

Australian Plants v Herbicides

- *'What is most intriguing is that the greatest higher plant, species diversity is found on the most Phosphate impoverished soils on the south-western Australian sand plains and is known as the kwongan vegetation'* (Professor Hans Lambers)
- *'In Australia there is actually very little data on pesticide use and environmental impact. This makes it difficult to judge how Australia is tracking against other countries, and how our flora and fauna are responding with continued exposure to these toxins.'* (Croplife, Australia)
- Broad-spectrum pesticides are some of the cheapest chemicals in Australia costing only A\$1.50 per hectare to apply in grain crops, making them an obvious choice. (Croplife, Australia)
- *'There is no single list of banned chemicals, but several useful sources for information about restrictions on chemicals.'* (NICNAS, Australia)

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Red/Green Kangaroo Paw

Unpredictable
off- target effects
of herbicides and
adjuvants in
bushland
restoration



Rationale

- Herbicides and adjuvants are routinely used to remove weeds.
- The main method of application is spraying a mixture of herbicides and adjuvants.
- **Herbicides** - good Agricultural knowledge base, but more limited when native systems are involved.
- **Adjuvants** - good knowledge base on their effects on herbicide uptake, but little information on phytotoxic effects in isolation.

Objectives

- To separate the effects of herbicides and adjuvants on:
 - Plant Growth:**
 - Germination
 - Seedling emergence
 - Growth, health and survival of seedlings
 - Soil Environment:**
 - Persistence
 - Nutrients
 - Soil structure

Study Species



Anigozanthos manglesii



Acacia pulchella



Kunzea ericifolia



Austrostipa elegantissima



Eucalyptus marginata



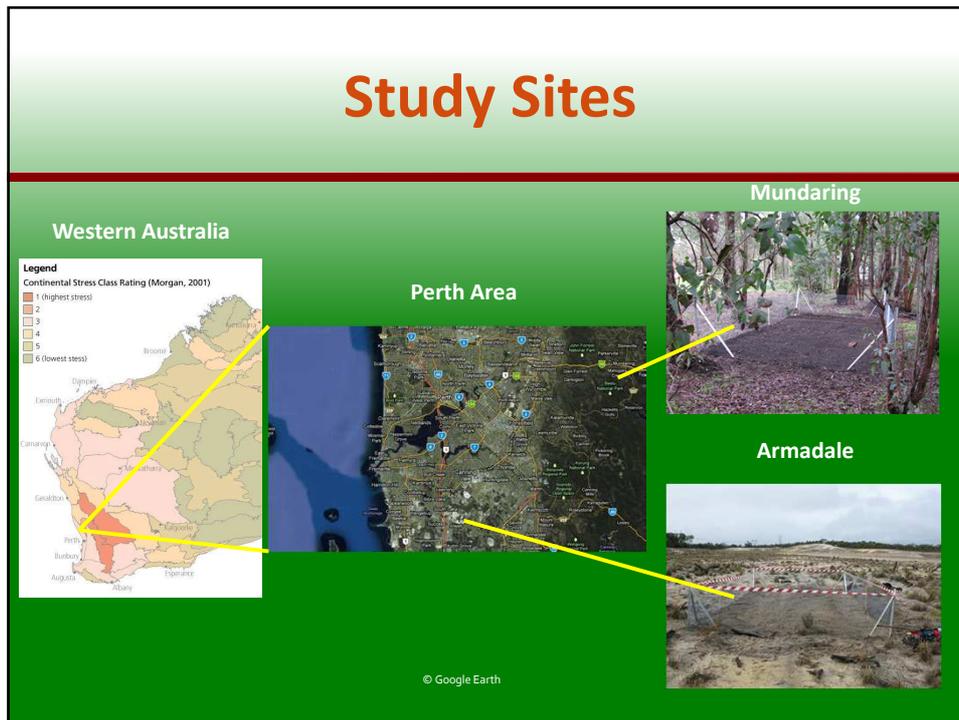
Banksia grandis

Test Chemicals

Name	Common Name	Use
Agral 90	Nonyl phenol ethanoate	Emulsifiers & surfactants
Pulse wetter	Polyether modified polysiloxane	Wetter
Wetter 1000	Alcohol Ethoxylate	Wetter and spreader
Logran	Triasulfuron	<ul style="list-style-type: none"> •Pre-emergence for broadleaf and grassy weeds •Post-emergence for broadleaf weeds.
Metsulfuron	Metsulfuron-methyl	Selective control of broadleaf weeds.
Targa	Quizalofop-P-ethyl	Post-emergence on grass weed.
Fusilade	Fluazifop-P-butyl	Post-emergence for grass weeds
Lontrel	Clopyralid	Post-emergence for broadleaf weeds
Dalapon	Sodium/Magnesium Dalapon	Post-emergent for broadleaf weeds

