

ORIGINAL RESEARCH ARTICLE

Chemical residues in beebread, honey, pollen and wax samples collected from bee hives placed on canola crops in Western Australia

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Online Supplementary Material

Table S1. Canola location, variety, management and chemical use of the 15 farms used for the 2014 survey. Herbicide systems: TT - triazine tolerant; RR - Roundup Ready (Genetically modified (GM)); CL - Clearfield.

Farm	Farm code	Location	Canola variety	GM	Date planted	Kg seed/ha	Crop size (ha)	Exp. beehives in	Exp. beehives out	Prior crop	Chemicals/ha	Comments
1	EC50	Three Springs (Strutton Rd)	Nuseed GT-50 RR	Y	28-Apr	2-4	350	25-Jul	25-Aug	wheat 2013 canola 2012	alpha-cypermethrin 150ml, chlorpyrifos 200ml, glyphosate (2 applications), Seed treatment: Jockey (fluquinconazole/Gaucho (imidacloprid)	No beekeepers on the property for 4-5 years
2	EC	Three Springs (Dookanooka)	Pioneer 43Y23 RR CL	Y	02-May	2-4	>350	25-Jul	25-Aug	wheat 2013 wheat 2012	alpha-cypermethrin 150ml, chlorpyrifos 200ml, glyphosate (2 applications), Seed treatment: Cruiser OPTI MAX (thiamethoxam/lambda-cyhalothrin)	No beekeepers on the property for 4-5 years
3	BFB	Three Springs (watertank)	Nuseed ATR Cobbler TT	N	30-Apr	4	88	25-Jul	25-Aug	unknown	Atrazine (Gesaprim) 1.1kg - 2 applications, propyzamide (herbicide) 1kg, paraquat 1L, chlorpyrifos (Lorsban) 500ml, atrazine 1.1kg - 2 applications, iprodione (Sextant) 200ml, alpha-cypermethrin (Ken-Tac) 200ml, clethodim (Havoc) 500ml, Hasten 1% (adjuvant - fatty acid esters), Amso 1% (adjuvant - ammonium sulphate), Seed treatment: nil.	Beekeeper (BF) beehives in on the 18 July with one load (100 hives). There are 600 more hives elsewhere on the extensive farm holding
4	AT	Three Springs (15km West)	Pioneer 44Y24 RR CL	Y	04-May	2.7	60	25-Jul	25-Aug	unknown	Trifluralin (Treflan) 1.8L, paraquat 1L, chlorpyrifos 500ml, glyphosate (Roundup Ready) 900g - 2 applications, alpha-cypermethrin (Alpha-Duo) 200ml, Seed treatment: Cruiser OPTI MAX (thiamethoxam/lambda-cyhalothrin.	
5	ATT	Three Springs (2km South)	Nuseed ATR Cobbler TT Nuseed ATR Bonito TT	N	03-May	2.6	187	25-Jul	25-Aug	unknown	Atrazine (Gesaprim) 1.1kg - 2 applications, trifluralin (Treflan) 1.8L, paraquat 1L, chlorpyrifos (Lorsban) 500ml, atrazine 1.1kg - 2 applications, iprodione (Sextant) 200ml, alpha-cypermethrin (Ken-Tac) 200ml, clethodim (Havoc) 500ml, Hasten 1% (adjuvant - fatty acid esters), Amso 1% (adjuvant - ammonium sulphate), Seed treatment: Cruiser OPTI MAX (thiamethoxam/lambda-cyhalothrin.	Beekeeper (BF) beehives in on 23 July with one load (100 hives). There are 600 hives on rest of the extensive farm holding.

Farm	Farm code	Location	Canola variety	GM	Date planted	Kg seed/ha	Crop size (ha)	Exp. beehives in	Exp. beehives out	Prior crop	Chemicals/ha	Comments
6	ABK	Kulin (Hinkley Rd)	Nuseed ATR Cobbler TT	N	first week in May	9 ?	260	27-Jul	03-Sep	Wheat 2013	Atrazine 2kg, atrazine 1.5kg, omethoate (miticide) 500ml, quizalofop (Targa herbicide) 100ml, sethoxydim (Sertin) 500ml, Seed treatment: nil.	Beekeeper (AB) has been on the same farm site for 2 years ~ 100 hives.
7	ABB	Kulin (Tolga)	NPZA Sturt TT	N	Unk	1.4	2-3	27-Jul	03-Sep	Barley wheat pasture 2013	Atrazine, quizalofop-p-ethyl (Targa herbicide), Seed treatment: imidacloprid & fipronil.	
8	BS	Kulin (Tarin Rock)	NPZA Sturt TT	N	Unk	1.4	100	27-Jul	03-Sep	Barley wheat pasture 2013	Atrazine - 2 applications 2.2kg, quizalofop (Targa herbicide) 250ml, clethodim (Select) 450ml, Seed treatment: Jockey (fluquinconazole/Gaucha (imidacloprid)	
9	KF	Moora	Pacific seeds Crusher TT	N	25-Apr	6	650	29-Jul	11-Sep	Hay oats 2013	Atrazine 1.1kg - 2 applications, chlorpyrifos (Lorsban) 500ml, bifenthrin 200ml, trifluran (treflan) 3L, clethodim 500ml, quizalofop 200ml, Seed treatment: nil.	Beekeeper (KF) beehives in on 24 Jul with 100 hives, 29 July with 100 hives; Beekeeper (BM) beehives in on 3 July with 300 hives. BM has used the property for 3-4 years & extracted 3 boxes of honey to 10 Sept.
10	BM											

