

(Variety)	Application				PHI, days	Residues, mg/kg, as glufosinate free acid		Ref
	Form	kg ai/ha	kg ai/hl	no.		glufosinate	MPP	
(Carmel)	SL	1.7		3	15	< <u>0.5</u> (3)	<0.5 (3)	A48446 07-CA-85-018
(Carmel)	SL	3.4		3	15	<0.5 (3)	<0.5 (3)	A48446 07-CA-85-018
(Special)	SL	1.7		3	15	< <u>0.5</u> (3)	<0.5 (3)	A48446 07-CA-85-018
(Special)	SL	3.4		3	15	<0.5 (3)	<0.5 (3)	A48446 07-CA-85-018
(Non-Peril)	SL	1.7		3	14	< <u>0.5</u> (3)	<0.5 (3)	A48446 07-CA-85-037
(Non-Peril)	SL	3.4		3	14	<0.5 (3)	<0.5 (3)	A48446 07-CA-85-037

### Farm animal feeding studies

Studies on cows and laying hens were reported.

Groups of 3 lactating Holstein dairy cows (each weighing 430-610 kg) were dosed with glufosinate-ammonium + NAG (15+85) in gelatin capsules at total nominal levels equivalent to 9.1, 27 and 91 ppm glufosinate free acid in the diet for 28 consecutive days (Czarnecki and Brady, 1995b). Doses were administered after the morning milking in four separate capsules, one containing glufosinate-ammonium and three containing NAG. Milk was collected twice each day and pooled for analysis. On day 29 the animals from each group were slaughtered. The cows consumed a nominal 21 kg (average 16.8-25.4 kg) feed each per day.

The dosing mixture (glufosinate-ammonium 15 parts + NAG 85 parts) was chosen to represent the typical terminal residue composition in glufosinate-resistant crops that might be fed to animals.

Residues were not detected in milk from the lowest dosing level, detected in a few samples from the middle level, and consistently detected the highest dose group where a plateau was reached on day 3. Two milk samples from the same cow (on days 16 and 18) had unusually high residues, which corresponded with a period of low feed consumption (a constant dose representing a higher feed concentration) and low milk production. Residues in the tissues were below the LODs at the lower doses. At the highest dose they were detected in the kidneys and liver, but not in muscle or fat.

Table 62. Residues in the tissues of lactating dairy cows dosed with glufosinate-ammonium + NAG (15+85) in gelatin capsules at levels equivalent to 9.1, 27 and 91 ppm glufosinate free acid in the diet for 28 consecutive days (Czarnecki and Brady, 1995b).

Tissue	Residues, mg/kg, expressed as glufosinate free acid					
	9.1 ppm		27 ppm		91 ppm	
	glufosinate + NAG	MPP	glufosinate + NAG	MPP	Glufosinate + NAG	MPP
Muscle	<0.05 (3)	<0.05 (3)	<0.05 (3)	<0.05 (3)	<0.05 (3)	<0.05 (3)
Fat, perirenal	<0.05 (3)	<0.05 (3)	<0.05 (3)	<0.05 (3)	<0.05 (3)	<0.05 (3)
Liver	<0.1 (3)	<0.1 (3)	<0.1 (3)	<0.1 (3)	<0.1 (3)	0.28 0.29 0.25
Kidneys	<0.1 (3)	<0.1 (3)	<0.1 (3)	<0.1 (3)	0.10 0.14 0.15	<0.1 (2) 0.13

Table 63. Residues in the milk of lactating dairy cows dosed with glufosinate-ammonium + NAG (15+85) in gelatin capsules at levels equivalent to 9.1, 27 and 91 ppm glufosinate free acid in the diet for 28 consecutive days (Czarnecki and Brady, 1995b).

Day	Residues, mg/kg, expressed as glufosinate free acid					
	9.1 ppm		27 ppm		91 ppm	
	glufosinate + NAG	MPP	glufosinate + NAG	MPP	glufosinate + NAG	MPP
1	<0.02 (3)	<0.02 (3)	<0.02 (3)	<0.02 (3)	<0.02 (3)	<0.02 (3)
3	<0.02 (3)	<0.02 (3)	<0.02 (3)	<0.02 (3)	0.05 0.04 0.05	<0.02 (3)
5	<0.02 (3)	<0.02 (3)	<0.02 (3)	<0.02 (3)	0.05 0.04 0.03	<0.02 (3)
7	<0.02 (3)	<0.02 (3)	0.02 <0.02 (2)	<0.02 (3)	0.04 0.05 0.02	<0.02 (3)
9	<0.02 (3)	<0.02 (3)	<0.02 (3)	<0.02 (3)	0.03 0.03 0.03	<0.02 (3)
11	<0.02 (3)	<0.02 (3)	0.02 <0.02 (2)	<0.02 (3)	0.04 0.03 0.03	<0.02 (3)
14	<0.02 (3)	<0.02 (3)	<0.02 (3)	<0.02 (3)	0.03 0.03 0.03	<0.02 (3)
16	<0.02 (3)	<0.02 (3)	<0.02 (2) 0.02	<0.02 (3)	0.05 0.23 0.03	<0.02 0.03 <0.02
18	<0.02 (3)	<0.02 (3)	<0.02 (3)	<0.02 (3)	0.04 0.14 0.03	<0.02 0.03 <0.02
21	<0.02 (3)	<0.02 (3)	0.03 <0.02 (2)	<0.02 (3)	0.05 0.05 0.04	<0.02 (3)
23	<0.02 (3)	<0.02 (3)	0.02 <0.02 0.03	<0.02 (3)	0.064 0.03 0.02	<0.02 (3)
25	<0.02 (3)	<0.02 (3)	0.02 <0.02 (2)	<0.02 (3)	0.072 0.02 0.03	<0.02 (3)
28	<0.02 (3)	<0.02 (3)	0.02 <0.02 (2)	<0.02 (3)	0.05 0.04 0.03	<0.02 (3)

Groups of 20 white leghorn laying hens (each bird weighing 1.4-1.5 kg) were dosed with glufosinate-ammonium + NAG L-isomer, 15+85 in gelatin capsules at nominal levels equivalent to 0.36, 1.1 and 3.6 ppm glufosinate free acid in the diet for 28 days (Czarnecki and Brady, 1995a; Helsten, 1995; Crotts and McKinney, 1995). On day 29 twelve hens from each group were slaughtered. The remaining hens from each group were placed on a residue-free diet and killed on days 35 and 42. Eggs were collected daily.

The dosing levels were chosen on the assumption of feed consumption of 180 g/bird/day, but the birds consumed 133-160 g feed each per day. The actual dosing levels would be about 20% higher than intended.

No residues of glufosinate + NAG or MPP were found above the LOD in any of the tissues or eggs (Table 64).

Table 64. Residues in the tissues and eggs of hens dosed with glufosinate + NAG, (15+85) at levels equivalent to 0.36, 1.1 and 3.6 ppm in the feed for 28 days (Czarnecki and Brady, 1995a).

Commodity	Residues expressed as glufosinate free acid, mg/kg					
	0.36 ppm		1.1 ppm		3.6 ppm	
	glufosinate + NAG	MPP	glufosinate + NAG	MPP	glufosinate + NAG	MPP
Skin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Muscle	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Liver	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fat	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Eggs <sup>1</sup>	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

<sup>1</sup>Eggs from days 1, 3, 5, 7, 9, 11, 14, 16, 18, 21, 23, 25 and 28 were analysed.

