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GROWNOTES™

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GRAINS RESEARCH & DEVELOPMENT CORPORATION

TRITICALE

SECTION 12

HARVEST

HARVESTING ISSUES | HARVEST TIMING | HARVESTING TRITICALE FOR SILAGE | CONSIDERATIONS FOR HARVEST EQUIPMENT | FIRE PREVENTION | RECEIVAL STANDARDS | HARVEST WEED-SEED MANAGEMENT

Harvest

Key messages

- Harvesting and storage management for triticale is generally similar to that for wheat. However, spring triticale for grain matures later than wheat, and is also more susceptible to sprouting at harvest than wheat.
- Preferred harvest moisture content to protect against damage due to heating caused by mould is 12.5%.
- For best returns, aim to harvest crops at 12% moisture or less, produce grain with a minimum test weight of 65 kg/hL and minimise other cereal grain contaminants.
- A drawback of triticale grown for grain is that it is prone to shattering.
- Harvester settings should be set similar to those for wheat, with care taken to slow the cylinder speed to minimise grain cracking and splitting.
- Some varieties are difficult to thresh cleanly, and may end up with intact head sections in the grain sample, or with cracked grain because of tight concave settings. Some varieties are prone to shedding in windy conditions.

12.1 Harvesting issues

Triticale grown for grain can be prone to shattering (Photo 1). There is a spot about a quarter to a third of the way down from the tip on the rachis (stem) that is very weak. [1]

Photo 1: *Shattered cereal grain.*

Source: USDA Agricultural Research Service

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[1] PNW-Ag (n.d.) Alternative crops: triticale in the US. Washington State University.

Triticale varieties vary strongly in how cleanly they can be threshed. Some varieties are difficult in this regard, and leave intact head sections in the harvested grain, or the grain cracks because of tight concave settings. Some varieties are prone to shedding in windy conditions.

The level of carried over (hard seed) self-sown plants that occurs after a triticale crop appears to be higher than with other winter cereals. No data exists on varietal differences in hard-seed levels, but especially where some seed shedding has occurred carryover will need careful management. [2]

12.1.1 Windrowing

Windrowing, or swathing, involves cutting the crop and placing it in rows held together by interlaced straws, and supported above the ground by the remaining stubble. Triticale is not often windrowed. The practice 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.
- Windrowing is not a common practice in Australia.

If the crop is too thin or the stubble too short to support the window above the ground, it 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 result in picking up soil and contaminating the grain.

Timing

If growers to choose to windrow triticale, windrowing can begin when grain moisture content (MC) is below 35% (this being the very upper level); i.e. when the grain is at the medium dough stage (hard, but can still be dented with the thumbnail).

> *I usually use the thumbnail denting and add 3- 5 days on the youngest tiller. My older tillers would be closer to hard dough stage, so 35% grain moisture is on the high end of the scale when deciding windrow timing.*

Agronomist's view

Harvest settings should be set similar to those for wheat, with care taken to slow the cylinder speed to minimise grain cracking and splitting. [3]

When considering windrowing triticale, note that:

- 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.
- Although it may be easier to windrow later, the windrows of a ripe crop may not interlock well enough to withstand disturbance by strong winds.

Cutting

- Cut across the sowing direction or at 45° for crops planted on wider rows, so the windrow sits up on the stubble. Windrowing is not recommended for paddocks where the crop row spacing is wider than 25 cm.
- Avoid placing windrows in the same location each year, so nutrients do not become concentrated in one place.

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[2] RS Jessop, M Fittler (2009) Appendix 1. Triticale production manual: an aid to improved triticale production and utilisation. In J Roake, R Trethowan, R Jessop, M Fittler, Improved triticale production through breeding and agronomy. Pork CRC, http://www.apri.com.au/1A-102_Final_Research_Report_.pdf

[3] Alberta Agriculture and Forestry (2016) Triticale crop production. Alberta Agriculture and Forestry, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

- 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 in 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 windrow height at 10–20 cm above the ground (i.e. one-third crop height) and adjust to produce an even windrow with well-interlaced straws that sit above the ground, to allow good air circulation and rapid drying should rain occur.

