Evaluating herbicide tolerance with new crop varieties

**PROJECT DETAILS**

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<td>PROJECT TITLE:</td>
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**Summary**

Improved varieties of all major crop species are continually being developed and commercially released. It is not uncommon, however, for some of these new varieties to be sensitive to herbicides currently considered safe, resulting in reduced yield and therefore lower farm profit. This project aimed to identify, document and publicise any such sensitivities through a series of field trials. During this project, a total of 42 trials were conducted on cereal and pulse varieties. The trials were publicised at 12 field days and results extended through nine Crop Update presentations, 16 publications and 17 extension articles plus the Crop Variety Sowing Guide and e-Variety Profiler.

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Conclusions

- EGA Eagle Rock™ has metribuzin tolerance similar to Blade and significantly better than Cammy™ and Spear wheat. Tank-mixed application of metribuzin 150g a.i./ha with Stomp®, Triflur™ X (2 L/ha), diuron (1L/ha) or Dual Gold® (0.250L/ha) pre-emergent or with Jaguar® (0.5L/ha), Tigrex® (0.5L/ha), Monza® (12.5g/ha) or Atlantis® (165mL/ha) post-emergent appeared safe. This variety does not have cross-tolerance to higher rates of atrazine (1kg a.i./ha).

- EGA Eagle Rock exhibited some sensitivity to Hussar® and phenoxy herbicides (MCPA®, 2,4-D® and dicamba®) applied at highest label rates and recommended timings.

- Potential new releases WAWHT 2499 and WAWHT 2425, and wheat varieties released during the tenure of this project - EGA Castle Rock™, EGA Bonnie Rock™, GBA Ruby™ and GBA Sapphire™ - showed good tolerance to commonly used herbicides at the highest label rates. Further testing is needed to confirm these results.

- GBA Shenton seems sensitive to dicamba and Jtarning® to Mataven L®, Paragon® and 2,4-D (amine and ester).

- Carnamah appears sensitive to 2,4-D (ester) 0.7L/ha at 5-6 leaf stage (label recommended application timing).

- For radish control in wheat, Eclipse® at kernel watery ripe stage and Balance® as post-sowing pre-emergence (PSPE) were safe to the bread wheat varieties tested. Balance® was comparatively damaging to durum wheat varieties.

- Mataven L® 3.0L/ha at 3-4 leaf stage was safe to the durum wheat varieties tested.

- Baudin® and Mundah barley seem sensitive to application of Paragon® 0.375-0.5L/ha at Zadoks (Z) growth stage 13 to 14 (Z13 to Z14) and 2,4-D ester 0.75L/ha from five-leaf to flag leaf stage, respectively.

- Mandelup® and WALAN 2173M lupins possess good tolerance to metribuzin and its mixtures with other herbicides. These varieties have metribuzin tolerance similar to Kalya® - better than Tanjil®.

- Do not use high rates of diuron or simazine in situations where concentration of the herbicide in the seeding slot of lupins may occur.

- Metribuzin used pre-emergence (225g a.i./ha) and post-emergence (175g a.i./ha) was tolerated well by all the field pea varieties except Helena®, and Helena has shown some inconsistency in its tolerance to metribuzin. However, metribuzin at lower rates (up to 150g a.i./ha - pre and 75g a.i./ha -post-emergence) applied mixed with other herbicides was safe to most of the varieties including Helena.

- Simazine at a rate (1kg a.i./ha) that provides some broadleaf weed control was damaging to the field pea varieties tested.

- Recently released chickpea varieties Sonali® and Rupal® and potential new releases WACPE 2098 and 97016-29 have herbicide tolerance similar to Howzat® and Sona®.

- An interaction between foliar leaf disease (ascochyta blight) and herbicides/herbicides + fungicide impacted on chickpea plant height under glasshouse conditions. This interaction would be more pronounced on other growth parameters and possibly on seed yield under field conditions.

- Potential new kabuli chickpeas (FLIP 503 and FLIP 530) and lentils (CIPAL 203 and CIPAL 402) seem to have herbicide tolerance at least as good as Kaniva and Cassab® (standard varieties), respectively. These need further testing to confirm the results.
Recommendations

To manage grass and broadleaf weeds in EGA Eagle Rock®, metribuzin® 150g a.i./ha alone or in mixtures with pendimethalin®, trifluralin®, diuron® and metolachlor® at the registered rates can be used safely on sandy to clay loam soils. If using knife points for seeding, apply metribuzin or its mixtures before seeding the crop for improved crop safety. Post-emergence use of metribuzin in wheat is not registered.