## FATE OF RESIDUES IN STORAGE AND PROCESSING

The effects of commercial processing on residues in sugar beet, maize, soya bean seed and canola seed were reported.

Zietz and Simpson (1997) processed tolerant sugar beet roots (80-100 kg in each trial) from three glufosinate-ammonium residue trials in France, Germany and the UK (Hees and Werner, 1997d) and measured the residues in the processed fractions. The crops were each treated twice with glufosinate-ammonium at 0.80 kg ai/ha with the final treatment at GS19 (9 or more leaves unfolded) or GS31 (beginning of crop cover formation) and harvest 111-124 days later. The process (Figure 6) simulated a commercial operation.

The results are shown in Table 65.

Residues generally tended to remain in the juice and ultimately to appear in the molasses. Residues were not detected (<0.05 mg/kg) in the raw sugar.

Processing factors were calculated only for the glufosinate + NAG residues because the MPP residues in the sugar beet were too low to be useful. Processing factors for raw sugar could not be determined because residues were not found in the sugar in any of the trials. The processing factors for molasses were 5.0, 11.5 and 3.8 (mean 6.8) showing that glufosinate residues in the roots become concentrated in the molasses after removal of water.

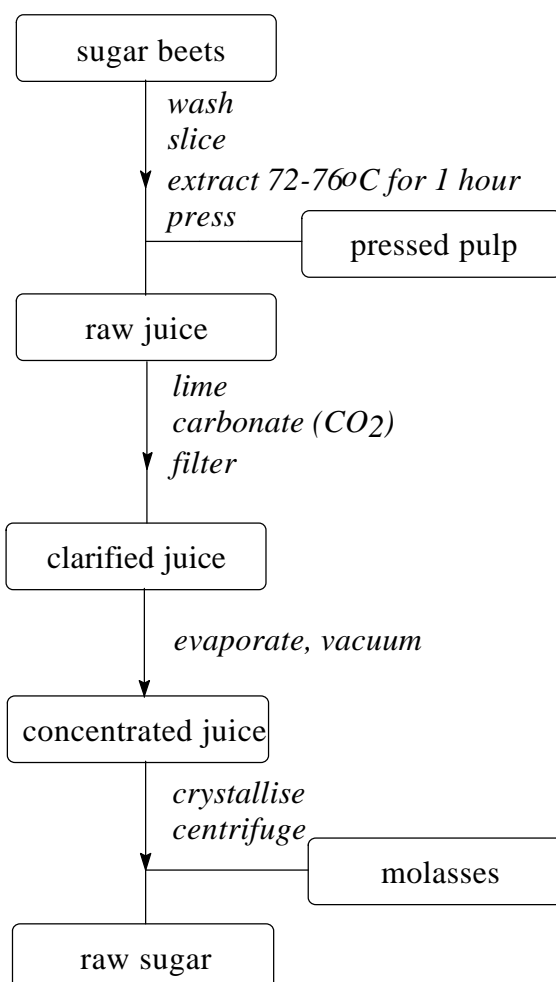


Figure 6. Sugar beet processing.

Table 65. Glufosinate residues in sugar beet roots and processing fractions arising from glufosinate-ammonium treatment of transgenic sugar beet in trials in Germany (DEU010102), France (FRA000202) and the UK (GBR000102) (Hees and Werner 1997d, Zietz and Simpson 1997).

Commodity	Residues, mg/kg as glufosinate free acid					
	DEU010102		FRA000202		GBR000102	
	glufosinate + NAG	MPP	glufosinate + NAG	MPP	glufosinate + NAG	MPP
Root	0.3	0.05	0.06	<0.05	0.99	<0.05
Pressed pulp	<0.05	<0.05	<0.05	<0.05	0.13	<0.05
Raw juice	0.25	<0.05	0.11	<0.05	0.77	0.05
Clarified juice	0.19	<0.05	0.09	<0.05	0.82	0.05
Concentrated juice	0.72	0.14	0.55	0.05	2.5	0.17

Commodity	Residues, mg/kg as glufosinate free acid					
	DEU010102		FRA000202		GBR000102	
	glufosinate + NAG	MPP	glufosinate + NAG	MPP	glufosinate + NAG	MPP
Raw sugar	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molasses	1.5	0.23	0.69	0.06	3.8	<0.05

Brady and Bertrand (1997) treated transgenic sugar beet, variety T-4A, with glufosinate-ammonium three times at 3.0 kg ai/ha, about 5 times the label rate and harvested the crop 136 days after the final treatment at the eighth leaf stage. The laboratory processing of 141 kg sugar beet roots was designed to simulate a commercial process (Englar, 1997) and was similar to that in Figure 6. The results are shown in Table 66.

In this trial, in contrast to the Zietz and Simpson trial, MPP was the main component of the residue. The total residue was used to calculate processing factors of 0 (<0.08) for refined sugar, and 6.4 for molasses.

Table 66. Glufosinate residues in sugar beet root and processing fractions arising from glufosinate-ammonium treatment of transgenic sugar beet in trials in the USA at 3.0 kg ai/ha and harvest 136 days after the last of three treatments (Brady and Bertrand, 1997).

Commodity	Residues, mg/kg as glufosinate free acid	
	glufosinate + NAG	MPP
Root	0.27 0.24	1.0 0.96
Dried pulp	0.14 0.15	0.56 0.63
Refined sugar	<0.05 (2)	<0.05 (2)
Molasses	1.7 1.4	6.5 6.1

Czarnecki (1996) showed that the residues in grain dust were about 10 times as high as in the grain from glufosinate-ammonium-treated tolerant maize. The grain dust contained 0.62 mg/kg of MPP and 3.0 mg/kg glufosinate + NAG from grain containing MPP and glufosinate + NAG at 0.062 and 0.31 mg/kg respectively, all expressed as glufosinate free acid. Residue levels increased as particle size decreased, with levels in the <425  $\mu\text{m}$  fraction 2.5-3 times those in the >2450  $\mu\text{m}$  fraction.

