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GRDC GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

VETCH

SECTION 14

ENVIRONMENTAL ISSUES

FROST ISSUES FOR VETCH | WATERLOGGING/FLOODING ISSUES FOR THIS CROP | OTHER ENVIRONMENTAL ISSUES

Environmental issues

MORE INFORMATION

Frost - Frequently Asked Questions booklet

Key messages

- All vetch varieties are moderately sensitive to frost damage.
- Knowing the frost risk in each paddock, altering sowing times and variety choice are the best ways to management for frost.
- Vetch is not well-adapted to waterlogging.
- Reduce the impact of waterlogging through the choice of crop, seeding, fertiliser and weed control.
- Though vetch is drought-tolerant, under sever moisture stress plants will defoliate.

14.1 Frost issues for Vetch

Key points:

- Frost doesn't cause extensive damage every year, but some areas are more prone to it and can cause frequent damage.
- All the vetches are moderately frost sensitive and seedlings can be cut back severely by heavy frosts. [1]
- However, trials in Tasmania have shown that vetch crops have considerable potential as a means of avoiding the problem of grain losses due to late frosts. [2]
- Minor agronomic tweaks might be necessary in some frost prone areas.
- In the event of severe frost, monitoring needs to occur up to two weeks after the event to detect the full extent of the damage. [3]

Spring radiation frost is of significant importance in Australia, as it causes large yield and revenue losses to the national economy: it is estimated to cost about $360 million a year in unfulfilled or lost yield potential. [4]

14.1.1 Conditions that lead to frost

Clear, calm and dry nights following cold days are the precursor conditions for a radiation frost (or hoar frost). These conditions are most often met during winter and spring where high pressures follow a cold front, bringing cold air from the Southern Ocean and settled, cloudless weather (Figure 1). [5] When the loss of heat from the earth during the night decreases the temperature at ground level to zero, a frost occurs. Wind and cloud reduce the likelihood of frost by decreasing the loss of heat to the atmosphere. The extent of frost damage is determined by how quickly the temperature gets to zero, how long its stays below zero, and the how far below zero it falls.

1 DAF (2011) Vetches in southern Queensland. DAF QLD. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/pastures/vetches

2 G Dean (2001) Production of legume forage crops in frost-prone areas of Tasmania. Agronomy Australia Proceedings. http://agronomyaustraliaproceedings.org/images/sampledata/2001/3/a/dean.pdf

3 D Grey (2014) Frost damage in crops: where to from here? GRDC Update Paper. GRDC, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Frost-damage-in-crops-where-to-from-here

4 R Barr (2016) Diversity the key to balancing frost heat risks. GRDC, https://grdc.com.au/Media-Centre/Media-News/South/2016/01/Diversity-the-key-to-balancing-frost-heat-risks

5 D Grey (2014) Frost damage in crops: where to from here? GRDC Update Paper. GRDC, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Frost-damage-in-crops-where-to-from-here

VIDEOS

WATCH: GCTV15: Frost ratings

WATCH: GCTV15: The frost ranking challenge

WATCH: GCTV12: Frost susceptibility ranked

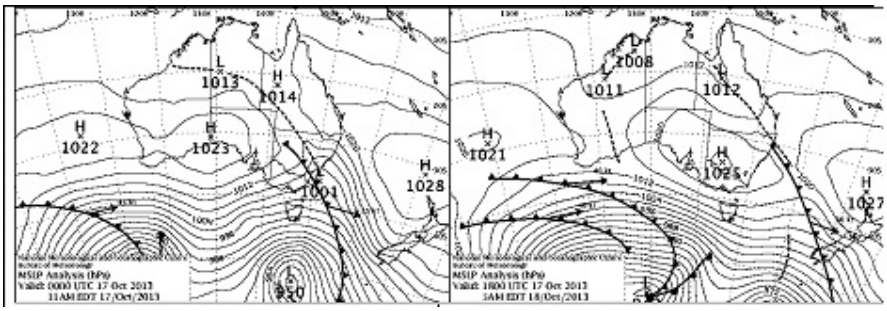

Figure 1: *A cold front passes through, injecting cold air in from the Southern Ocean the day before a frost (left). Overnight, the high-pressure system stabilises over south-east Australia, meaning clear skies and no wind leading to a frost event (right).*