In a lupin-wheat rotation EGA Eagle Rock may be the best option following lupins if metribuzin residues are of concern. In such situations, minimise the risk of weeds developing metribuzin resistance by using alternative herbicides for weed management in the wheat phase.

For post-emergence broadleaf weed control in EGA Eagle Rock, herbicides like Tigrex® (1L), Paragon® (375ml), Buctril® (MA 14L), Barrel® (1.4L), Affinity® (50g + MCPA® 0.5L), Eclipse® (5g + MCPA LVE® 0.5L) and diuron (0.5L + 2,4-D® (amine) 0.2L/ha) can be used safely at Z13 to Z14.

Use only the recommended lower rate of dicamba® (0.28L/ha) on GBA Shenton. Use alternative herbicides like Achieve®, Tigrex® or MCPA on Jitarning® instead of Mataven® L®, Paragon® or 2,4-D (amine and ester).

Apply 2,4-D formulations at higher rates at 6-7 leaf stage on Carnamah. The label recommended application timing of 5-6 leaf stage corresponds to the double ridge stage of grain head development.

For control of wild radish and other broadleaf weeds susceptible to group F and group B herbicides, Balance® at 100g/ha applied pre-emergence in bread wheat and barley varieties and Eclipse® at Z70 to Z71 in bread and durum wheats and barley varieties could be potential options (if registered).

Follow label recommendations for early application of MCPA (amine and ester) at lower rates in barley. Use 2,4-D amine formulation at higher rates (up to 1.5L/ha) instead of ester (0.5-0.75L/ha) on Mundah from five-leaf to flag leaf just visible. Although application of 2,4-D (amine and ester) after flag leaf emergence was safe for all varieties except Mundah (for ester), it is not yet registered.

Avoid using Paragon® on Baudin®. Tigrex®, Giant®, etc at the label rates could provide safe alternatives.

To control broadleaf weeds, metribuzin alone and in mixture with other herbicides at the label rates can be safely used on Mandelup®.

If sowing lupins with knife points and soil active or residual herbicides are to be applied post-seeding pre-emergence (PSPE), fill furrows by harrowing to improve crop safety.

Use cynazine® (Bladex®) instead of diuron and lower rates of metribuzin in field peas on light textured soils.

To control silver grass in field peas, use safe and registered herbicide Raptor WPG® instead of simazine®.

MCPA (sodium) causes twisted stems and retards field pea growth for up to 2-3 weeks after application. If growing conditions are good/normal after application of MCPA (sodium) plants do recover from these symptoms without any effect on yield. However, if growing conditions after application are expected to be stressful for the crop, do not use this option.

On soil types lighter/marginal for chickpea production, use lower rates of simazine (0.5-0.75kg a.i./ha) and metribuzin (75-150g a.i./ha) alone or in mixture with each other.

Do not apply fungicide in a mixture with herbicides on chickpeas affected by foliar diseases like ascochyta, as the combination of chemicals and disease can result in yield losses. Follow the label recommendations for fungicides and herbicides.

Outcomes

Economic Outcomes

This research was primarily aimed at reducing potentially significant yield losses. The choice of a less damaging herbicide can avoid yield penalties that may average more than 5%. This project also contributed to obtaining appropriate permits for use of certain unregistered herbicides in wheat, field peas and faba beans. This will help growers manage ‘difficult to kill’ weeds more effectively and so increase crop productivity.

The findings will be most relevant to growers using new crop varieties in the western region but will also be of value to growers in the southern and eastern regions.

Environmental outcomes

Growers in the Western Australian (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 their impact on crops. This will help in the management of herbicide resistant weeds.

**Social outcomes**

In this project, a wide range of herbicides with different timings of application were tested for their impacts on crop varieties. Widening the choice of herbicides can help growers overcome time pressures by spreading spraying tasks over a wider range of crop growth stages.

**Achievements/Benefits**

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 a new variety and continue to use their usual herbicide.

**Project aims**

1. To identify herbicide sensitivities or tolerances in newly released varieties or potential varieties of cereals and pulses.
2. To study the interaction of foliar leaf diseases with herbicides leading to herbicide injury in herbicide tolerant chickpea and lupin varieties.
3. Provide growers and agribusiness with current herbicide tolerance information.

