NORTHERN
SEPTEMBER 2018

GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

BARLEY

SECTION 12

HARVEST

HEADER SETTINGS | MONITORING GRAIN LOSS | WET HARVEST ISSUES AND MANAGEMENT | FIRE PREVENTION | RECEIVAL STANDARDS | HARVEST WEED SEED CONTROL

SECTION 12

Harvest

Barley is generally harvested from October to late November prior to wheat, which provides some spread of harvest timing. It can be expected to yield similar or better than wheat. The crop dries down well and desiccation is generally not necessary unless late weed growth needs to be controlled. [1]

More information

Barley planting, nutrition and harvesting at http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

Effect of delayed harvest on barley varieties in GRDC Grains Research Update, Northern Region Spring 2013 edition at https://www.grdc.com.au/~/media/31326C5963D14D6594F2D3EF896F3CE4.pdf

12.1 Header settings

Suggested header setting adjustments for barley:

Drum speed (rpm):

- Conventional, 700-1000
- Rotary, 700-1000

Concave clearance (mm):

- Front, 8
- Rear, 3

Fan speed: high

As maintaining germination above 95% is vital, harvest and handling is of particular importance for malting barley. Even minor damage to the seed can affect the ability of the seed to germinate. Cracked grains, skinned or partially skinned grains, and grains killed through damage to the germ do not malt properly.

When examining a barley seed sample for damage, look at individual grains and not just a mass of grain. Always examine the back of the grain first and ignore the crease side. Severe cracking and germ damage are nearly always accompanied by a high degree of skinning. The most common causes for this are:

- Drum speed too high: Use only the slowest drum speed that will effectively thresh the grain from the barley head. A higher drum speed is needed when harvesting crops not properly ripe and can cause serious grain damage.
- An incorrectly adjusted or warped concave: The initial header settings should have the concave set one notch wider than for wheat. Check the setting frequently during the day. If the thresher drum speed is correct, concave adjustments should cope with the changes in temperature and other harvesting conditions met during the day.

The airflow may need to be increased slightly to obtain a clean sample.

The application of heat can also affect germination of grain and this should be taken into account if artificial drying is intended for malting-quality barley. [2]

[1] DAFF (2012) Barley planting, nutrition and harvesting. Department of Agriculture, Fisheries and Forestry Queensland. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

[2] DAFF (2012) Barley planting, nutrition and harvesting. Department of Agriculture, Fisheries and Forestry Queensland. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

12.2 Monitoring grain loss

Monitoring for grain loss should begin before harvest. A seed count on the ground of more than 26 seeds in an area 10 cm by 100 cm means a loss of >100 kg/ha. After checking for any grain on the ground prior to harvest, you should check after you begin harvest to determine any harvest loss. It is recommended that a minimum of 10 counts be taken and averaged. [3]

12.3 Wet harvest issues and management

Because mature barley does not stand weather damage as well as wheat, it is important not to delay harvest. Lodging can be a problem and patches of unripe crop on headlands and low-lying areas should be avoided, as unripe grains can contaminate samples and cause downgrading. [4]

Barley is physiologically mature at 30–50% moisture, which is well before it is ripe enough to harvest mechanically. [5]

When ripe, winter cereals are easy to thresh, and harvest can begin at moisture content as high as 20%, although generally very little is harvested at >18% moisture. If harvested at >12.5% moisture, access to an aeration or drying facility is necessary. (See the following section for more information on storing barley.) [6]

Delayed harvest due to wet weather is common in the northern grain region. These conditions can result in yield losses and downgrades in grain quality, which varies significantly between cereal varieties. Varietal differences in yield loss with delayed harvest can exceed 1.5 t/ha. If growers know which varieties are most susceptible to wet weather, they can potentially make more informed decisions about prioritising harvest by variety.

Trials investigating the impact of a wet weather-delayed harvest on barley yield and quality and the effect of variety have been conducted at Condobolin and Tamworth in New South Wales (NSW) as part of the Variety Specific Agronomy Packages (VSAP) project. Trials at Turretfield and Moyhall in South Australia are part of the Southern Barley Agronomy (SBA) project.

Up to 16 varieties were harvested at two to four harvest dates, beginning at physiological maturity. In many experiments there were significant rainfall (>100 mm) events between the harvest dates (Table 1).

