Windmill grass, (*Chloris Truncata)* the current state of play.

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Key words

Windmill Grass, *Chloris Truncata*, glyphosate resistance, summer fallow, weed control, double knock

GRDC code

Take home message

- Windmill grass has been confirmed as glyphosate resistant
- Windmill Grass is quickly becoming one of the central regions most problematic weeds in zero tillage, summer fallows
- Some effective herbicide control options identified with “Double Knocking” the key to success

Background

Chloris Trucata, commonly known as windmill grass (WG) and sometimes referred to as umbrella grass or blowaway grass is one of 14 Chloris species in Australia, 9 of which occur in NSW (Wheeler, 1982). It is the authors’ observation that Windmill grass has increased its prominence in cropping paddocks rapidly over the last 4-5 years especially in zero tillage systems. However it is a species that has been present in the local area for more than 15years (Street unpublished).

Past trial work in Western Australia has shown that it can cause yield penalties of 0.3 t/ha in wheat where left uncontrolled (Borger, 2009). Anecdotally in the Central West NSW it has in severe cases resulted in yield penalties of over 50% (perrs. Com).

As a weed WG has shown to be very difficult to control in zero tillage systems with herbicides. As such it challenges these systems and threatens to see a need for cultivation to control it. This could jeopardise or at least reduce many of the gains that zero tillage systems have offered.

Very little trial work is available in the control options for WG, most of which is summarised below. Grain Orana Alliance has recently undertaken the task of seeking out answers to control WG in summer fallows. The findings of such work to date is summarised below.

However to add a further dimension to the challenges of controlling such a weed at least one population has been recently identified as resistant to glyphosate. This adds it to a list of other problematic grass weeds of summer fallows of barnyard grass and liverseed grass (Preston 2010).

Why is it a problem?

Farming systems in the Central West Region have continued to evolve over the last decade. The general trend has been a reduction in tillage or complete removal of it. During the last 4-5 years we have seen a shift to also removing grazing stock from cropping paddocks as well. This has meant that many paddocks are completely reliant on glyphosate based herbicide applications for summer weed control.

As will be discussed later WG in many cases is quite tolerant of glyphosate and our current commonly used tank mix partners have no efficacy on grass weeds. Windmill grass has therefore been able to thrive in an environment devoid of effective control measures or even some level of competition. The identification of glyphosate resistance also question if the increase in WG populations is not going completely unchecked in some situations.

It has been assumed that the impact WG has on subsequent crop growth has primarily been through summer moisture use. Observations of GOA's recent trial work highlights this is possibly not the only mode through which it effects crop performance.

Following two separate herbicide trials in 2009-2010 deep soil tests (60cm) were taken in plots where good control was achieved (>95%) and in untreated plots. These showed where WG was not controlled there was a range of reduction in available N of 43-60% indicating possible nitrogen influences (Street, unpublished).

Following these trials, one site was sown to canola and the other site to lupins. The cropping period of 2010 was very wet and at many times the paddocks bordered on waterlogged. Despite this severe crop biomass reductions were evident in both crops but plant establishment and populations appeared unaffected. The lupins appeared to nodulate to an acceptable level so it would be thought that the reduced soil N would have had limited effects in comparison to the canola crop.

Considering that moisture was at excess for much of the growing season, the author is questioning if there is not some other pathways through which WG also affects crop performance.

Controlling the problem

Current registrations

Current herbicide registrations for control of Windmill grass in summer fallow are limited to Touchdown Hi Tech (500gm/ lt Glyphosate). No other formulations of glyphosate are registered to control this weed.

There are only two other products registered for selective control of this weed in various situations as listed in the table below.

Product Name	Active Ingredient	Use situation
Factor™	250g/lt Butoxydim	Various summer crops- e.g. mungbeans, cotton, sunflowers
Dacthal 900™	900g/lt Chlorthal-Dimethyl	Various brassica and vegetable crops, cotton, lucerne and lawns

Table 1 Registered herbicide for Windmill or *Chloris sp*. Control

Source; (www.pestgennie.com.au 2011)

Therefore there are few registered control options. Touchdown Hi-Tech seems a suitable option for WG grass control in fallow but practical experience in the GOA region is indicating that it is not effective even in susceptible populations.

Previous work-

Previous trial work in controlling this weed is also quite limited.

Stewart, 2002 undertook one trial in Western Australia investigating control with 26 different herbicide options. This work showed that Touchdown Broadacre Tm (TD- BA) offered ~96% control but another formulation of a Group M herbicide at comparable use rates only controlled 10% at 52 days after application (DAA). A group M herbicide @ 2lt/ha followed by a double knock of Sprayseed Tm offered moderate improvement in control (61% control @ 52 DAA). A point to note is that this work was carried out with TD-BA the currently commercially available formulation is Touchdown Hitech (TDHT). TDHT still retains the registration for control of WG but the formulation is different and the author is unsure if this change would affect the efficacy.