A total of 42 field trials (13 at Mullewa, eight at Katanning, seven at Merredin, five at Wongan Hills, four at Avondale, two each at Erdau and Esperance and one at Muresk) were conducted. The trials included wheat (11), lupins (11), field peas (6), barley (5), desi chickpeas (4), kabuli chickpeas (2), oats (1), lentils (1) and faba beans (1). Three pot trials involving 286 pots were also conducted. Nufarm Australia Ltd provided 50% of the trial cost and labour (for trial assistance) for a trial on barley tolerance to phenoxy herbicides during 2002.

The key findings from these trials were:

**Wheat**

- Metribuzin# tolerance in EGA Eagle Rock(1). The level of metribuzin tolerance in EGA Eagle Rock (WAWHT 2525A) was identified and demonstrated to growers. It tolerated up to three times the registered rate (in Blade wheat) of pre-emergent metribuzin (450g a.i./ha) very well on a range of soil types. Safe pre- and post-emergent metribuzin mixtures with other herbicides with the potential to broaden the spectrum of weeds controlled in this variety were identified. The cross-tolerance of EGA Eagle Rock to triazine# herbicides was also tested. Based on this research work, the Australian Pesticides and Veterinary Medicines Authority (APVMA) has issued a permit (PER8197) for use of metribuzin in EGA Eagle Rock wheat Australia wide. The permit is valid until 31st August 2006.
- EGA Eagle Rock was found to be sensitive to Hussar®# and high rates of phenoxy herbicides (MCPA#, 2,4-D# and dicamba #) applied at the 5-6 leaf stage of the crop were identified. Lower rates of phenoxy herbicides in mixtures with other herbicides at earlier timings (Z13 to Z14) were safe to this variety.
- WAWHT 2499 and WAWHT 2425, earmarked for release in 2005, showed good tolerance to all the herbicides tested. Data from two trials detailing these varieties’ reactions to herbicides will be available at the time of release.
- EGA Castle Rock(1), EGA Bonnie Rock(1), GBA Ruby(1), GBA Sapphire(1), Bellaroil and Kalka(1), with Wyalkatchem(1) (standard variety), showed good tolerance to all the herbicides and herbicide mixtures tested.
- GBA Shenton showed sensitivity to dicamba 500 at a higher rate (0.5L/ha) than the commonly used (0.28L/ha) at Mullewa during 2004. The other varieties in the trial exhibited good tolerance to the higher rate of dicamba.
- Jitarning(1), a soft wheat variety, showed sensitivity to Mataven L®# (3L/ha), Paragon®# (0.375L/ha) plus 2,4-D amine 500 (1.0L/ha) and ester 800 (0.7L/ha) during 2003 but there was no significant adverse effect from these herbicides on Tincurrin (a standard soft wheat variety).
- Carnamah yield was reduced significantly by 2,4-D ester (0.7L/ha) applied at Z15 to Z16 at Merredin during 2003. Carnamah also showed sensitivity to 2,4-D ester (0.75L/ha) applied at Z15 to Z16 in 2001 trials.
- Logran®# 15g and Eclipse®# 10g+ Uptake® oil 0.5%/ha applied at kernel watery ripe stage (Z70 to Z71) were tolerated by all the varieties tested during 2003 at Mullewa and Merredin. Eclipse is not registered in wheat for late radish control.
- Balance®# (isoxaflutole) 100g/ha, a chickpea herbicide applied post-seeding pre-emergent (PSPE), was tolerated quite well by bread wheats (data from two to five trials involving six varieties) but durum wheat varieties, particularly Wollaroi,
showed sensitivity to it at Mullewa during 2003.

- The Mataven L® label says do not apply this herbicide to durum varieties including Kamilaroi, Yallaroi and Wollaroi. However, it was found safe to durum wheat varieties including Bellaroi and Kalka in herbicide tolerance trials in WA.