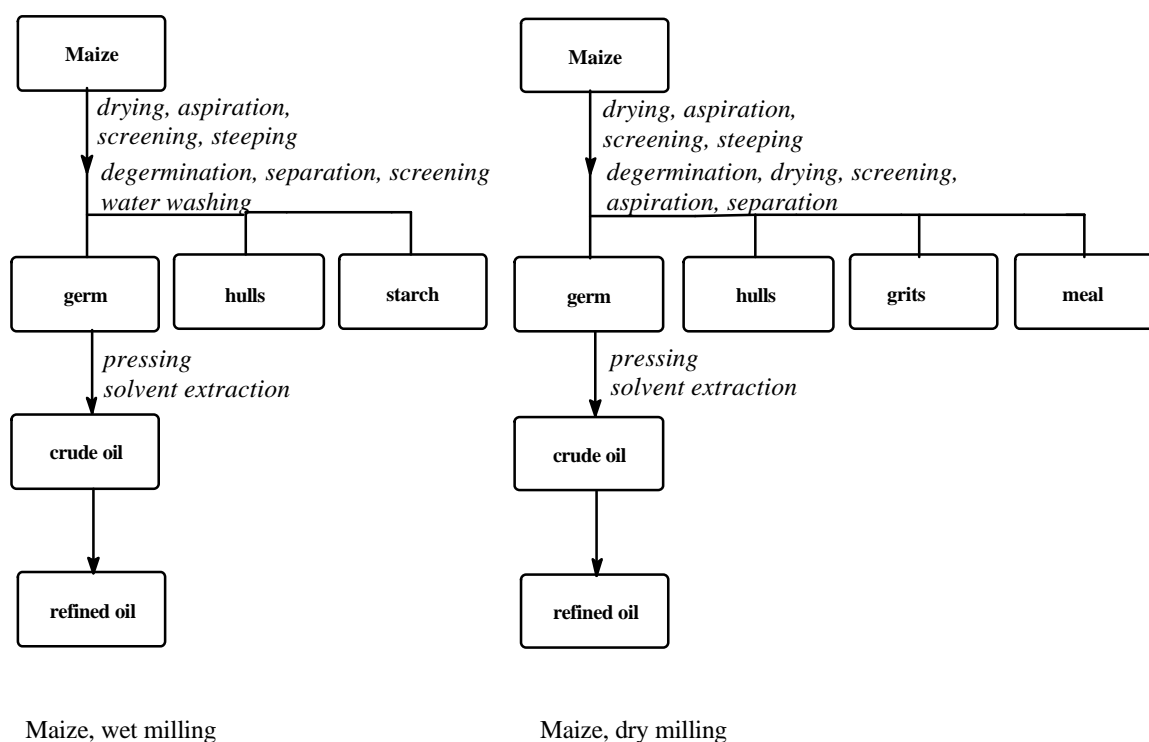
To provide samples for a processing study in the USA Brady *et al.* (1994) treated glufosinate-tolerant maize (60 cm stage) with glufosinate-ammonium at 0.50 kg ai/ha (3 times the proposed label rate) in a trial in Iowa. In a second trial in Nebraska glufosinate-ammonium was applied at 0.36 kg ai/ha to 30 cm maize with a second treatment at 0.50 kg ai/ha at the 60 cm growth stage. The maize was treated by wet and dry milling processes (Figure 7). The results are shown in Table 67.

The residues were all below the LOD (0.05 mg/kg) in the Iowa trial. NAG was present at the LOD in the meal, flour and grits and at 0.1 mg/kg in the hulls in the Nebraska trial. The best estimates for processing factors are corn meal, corn flour and grits 1, hulls 2.

Table 67. Residues in maize and processed fractions resulting from dry and wet milling of glufosinate-tolerant maize treated at excessive rates with glufosinate-ammonium (Brady *et al.* 1994).

Commodity	Iowa trial			Nebraska trial		
	Residues, mg/kg as glufosinate					
	Glufosinate	MPP	NAG	Glufosinate	MPP	NAG
Maize	<0.05	<0.05	<0.05	<0.05	<0.05	0.054
Corn meal (dry milled)	<0.05	<0.05	<0.05	<0.05	<0.05	0.051
Corn flour (dry milled)	<0.05	<0.05	<0.05	<0.05	<0.05	0.053
Corn hulls (dry milled)	<0.05	<0.05	<0.05	<0.05	<0.05	0.10
Corn grits (dry milled)	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Corn crude oil (dry milled)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Corn refined oil (dry milled)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Corn hulls (wet milled)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Corn starch (wet milled)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Corn crude oil (wet milled)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Corn refined oil (wet milled)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Figure 7. Wet and dry milling of maize (Brady *et al.*, 1994).



Brady (1995e) processed seed from transgenic soya bean crops treated at excessive rates with glufosinate-ammonium and measured the residues, expressed as glufosinate free acid, in the aspirated grain fractions (grain dust). In the two trials 32 kg of soya bean seed produced 78 and 228 g of grain dust. Residues in the grain dust were 8.6 and 2.8 times the levels in the grain in the two trials.

Trial	soya bean seeds		grain dust	
	glufosinate + NAG	MPP	glufosinate + NAG	MPP
IN-01	3.4 mg/kg	1.1 mg/kg	31mg/kg	8.7 mg/kg
MO-01	1.5 mg/kg	1.8 mg/kg	4.3mg/kg	4.7 mg/kg

Czarnecki *et al.* (1994a) treated a transgenic soya bean crop in the USA (Iowa) with glufosinate-ammonium at 2.6 kg ai/ha (5 times the normal rate) at the six-trifoliolate growth stage and harvested the soya beans for processing 96 days later. After processing 31 kg of the soya beans (Figure 8) the hulls contained the highest residues with lower levels in the meal. Residues of

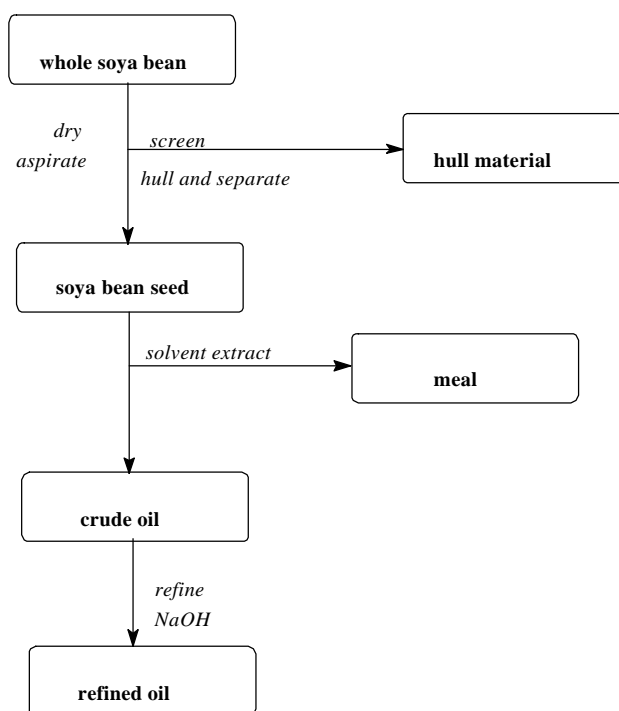


Figure 8. Simulated commercial processing of soya beans

glufosinate, NAG and MPP were not detected (<0.05 mg/kg) in the refined or crude oil. The results are shown in Table 68.

The calculated processing factors for residues in the meal and crude or refined oil are 1.3 and 0 (<0.3) respectively.

Table 68. Residues of glufosinate, NAG and MPP in seeds and processed commodities from glufosinate-treated transgenic soya beans (Czarnecki *et al.*, 1994a).

Commodity	Residues as glufosinate free acid, mg/kg		
	glufosinate	NAG	MPP
Seeds	<0.05	0.07	0.08
Hulls	0.07	0.27	0.30
Meal	<0.05	0.08	0.12
Refined oil	<0.05	<0.05	<0.05
Crude oil	<0.05	<0.05	<0.05

MacDonald (1996a) treated a transgenic canola crop in Canada (Saskatchewan) with single applications of glufosinate-ammonium at 0.75, 1.5 and 3.8 kg ai/ha (up to 4 times the normal rate) at the 4-6 leaf growth stage and harvested the seed (3.5-5 kg) for processing 70 days later.

Processing was on a small scale but was intended to simulate commercial practice. The canola seed was dried and cleaned and, after conditioning, crude oil was produced first by pressing and then by hexane extraction of the cake. The cake was toasted. The crude oil was refined, bleached and deodorised. The results are shown in Table 69.