Harvesting the windrow

Complete harvesting of the windrowed crop 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 four to eight days), grain may sprout and become stained.
- 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 at sufficient speed to prevent the crop material banking up.
- Rows pick up best when the header follows the direction of the windrow (i.e. heads first).

12.2 Harvest timing

Harvesting for triticale is generally similar to that for wheat (Photo 2). However, triticale for grain is late-maturing, and is also more susceptible to sprouting conditions at harvest than wheat.

Photo 2: *When conditions allow, direct heading of triticale is best.*

Source: Capital Press

Growers with access to grain dryers and aerated silos can harvest triticale at a higher MC (e.g. 13–14%) however, majority of growers in the Northern region often wait until triticale grain reaches 12.5% MC before harvesting. Moisture content lower than 12.5% is very desirable, as most moulds and insects tend to be inactive below this moisture level. Deliveries to bulk handlers can be at 12.5%. Triticale is prone to weevil infestation during storage so ensure that these moisture content values are met.

For more information on storing triticale, see Section 13: Storage.

For the best returns, aim to harvest crops at 12% MC or less, produce grain with a minimum test weight of 65 kg/hL and minimise other cereal grain contaminants.

12.2.1 Lodging

Triticale is taller than wheat and has larger ears, both of which contribute to a higher risk of its lodging. [4]

Lodging is when the crop falls over. A normal, standing crop is finely balanced, so anything that upsets the balance can cause it to lodge: strong winds, heavy rain, a very wet soil during late grainfilling, tall thin stems that bend easily, root or stem rots that weaken the plant base. The worst combination is winds associated with excess water. Lodging can also occur in very fertile soils, in which case it is best to plan to harvest early. [5]

Lodging can destroy canopy structure. Solar radiation is no longer intercepted efficiently as it is in a standing crop, where greater amounts of light falling on the young, upper leaves and lesser amounts on the old leaves. Heads get covered in the tangle, and the collapsed crop becomes more susceptible to pests and diseases.

Lodging during early stem elongation has a relatively small effect on yield, as the crop is able to right itself and reform the canopy. The stem nodes alter their angle of extension, and make new growth vertical. However, from anthesis onwards the effects of lodging are large. For every day that the crop is lodged, yield declines by more than 1%. So in crops that lodged badly shortly after anthesis and remain fallen, the final yield will be less than half that of the upright part of the crop.

Any lodging also makes harvesting more difficult and increases the likelihood of losing grain during harvesting [6] (Photo 3). [7]

Photo 3: *Lodged cereal crop.*

Source: Farming UK

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[4] D Kindred (n.d.) The triticale challenge. ADAS, http://www.elsoms.com/assets/downloads/ADAS_The_triticale_challenge.pdf

[5] Albert Lea Seed (n.d.) Triticale. Albert Lea Seed, http://www.alseed.com/UserFiles/Documents/Product%20Info%20Sheets-PDF/Basics%20Triticale-2010.pdf

[6] CIMMYT (n.d.) Wheat Doctor: Lodging. International Maize and Wheat Improvement Center, http://wheatdoctor.org/lodging

[7] Farming UK (2015) Scene is set for cereal lodging risks. 12 February 2015. Farming UK, https://www.farminguk.com/News/Scene-is-set-for-cereal-lodging-risks_32861.html

Salvaging lodged crops generally requires a combination of equipment, as is or modified, and technique. Crop lifters, which can be attached to the sickle bar of most headers. Check with your machinery dealer to make sure any attachments will fit on your model of header. Innovative farmers have also developed their own modifications, with varied success; care must be taken not to damage the rest of the machine.

Lifting the lodged crop is preferable to having the header on the deck. Not only will you run less plant material through the combine, you are likely to leave more residues attached by the roots. Running less plant material through the combine can save fuel and wear on the header, allow faster harvesting,

Equipment choice and modifications alone will not maximise the harvest efficiency of lodged crops. Recommendations are to travel slowly, and to choose the optimum direction of travel. If wind was a significant factor in the lodging of crops, most of the plants are likely be lying in one direction. This situation generally allows harvesting to occur in the two directions that are perpendicular to the direction in which the plants are leaning or lying. The best results may be obtained by harvesting in one direction, likely at an angle against the direction the plants are lying, and 'deadheading' back for the next pass. If the lodging is more random, as might occur with severe stalk weakness, the direction of travel may not matter. Once as much of the crop as possible has been harvested mechanically, producers may also consider grazing. Livestock may require supplementation to meet their nutrient requirements. It is recommended to remove livestock before excessive residue is removed and the land is at risk of wind or water erosion. [8]

