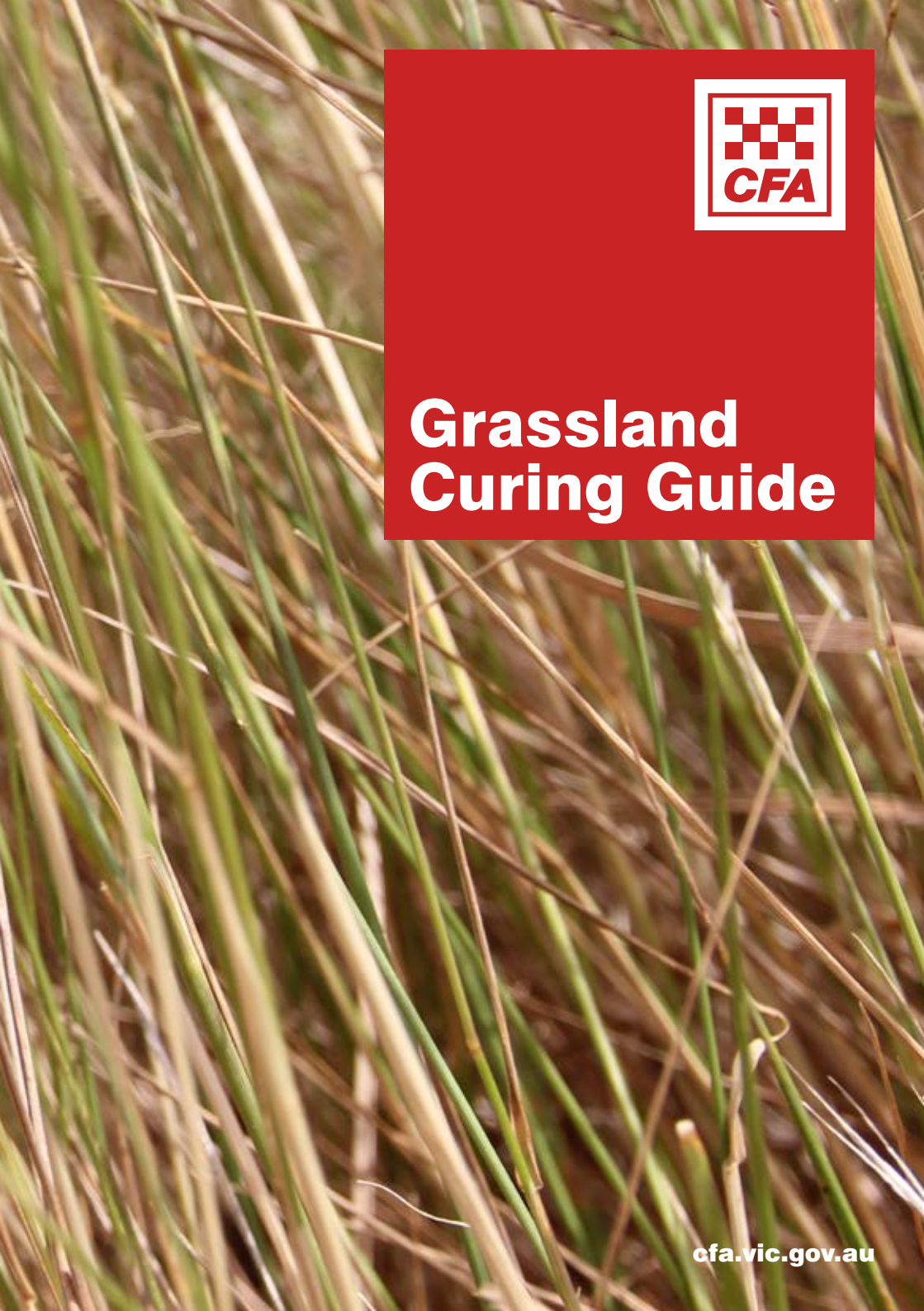

Grassland Curing Guide

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CFA Grassland Curing Guide

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Aim

This guide is designed to aid CFA Grassland Curing observers to visually estimate grassland curing. Grassland curing observations are collected by CFA volunteers across the state of Victoria leading up to and during the fire season. Curing data helps provide CFA operations with the information necessary to:

- Assess the onset of the grassfire season
- Decide when to implement fire restrictions
- Provide better information for community warnings
- Determine Fire Danger Ratings and Total Fire Bans
- Calculate potential grass fire behaviour and rate of spread
- Allocate fire fighting resources appropriately.