Lodging and head loss were measured at each date and physical tests were conducted on grain samples from each plot. At most sites, differences in variety responses to weather damage were recorded, particularly in the loss of test weight.

Varieties that are susceptible to sprouting and weather damage or that typically have low test weights and therefore should be harvested without delay once mature were identified. Varietal and weather influences on kernel weight, screenings, grain colour, and stirring number (RVA) were also reported. Stirring number indicates pre-harvest sprouting before the visual signs are present.

3 DAFF (2012) Barley planting, nutrition and harvesting. Department of Agriculture, Fisheries and Forestry Queensland. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

4 DAFF (2012) Barley planting, nutrition and harvesting. Department of Agriculture, Fisheries and Forestry Queensland. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

5 DAFF (2012) Barley planting, nutrition and harvesting. Department of Agriculture, Fisheries and Forestry Queensland. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

6 DAFF (2012) Barley planting, nutrition and harvesting. Department of Agriculture, Fisheries and Forestry Queensland. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

Delays in harvest at Tamworth in 2011 from harvest 1 to harvests 2, 3 and 4 resulted in significant average yield losses of 0.38, 0.44 and 0.42 t/ha, respectively, in 12 barley varieties (Figure 1).

The yield penalty from delaying harvest from harvest 1 to 4 varied significantly between varieties. Fitzroy⟮D⟯ and Buloke⟮D⟯ incurred the greatest yield losses (2.2 and 2.1 t/ha, respectively) of the 12 varieties, whereas Roe⟮D⟯, Vlamingh⟮D⟯ and Grout⟮D⟯ (0.5, 0.7 and 0.7 t/ha, respectively) had the smallest losses.

Commander⟮D⟯, Gairdner⟮D⟯, Hindmarsh⟮D⟯ and Shepherd⟮D⟯ all had similar yield losses (average 1.2 t/ha) from delaying harvest at Tamworth by 26 days and experiencing 215 mm of rainfall.

Delaying harvest had a significant effect on all grain quality attributes (Figure 1). The 1000-grain weight was similar for harvests 1 and 2, which were significantly higher (by 1.9 g) than both harvests 3 and 4. Retention significantly increased from harvests 1 and 2 to harvest 3 (96.2 %) before another significant increase for harvest 4 (97%). Retention is the material retained above the 2.5-mm screen.

Screenings were negligible across the four harvest times but did significantly decline from 1.5% for harvest 1 to 0.7% for harvest 4. Test weight significantly declined by 3.1 kg/hL between harvest 1 and 2 before declining a further 2.7 kg/hL for harvests 3 and 4, which were similar.

Grain protein concentration was on average similar for harvest 1 and 2, while harvest 3 and 4 were similar. Protein increased by almost 1% between harvests 2 and 3.

Test weight declined significantly in both the Tamworth and Turretfield trials due to delayed harvest.

The VSAP project (northern region) and the SBA project (southern region) are continuing this year and include 15 wheat varieties. [7]

Table 1: Rainfall received between harvests 1 and 4 at Tamworth Agricultural Institute Farm, 2011

Harvest date	11th Nov	18th Nov	28th Nov	7th Dec	Total rainfall (mm)
Rainfall (mm)		34	109	72	215

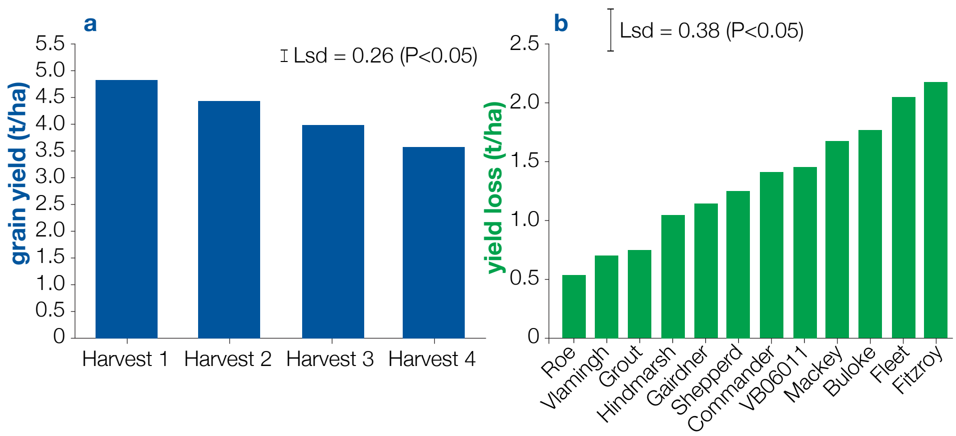

Figure 1: (a) Effect of harvest time on grain yield at Tamworth in 2011 averaged across all varieties, and (b) yield losses (from harvest 1 to hHarvest 4) for 11 barley varieties at Tamworth in 2011.

