



Animal Residue Data Sheet Clethodim

Clethodim is registered in Australia for use on a range of crops including canola, peanuts, soybeans, cotton, legumes (chick peas, faba beans, field peas, lentils, lupins and mung beans), and vegetables (cabbage, celery, lettuce, beetroot, potatoes and onions). Details of the registered use patterns can be found on the approved labels of registered products containing clethodim as the active constituent. This Animal Residue Data Sheet provides information on the possible residues in feed commodities obtained from crops treated with clethodim. It also provides information on the anticipated maximum dietary exposure of animals fed treated commodities, which should not result in the violation of animal MRLs.

Current MRLs

Residues arising from registered use patterns for clethodim are covered by the sethoxydim entries in the *MRL Standard*. The Australian MRLs for Sethoxydim in food and animal feed commodities, as listed in Table 1 and Table 4 of the *MRL Standard* (as at June 2004) are shown below. The residue definition of clethodim (and sethoxydim) is the “*sum of sethoxydim and metabolites containing the 5-(2-ethylthiopropyl)cyclohexane-3-one and 5-(2-ethylthiopropyl)-5-hydroxycyclohexene-3-one moieties and their sulfoxides and sulfones, expressed as sethoxydim*”. MRLs associated with registered clethodim use-patterns are highlighted in shaded cells.

Code	Food	MRL, mg/kg
Food Commodities		
VS 0621	Asparagus	1
VP 0061	Beans, except broad bean and soya bean	*0.1
	Bergamot	*0.1
VP 0522	Broad bean (green pods and immature seeds)	*0.1
VB 0040	Brassica (cole or cabbage) vegetables, Head cabbages, Flowerhead brassicas	0.5
VS 0624	Celery	0.1
VL 0465	Chervil	*0.1
	Coriander (leaves, stems, roots)	*0.1
HS 0779	Coriander seed	*0.1
SO 0691	Cotton seed	0.2
HS 0730	Dill seed	*0.1
VL 0476	Endive	0.05
VA 0380	Fennel, bulb	*0.01
HS 0731	Fennel seed	*0.1
VC 0045	Fruiting vegetables, Cucurbits	*0.1
VA 0381	Garlic	0.3
HH 0092	Herbs [except thyme]	*0.1
	Kaffir lime leaves	*0.1
VA 0384	Leeks	T0.3
	Lemon grass	*0.1
DT 1111	Lemon verbena [fresh weight]	*0.1
VL 0482	Lettuce, Head	0.2
VL 0483	Lettuce, Leaf	0.2
SO 0693	Linseed	0.5
VD 0545	Lupin (dry)	0.2
	Mizuna	*0.1
VA 0385	Onion, Bulb	0.3
SO 0697	Peanut	3
VP 0063	Peas	*0.1
SO 0698	Poppy seed	0.2
VD 0070	Pulses [except lupin (dry)]	*0.1

Code	Food	MRL, mg/kg
SO 0495	Rape seed	0.5
VR 0075	Root and tuber vegetables	1
	Rose and dianthus (edible flowers)	*0.1
VL 0496	Rucola (rocket)	*0.1
HH 4731	Salad burnett	*0.1
VL 0502	Spinach	*0.1
VA 0389	Spring onion	T0.05
FB 0275	Strawberry	0.1
SO 0702	Sunflower seed	*0.1
HH 0750	Thyme	0.5
VO 0448	Tomato	0.1
HS 0794	Tumeric, root	1
GC 0654	Wheat	*0.1
Animal commodities		
MO 0105	Edible offal (mammalian)	*0.05
PE 0112	Eggs	*0.05
MM 0095	Meat (mammalian)	*0.05
ML 0106	Milks	*0.05
PO 0111	Poultry, Edible offal of	*0.05
PM 0110	Poultry meat	*0.05
Animal feed commodities		
AL 0157	Legume animal feeds [except peanut fodder and peanut forage (green)]	15
AL 0697	Peanut fodder	10
AL 1270	Peanut forage (green)	10
	Rape seed fodder and forage	10
	Wheat forage (green) [fresh weight]	*0.1
AS 0654	Wheat straw and fodder, dry	*0.1

Summary of maximum feeding levels and livestock dietary intakes

The Maximum Feeding Level (MFL, the feeding level at which the MRLs are based), the equivalent Daily Dietary Intake For Livestock (DDIL) and the equivalent daily intake of clethodim are summarised below.

