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GRDC
GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

CEREAL RYE

SECTION 12

HARVEST

WINDROWING | HARVEST TIMING | FIRE PREVENTION | RECEIVAL STANDARDS | HARVEST WEED-SEED MANAGEMENT

Harvest

Key messages

- Rye is ready to harvest when the leaves are dead and the stems have turned yellow-brown.
- Rye is susceptible to head shatter making it difficult to harvest and results in many volunteer plants emerging in the field next season.
- Because cereal rye matures earlier than other small grains, strict harvest and grazing management procedures are important to prevent it from becoming a weed.
- The limited information available on cereal rye suggests that the preferred growth stage to harvest for silage is the boot stage. Feed quality of cereal rye deteriorates more quickly with maturity compared to other cereals.
- Ensure that all equipment is clean and work to avoid blockages so that fire risk is minimised.

Although rye comes into ear earlier than wheat, the grain takes much longer to mature. Rye is ready to harvest when the leaves are dead and the stems have turned yellow-brown [1], and the crop should be harvested as soon as the grain is thoroughly dry and hard. However, rye grain shatters very easily when ripe, and seed losses from shattering can occur soon after it ripens (Photo 1). Rye is harvested with a conventional header. The grain is lighter and longer than wheat, so the machine will require minor adjustments from normal wheat settings. [2] The grain threshes very easily.
Under dry threshing conditions care must be taken to adjust the concave setting and/or cylinder speed to minimise cracking. [3]

Photo 1: *Shattered seed head in mature rye: about ¾ of the head has broken off and fallen to the ground.*

Photo: Joseph Lofthouse

1 Plant Village (n.d.) Rye Secale cereale. Plant Village, https://www.plantvillage.org/en/topics/rye/diseases_and_pests_description_uses_propagation

2 Agriculture Victoria (2013) Growing cereal rye. Note AG0403. Updated. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-cereal-rye

3 Alberta Agriculture and Forestry (2016) Fall rye production. Revised. AgDex 117/20-1. Alberta Agriculture and Forestry,

12.1 Windrowing

Rye shatters very easily when ripe. For this reason, common practice in the North America is to windrow cereal rye. In North America, waiting for the rye crop moisture to dry down for straight combining results in substantial shattering, and leads to volunteer crop problems in following years. [4]

Windrowing or swathing involves cutting the crop and placing it in rows held together by interlaced straws, supported above the ground by the remaining stubble (Photo 2). It can be considered as an option where:

- the crop is uneven in maturity, or the climate does not allow for rapid drying of the grain naturally
- there is a risk of crop losses from shedding and lodging

High yielding crops may gain more from windrowing than low yielding crops. Generally, crops expected to yield less than 2 t/ha should not be windrowed. Picking up windrowed cereals is significantly slower than direct heading because of the large volume of material.

If the crop is too thin or the stubble too short to support the windrow above the ground, the crop should not be windrowed. Heads on the ground may sprout and attempts to pick up heads that are lying close to the soil surface will pick up soil. [5]

Photo 2: *Directing chaff into a narrow windrow using a custom-made chute.*

Source: GRDC

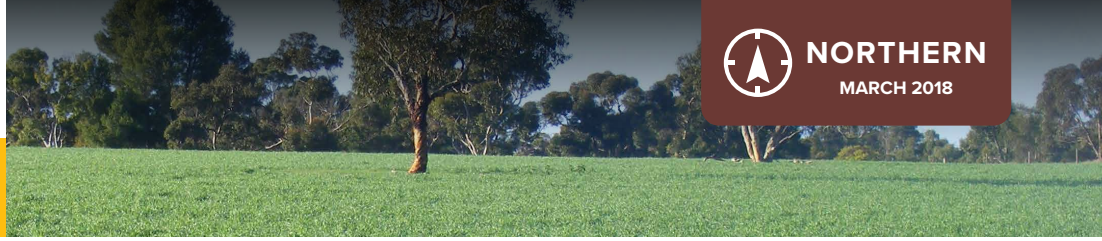
12.1.1 Timing

Windrowing can begin when grain moisture content is below 35%—when grain is at the medium dough stage, hard but can still be dented with the thumbnail.