[7] GRDC (2013) Effect of delayed harvest on barley varieties. Grains Research Update, Northern Region Spring 2013. http://www.icanrural.com.au/newsletters/NL72.pdf

Table 2: Effect of harvest time on grain quality traits, protein, 1000-grain weight, retention, screenings and test weight across 11 barley varieties at Tamworth in 2011. Within a column, values designated with different letters are significantly different (P < 0.05)

Harvest time	Protein (%)	1000 Grain Weight (g)	Retention (%)	Screenings (%)	Test Weight (kg/hL)
Harvest 1	11.5 b	51.7 a	95.2 c	1.5 a	72.0 a
Harvest 2	11.6 b	51.7 a	95.5 c	1.0 b	68.9 b
Harvest 3	12.4 a	49.6 b	96.2 b	0.9 b	66.1 c
Harvest 4	12.4 a	49.6 b	97.0 a	0.7 c	66.3 c
Lsd (P<0.05)	0.2	1.7	0.4	0.1	0.4

12.4 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 higher risk of fires. [8]

More information

NSW Rural Fire Service Farm Firewise page at http://www.rfs.nsw.gov.au/dsp_content.cfm?cat_id=1161

http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-101/A-few-steps-to-preventing-header-fires

Using machinery

To assist in 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 fires. To prevent overheating of tractors, motorcycles, off-road vehicles and other mechanical equipment, all machinery needs to be properly serviced and maintained. Keeping fire-fighting equipment available and maintained is not just common sense—it is a legal requirement.

Take great care when using this equipment outdoors. Tips on machinery include:

- Be extremely careful when using cutters and welders to repair plant equipment including angle grinders, welders and cutting equipment.
- Ensure machinery components including brakes and bearings do not overheat as these components can drop hot metal on to the ground, starting a fire.
- Use machinery correctly, as incorrect usage can cause it to overheat and ignite.
- Be aware that blades of slashers, mowers and similar equipment may hit rocks or metal, causing sparks to ignite dry grass.
- Avoid using machinery during inappropriate weather conditions such as high temperatures, low humidity and windy conditions.
- Do maintenance and repairs in a hazard-free, clean working area such as on bare ground or 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 as well. [9]

The Farm FireWise Checklist and Action Plan can be downloaded here, or you can request one through your local Fire Control Centre.

12.4.1 Steps to preventing header fires

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

[8] NSW Rural Fire Service, Farm Firewise., NSW Government 2014. http://www.rfs.nsw.gov.au/__data/assets/pdf_file/0019/9451/Guide-to-Farm-FireWise.pdf

[9] NSW Rural Fire Service, Farm Firewise, NSW Government, 2014. http://www.rfs.nsw.gov.au/__data/assets/pdf_file/0019/9451/Guide-to-Farm-FireWise.pdf

Figure 2: Keeping headers clean can reduce the risk of fire. (Photo: Rebecca Thyer)

Key points:

- Most harvester fires start in the engine or engine bay.
- Others are caused by failed bearings, brakes and electricals and rock strikes.
- Regular removal of flammable material from the engine bay is urged. [10]

12.5 Receival standards

The minimum protein level acceptable for malt-grade barley is 9%. Malt protein content is reported at 0% moisture (dry), which will be 1–1.5% greater than the 'as is' basis commonly used for feed grain. In line with malting industry standards, Graincorp reports all protein figures at 0% moisture basis. Feedlots generally use the 'as is' figure.

Growers should check receival standards with GrainCorp Australia or their local grain merchant. Specifications are updated each season and include all relevant information. Other purchasers of barley grain may use different specifications. [11]

Most grain purchasers will base their quality requirements on Grain Trade Australia (GTA) standards. For feed barley, grain is required to meet screenings and hectolitre weight specifications. For malting barley, as well as screenings and hectolitre weights, there are requirements for retention (above the 2.5-mm screen) and protein.