Source: GRDC

Though temperatures (particularly in winter and spring) are getting warmer, frost is still a major issue, and likely to remain so. CSIRO researchers found that in some areas of Australia the number of frost events is increasing (with the greatest increase in August), and that central western NSW, the Eyre Peninsula, Esperance and the northern Victorian Mallee were the only major crop growing areas to be less affected by frost from 1961 to 2010 (Figure 2). [6] This increase is thought to be caused by the latitude of the subtropical ridge of high pressure drifting south (causing more stable pressure systems) and the existence of more El Niño conditions during this period. [7]

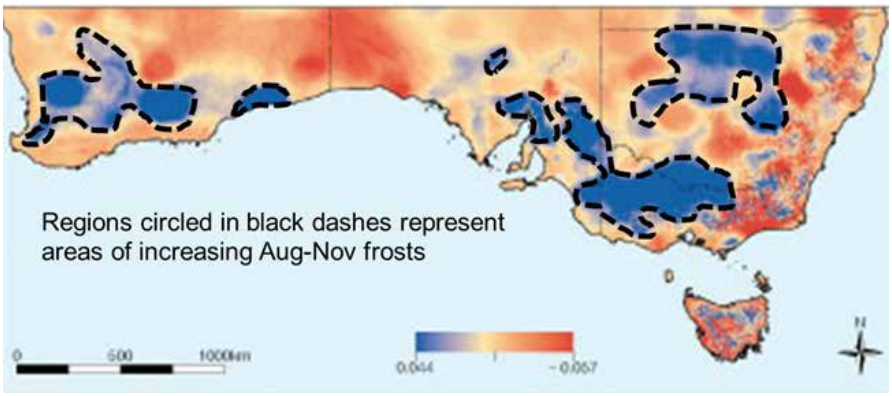

Figure 2: *Region of increasing August–November frost events.*

Source: GRDC

14.1.2 Frost damage

It is difficult to accurately assess the amount of frost damage in a crop because of its patchy nature and the difficulty in predicting compensation that may occur. To diagnose frost damage in pulse and canola crops, inspect between bud formation and during pod growth if night air temperature (recorded 1.2 m above ground) falls below 2°C and there was a frost (Photo 1). Check low-lying, light-coloured soil types and known frost-prone areas first. Then check other areas. Symptoms may not be obvious for five to seven days after the frost. [8]

6 D Grey (2014) Frost damage in crops: where to from here? GRDC Update Paper. GRDC, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Frost-damage-in-crops-where-to-from-here

7 D Grey (2014) Frost damage in crops: where to from here? GRDC Update Paper. GRDC, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Frost-damage-in-crops-where-to-from-here

8 B Biddulph (2016) Frost: Diagnosing the problem. DAFWA. https://www.agric.wa.gov.au/frost/frost-diagnosing-problem?nopaging=1

Photo 1: *A frosted vetch crop.*

Photo: Grant Alday

VIDEOS

WATCH: GCTV20: Frost's emotional impact—is it greater than its economic impact?

Impact and cost of frost

The real cost of frost is a combination of the actual cost due to both reduced yield and quality, along with the hidden cost of managment tactics used to try and minimise frost risk. The hidden costs associated with conservative management to minimise frost risk includes:

- delayed sowing and its associated yield reduction
- sowing less profitable crops (i.e. tolerant crops) in an attempt to reduce the impacts of frost
- avoiding cropping on the valley floors which also contain some of the most productive parts of the landscape.

Frosts can also have quite a large social impact as it happens so suddenly, unlike drought which one can adapt to mentally and financially by reducing further inputs as it unfolds. [9]

14.1.3 Managing frost

Frost risk is difficult to manage in pulses, however some key management strategies may reduce the risk or extent of damage. These strategies include:

- Know the topography, and map areas of greatest risk so that they can be managed to minimise frost damage.
- Choosing the right crop type, crop variety and sowing time can help reduce exposure or impact at vulnerable growth stages.
- Carefully assess the soil type, condition and soil moisture levels, along with stubble and canopy management.
- Correct crop nutrition and minimised crop stress can influence the degree of frost damage.

