FOREST LEARNING

Teacher

Managing competition between forestry plants.

Teacher Overview

Within this lesson, students will:

- gain an understanding about how forestry plants compete for resources to grow and how this impacts on the growth and development of an individual plant and also a coupe.
- develop an appreciation for the concepts, and understand the reasons behind, planting density and thinning and understand how plantation management can impact factors such as height, diameter and carbon storage of a forest.
- view source material and complete a series of workstations to compile their information on the required outcomes.

Stage

Year 12 Agriculture

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Syllabus Links

Outcomes

H1.1 explains the influence of the physical, biological, social, historical and economic factors on sustainable agricultural production

H2.1 describes the inputs, processes and interactions of plant production systems

Students learn about:

- Competition in plant communities.

Students learn to:

- Describe sources of competition in plant communities.
- Investigate how farmers manage plant competition through plant density and weedcontrol strategies.

Lesson Overview

Activity One (Approx. 15 minutes):

Teacher preparation:

Book and have access to a class set of ipads or laptops with internet connection or photocopy a class set of the news story using the URL below.

Activity Outline:

Students will view a stimulus article on tree thinning and begin to gain a basic understanding of some of the positives and negatives of thinning forestry trees. Students should open the URL and complete the series of questions in the spaces provided on their printed worksheets.

Source Material: An introduction to the forestry management and competition.
Online Publication: Science – American Association for the Advancement of Science
Title of Article: To save forests, cut some trees down, scientists say
Author: Ula Chrobak Apr. 21, 2017 , 2:00 PM
URL: http://www.sciencemag.org/news/2017/04/save-forests-cut-some-trees-down-scientists-say

Activity Two (Approx. 8 minutes):

Teacher preparation:
Set up a smart board or other video access to the following URL link using internet connection.

Activity Outline:
Students are to view the video (individually or as a class) from a news report to gain an understanding on the process of tree thinning before completing their workstation activity.

Activity 2 URL: http://abc7news.com/weather/uc-berkeley-testing-ecosystem-by-cutting-down-trees-in-sierra/1429478/

Source: Anc 7UC Berkely testing ecosystem by cutting down trees in Sierra. Dan Ashley Friday, July 15, 2016

Activity Three (Approx. 40 minutes):

Teacher preparation:
Make photocopies of the source material (workstations) on plant competition and management.

Activity Outline:
Students are to rotate around the workstations and make a short summary in the provided student worksheets for each of the workstations with respect to their relevance on the topics of:

- Competition between plants in the forestry industry and/or
- Management of competition by farmers/producers.

If the workstation only has relevance to one of these topics, then students should only complete this area of the table.

PRINT THE FOLLOWING WORKSTATIONS ON THE FOLLOWING PAGES

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Workstation Introduction: Tree basal area

Tree Basal Area (TBA) is the cross-sectional area (over the bark) at breast height (1.3 metres above the ground) measured in metres squared (m^2). TBA can be used to estimate tree volumes and tree stand competition.

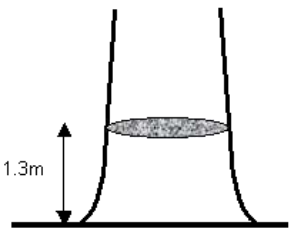
<u>How to calculate TBA</u>

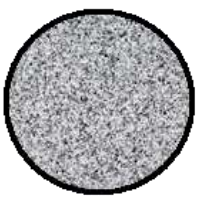
1. Measure the diameter of the tree at breast height in centimetres (DBH).
2. Calculate the basal area (m^2) using an equation based on the formula for the area of a circle (area = πr^2 where r = radius and π = 3.142) and the formula for radius (r=diameter/2 = DBH/2).

Therefore:

$$\text{Tree Basal Area (TBA) } (m^2) = \pi r^2$$
$$= 3.142 \times (DBH/200)^2$$

This formula converts the diameter in centimetres to the basal area in square metres. The same technique can be used to calculate the cross sectional area of the tree at any point along the stem.





Basal Area (BA) in square metres

$BA = (D/200)^2 \times \pi$

Where:

$\pi = 3.142$

D = Diameter (cm)

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THE INFLUENCE OF COMPETITION ON TREE GROWTH AND FORM

Workstation 1: Competition and height growth

The degree to which competition affects the "form" of trees can be critical where is it necessary to grow straight trees for producing higher value saw logs, or control branch size. Many plantation species commonly grown for timber, including eucalypts and pine trees, have strong apical dominance. This means that most of the growth expansion of a seedling or sapling is concentrated in the uppermost bud, allowing trees to grow tall and straight even when planted in the open. Others, like many of the rainforest species, have low apical dominance and will tend to grow broadly like an apple tree if sidelight is not controlled. In this case, maintaining a sufficient level of competition to encourage reduced branching and straight growth may be essential.

