal mix : Each line contain one species.

3- Strips (tape) mix : Like follow figure.

4- Groups mix : Like follow figure.

key answer:

Pre text

1- c
2- c
3- f
4- c
5- c

References

الالوسي ، يونس محمد وعلي محي التلال . الغابات العامة . الطبعة الاولى . وزارة التعليم العالي والبحث العلمي. هيئة التعليم التقني . دار التقني للطباعة والنشر. بغداد/ العراق.

الوحـــــدة النمطية الحادية عشر

Training in ***Eleventh modular unit***

Prunning and Thinning in forests – Importance – Kinds of Prunning and Thinning-

٢- الاختبار القبلي (Pre – Test)

Circle the correct answer :

1- Pruning is cut or removing branches from the lower part of the tree

2- Pruning will allow clear wood to develop.

3- Natural pruning depending on the species.

4- Thinning is cutting the trees as a form of single trees or lines or groups before the felling cycle.

5- Thinning decrease the growth of the remaining trees

●Note : Check the answers in key answer page 42

٣.عرض الوحدة النمطية

Pruning

Pruning is cut or removing branches from the lower part of the tree and dead parts of tree which shade the tree.

Pruning branches can produce healthier and more valuable trees, while also improving other aspects of forest health.

Pruning Purposes

Removing branches from the lower part of the tree will allow clear wood to develop. This wood can be much more valuable for use as veneer, plywood and finished materials following harvest. Pruning lower branches, particularly dead limbs, helps reduce the chance of fire climbing the tree and reduces access to potential damaging animals, such as porcupines.

There are two types of Pruning

1- Natural Pruning

2- Artificial Pruning

Natural pruning occurs in natural forests and this varies depending on the species, whether it was needle forest or broadleaf forest.

Natural Pruning start from lower to upper part of tree, this depends on the environment, density , the species . This occurs under the natural effects and often in winter because of wind and snow as it helps to fall.

Artificial Pruning occurs by human intervention in a direct and primary objective is to get good production from wood during the felling cycle so that fits with the goal of forest.

If the aim of the forest is to produce wood with good trunks , the purpose of pruning here is not forming knots on a wooden leg and if the goal is to windbreaks usefulness pruning here is to make the source almost a semi-permeable effect of wind.

Pruning timing

Pruning is best conducted in the fall or winter. As with thinning, this will reduce the potential for insect infestations in the debris.

Pruning Techniques

Branches should be removed to a height of 15 to 20 feet, depending on the overall height of the tree. Be sure to leave a substantial crown, at least 2/3 to 3/4 of the total height.

Thinning

Cutting the trees as a form of single trees or lines or groups before the felling cycle that is process to determine the number of the trees in the unit area of the forest by removing trees poor, sick and dense in order to improve Improve production quantityand quality and and start at the stage of pole and ending before the felling cycle.

Forest trees often grow too close together for the development of timber suitable for harvest. Crowded trees compete for light, moisture, and nutrients, resulting in slow growth and weakened condition. To avoid overcrowding and competition, a stand of trees should be thinned when young to increase the growing space available to each tree. The primary goal of thinning is to produce fewer large, healthy trees for logging rather than many small, weak trees.

Thinning Purposes

There are five basic objectives may be met through implementation of a thinning program:

1. Increase the growth of the remaining trees, particularly the diameter of the tree rather than the height. This allows trees to reach a marketable size more quickly.

2. Select the most favorable species for growth by removing the unwanted, broken, deformed or low value trees.
3. Reduce vulnerability to insects and diseases by improving the health of remaining trees.
4. Utilize or sell trees that are cut.
5. Reduce the incidence of fires in the forest

Types of Thinning

1- Low thinning
2- Crown thinning
3- Selection thinning
4- Mechanical thinning
5- Free thinning

key answer:

Pre text

1- c
2- c
3- c
4- c
5- f

References

1- James McKenna and Keith Woeste. 2010. North Central Research Station, USDA Forest Service. Forestry Information: Additional pruning information is available from the Washington State Department of Natural Resources. 2010 Spokane County Conservation District

2- الالوسي ، يونس محمد وعلي محي التلال . الغابات العامة . الطبعة الاولى . وزارة التعليم العالي والبحث العلمي. هيئة التعليم التقني . دار التقني للطباعة والنشر. بغداد/ العراق.