Modifications to conditions over large areas are required to reduce frost risk. Small changes in management can have a big impact because frost damage occurs at specific 'trigger' temperatures. Keeping the air temperature even 0.1°C above the critical 'trigger' point will avoid frost damage. Air flow through the canopy can also

9 B Biddulph (2017) Frost and cropping. DAFWA. https://www.agric.wa.gov.au/frost/frost-and-cropping?page=0%2C0

have a positive impact towards avoiding frost damage. If the frost is severe, below the 'trigger temperature', damage occurs regardless of management, so then avoidance becomes important.

The soil is the heat bank, and it is desirable to have warm soil so that warm air can rise at night to minimize frost risk. The crop canopy will trap cold air on top, so a dense canopy is not necessarily desirable.

Problem areas and timings

Mapping or marking areas identified as frost-prone will enable growers to target frost and crop management strategies to these high-risk areas. Knowing when the period of greatest probability of frost risk occurs is also important for crop management. After a frost event, make note of the location and severity, as this will help to inform future crop choice and post frost decisions. Check low lying, light coloured soil types and known frost prone areas first.

Crop choice and time of sowing

Strategies to minimise frost damage in pulses work in combinations of either: growing a more tolerant species; trying to avoid having peak flowering and early podding during the period of most risk; extended flowering to compensate for losses to frost; or ensuring that most grain is sufficiently filled to avoid damage when frost occurs (Table 1). Time of flowering affects tolerance and the ability to compensate after the frost has occurred. Targeting flowering and early podding to periods of least frost risk (lowest probability) is achieved through combinations of sowing date and variety choice based on flowering time and flowering duration. Local experience will indicate the best choices.

Late flowering targets avoidance of early frosts, but in the absence of frost may also reduce yield potential due to moisture deficiency or high temperatures. Very early flowering can allow pods to be sufficiently developed to escape frost damage, and ensure some grain yield at least before a frost occurs. Increased disease risk needs to be considered with early sowing.

Frost damage risk can be reduced by not sowing varieties earlier than the recommended sowing window and so avoid flowering in July to early August.

Spread the risk

Match different pulses to risk areas by sowing a different variety or species into targeted areas within the same paddock. Matching the crop, variety, sowing date and subsequent inputs to the frost risk location spreads the risk.

Have forage as an optional use. Designating hay or forage as a possible optional use for the pulse in high frost-risk paddocks provides flexibility (Photo 2).

Photo 2: *Frosted pulses make excellent quality forage.*

Source: Pulse Australia

Reduce frost damage

Minimise input costs to reduce financial risk exposure in frost-prone paddocks. Bear in mind though, that reducing inputs may reduce financial exposure and assist grain gross margins when crops are hit by frost, but can lessen the chance of a successful hay cut or jeopardise the crop if no frost occurs.

Manage nodulation and nutrition. Ensure pulse crops are adequately nodulated and fixing nitrogen. Ensure pulses have an adequate supply of trace elements and macro-nutrients – (supplying high levels is unlikely to increase frost tolerance). Crops deficient or marginal in potassium and copper are likely to be more susceptible to frost damage, and this may also be the case for molybdenum. Foliar application of copper, zinc or manganese may assist, but only if the crop is deficient in the element applied.

Canopy management. A bulky crop canopy, and exposure of the upper pods may increase frost damage. The pulse canopy can be managed. Semi-leafless, erect peas may be more vulnerable than conventional, lodging types because their pods are more exposed

Sow in wider rows, so that frost is allowed to get to ground level, and the inter-row soil is more exposed. An open canopy does not trap cold air. Wide rows require the soil to be moist to trap the heat in the soil during the day. With wide or paired rows and a wide gap, the heat can radiate up.

Channel cold air flow away from the susceptible crop by using wide rows aligned up and down the hill or slope. A sacrifice area may be required where the cold air settles.