- It is better to windrow early to prevent losses from shedding and lodging, but not when the ground is wet after rain.
- Avoid windrowing too early as the grain is not fully developed and will result in small pinched grain.

4 Alberta Agriculture and Forestry (2016) Fall rye production. Revised. AgDex 117/20-1. Alberta Agriculture and Forestry, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1269/$file/117_20-1.pdf

5 G Troup (2016) Oats: harvesting, swathing and grain storage, Swathing. DAFWA, https://www.agric.wa.gov.au/oats/oats-harvesting-swathing-and-grain-storage?page=0%2C1



- Although it may be easier to windrow later, the windrows of a ripe crop may not interlock well enough to withstand disturbance from strong wind. [6]

12.1.2 Cutting

- Cut across the sowing direction, or at 45 degrees for crops with wider row spacing, so the windrow sits-up on the stubble. Windrowing is not recommended for paddocks where the crop row spacing is over 25 cm.
- Avoid placing windrows in the same location each year so nutrients are not concentrated in one place.
- Windrow size or width of cut should match header capacity. A double-up attachment to the windrower or placing two windrows side by side requires a larger capacity header and concentrates the residue in a narrow band within the paddock.
- Cutting height should be adjusted to keep sufficient straw on the head to hold the windrow together (minimum 30 cm) and sufficient stubble height to support the windrow.
- Start the cutting height at 10–20 cm above the ground (one-third crop height) and adjust to produce an even windrow with well-interlaced straws that sit above the ground. This allows good air circulation and rapid drying should rain occur. [7]

12.1.3 Harvesting the windrow

Harvesting of the windrowed crop must be completed as soon as possible, ideally within 10 days of windrowing.

- If left too long and subjected to long periods of wetting (more than 25 mm of rain over 4–8 days), grain may sprout and become stained. The windrow may also become contaminated with bronze field beetle.
- When the windrow is picked up, the reel should be rotating slightly faster than ground speed, but not fast enough to knock the heads off the stems.
- The conveyor canvas should be revolving sufficiently fast to prevent the crop material banking up.
- Rows pick up best when the header follows the direction of the windrow (heads first).

One of the major sources of contamination in windrowed cereals is the stubble being torn out during the windrowing operation. This generally occurs when the windrower is operated at too high a ground speed or when trying to windrow when the straw is tough due to it being cool or damp. [8]

MORE INFORMATION

Setting up at harvest for narrow windrow burning

12.2 Harvest timing

Cereal rye is harvested at about the same time as wheat. Harvest as soon as the grain dries and hardens. Ripe crops that are left to stand are likely to shed grain. Maturity is often uneven, so inspect the whole paddock before harvesting.

One way to determine whether rye is ripe for harvest is to use your fingernail to test its strength: the nail, when pressed firmly into the kernel, should make only a very light indent, this is called the soft-dough stage, (Photo 3, top). When kernel moisture content has dropped to 13–14%, the grain is harvest ripe. The surface cannot be dented with a thumbnail (Photo 3, bottom). [9]

6 G Troup (2016) Oats: harvesting, swathing and grain storage, Swathing. DAFWA, https://www.agric.wa.gov.au/oats/oats-harvesting-swathing-and-grain-storage?page=0%2C1

7 G Troup (2016) Oats: harvesting, swathing and grain storage, Swathing. DAFWA,https://www.agric.wa.gov.au/oats/oats-harvesting-swathing-and-grain-storage?page=0%2C1

8 G Troup (2016) Oats: harvesting, swathing and grain storage, Swathing. DAFWA,https://www.agric.wa.gov.au/oats/oats-harvesting-swathing-and-grain-storage?page=0%2C1