Specification sheets are usually available from July each season and include all relevant information. Other purchasers of barley grain may use different specifications. GrainCorp provides a grower harvest information kit, including local contacts, contract options, warehousing conditions, grain-protection strategies and more. [12]

Download the latest barley receival standards from the GTA website: http://www.graintrade.org.au/commodity_standards

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

[11] DAFF (2012) Barley planting, nutrition and harvesting, Department of Agriculture, Fisheries and Forestry Queensland. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

[12] DAFF (2012) Barley planting, nutrition and harvesting. Department of Agriculture, Fisheries and Forestry Queensland. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

12.6 Harvest weed seed control

Targeting weed seeds at harvest is a pre-emptive action against problematic annual weed populations. Our most damaging crop weeds—annual ryegrass, wild radish, wild oats and brome grass—are all capable of establishing large persistent seed-banks. Thus, if annual weeds are freely allowed to produce seed that enters the seed-bank, the inevitable consequences will be an unsustainable cropping system. Fortunately, seed-bank decline is rapid for these weed species with annual seed losses of 60–80%. Consequently, without inputs a very large seed-bank (>1000 seed/m^2) can be reduced to a very modest one (<100 seed/m^2) in just 4 years. A low weed seed-bank allows easier and more effective weed control with a reduced risk for the development of herbicide resistance. Thus, effective weed management in productive cropping systems is reliant on preventing viable seed entering the seed-bank. Towards this end, a number of systems have been developed over the past three decades that target the weed-seed-bearing chaff fraction during harvest. [13]

12.6.1 Intercepting annual weed seed

In Western Australia (WA), where high frequencies of herbicide-resistant annual weed populations (Owen and Powles 2009; Owen *et al.* 2007; Walsh *et al.* 2007) have been driving farming practices for the last decade, techniques targeting weed seeds during harvest have been widely adopted. At crop harvest, high proportions of total seed production for the dominant weed species are retained above harvester cutting height (Table 3). Additionally, for some of these species such as wild radish, high proportions of seed retention are maintained over much of the harvest period (Figure 3). Therefore, the collection and management of the weed-seed-bearing chaff fraction can result in significant reductions in annual weed population densities. Barley is a great crop for this as it is generally harvested low and has a greater chance of seed collection.

Table 3: Proportion of total seed production retained above a low (15cm) harvest cutting height

Species	Seed retention above 15 cm (%)
Annual ryegrass	88
Wild radish	99
Brome grass	73
Wild oats	85

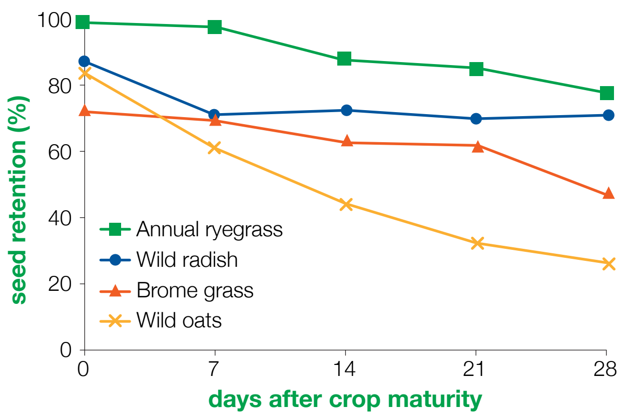

Figure 3: Seed retention above 15 cm harvest height over the first 4 weeks of harvest for the major crop weeds of WA wheat crops.

Lower in-crop weed densities are easier to manage and their potential development as herbicide-resistant populations is dramatically reduced. Farmers in WA have driven the

[13] M Walsh, S Powles (2012) Harvest weed seed control. GRDC Update Papers 12 April, 2012. https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Harvest-weed-seed-control

development of several systems now available that effectively reduce inputs of annual ryegrass, wild radish, wild oats and brome grass into the seed-bank. The adoption of these systems has been critical for the continuation of intensive cropping systems. [14]

Chaff carts

Chaff carts are towed behind headers during harvest with the aim of collecting the chaff fraction as it exits the harvester. The weed-seed collection efficiency of several commercially operating harvesters with attached chaff carts has been evaluated by the *Australian Herbicide Resistance Initiative (*AHRI) and found to collect 75–85% of annual ryegrass seeds and 85–95% of wild radish seeds that entered the front of the header during the harvest operation (Walsh and Powles 2007). Collected chaff must be managed to remove weed seeds from the cropping system. Typically, this material is left in piles in the paddock to be burnt in the following autumn. In some instances, chaff is removed from the paddock and used as a valuable source of feed for livestock. [15]

