Evaluating herbicide tolerance with new crop varieties

Summary
New and improved varieties of all major crop species are continually being developed and released for grower use. It is not uncommon, however, for new varieties to be sensitive to herbicides that are safe on current varieties. In such cases, growers may lose yield if they grow the newer variety. This project aimed to identify, document and publicise any such sensitivities.

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Conclusions

- Application of phenoxy\# herbicides at or before double ridge stage of ear development caused differential ear head deformities across all wheat varieties. In trials conducted during 2000, the seed yield was affected only at Wongan Hills. Visual head distortion symptoms caused by phenoxy herbicides do not appear to be a good indicator of yield penalty. Brookton\(\text{TM}\) and Calingiri\(\text{TM}\) showed more sensitivity to phenoxy herbicides than other varieties under late sown and moisture stress conditions at Wongan Hills. Westonia\(\text{TM}\) and Karlgarin\(\text{TM}\), with lower head deformities and no yield reduction, seem to be more tolerant to phenoxy herbicides.

- Dicamba\# or phenoxy herbicides caused phytotoxicity to moisture stressed wheat varieties and Treflan\textregistered\#, Stomp\textregistered\# and Glean\textregistered\# to the waterlogged wheats.

- Camm\(\text{TM}\) and Karlgarin seem more sensitive to pre-emergent Glean\textregistered\# under normal to dry conditions and Westonia to Ally\# in the southern agricultural region of Western Australia (WA).

- Durum wheats appear more sensitive to the herbicides belonging to group B and D. Wollaroi\(\text{TM}\) showed sensitivity to more herbicides than other varieties.

- Safe phenoxy herbicide application time in barley begins at double ridge stage + one leaf. Head deformities are a poor indicator of yield reduction. Application of 2,4-D\# after flag leaf emergence caused no significant reduction in yield in any of the varieties.

- Pre-emergent application of Glean\textregistered\# alone or its mixtures with diuron\# was damaging to most of the barley and oat varieties.

- In general, field peas showed good tolerance to most herbicides, but Helena\(\text{TM}\), WAPEA2039 and Dunwa\(\text{TM}\) have shown some sensitivities to pre-emergent Lexone\#. New herbicides Snipper\# and Raptor\# were safe to all the varieties tested. Lexone\# alone and in mixture with Spinnaker\# and diuron was damaging to Cooke field peas on sandy soils.

- All the chickpea varieties showed good tolerance to the commonly used pre-emergent herbicides. Broadstrike\# + oil was safe to all the chickpea varieties and gives much better radish control, but addition of oil with Broadstrike is not registered. Spinnaker\# was phytotoxic to Sonia\(\text{TM}\) and Heera\(\text{TM}\) and Lexone\textregistered\# to Sona, whereas Howzat tolerated these herbicides quite well on a sandy soil.

- Bladex\# 2L/ha, diuron 2L/ha, Bladex\# 2L/ha (incorporated by sowing (IBS)) followed by diuron 1.5L/ha (early post emergence (EPP)), Spinnaker\# 150ml/Lexone\# 200g were safe to Digger, Cassab and ILL720. Brodal\# 100ml/ha, Snipper\# 50g/ha and their mixes with Lexone\# and Broadstrike\# 20g/ha (alone) were the safe post-emergent herbicides to all the varieties tested. Diuron, Spinnaker\#, Snipper\# and Brodal\#/Snipper\# + Lexone\# are not registered in lentils.

- Diuron as pre-emergent (an unregistered herbicide in faba beans) was found to be safe to all the faba bean varieties. Basagran\# 2L, Spinnaker\# 200g and Raptor\# 30g/ha applied at 2-3 leaf stage were safe to all the varieties but these are also unregistered in faba beans.

- The main concern in the new lupin varieties is metribuzin\# tolerance. Three way mixes of Brodal\#/Snipper\#, simazine\# and metribuzin were the riskiest options. Bounty\# was safe to all the lupin varieties except Tanjil\(\text{TM}\) during 2000. Diuron or diuron+Lexone\# safety in lupins was related to the seeding system used and their timing of application.