Cereal stubble presence provides a cooler soil and root zone, worsening the frost effect compared with bare soil. Standing stubble is considered less harmful than slashed stubble as less light is reflected and the soil is more exposed to the sun. Dark coloured stubble will be more beneficial than light coloured.

Rolling can help keep soils warm by preventing soil moisture loss, but not necessarily on self-mulching or cracking soils. Note that press wheels roll only in the seed row, but not the inter-row. With no-till practice, avoid having bare, firm moist soil as it will lose some of its stored heat.

Claying or delving sandy soils increase the ability of the soil to absorb and hold heat by making the soil colour darker, and retaining moisture nearer the surface.

Higher carbohydrate level in the plant during frost leads to is less leakage during thawing. Biological farmers measure sugars in the plant sap ('Brix' reading). A higher sugar content (high Brix) will also have a lower freezing point, and associated protection against frost damage. The effectiveness of various products applied to soil and plant to increase plant carbohydrates is unknown.

Better varieties coming. The GRDC is investing through Pulse Breeding Australia in germplasm enhancement and pulse variety breeding for frost tolerance, including altered flowering time and duration to avoid frost; and screening of pulse varieties for relative levels of frost tolerance in the field. New varieties will be released when available. [10]

What to do with a frosted crop

A frosted vetch crop has a number of management options due to the fact that it is so often grown as a forage and as such is not always harvested so frosted grain is not an issue.

There are a number of options to make use of a frosted crop, each with advantages and disadvantages (Table 1).

VIDEOS

WATCH: Frost initiative: Do micronutrients reduce frost risk?

WATCH: MPCN: Copper and frost relationship investigated

10 Pulse Australia. (2015). Australian Pulse Bulletin. Minimising frost damage in pulses. http://pulseaus.com.au/growing-pulses/publications/minimise-frost-damage

Table 1: *Management options for frost-damaged crops, with advantages and disadvantages.*

Options	Advantages	Disadvantages
Harvest	Salvage remaining grain	Cost may be greater than return
	More time for stubble to break down before sowing	Need to control weeds
		Threshing problems
	Machinery available	Removal of organic matter
Hay, silage	Stubble removed	Costs $35–50/t to make hay
	Additional weed control	Quality may be poor
		Nutrient removal
Graze	Feed value	Inadequate stock to use feed
		Remaining grain may cause acidosis
		Stubble may be difficult to sow into
Spray	Stops weeds seeding	With a thick crop, difficulty getting chemicals onto all of the weeds
	Preserves feed quality for grazing	May not be as effective as burning
	Gives time for final decisions	Boom height limitation
	Retains feed	Costs $5/ha plus cost of herbicide
	Retains organic matter	Some grain still in crop
Plough	Recycles nutrients and retains organic matter	Requires offset disc to cut straw
	Stops weed seedset	Soil moisture needed for breakdown and incorporation of stubble
	Green manure effect	
Swathe	Stops weed seedset	Relocation of nutrients to windrow
	Windrow can be baled	Low market value for straw
	Regrowth can be grazed	Poor weed control under windrow
	Weed regrowth can be sprayed	Costs to windrow
		Costs per herbicide to spray

Source: GRDC

MORE INFORMATION

Tips and tactics: Managing frost risk

An analysis of frost impact plus guidelines to reduce frost risk and assess frost damage

Frost and cropping

Useful tools

There are numerous useful tools that can help growers decisions about aspects of cropping to maximise yields in frost-prone areas. Among them are:

- Bureau of Meteorology's BOM Weather app
- Plant development and yield apps—MyCrop and Flower Power (both from DAFWA), Yield Prophet
- Temperature monitors such as Tinytag

National Frost Initiative

Frost has been estimated to cost Australian growers around $360 million in direct and indirect yield losses every year. To help the grains industry minimise the damage frost causes, the GRDC has invested about $13.5 million in more than 60 frost-related projects since 1999. In 2014, it began the National Frost Initiative, to provide the Australian grains industry with targeted research, development and extension solutions to manage the impact of frost and maximise seasonal profit. [11]