الوحـــــدة النمطية الثانية عشر

Training in *Twelfth modular unit*

Forest Protection – Importance of protection – Vital factors

(Human,animal,diseases,insects,weeds)

٢- الاختبار القبلي (Pre – Test)

Give your answer by (True) or (False)

1- Forest conservation is the science that deals with the effect of vital and non vital factors.
2- vital factors include viruses, bacteria, fungi and others .
3- There is no mutual relationships between plants and animals.
4- Some animals feed on some neighborhoods harmful.
5- Physiological dependence are two forms of symbiosis and parasitism.

.

- **Note : Check the answers in key answer as in** page 47

٣.عرض الوحدة النمطية

Forest Conservation (Protection)

Forest Conservation science : The science that deals with the effect of vital and non vital factors on nurseries , stands , forests and prevention methods from its damage and control to reach of all the targets demand.

Factors that cause damage to the forest

1-non vital factors

2- vital factors

vital factors : Its include

1- Damage of plant diseases and their causes

a- Viruses

b- Bacteria

c- Fungi

2- Insect damage

3- effect of the weeds and plant parasitic

4- effect of grazing

5- Damage to wild animals

6- Human Damage

vital factors

1) Human impact on forests

Summarized the human effects on forest in the following points :

6- Fruits Collection.

7- Cut the trees for timber , construction , fuel and various Industries.

8- Cut large areas of forests to get agricultural land.

9- Deliberate fires.

10- hard grazing.

2) Mutual relationships among plants (Phytobiotic Factors)

1- The Competition

Competition occurs among the trees themselves or between trees and shrubs and weeds, where increasing competition for light, humidity, and food , The tree is the strongest that remain.

2- The Dependence

It is on three types :

a- Physiological Dependence :

This type of links are two forms of : symbiosis and parasitism.

Symbiosis

An exchange of benefit between the two different organisms without occurrence of any damage for both parties such as bacteria in root nodules of Acacia and Mycorrhiza fungi on pine roots. the important functions of these organisms are to make the complex nitrogen compounds available to the roots of trees after conversion to simpler compounds.

Parasitism

Feeding organism called (parasite) on another organism (Host) without compensation, and this phenomenon leads to the weakening of the host or damage . For example the (Endothia parasitica) fungi led to the extinction of the chestnut tree from natural distribution region in U.S.A. And get some small seedling of some fungi leads to its wilt and damage. Seedling wilt disease (Damping off) is caused by fungal species belonging to the genus (Pythium, Fusarium, Rhizoctonia) that attack the roots or stems after the seedling emergence on the soil surface.The infection appeared in the nursery of the College of Agriculture and Forestry / Hamam Alalyl in 1972 and led to the death of small pine seedling *Pinus brutia*.

b- Ecological Dependence :

Is to protect some plants to some other, such as providing shade for shade loving plants (intolerant trees), or protection by spiny plants to growing plants next to it from grazing and other

c- Mechanical Dependence :

Is the provision of assistance neighborhoods to each other for the purpose of continuing growth and survival. For example, climbing plants that climb on forests trees, the trees provide the opportunity for these plants to grow.

3) Mutual relationships between plants and Animals

1- Plants provide food for the revival of the other (plants or animals) directly or indirectly, any plants that are one of the major factors to the survival and spread of other neighborhoods.

2- The animals that live in the forest , transfer of seeds by their Bodies. and others working to improve the soil can also add some animal manure to the land of the forest.

3- Some animals feed on some neighborhoods harmful.

4- Transfer the pollen grains by the insects.

5- Harmful to some birds nesting in trunks of trees such as woodpeckers

and some of Rodents which make of holes in the trunks of trees.