What is Grassland Curing?

Grassland curing is the process in which grasses die or become dormant and dry out. Curing is measured as the percentage of dead material in a grassland.

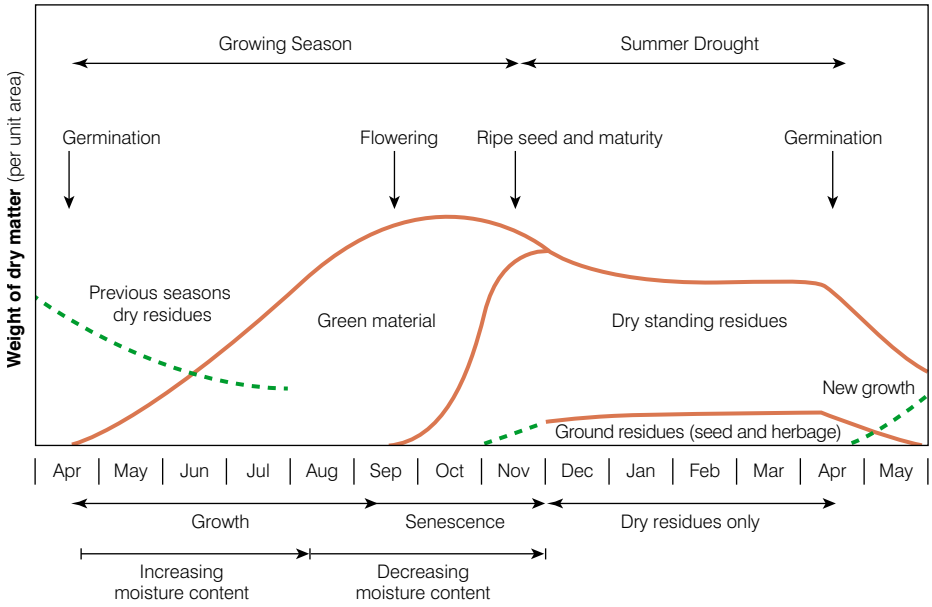
Most grass species have a life cycle in which after flowering, the plant dies or becomes dormant and dries out. This process is termed curing.

The Grass Curing Process

During spring, grasses undergo a period of growth that is normally completed by late spring to early summer, depending on grass species and seasonal variables such as rainfall and temperature. By early summer, most grasses have produced a fully mature seed head and have already begun to lose their ability to draw moisture from the soil. As the summer progresses, the grass continues to dry out and will eventually die or become dormant (see Figure 1).

From the time seed heads are fully developed, it will take on average six to ten weeks for grasses to become fully cured under average Victorian weather conditions (see Figure 2). As grasses cure, the amount of moisture within the grass decreases and the amount of dead material in the grassland increases, heightening the potential for fire to ignite and spread in these fuels.

Figure 1: Life cycle of a grassland near Adelaide (South Australia) (Parrot 1964)



During the curing process, grasses undergo a number of physiological changes. The most obvious observable change is the gradual loss of chlorophyll, the pigment that makes living grass appear green. This process will vary between species, but typically the maturing seed head and leaf blades will start to lose chlorophyll first, eventually followed by the stem. Initially, grasses will change colour from a vibrant green to a yellow-green as chlorophyll levels decrease.

At about 50% cured, sections of the grass will start appearing straw coloured and this will progress until there is no green (chlorophyll) left in the grass and the yellow hue becomes bleached. At this point, the grass is considered 100% cured. A modified version of McArthur's (1966) description of the progression of curing of grasses in south-eastern Australia and the associated physiological changes is presented in Table 1.