11 T March, S Knights, B Biddulph, F Ogbonnaya, R Maccallum and R Belford (2015) The GRDC National Frost Initiative. GRDC Update Paper. GRDC, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/The-GRDC-National-Frost-Initiative

VIDEOS

WATCH: GCTV3: Frost R&D

WATCH: GCTV16: National Frost Initiative

MORE INFORMATION

Managing frost risk: northern, southern and western regions

The initiative is addressing frost management through multidisciplinary research projects in the following programs:

1. Genetics—developing more frost-tolerant wheat and barley germplasm and ranking current wheat and barley varieties for susceptibility to frost.
2. Management—developing best-practise strategies for crop canopy, stubble, nutrition and agronomic management so growers can minimise the effects of frost; and searching for innovative products that may minimise the impact of frost.
3. Environment—predicting the occurrence, severity and impact of frost events on crop yields and mapping frost events at the farm scale to enable better risk management. [12]

14.2 Waterlogging/flooding issues for this crop

Waterlogging occurs when there is insufficient oxygen in the soil pore space for plant roots to adequately respire. Waterlogging causes low soil oxygen concentrations, which limit root and shoot growth, function and survival. Root harming gases such as carbon dioxide and ethylene also accumulate in the root zone and affect the plants. Waterlogging symptoms include yellowing, stunting, or generally weak appearance in the low-lying areas or patches (Photo 3).

Transient (hours to days) and longer term waterlogging (days to weeks) can cause substantial crop loss depending on the growth stage where waterlogging occurs. This problem occurs in low-lying areas in uneven fields either in irrigated lands or rainfed conditions during rainy season. Waterlogging can reduce root growth, and consequently reduce shoot extension and branching resulting in reduced plant biomass.

The risk of yield reduction and crop failure from waterlogging limit the range of soils where susceptible crops can be grown and even in better soils, that do not suffer prolonged waterlogging, short periods of transient waterlogging can have devastating effects when waterlogging occurs during reproductive growth.

Photo 3: *A patch in a pulse crop that is damaged and dying due to prolonged waterlogging.*

Photo: David Jochinke

12 GRDC (2016) Managing frost risk: northern, southern and western regions. Tips and Tactics. GRDC, https://grdc.com.au/resources-and-publications/all-publications/factsheets/2016/02/managingfrostrisk

Vetch is more tolerant than lentil or chickpea to waterlogging but is still considered sensitive. [13] Some anecdotal reports state that vetch shows a similar response to waterlogging as narrow-leafed lupin. [14]

14.2.1 Hardpans and waterlogging in southern NSW

Many pulse crops in southern NSW and northern Victoria had symptoms of waterlogging in 2016. Throughout spring, many plant samples were received at the diagnostic laboratory at Wagga Wagga with evidence of waterlogging, leading to premature death.

Waterlogging can have a three stage effect on pulse crops. Firstly, plants standing in free water can effectively 'drown' if the waterlogged conditions occur over an extended period and the pulse crop will die prematurely. Secondly, waterlogged conditions can promote root pathogens to infect and cause injury, such as Phytophthora, which are expressed later in the season. Thirdly, observations in northern NSW pulse trials and crops since 2010 have consistently shown that resistance to foliar disease is reduced if plants are waterlogged.

Hardpans (or ploughpans) can lead to waterlogging issues, in particular the development of perched watertables in the root zone. Hardpans often form just below the depth of cultivation. This can result in root disease development, poor nodulation or poor root growth. In the 1990s, a survey of pulse crops in southern NSW found 50% of paddocks to have soil bulk densities high enough to limit water movement and root development in pulse crops.

Check paddocks to be sown to pulses for hardpan layers. It may be necessary to cultivate paddocks at a deeper level or use ripping tynes to break up layers. [15]

14.2.2 How can waterlogging be monitored?

Waterlogging occurs:

- Where water accumulates in poorly drained areas such as valleys, at the change of slope or below rocks.
- In duplex soils, particularly sandy duplexes with less than 30 cm sand over clay.
- In deeper-sown crops.
- in crops with low levels of nitrogen.
- In very warm conditions when oxygen is more rapidly depleted in the soil. [16]
- In compacted soils

As well, waterlogging greatly increases crop damage from salinity. Germination and early growth can be much worse on marginally saline areas after waterlogging events.

