

Western Australian agronomic research and development for resistance management

Michael Walsh

Western Australia Herbicide Resistance Initiative, Faculty of Natural and Agricultural Sciences,
University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009, Australia
mwalsh@agric.uwa.edu.au

Summary The continuing development and spread of herbicide resistant populations of major weed species is driving the development of alternate weed control practices. The emphasis on min-till and stubble management procedures as part of intensive cropping systems in Western Australia is driving the requirement for these additional weed control techniques. Adoption of delayed seeding and increased seeding rate practices is helping to reduce the reliance on in-crop selective herbicides. However, neither technique is without problems or limitations. Weed seed collection and removal/destruction at harvest is a very effective technique for reducing weed seedbank inputs. The adoption by WA farmers of the current limited technology is clear evidence of the value of this weed control method. With the continuing research and development effort it is likely that significant advances will be made in this area of weed control over the short-term.

Keywords Weed seed collection, chaff cart, annual ryegrass, wild radish.

INTRODUCTION

In Western Australian dryland cropping systems, herbicides dominate as the preferred weed control technique. Herbicides fit particularly well with the stubble retention and no-till farming systems, which dominate crop production enterprises across this region. However, there is now widespread resistance to crop selective herbicides with very high frequencies of resistant annual ryegrass (*Lolium rigidum*) (Llewellyn and Powles 2001) and wild radish (*Raphanus raphanistrum*) (Walsh *et al.* 2001) populations. The widespread occurrence of resistant populations of these weeds and the desire of farmers to continue intensive crop production systems has driven the need to develop alternate weed control practices.

Delayed seeding and increased seeding rates Delayed seeding and increased seeding rates have been widely adopted by Western Australian crop producers as a means of reducing early season crop competition with dominant weed species. Delayed seeding allows pre-seeding weed control using non-selective herbicides such as glyphosate and paraquat. Although effective in controlling the initial emergence of weeds

following the break of the season there are subsequent yield penalties associated with delayed seeding (Anderson and Sawkins 1997). The increased reliance on non-selective herbicides is now causing some concerns. In particular there has been an increased reliance on glyphosate and cases of resistance to this herbicide are now being documented (Powles *et al.* 1998, Pratley *et al.* 1999). With the first confirmed glyphosate resistance case in W.A. (Neve *et al.* unpublished) there is a real concern of the widespread development of glyphosate resistance. Increased crop seeding rates have been demonstrated across many regions of the Western Australian wheatbelt as a means of reducing the impact of weed populations (Peltzer 1999, Minkey 2002). Consequently, elevated seeding rates for wheat crops in particular are now a standard practice by western Australian crop producers. However, despite the efficacy of higher seeding rates and pre-seeding weed control with non-selective herbicides these practices alone or combined do not adequately control weed populations. Therefore, there remains the need to develop additional weed management procedures for Western Australian cropping.

Collection and destruction/removal of weed seeds during the harvest operation The targeting of weed seeds during the harvest operation has been proven as a highly effective means of reducing weed seedbanks. Several studies have identified the potential for collecting and removing the seed of annual weed species during the harvest operation (Fogelfors 1982, Gill and Holmes 1997, Matthews *et al.* 1996, Shirliff *et al.* 2000, Walsh 1996). The two most problematic weed species of Western Australian, cropping, annual ryegrass and wild radish, produce mature non-shattering weed seeds on erect seed heads coinciding with crop maturity. Consequently, many of these weed seeds are collected by and pass through the harvester during the harvest operation. Usually these weed seeds are subsequently distributed across the paddock in either the chaff or straw residue fractions. However, there is an opportunity to collect and remove weed seeds as they pass through the harvester thereby preventing them from entering the seedbank. One method that has

been adopted on Western Australian farms is the use of chaff carts. These carts are attached to headers with the aim of collecting all chaff material as it exits the harvester. This fraction of the harvest residue contains the greatest proportion of weed seed. For example it has been estimated that up to 95% of ryegrass seed that enters the harvester exits in the chaff fraction (Walsh and Parker 2002).