Figure 2: A generalised seasonal progression of curing in south-eastern Australia

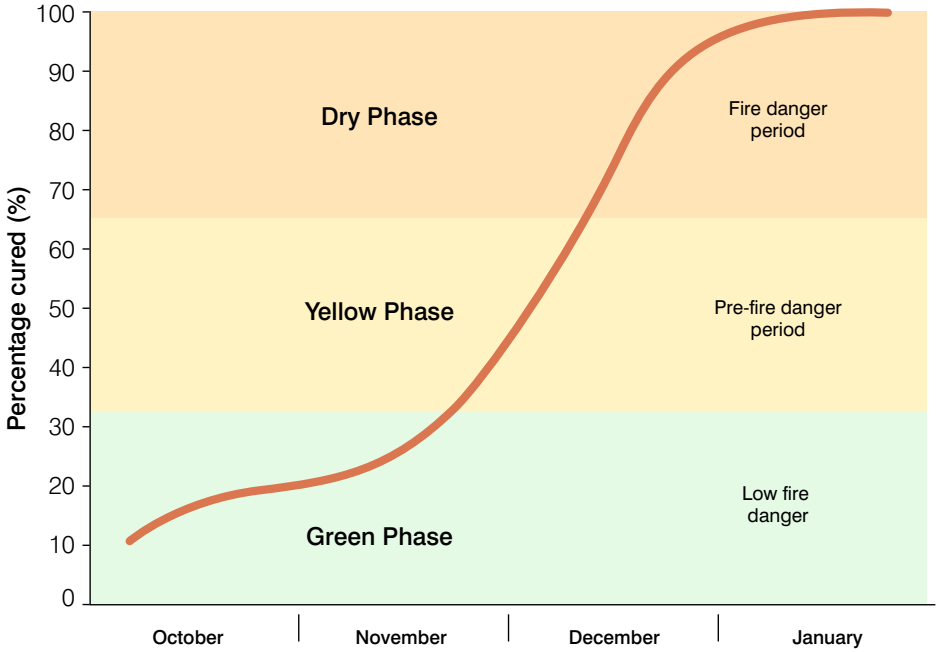


Table 1: Grass curing – key attributes (modified from McArthur, 1966a)

	% CURED OR % DEAD	GRASS COLOUR	SEED HEAD DEVELOPMENT	LANDSCAPE FEATURES
GREEN PHASE	0	Green	From beginning of grass growth to commencement of seed head development	Landscape is entirely green, no seed heads visible
	10	Green	Seed heads formed and flowering	Landscape is entirely green with green seed heads visible
	20	Green – Yellow	Seed heads maturing and seeds beginning to drop	Seed heads change colour; first easily visible appearance of dead material in landscape
	30	Green – Yellow	Most seed heads mature and seed dropping	Yellowing becoming apparent in leaves
YELLOW PHASE	40	Yellow – Green	Most seed heads mature and seed dropping	Green, with yellowing a significant part of landscape
	50	Yellow – Green	Up to ½ of all stems have dropped their seed	Landscape half green and half yellow
	60	Yellow – Green	Over ½ of all stems have dropped their seed	Yellow, with green a significant part of landscape
DRY PHASE	70	Yellow – Straw. Lower third of stalk may be green.	Most seed heads have dropped their seed	Minor amount of green or greenish-yellow visible in landscape
	80	Yellow – Straw	Almost all seed heads have dropped their seed	Non-significant amount of green or greenish-yellow visible in landscape
	90	Straw. Odd individual stalk may be green	Essentially all seed has dropped	Very little green showing anywhere, some green in wetter areas such as roadside and river valleys
	100	Bleached. All stalks fully cured	All seed heads have dropped their seed	No green anywhere in landscape

Grassland Curing and Fire Behaviour

When considering fuels, curing is the most important factor influencing fire behaviour in grasslands. Curing affects fire behaviour in two ways – by gradually increasing the amount of dead material in the grassland and by gradually decreasing the live fuel moisture of the curing grass. The result of these two changes is an increased chance of fire ignition and increase in fire intensity and spread as grasses cure.