Tree density also influences tree form and height. Increasing the initial stocking rate (stems/ha) of a plantation can lead to an increase in tree height, although this reaches a limit. Above this point, height growth remains fairly constant, even with a trebling of the stocking rate. Research suggests that the loss of height growth at low stockings is largely the result of excessive exposure.

Farm Forest Line Accessed 16th May 2017
Written by Rowan Reid, Marina Hurley and Peter Stephen. Melbourne University, Australia
http://www.farmforestline.com.au/pages/5.6.1_influence.html

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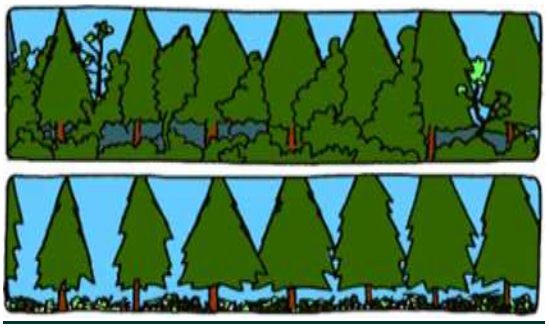
THE INFLUENCE OF COMPETITION ON TREE GROWTH AND FORM



Workstation 2: Competition and diameter growth

Once site resources, particularly light and moisture, become limiting, any increase in competition will lead to a direct reduction in the size or efficiency of the individual tree canopy. As a result, the amount of sugars produced by the leaves and fed down the branches and trunk for cambium growth will be reduced. This results in reduced diameter growth. Increasing the basal area above 5m^2/ha in a young eucalypt plantation can cause a dramatic drop in the annual diameter increment. To maximize diameter growth, sufficient trees must be initially established to allow mutual shelter to promote healthy growth. Then, when the trees grow, the forest must be thinned to reduce competition. Repeated thinning to avoid excessive competition, while maintaining mutual shelter will allow the trees to maximise height and diameter growth.

Farmers can use unthinned eucalypt or pine plantations growing on similar soil types in their area as an indication of the basal areas of fully stocked stands. Better still, farmers can establish measurement plots in their own forests and monitor diameter growth over time. When they notice the diameter growth falling they can determine the corresponding basal area and make a judgment of the extent of thinning required.

Farm Forest Line Accessed 16th May 2017

Written by Rowan Reid, Marina Hurley and Peter Stephen. Melbourne University, Australia.
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THE INFLUENCE OF COMPETITION ON TREE GROWTH AND FORM

Workstation 3: Competition and volume production

Although individual tree diameter declines with increasing competition, the total volume of wood on the site increases.

If the object is only to maximise the volume of timber, as for pulpwood or fuelwood, then the higher the stocking rate, the greater the yield. This is why pulpwood plantations are established at over 1000 trees per hectare (<3x3 metre spacing) and left unthinned until they are harvested. The rate of volume production is greatest when the canopy of the young plantation first reaches its full potential. As trees continue to grow, competition then increases and the rate of volume production may decline.

Eventually, the plantation reaches a maximum volume for the site. At this point any further growth of individual trees can only be possible if other trees die or are removed. Currently many unmanaged native forests are at this point, as demonstrated by repeated measurements of total volume, showing no change over time. Stability is a common problem in dense stands. Tall, thin trees are susceptible to toppling or bending in strong wind, particularly if the soils are prone to water logging. Other problems common in dense plantations include increased difficulty of harvesting, lack of light to support understorey plants, and an increased susceptibility to drought, insects and disease.

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THE INFLUENCE OF COMPETITION ON TREE GROWTH AND FORM

Workstation 4: Competition and branch development

Depending on the product specifications and the species involved, shading of the lower branches may be sufficient to control branch size or even encourage self-pruning. However, because competition reduces the size of the canopy it will also lead to a reduction in diameter growth. If trees do not naturally cast off branches soon after they die, the dead branches may remain in the new wood forming loose black knots and provide an access point for rot. In this case the branches would still need to be manually pruned to produce clear wood. Even where the trees are to be manually pruned, encouraging smaller branch size by allowing some competition may make pruning easier.