3)The Insects

Harmful to some insects, leaves , branches, wood, or even the roots and seeds. There are vary on the severity of damage according to species. pure forest affected by insects more than mixed forest, also Ever green needle-trees sensitive to insect injuries at the stage of young and aging more than deciduous species .

4)The Weeds

The Weeds Cause many damages can be divided into :

2- The Weeds Impede the operations of the cutting and natural regeneration in the forest.

3- Reduce the proportion of nutrients in the soil, and thus affect the productivity.

4- Cover small seedlings and competing their in the air ,light, heat and water needed to grow.

4- Lead to increased risk of fire and obstructing firefighting operations.

5- Operates a shelter for rats and insects, thus facilitating their Spread.

key answer:

Pre text

1- c
2- c
3- f
4- c
5- c

Reference

- الالوسي ، يونس محمد وعلي محي التلال . الغابات العامة . الطبعة الاولى . وزارة التعليم العالي والبحث العلمي. هيئة التعليم التقني . دار التقني للطباعة والنشر . بغداد/ العراق.

الوحـــــدة النمطية الثالثةعشر

Training in ***Thirteenth modular unit***

Non- Vital factors – Importance – Its effect on forests

(Poison gases, Fires, Soil factors, Climate)

٢- الاختبار القبلي (Pre – Test)

Give your answer by (True) or (False)

1- Wind and storm damages consider of unvital factors
2- The presence of dry organic matter on the forest floor helps fires.
3-From the damages of Fire inside the forest is Considerable material losses.
4- The forest environment impact by the effect of fire on living organisms .
5- Hydrogen Chloride and Hydrogen Sulphide are untoxic gases.

.

- **Note : Check the answers in key answer** page 51

٣.عرض الوحدة النمطية

Non vital factors: Its include

1- damages of fire

2-Damages of fumes and toxic gases

3-Wind and storm damages

4-Freezing damages

5- effect of the high temperatures

6- Snow damage

7- Hailstone damage

8- lightning damage

Types of fires

1- Ground Fire

2- Surface Fire

3- Stem Fire

3- Crown Fire

Factors that help fires

1- The presence of dry organic matter on the forest floor

2- Heat and drought to help fires

3- Wind speed

4- Deliberate burning of forests

5- lightning

6- Power lines (Electrical Lines) passing within forests

7- Ignorance and neglect

8- Type of Forest

9- Forest age

10- Types of trees that make up the forest

11- The presence of roads inside the forest

12- The presence of natural barriers

damages of Fire inside the forest

1- Considerable material losses.

2- Degradation of natural and artificial regeneration in the forest.

3-The difficulty of working in burned forest.

4- Fire leads to erosion and drifting.

5- Human Losses may occur as a result of fire.

6- The forest environment impact by the effect of fire on living organisms in the fire area

prevention methods of forest fires

1- when increasing the distances inside the forest the fire decreased.
2- The mix in the establishment of forest.
3- Making of fire lines.
4- Prunning and thinning reduce of forest density.
5- Must provide a fire brigade in each of the forests office.
6- Establishment of fire control towers on high ground in the forest.

The effect of toxic gases on forests

There are a wide range of toxic gases that affect forest trees. These gases subtracted from the chimneys of different industries,

especially heavy industries such as making kinds of minerals or coal combustion.

The most toxic and harmful gases:

SO_2 gas

Hydrogen Chloride

Hydrogen Sulphide

SO_3 gas

CO gas

CO_2 gas

key answer:

Pre text

1- c
2- c
3- c
4- c
5- f

Reference

- الالوسي ، يونس محمد وعلي محي التلال . الغابات العامة . الطبعة الاولى . وزارة التعليم العالي والبحث العلمي. هيئة التعليم التقني . دار التقني للطباعة والنشر. بغداد/ العراق.

الوحـــــدة النمطية الرابعة عشر

Training in Fourteenth modular unit

Forests Environment–Effecting factors on forests growth – Climatic factors – Edaphic factors – Biological factors.