The keys for preventing lodging are:

- Irrigation timing—do not irrigate when you expect wind. Avoid irrigating if high winds are forecast. The yield loss associated with extensive lodging is greater than for a day of water stress.
- Late irrigation—avoid over-wetting the soil late in grainfilling.
- Variety—change to a shorter variety if your area is prone to high winds or rainstorms during the later stages of growth.
- Nitrogen—reduce nitrogen applications, particularly very late applications, to unimproved, tall varieties. Split nitrogen applications between planting and first node.
- Plant density—reduce seeding density and/or planting depth to encourage early tillering and crown-root production. This can give plants a stronger base.
- Diseases—control crown and root diseases by appropriate agronomy and/or seed dressings.
- Potassium—use a potassium fertiliser.
- Raised beds—adopt the raised bed planting system. Irrigation in this system does not wet the soil around the base of the plant to the same extent as flat plantings. [9]

12.3 Harvesting triticale for silage

The cutting and storage of triticale forage for silage is similar to that of any small-cereal forage crop. The harvest date of triticale for silage is very important. As plants develop beyond the boot stage and into early grainfill, the protein and energy levels drop, while the fibre level increases rapidly. Although there is a general increase in dry-matter yield as the crop matures, the increased yield is more often offset by the reduction in forage quality. Consequently, the best time to cut triticale for silage is in the boot stage to early-heading stage. [10]

When timing the harvest, consider the following:

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[8] B Fanning (2013) Harvesting lodged crops. South Dakota State University, https://igrow.org/agronomy/corn/harvesting-lodged-crops/

[9] CIMMYT (n.d.) Wheat Doctor: Lodging. International Maize and Wheat Improvement Center, http://wheatdoctor.org/lodging

[10] M Mergoum, H Gómez-Macpherson (eds) (2004) Triticale improvement and production. FAO Plant Production and Protection Paper No. 179. Food and Agriculture Organisation, http://www.fao.org/docrep/009/y5553e/y5553e00.htm

- End use of the silage, i.e. for animal production *v*. maintenance rations.
- Weather conditions at harvest.
- Soil type and soil moisture conditions at harvest.
- If spring sowing, when the follow-up pasture is to be sown.
- If double-cropping, when the follow-up crop needs to be sown.
- Availability of suitable harvesting machinery.
- Effect on dry-matter yield.

Cereals can be harvested at two stages:

- Flag leaf/boot–early ear emergence stages; and
- Soft-dough stage.

When using triticale for silage, the optimum time for harvest is recommended as being at the soft-dough stage, in order to get the best balance between quality and yield. [11]

Triticale is particularly well-adapted for producing a high forage yield on highly fertile paddocks. Harvesting protocols and timing must be adjusted to accommodate the differences between triticale and barley in these situations. In high-productivity systems where lodging is a problem, triticale should be compared to semi-dwarf barley, which is also specially adapted to high-fertility conditions.

MORE INFORMATION

When to cut forage cereals

Triticale for silage

12.4 Considerations for harvest equipment

Harvester settings should be set similar to those for wheat, with care taken to slow the cylinder speed to minimize grain cracking and splitting (Photo 4). [12]

Seed size can be of concern when harvesting triticale. Compared to bread wheat, triticale varieties generally have a large seed and a large embryo with an elongated beak. Caution must be taken to ensure that any mechanical harvesters are appropriately set so that there is no damage to the embryo. Embryo damage and seed cracking can have a significant impact on seed viability during storage. This can be a problem since many triticale varieties are hard to thresh compared to wheat and rye.