Dead grasses have a much lower fuel moisture content than live fuels; dead fuel moisture contents range from 2% to 35% of their oven dry weight (ODW) depending on environmental conditions, and live fuels can range anywhere from 30% to 260% ODW. While dead fuel moisture content varies with environmental conditions (such as temperature, relative humidity and wind speed), live fuel moisture gradually decreases as grasses cure.

The amount of energy (in the form of heat) that is required to ignite and sustain a fire in grass decreases as the fuel moisture content of that grass decreases. In partially cured grasslands, there needs to be enough dead fuel in order to ignite and sustain fire spread. Surrounding green grass with higher fuel moisture contents will require a substantial heat input to burn off excess moisture and ignite. If the combustion process does not produce enough heat to ignite the greener sections of the grass, fire spread will either be very patchy or not spread at all. Burning under these conditions will produce very small flame heights, will be low intensity and be easily suppressible (see Figure 3).

Figure 3: A low intensity burn in 40% cured grass.

Figure 4: A high intensity burn in 100% cured grass.

As grasses cure and live fuel moisture decreases and the amount of dead fuel increases, less heat is required to ignite the grass. As a result, more heat is released as it combusts. Burning under these conditions can produce large to very high flame heights (2 m+), can spread very quickly, be very intense and will be much more difficult to suppress (see Figure 4). Table 2 summarises expected fire behaviour characteristics at different stages of curing under normal south-eastern Australian summer conditions.

Decomposing dead material from previous season's growth (or thatch), which forms a matted layer of fuel beneath the current season's growth, can contribute substantially to the amount of dead material in a grassland, and therefore have an important impact on fire behaviour. This influence is particularly important when the current season's growth have curing values around 30%-50%.

In the absence of thatch, this grass would not necessarily be able to sustain fire spread, but dry thatch underneath increases the amount of dead material available for combustion and increases the ability of fire to carry through the greener grass. This type of fire will produce very small flame heights, be patchy in its progression and will be low intensity.

Table 2: Expected fire behaviour characteristics at different stages of curing under normal south-eastern Australian summer conditions

	% CURED	WILL IT IGNITE?	FLAME HEIGHTS	SPREAD NOTES	SUPPRESSION DIFFICULTY
GREEN PHASE	0	No	N/A	Fire fails to spread	N/A
	10				
	20				
	30				
YELLOW PHASE	40	Maybe, especially if substantial thatch is present	Low, typically lower than the fuel height	Fire front will be fragmented. Fuel consumption will be patchy. Fire will be carried by thatch underneath current season's growth. Smoky.	Low
	50				
	60	Yes	Medium	Fragmented fire front with faster spread rates in areas of dry fuels. Patchy fuel consumption. Smoky.	Moderate
DRY PHASE	70	Yes	Medium	Fire spread will be moderate. Patchy areas of green will slow spread. Smoky.	High
	80	Yes	High	Fire spread will be fast. Under strong winds, fire will be difficult to suppress.	High
	90	Yes	High	Fire spread will be very fast under strong winds.	Very high
	100	Yes	High	Fire spread will be very fast under strong winds.	Very high

Assessing Grassland Curing

Curing is measured as the proportion of dead material in a grassland. CFA observers report curing in 10% increments. A grassland with a curing value of 0% means there is no dead material present in the grassland. A curing value of 100% means all the grass in the grassland is dead.

This guide is designed to assist in visual estimation of curing as it is a quick and efficient way to assess the degree of curing. Colour photographs are provided to aid in the assessment process. Do not rely solely on the photos for your assessment as they are not able to capture all the key attributes and are not representative of all grass curing situations.

To accompany the photos, this guide also provides descriptions of key attributes to describe different stages of grass curing and expected fire behaviour. These key grass attributes are:

- **Grass colour**
  - What is the dominant colour of grass stems and leaves in the grassland?
- **Seed head development**
  - Have seed heads developed? Are they flowering and/or dropping seed?
- **Landscape features**
  - How is curing progressing in the surrounding landscape?
- **Expected fire behaviour**
  - Under typical summer conditions, are grasses expected to ignite? If so, what kind of spread and flame height would be expected?