9 JacksonL, Williams J (2006) Small grain production part 2: Growth and developments of small grains. University of California, http://anrcatalog.ucanr.edu/pdf/8165.pdf

Photo 3: *Stages of cereal-grain ripening from the milk stage (top) to the harvest-ripe stage (bottom).*

Source: Jackson and Williams 2006

The moisture level in rye should be about 12% at harvest (Photo 4). Only harvest in dry conditions. When harvesting with a combine, growers may need to cut the straw high in order to avoid clogging the equipment, since rye is tall and produces a large quantity of straw. This will obviously leave taller stubble in the paddock. [10]

Photo 4: *Rye ripening.*

Photo: Plant Village

10 UVM Extension Crops and Soils Team (2011) Cereal rye, http://northerngraingrowers.org/wp-content/uploads/RYE.pdf

12.2.1 Harvesting after lodging

Lodging is when portions of the crop fall over due to strong wind, and occasionally in very high-yielding crops (which have heavy heads) or in varieties with weak stems.

The lodged plants will begin to lose nutritive value, and the grain may even begin to sprout if it is advanced enough in its formation; i.e. at the hard-dough stage.

If possible, harvest a lodged crop within days of it lodging, before its nutritive value deteriorates too much, and before mould and deleterious bacteria build up. Travelling in the opposite direction to the lodged plants will ensure less difficulty in the harvest operation and minimal losses.

Crops that have lodged for some time can be a problem. If the harvester travels in the opposite direction to that in which the plants have lodged the nutritive value of the seed will be decreased, due to harvesting decaying plants. Decaying plant material will also adversely affect fermentation. [11]

12.2.2 Harvesting forage cereals

Cereals suitable for ensiling are cereal rye, oats, barley, wheat and triticale. The limited information available on cereal rye suggests that the preferred growth stage to harvest it for silage is the boot stage. This is because the feed quality of cereal rye deteriorates more quickly with maturity compared to other cereals. [12]

When to cut for silage

The timing of harvest should take into consideration the following:

- The end use of the silage; i.e. for animal production or maintenance rations
- Weather conditions at harvest.
- Soil type and soil-moisture conditions at harvest.
- If double cropping, when the following crop needs to be sown.
- The availability of suitable harvesting machinery.

Harvesting at the correct percentage of dry matter (DM) is important to ensure optimal yield, minimal loss of nutritive value, and a desirable fermentation process.

Dry matter levels for ensiling

If cutting at the flag-leaf or boot stages, the recommended DM levels are 33–40% for forage, and 38–50% DM for baling. The recommended ranges for cutting at the soft-dough stage are 35–42% DM for forage, and 38–45% DM for silage that is baled.

In the later stages of growth, cereal plants contain large stems, with leaves ranging from green (alive) to yellowing (dying) and grain heads in various stages of formation. This makes the estimation of the DM content difficult. Therefore, it is essential that a representative sample of the whole crop to be silage is obtained for estimating the DM content.

Mowing

The stage of growth of the crop at harvest will determine whether it is mown and wilted before harvesting or direct-cut and ensiled as a standing crop. However, the height of cutting can have some bearing on how the product is stored.

Cutting height is usually 7–10 cm above ground level. Cutting higher will result in a slight increase in nutritive value, but at the cost of reduced yields.

If cut when mown and wilted, the higher cutting height will tend to keep the mown windrow higher off the ground, thereby allowing more airflow under the crop and a

11 F Mickan (2008) Harvesting forage cereals. Note Ag1244. Updated. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/harvesting-forage-cereals

12 NW Griffiths, FJ Mickan and AG Kasier (2004) Chapter 5: Crops and by-products for silage. In Successful silage. 2nd edn. NSW DPI, https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/294053/successful-silage-topfodder.pdf

slightly faster wilting rate. It will also reduce the risk of soil contamination by other equipment, e.g. in operations such as raking.