In triticale varieties without the wheat rachis, threshing frequently results in incomplete seed and chaff removal from the spike, and breakage may occur at the rachis nodes. In the wheat-rachis types, breakage does not occur. [13]

Harvest triticale as you would wheat, although adjust harvester speed to slightly slower than for harvesting wheat. [14]

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[11] Alberta Agriculture and Forestry (2016) Triticale for silage. Alberta Agriculture and Forestry, www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10569

[12] Alberta Agriculture and Forestry (2016) Triticale crop production. Alberta Agriculture and Forestry, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

[13] M Mergoum, H Gómez-Macpherson (eds) (2004) Triticale improvement and production. FAO Plant Production and Protection Paper No. 179. Food and Agriculture Organisation, http://www.fao.org/docrep/009/y5553e/y5553e00.htm

[14] UVM Extension Crops and Soils Team (2011) Triticale. University of Vermont, http://northerngraingrowers.org/wp-content/uploads/TRITICALE.pdf

Photo 4: *Triticale being harvested using a combine harvester.*

Source: Midwest Cover Crops Council

12.4.1 Setting header height

In 2014 trials in Victoria's high-rainfall zone (HRZ) it was found that there is a 10% gain in header efficiency for every 10-cm increase in harvest height. The trials compared three harvest heights—15 cm, 30 cm and 50 cm—in wheat and barley. The trials showed that harvesting at a height of 15 cm makes harvesting much slower, and also incurs additional fuel consumption. At the other end of the scale, at a height 50 cm, harvesting was around 25% faster than 30 cm. A rule of thumb is a 10% efficiency gain for every 10 cm increase in 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, or 38% more time than if it had been harvested at 50 cm. [15]

> *On the taller triticale varieties, harvest height will be lower than most wheat, as triticale is more uneven in tiller height than wheat. You generally have to take 10–20% more stubble than wheat when harvesting triticale.*

Agronomist's view

Harvesting low is done to reduce stubble loads, and is achieved by baling or burning the windrows, or spreading the trash and straw as evenly as possible across the header windrow. Harvesting low and treating weed seeds can also help to reduce the weed seedbank over time, and that, in turn, can assist with managing weeds and herbicide resistance.

Whatever height the header is set to, it is important to ensure that all equipment is clean and free of anything that might contaminate the harvested grain (Photo 5).

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[15] 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

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

Source: Agência Brasil

12.4.2 Forage harvesters

Ideally, whole-crop cereals should be harvested using a precision-chopping forage harvester to ensure a short chop length of 20–50 mm. This ensures the material can be well compacted in the stack or pit, so minimising the amount of air trapped and reducing losses of nutritive value and dry matter (DM). Losses are due to continued plant and microbial respiration during the early phases of fermentation. Increased density also reduces the rate of aerobic spoilage when the stack is opened; this is a common though not an insurmountable problem with cereal silages.

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

The drier the DM content of the crop at harvest, the shorter the chop length required. Chopping the material short also ensures a thorough mixing of the highly nutritious heads with the much less nutritious stems and leaves. When all parts of the forage are well mixed, less wastage also as animals cannot easily select the heads and leave the stem material.

Farmers direct-harvesting forage cereals at the later growth stage are increasingly using forage harvesters that have a cutter bar instead of the typical rotary disc mowers, as this reduces grain loss. When using disc mowers, 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 nutritional value will also be slightly lower.

If the crop is harvested after the soft-dough stage, the grain will be hardening as it matures. In this case, forage harvesters, which are fitted with specific rollers for cracking grain, often referred to as 'primary processing', will be essential. [16]

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[16] F Mickan (2008) Harvesting forage cereals. Note AG1244. Revised. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/harvesting-forage-cereals

12.5 Fire prevention

With so much flammable grain dust and chaff generated by harvesters during summer harvests, fire is a big risk, so grain growers must take precautions to minimise the likelihood of fires. Fires are a regular occurrence during harvest in stubble as well as standing crops. The main cause is hot machinery harvesting with combustible material. This is exacerbated on hot, dry, windy days. Seasonal conditions can also contribute to lower moisture content in grain, and this, too, increases the risk of fires.