Species	MFL, ppm in diet	Equivalent DDIL, mg/kg bw	Equivalent intake of clethodim, mg/animal/day
Cattle ^a	19.3	0.65	386
Sheep ^b	19.3	0.80	48
Pig ^c	19.3	0.80	48
Poultry ^d	11.5	1.04	1.7

^a Based on actual consumption data from an animal transfer study with lactating cows
^b Based on a 60 kg animal consuming 2.5 kg DM/day
^c Based on a 60 kg animal consuming 2.5 kg DM/day
^d Based on actual consumption data from an animal transfer study with laying hens

Detailed information

All feed commodities

Feed commodities that may contain residues of clethodim are listed in the table below. The theoretical maximum proportion of the diet that the commodity can comprise, when residues are present at the MRL, without the significant risk of animal commodity MRLs being violated is also given. For instance, were oilseeds to be fed to cattle at 30% of the diet, the remainder of the diet would need to be free of residues of clethodim to minimise the risk of cattle commodity MRLs being violated. It should be noted that the feeding levels assumed by the APVMA when setting animal commodity MRLs are theoretical values, and they should not be taken as recommendations of appropriate rations for livestock.

Commodity ^a	Assumed Maximum proportion of diet (%) ^b	Feed intake (kg/animal/day) ^c	MRL (mg/kg) ^d	Maximum intake of clethodim from commodity (mg/animal/day) ^e	Theoretical maximum proportion of diet (%) ^f
Cattle (Based on a 500 kg animal consuming 20 kg DM/day)					
Legume animal feeds (includes fodder/forage/straw of pulse crops)	100	20	15	300	100
Rape seed fodder and forage	100	20	10	200	100
Peanut fodder and forage	100	20	10	200	100
Lupins (dry)	100	20	0.2	4	100
Pulses [except lupin (dry)]	100	20	*0.1	2	100
Oilseeds (Cotton seed, rape seed)	30	6	0.5	3	100
Brassica vegetables wastes	5	1	0.5	0.5	100
Root and tuber vegetable wastes	5	1	2	2	100
Sheep (Based on a 60 kg animal consuming 2.5 kg DM/day)					
Legume animal feeds (includes fodder/forage/straw of pulse crops)	100	2.5	15	37.5	100
Rape seed fodder and forage	100	2.5	10	25	100
Peanut fodder and forage	100	2.5	10	25	100
Lupins (dry)	100	2.5	0.2	0.50	100
Pulses [except lupin (dry)]	100	2.5	*0.1	0.25	100
Oilseeds (Cotton seed, rape seed)	30	0.75	0.5	0.375	100
Brassica vegetables wastes	5	0.125	0.5	0.0625	100
Root and tuber vegetable wastes	5	0.125	2	0.25	100
Pigs (Based on a 60 kg animal consuming 2.5 kg DM/day)					
Lupins (dry)	100	2.5	0.2	0.50	100
Pulses [except lupin (dry)]	100	2.5	*0.1	0.25	100
Oilseeds (Cotton seed, rape seed)	30	0.75	0.5	0.375	100
Brassica vegetables wastes	5	0.125	0.5	0.0625	100
Root and tuber vegetable wastes	5	0.125	2	0.25	100
Poultry (Based on a 2 kg animal consuming 150 g DM/day)					
Lupins (dry)	100	0.150	0.2	0.030	100
Pulses [except lupin (dry)]	100	0.150	*0.1	0.015	100
Oilseeds (Cotton seed, rape seed)	30	0.045	0.5	0.0225	100

^a The feed commodities that may contain residues of clethodim, and may form more than 20% of an animals diet.

^b The maximum % of the diet that the commodity is assumed to comprise for the purposes of setting MRLs, based on Stockfeed Information Document 1

^c The equivalent amount of feed for an animal of designated weight and feed intake that is assumed for the purposes of setting MRLs

^d The MRL for each feed commodity (correction for dry weight basis where required)

^e The maximum intake of clethodim when the commodity is fed at the maximum assumed level (Column 1) in the absence of other sources of clethodim.