Glufosinate itself was not detected in the seed or any processed fraction. The main residue was NAG. No residues were detected in the oils. The residues of NAG remain with the meal and

change little during toasting. The calculated processing factor for untoasted meal is 3.1 (2.7, 3.1, 3.7) and for toasted meal 3.7 (3.1, 3.3, 4.8).

Table 69. Residues in seed and processed fractions from transgenic canola treated with glufosinate at three rates and harvested 70 days later in Canada (MacDonald 1996a).

Commodity	Residues, mg/kg as glufosinate free acid								
	0.75 kh ai/ha			1.5 kg ai/ha			3.8 kg ai/ha		
	glufosinate	MPP	NAG	Glufosinate	MPP	NAG	glufosinate	MPP	NAG
Seed	<0.05	<0.05	0.063	<0.05	<0.05	0.060	<0.05	<0.05	0.21
Meal, untoasted	<0.05	<0.05	0.17	<0.05	<0.05	0.22	<0.05	0.11	0.64
Meal, toasted	<0.05	<0.05	0.21	<0.05	0.05	0.29	<0.05	0.11	0.64
Oil, crude	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Oil, refined	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Oil, bleached	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Oil, deodorized	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Soapstock	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.083

### Residues in the edible portion of food commodities

The only information was the from processing studies on soya bean, canola and sugar beet.

The processing factors for the residues in soya bean meal and crude or refined oil were 1.3 and 0 (<0.3) respectively. Residues were not detected (<0.05 mg/kg) in the crude or refined oil.

The processing factor for residues in untoasted canola meal was 3.1 and for toasted meal 3.7. Residues were not detected (<0.05 mg/kg) in the crude, refined, bleached or deodorized oil.

The processing factors for raw sugar and molasses in one trial were 0 (<0.35) and 6.8 respectively. In another trial the processing factors for refined sugar and molasses were 0 (<0.08) and 6.4 respectively. No residues were detected (<0.05 mg/kg) in the raw or refined sugar.

### RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

No information.

### NATIONAL MAXIMUM RESIDUE LIMITS

The Meeting was informed of the following national MRLs.

Country	MRL, mg/kg	Commodity
Argentina <u>1/</u>	0.05	corn grain, corn forage, corn fodder
	<u>2/</u>	top fruits, stone fruits, citrus, grapes
Australia <u>3/</u>	15	mixed pasture (legume/grasses)
	5	edible offal (mammalian)
	0.2	assorted tropical and sub-tropical fruits – inedible peel
	0.1	berries and other small fruits, citrus fruits, meat (mammalian), tree nuts, pome fruits
	0.05	milks, stone fruits
Austria <u>4/</u>	0.1	all crops
Belgium <u>5/</u>	2	potatoes

Country	MRL, mg/kg	Commodity
	0.05	all other crops
Brazil <u>6/</u>	0.05	lettuce, cotton, banana, citrus, potatoes, coffee, apple, maize, peach, Savoy-cabbage, soya beans, wheat, grape, bean
Canada <u>7/</u>	6	lentils
	3	rape seed (canola)
	1	liver and kidneys of cattle, goats, hogs, poultry and sheep
	0.5	dry white beans
	0.4	potatoes
	0.2	corn
Colombia	<u>8/</u>	cotton, banana, soya bean, papaya, citrus, grape, strawberry, passion-flower, African palm, potatoes, coffee
Denmark		<u>9/</u>
Finland		<u>9/</u>
France <u>10/</u>	0.5	citrus, small berries, bananas, cherries, stone fruits, pome fruits, hazel nuts, tree nuts, olives, carrots, chicory, cabbage, spinach, beans, lettuce, lamb's lettuce, sweet maize, onions, potatoes
Germany <u>11/</u>	3	pulses, sunflower seeds with hulls
	1	potatoes, rape seed
	0.5	currants, kiwifruit
	0.2	bananas, citrus
	0.1	other food of plant origin
Greece		<u>9/</u>
Ireland		<u>9/</u>
Italy	0.1	citrus, small berries and small fruits, stone fruits, pome fruits, tree nuts, hazel nuts, kiwis, onion, cabbage, lettuce, beans, carrots, kohlrabi, radish, asparagus, potatoes, soya beans
Japan	0.5	potato, rice, tea
	0.3	mandarin, other citrus, large fruits, small fruits, oil seeds, nuts
	0.2	wheat, other cereals, vegetables, beans (immature + pods), leafy vegetables, rhizomes, bulb vegetables, mushrooms
	0.1	soya bean
Luxemburg <u>5/</u>	0.2	potatoes
	0.05	fruits and vegetables
Netherlands <u>12/</u>	0.5	potatoes
	0.05	fruit, vegetables
	0-0.05 <u>13/</u>	other food commodities
Norway		<u>9/</u>
Poland	3	legume vegetables
	0.2	fruits, vegetables (except legume vegetables)
Portugal <u>14/</u>	3	barley
	1	wheat
	0.5	potatoes
	0.1	citrus, berries, brassicae
	0.1 <u>15/</u>	tea, hop
	0.05 <u>15/</u>	pome fruits, stone fruits, other fruits, roots and tubercles, bulbs, fruits and vegetables, hard shelled fruits, leaf vegetables and fresh spice plants, fresh leguminosae, stalks, fungi, leguminosae (dried) grains, oil seeds, other cereals
Spain <u>16/</u>	0.05	fruits, vegetables, potatoes, cereals
	0.01 <u>17/</u>	legumes, oily seeds, tea and other infusions, dried hops, spices, tobacco, sugar beet, sugarcane, forages and hays, dried products (raisins, plums, etc)
South Africa <u>18/</u>	2	soya beans
	0.2	canola, maize
Sweden		<u>9/</u>
Switzerland	0.5	potatoes
	0.05	fruits and vegetables
UK <u>19/</u>	5.0	barley
	3.0	peas

Country	MRL, mg/kg	Commodity
	1.0	potatoes, wheat, linseed, field beans
	0.5	rape seed
USA	25	aspirated grain fractions (grain dust) <u>20/</u>
	6	corn stover <u>20/</u>
	5	soya bean hulls <u>20/</u>
	4	corn forage <u>20/</u>
	2	soya beans <u>20/</u>
	0.5	almond hulls <u>21/</u>
	0.3	banana (0.2 in pulp) <u>22/</u>
	0.2	corn grain <u>20/</u>
	0.1	meat by-products such as kidneys and liver of cattle, goats, hogs, horses, poultry and sheep <u>21/</u>
	0.1	tree nuts <u>21/</u>
	0.05 <u>21/</u>	apples, cattle fat, cattle meat, eggs, goats fat, goats meat, grapes, hogs fat, hogs meat, horses fat, horses meat, poultry fat, poultry meat, sheep fat, sheep meat
	0.02	milk <u>21/</u>

1/ Definition of the residue: glufosinate-ammonium, expressed as glufosinate free acid

2/ For these crops Argentina follows MRLs established in Brazil or Germany.

3/ Definition of the residue: sum of glufosinate-ammonium and 3-[hydroxy(methyl)phosphinoyl]propionic acid, calculated as glufosinate (free acid).