٢- الاختبار القبلي (Pre – Test)

Give your answer by (True) or (False)

1- The species vary in their ability to withstand low temperatures.
2- Edaphic factors consider one of site factors
3- *Larix spp.* , *Betula spp* are from Frost-non tolerant trees.
4- *Acacia cyanophylla* , *Eucalyptus citrodora* are from Frost-tolerant trees.
5-Xerophyte is drought regions plants like *Calluna vulgaris, app., Erica arborea.*

- **Note : Check the answers in key answer** page 57

٣.عرض الوحدة النمطية

Environmental factors

Forests are the unity of life occupy a certain area of the earth and have a close relationship to the site in which they live. In the science of silviculture the site known as set of circumstances and factors that the vegetative groups or one plant living under its effect.

Site factors include the following factors:

1. Climatic factors
2. Edaphic factors
3. Physiographic factors
4. Biotic factor

Climatic factors

1- Temperature

The species vary in their ability to withstand low temperatures, for example die a large number of tropical plants when temperatures decrease around zero centigrade, while polar plants withstand low temperature of about (40-50) under zero. The effect of low temperatures on the trees showed either in the form of physiological damage, yellowing or reddening or mechanical damage such as burning leaves and tender twigs or cracked tree trunk.

Frost-tolerant trees

Larix spp. , Betula spp. , Populus tremula , P. nigra , Pinus nigra , Pinus sylvestris , Juniperus spp. , Pistacia khinjuk , Quercus spp.

Frost-semi tolerant trees

Pinus Pinea , P. halepensis , Capressus sempervirens , Robinia pseudocacia , Ailanthus glandulosa , Acer cenerascens , Eucalyptus camaldulensis , Olea europea , Casuarina equisetifolia.

Frost-non tolerant trees

Acacia cyanophylla , Eucalyptus citrodora , Acacia farnesiana , Zizyphus spina-christi , Arucariaexcelsa.

The effect of high temperatures on trees like sunny burning , transpiration increasing and the delay in growth specialy in natural regeneration areas in forest .

Species resistance to high temperatures

Lauras nobilis, Quercus ilex, Capressus sempervirens, Pinus brutia, Pinus Pinea, Acacia spp.

Species resistance to medium temperatures

Quercus pedunculata , Fraxinus spp. , Eucalyptus camaldulensis , Corylus ovellana.

Species unresistance to high temperatures

Populus tremula , Fagus orientalis , Abies cilicica , Quercus libani , Acer spp. , Celtis spp. , Taxus spp. , Alnus spp. , Pinus sylvestris.

2- Moisture

Humidity plays an important role in the growth of trees and Forest composition. Lack of moisture leads to the veldt , prairies and deserts. There is moisture or water in the protoplasm and the walls of plant cells, and without them can not be carried out of breath and photosynthesis and transpiration. As that moisture is one of the main factors that determine the

natural spread of forest growth on the surface of the globe. The rain, snow , hailstone , dew , soil moisture and air humidity consider of the most important sources of moisture on the surface of the globe. Can distinguish three degrees of moisture, namely: the Maximum moisture , Optimum moisture and Minimum moisture. The minimum moisture (drought) is very important for the growth of trees and evolution and the leaves start to yellowing, wilt and drought, and begin to plant death in the case of low humidity to under Minimum moisture. But if the moisture in the extreme state , it leads to death of the plant because the rate of oxygen in the soil will decrease, then the roots can not take the oxygen necessary for their growth.

Plants divided according to the degree of tolerance and requirements for moisture to four groups :

5. **Xerophyte :** drought regions plants : like *Calluna vulgaris, app., Erica arborea.*
6. **Hygrophyte** : Moist regions plants : like *Alnus spp. , Fraxinus spp., Platanus spp.*
7. **Mesophyte :** Medium-Moist regions plants : like *Pistacia khinjuk, Crataegus azarolus , Malia azedrach, Casuarina equisetifolia.*
8. **Tropophyte :** like Mansoom plants : *Delbergia sisso, Tectona grandis, Zizyphus jujube*

2- Light

Light is the most important factors that determine plant growth and composition of vegetation. The major importance in process of photosynthesis and the leaves construction , longitudinal growth of trees and diameter. The sun is the main source of light and reach to the plants either directly called direct light or indirectly called Diffuse Lihgt.