^f The maximum % of the diet at which the commodity could theoretically be fed without significant risk of exceeding animal commodity MRLs. It is assumed that the residue in the feed commodity is present at the MRL (or dry weight equivalent) and other dietary sources of clethodim (and sethoxydim) are absent.

Abbreviations and definitions

DM: Dry matter. The feed consumption for livestock and the residue levels in feed commodities are expressed on a dry matter basis.

DDIL: Daily Dietary Intake for Livestock. The level of dietary exposure for a specified chemical in a specified species that should not result in exceedance of the relevant animal commodity MRLs. Expressed in mg chemical/kg bodyweight.

MFL: Maximum Feeding Level. The level of dietary exposure for a specified chemical in a specified species that should not result in exceedance of the relevant animal commodity MRLs. Expressed in terms of ppm in the feed.

MRL: The concentration of a chemical residue, in units of mg/kg, that is legally permitted in or on a food or food commodity.

ppm in the feed: Parts per million in the feed. An alternate way of expressing the level of dietary exposure for a chemical. The level of chemical intake is calculated as though it were present uniformly in the total feed intake. The ppm in the feed is calculated using the following formula: $DDIL \text{ (mg chemical/kg bw)} \times \text{body weight (kg)} \div \text{daily feed intake (kg)}$.

STMR-P: Supervised Trial Median Residue of the processed commodity. The highest residue that livestock are likely to be exposed to in practice when fed processed commodities over a prolonged period. This is derived from the STMR of the whole commodity multiplied by the processing factor.

Attachment 1: Anticipated maximum dietary exposure

The following calculations outline the theoretical diet used to calculate the maximum anticipated dietary exposure, maximum feeding level (MFL) and the daily dietary intake for livestock (DDIL) for cattle, sheep, pigs and poultry.

Cattle

Feed group	Feed commodity	% in the diet	Feed intake, kg/animal/day ^a	MRL, mg/kg	% DM ^b	Intake of clethodim, mg/animal/day ^c
Legume animal feeds [100 % maximum]	Pulse fodder and forage	100	20	15	--	300
Total		100	20			300

^aBased on assumed feed consumption of 20 kg dry matter/day
^bEstimate of percentage dry matter. Applied to MRLs expressed on a fresh weight basis
^cBased on assumed bodyweight of 500 kg

Maximum anticipated dietary exposure: 300 mg/animal/day
 equivalent to: 0.60 mg/kg bw
 equivalent to: 15 ppm in the diet

MFL (Based on the available animal feeding data (Attachment 2)):
 19.3 ppm in the diet
 equivalent DDIL: 0.65 mg/kg bw

Sheep

Feed group	Feed commodity	% in the diet	Feed intake, kg/animal/day ^a	MRL, mg/kg	% DM ^b	Intake of clethodim, mg/animal/day ^c
Legume animal feeds [100 % maximum]	Pulse fodder and forage	100	2.5	15	--	37.5
Total		100	2.5			37.5

^aBased on assumed feed consumption of 2.5 kg dry matter/day
^bEstimate of percentage dry matter. Applied to MRLs expressed on a fresh weight basis
^cBased on assumed bodyweight of 60 kg

Maximum anticipated dietary exposure: 37.5 mg/animal/day
 equivalent to: 0.625 mg/kg bw
 equivalent to: 15 ppm in the diet

MFL (Based on the available animal feeding data for dairy cattle (Attachment 2)):
 19.3 ppm in the diet
 equivalent DDIL: 0.80 mg/kg bw

Pigs

Feed group	Feed commodity	% in the diet	Feed intake, kg/animal/day ^a	MRL, mg/kg	% DM ^b	Intake of clethodim, mg/animal/day ^c
Vegetable by-products [5 % maximum]	Root and tuber vegetables	5	0.125	2	--	0.250
Oilseeds [30 % maximum]	Rape seed	30	0.750	0.5	--	0.375
Pulses/legumes [100 % maximum]	Lupins (dry)	65	1.625	0.2	--	0.325
Total		100	2.50			0.950