4/ Definition of the residue: DL-homoalanin-4-yl-(methyl)phosphinic acid: in total calculated as glufosinate

5/ Definition of the residue: DL-homoalanin-4-yl-(methyl)phosphinic acid and 3-methylphosphinicopropionic acid calculated as glufosinate free acid.

6/ Definition of the residue: glufosinate-ammonium, expressed as glufosinate free acid

7/ Definition of the residue: 4-(hydroxy-(methyl)-phosphinoyl)-DL-homoalaninate ammonium salt, including the metabolite 3-methyl-phosphinicopropionic acid.

8/ Definition of the residue: the authorities accept the MRLs established by Codex and EPA

9/ No MRLs have been established by Denmark, Finland, Greece, Ireland, Norway or Sweden. Codex MRLs or those established in other EU countries are accepted

10/ Definition of the residue: 4-(hydroxy(methyl)phosphinoyl)-D,L-homoalanine

11/ Definition of the residue: DL-homoalanin-4-yl-(methyl)phosphinic acid and 3-methylphosphinicopropionic acid calculated as glufosinate

12/ Definition of the residue: glufosinate-ammonium, expressed as glufosinate.

13/ Range of 0 - 0.05 mg/kg because the LOD is 0.05 mg/kg

14/ Definition of the residue: glufosinate-ammonium and its metabolites 2-acetamido-4-methylphosphinico-butanoic acid and 3-methylphosphinicopropionic acid, expressed as glufosinate

15/ At the limit of determination

16/ Definition of the residue: glufosinate and its ammonium salt, expressed as glufosinate;

17/ 0.01 mg/kg is based on an earlier lower limit of quantification but will be adjusted to 0.05 mg/kg in near future for harmonisation purposes

18/ Definition of the residue: Glufosinate-ammonium and its metabolites 2-acetamido-4-methylphosphinico-butanoic acid and 3-methylphosphinicopropionic acid, expressed a glufosinate free acid equivalents. MRLs are temporary until 1999 and will be re-evaluated in the light of JMPR evaluation and Codex Alimentarius standards.

19/ Definition of the residue: DL-homoalanin-4-yl-(methyl)phosphinic acid and 3-methylphosphinicopropionic acid calculated as glufosinate free acid.

20/ Definition of the residue: glufosinate-ammonium and its metabolites 2-acetamido-4-methylphosphinico-butanoic acid and 3-methylphosphinicopropionic acid. Time-limited tolerance expiring 13 July 1999.

21/ Definition of the residue: glufosinate and its metabolite 3-methylphosphinico-propionic acid. Time-limited tolerance expiring 13 July 1999.

22/ Definition of the residue: combined residues of glufosinate ammonium and 3-methylphosphinicopropionic acid expressed as glufosinate equivalents. Time-limited tolerance expiring 18 Jan 2000.

## APPRAISAL

Glufosinate-ammonium was first evaluated for residues and toxicology by the 1991 JMPR and subsequently for residues in 1994. Glufosinate-tolerant crops have now been developed with new GAP and different residue patterns, requiring new MRLs.

The Meeting received information on metabolism and environmental fate, registered uses and supervised residue trials on tropical fruits, tree nuts and various genetically-modified field crops. Feeding and processing studies were also reported.

Studies on the metabolism of glufosinate-ammonium in genetically modified rape seed (canola), sugar beet, maize, soya beans and tomatoes showed that the tolerant crops rapidly converted the active glufosinate isomer (L-glufosinate) to *N*-acetyl-glufosinate (NAG). The main components of the residue in tolerant plants are the L-isomer of NAG and D-isomer of glufosinate.

The Meeting received information on animal metabolism studies on rats, lactating goats and laying hens.

When rats were dosed orally with L-[3,4-<sup>14</sup>C]NAG some de-acetylation to glufosinate occurred and some glufosinate was bioavailable, but unchanged NAG was the main component (85-89%) of the TRR in the faecal extracts. Almost all of the administered <sup>14</sup>C was excreted in the faeces within 4 days.

When rats were dosed orally with [3,4-<sup>14</sup>C]glufosinate-ammonium, 75-89% of the <sup>14</sup>C was excreted in the faeces and 8-11% in the urine within 48 hours. The main components in the faecal extracts were glufosinate (77% of administered <sup>14</sup>C), NAG (7.5%), 4-methylphosphinico-2-hydroxybutanoic acid or MHB (4.3%) and 3-methylphosphinopropionic acid or MPP (1.3%). The main components in the urine were glufosinate (4.3%) and MPP (0.8%).

Very small amounts of the administered <sup>14</sup>C were found in the tissues (<0.1%) and milk (<0.02%) of a lactating goat dosed orally for 4 days with [3,4-<sup>14</sup>C]glufosinate. Levels of <sup>14</sup>C reached a plateau in the milk by day 2. Levels of <sup>14</sup>C were higher in the kidneys and liver than in other tissues. Glufosinate and MPP constituted about 50% and 30% respectively of the residue in both kidneys and liver. Glufosinate accounted for 50% of the <sup>14</sup>C in the milk. When a lactating goat was dosed orally with L-[3,4-<sup>14</sup>C]NAG the disposition of <sup>14</sup>C in the tissues and milk was similar to that after dosing with glufosinate. Glufosinate was the main residue in the kidneys, liver and milk with NAG and MPP forming a substantial part of the residue in the kidneys and liver.

Less than 0.02% of the administered <sup>14</sup>C was present in the edible tissues when laying hens were dosed orally for 14 days with [3,4-<sup>14</sup>C]glufosinate-ammonium. MPP and glufosinate were the main residues identified in the liver and eggs respectively. After dosing orally for 14 days with L-[3,4-<sup>14</sup>C]NAG less than 0.1% of the administered dose was present in the edible tissues and blood. NAG was the main residue identified in liver and egg yolks while glufosinate was the main residue in egg whites.

The Meeting received information on metabolism studies in rape seed, canola, sugar beet, maize, soya beans and tomatoes.

Genetically modified rape plants rapidly acetylated glufosinate. Cut rape plants were placed in a nutrient solution containing [3,4-<sup>14</sup>C]glufosinate-ammonium for 6 days, by which time 57% of the <sup>14</sup>C in the plants was associated with NAG and 36% with glufosinate.

In glufosinate-tolerant canola plant tissues sampled 1 hour after treatment with [<sup>14</sup>C]glufosinate, 73% and 18% of the <sup>14</sup>C was present as glufosinate and NAG respectively,

demonstrating very rapid acetylation of glufosinate. After 21 days 60%, 21% and 7% of the  $^{14}\text{C}$  corresponded to NAG, glufosinate and MPP respectively.

When glufosinate-tolerant sugar beet plants were sprayed with [3,4- $^{14}\text{C}$ ]glufosinate-ammonium the racemic isomer composition in the surface residue was unchanged, but in the absorbed residue L-glufosinate was metabolised to L-NAG.

Glufosinate was generally a minor component of the residue in treated tolerant maize. NAG was the main residue in the forage, silage and fodder, while MPP was the major component in grain, cobs and husks. The GLC enforcement analytical method for glufosinate, MPP and NAG was in reasonable agreement with a radiolabel method for the residues in the forage.

NAG was the main residue in the forage, straw, pods and beans of treated tolerant soya bean plants. MPP levels exceeded glufosinate levels in the pods and beans. The GLC enforcement method and an HPLC radiolabel method were in reasonable agreement in analyses of forage, straw, pods and beans at the higher residue levels, but at low levels the result from the enforcement method was less than from the  $^{14}\text{C}$  measurement.