All plants need light because of the absence of light entirely or partly, the growth will be weak in the shoots and roots , then the plant appears light yellow color because of the absence of chlorophyll pigment . In the case of light is very weak, the photosynthesis becomes insufficient to respond to lose energy by respiration whereas the building of organic materials to be weak in this case and lead to stunted growth

of the tree, and may lead to the death of the tree in case of continued. If the light intensity is higher than the minimum necessary for the growth of the tree, the process of building organic matters (Anabolism) occurs more rapidly than the process of Catabolism . ***(metabolism consisting of anabolism and catabolism)***. But trees grow in the best okay in the case that the light intensity in the optimization. Measured the intensity of light in different ways, including the method to use apparatus to measure light intensity as a **lux meter** and express to the intensity of light by **lux or candle / ft.**

Edaphic factors

Soil plays a big role and important in the lives of forest plants and distribution are working to install trees and providing water and nutrients needed for various physiological processes.

Mechanical advantages of forests to soil

a. Improve soil structure : This depends on the nature of roots which Formed by trees.

There are many types of roots :

a- Trees with pivoted roots : Extends the main root in these species vertically to the depths of the soil like the roots of trees : *Quercus aegilops, Q. infectoria , Pinus brutia, P. sylvestris, Juglans regia.*

b- Trees with cardial roots : Roots are tangled such as the heart like : *Platanus orientalis, Acer spp., Ulmus spp.Abies.*

c-Trees with shallow roots: Found in this species only shallow lateral roots like : Picea orientalis, Populus tremula, Salix spp.,

d-Trees with pivoted and shallow roots: In these species, the pivots and lateral roots are strong and widespread long-distance like: *Casuarina equisetifolia, Quercus ilex, Capressus sempervirens, Pinus brutia,* Carpinus spp.

key answer:

Pre text

1- c
2- c
3- f
4- f
5- c

References

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الوحـــــدة النمطية الخامسة عشر

Training in Fifteenth modular unit

Trees cutting - Felling a tree - limiting the direction of felling – under cut – back cut – felling.

٢- الاختبار القبلي (Pre – Test)

Give your answer by (True) or (False)

1- Cutting of trees conducted by automatic saw and other helping tools.
2- From the process of logging ,Set the direction of cutting.
3- Felling of tree start befor the process of back cut where the tree start slopping
4- The use of hydraulic jacks to protect the trees near the trees to be cut and without harm them .
5-The use of wedges for the purpose of opening the saw splitting of the hand of back cut.

- **Note : Check the answers in key answer** page 60

٣.عرض الوحدة النمطية

Trees cutting (logging)

Choose the appropriate method for cutting trees and cleaning of the crust and twigs . This is done according to the size of investment and type of tools and machines which belongs to logging. Cutting of trees conducted by automatic saw and other helping tools like iron hammer , iron wedge and iron claws.

The process of logging the following steps :

1. **Set the direction of cutting** : For the purpose of ensuring the safety of the tree when it felling and not to harm trees and shrubs adjacent.
2. **Under cut :** Includes lower cut and another oblique with perpendicular direction to the direction of the falling and its depth about a quarter of the tree diameter. corners at the junction of the lower cut with oblique cut must be no more than 45 degrees.
3. **Back cut :** back cut achieve in the opposite direction of the under cut by the saw . and Preferably be at the level of under cut or little higher.
4. **Felling of tree :** Start this stage after the process of back cut where the tree start slopping . When the tree diameter increase , the time of felling increase too .

So it must be control of felling of tree to right direction by the following factors :

a- The use of wedges for the purpose of opening the saw splitting of the hand of back cut larger angle where Leads to tendency of tree to required felling direction.

b- The use of hydraulic jacks to protect the trees near the trees to be cut and without harm them, and also facilitate the task of workers to cleaning the felled trees . The importance of careful

on the direction of felling increase in the Sloping regions and at the increasing of the diameter and height.

key answer:

Pre text

1-c
2-c
3-f
4-c
5-c

references

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