^aBased on assumed feed consumption of 2.5 kg dry matter/day
^bEstimate of percentage dry matter. Applied to MRLs expressed on a fresh weight basis
^cBased on assumed bodyweight of 60 kg

Maximum anticipated dietary exposure: 0.95 mg/animal/day
 equivalent to: 0.016 mg/kg bw
 equivalent to: 0.38 ppm in the diet

MFL (Based on the available animal feeding data for dairy cattle (Attachment 2)):
 19.3 ppm in the diet
 equivalent DDIL: 0.80 mg/kg bw

Poultry

Feed group	Feed commodity	% in the diet	Feed intake, kg/animal/day ^a	MRL, mg/kg	% DM ^b	Intake of clethodim, mg/animal/day ^c
Oilseeds [30 % maximum]	Rape seed	30	0.045	0.5	--	0.0225
Pulses/legumes [100 % maximum]	Lupins (dry)	70	0.105	0.2	--	0.021
Total		100	0.150			0.0435

^aBased on assumed feed consumption of 0.150 kg dry matter/day
^bEstimate of percentage dry matter. Applied to MRLs expressed on a fresh weight basis
^cBased on assumed bodyweight of 2 kg

Maximum anticipated dietary exposure: 0.0435 mg/animal/day
 equivalent to: 0.022 mg/kg bw
 equivalent to: 0.29 ppm in the diet

MFL (Based on the available animal feeding data (Attachment 2)):
 11.5 ppm in the diet
 equivalent DDIL: 1.04 mg/kg bw

Attachment 2: Residue data

The residue definition of clethodim (and sethoxydim) in Australia is “*sum of sethoxydim and metabolites containing the 5-(2-ethylthiopropyl)cyclohexane-3-one and 5-(2-ethylthiopropyl)-5-hydroxycyclohexene-3-one moieties and their sulfoxides and sulfones, expressed as sethoxydim*”.

Selected residue data for animal feed commodities

Clethodim residues in Legume Animal Feeds {Source: 1997 JMPR Review of Clethodim}

Location, year, Ref	Rate, g ai/ha	No.	PHI, days	% DM ^o	Clethodim residues mg sethoxydim equiv./kg DM	
					Raw results	Corrected to 1× rate
Alfalfa (lucerne) Australia, Not dated	120 g ai/ha (0.86×)	1	0	35	6.0	20
			3	35	1.1	3.7
			14	35	0.12	0.4
	240 g ai/ha (1.7×)	1	0	35	1.1	1.9
			3	35	3.2	5.4
			7	35	1.8	3.0
			14	35	0.66	1.1
	480 g ai/ha (3.4×)	1	0	35	24.6	21
			14	35	0.55	0.5
Soybean forage USA, 1987/88	448 g ai/ha (5×)	2	0	31	10, 9	6.5, 5.8
			7	29	3.7, 2.7	2.6, 1.9
			14	29	2.6, 3.0	1.8, 2.1
			28	43	1.8, 2.0	0.8, 0.9
	280 g ai/ha (3.1×)	2	7	27	2.5, 2.7	3.0, 3.2
			7	25	1.1, 1.1	1.4, 1.4
			7	26	5.9, 4.2	7.3, 5.2
			7	28	2.3, 2.4	2.6, 2.8
			7	25	2.7, 1.5	3.5, 1.9
			7	25	2.7, 2.4	3.5, 3.1
			7	29	5.5, 3.1	6.1, 3.4
			7	18	3.1, 3.3	5.6, 5.9
			7	28	0.54, 0.41	0.6, 0.6
			12	24	5.2, 3.7	7.0, 5.0
			34	30	1.0, 1.0	1.1, 1.1
Peanut forage Australia, 1993/94	240 g ai/ha (2.7×)	1	11	100	15.5	5.7
			18	100	10.0	3.7
			49	100	2.1	0.8
	480 g ai/ha (5.3×)	1	11	100	29.1	5.5
			18	100	21.8	4.1
			49	100	5.1	1.0
Peanut forage USA, Not dated	280 g ai/ha (3.1×)	2	0	25	3.5, 6.7	4.5, 8.6
			12	25	0.61, 0.81	0.8, 1.0
			19	25	0.48, 0.66	0.6, 0.9
			26	25	0.35, 0.41	0.5, 0.5
			33	25	0.32, 0.36	0.4, 0.5
			40	25	0.17, 0.20	0.2, 0.3

^oIn the absence of actual data for dry matter content, a value of 35 % DM was used for alfalfa (lucerne) forage, and a value of 25 % DM was used for peanut forage. [Source: EPA Residue Chemistry Test Guidelines OPPTS 860.1000 Background].