Further work by Borger, Reithmuller and Hashem (2008-09) showed seedlings were readily controlled by non selective herbicides- Group M or Group L in glasshouse conditions. However no tested treatments showed effective control when applied to mature plants in glasshouse conditions. A field trial conducted showed very conflicting results, in this trial all the Group M herbicide treatments were effective.

Borger et al (2008-2009) suggested this demonstrated windmill grass' ability to recover from herbicide damage when in the presence of adequate water and fertiliser as experienced in the glasshouse trial. The external field trial had no significant rainfall post application and as such weeds were not able to recover from the herbicide application.

A Group A herbicide alone or Group M herbicide followed by a double knock also offered good control (~73% & ~90% respectively).

Northern Grower Alliance (NGA) conducted one trial on WG control in 2009/10. The best treatment in this trial showed a maximum of 96% control with a Group M herbicide at a very high rate. Group M herbicides at lower rates however only offered suppression (~80-85% control) at best as did Group A followed by a double knock of paraquat (NGA unpublished).

Other treatments incorporating a double knock of paraquat but not performing well enough to consider as control options showed marked improvement. This was particularly true with all the group A products tested but a Group M at a high rate was also improved by double knocking.

In summary, Stewart's, Borger's et al. and NGA work showed some conflicting results by way of control of WG by group M formulation but all showed value in double knock strategies. Borger et al and NGA demonstrated that group A herbicides may have some fit in the control of WG, NGA demonstrated that double knocking maybe the key to success. Borger et al also suggests that follow on conditions post spraying will have significant impact on final control.