Tips for making consistent, repeatable observations

Results from different grass curing observers can vary greatly. To help make observation more consistent and reliable:

- Complete CFA's Grassland Curing Observer online training, available at **www.cfa.vic.gov.au/grass**
- Walk through the area to be assessed. Grass curing looks very different when viewed from within the grassland as opposed to looking out across it (for example, from a car window or fence line).
- Occasionally conduct assessments with other observers. Conduct assessments individually and discuss the results. Discussions should centre on what differences (if any) were identified in the key attributes. For example, one observer might have a different assessment of the grass colour.

How to use this guide

Step 1.

Use the descriptions of the curing phases to narrow down the range of potential curing values (refer to Table 1 for descriptions).

Is the grassland in the:

CURING PHASE	GO TO PAGE NO.
Green Phase	10
Yellow Phase	18
Dry Phase	24

Step 2.

Determine the curing value by examining multiple points within the grassland up close and comparing them to the **key attribute** descriptions and photos.

Step 3.

If your grassland has substantial thatch (see sidebar), increase your curing estimate by 10-20% depending on the amount present.

Figure 5: An example of dense thatch in the foreground. In this example, the thatch is dense enough to prevent grass from growing through it.

Decomposing grasses from previous season's can contribute substantially to the amount of dead fuel in a grassland and is therefore important to include in your curing estimation.

This grass is referred to as thatch. It is often necessary to part the current season's grass to examine how much thatch is underneath. Even if a paddock has been harvested or grazed the previous season, there is often a couple centimeters of dead grass remaining the following season. This remaining grass will contribute to the overall amount of dead material in the grassland. When estimating the degree of curing in a grassland, the amount of thatch is particularly important in the earlier stages of curing as it will be much drier than the green and yellowing grasses and may be capable of carrying a fire through green grass that would otherwise not burn.

0% CURED

0% CURED

KEY ATTRIBUTES

Grass colour:

Green

Seed head development:

From beginning of grass growth to commencement of seed head development

Landscape features:

Entirely green, no seed heads visible

Will it ignite:

No

Expected fire behaviour:

None

10% CURED

10% CURED

KEY ATTRIBUTES

Grass colour:
Green

Seed head development:
Seed heads formed and flowering

Landscape features:
Entirely green, seed heads visible

Will it ignite:
No

Expected fire behaviour:
None

20% CURED

20% CURED

KEY ATTRIBUTES

Grass colour:

Green-yellow

Seed head development:

Seed heads maturing and seeds beginning to drop

Landscape features:

Seed heads changing colour; first easily visible sign of dead material in the landscape

Will it ignite:

No

Expected fire behaviour:

None

30% CURED

30% CURED

KEY ATTRIBUTES

Grass colour:
Green-yellow

Seed head development:
Most seed heads mature and seed dropping

Landscape features:
Yellowing becoming apparent in leaves

Will it ignite:
No

Expected fire behaviour:
None

40% CURED

40% CURED

KEY ATTRIBUTES

Grass colour:
Yellow-green

Seed head development:
Most seed heads mature and seed dropping

Landscape features:
Green, with yellowing a significant part of the landscape

Will it ignite:
Maybe, especially if thatch is present

Expected fire behaviour:
Low flame height, slow and patchy spread, very smoky

50% CURED

50% CURED

KEY ATTRIBUTES

Grass colour:

Yellow-green

Seed head development:

Up to half of all stems have dropped their seed

Landscape features:

Landscape half green and half yellow

Will it ignite:

Maybe, especially if thatch is present

Expected fire behaviour:

Low flame height, slow and patchy spread, very smoky

60% CURED

60% CURED

KEY ATTRIBUTES

Grass colour:

Yellow-green

Seed head development:

Up to half of all stems have dropped their seed

Landscape features:

Yellow, with green a significant part of the landscape

Will it ignite:

Yes

Expected fire behaviour:

Medium flame height and fire spread with a patchy and uneven fire front, smoky

70% CURED

70% CURED

KEY ATTRIBUTES

Grass colour:

Yellow-straw, lower third of stalk may still be green

Seed head development:

Most seed heads have dropped their seed

Landscape features:

Minor amount of green in landscape

Will it ignite:

Yes

Expected fire behaviour:

Medium flame height and fire spread with a patchy and uneven fire front, smoky

80% CURED

80% CURED

KEY ATTRIBUTES

Grass colour:

Yellow-straw

Seed head development:

Almost all seed heads have dropped their seed

Landscape features:

Non-significant amount of green in landscape

Will it ignite:

Yes

Expected fire behaviour:

High flame height and fast fire spread, will be difficult to supress under strong winds

90% CURED

90% CURED

KEY ATTRIBUTES

Grass colour:

Straw, odd individual stalk may be green

Seed head development:

Essentially all seed heads have dropped their seed

Landscape features:

Very little green showing anywhere, some green may still exist in roadsides and river valleys

Will it ignite:

Yes

Expected fire behaviour:

High flame height and very fast fire spread, will be very difficult to suppress under strong winds

100% CURED

100% CURED

KEY ATTRIBUTES

Grass colour:

Bleached

Seed head development:

All seed heads have dropped their seed

Landscape features:

No green anywhere in landscape

Will it ignite:

Yes

Expected fire behaviour:

High flame height and very fast fire spread, will be very difficult to suppress under strong winds

Typical Seasonal Patterns

The following tips can be used as a guide for most grasslands during a typical Victorian summer:

- Over a series of paddocks, and even within the same paddock, the progression of curing may be patchy, especially during the 40-80% curing stages (that is, some parts will cure faster than others).
  - Curing is patchier with an increasing number of species and variable topography. For example, grasses on dry ridges will cure quicker than grasses in moist, low lying areas or creeks.
  - Annual and perennial grasses will cure at different rates (see Annuals vs. Perennial Grasses, pg 34).
- Late spring or early summer rains can delay the maturing process until the onset of hot, dry weather conditions, when curing will proceed rapidly. Lack of spring rains and early commencement of summer will cause grasslands to cure early, but less rapidly.
- Substantial rainfall before 60% cured can prolong grass life and slow curing, while rainfall after 60% cured will not further delay the curing of mature grass.
- Long-term rainfall and temperature patterns as well as the life cycle of the individual grass species influence the progression of curing.

Curing Anomalies

A selection of common situations in which curing does not follow the typical progression is highlighted in this section. The situations and recommendations below are only meant to be used as a guide and will not be appropriate in every situation.

Remember, curing observations are used operationally, so if you are unsure of how to assess a particular curing situation, consider how fire would spread through the grassland and assign the most appropriate curing value.

If you are still unsure of how to assess the curing in your area, please email grassland@cfa.vic.gov.au or call CFA Grassland Curing on 1800 100 168. Provide your name and contact details and ask for a Grassland Curing Officer to contact you.

Green Up

Summer rain can trigger re-sprouting of perennial grasses and the germination of dormant seeds, creating a layer of green vegetation beneath the older, cured grass sward. The presence of green growth will decrease the curing value by increasing the amount of live material in the grassland. However, because your curing values are being used operationally, it is important to consider how the ignition and spread of a fire would be affected by the regrowth. If the older, cured grass is continuous and substantially taller than the new growth, the curing value should reflect the dead grass component that would carry the fire and not take into account the new, green growth. If the regrowth is in short, heavily grazed grass and the green regrowth makes up a large and visible portion of the available fuel load, an average curing value based on the percentage of live to dead grass should be made.