White - Adjuvants, Yellow - Herbicides

Study Sites



Germination

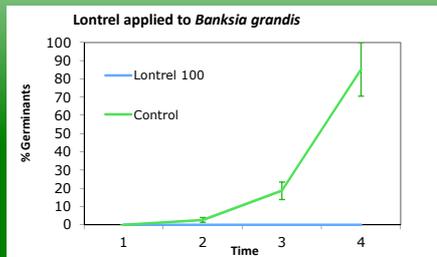
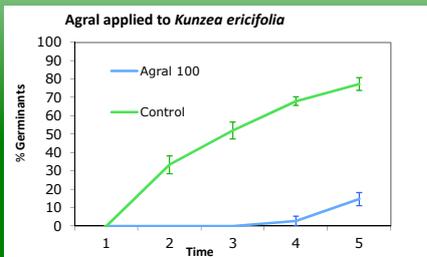
Hypothesis - Both herbicides and adjuvants will have a toxic effect on the off target plant species.



Method

- Seeds were sown on sterile white sand in petri dishes.
- Each petri dish had 8ml of liquid added.
- Each chemical was added at 50%, 100% and 200% of field concentrations.

Sample Results



Chemicals applied at 100% Field application rates

- Agral is marketed as:
 - “Increases wetting and improves spray coverage. It will not injure the most tender foliage if used as directed”.
- Lontrel is marketed as:
 - “For control of a wide range of broadleaf weeds in crops, pastures, fallow land, forests and industrial situations”.

Discussion-Germination

	Agral			Dalapon			Fusilade			Logran			Lontrel			Met			Pulse			Targa			Wetter		
Field concentration	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200
Acacia pulchella																											
Anigozanthos manglesii																											
Austrostipa elegantissima																											
Banksia grandis																											
Eucalyptus marginata																											
Kunzea ericifolia																											
Ehrharta calycina																											
Euphorbia terracina																											
Pelargonium capitatum																											
Pennisetum setaceum																											

Red is a decrease in germination, Green is an increase in germination from control

- All chemicals, adjuvants or herbicides had an affect on the test species.
- In most cases the result was a decrease in germination.
- Adjuvants often had a greater impact than the herbicides

Seedling Emergence

Hypothesis: All chemicals will reduce emergence, lower seedling survivability and depress health in the trial species.



Method

- Ten species, ten treatments, two soils, two depths, five replicates.
- Emergence was recorded weekly for 12 weeks.

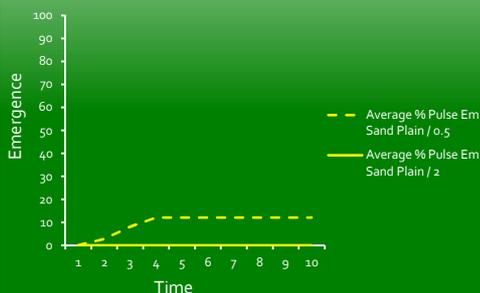
Observations

- Emergence with subsequent death was recorded.
- Condition/health of seedlings was recorded.
- Both ex-situ and in-situ experiments carried out.



Results Emergence

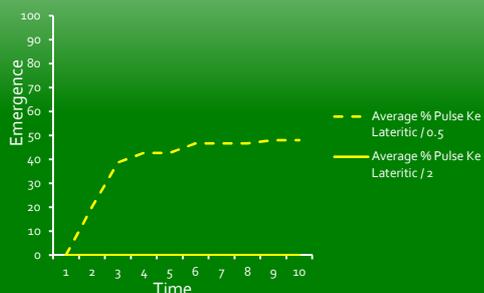
Graphs showing percentage emergence of *Eucalyptus marginata*, treated with Pulse in grey sand, sown at different depths



- This graph shows a reduced emergence of seedlings with increased sowing depth.
- Here the chemical has a greater effect on shallow seed banks.