12.5.1 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 harvesting when the danger is extreme.
2. On the more hazardous days, focus on service, maintenance and machine hygiene. Follow systematic preparation and prevention procedures.
3. Use every means possible to avoid the accumulation of flammable material on the manifold, turbocharger and the exhaust system. Be aware of cross-winds and tailwinds that can disrupt the radiator fan air blast that normally keeps the exhaust area clean.
4. Be on the lookout for places where chaffing can occur, e.g. 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 and ready to respond.
8. Static electricity will not start a fire, but may help dust accumulate. Drag chains or cables may help dissipate electrical charges but are not universally successful in all conditions. As an alternative, 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 days of high fire risk.
11. Maintain two-way or mobile phone contact with a base and others, and establish a plan with the harvest team so that everyone can respond to a fire if it occurs. [17]

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, tractors, motorcycles, off-road vehicles and mechanical equipment also need to be properly serviced and maintained. Fire-fighting equipment must be available and maintained—this is not just common sense, it is a legal requirement.

Take great care when using this equipment outdoors:

- Most harvester fires start in the engine or engine bay.
- Other fires are caused by failed bearings, brakes and electricals, and rock strikes. [18]

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

[18] N Baxter (2012) A few steps to preventing header fires. Ground Cover. Issue 101, November–December 2012. GRDC, http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-101/A-few-steps-to-preventing-header-fires

- Be extremely careful when using cutting equipment, angle grinds and welders to repair plant equipment.
- Ensure that machinery components, including brakes and bearings, do not overheat, as they can drop hot metal onto the ground and start a fire.
- Use machinery correctly, as incorrect usage can cause it to overheat and ignite.
- Be aware that when the blades of slashers, mowers and similar equipment hit rocks or metal, they can create sparks and ignite dry grass.
- Avoid using machinery during when temperatures are high, humidity is low and winds are strong.
- Do repairs and maintenance in a hazard-free, clean working area such as on bare ground, on concrete or in a workshop, rather than in the paddock.
- Keep machinery clean and as free of fine debris as possible, to reduce the likelihood of onboard ignitions. [19]

With research showing an average of 1,000 combine harvester fires and 12 harvesters burnt to the ground every year in Australia (Photo 6) [20], agricultural engineers encourage care in keeping headers clean to reduce the potential for crop and machinery losses.

Photo 6: *GRDC figures show that there are 1,000 combine harvester fires in Australia each year.*

Source: Weekly Times

12.5.2 Harvesting in low-risk conditions

Growers can use the GFDI 35 guide to assess the wind speed at which harvest should cease. The Country Fire Service of South Australia publishes this ready-reckoner, which combines wind speed, relative humidity and temperature to arrive at conditions at which harvesting should be halted (Figure 1). [21] To use the table:

1. Find the current temperature on the left-hand side in the red section.
2. Find the current relative humidity, rounded down, in the blue section. Find the intersection between these two values.
3. Read the wind speed at the intersection point, in the yellow section. If your current wind speed is the same or higher, you should stop harvesting until conditions take you under the threshold. In the worked example, the temperature

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[19] NSW Rural Fire Service (n.d.) Farm fire safety. NSW Rural Fire Service, http://www.rfs.nsw.gov.au/dsp_content.cfm?cat_id=1161

[20] J Law (2016) Use commonsense to prevent combine harvester fire during harvest. 2 September 2016. Weekly Times, http://www.weeklytimesnow.com.au/machine/use-commonsense-to-prevent-combine-harvester-fire-during-harvest/news-story/f033c730547be732cedd997f4f6dbca7

[21] CFSSA (2014) Grain harvesting operation weather restrictions [download]. In CFS Code of Practice: Grain Harvesting. Country Fire Service South Australia, https://www.cfs.sa.gov.au/utils/html_view.jsp?id=56784