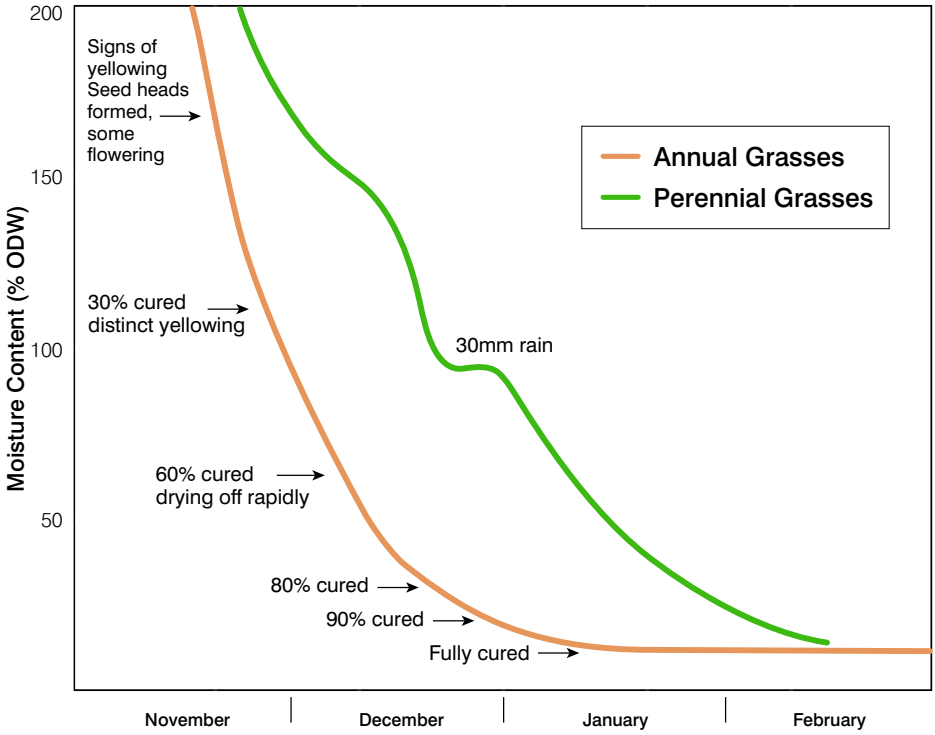
Figure 6: Green grass growing up through fully cured grass.

Annuals vs. Perennial Grasses

Annual and perennial grasses have different life cycles and cure at different rates. Annual grasses have a life cycle that is contained within a single growing season. Annual grasses germinate and grow from seed and after producing seeds, the entire plant, including the root systems, dies. Perennial grasses persist over many seasons and while above ground growth may cure and die, the root systems remain alive and new growth will re-emerge from the roots when conditions are favourable.

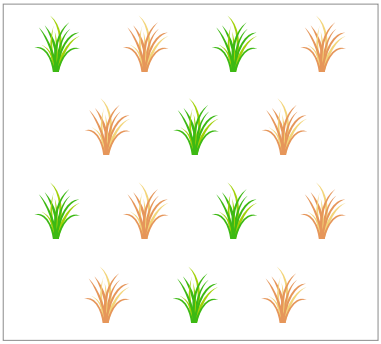
Perennial grasses generally cure in a less predictable fashion than annual grasses. Specifically, perennials typically cure more slowly than annual grasses and the effects of rain in delaying curing are more pronounced in perennial species (see Figure 7). It is important to be aware of the potential variation in curing in mixed annual perennial grasslands.

Figure 7: Moisture content and curing of annual and perennial grasslands in the A.C.T. during the spring of 1964-65 (McArthur 1966b).

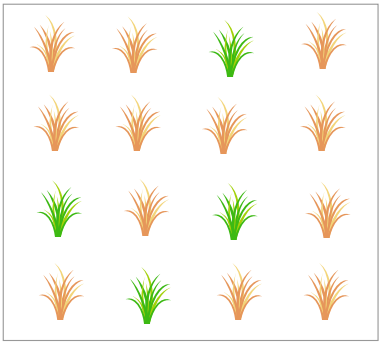


Below are three variations of a paddock with a mixture of annual and perennial species and some basic guidelines on how to estimate curing in the different situations:

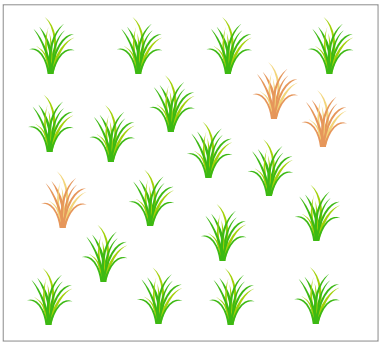
In mid-December, a perennial species is 50% cured and an annual species is 90% cured.