However, cutting at greater heights will mean leaving behind more stubble, which creates a problem of future removal and preparation for the next forage crop. [13]

12.2.3 Equipment

Cereal rye is tall and the bulky straw makes harvesting slow, due to the large volume of material going through the harvester.

Clean out all machinery and equipment before and after harvest to prevent cross-contamination between cereal grains (Photo 5). [14]

Photo 5: *Cereal harvest under way. It is important to clean all equipment prior to and after harvesting.*

Photo: Agency Brazil

Standard headers

A standard wheat header is suitable for harvesting cereal rye. Adjustments need to be made to the harvester settings to avoid grain losses and damage, because the grain is lighter and longer than wheat. [15]

Tall crops are likely to lean or lodge, so crop lifters might be necessary.

In trials in 2014 in the southern high-rainfall zone (HRZ), researchers found that there is a 10% lift in header efficiency for every 10-centimetre increase in harvest height. They compared three harvest heights—15 cm, 30 cm and 50 cm—in wheat and barley (Note that cereal rye grows taller than wheat).

The trials also showed how much slower harvesting is at a height of 15 cm; as well as time costs, fuel consumption goes up, too. When they increased the height from 30 cm to 50 cm, harvesting was around 25% faster. A rule of thumb is that there is a 10% efficiency increase for every 10 cm of harvest height. If a 100 ha crop is harvested at 15 cm it will take about 20% more time to harvest than a crop cut at 30 cm, and 38% more time than if it had been harvested at 50 cm. [16]

13 F Mickan (2008) Harvesting forage cereals. Note Ag1244. Updated. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/harvesting-forage-cereals

14 P Matthews, D McCaffery and L Jenkins. (2016).Winter crop variety sowing guide 2016. DPI NSW, https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/winter-crop-variety-sowing-guide

15 Agriculture Victoria (2013) Growing cereal rye. Note AG0403. Updated. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-cereal-rye

16 A Lawson (2015) Header efficiency increases with harvest height. Ground Cover. Issue 118, September–October 2015. GRDC, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-118-Sep-Oct-2015/Header-efficiency-increases-with-harvest-height

However, there are reasons for harvesting low: it is done to reduce stubble loads to manageable levels, which is achieved by baling the stubble or burning the windrows, or spreading trash and straw as evenly as possible across the header swathe.

Treating weed seeds while harvesting low may help to reduce the weed seedbank in the soil over time, and this can assist with weed control and the management of herbicide resistance.

Forage harvesters

Cereals for whole-crop silage (WCS) should ideally be harvested using a precision-chopping forage harvester to ensure a short chop length (20–50 mm). This ensures that the material can be well compacted in the stack or pit to minimise the amount of air trapped, and thereby minimise losses of nutritive value and DM. Losses are due to continued plant and microbial respiration during the early phases of fermentation.

Most other forage-harvesting machines, e.g. self-loading wagons, cut the material to varying lengths, often over 200 mm, making adequate compaction very difficult.

The drier the crop DM content at harvest, the shorter the chop length required. Chopping the material short also ensures a thorough mixing of the high nutritive heads with the much lower nutritive stems and leaves.

Increased density also reduces the rate of aerobic spoilage at stack opening, a common although not insurmountable problem with cereal silages. Less wastage also occurs, as animals cannot easily select the heads and leave the stem material when fed.

Forage cereals being direct-harvested at the later growth stage is increasingly being carried out with forage harvesters that have a cutter bar instead of the typical rotary-disc mowers to reduce grain loss. Grain loss from the gaps in the housing of the chopping and feeding mechanisms can be minimised by fitting blanking plates.

Grain loss may be slightly higher in pre-mown crops due to the rotary-disc action of the mower and, particularly if raked before harvesting, DM yield and nutritive value will also be slightly lower.

If the crop is harvested after the soft-dough stage, the grain will be hardening as it matures. Forage harvesters, which are fitted with rollers specifically for cracking grain (often referred to as primary processing), will be essential.