Annual ryegrass seed collection by chaff carts Harvesters with attached chaff carts were evaluated in wheat crops in Western Australia in 1999 to determine the efficacy of chaff carts in the collection and removal of ryegrass seed. Annual ryegrass seed collection efficiency, was determined on four commercially operating harvesters in wheat crops with areas of naturally occurring ryegrass infestations. It was determined that 70–80% of annual ryegrass seed entering these harvesters was collected and removed during the harvest operation (Walsh and Parker 2002). However, there was considerable seed shedding prior to harvest thus the proportion of the total annual ryegrass seed production that was collected and removed by these harvesters and chaff carts was less than 50%. The proportion of ryegrass seed that has already shed at the time of harvest is obviously variable dependant on seasonal events.

Wild radish seed collection by chaff carts The proportion of wild radish seed that can be removed during the harvest operation is much higher than that for annual ryegrass. In studies conducted during the 2001 harvest there was almost complete collection and removal of wild radish seed that entered the harvester during the harvest operation (Walsh and Parker 2002). Seed were primarily collected in the grain sample (75%) but there was also a significant proportion collected in the chaff fraction (20%). Overall, when a chaff cart was attached 95% of the wild radish seed that entered the header was collected and removed during harvest.

Baling of chaff material An alternative to the *in situ* burning or grazing of chaff heaps is to bale all the chaff and straw material produced by the harvest operation. Baling allows for the collected straw and chaff material, as well as the weed seeds they contain, to be easily collected and transported from paddocks. Currently in WA the opportunity exists for this material to be used as a livestock feed source. There are two methods being used by farmers to bale the chaff and straw. The first uses the 'Chafftop' which is a device attached to the back of the harvester that collects the chaff material exiting the harvester and deposits it on

top of the straw windrow. The placement of the chaff material on the top of the windrow is the reverse to the conventional system and increases the potential for chaff material to be collected during a subsequent baling operation. These windrows are then baled at some stage after the completion of harvest using a conventional baling system. The second option is to direct all chaff and straw material into a trailing baler that is attached to and driven by the harvester. This system potentially increases the amount of baled material and can improve the efficiency of weed seed collection by avoiding the deposition and subsequent collection of a windrow. Both systems allow for the removal of weed seeds in baled material that also has an economic value.

Destruction of chaff material during harvest The logistics of trying to handle the vast quantities of chaff material produced during the harvest operation has instigated the concept of treating this chaff material to control the weeds seeds contained within it as part of the harvest operation. In excess of 100 m³ h⁻¹ of chaff material is produced during the harvest of a typical wheat crop grown in a Western Australian dryland cropping system. There are enormous difficulties in collecting and handling this material and there is little doubt that this has restricted adoption of the chaff cart technology. An alternative is the processing of the chaff material sufficient to destroy the weed seeds as it exits the harvester. Damaging weed seeds either physically or chemically during the harvest operation to prevent subsequent germination removes the need to collect and handle large volumes of chaff material. Although there is limited research in this area a study conducted in Oklahoma indicated that hammer mills and roller mills could be used to control cheat (*Bromus secalinus*) seed during harvest (Gossen *et al.* 1998). Harvestaire®, a Western Australian agricultural engineering company, has been pursuing this idea in the current development of their 'Rotomill'. This device can be mounted beneath an extension of the top sieve at the rear of the harvester. Chaff material would be processed by the 'Rotomill', sufficient to destroy any weed seeds, as it exits the harvester. Another innovative idea is the development of a system for treating chaff material with harvester engine exhaust gases. This research is being pursued by Dr. John Matthews, University of Adelaide, where exhaust gases from the harvester motor are being used to sterilise weed seeds in the chaff fraction. Due to the increasing interest in this area of weed seed control it is likely that these and other options, if commercialised, would be very popular amongst Western Australian crop producers.