Results Emergence

Graph showing percentage emergence of *Kunzea ericifolia*, treated with Pulse in Lateritic soil, sown at different depths

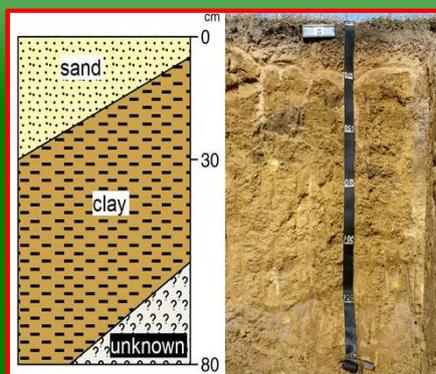


- The graph shows a reduced emergence of seedlings with increased sowing depth.
- In this instance the chemical has a greater effect on deeper seed banks.

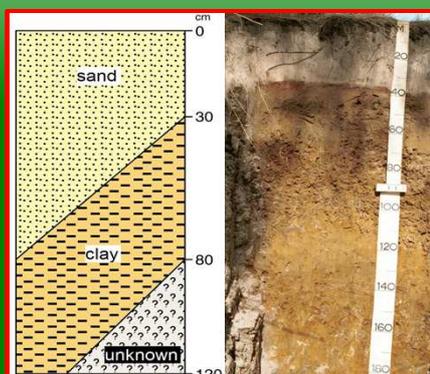
Soil types

- Two soil types were tested in the study:

Lateritic (Yarragil)

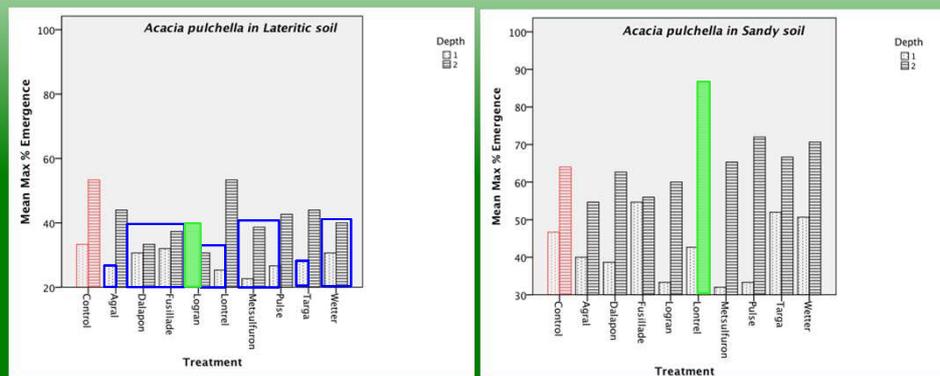


Guildford sand



- Both are considered productive (by WA standards).

Soil Types



- Emergence was usually greater in sandy soils.
- Emergence was usually greater for seeds sown at 2cm depth.
- Herbicide had more significant effects in lateritic soil.

Persistence

Hypothesis: that chemicals will remain active in the soil for a period of weeks after application



Method

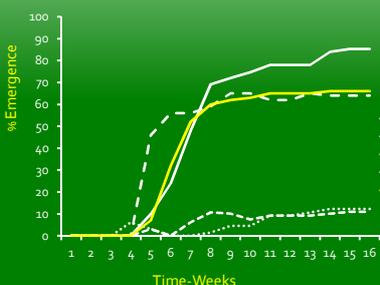
- Ten species sown, ten treatments, two soils, five replicates.
- Seeds sown weekly for 4 weeks post spraying.

Observation

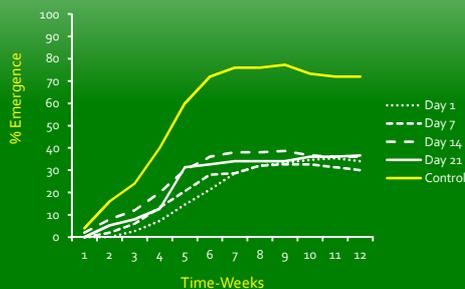
- Emergence was recorded weekly for 12/16 weeks.
- Subsequent death was recorded.
- Condition/health of seedlings was recorded.

Persistence Results

Persistence of Agral on Banksia grandis in Lateritic soil



Persistence of Agral on Banksia grandis in Sandy soil



- Initial emergence is delayed more in Lateritic than sandy soils.
- Overall, Banksia emergence is lower in sandy soils than Lateritic soils .
- Persistence in Lateritic soil is often less than in sandy soils.