Balers

Harvesting the whole crop using balers is not recommended, as dense compaction is often not achieved and vermin damage to the bales in storage can be a serious problem. If whole-crop cereals are to be harvested with round or square balers, the material needs to be wilted to slightly higher DM contents to ensure a lactic-acid fermentation occurs.

If using a baler, those with chopping mechanisms are highly recommended to aid compaction. The fermentation process and animal intakes of WCS will also benefit substantially from chopping. Once past the ideal stage for harvesting, cereal stems become more lignified (stiffer) and the stems are hollow, i.e. contain more internal air. Drier stems allow more air to be trapped within and between the stems in the bale. In this situation a chopping baler, with all knives in operation, is highly recommended. An alternative is to bale at the moister end of the DM range recommended for baling. Baling with some dew on the material will also be useful if DM levels are above those recommended.

Baling at a slower forward speed will also allow most balers to produce a denser bale. Baling material that is too dry, or not tightly compacted, results in large volumes of air being trapped in the bale thus reducing nutritive value and increased risk of puncturing by the stalks.

Anecdotal feedback from some machinery operators is that, if a mower only is used for the later growth stages of the crop, particularly when baling, the baler should travel in the opposite direction to the mower. The heads of the crop are picked up

first, and this results in much less trouble in the picking up and feeding in of the forage into the machine. However, one piece of research has indicated that friction from the rolling mechanisms in some balers induces heavier grain loss than that from forage harvesters. More research is needed to quantify losses at all stages of WCS harvesting and storage.

Applying net-wrap instead of twine will also reduce the amount of air trapped between the plastic and the bale as the twine, especially in slightly loose bales, will pull into the bale. This allows air to travel around the twine once plastic is applied, and the feed may become mouldy, particularly if the plastic is holed. Applying net-wrap will also minimise straw stalks protruding from the bales and puncturing the stretch-wrap plastic seal, thereby allowing air to enter. [17]

12.3 Fire prevention

Grain growers must take precautions during the harvest season, as operating machinery in extreme fire conditions is dangerous. They should take all possible measures to minimise the risk of fire. Fires are regularly experienced during harvest in stubble as well as standing crops. The main cause is hot machinery combining with combustible material. This is exacerbated on hot, dry, windy days. Seasonal conditions can also contribute to lower moisture content in grain and therefore a greater risk of fires.

Harvester fire reduction checklist

1. Recognise the big four factors that contribute to fires: relative humidity, ambient temperature, wind and crop type and conditions. Stop harvest when the danger is extreme.
2. Focus on service, maintenance and machine hygiene at harvest on the days more hazardous for fire. Follow systematic preparation and prevention procedures.
3. Use every means possible to avoid the accumulation of flammable material on the manifold, turbocharger or the exhaust system. Be aware of side and tailwinds that can disrupt the radiator fan airblast that normally keeps the exhaust area clean.
4. Be on the lookout for places where chaffing can occur, such as fuel lines, battery cables, wiring looms, tyres and drive belts.
5. Avoid overloading electrical circuits. Do not replace a blown fuse with a higher amperage fuse. It is your only protection against wiring damage from shorts and overloading.
6. Periodically check bearings around the harvester front and the machine. Use a hand-held digital heat-measuring gun for temperature diagnostics on bearings and brakes.
7. Maintain fire extinguishers on the harvester and consider adding a water-type extinguisher for residue fires. Keep a well maintained fire fighting unit close-by to the harvesting operation ready to respond.
8. Static will not start a fire but may contribute to dust accumulation. Drag chains or cables may help dissipate electrical charge but are not universally successful in all conditions. There are some machine mounted fire-suppression options on the market.
9. If fitted, use the battery isolation switch when the harvester is parked. Use vermin deterrents in the cab and elsewhere, as vermin chew some types of electrical insulation.
10. Observe the Grassland Fire Danger Index (GFDI) protocol on high fire risk days.