Identifying problem areas

- Plants can be waterlogged if there is a water table within 30 cm of the surface. There may be no indication at the surface that water is lying in the root zone. Observe plant symptoms and paddock clues, and verify by digging a hole to test for water seepage. [17]

The best way to identify problem areas is to dig holes about 40 cm deep in winter, and see if water seeps or flows into them (Photo 4). If it does, the soil is waterlogged. Some farmers put slotted PVC pipe into augered holes. They can then monitor

13 R Matic, S Nagel, G Kirby (2008) Common Vetch. Pastures Australia. http://keys.lucidcentral.org/keys/v3/pastures/Html/Common_vetch.htm

14 French, B., & White, P. (2005). Soil and environmental factors affecting pulse adaptation in Western Australia. *Australian Journal of Agricultural Research*, *50*, 375–387.

15 K Lindbeck (2017) GRDC Update Papers: The watch outs for pulse disease in 2017. https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2017/02/the-watch-outs-for-pulse-diseases-in-2017

16 DAFWA (2015) Diagnosing waterlogging in cereals. DAFWA, https://www.agric.wa.gov.au/mycrop/diagnosing-waterlogging-cereals

17 DAFWA (2015) Diagnosing waterlogging in cereals. DAFWA, https://www.agric.wa.gov.au/mycrop/diagnosing-waterlogging-cereals

the water levels in their paddocks. Digging holes for fence posts often reveals waterlogging.

Symptoms in the crop of waterlogging include:

- Yellowing of crops and pastures.
- The presence of weeds such as toad rush, cotula, dock and Yorkshire fog grass. [18]

Photo 4: *Water fills a hole that has been dug in waterlogged soil.*

Source: Soilquality)

Other impacts of waterlogging and floods

Heat from stagnant water

Stagnant water, particularly if it is shallow, can heat up in hot, sunny weather and may kill plants in a few hours. Remove excess water as soon as possible after flooding to give plants the best chance of survival.

Chemical and biological contaminants

Floodwater may carry contaminants, particularly from off-farm run-off. You should discard all produce, particularly leafy crops, that have been exposed to run-off from beyond the farm.

Make sure you take food-safety precautions, and test soils before replanting, even if crops look healthy. Contaminants will reduce over time with follow-up rainfall and sunny weather.

Iron chlorosis or nitrogen deficiency

Floods and high rainfall can leach essential nutrients from the soil, which can affect plant health. Nutrients such as iron and nitrogen can be replaced by fertilising.

Soils with high clay content

Soils with a high clay content can become compacted and form a crust after heavy rain and flooding. Floodwater also deposits a fine clay layer or crust on top of the soil, and this can prevent oxygen penetrating into the soil (aeration).

18 Soilquality (2016) Waterlogging. Fact sheet. Soilquality, http://soilquality.org.au/factsheets/waterlogging

VIDEOS

WATCH: GCTV3: Big wet—management strategies after flooding

Pests and diseases

Many diseases are more active in wet, humid conditions, and pests can also cause problems. Remove dying or dead plants that may become an entry point for disease organisms or insect pests. Apply suitable disease-control measures as soon as possible, and monitor for pests. [19]

14.2.3 Managing waterlogging

Key points:

- Reduce the impact of waterlogging through the choice of crop, seeding, fertiliser and weed control.
- Avoid growing vetch on regularly waterlogged soils.
- Sow waterlogging-tolerant crops such as oats and faba beans.
- Sow as early as possible with a higher seeding rate.
- Drainage may be appropriate on sandy duplex soils on sloping sites.
- For paddocks susceptible to waterlogging, plant them first with the best crop choice for vigorous early growth.
- Raised beds are more effective on relatively flat areas and on heavier textured soils, but areas need to be large enough to justify machinery costs.
- Employ practices that reduce or prevent compaction

Drainage is usually the best way of reducing waterlogging. Drain waterlogged soils as quickly as possible, and cultivate between rows to aerate the soil.