TABLE OF CONTENTS

FEEDBACK

PODCAST

GRDC podcast: Harvester fires

MORE INFORMATION

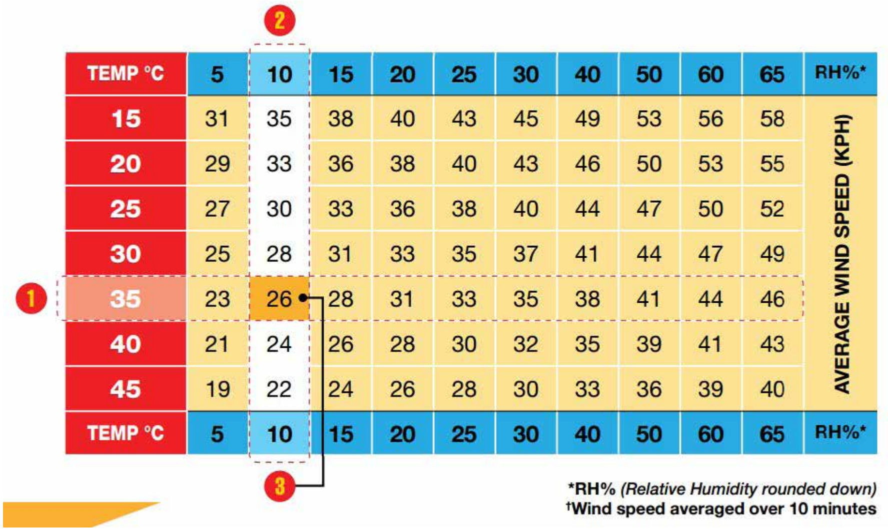
GRDC Reducing Harvester Fire Risk: The Back Pocket Guide

An investigation into combine harvester fires

Plan of attack needed for harvester fires

Grain Trade Australia, Cereal rye and triticale trading standards 2016–2017 season

is 35°C and the relative humidity is 10%, so the wind speed at which harvesting stops is 26 km/h.



TEMP °C	5	10	15	20	25	30	40	50	60	65	RH%*
15	31	35	38	40	43	45	49	53	56	58	
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%*

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

Figure 1: *GFDI 35 calculator for determining when harvesting may ignite grassland fires. In this example, if the temperature is 35°C and the relative humidity is 10%, harvesting should be halted when the wind speed reaches 26 km/h.*

Source: Country Fire Service South Australia

12.6 Receival standards

It is important to stay up to date with the Grain Trade Australia (GTA) national grain receival standards, as they change from time to time. The GTA Trading Standards are a critical tool for anyone purchasing, selling, trading, broking or otherwise operating in the commercial grain industry. They cover all grains, oilseeds and pulses, and related commodities.

For triticale, there is no minimum variety specification, and a load may be delivered with a varietal mix at any level. Any variety is eligible for delivery into the triticale grade (Table 1). [22]

Table 1: *Triticale receival standards current at 1 August 2016 for the Northern region.*

Parameter	Specification	Comment / variation
Description	n/a	Approved varieties only
Moisture Max (%)	12.5	
Test Weight Min (kg/hl)	65.0	
Unmillable Material below the screen Max (% by weight)	10.0	All matter passing through a 2.0 mm slotted screen – 40 shakes in the direction of the slots
Unmillable Material above the screen Max (% by weight)	5.0	Includes whiteheads, chaff, backbone, Wild Radish pods, Milk Thistle pods or other seedpods not otherwise listed. Excludes contaminants where tolerances already exist
Defective grain max (% by count, 300 grain sample, unless otherwise stated)		
Sprouted	2.0	Split germ or visible signs of rootlet growth

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[22] CBH (2016) 2016–17 CBH public receival standards WA as at 1st October 2016 [download]. In Grain standards in Western Australia, http://www.giwa.org.au/standards