17 F Mickan (2008) Harvesting forage cereals. Note Ag1244. Updated. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/harvesting-forage-cereals

11. Maintain two-way or mobile phone contact with base and others and establish a plan with the harvest team to respond to fires if one occurs. [18]

Using machinery

To preventing machinery fires, it is imperative that all headers, chaser bins, tractors and augers be regularly cleaned and maintained. All machinery and vehicles must have an effective spark arrester fitted to the exhaust system. To prevent overheating of tractors, motorcycles, off-road vehicles and other mechanical equipment, all machinery needs to be properly serviced and maintained. Fire-fighting equipment must be available and maintained—it is not just common sense; it is a legal requirement.

Take great care when using this equipment outdoors:

Be extremely careful when using cutters and welders to repair plant equipment; this includes angle grinders, welders and cutting equipment,

Ensure that machinery components including brakes and bearings do not overheat, as these components can drop hot metal onto the ground, starting a fire.

Use machinery correctly, as incorrect usage can cause it to overheat and ignite.

Be aware that when blades of slashers, mowers and similar equipment hit rocks or metal, they can cause sparks to ignite dry grass.

Avoid using machinery during inappropriate weather conditions of high temperatures, low humidity and high wind.

Do repairs and maintenance in a hazard-free, clean working area such as on bare ground, concrete or in a workshop, rather than in the field.

Keep machinery clean and as free from fine debris as possible, as this can reduce onboard ignitions. [19]

Harvester fire research

With research showing an average of 12 harvesters burnt to the ground every year in Australia (Photo 6), agricultural engineers encourage care in keeping headers clean to reduce the potential for crop and machinery losses.

Key findings:

- Most harvester fires start in the engine or engine bay.
- Other fires are caused by failed bearings, brakes and electricals, and rock strikes. [20]

18 Barr R. (2015). Plant of attack needed for harvester fires. https://grdc.com.au/Media-Centre/Media-News/South/2015/10/Plan-of-attack-needed-for-harvester-fires

19 NSW Rural fire Service. Farm firewise. NSW Government, http://www.rfs.nsw.gov.au/plan-and-prepare/farm-fire-safety

20 GRDC (2012) A few steps to preventing header fires. GRDC Ground Cover Issue 101, http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-101/A-few-steps-to-preventing-header-fires

Photo 6: *GRDC figures show that there are 1000 combine harvester fires in Australia each year.*

Source: Weekly Times

12.3.1 Harvesting in low-risk conditions

Growers can use the Grassland Fire Danger Index guide to assess the wind speed at which harvest must cease (a GFDI of 35), depending on the temperature and relative humidity (Figure 1).

Step 1: Read the temperature on the left hand side.

Step 2: Move across to the relative humidity.

Step 3: Read the wind speed at the intersection. In the worked example, the temperature is 35°C and the relative humidity is 10% so the wind speed limit is 26kph.

TEMP °C	5	10	15	20	25	30	40	50	60	65	RH%*
15	31	35	38	40	43	45	49	53	56	58	AVERAGE WIND SPEED (KPH)
20	29	33	36	38	40	43	46	50	53	55	
25	27	30	33	36	38	40	44	47	50	52	
30	25	28	31	33	35	37	41	44	47	49	
35	23	26	28	31	33	35	38	41	44	46	
40	21	24	26	28	30	32	35	39	41	43	
45	19	22	24	26	28	30	33	36	39	40	
TEMP °C	5	10	15	20	25	30	40	50	60	65	RH%*

1 2 3

*RH% *(Relative Humidity rounded down)*
†Wind speed averaged over 10 minutes

Figure 1: *Grassland fire danger index guide.*

Source: CFS South Australia

PODCAST

GRDC Podcasts: Harvester Fires.