Persistence Summary

Species	Acacia				Anigozanthos				Austrostipa				Banksia				Eucalyptus				Kunzea				Ehrharta				Euphorbia				Pelargonium			
Lateritic Soil	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Agral	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Dalapon	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Fusilade	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Logran	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Lontrel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Metsulfuron	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Pulse	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Targa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Wetter	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				

- Anigozanthos, Austrostipa and Kunzea are all strongly and persistently affected.
- Some Chemicals start off with a positive effect but this becomes negative.
- No correlation between seed size or type and effect.

Discussion

- In all experiments, All chemicals negatively affected the growth and development of off-target plants, regardless of whether they were Adjuvants or Herbicides.
- Soil type had a strong bearing on the degree to which off-target plants were affected by the chemicals.
- Seed Burial depth altered the degree of effect a chemical had (**but it was not consistent**).
- Being described as pre or post emergent or selective, did not preclude the chemical from affecting plants outside this description

Take Home Message

- When chemical companies talk about off-target effects they are referring to crop species only.
- If you really want to know what the effect of herbicides and adjuvants will be, carry out trials!

Australian Pesticides Use

- *Over 8000 pesticide and veterinary products are registered for use in Australian agriculture, horticulture, livestock, forestry, commercial premises, parks, homes and gardens. More than 80 of these are prohibited in 27 member countries of the European Union.*
- *This list includes*
 - *17 pesticides that are known, likely or probable carcinogens,*
 - *48 pesticides flagged as potential endocrine (hormone) disruptors.*
 - *More than 20 are classified as either extremely or highly hazardous by the World Health Organisation.*
 - *Three of the pesticides are subject to actions by International Conventions but are still used in Australia.*

(WWF, 2010)

Australian Pesticides Use

- **Nonyl phenol ethanoate (Agral®) is exempt from registration in Australia, whilst being banned by the EU.**
- **Atrazine®, an herbicide, is banned in 60 countries, but still currently registered for use in Australia.**
- **In Australia, if an adjuvant is pre-mixed with a herbicide, it does not need to be registered as it is not the 'active' ingredient.**

Acknowledgements

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- School of Plants Biology (University of Western Australia)

Test Chemicals

Name	Common Name	Chemical Composition	Use	Group	Mode of action
Agrol 90	Non-ionic wetter	600g/L nonyl phenol ethylene oxide condensate	emulsifiers & surfactants		Helps reduce the natural surface tension of droplets.
Puba wetter	organosilicone based surfactant	1,020g/Lpolyether modified polysiloxane	Wetter		Produces very low surface tension, resulting in stomatal flooding and uptake of pesticides.
Wetter 1000	Alcohol Ethoxylate	Polyalkylene Oxide	Wetter and spreader		Improves the wetting and spreading action of herbicides, by reducing surface tension of droplets
Logran	Triasulfuron	3-(6-methoxy-4-methyl-1,3,5-triazin-2-yl)-1-[2-chloroethoxy]-phenylsulfonyl-urea.	Preemergence to control broadleaf and grassy weeds; postemergence to control broadleaf weeds.	B	Inhibition of acetolactate synthase ALS (acetohydroxyacid synthase AHAS)
Metsulfuron	Metsulfuron-methyl	Methyl 2-(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino carbamoyl sulfamoylbenzoate(1)	selective control of broadleaf weeds.	B	inhibits amino acid production by inhibiting acetolactate synthase. Preventing cell division.
Targa	Quizalofop-P-ethyl	Ethyl (R)-2-[4-(6-chloroquinoxalin-2-yloxy)phenoxy]propionate(1)	Postemergence on grass weed.	A	Acetyl CoA carboxylase inhibitor; inhibition of fatty acid biosynthesis.
Fusilade	Fluazifop-P-butyl	Butyl (R)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanoate	Postemergence for grass weeds	A	Inhibition of acetyl CoA carboxylase (ACCase)
Lontrel	Clopyralid	3,6-dichloropicolinic acid	Postemergence for broadleaf weeds	D	Action like indole acetic acid (synthetic auxins), uncontrolled growth. Inhibitors of microtubule assembly
Dalapon	Sodium/Magnesium Dalapon	Sodium 2,2-dichloropropionic acid		J	a) Inhibition of lipid synthesis — not ACCase b) protein degradation results in ammonia toxicity c) unknown