The translocation of [ $^{14}\text{C}$ ]glufosinate-ammonium from treated leaves to shoots, other leaves and roots was approximately 4 times as fast in glufosinate-resistant tomato plants as in susceptible tomatoes. Most of the surface residue was glufosinate itself, but this was very rapidly converted to NAG once absorbed into the leaves. NAG constituted essentially all the residue in the ripe fruit harvested 60 or 74 days after the plants were treated.

The Meeting received information on the degradation and dissipation of glufosinate-ammonium in soil, residues in rotational crops and fate in water-sediment systems.

Glufosinate disappeared with a half-life of about 3-6 days during aerobic incubation with a sandy loam soil. MPP, the major product, reached its maximum after about 14 days incubation. MPA, 2-methylphosphinicoacetic acid, became the main residue after long intervals. Glufosinate suffered 62% and 31% mineralization during 120 days incubation with and without incorporation of plant material into the soil respectively.

In a dissipation study glufosinate-ammonium, applied 3 times to bare ground, dissipated quickly with calculated half-lives of 15, 7.2 and 2.7 days, the increased rates probably being related to increased soil moisture and temperature. The estimated half-lives for MPP after its residues peaked were 38, 14 and 16 days, and for MPA 25, 19 and 7 days. No residues were detected below a 45-60 cm depth section, but glufosinate and MPP reached a depth of 30-45 cm on several occasions during the study. Glufosinate and its degradation products have some mobility in soil but their rapid dissipation ensures that travel down the soil profile is limited.

When L-[3,4- $^{14}\text{C}$ ]NAG was incubated in a sandy loam soil it was very rapidly converted to L-glufosinate, which was then itself broken down and mineralized. The comparable rate of mineralization and production of unextractable residues suggests that the degradation pathway for NAG is through glufosinate. Further experiments showed that the half-life of NAG was only hours.

No important degradation products other than  $\text{CO}_2$  were identified when [2- $^{14}\text{C}$ ]MPA was incubated in a sandy loam under aerobic conditions. Estimated decline and mineralization half-lives were 24 and 74 days respectively. Degradation in a loamy sand was much slower. When MPP was incubated under aerobic conditions in a sandy loam, MPA was the only significant product after 120 days.

After 3 days incubation of a sandy loam soil with tolerant tomato leaves containing residues, mainly of glufosinate and NAG, most of the residue had been converted to MPP, which itself was degraded more slowly to MPA and ultimately to CO<sub>2</sub>.

Residues of degradation products of glufosinate should be undetectable or at very low levels in rotational crops. When radishes, lettuce and wheat were sown in a confined rotational crop study 28 days after glufosinate treatment of bare ground (to simulate re-sowing a failed crop) residues of MPP and MPA were present at low levels in the crops, demonstrating possible uptake of these compounds. The pattern of residues was similar in the three crops. When sowing was 119 days after treatment (to simulate a following crop) residues were not detectable in lettuce or radishes but MPP and MPA were detected by <sup>14</sup>C methods at very low levels in the wheat grain and straw.

The photolytic breakdown of glufosinate in natural waters was very slow.

MPP became the major component of the residue within a few days when [3,4-<sup>14</sup>C]glufosinate-ammonium was incubated in a water-sediment system at 20°C. Glufosinate itself disappeared with a half-life of 3 days, but only 25% mineralization occurred during the 361 days of the study. In other experiments the rates of degradation were shown to be affected by the source of the water and the residue level of glufosinate (with faster disappearance at lower levels). In all cases most of the residue was in the water phase.

### Methods of residue analysis

The main components of the residue in genetically modified tolerant crops are glufosinate, NAG and MPP. Analytical methods have been designed to measure the three components separately or, because glufosinate and NAG produce the same derivative in the analytical procedure, to measure glufosinate and NAG combined and MPP separately. Residues are extracted from the finely ground sample with water, and the extract is cleaned up on an anion exchange resin column. After solvent exchange, NAG and MPP are separated from glufosinate on a cation exchange column. The residues are taken up in glacial acetic acid and methylated, and glufosinate acetylated, with trimethyl orthoacetate in refluxing acetic acid. After solvent exchange and final clean-up on a silica gel cartridge the derivatized residues are determined by GLC with flame-photometric detection.

Modifications of the extraction and initial clean-up are needed for samples such as maize oil, fats and milk. A variation of the method dispenses with the cation exchange separation and determines glufosinate and NAG as a combined GLC peak because both compounds produce the same analytical derivative. The LOD for crop samples is typically 0.05 mg/kg for each analyte. Analytical recoveries have been extensively tested and found satisfactory on many substrates.

Analysts should be aware that transgenic glufosinate-tolerant soya beans plants can convert L-glufosinate to NAG very rapidly, giving apparently low analytical recoveries in spiked samples.

Glufosinate, NAG and MPP were shown to be stable during frozen storage for intervals of 12, 15 or 24 months in the following substrates: genetically modified maize and soya beans and their processed commodities, cow and chicken tissues, milk, eggs, susceptible maize grain, and transgenic rape seed and sugar beet roots. The 1994 JMPR reported that residues of glufosinate and MPP (described as Hoe 061517) in apples, oranges, kiwifruit, maize, soya beans and almonds were stable during frozen storage.

Some samples from the supervised trials were stored for 2 years, but the storage stability studies have demonstrated that the residues were still stable.

### Definition of the residue

The current definition includes glufosinate and MPP and is based on the residues occurring in conventional crops. When glufosinate is used on glufosinate-tolerant crops NAG is produced. It should be included in the residue definition for enforcement because NAG is generally the main component of the residue and because the same derivative is produced in the analytical method from glufosinate itself and NAG, and in the simplified method both appear in the GLC peak from their common derivative. The revised residue definition is also suitable for commodities from conventional crops because if NAG is absent it will not contribute to the analytical result and if present at low levels it is necessarily included in the analytical result.

A suitable revised residue definition would be *Sum of glufosinate-ammonium, 3-(hydroxy(methyl)phosphinoyl)propionic acid and N-acetyl-glufosinate expressed as glufosinate (free acid)*, but the Meeting could not consider the adoption of this definition until the toxicological evaluation of NAG had been completed.

The residue reported in the supervised trials consists of three components, but is often reported with the glufosinate and NAG residue combined. The metabolism studies show that residues of the main component constitute 65-75% of the combined residue when all three components are at measurable levels. It follows that if all three components are below the LOD a reasonable assumption is that the combined residue is also below or close to the LOD. When one component is above and the others are below the LOD, the combined residue is assumed to be equal to the residue of the main component.

The method of calculating the total residue for various situations is illustrated by the following example.

Glufosinate	MPP	NAG	Total
<0.05	<0.05	<0.05	<0.05
<0.05	<0.05	0.06	0.06
0.05	<0.05	0.09	0.14

Information was made available on uses of glufosinate around fruit trees and nut trees. Limited information was provided on GAP for use of glufosinate on transgenic crops.