MORE INFORMATION

GRDC Reducing Harvester Fire Risk: The Back Pocket Guide

An investigation into harvester fires

Plan of attack needed for harvester fires

12.4 Receival standards

Cereal-rye standards are to be applied on individual truck loads, and must not be averaged over a number of loads (Table 1). [21]

Table 1: *Grain Trade Australia receival standards for cereal rye.*

Category	Standard
Moisture Max (%)	12.0
Description	Clean, sound mature whole grain, amber–light brown colour, free of genetic modification. The seller warrants the rye is fit for human consumption and complies with the standards laid down under the Food Standard Code.
General	Rye tendered for delivery shall be free of any uncharacteristic odour, infestation, objectionable material and any nominated commercially unacceptable contaminant.
Specific allergens	Nil presence of peanuts or biological material of any kind derived from the peanut plant in rye tendered for delivery.
Chemical treatment	No chemical treatments are to be used on harvested rye unless authorised in writing by Allied Mills, and any other chemical treatments must be declared at the time of receival. It is illegal to deliver grains containing above 0.3 ppm of phosphine.

Source: Grain Flow

MORE INFORMATION

AWB receival standards for cereal rye in 2016–2017

Grain Trade Australia, Cereal rye and triticale trading standards 2015–16

Cereal rye standards 2015–2016

12.5 Harvest weed-seed management

There are several ways of utilising harvest to lessen the numbers of viable weed seeds, to prevent weed seed returning to the seedbank and then proliferate during the next season. Techniques include harvest weed-seed control (HWSC), windrow burning, and the use of chaff carts, direct baling the Harrington Seed Destructor. It has been shown that these systems have similar effectiveness. [22]

12.5.1 Harvest weed-seed control

Many Northern grain growers have been a little sceptical about introducing harvest weed-seed control (HWSC) as a tool for combating herbicide resistance. Although few growers in Queensland and New South Wales incorporate HWSC into their management practices at the moment, this is likely to change. Nationally, HWSC is proven to reduce the weed seedbank, and some weeds of the northern grains region are suited to this method of control, particularly in a farming environment of increasing herbicide resistance.

Weed-seed capture and control at harvest can add to the effectiveness of other tactics to put the weed seedbank into decline. Up to 95% of annual ryegrass seeds that enter the harvester exit in the chaff fraction. If these can be captured, they can be destroyed or removed.

Western Australian farmers and researchers have developed several systems to effectively reduce the return of annual ryegrass and wild radish seed into the seed bank, and help put weed populations into decline.

A key tactic for all harvest weed-seed control operations is to maximise the percentage of weed seeds that enter the header. This means harvesting as early as possible before weed seed is shed, and harvesting as low as is practical, e.g. at 'beer-can height'.

21 Grain Flow (2016) Cereal rye standards 2015–16. Grain Flow, http://www.grainflow.com.au/NR/rdonlyres/A655AD52-F1D1-43B6-92A0-60226BE6FDB5/0/GFCerealRyeStandards201516.pdf

22 M Street and G Shepherd (2013) Windrow burning for weed control: WA fad or a viable option for the east? GRDC Update Paper. GRDC, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Windrow-burning-for-weed-control-WA-fad-or-viable-option-for-the-east

MORE INFORMATION

GRDC's Tactics for managing weed populations

Section on narrow-windrow burning in GRDC's Tactics for managing weed populations

Windrow burning for weed control: WA fad or a viable option for the east?

Northern weeds suited to HWSC

- Definitely—turnip weed and African turnip weed are potentially very good candidates for HWSC, although these species are not yet resistant.
- Definitely in winter crops—annual ryegrass and wild oats. Wild oats shed seed at about 2% per day and ryegrass at 1% a day, but it is still worth using HWSC at the start of harvest.
- Possibly in winter crops—barnyard grass and feathertop Rhodes grass are known to shed their seed in summer crops, but where they germinate in spring in winter crops they may be suitable candidates for HWSC.
- Possibly in summer crops—feathertop Rhodes grass provides an opportunity for HWSC in summer crops where there is a high percentage of seed retention at the start of harvest. [23]

12.5.2 Burning in narrow windrows

During traditional whole-paddock stubble burning, the very high temperatures needed to destroy weed seeds are not sustained for long enough to kill most weed seeds. However, by concentrating harvest residues, which includes weed seeds, into a narrow windrow, the fuel load is increased and the period of high temperatures extends to several minutes, improving the kill of weed seeds.