Selected animal transfer data

Lactating cows – milk and tissues

Lactating cows (n=12) were dosed orally (by capsule) for 28 consecutive days with a combination of clethodim and clethodim sulfoxide. Full details of the dosing regime are provided in the table below. Milk was collected from treated animals throughout the treatment period. Groups of animals (n=3/treatment rate) were sacrificed within 24 hours of the last dose. The remaining animals (n=1/treatment rate) were sacrificed after 2 days withdrawal.

Dose rate	Clethodim	Sulfoxide	Clethodim	Sulfoxide	*Total dose	*Total dose
	(mg/kg dry feed)	(mg/kg dry feed)	(mg/kg bw)	(mg/kg bw)	(mg/kg dry feed)	(mg/kg bw)
1×	1.0	19.1	0.034	0.65	19.3	0.65
3×	3.2	60.3	0.099	1.87	61	1.89
10×	10.8	204.9	0.299	5.68	207	5.73

*Total dose = clethodim + clethodim sulfoxide, expressed as clethodim equivalents.

Residues of clethodim equivalents in cattle tissues following 28 consecutive daily doses

Matrix	Feed level, mg/kg feed	Dose rate, mg/kg bw	Maximum residue, mg/kg			
			DME	S-methyl DME	DME-OH	Total residue
Muscle	19.3	0.65	<0.05	<0.05	<0.05	<0.15
	61	1.89	<0.05	<0.05	<0.05	<0.15
	207	5.7	0.07	<0.05	<0.05	<0.17
Fat	19.3	0.65	<0.05	<0.05	<0.05	<0.15
	61	1.89	0.052	<0.05	<0.05	<0.152
	207	5.7	0.153	<0.05	<0.05	<0.253
Liver	19.3	0.65	0.059	<0.05	<0.05	<0.159
	61	1.89	0.119	<0.05	<0.05	<0.219
	207	5.7	0.445	0.087	<0.05	<0.582
Kidney	19.3	0.65	0.051	<0.05	<0.05	<0.151
	61	1.89	0.170	<0.05	<0.05	<0.270
	207	5.7	0.538	0.078	<0.05	<0.666
Milk (whole, days 1-28)	19.3	0.65	<0.0125	<0.0125	<0.0125	<0.0375
	61	1.89	0.0334	<0.0125	<0.0125	<0.0584
	207	5.7	0.0812	0.0316	<0.0125	<0.1253

DME = Dimethyl 3-[2-(ethylsulfonyl)-propyl]pentanedioate, expressed as mg/kg clethodim equivalents.

S-methyl DME = the S-methyl analogue of Dimethyl 3-[2-(ethylsulfonyl)-propyl]pentanedioate, expressed as mg/kg clethodim equivalents.

DME-OH = 3-hydroxy substituted Dimethyl 3-[2-(ethylsulfonyl)-propyl]pentanedioate, expressed as mg/kg clethodim equivalents.

Total residue = Sum of DME + S-methyl DME + DME-OH, expressed as mg/kg clethodim equivalents.

Residues of clethodim, mg/kg, in milk and tissues of the depuration animals (from the above trial where lactating Holstein cows were dosed orally for 28 consecutive days with clethodim at levels of 19.3, 61 and 207 ppm in the diet (equivalent to 0.65, 1.89 and 5.7 mg/kg bw, respectively)).