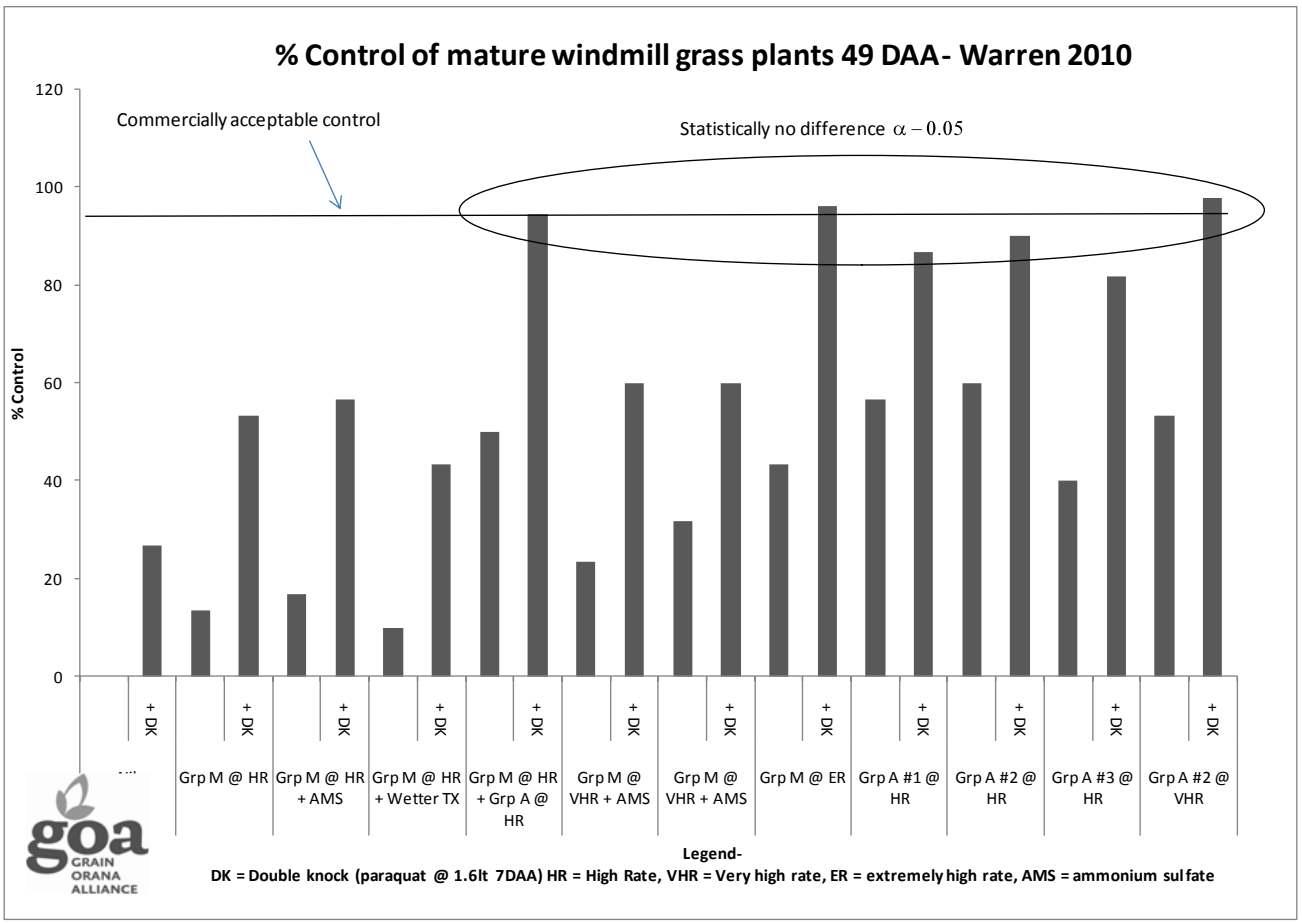
Current trial work

Grain Orana Alliance (GOA) established 3 trial sites in 2009/10 looking at control of WG. There were two main aspects

1. Assessing various herbicides for control of WG
2. Effect herbicide application timing has upon efficacy.

The first site was sprayed in October 2009 after 25mm of rainfall after an extended dry period. This trial although initially demonstrating good control by a number of treatments saw most plants reshoot after significant rainfall between the 25th of December and 1st of January (~125mm). Initially this trial did demonstrate the value in double knocking with paraquat showing in most treatments a least a two fold increase in control. However the final control of all treatments was still poor and well below what would be considered acceptable.

A second site for this trial was established on the 5th of January 2010 following significant rainfall in late 2009. The summary of the results of this trial is shown in Graph 1 below.

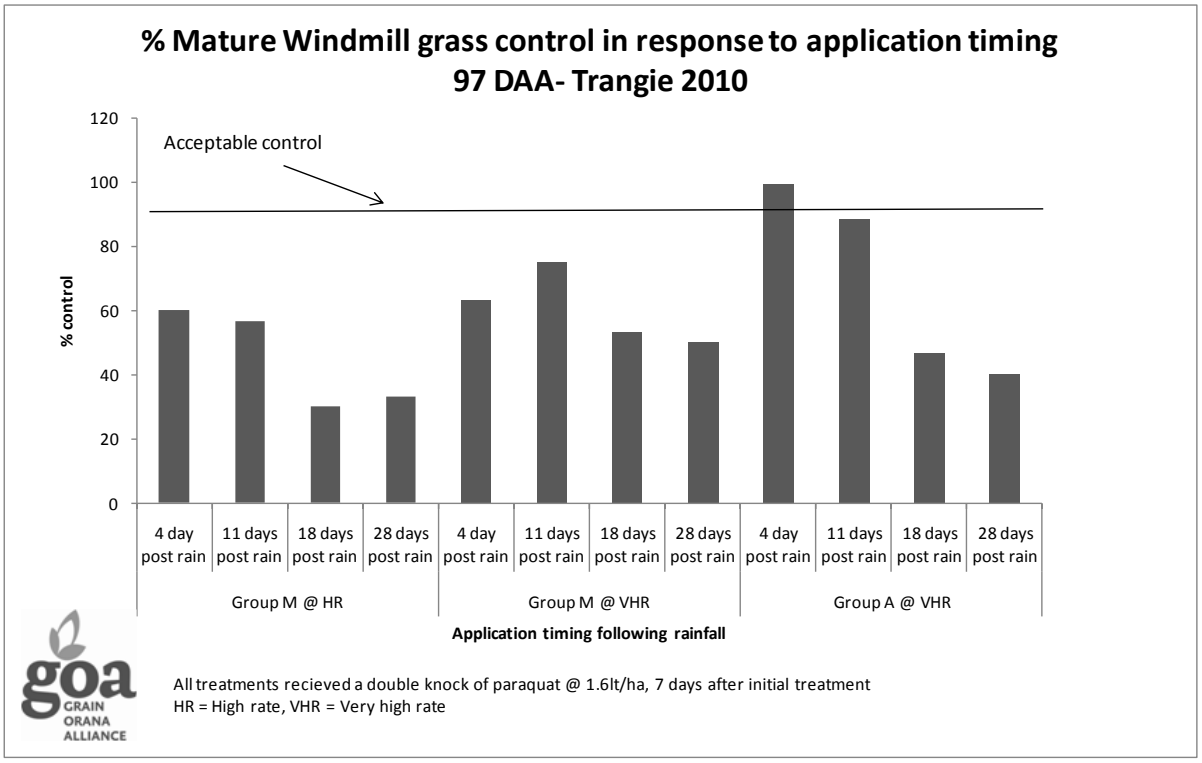


Graph 1 Control of mature Windmill grass plants by various herbicide treatments at 49DAA- Source; GOA

It is demonstrated that the addition of a double knock (+DK) to any of the above treatments has significantly increased the level of control of the mature WG plants. Despite this none of the group M treatments with the exception of the extreme rate (ER) have not reached acceptable control levels. It is also demonstrated that group A herbicides with double knocking treatments have performed well, a number of products actually achieving commercially acceptable control.