Windrow burning: the WA experience

Windrow burning has been widely adopted in Western Australia as an option for dealing with weed seeds that are resistant to herbicides. It is used as part of an integrated harvest weed-management strategy that includes these considerations:

- Continued reliance on herbicides alone is not sustainable in continuous-cropping systems. Rotating herbicides alone will not prevent the development of resistance.
- The early implementation of windrow burning will prolong the usefulness of herbicides, not replace them.
- Windrow burning is the cheapest non-chemical technique for managing weed seeds present at harvest.
- Even with higher summer rainfall, windrow burning is a viable option for NSW cropping systems.
- Windrow burning is an effective weed-management strategy, even in the absence of resistance.
- Growers need to begin experimenting now on small areas to gain the experience needed to successfully implement the strategy. [24]

12.5.3 Chaff carts

Chaff carts are towed behind headers during harvest to collect the chaff fraction (Photo 7). The chaff that is collected is dumped into piles and then burnt the following autumn or used as a source of stock feed.

23 T Somes (2016) Can harvest weed-seed control work for the North? Ground Cover. Issue 124, September–October 2016. GRDC, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-124-SeptemberOctober-2016/Can-harvest-weedseed-control-work-in-the-north

24 M Street and G Shepherd (2013) Windrow burning for weed control: WA fad or a viable option for the east? GRDC Update Paper. GRDC, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Windrow-burning-for-weed-control-WA-fad-or-viable-option-for-the-east

MORE INFORMATION

Section on chaff carts in GRDC's Tactics for managing weed populations

Section on bale-direct systems in GRDC's Tactics for managing weed populations

Small and large baler projects of the Shields family

Section on the Harrington Seed Destructor in GRDC's Tactics for managing weed populations

Chaff deck concentrates weeds in controlled traffic

VIDEOS

WATCH: A beginner's guide to harvest weed seed control

Photo 7: *Chaff cart in action*

Photo: A. Storrie

12.5.4 Bale-direct system

The bale-direct system uses a baler attached to the harvester to collect all chaff and straw material. This system requires a large baler to be attached to the back of the harvester. As well as removing weed seeds, the baled material has an economic value as a livestock feed. Header-towed bailing systems were developed in Western Australia by the Shields family.

12.5.5 Harrington Seed Destructor

The integrated Harrington Seed Destructor (iHSD) is the invention of Ray Harrington, a progressive farmer from Darkan, WA. Developed as a trail-behind unit, the iHSD comprises a chaff-processing cage mill, and chaff and straw delivery systems. The retention of all harvest residues in the field reduces the loss and/or banding of nutrients and maintains all organic matter to protect the soil from wind and water erosion, as well as reducing evaporation loss compared to the use of windrow burning, chaff carts and baling. [25]

The chaff deck places the chaff exiting the sieves of the harvester on to permanent wheel tracks. Growers using chaff decks have observed that few weeds germinate from the chaff fraction and believe that many weed seeds rot in it. A permanent tramline farming system is necessary to be able to implement the chaff deck system. [26]

25 GRDC (n.d.) Section 6. Managing weeds at harvest. GRDC, https://grdc.com.au/Resources/IWMhub/Section-6-Managing-weeds-at-harvest

26 Roberts P. (2014). New systems broaden harvest weed control options. GRDC. https://grdc.com.au/Media-Centre/Media-News/West/2014/11/New-systems-broaden-harvest-weed-control-options