- Of the 13 herbicides tested, Ally\# 5g and Glean\textregistered\# 20g/ha applied at 3-4 leaf stage of Williams Lovegrass (Teff) were tolerated well by its two lines (260070 and 260083).
Recommendations

- To use higher rates of MCPA and 2,4-D (amine and ester) on Wyalkatchem, Westonia and Amery and apply these herbicides at Z15-Z16 (5-6 leaves on the main stem) on Carnamah, Camm, Brookton and Karlgarin at Z16-Z17 and in Calingiri at Z17-Z18 (Attachment 14, Table 1). At these stages, floral initiation will be completed in the varieties.
- Durum wheat varieties tolerated MCPA and 2,4-D amine very well when applied at Z15-Z16 stage.
-Dicamba or phenoxy herbicides should not be applied to moisture stressed wheat plants or to the crops where moisture stress is expected after their application.
- Under waterlogging conditions or if there is any chance of waterlogging just after seeding, Treflan®, Stomp® and Clean® should not be used. Safer products or post-emergent spraying should be considered.
- Ally® should not be applied to Westonia wheat in the southern agricultural region of the Western Australian (WA) wheatbelt.
- Follow label recommendations for early application of MCPA (amine and ester) at lower rates in barley. To use higher rates of MCPA and 2,4-D (amine and ester) in Unicorn, Stirling, Harrington and WABAR2110, apply at Z15-Z16 (5-6 leaves on the main stem) and in Gairdner and Skiff at Z16-Z17 (Attachment 14, Table 2). Although application of 2,4-D (amine and ester) after flag leaf emergence was safe on all the barley varieties, it is not yet registered and therefore illegal to recommend.
- Glean® alone or in mixture with diuron as a pre-emergent should not be used in barley and oats as it is damaging and is not registered to use in these crops.
- Bladex®, diuron and Spinnaker® as pre-emergents are safe to use in field pea varieties on loamy sand to clay loam soils. Avoid using higher rates of Lexone® in Helena. New post-emergent herbicides Raptor® and Sniper® and mixes of Brodal® and Sniper® with metribuzin® can safely be used in all the varieties. Lexone® alone and in a mixture with Spinnaker® and diuron should not be used in Cooke field peas on sandy soils.
- Spinnaker® should not be used in Sona and Heera and Lexone® in Sona on a sandy soil. Balance® at the registered rate can safely be used in all the chickpea varieties even on a sandy soil.
- Herbicides registered to use in lentils can safely be used in the new lentil varieties. Maximum Brodal® rate tested in trials was 100ml/ha.
- Basagran® 2L, Spinnaker® 200g and Raptor® 30g/ha applied at 2-3 leaf stage can safely be applied to all faba bean varieties but these are unregistered in this crop in WA.
- Apply diuron or diuron+Lexone® before seeding in lupins if using knife points followed by press wheels. If knife points and press wheels will be fallowed by harrows, then these treatments can be applied immediately after seeding or before crop emergence.
- Limited data suggest that Ally® 5g and Glean® 20g /ha can safely be used in Williams Lovegrass(Teff) at 3-4 leaf stage.

Outcomes

Expected Outcome (benefits)

Economic Outcomes

Growers in the WA wheatbelt are losing millions of dollars every year due to competition from herbicide resistant weeds. In this project, a wide range of herbicides and herbicide mixtures with different modes of action were tested for crop tolerance. This will help in management of herbicide resistant weeds. The research will be most relevant to growers using new crop varieties in the Western Region and indirectly in the Southern and Eastern Regions.

Social Outcomes

In this project, a wide range of herbicides having different timings of application were tested for tolerance in crop varieties. Widening the choice of herbicides can help growers overcome time pressures by spreading their spraying tasks over a wider stage of crop growths.

Achievements/Benefits

Overview of Project Achievements
The project's three main aims were:

1. To identify herbicide sensitivities or tolerances of newly released varieties or potential varieties of cereals, pulses and oilseeds, and to document critical growth stages for herbicide sensitivities in these.
2. To identify and evaluate herbicide tolerance and resistance genes in crop varieties in association with plant breeding programs.
3. To provide growers and agribusiness with the latest herbicide tolerance information.