Farm	Farm code	Location	Canola variety	GM	Date planted	Kg seed/ha	Crop size (ha)	Exp. beehives in	Exp. beehives out	Prior crop	Chemicals/ha	Comments
11	JM	Moora	Duvuro ATR Stubby TT	N	15-May	5	208	29-Jul	11-Sep	Pasture 2013	Atrazine 1.1kg - 2 applications, bifenthrin (red legged mite), Select herbicide, Seed treatment: nil	
12	WTR	Cataby	Pacific seeds Crusher TT	N	Unk	Unk	Unk	12-Aug	11-Sep	unknown	Farm had no copies of on-farm chemical use - they used an off-farm agronomist/consultant, Seed treatment: nil.	Beekeeper: beehives in on 6 Aug.
13	NMR	Bindi Bindi	Nuseed GT-41 RR	Y	26-Apr	2.6	363	19-Aug	14-Sep	Barley 2013	Trifluralin 2.5L, chlorpyrifos 350ml, bifenthrin 200ml, glyphosate (Roundup Ready Plantshield) 900g - 2 applications, alpha-cypermethrin 150ml - 2 applications, prothioconazole+tebuconazole (Prosaro - fungicide) 450 ml, Seed treatment: Cruiser OPTI MAX (10L/tonne & 4L/tonne) thiamethoxam/lambda-cyhalothrin.	Flowering commenced 10 Jul.
14	NM	Bindi Bindi	Nuseed ATR Stingray TT	N	11-Apr	3.1	220	19-Aug	14-Sep	Barley 2013	Atrazine 1.1kg - 2 applications, bifenthrin 200ml, chlorpyrifos 350ml, trifluralin 2.5L, quizalofop 200ml, triclopyr 100ml, clethodim 500ml, quizalofop 60ml, alpha-cypermethrin	Flowering commenced 1 Jul.
15	NMM	Bindi Bindi	Nuseed ATR Stingray TT Nuseed ATR Bonito TT	N	11-Apr	3.1	34	19-Aug	14-Sep	Barley 2013	Atrazine 1.1kg - 2 applications, bifenthrin 200ml, chlorpyrifos 350ml, trifluralin 2.5L, quizalofop 200ml, triclopyr 100ml, clethodim 500ml, quizalofop 60ml, alpha-cypermethrin 150ml, Seed treatment: Cruiser OPTI MAX (thiamethoxam/lambda-cyhalothrin, flutriafol - banded 250ml	Flowering commenced 1 Jul.

Supplementary materials and methods

To determine the feasibility of analysis, only bee bread – the highest contaminated source within the hive, with the most samples was investigated from DAFWA experimental hives (as they were present on all farms) was analyzed along with samples from beehives located on native flora (B1-B4 sites). Data from six beekeepers who had hives on canola farms was excluded. The number of chemicals detected in a sample was calculated as the total number of chemicals that had a trace (T) detected or a value greater than zero.

The counts of the number of chemicals detected were consistent with what might be expected, namely the fewest chemicals for native flora and GM treated seed samples, more for Non-GM treated seed samples and the most for Non-GM, non-treated seed samples. When there were chemicals detected, GM samples tended to have more chemicals detected. Because so many of the counts are very small, a standard χ^2 test would be unreliable. Therefore, a presence/absence variable was investigated, where presence indicated that one or more chemicals were detected in the sample and absence for no chemicals detected in the sample.

A Pearson's χ^2 test was conducted on the Not Detected/Detected data (not shown) to determine whether there were differences between the treatment type in terms of likelihood of chemicals being detected in beebread. Although the trend in the *ratio* of the number of hives with/without chemicals appears meaningful, there was insufficient power to detect any statistically significant difference (p-value 0.533, $\chi^2 = 2.195$, df = 3).

When beekeeper's hives were included in a χ^2 test on treatment types, a statistically significant difference was found (p-value = 0.024), however small expected counts make the test unreliable. The same test using presence/absence rather than counts of chemicals had no significant difference (p-value = 0.114). A χ^2 test (excluding beekeeper hives) on treatment types for the counts of samples that had 'No chemicals' detected, '1-2 chemicals' detected and '3-4 chemicals' detected was also not significant (p-value = 0.642).