A third trial site was also established on the 5th of January 2010. This trial site aimed to investigate the effect delayed application had on herbicide efficacy. Three treatments were applied at 4 different timings. Two rates of Group M herbicide (HR- high rate, and VHR- very high rate) and a very high rate (VHR) of a Group A were applied to separate plots, each was

followed by a double knock at 7 days after initial treatment. The delayed treatments aimed to mimic delaying of applications where the plants would come under increasing moisture stress (no rainfall was received within the treatment period). The results are shown in graph 2.



Graph 2 Mature windmill grass control in response to delayed herbicide application at 97 DAA. Source; GOA

The results suggest that regardless of the product choice, control drops off sharply between 11-18 days post rainfall. In the case of the group M herbicides an already poor level of control is lessened further. In the case of the VHR of the group A, the first two timings either exceed what is considered acceptable control or performed close to. However with the further delay, control levels rapidly become un-acceptable. While not shown seedling control followed very similar trends.

GOA has established in late 2010 five more trial protocols investigating herbicide control of windmill grass. The main targets of these trials are

- Further investigation of Group A herbicides for controlling WG
- Comparing four current and common formulations of glyphosate
- Further validation of the effect moisture stress has on herbicide efficacy
- Investigation into the ideal timing of the double knock application
- Residual herbicides for control of WG

Data for these trials was not available at the time of writing.

To summarise our current understanding of herbicide control of WG

- Moisture stress and availability both at spraying and post spraying seems to affect control. Good moisture is needed at spraying (Street unpublished) but dry conditions following may improve final kill (Borger et al, 2009)
- Glyphosate formulation may impact upon control (Stewart, 2002)
- Group A herbicides show good promise (Street unpublished, Borger et al, 2009, NGA unpublished)
- Double knock tactics have offered increased control in some trials offering the best performance (Street unpublished. Borger et al, 2009).

Herbicide resistance/ Herbicide tolerance

As part of GOA's investigation into WG management it sampled a number of WG populations for herbicide resistance testing. From these sampled populations there was one confirmed case of resistant and a second sample as low level resistance to Touchdown herbicide.

This unfortunately ranks WG with other summer grass species such as Barnyard Grass and Liverseed grass as glyphosate resistant. This status significantly disadvantages managers in controlling weeds in fallows for moisture conservation.

Both Liverseed and Barnyard Grass are prolific seeders as is WG and are able to produce up to 110,000 seeds per plant. However with WG, the seed head actually breaks from the plant and is readily carried by wind some distances. This readily disperses what could be potentially resistant WG seeds over large areas and great distances.

It is the authors' opinion that this will make containment of resistant populations much more difficult for land managers than it is for Barnyard or Liverseed Grass. It will also mean that ensuring WG that has developed resistance elsewhere does not establish on your farm almost impossible no matter how diligent you are with your herbicide resistance management.

Summary

WG although most likely present for some time has emerged recently as a major threat to efficiencies of zero till systems most likely as a result in evolution of just that system. The removal from the system of all other control methods other than herbicides has favoured its survival and proliferation. The use of herbicides which are generally not effective has seen the weed infest paddocks at an ever increasing rate and the recent identification of glyphosate resistance adds further to the difficulties of control.

Research into this problem has been limited with some conflicting data. Common outcomes are:

- Final control is related to moisture availability before, during and after spraying.
- Double knock treatments can increase effectiveness
- Group A herbicides appear promising for control but are unregistered for such use patterns

Further work by GOA in 2011 will hopefully compare glyphosate formulations as well as a number of other aspects important in herbicide control of WG.

The recent identification of glyphosate resistance in WG and the problems that it proving to growers has seen the weed attracting attention of such bodies as the Australian Glyphosate Sustainability Working group and other researchers like DEEDI and I & I NSW. It has been

recently identified to GRDC as one of the 5 major weeds in the northern cropping region. As such we will see an increased focus on developing our understanding and controlling this problem weed both locally and from a national perspective.

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