### Barley

- WABAR 2175, a potential malting release in 2006, showed good tolerance to the barley herbicides. At the time of release of this cross-bred, there is expected to be three years’ trial data on its tolerance to herbicides.
- Baudin® showed sensitivity to Paragon® (0.375-0.5L/ha) applied at Z13 to Z14 in two out of three previous trials. Stirling, a standard variety, was not affected by Paragon® in any of the trials conducted as part of this project.
- Balance® 100g/ha PSPE (three trials) and Eclipse® 10g/ha + Uptake® oil 0.5% at Z70 to Z73 (two trials) were safe to all new barley varieties.
- MCPA (amine and ester) at 0.5 L/ha was tolerated well by Unicorn®, Stirling, Gairdner, Skiff, Harrington and Mundah at Z11 to Z12, Z12 to Z13 and Z13 to Z14. Higher rates of MCPA amine (1.25L/ha) and ester (1.0L/ha) were also tolerated well by all the varieties at Z13 to Z14 and Z14 to Z15. MCPA ester (1.0L/ha) caused significant yield reduction in Harrington. 2,4-D amine (0.5L-1.5L/ha) and ester (0.25L-0.75L/ha) were also safe to all the varieties from Z13 to Z15.
- Higher rates of 2,4-D ester (0.75L/ha) caused significant yield reduction in Mundah applied at Z15 to Z16 onwards. All the varieties except Mundah tolerated both formulations of 2,4-D applied after full flag leaf emergence.

### Oats

The only oat trial conducted during this project was at Katanning, where the site was heavily infested with ryegrass. A fairly weed free replication of Possum® was the only treatment harvested. Affinity® 50g + MCPA (amine) 0.5L and Igran® 0.85L + MCPA (amine) 0.5L/ha at Z13-Z14; 2,4-D amine (1.3L/ha), ester (0.7L/ha) and dicamba (0.7L/ha) at Z15-Z16 and Logran® 10g+ Uptake® oil 1%/ha at Z30 caused more than 10% yield reduction in Possum.

### Lupins

- WALAN 2173M, a potential new variety, showed good tolerance to a range of herbicides including metribuzin and its mixtures (similar to Mandelup® and Kalya®). Two to three years’ data in its herbicide tolerance will be available at the time of its release.
- Mandelup (WALAN 2141) was found to have better metribuzin tolerance than Tanjil® and this was demonstrated to growers. Mandelup also exhibited good tolerance to other commonly used lupin herbicides. At the time of release of this variety, data from five trials over two years was available.
- Tanjil continued to show sensitivity to metribuzin and its mixtures.
- Early generation lupin material (Stage 2-4 -107 lines) was tested for six commonly used herbicides at Wongan Hills and Mullewa during 2002. The following year, 138 lines of narrow-leaf lupins and 18 lines of yellow and atlanticus lupins were evaluated for metribuzin tolerance at Wongan Hills and Mullewa.
- Under the dry conditions of 2002, a trial at Mullewa indicated that lupin plants moisture stressed before and after application could become sensitive to herbicides to which generally they are tolerant. This was particularly noticeable for post-emergent metribuzin and its mixtures across all the varieties (Belara, Tanjil, Kalya and Mandelup).
- Diuron® and simazine® applied over the knife point seeding furrows resulted in significant yield loss across all the lupin varieties at Wongan Hills (2003) and Mullewa (2004) when the furrows were filled as a result of rainfall events within two to three weeks of application.
- Bounty® (85g/ha) alone or in mixture with Affinity®, (25g and 50g/ha), applied to Wodjil® lupins (yellow lupins) at the four-leaf stage reduced plant height by more than 20%. Addition of Affinity® to Bounty® seems to reduce its phytotoxic effect on Wodjil. These herbicides and herbicide mixtures were safe to the narrow-leafed varieties Mandelup and Tanjil (pot trial).

### Field Peas

- The research work done on field peas in previous herbicide tolerance projects was instrumental in gaining the current permit for use of metribuzin on field peas. The permit (PER 8833) is valid up to the year 2010.
- Diuron was observed to cause seedling death in crops on light textured soils. Cyanazine (Bladex®) was safer than diuron on such soils for all varieties.
- Pre-emergent simazine (1.0kg a.i./ha) was not tolerated by field pea varieties including Kaspa® and Helena®. Simazine (0.5kg a.i./ha) was tolerated by all the varieties but this rate provides control only of shallow rooted weed species such as
silvergrass. The use of simazine (either pre- or post-emergence) in field peas is not registered in WA.

- Raptor WG® (imazamox) (45g) + BS1000® (0.2%/ha) or Raptor WG® (30g) + Spinnaker® (88mL) was tolerated well by all varieties in the trial. Odyssey® - a ready-mix of Raptor WG® and Spinnaker® - is registered for use in field peas in Canada.
- MCPA (as the sodium salt) (1.0L/ha) applied at 7-8 node stage for late radish control, was tolerated well by all the varieties.
- The three-way mixes of Brodal® (100mL/ha) or Sniper® (30g/ha) with metribuzin (75g a.i./ha) and simazine 500 (0.5L/ha) applied at 6-7 node stage for control of wild radish and doublegees (three-cornered jack) were phytotoxic and had a very low safety margin in all field pea varieties.