Parameter	Specification	Comment / variation
Insect Damaged	2.0	
Stained, of which:	15.0	Includes Weather Stained, Field Fungi
Pink Stained	5.0	Various fungal species that cause pink staining
Bin Burnt, Heat Damaged or Storage Mould (count per half litre)	1	
Dry Green or Sappy	2.0	
Frost Damaged	2.0	
Foreign seed contaminants max (count of seeds in total per half litre unless otherwise stated)		
Type 1 (Individual seed basis)	8	Colocynth, Double Gee/Spiny Emex/ Three Cornered Jack, Jute, Long Headed Poppy, Mexican Poppy, Field Poppy, Horned Poppy, Wild Poppy, New Zealand Spinach, Parthenium Weed (Qld only)
Type 2 (entire load)	Nil	Castor Oil Plant, Coriander, Crow Garlic/ Wild Garlic, Darling Pea, Opium Poppy, Peanut seeds and pods, Ragweed, Rattlepods, Starburr, St. John's Wort
Type 3 (a)	2	Bathurst Burr, Bellvine, Branched Broomrape, Bulls Head/Caltrop/Cats Head, Cape Tulip, Cottonseed, Dodder, Noogoora Burr, Thornapple/False Castor Oil
Type 3 (b)	4	Vetch (Blue/Tare), Vetch (Commercial)
Type 3 (c)	8	Heliotrope (Blue), Heliotrope (Common)
Type 4	20	Bindweed (Field), Cutleaf Mignonette seeds or pods, Damel, Hexham Scent (Hexham Scent is only acceptable if no tainting odour is present) or King Island Melilot, Hoary Cress, Mintweed, Nightshades, Paddy Melon, Skeleton Weed, Variegated Thistle
Type 5	40	Knapweed (Creeping/Russian), Patterson's Curse/Salvation Jane, Sesbania pea
Type 6	50	Saffron Thistle, Johnson Grass, Columbus Grass
Type 7 (a)	10	Broad Beans, Chickpeas, Corn (Maize), Cowpea, Faba Beans, Lentils, Lupin, Peas (Field), Safflower, Soybean, Sunflower and any other seeds or pods greater than 5 mm in diameter
Type 7 (b)	150	Barley, Bindweed (Australian), Bindweed (Black), Wheat, Durum, Oats (Black), Oats (Sand), Oats (Wild), Oats (Common), Rice, Rye (Cereal), Sorghum (Forage), Sorghum (Grain), Turnip Weed and any other weed seeds not specified in Types 1–7(a) or SFS
Small Foreign Seeds (% by weight)	1.2	All foreign seeds not specified in Types 1–7(b) that fall below the 2.0 mm screen during the Screenings process

Source: Grain Trade Australia

12.7 Harvest weed-seed management

Many northern grain growers have been sceptical about introducing harvest weed-seed control (HWSC) as another tool for combating herbicide resistance. The Queensland Department of Agriculture and Fisheries (DAF) principal weed science researcher Dr Michael Widderick says few growers in Queensland or New South Wales incorporate HWSC into their management practices, but, like other leading researchers, he believes this will change. Nationally, HWSC has been proven to reduce the weed seedbank, and if it could be made to work well in the Northern Region it would be a major positive for weed control in what is an increasingly herbicide-resistant environment.

There are several commercially available HWSC methods that effectively target the weed-seed-bearing chaff fraction during harvest. The main ones are narrow windrow burning, chaff carts, bale-direct stubble (BDS), and the integrated Harrington Seed Destructor (iHSD). Studies of these practices have clearly demonstrated their efficacy in preventing inputs of viable seed into the seedbank. Each is suited to a different set of problems and conditions, so two or more may need to be combined. With the ongoing development and refinement of HWSC options, two relatively new systems, chaff tramlining and the iHSD, have been introduced. Expectations are that their adoption will be high in the Northern Region.

Chaff tramlining is a simple, effective approach that removes the need for residue burning for HWSC. It is particularly suited to high-residue situations with dedicated tramlines. The newly commercialised iHSD, an update on the HSD, is a more sophisticated approach to HWSC where two hydraulically driven chaff-processing mills are neatly fitted to the rear of the harvester. This very effective system also reduces the need for residue burning, and has the added advantage of redistributing all residues back across the paddock. [23]

12.7.1 Which northern weeds suit HWSC?

HWSC works for many northern weeds:

- Definitely in—turnip weed and African turnip weed are potentially very good candidates for HWSC, although they are not yet resistant to herbicides (note that these have only been tested in winter weeds–not tested in summer crops yet).
- Definitely in (winter crops)—annual ryegrass and wild oats at the start of harvest, even though wild oats sheds seed at about 2% a day and ryegrass at 1% a day.
- 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 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. [24]

12.7.2 Harvest weed-seed controls

Weed-seed capture and control at harvest can be a valuable addition to the suite of tactics employed to put the weed seedbank into decline. For example, up to 95% of annual ryegrass seeds that enter the harvester exit in the chaff fraction. If the chaff can be captured, the seeds 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. Such practices have potential in the Northern region.