Glufosinate-ammonium is registered for use in Australia as a directed spray for weed control around avocados, bananas, feijoa, guava, kiwifruit, litchis, mangoes, papaya, passion fruit, pineapples and rambutans at 0.20-1.0 kg ai/ha. Malaysia has similar registered uses for glufosinate-ammonium as a directed herbicide spray around bananas, carambola, durians, guava, jack fruit and mangoes at 0.3-0.5 kg ai/ha. Residues in the fruit would generally not be expected from this type of use. Glufosinate itself is not taken up by roots but MPP, the main degradation product in soil, can be absorbed by the roots and translocated through the crop.

### Supervised trials

Supervised trials were reported on tropical fruits, nut trees, maize, soya beans, rape, canola and sugar beet.

Residues were not detected in avocados in 3 Australian trials where glufosinate was used at 1.0, 1.2 and 2.0 kg ai/ha. In one trial at 1.2 kg ai/ha, glufosinate was detected at 0.06 mg/kg (presumably direct contamination during application) in 1 sample on day 0, but in no other samples. Residues were not detected in the fruit from 3 Australian trials on mangoes where the application rates were 1.0, 1.2 and 2.0 kg ai/ha or 1 trial on papayas at 1.2 kg ai/ha.

Residues were not detected in the fruit from Malaysian trials on carambola and guavas (2 trials at 0.5 kg ai/ha and 2 at 1 kg ai/ha on each fruit).

The Meeting agreed to consider these fruits together as “tropical fruits with inedible peel” but noted that a CXL of 0.2 mg/kg had already been established for banana, which would have to be excluded from the group. The residues in rank order from the 16 trials were <0.05, <0.05, <0.05, <0.05, <0.05, <0.05, <0.05, <0.05, <0.05, 0.06, <0.1, <0.1, <0.1 and <0.1 mg/kg.

In view of the type of use and generally unquantifiable residues at 3-5 sampling intervals in all of the trials the Meeting estimated a maximum residue level of 0.05\* mg/kg and an STMR of 0.05 mg/kg for glufosinate in Assorted tropical and sub-tropical fruits – inedible peel (except banana).

The US registered use for glufosinate around almond, pecan and walnut trees permits a directed application at 1.7 kg ai/ha, with no more than 5.1 kg ai/ha total per year, and a 14-day PHI. MPP residues were 0.07 mg/kg in almonds from a US trial at the label rate and up to 0.22 mg/kg in a trial at twice the label rate. MPP is the main degradation product in soil, so its presence demonstrates the possibility of root uptake rather than contamination of foliage by spray. Residues were not detected in almonds from 3 other trials at the label rate or 3 trials at the double rate. The trials were in California in 1985.

Residues were not detected (<0.05 mg/kg) in nuts from 3 trials on pecans (USA, 1985) with glufosinate applied at 1.7 kg ai/ha and 3 at twice that rate. In 2 trials nuts were harvested 21 days after application rather than 14 days, but the use pattern is sufficiently close to GAP. Residues were not detected (<0.05 mg/kg) in nuts from 6 walnut trials at 1.7 kg ai/ha, 5 trials 3.4 kg/ha or 3 at other rates higher than GAP in the USA in 1985.

The Australian registration for glufosinate-ammonium permits 0.2-1.0 kg ai/ha as a directed spray around nut trees. Residues were not detected (<0.1, <0.05 mg/kg) in macadamia nuts in Australian trials from 1992 and 1995 at the label rate (2 trials) and double rate (2 trials).

Italian registration permits a directed application of 0.5-1.6 kg ai/ha (maximum 2.5 kg ai/ha per year) for weed control around hazelnuts. Residues were not detected (<0.05 mg/kg) in nuts from 5 hazelnut trials in Italy in 1985 according to GAP.

The Meeting considered the 4 almond, 6 pecan, 14 walnut, 4 macadamia and 5 hazelnut trials as a group. The residues in the 33 trials were <0.05 (30), 0.07 and <0.1 (2) mg/kg. The Meeting estimated a maximum residue level of 0.1 mg/kg and an STMR level of 0.05 mg/kg for glufosinate in tree nuts.

Glufosinate-ammonium is registered in Canada for use on transgenic maize at 0.30-0.50 kg ai/ha with final application at the 8-10 leaf stage. In Canadian trials in 1994-5 no residues (<0.05 mg/kg) were detected in 7 trials at 0.5 or 0.6 kg ai/ha or 3 trials at 1.0 kg/ha applied at growth stage GS 17-19 (7-9 leaves), or in 4 trials at 0.6 kg ai/ha at a later growth stage (GS 33, 3 nodes detectable).

Glufosinate-ammonium is registered in Portugal for use on transgenic maize at 0.40-0.80 kg ai/ha with the final application when the plant has no more than 8-10 leaves. In 7 Italian trials and 3 Spanish trials in 1996 according to Portuguese GAP no residues (<0.05 mg/kg) were detected in the harvested maize.

The German registration for glufosinate-ammonium on tolerant maize allows a single application of 0.9 kg ai/ha during the 3-8 leaf growth stage or 2 applications 6 weeks apart at 0.45 kg ai/ha with the final application at the 8-leaf stage. Residues were below the LOD (0.05 mg/kg) in 13 trials in Germany where the trial conditions (2 applications of 0.45-0.60 kg ai/ha, the second at GS 18

or GS 19, i.e. 8 or 9 leaves) were considered to comply with the registered use, 22 trials in France in accord with German GAP, and in 5 trials in Germany and 7 in France where glufosinate-ammonium was used at excessive rates (2 applications of 0.80 kg ai/ha).

Glufosinate-ammonium is registered for use in the USA on tolerant maize with 2 applications at 0.23-0.41 kg ai/ha, the second at a plant height of 60 cm with harvest 70 days later. Supervised trials on maize in the USA at rates of 0.40-0.50 kg ai/ha (1 or 2 applications) at the nominated growth stage were accepted as equivalent to the maximum GAP. The PHI (70 days) was considered secondary to the growth stage in deciding the timing of the applications. In many cases the grain was harvested 90-120 days after the final treatment. The residues (glufosinate + NAG + MPP expressed as glufosinate) in the 35 trials according to GAP were <0.05 (29), 0.05 (2) and 0.07 (4) mg/kg.

In summary, the residues of glufosinate + NAG + MPP expressed as glufosinate in tolerant maize were Canada <0.05 (14) mg/kg, Italy <0.05 (7) mg/kg, Spain <0.05 (3) mg/kg, Germany <0.05 (18) mg/kg, France <0.05 (29) mg/kg, the USA <0.05 (29), 0.05 (2) and 0.07 (4) mg/kg. The residues in rank order were <0.05 (100), 0.05 (2) and 0.07 (4) mg/kg.

The Meeting estimated a maximum residue level of 0.1 mg/kg for glufosinate in maize and noted that this was equivalent to the existing CXL. The major residue in the glufosinate-tolerant crop is NAG, which is not included in the current residue definition. NAG was included in the reported residues where the derivatization GLC procedure without an ion-exchange separation step was used, and was below the LOD when determined separately.

Glufosinate is registered for use on transgenic glufosinate-tolerant canola in Canada with 1 application at 0.60 kg ai/ha or 2 applications of 0.30-0.50 kg ai/ha, the final application at the early bolting growth stage. The label carries the instruction not to graze the treated crop or cut for hay. The Meeting was informed that the 10 leaves stage is very close to bolting. Only two supervised trials in Canada met the condition of final treatment at the 10-leaf stage, each with 1 application of 0.5 or 0.75 kg ai/ha. Residues were not detected (<0.05 mg/kg) in either of the trials, but 2 trials were insufficient to support a recommendation.