Baling

An alternative to the *in-situ* burning or grazing of chaff is to bale all chaff and straw material as it exits the harvester. The Bale Direct System developed by the Shields family in Wongan Hills as a means for improving straw hay production consists of a large square baler directly attached to the harvester that collects and bales all harvest residues. A significant secondary benefit is the collection and removal of annual weed seeds. Studies by AHRI determined that approximately 95% of annual ryegrass seed entering the harvester was collected in the bales (Walsh and Powles 2007). In addition to being an effective system for weed-seed removal, the baled material can have a substantial economic value as a feed source. However, as with all baling systems, consideration must be given to nutrient removal. [16]

Windrow burning

Establishing narrow windrows suitable for autumn burning is achieved by attaching chutes to the rear of the harvester to concentrate the straw and chaff residues as they exit the harvester (Walsh and Newman 2007). This concentration of residue effectively increases the seed destruction potential of residue burning. With more fuel in these narrow windrows, the residues burn hotter than standing stubbles or even conventional windrows. Weed-seed kill levels of 99% of both annual ryegrass and wild radish have been recorded from the burning of wheat, canola and lupin stubble windrows. [17]

Chaff grinding

Processing of chaff sufficient to destroy any weed seeds present during the harvest operation represents the ideal system for large-scale Australian conservation-cropping systems. Rendering weed seeds non-viable as they exit the harvester removes the need to collect, handle and/or burn large volumes of chaff and straw residues. Due to the importance and potential industry benefits of this process, there has been substantial interest in the development of an effective system. Darkan farmer Ray Harrington has developed the Harrington Seed Destructor (HSD), a cage-mill-based system attached to the harvester that processes chaff during harvest. Evaluation of this system under commercial harvest conditions by AHRI over the past four seasons has determined the HSD will destroy at least 95% of annual weed seed during harvest. With the efficacy

14 M Walsh, S Powles (2012) Harvest weed seed control. GRDC Update Papers 12 April 2012. https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Harvest-weed-seed-control

15 M Walsh, S Powles (2012) Harvest weed seed control. GRDC Update Papers 12 April 2012. https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Harvest-weed-seed-control

16 M Walsh, S Powles (2012) Harvest weed seed control. GRDC Update Papers 12 April 2012. https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Harvest-weed-seed-control

17 M Walsh, S Powles (2012) Harvest weed seed control. GRDC Update Papers 12 April 2012. https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Harvest-weed-seed-control

A 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

of this system now well established, the development of the HSD system is now progressing towards commercial production. [18]

Summary

Productive, large-scale conservation cropping as practiced across large areas of the Australian grain-belt is reliant on herbicides for the management of weed populations. This reliance has produced, and continues to produce, widespread occurrence of herbicide-resistant weed populations. Herbicide dependency and resulting loss of effective herbicides is constraining effective grain-crop production. Consequently, producers are farming to control weeds instead of for grain crop production.
Harvest weed-seed control provides the opportunity to more effectively manage weed populations and move away from the reliance on herbicidal weed control. The consequence of this is that growers regain flexibility in the overall management of their cropping program. [19]

12.6.2 Harvest weed seed management in the northern grains region

A survey across 1400 transects in 70 paddocks assessed the weed distribution, density and seed production at harvest time in wheat, chickpea and sorghum crops in four cropping zones of the northern grain region. In brief, 70 weed species were identified, of which 12 were found in 7–45 paddocks. The survey identified value in investigating harvest weed seed management options, including the HSD, to greatly reduce seed-bank replenishment of problem weeds.

Background

The 2011–12 survey was a joint effort between Department of Agriculture, fisheries and Forestry Queensland (DAFF), Queensland Alliance for Agriculture and Food Innovation (QAAFI) and AHRI. [20]

The focus of this project was to identify the potential for harvest weed-seed management in the northern grain region of northern NSW, southern and central Queensland.

At present, harvest weed seed management is not practiced as a weed control option in the northern crop production regions. The potential for this approach has not been evaluated in the summer or winter cropping systems across these regions. To address this situation, surveys were conducted in northern NSW, and southern and central Queensland summer and winter crop-production zones.