Sample	Dose rate (ppm in the diet)	Withdrawal period (days)	Residues, mg/kg			
			DME	S-methyl DME	DME-OH	Total residue
Whole milk	19.3	0	<0.0125	<0.0125	<0.0125	<0.0375
		1	<0.0125	<0.0125	<0.0125	<0.0375
		2	<0.0125	<0.0125	<0.0125	<0.0375
		3	<0.0125	<0.0125	<0.0125	<0.0375
	61	0	0.0334	<0.0125	<0.0125	<0.0584
		1	<0.0125	<0.0125	<0.0125	<0.0375
		2	<0.0125	<0.0125	<0.0125	<0.0375
		3	<0.0125	<0.0125	<0.0125	<0.0375
	207	0	0.0591	<0.0125	<0.0125	<0.0841
		1	0.0130	<0.0125	<0.0125	<0.0380
		2	<0.0125	<0.0125	<0.0125	<0.0375
		3	<0.0125	<0.0125	<0.0125	<0.0375

DME = Dimethyl 3-[2-(ethylsulfonyl)-propyl]pentanedioate, expressed as mg/kg clethodim equivalents.

S-methyl DME = the S-methyl analogue of Dimethyl 3-[2-(ethylsulfonyl)-propyl]pentanedioate, expressed as mg/kg clethodim equivalents.

DME-OH = 3-hydroxy substituted Dimethyl 3-[2-(ethylsulfonyl)-propyl]pentanedioate, expressed as mg/kg clethodim equivalents.

Total residue = Sum of DME + S-methyl DME + DME-OH, expressed as mg/kg clethodim equivalents.

Laying Hens

White Leghorn chickens (n=60) were orally dosed with capsules containing 5% clethodim and 95 % clethodim sulfoxide for 28 consecutive days. Three dose rates were used, and details are tabulated below. Eggs were collected from treated birds throughout the treatment period. Groups of birds (n=10/treatment rate) were sacrificed within 24 hours of the last dose. The remaining birds (n=10/treatment rate) were sacrificed after 2 days withdrawal.

Dose rate	Clethodim	Sulfoxide	Clethodim	Sulfoxide	*Total dose	*Total dose
	(mg/kg feed)	(mg/kg feed)	(mg/kg bw)	(mg/kg bw)	(mg/kg feed)	(mg/kg bw)
1×	0.75	11.2	0.068	1.02	11.5	1.04
3×	1.89	34.1	0.167	3.01	34.5	3.05
10×	18.7	108.2	1.64	9.50	122	10.7

*Total dose = clethodim + clethodim sulfoxide, expressed as clethodim equivalents.

Residues of clethodim equivalents in poultry tissues/eggs following 28 consecutive daily doses

Matrix	Feed level, mg/kg feed	Dose rate, mg/kg bw	Maximum residue, mg/kg			
			DME	S-methyl DME	DME-OH	Total residue
Muscle	11.5	1.04	<0.05	<0.05	<0.05	<0.15
	34.5	3.05	<0.05	<0.05	<0.05	<0.15
	122	10.7	<0.05	<0.05	<0.05	<0.15
Fat	11.5	1.04	<0.05	<0.05	<0.05	<0.15
	34.5	3.05	<0.05	<0.05	<0.05	<0.15
	122	10.7	<0.05	<0.05	<0.05	<0.15
Liver	11.5	1.04	<0.05	<0.05	<0.05	<0.15
	34.5	3.05	<0.05	<0.05	<0.05	<0.15
	122	10.7	0.06	<0.05	<0.05	<0.15
Eggs (whole, days 1-28)	11.5	1.04	<0.05	<0.05	<0.05	<0.15
	34.5	3.05	0.09	<0.05	<0.05	<0.19
	122	10.7	0.24	<0.05	<0.05	<0.34
Eggs (whole, after 1 or 2 days withdrawal)	11.5	1.04	<0.05	<0.05	<0.05	<0.15
	34.5	3.05	<0.05	<0.05	<0.05	<0.15
	122	10.7	<0.05	<0.05	<0.05	<0.15

DME = Dimethyl 3-[2-(ethylsulfonyl)-propyl]pentanedioate, expressed as mg/kg clethodim equivalents.

S-methyl DME = the S-methyl analogue of Dimethyl 3-[2-(ethylsulfonyl)-propyl]pentanedioate, expressed as mg/kg clethodim equivalents.

DME-OH = 3-hydroxy substituted Dimethyl 3-[2-(ethylsulfonyl)-propyl]pentanedioate, expressed as mg/kg clethodim equivalents.

Total residue = Sum of DME + S-methyl DME + DME-OH, expressed as mg/kg clethodim equivalents.