Desi chickpeas

- Sonali (WACPE 2075) and Rupali (WACPE 2095) showed similar herbicide tolerances to those of Sona and Howzat (standard varieties). At the time of their release, data from two trials were available for these varieties.
- Potential new releases WACPE 2098 and 97016-29 were observed only visually for herbicide tolerance. These seem to have herbicide tolerance similar to Sona and Howzat.
- On a loamy sand soil at Mullewa during 2004, simazine (1kg a.i./ha) applied before seeding and metribuzin (225g a.i./ha) PSPE or these applied in succession (metribuzin 112.5g a.i./ha) resulted in an average 10-50% plant kill across all the varieties.
- Under disease free conditions, Broadstrike® (25g/ha) + Uptake® oil 0.25% was tolerated by the varieties tested. The use of Uptake® oil with Broadstrike® in chickpeas is not registered.
- Sonali showed good tolerance to pre-emergent Balance® up to 400g/ha (with and without simazine 1L/ha), which is similar to Howzat. Application of Balance® (100g/ha) at 2-3 node stage reduced plant population, height and dry weight of both the varieties by more than 10% (in a pot trial). Post-emergent use of Balance® in chickpeas is not registered.
- Interaction of foliar disease and herbicides in chickpeas. Aramo® (300mL) + Hasten® (375mL) + D C Trate® 1% and Broadstrike (25g/ha) alone or each in mixture with Bravo® (1.5L/ha) applied to healthy Sonali chickpea plants had no effect on plant height or dry weight. Application of these chemicals to plants under medium to high disease pressure (ascocytta blight) resulted in significantly reduced height and dry weight compared to healthy plants. Application of herbicides alone or in mixture with Bravo® further reduced the plant height of the diseased plants and this reduction was significant for Broadstrike® + Bravo® and Targa® + D C Trate® + Bravo®. As in the glasshouse, no secondary infection of ascocytta occurred and the diseased plants showed some recovery in the form of emergence of healthy secondary branches. The dry weight of the diseased plants treated with the herbicides + Bravo® was two to three times less than similar plants treated with each of the herbicides alone.

Kabuli chickpeas

The potential new release FLIP97 530 and Kaniva (standard variety) showed sensitivity to pre-emergent metribuzin (225g a.i./ha) on clay loam soil. FLIP97 503 tolerated metribuzin and the other herbicides very well.

Lentils

Potential new releases FLIP 203 and FLIP 402, along with Cassab® (standard variety), showed good tolerance to the highest label rates of herbicides registered in lentils (cyanazine, metribuzin, diflufenican®, picolinafen® and flumetsulam®).

Faba beans

- The information generated on herbicide tolerance of the faba bean varieties Fiesta®, Fiord and Ascot® during the previous project (DAW 618) contributed to the industry gaining a permit (PER) for Raptor® (imazamox) use on faba beans.
- During the tenure of the project only one trial on faba beans was conducted. The trial was heavily infested with weeds and the faba bean plants were infected with a foliar disease so it was difficult to assess herbicide effects and the trial was not harvested. Weeds were counted (using quadrats) at the flowering stage of the beans to work out the weed control efficiency of the treatments.

Several extension activities have been conducted as a result of this project:

- Two sets of results were published in the proceedings of the 14th Australian Weeds Conference, and other information has been published in 16 Crop update proceedings and 17 Agricultural Memo/e-Weed/Newsletters).
- The trials were publicised at 12 field days.
• Presentations were given at the Perth Agribusiness Crop Updates and associated Regional Crop Updates.
• Wheat, barley and lupin herbicide tolerance information from the past four to five years’ trials has been included in e-Variety Profiler.
• Herbicide tolerance information was updated each year in the Crop Variety Sowing Guide and Farm Budget Guide.

Industry benefits

This research was 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 management of herbicide resistance and can help growers overcome time pressures by enabling them to spread spraying tasks over a wider range of crop growth stages.

This research also contributed to successful applications for permits for use of certain unregistered herbicides in wheat (EGA Eagle Rock), field peas and faba beans for better and more cost-effective management of some difficult to kill weeds.

Other research

The research and development opportunities identified during this project have been incorporated into the current GRDC-funded project ‘Effect of herbicides on nodulation in lupins’.

Additional information