Farm Forest Line Accessed 16th May 2017

Written by Rowan Reid, Marina Hurley and Peter Stephen. Melbourne University, Australia

http://www.farmforestline.com.au/pages/5.6.1_influence.html

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THINNING: THE MANAGEMENT OF COMPETITION BETWEEN TREES

Workstation 5: Introduction to thinning

Once established, individual plants on a site will both support and compete with each other. As the trees grow up together, what began as welcome shelter from the elements may very soon turn into competition for limited resources. The species composition, spatial arrangement and the impact of natural, accidental or managed interventions will determine how these interactions play out over time. Being able to manage the positive and negative interactions that occur between individual plants within a forest is possibly the most important aspect of silviculture (*definition: the science of forestry*).

Competition can have both a positive and a negative effect on tree growth and wood quality. In young plantations, a dense forest encourages rapid tree growth by suppressing weeds and providing mutual shelter from strong winds. However, as these trees continue to grow they begin to compete for light and moisture and slow each other's growth. Although tree stocking (stems/ha) is commonly used to describe the level of competition, it is limited because it does not take account of the size of the trees. A more useful measure of competition is the basal area.

Farm Forest Line Accessed 16th May 2017

Written by Rowan Reid, Marina Hurley and Peter Stephen. Melbourne University, Australia

http://www.farmforestline.com.au/pages/5.6_thinning.html

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THINNING: THE MANAGEMENT OF COMPETITION BETWEEN TREES

Workstation 6: Tree and Forest Measurement

Basal area is the cross-sectional area of all tree stems at 1.3m height per hectare and is directly related to the volume of timber. An appreciation of how forest trees behave under varying degrees of competition can be drawn from trials where the same species has been planted at different stocking rates. Inter-tree competition plays a powerful role in determining tree diameter and stand volume growth in plantations of eucalypt, poplar and pine. Similar relationships could be presented for many other tall forest species. From these examples and others, we are able to make some general comments about the effect of competition of tree growth.

There is a great difference in the degree to which competition effects different species. Tolerant trees, such as the native and exotic pines, can form dense narrow canopies that allow forests to reach high levels of competition before individual tree growth is suppressed. Many of the hardwoods, including the eucalypts and teak, are much less tolerant. The lower shaded leaves of the eucalypts die as the competition increases, leaving only a small amount of canopy on each tree to sustain growth.

The basal area in a young eucalypt plantation commonly increases rapidly until competition between the trees themselves slows diameter increments thereby limiting basal area growth. The basal area of eucalypt plantations in Australia appears to reach a natural limit of around $50m^2$/ha even on the best sites. On sites with medium to low rainfall, shallow soils or low fertility, the maximum basal area for a young eucalypt plantation may be closer to $20m^2$/ha. If left

untended, any further growth in diameter in the dominant trees must be offset by the death of suppressed trees. By contrast, unthinned pine plantations grow slower in the early years but can achieve basal areas as high as 100m^2/ha on high quality sites. Because pines are more tolerant of competition, it is not unusual for them to yield twice the volume of timber at harvest than the native eucalypt forest they replaced.

Farm Forest Line Accessed 16th May 2017
Written by Rowan Reid, Marina Hurley and Peter Stephen. Melbourne University, Australia
http://www.farmforestline.com.au/pages/5.6_thinning.html

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References

1. Science – American Association for the Advancement of Science: To save forests, cut some trees down, scientists say (Ula Chrobak) Apr. 21, 2017
   Accessed 18th May 2017
   http://www.sciencemag.org/news/2017/04/save-forests-cut-some-trees-down-scientists-say
2. Berkely testing ecosystem by cutting down trees in Sierra. Dan Ashley
   Friday, July 15, 2016
   Accessed 18th May 2017
   http://abc7news.com/weather/uc-berkeley-testing-ecosystem-by-cutting-down-trees-in-sierra/1429478/
3. Farm Forest Line Written by Rowan Reid, Marina Hurley and Peter Stephen. Melbourne University, Australia
   Accessed 16th May 2017
   http://farmforestline.com.au/pages/6_tree_forest_meas.html

Resources

a) Student worksheet.
b) Online Sources (links provided on the worksheet).
c) Sample answers provided.

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Sample Answers

Activity One

a) Identify the two main benefits of thinning forest growth.

- Creates tougher trees that can endure climate change
- Can absorb carbon out of the air as fast as dense forests

b) Identify factors that "stressed" trees are at more risk of.