Good drainage is essential for maintaining crop health. Wet weather provides a good opportunity to improve the drainage of your crop land, as it allows you to identify and address problem areas.

There are several things you can do to improve crop drainage, immediately and in the longer term.

Drainage problems after flooding

After significant rain or flooding, inspect the crops when it is safe to do so and mark areas (e.g. with coloured pegs) that are affected by poor drainage. If possible, take immediate steps (e.g. by digging drains) to improve the drainage of these areas so that the water can get away.

Irrigation after waterlogging

To avoid recurrence of waterlogging, time irrigation by applying small amounts often until the crop's root system has recovered.

Ways to improve drainage

In the longer term, look for ways to improve the drainage of the affected areas. Options include:

- reshaping the layout of the field
- improving surface drainage
- installing subsurface drainage

If the drainage can't be improved, consider using the area for some other purpose (e.g. as a silt trap). [20]

MORE INFORMATION

Cropping on raised beds in southern NSW

19 Queensland Government Business and Industry Portal (2016). Managing risks to waterlogged crops. Queensland Government, https://www.business.qld.gov.au/industry/agriculture/crop-growing/disaster-recovery-for-crop-farming/saving-crops-floods/managing-risks-waterlogged-crops

20 Queensland Government Business and Industry Portal (2016) Improving drainage of crop land. Queensland Government, https://www.business.qld.gov.au/industry/agriculture/crop-growing/disaster-recovery-for-crop-farming/saving-crops-floods/improving-drainage-crop-land

MORE INFORMATION

Nitrogen management in waterlogged crops

Should waterlogged crops be topdressed with N fertiliser?

Choice of crop species

Some species of grains crop are more tolerant to waterlogging and being flooded than others. Grain legumes and canola are generally more susceptible to waterlogging than cereals.

Seeding crops early and using long-season varieties help to avoid crop damage from waterlogging. Damage will be particularly severe if plants are waterlogged between germination and emergence. Plant first those paddocks that are susceptible to waterlogging. However, if waterlogging delays emergence and reduces plant, resow the crop.

Seeding rates

Increase sowing rates in areas susceptible to waterlogging to give some insurance against uneven germination. High sowing rates will also increase the competitiveness of the crop against weeds, which take advantage of stressed crops. Seeding crops early and using long-season varieties help to avoid crop damage from waterlogging. Crop damage is particularly severe if plants are waterlogged between germination and emergence. Plant first those paddocks that are susceptible to waterlogging.

Raised beds

Raised beds are the only long-term option for preventing waterlogging and increasing crop yield on target areas (Photo 5). Crop yields are more reliable and yield and profit are increased.

Photo 5: *Waterlogged crop without raised beds (left) while the crop on raised beds remains healthy (right).*

Source: DAFWA

Raised beds are an option when:

- The probability of waterlogging is 50% or more in the wettest months (usually June to August) when the emerging crops are most susceptible and on susceptible soils.
- Shallow water tables and large gravel contents in the soil reduce the soil's capacity to absorb rainfall, resulting in a high frequency of waterlogging.
- Where hill slopes are greater than 3%, waterlogging may not be a problem. In shallow or gravelly soils, however, waterlogging can occur on land with slopes greater than 3%.

Susceptible soils are:

MORE INFORMATION

Cropping on raised beds in southern NSW

Raised bed cropping

Innovative management techniques to reduce waterlogging

- Shallow sand, high gravel content soils and loam-over-clay soils situated in areas where the waterlogging frequency is greater than 50%.
- Soils in areas with a shallow water table will also be susceptible but that land is likely to be salt-affected and reclamation of the salinity is likely to be difficult, even with the use of raised beds.

Raised beds may be an option in many situations and professional advice should be obtained before installing them. [21]

14.3 Other environmental issues

For information on salinity, sodicity and other soil constraints, see Section 1: Planning and Paddock preparation.