If the paddock is an even mix and distribution of the two species, choose an average curing value of 70% for the entire paddock.



If the paddock consists of a majority of annual grass species but has a component of perennial grass evenly distributed throughout the paddock, adjust the curing of the annual species to account for the perennial grass to 80%.



If the paddock is dominated by the perennial species with small pockets of the annual species present which will not likely affect the spread of fire, do not include the annual species in your curing estimation.

Annual Species

Perennial Species

A selection of common annual and perennial species found in Victoria:

ANNUAL SPECIES
Annual ryegrass
Wild oat
Great brome grass
Corn, wheat, barley
PERENNIAL SPECIES
Most turf/lawn species
Phalaris
Cocksfoot
Kangaroo grass

Species Variation

Certain species of grass, such as Kangaroo grass and annual ryegrass change colours as they cure. As Kangaroo grass cures, instead of gradually becoming yellow and then bleached like most species of grass, it becomes a distinct reddish-brown when it matures (see Figure 8). Similarly, annual ryegrass turns a reddish-purple colour as it cures and then gradually bleaches out (see Figure 9). It is important to be aware that not all grasses follow the patterns described in Table 1.

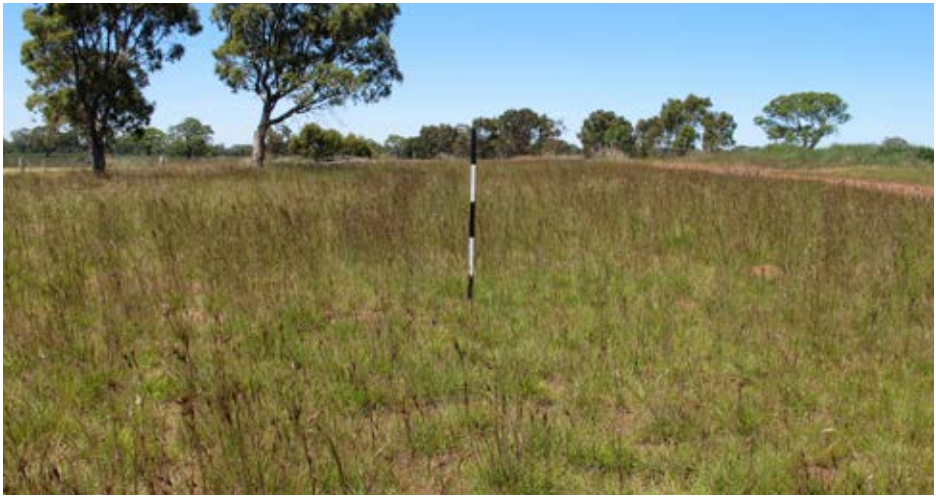


Figure 8: Maturing Kangaroo grass becomes a distinctive red colour.

Figure 9: The curing progression of ryegrass from green to red-purple to a bleached colour.

References

Garvey M and Millie S (2000) *Grassland Curing Guide*. Country Fire Authority, Community Safety Department, Melbourne.

McArthur AG (1966a) *The application of a drought index system to Australian fire control*. Forest Research Institute, Forestry and Timber Bureau, Canberra. Unpublised note dated August 1966.

McArthur AG (1966b) *Weather and grassland fire behaviour*. Department of National Development, Forestry and Timber Bureau, Canberra. Leaflet 100.

Parrot RT (1964) *The growth, senescence and ignitability of annual pastures*. MAgSci thesis. University of Adelaide, Department of Agronomy, Waite Institute.

Recommended Reading

Cheney P and Sullivan A (2008) *Grassfires: fuels, weather and fire behaviour, 2nd Edition*. CSIRO Publising, Collingwood, Vic.

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