Glufosinate-ammonium is registered for use in the USA on tolerant soya beans with 2 applications at 0.23-0.41 kg ai/ha, the second application at bloom with harvest 70 days later. Supervised trials on soya beans in the USA with 2 applications of 0.40-0.50 kg ai/ha at the nominated growth stage were accepted as equivalent to the maximum GAP. The PHI (70 days) was considered as secondary to the growth stage in deciding the timing of the applications. In the trials the grain was harvested 62-102 days after the final treatment. The residues of glufosinate + NAG + MPP expressed as glufosinate in the 20 trials according to GAP in rank order (median underlined) were 0.32, 0.39, 0.43, 0.52, 0.56, 0.71, 0.72, 0.78, 0.81, 0.85, 0.89, 0.92, 0.96, 1.02, 1.24, 1.26, 1.33, 1.56, 1.64 and 1.88 mg/kg.

The Meeting estimated a maximum residue level of 2 mg/kg for soya beans but could not recommend it as suitable for use as an MRL until the toxicological evaluation of NAG had been completed.

Residues in almond hulls from 3 trials on almonds at the label rate and 3 at twice that rate (see above) were all <0.5 mg/kg. Unfortunately, residues in the hulls were not determined in the 2 trials where MPP was detected in the almonds. However, the Meeting estimated a maximum residue level of 0.5 mg/kg for almond hulls, which is recommended for use as an MRL.

The registered use of glufosinate-ammonium on tolerant maize in the USA (see above) specifies pre-harvest intervals of 60 and 70 days for maize forage and fodder respectively. The supervised trials on maize in the USA described above, which complied with GAP, showed residues

of glufosinate + NAG + MPP expressed as glufosinate in the forage or silage harvested 60-92 days after treatment (the residue is reasonably persistent) in rank order, median underlined, of 0.09, 0.12, 0.12, 0.13, 0.17, 0.2, 0.26, 0.28, 0.3, 0.32, 0.33, 0.33, 0.36, 0.4, 0.48, 0.53, 0.53, 0.54, 0.54, 0.68, 0.74, 0.78, 0.78, 0.79, 0.9, 1.07, 1.1, 1.19, 1.2, 1.45, 1.67, 1.7, 1.71, 1.76, 2.9 and 3.48 mg/kg.

The residues of glufosinate + NAG + MPP expressed as glufosinate in maize fodder harvested 84-122 days after treatment were 0.07, 0.08, 0.11, 0.12, 0.15, 0.22, 0.25, 0.25, 0.32, 0.33, 0.43, 0.5, 0.53, 0.58, 0.65, 0.68, 0.69, 0.72, 0.8, 0.94, 0.95, 1.13, 1.19, 1.32, 1.42, 1.5, 1.69, 1.74, 1.76, 1.78, 1.96, 2.31, 2.65, 2.83 and 5.4 mg/kg.

The Meeting estimated maximum residue levels of 5 mg/kg in maize forage and 10 mg/kg in maize fodder but could not recommend them as suitable for use as MRLs until the toxicological evaluation of NAG had been completed.

Feeding studies on lactating dairy cows and laying hens were reported.

Lactating dairy cows were dosed with glufosinate-ammonium + NAG (15 + 85% to simulate the typical terminal residue) at rates equivalent to 9, 27 and 91 ppm glufosinate free acid equivalents in the diet for 28 days. Residues were not detected in the milk at the 9 ppm feeding level, but reached a plateau on day 3 at the 91 ppm level. Residues (glufosinate, NAG and MPP) in the tissues were below the LODs at the lower feeding levels; at 91 ppm they were detected in the kidneys and liver, but not in muscle or fat. MPP was the major residue in the liver.

Laying hens were dosed with glufosinate-ammonium + NAG (15 + 85) at levels equivalent to 0.36, 1.1 and 3.6 ppm glufosinate free acid equivalents in the diet for 28 days. Residues (glufosinate, NAG and MPP) were not detected in the tissues or eggs.

Studies on the fate of residues during the commercial food processing of sugar beet, maize, soya beans and canola were reported.

When tolerant sugar beet were treated with glufosinate-ammonium and processed, residues of glufosinate, NAG and MPP tended to remain in the juice and ultimately appear in the molasses. Residues were not detected (<0.05 mg/kg) in the raw sugar. The processing factors for glufosinate + NAG for raw sugar in 3 trials were nominally 0 (<0.17), 0 (<0.83) and 0 (<0.05) on the basis of the residues in the roots. The mean processing factor for molasses was 6.8, showing that glufosinate residues are concentrated in the molasses on evaporation of the water. In another study on sugar beet with fivefold application rates MPP was the main residue component and again no residues were detected in the raw sugar. The calculated processing factors were 0 (<0.08) for refined sugar and 6.4 for molasses.

In 2 processing trials (wet and dry milling) of glufosinate-tolerant maize treated with excessive rates of glufosinate-ammonium, only NAG was quantifiable in the grain from only one trial. In this trial no residues (<0.05 mg/kg) were detected in crude or refined oil from either process or in the starch and hulls from the wet milling process. The estimated processing factors were meal 1, grits 1, and hulls 2, all from dry milling.

Residues of glufosinate, NAG and MPP were not detected (<0.05 mg/kg) in refined or crude oil in a processing study with a transgenic soya bean crop treated with glufosinate-ammonium at a fivefold rate. The calculated factors for processing seed to meal and seed to crude or refined oil are 1.3 and 0 (<0.3) respectively.

Glufosinate itself was not detected in the seed or any processed fraction of a transgenic canola crop treated at a fourfold rate with glufosinate-ammonium. The main residue was NAG. The

calculated processing factor for untoasted meal was 3.1 and for toasted meal 3.7. No residues (<0.05 mg/kg) were detected in the oils.

Information was made available to the Meeting on national MRLs. Governments have adopted a variety of residue definitions.

## RECOMMENDATIONS

On the basis of data from supervised trials the Meeting estimated the maximum residue levels and STMRs listed below. The maximum residue levels are recommended for use as MRLs.

Definition of the residue for compliance with MRLs and for the estimation dietary intake: sum of glufosinate-ammonium and 3-[hydroxy(methyl)phosphinoyl]propionic acid calculated as glufosinate (free acid)

CCN	Commodity Name	Recommended MRL, mg/kg		STMR
		New	Previous	
FI 0030	Assorted tropical and sub-tropical fruits - inedible peel <sup>1</sup>	0.05*	-	0.05
FI 0341	Kiwifruit	W <sup>2</sup>	0.05*	
TN 0085	Tree nuts	0.1	-	0.05
AM 0660	Almond hulls	0.5	-	

<sup>1</sup>Except Banana

<sup>2</sup>Replaced by recommendation for group MRL

\*At or about the limit of determination.

## DIETARY RISK ASSESSMENT

Estimated STMRs for glufosinate-ammonium on tropical fruit and tree nuts have been added to the previous list of MRLs (21) for other commodities. The estimated dietary intakes of glufosinate-ammonium expressed as glufosinate for the 5 GEMS/Food regional diets were in the range of 3 to 10% of the ADI. The Meeting concluded that the intake of residues of glufosinate-ammonium resulting from its uses that have been considered by the JMPR is unlikely to present a public health concern.

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