14.3.1 Drought stress

Key points:

- Drought stress is a key yield-limiting factor in crop production.
- Though vetch is considered drought tolerant, it is most sensitive to drought stress in the early stages of establishment. [22] Vetch can defoliate under severe moisture stress. [23]
- There are few strategies to manage for drought conditions.

Vetch has been adopted by Australian farmers as a legume rotation crop where drought is the major environmental stress. Its substantial root system and its ability to flower quickly and set seed in a dry spring give it good drought tolerance. Vetch is better adapted to these regions than field peas, chickpeas, lentils, faba beans or lupins. [24]

Drought is one of the major environmental factors that reduces grain production in the rain-fed and semi-arid regions of Australia (Photo 6).

Photo 6: *Drought conditions in 2015 left a dry landscape prone to dust storms.*

Photo: Brad Collis, Source: GRDC

21 D Bakker. (2015). Raised beds to alleviate waterlogging. https://www.agric.wa.gov.au/waterlogging/raised-beds-alleviate-waterlogging

22 J Frame. Vicia sativa L. FAO. http://ecocrop.fao.org/ecocrop/srv/en/cropView?id=238003

23 DAF (2011) Vetches in southern Queensland. DAF QLD. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/pastures/vetches

24 R Matic (2015) GRDC Final Reports: DAS00013 – Vetch variety improvement for Australian field crop farming systems. https://grdc.com.au/research/reports/report?id=268

14.3.2 Managing drought stress

Drought can be unpredictable and can last for extended periods of unknown length, therefore it is difficult to prepare for it. Best management practices in farming revolve around conserving soil moisture. Modern day practices such as zero tillage and stubble retention help conserve this water. Sound summer weed management will prevent weeds robbing the paddock of moisture. All these things can help grow a better crop in low rainfall years. Consider carefully your starting moisture in a predicted low rainfall or El Nino year, if the starting moisture is not adequate, don't sow.

In drought, it is important to not ignore the signs and to have a plan, act early, review and then plan again, and revise the plan with each action as you play out your strategy.

Step One: Check the most limiting farm resources:

- funds available;
- surface/subsoil moisture for crop leaf and root growth;
- need to service machinery – breakdowns cost time, money and frustration.

Step Two: Set action strategies, considering:

- breakeven position of each strategy chosen;
- windows of opportunity to adopt management practices that will be profitable during drought;
- available resources and the implications for ground cover, chemical residues, etc., of carrying out each strategy;
- when situations are changing, conditional and timely fall-back options.

Step Three: Monitor and review performance, position and outlook by:

- using your established network to stay informed about key factors that affect your drought strategies;
- being proactive about the decisions made;
- being prepared for change;
- remembering that the impact falls very heavily not only on the decision makers but on the whole farm family. [25]

Soil management following drought

The principal aim after rain should be to establish either pasture or crop as a groundcover on your bare paddocks as quickly as possible. This is especially important on the red soils, but is also important for the clays. After drought, many soils will be in a different condition to what is considered to be their 'normal' condition. Some will be bare and powdery on the surface, some will be further eroded by wind or water, and some will have higher levels of nitrogen (N) and phosphorus (P) than expected. Loss of effective ground cover (due to grazing or cultivation) leaves the soil highly prone to erosion by wind and water. Research by the former Department of Land and Water Conservation's Soil Services showed that erosion due to drought-breaking rain can make up 90% of the total soil loss in a 20–30 year cycle. Following a drought, available N and P levels in the soil are generally higher than in a normal season. However, most of the N and P is in the topsoil, so if erosion strips the topsoil much of this benefit is lost. [26]

MORE INFORMATION

Make sure to consider the impacts of herbicide residues following drought.

Winter cropping following drought

Soil management following drought

DPI NSW Drought Hub

Drought planning

Managing drought

25 Meaker G, McCormick L, Blackwood I. (2007). Primefacts: Drought planning. NSW DPI. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/96236/drought-planning.pdf

26 Jenkins A. (2007). Primefacts: Soil management following drought. NSW DPI. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0012/104007/soil-management-following-drought.pdf