The approach was to identify weed species with upright, seed-bearing plant parts that will potentially be collected during the harvest of the dominant crops of these regions. These surveys provide a comprehensive set of data allowing the accurate determination of the potential for successful use of at-harvest weed-seed management systems for the northern region.

Approach

A random survey was conducted on 70 paddocks of wheat, chickpea and sorghum in the four main cropping zones of the northern grain region (Table 4). Within each paddock 20 transects of 10 m^2 (1 m by 10 m) were selected using a zigzag pattern to be representative of weed infestations across the paddock, the same protocol as used in previous published northern region weed surveys.

The following measurements were made in each transect:

More information

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Harvest-weed-seed-control

For further analysis of harvest weed seed management for the northern region, visit http://www.weedsmart.org.au/giving-a-rats/is-harvest-weed-seed-management-a-goer-north-of-dubbo/

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/What-percent-of-northern-weed-seed-might-it-be-possible-to-capture-and-remove-at-harvest-time-A-scoping-study

http://www.grdc.com.au/MR-HarvestWeedSeedControl

http://www.agronomo.com.au/storage/newsletters/05-Winter-2013.pdf

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Windrow-burning-for-weed-control-WA-fad-or-viable-option-for-the-east

View the Grain Orana Alliance video at http://www.youtube.com/watch?v=vfpvscKiZd8.

[18] M Walsh, S Powles (2012) Harvest weed seed control. GRDC Update Papers 12 April 2012. https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Harvest-weed-seed-control

[19] M Walsh, S Powles (2012) Harvest weed seed control. GRDC Update Papers 12 April 2012. https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Harvest-weed-seed-control

[20] S Walker, M Widderick (2013) Queensland, Weed seed management at harvest. Northern Grower Alliance. http://www.nga.org.au/results-and-publications/download/146/general-uploads/weed-seed-management-at-harvest-nga.pdf

- weed species present
- density of weed species using the rating scale (plants/10 m^2): 1, 1–9; 2, 10–49; 2.5, 50–100; and 3, >100
- visual estimation of percentage of each species seeding

For every species seeding, three representative samples were collected from each paddock and the following measurements made:

- visual estimation of percentage of seeds or seed heads above potential harvest height (nominated as 5 cm for chickpea, 15 cm for wheat and 30 cm for sorghum)
- visual estimation of percentage total seed retained at time of sampling
- number of seeds or seed heads (and number of seeds in five representative seed heads) per plant above harvest height
- total seed production, number of seed retained and potential for harvest management (rated as percentage)

Table 4: Extent of northern region weed seed at harvest survey

Region and crop	Number of paddocks	Number of species present at harvest	Number of species retaining seed at harvest
Central Highlands, QLD			
Chickpea	5	8	6
Wheat	5	5	4
Sorghum	10	12	11
Darling Downs, QLD			
Chickpea	5	11	7
Wheat	5	12	10
Sorghum	10	15	11
South-west Down, QLD			
Chickpea	5	15	11
Wheat	5	8	3
Sorghum	10	25	19
Liverpool Plains, NSW			
Chickpea	5	22	16
Wheat	5	18	12
Sorghum	-	-	-
TOTAL	**70**	**70**	

Results

The weed flora was very diverse with 70 different species found, with 37 species in chickpea crops, 33 in wheat, and 38 in sorghum (see Table 5). Of the 15 species found in both winter and summer crops,70% had seed retained at harvest time.

Twelve weed species were commonly found across the cropping zones and crops in 7–45 paddocks (see Table 5). The most prevalent were the weeds with wind-blown seed—sowthistle and fleabane. There were three common grasses—barnyard grass, wild oat and feathertop Rhodes grass; three brassicas—turnip weed, mustard and African turnip weed; plus five other broadleaf weeds—bladder ketmia, pigweed, native jute, Australian bindweed and wild gooseberry. Caustic weed was also present in 10 paddocks but not seeding.

For sowthistle and fleabane, a substantial number of seeds had already dropped from the plants, particularly for sowthistle in chickpea and fleabane in sorghum. However, many seeds remained on the plants, ranging from 770 to 14,660 seeds/plant for sowthistle and from 4885 to 46,255 seeds/plant for fleabane, the majority of which were above the potential harvest height. Thus, these weeds are a priority for harvest weed-seed management.