A total of 57 field trials were conducted (Mullewa (16), Merredin (12), Newdegate, Wongan Hills (6), Katanning, Esperance (4), Avondale, Buntine (3), Northam, Kalannie and Waddi Forest (1)). The trials included bread wheat (20), durum wheat (4), barley (5), oats (2), chickpeas (7), lupins (7), field peas (6), faba beans (3), lentils (2), and pulses (1). Five phenoxy herbicide tolerance trials (four wheat and one barley) were conducted during 2001.

The key findings from these trials were:

**Bread wheat**

Trials tested optimum application times for phenoxy herbicides on eight wheat varieties at four locations to produce an accurate user guide. Plants of different varieties were dissected to understand the relationship between timing of application and ear development of each variety. The effect of treatment on wheat grain receival standards was also determined.

- Trifluralin# and Stomp®# reduced emergence, growth and yield all of the varieties under waterlogged conditions at Merredin during 1999. Rate of emergence was lower with both herbicides at Buntine where zero-till furrows filled with soil, however the crop recovered at this site.
- Under dry conditions, dicamba 1.0L/ha significantly reduced the yield of all the varieties (except Carnamah and Wyalkatchem) tested at Newdegate during 2000 and at Merredin and Mullewa during 2001. Wyalkatchem and Carnamah were, however, adversely affected by this treatment at Esperance in 2001. Plants at these sites were under moisture stress before and/or after application of dicamba.
- Grain yield of Camm was reduced significantly by pre-emergent Glean® 12.5g/ha and post-emergent Ally®, Jaguar® and Tigrex®. Karlgarin yield was reduced by Glean® 12.5g/ha, Stomp® and Treflan® at two or more sites during the project.
- Westonia yield was affected adversely by Ally® 5g/ha at Esperance and Newdegate.
- 2001 variety releases: Harrismith was observed to be sensitive to Paragon® and Jaguar®, whereas Wyalkatchem tolerated all the herbicides tested at Mullewa and Merredin, but showed sensitivity to Paragon® and diuron 1 L+ Dual® 0.5L/ha at Esperance.

**Durum wheat**

- Pre-emergent Glean® reduced the yield of Wollaroi during all three years of testing. In one year the varieties Kamilaroi, Yollaroi and Tamaroi were also affected.
- Under waterlogged conditions at Merredin during 1999, Glean® + diuron (15g+1 L/ha) reduced yield of all the varieties tested (Kamilaroi, Yollaroi, Wallaroo and Tamaroi).
- Logran®# reduced the yield of Tamaroi, Wollaroi and Yollaroi, and Hussar®# reduced the yield of Kamilaroi significantly.
- Argold® (cynmethalin®) was found to be detrimental to all the durum wheat varieties, while Stomp® reduced the yield of Tamaroi and Wollaroi, and Treflan® reduced the yield of Tamaroi.
- Bromoxynil MCPA® was damaging to Wollaroi.

**Barley**

- Phenoxy herbicides caused differential ear head distortions in different barley varieties.
- Pre-emergent Glean 12.5 g/ha caused significant yield reduction in Unicorn®, Stirling, Gairdner®, Fitzgerald, Molloy® and Mundah®. Diuron + Glean® also caused damage in Gairdner, Harrington, Molloy and Mundah during 1999 and 2000.
- 2002 variety releases: Baudin® has shown some sensitivity to Barrel® (96% of control) and Hamelin® to Tigrex® (94%) in 200 at Katanning.
- Stirling (a standard variety) was also sensitive to Barrel® (95%) but not to Tigrex®.

**Oats**
• Diuron+Glean® (1L+15g/ha) caused significant yield loss in Pallinup®, Toodyay® and WAOAT2052. 2,4-D# amine caused losses in all varieties except WAOAT2052 and 2,4-D ester in Hotham® and Toodyay during 1999.  
• Jaguar® caused significant yield reduction in all the varieties and 2,4-D ester 1.0L/ha in Coomallo® during 2000 at Newdegate.

Field peas

• Helena® showed sensitivity to pre-emergent Lexone®# and two way mixes of Lexone®, diuron and Spinnaker®# during 1999 and 2000 and WAPEA2039 in 1999 only.  
• Dunwa® yield was also reduced by pre-emergent Lexone® during 2000.  
• Raptor®# 45g/ha and Sniper®# 50g/ha delayed flowering of Cooke by two weeks (75% and 58% of plants, respectively).  
Fifteen percent of the plants of Helena showed a similar delay to both herbicides, but there was no effect on yield.  
• Lexone® (a registered and safe herbicide on Cooke), alone and in mixture with Spinnaker® and diuron reduced the seed yield of this variety significantly on sandy soils, a soil type more suitable for lupin growing.