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[23] M Walsh (2016) Harvest weed seed control systems for the northern region. GRDC Update Paper. GRDC, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/07/Harvest-weed-seed-control-systems-for-the-northern-region

[24] 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

MORE INFORMATION

IWM manual section on harvest-weed management

Harvest weed seed control systems for the northern region

IWM manual section on narrow windrow burning

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

VIDEOS

WATCH: Grain Orana Alliance - Windrow burning for weed control in central western NSW

WATCH: Grain Orana Alliance– Burning the barriers to windrow burning in NSW

Early harvest

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

Narrow windrow burning

During traditional whole-paddock stubble burning, high temperatures are not able to be sustained for long enough to kill most weed seeds. By concentrating harvest residues and weed seed 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.

But is burning narrow windrows to control weeds a WA fad or a viable option for the east? There are several reasons Northern Region growers might consider it:

- Continued reliance on herbicides alone is not enough in continuous-cropping systems. Rotating herbicides alone will not prevent the development of resistance.
- 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 Northern cropping systems.
- Windrow burning is effective, 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 farm-wide. [25]

Narrow windrow burning is extremely effective—it destroys up to 99% of annual ryegrass and wild radish seeds—but it must be done properly. For ryegrass, a temperature of 400°C for at least 10 second is needed to destroy the viability of seeds. For wild radish, the temperature needs to be 500°C for at least 10 seconds. [26]

Chaff carts

Chaff carts are towed behind headers during harvest to collect the chaff fraction (Photo 7). The chaff can then be handled easily.

Chaff carts will collect and remove up to 85% of annual ryegrass and wild radish seeds that pass through a header. The chaff collected this way must be managed to ensure the seeds are removed permanently from the cropping system. This can be done by burning in the following autumn or by removing the chaff from the paddock and using it as a livestock feed. [27]

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[25] M Street, 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

[26] S Clarry (2015) Trials measure harvest weed-seed control. Ground Cover. Issue 115, March–April 2015. GRDC, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-115-MarApr-2015/Trials-measure-harvest-weed-seed-control

[27] Clarry S. (2015). Trials measure harvest weed-seed control. https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-115-MarApr-2015/Trials-measure-harvest-weed-seed-control

MORE INFORMATION

IWM manual section on chaff carts

IWM manual section on bale-direct systems

The 'Glenvar' bale-direct story

Photo 7: *Chaff cart in action.*

Photo: A. Storrie

Bale-direct systems

With the bale-direct system, a large baler is attached to the back of the harvester to collect all chaff and straw. As well as removing weed seeds, the baled material has an economic value as a livestock feed source.

Harrington Seed Destructor

The integrated HSD is the invention of Ray Harrington, a progressive farmer from Darkan, WA (Photo 8). [28] Developed as a unit that trails behind the harvester, the iHSD comprises a chaff-processing cage mill, and chaff and straw delivery systems. The HSD, which renders seeds non-viable by collecting and impacting the chaff as it exits the harvester, can be 92–99% effective, depending on seed species. [29]

All harvest residues are retained. Therefore, compared with windrow burning, chaff carts and baling, the farmer using the iHSD reduces the loss or banding of nutrients, maintains all organic matter to protect the soil from wind and water erosion, and reduces evaporation. [30]

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[28] A Roginski (2012) Seed destructor shows its national potential. Ground Cover. Issue 100, September–October 2012. GRDC, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-issue-100/Seed-destructor-shows-its-national-potential

[29] Clarry S. (2015). Trials measure harvest weed-seed control. https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-115-MarApr-2015/Trials-measure-harvest-weed-seed-control

[30] GRDC (n.d.) Section 6. Managing weeds at harvest. Integrated Weed Management Hub. GRDC, https://grdc.com.au/resources-and-publications/iwmhub/section-7-managing-weeds-at-harvest

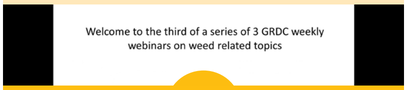
VIDEOS

WATCH: Harvest weed seed control for the high rainfall zone

WATCH: Harvest the time to get on top of resistant weeds

University of Adelaide weed management expert Dr Chris Pre calls on growers to ore about pre-emerge harvest-time control options, to cope with growing herbicide resistance issues.

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



Welcome to the third of a series of 3 GRDC weekly webinars on weed related topics

MORE INFORMATION

IWM manual section on Harrington Seed Destructor

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

Chaff deck concentrates weeds in controlled traffic

Photo 8: *Harrington Seed Destructor at work.*

Source: GRDC

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. [31]

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[31] 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