Barnyard grass was the third most prevalent weed with a substantial number of seeds remaining in all three crops, although there were more seeds dropped in sorghum (3520–4350) than winter crops (0–200). A substantial portion of feathertop Rhodes grass seed had dropped in chickpea (370–9905) and sorghum (0–21,940), although large numbers remained on the plant above harvest height.

Several hundred seeds remained on wild oat in wheat (155–294) and chickpea (180–220) but a large portion of wild oat seed had already dropped in wheat paddocks.

The brassica weeds produced substantial numbers of seeds in chickpea (150–112,075) but much less in wheat (0–995). The majority of the seeds were above the potential harvest height, and thus these weeds are a priority for harvest weed-seed management.

For bladder ketmia, pigweed, native jute, Australian bindweed and wild gooseberry, these had either no seed above harvest height or small numbers, except for wild gooseberry in sorghum with 11,625 seed remaining.

Some less-common weeds identified with large seed production above potential harvest height were:

- cudweed (2500–22,645 seeds)
- climbing buckwheat/bindweed (1400–9420 seeds)
- dock (30,060)
- mallow (6765 seeds)
- malvastrum (1115)
- Mexican poppy (15970)
- New Zealand spinach (1125)
- paradoxa grass (1040)
- sida (1725)
- St Barnaby's thistle (11,045)
- stink grass (18995)
- sweet summer grass (1660)
- wild sunflower (2750)
- windmill grass (6225 seeds)
- wireweed (820–4000 seeds)

Annual ryegrass and barley grass were only found in one paddock in the Liverpool Plains region.

Ryegrass is the most commonly seed collected species in the southern part of the region.

Table 5: The most common weed species seeding at harvest time in wheat, chickpea and sorghum, and data on seed loss, seed remaining and percentage of remaining seed above potential harvest height (averaged across each of 4 cropping zones) for each species. Seed data for each species are listed in order of wheat, chickpea and sorghum

Weed	Scientific name	Number of paddocks infested	Number of paddocks seeding	Seeds dropped per plant	Seeds remaining per plant	% above harvest height
Sowthistle	*Sonchus oleraceus*	45	38	150-10,150	770-2040	80-100
				2010-18,680	4470-14,660	100
				1290-3750	1070-8690	65-85
Fleabane	*Conyza bonariensis*	28	17	0-3180	4885-13,950	40-100
				0-14,230	17,790-46,255	90-100
				30,210-130,060	28,710-33,430	55-60

Weed	Scientific name	Number of paddocks infested	Number of paddocks seeding	Seeds dropped per plant	Seeds remaining per plant	% above harvest height
Barnyard grass	*Echinochloa spp*	20	17	200 0 3250-4350	3585 2865 730-14,040	100 60 20-25
Bladder ketmia	*Hibiscus trionum*	19	15	10 - 55-325	45 - 175-215	25 0 30-100
Wild oat	*Avena spp*	14	13	55-195 8-24 -	155-295 180-220 -	100 100 -
Turnip weed	*Raphanus raphanistrum*	10	9	- 0 25	- 150-28,170 455	0 95-100 20
African turnip weed / mustard	*Sisymbrium spp*	9	8	0 0 -	995 33,130-112,075 -	100 100 -
Pigweed	*Portulaca oleracea*	8	3			0 0 0
Native jute	*Corchorus capsularis*	8	6			0 0 0
Australian bindweed	*Convolvulus erubescens*	7	3	0	320	0 0-80 0
Feathertop Rhodes grass	*Chloris virgata*	7	7	- 370-9905 0-21,940	- 2485-11,610 13,640-31,040	0 100 60-75
Wild gooseberry	*Physalis minima*	7	5	- - 210	- - 11,625	- - 15

Implications

This survey has shown there is a clear and urgent need for growers to manage weeds better to prevent large annual replenishments of the seed-bank. A potential tactic is to use one of the harvest weed-seed management options, such as the HSD. These could be useful to greatly improve management of many weeds, particularly the summer and winter grasses, brassica weeds, some climbing weeds, and possibly sowthistle and fleabane if the technique is capable of capturing and destroying wind-blown seeds. [21]

[21] S Walker, M Widderick (2013) Weed seed management at harvest, Northern Grower Alliance. http://www.nga.org.au/results-and-publications/download/146/general-uploads/weed-seed-management-at-harvest-nga.pdf