Summer weed seed control Stubble retention and the reduction in livestock grazing of stubbles have combined to create a situation where weed seeds now remain on or close to the soil surface. Weed seeds remain relatively undisturbed on the soil surface during the hot, dry summer-autumn months from December to April. The combination of huge fields (400+ ha), flat terrain and weed seed on the surface over summer presents an opportunity to implement physical weed seed control practices, notwithstanding the logistical problems such as large energy requirements, specialised engineering and costs. Thus there appears to be an opportunity for, a much needed, new weed control practice to be developed for this particular situation. At this stage there is no 'close-to-market' technology available in this potential area of weed control. However, preliminary studies have identified the potential for late-summer early-autumn herbicide applications prior to the commencement of the growing season (Walsh *et al.* unpublished data). Certain residual herbicides applied during this period before the season opening rains have retained activity to control ryegrass seedlings emerging up to two months later. A significant advantage of this new weed control option is that crop seeding can commence immediately following the season commencing rainfall events.

ACKNOWLEDGMENTS

WAHRI is funded the Grains Research and Development Corporation.

REFERENCES

- Anderson, W.K. and Sawkins, D. (1997). Production practices for improved grain yield and quality of soft wheats in Western Australia. *Australian Journal of Experimental Agriculture* 37, 173-180.
- Fogelfors, H. (1982). Collection of chaff, awns and straw when combining and its influence on the seed bank and the composition of the weed flora, Vol. Weeds and Weed Control. 23rd Swedish Weed Conference, Sveriges Lantbruksuniversitet, Uppsala, Sweden.
- Gill, G.S. and Holmes, J.E. (1997). Efficacy of cultural control methods for combating herbicide-resistant *Lolium rigidum*. *Pesticide Science* 51, 352-358.
- Gossen, R.R.S., Tyril, R.J., Hauhouot, M., Peeper, T.F., Claypool, P.L. and Solie, J.B. (1998). Effects of mechanical damage on cheat (*Bromus secalinus*) caryopsis anatomy and germination. *Weed Science* 46, 249-257.
- Llewellyn, R.S. and Powles, S.B. (2001). High levels of herbicide resistance in rigid ryegrass (*Lolium rigidum*) in the wheat belt of Western Australia. *Weed Technology* 15, 242-248.
- Mathews, J.M., Llewellyn, R., Powles, S., Reeves, T. and Jaeschke, R. (1996). Seed catching: a method to control annual weeds, ed. M. Asghar. 8th Australian Agronomy Conference, University of Southern Queensland, Toowoomba, Queensland, Australia.
- Minkey, D. (2002). Seeding rate, row spacing and herbicides for weed control. Agribusiness Crop Updates, Australia, Department of Agriculture, Western Australia, pp. 21.
- Peltzer, S. (1999). Increased crop density reduces weed seed production without increasing screenings. 12th Australian Weeds Conference, pp. 510.
- Powles, S.B., Lorraine-Colwill, D., Dellow, J. and Preston, C. (1998). Evolved resistance to glyphosate in rigid ryegrass (*Lolium rigidum*) in Australia. *Weed Science* 46, 604-607.
- Pratley, J., Urwin, N., Stanton, R., Baines, P., Broster, J., Cullis, K., Schafer, D., Bohn, J. and Krueger, R. (1999). Resistance to glyphosate in *Lolium rigidum*. I. Bioevaluation. *Weed Science* 47, 405-411.
- Shirliffe, S.J., Entz, M.H. and Van Acker, R.C. (2000). *Avena fatua* development and seed shatter as related to thermal time. *Weed Science* 48, 555-560.
- Walsh, M.J. (1996). Effectiveness of seed collection systems collecting ryegrass seed, ed. M. Asghar. 8th Australian Agronomy Conference, University of Southern Queensland, Toowoomba, Queensland, Australia.
- Walsh, M.J. and Parker, W. (2002). Wild radish and ryegrass seed collection at harvest: Chaff carts and other devices. Agribusiness Crop Updates, Australia, Department of Agriculture, Western Australia, pp. 37.
- Walsh, M.J., Duane, R.D. and Powles, S.B. (2001). High frequency of chlorsulfuron-resistant wild radish (*Raphanus raphanistrum*) populations across the Western Australian wheatbelt. *Weed Technology* 15, 199-203.