Chickpeas

• Sona®, Heera® and Kaniva showed good tolerance to simazine# 2L/ha alone (IBS) and followed by Spinnaker®, Lexone, diuron and their mixes (immediately post plant (IPP)) to and Balance® (isoxafluatole®) at the registered rate.  
• All the varieties also showed good tolerance to Broadstrike®# plus spraying oil. Broadstrike® alone is currently registered for use, but with oil it gives much better radish control although there is concern that oil will exacerbate any leaf diseases.  
• Spinnaker® (a commonly used and safe herbicide in chickpeas on loamy sand to clay loam soils) was damaging to Sona and Heera and Lexone® to Sona only on a sandy soil. Howzat® tolerated these herbicides quite well on a sandy soil.  
Balance® at the registered rate was safe on all the varieties on sandy soils.

Lentils

• Bladex®# 2L/ha, diuron 2L/ha, Bladex® 2L/ha (IBS) followed by diuron 1.5L/ha (IPP) and Spinnaker® 150ml+Lexone® 200g were safe to Digger, Cassab and ILL720.  
• Cumra showed sensitivity to all the pre-emergent herbicides tested except Bladex® during 1999.  
• Brodal®# 100ml, Sniper® 50g/ha and their mixes with Lexone® and Broadstrike® 20g/ha (alone) were safe post-emergent herbicides for all varieties. Diuron, Spinnaker®, Sniper® and Brodal®/Sniper® + Lexone® are not registered in lentils.

Faba beans

• Simazine#, Spinnaker®, Lexone®, diuron, two way mixes of Spinnaker®, Lexone® and diuron or their three way mixes applied as pre-emergent were safe on Fiesta VF®, Fiord® and Ascot®.  
• No post-emergent herbicide has been registered yet in faba beans in WA. Basagran®# 2L, Spinnaker® 200g and Raptor® 30g/ha applied at 2-3 leaf stage were found to be safe for all varieties.

Lupins

• Metribuzin# tolerance in new lupins is of key concern and tolerance of all potential new varieties is being assessed. As baselines for assessment, Tanjil® has been identified as the most sensitive and Kalya® the most tolerant.  
• Three way mixes of Brodal®/Sniper®, simazine and metribuzin were the riskiest options.  
• Bounty® (a new herbicide for radish and doublegeee control) was safe to all the varieties except Tanjil during 2000.  
• Diuron or diuron+Lexone® applied as IPP over the sowing furrows caused damage to all the varieties.

Williams Lovegrass (Teff) (*Eragrostis tef*)

• Teff is under investigation as a warm season crop, especially under conditions such as waterlogging and presence of herbicide resistant weeds. Of the 13 herbicides tested, Allo® 5g and Glean® 20g/ha applied at 3-4 leaf stage of teff were tolerated well by its two lines (260070 and 260083) (pot trial).

A number of extension activities have also been conducted as a result of this project:

• Project results have been published in 16 conference proceedings, 14 newsletters, AgMemos, e-Weed, trial and demonstration reports.  
• Research trials have been presented at 20 field days.
Presentations were given at the Perth Agribusiness Crop Updates and associated regional Crop Updates. Herbicide tolerance information is updated each year in the Crop Variety Sowing Guide.

Industry Benefits

- This research is primarily aimed at reducing losses rather than increasing yields. The choice of less damaging herbicides can avoid yield penalties that may average more than 5%. Widening the choice of herbicides will also aid in resistance management, and can help growers overcome time pressures by spreading their spraying tasks over a wider stage of crop growths.

Other research

Research and development (R&D) opportunities identified during this project have been incorporated into the current GRDC funded project DAW00027.

Interaction between foliar diseases and tolerance of post-emergent herbicides in lupins and chickpeas.

Intellectual property summary

The information cannot be commercialised. All herbicides tested are already available in the marketplace.

Additional information

Attachments

13. List of Crop Update publications and presentations.
14. Trial results tables of double ridge stages of wheat and barley.