- More susceptible to drought and insect attacks.

c) Summarise the experiment being conducted in north-western Montana since 1961.

- In a western larch forest, areas broken into plots.
- 8 year old trees thinned from 10's of thousands per hectare to 494 per hectare
- Other plots left alone
- Measured tree height, diameter, and width of branches to estimate growth and carbon stored

d) Summarise the findings of this experiment to date.

- 8-year-old trees thinned from 10's of thousands per hectare to 494 per hectare = these trees grew thick trunks and broad canopies.
- Other plots left alone = grew tall and skinny as they competed for sunlight.
- Total carbon was nearly the same for both forests.
- The unthinned trees has more but the thinned forest compensated with bigger trees.

e) Explain the advantage of "big trees".

- More drought resilient and their thick bark can resist fire better
- Can fight off pest and disease and insects

f) Identify a potential problem with early thinning of some tree species.

- Some species rely on the thin trees for habitat.

Sample Answers

Activity Three

One: Summary of workstations

Tree basal area description - the cross-sectional area (over the bark) at breast height - can be used to estimate tree volumes and stand competition		
Workstation	Summary of plant competition	Summary of forestry management to reduce competition
Competition and height growth	- Many plantation species have strong apical dominance -Tree density also influences form and height. - Loss of height at low stockings is largely due to the result of excessive exposure.	- Necessary to grow straight trees or control branch size - Increasing the stocking rate of a plantation can lead to increase tree height (to a limit)
Competition and diameter growth	- Once site resources, particularly light and moisture, become limiting, any increase in competition will lead to a direct reduction in the size or efficiency of the individual tree canopy. - This results in reduced diameter growth	- Increasing the basal area above 5 m^2/ha in a young eucalypt plantation can cause a dramatic drop in the annual diameter increment. To maximize diameter growth sufficient trees must be initially established to allow mutual shelter to promote healthy growth. Then, when the trees grow, the forest must be thinned to reduce competition. Repeated thinning to avoid excessive competition, while maintaining mutual shelter will allow the trees to maximise height and diameter growth.
Competition and volume production	- Although individual tree diameter declines with increasing competition, the total volume of wood on the site increases.	- If the object is only to maximise the volume of timber, as for pulpwood or fuel wood, then the higher the stocking rate, the greater the yield. This is why

	- Eventually, the plantation reaches a maximum volume for the site. At this point any further growth of individual trees can only be possible if other trees die or are removed - Stability is a common problem in dense stands. Tall, thin trees are susceptible to toppling or bending in strong wind, particularly if the soils are prone to water logging. Other problems common in dense plantations include increased difficulty of harvesting, lack of light to support understorey plants, and an increased susceptibility to drought, insects and disease.	pulpwood plantations are established at over 1000 trees per hectare (<3x3 metre spacing) and left un-thinned until they are harvested.
Competition and branch development	- Shading of the lower branches may be sufficient to control branch size or even encourage self-pruning. However, because competition reduces the size of the canopy it will also lead to a reduction in diameter growth. If trees do not naturally cast off branches soon after they die, the dead branches may remain in the new wood forming loose black knots and provide an access point for rot.	- In this case the branches would still need to be manually pruned to produce clear wood. Even where the trees are to be manually pruned, encouraging smaller branch size by allowing some competition may make pruning easier.
Introduction to thinning	- Once established, individual plants on a site will both support and compete with each other. As the trees grow up together, what began as welcome shelter from the elements may very soon turn into competition for limited resources. The species composition, spatial arrangement	

	and the impact of natural, accidental or managed interventions will determine how these interactions play out over time - In young plantations a dense forest encourages rapid tree growth by suppressing weeds and providing mutual shelter from strong winds. However, as these trees continue to grow they begin to compete for light and moisture and slow each other's growth.	
Tree and Forest Measurement	- Inter-tree competition plays a powerful role in determining tree diameter and stand volume growth in plantations of eucalypt, poplar and pine. - Tolerant trees, e.g. native and exotic pines, can form dense, narrow canopies that allow forests to reach high levels of competition before individual tree growth is suppressed. Many of the hardwoods, e.g. eucalypts and teak, are much less tolerant. The lower shaded leaves of the eucalypts die as the competition increases, leaving only a small amount of canopy on each tree to sustain growth.	- Unthinned pine plantations grow slower in the early years but can achieve basal areas as high as 100m^2/ha on high quality sites. Because pines are more tolerant of competition it is not unusual for them to yield twice the volume of timber at harvest than the native eucalypt forest they replaced.