MANDIPROPAMID (231)

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EXPLANATION

Mandipropamid was first evaluated by JMPR in 2008 when an ADI of 0–0.2 mg/kg bw was established and an ARfD was considered unnecessary. At the 44th Session of the CCPR, mandipropamid was scheduled for the evaluation of 2013 JMPR for additional uses on hops.

RESIDUE ANALYSIS

Analytical methods

The Meeting received descriptions and validation data for analytical methods for residues of mandipropamid in hops and processed commodities. Methods rely on HPLC-MS/MS for analysis of mandipropamid in hops and wort.

Data collection method

Validation of Residue Analytical Method RAM 415/01 for the Determination of Residues in Crops. (Gill JP and Mound EL, 2004, NOA446510/0159)

Analyte: Mandipropamid, LC-MS/MS, Method RAM 415/01

LOQ: 0.01 mg/kg in crops

Description: Residues of mandipropamid were extracted from crop samples by homogenisation with acetonitrile:water (80:20 v/v). Extracts were centrifuged and aliquots diluted with water prior to being cleaned-up using polymeric solid-phase extraction cartridges. Residues of mandipropamid were quantified using high performance liquid chromatography with triple quadruple mass spectrometric detection (LC-MS/MS). The transition monitored for mandipropamid was 412.1 to 327.9.

Enforcement methods

RAM 415/02 is the up-dated version of RAM 415/01 that includes the relevant modifications for the analysis of hops and has two LC-MS/MS transitions. Two MRM transitions were monitored for quantification (m/z 412.0→328.0) and confirmation (m/z 412.0→125.0). The analytical procedures were similar. The validation data on hops and hop processed fractions using method RAM 415/01 are valid for RAM 415/02.

Table 1 Recovery results obtained during validation of method RAM 415/01 for mandipropamid in hops, green and dried cones (Transition m/z = 412.0→328.0)

Matrix	Fortification (mg/kg)	Number of Analyses	Mean Recovery (%)	RSD (%)	Recovery Range (%)
Hops (Green cones)	0.01	5	103	4	98–108
	0.1	5	105	3	101–108
	Overall	10	104	4	98–108
Hops (Dried cones)	0.01	5	103	3	100–108
	0.1	5	94	3	90–97
	Overall	10	98	6	90–108

Table 2 Recovery results obtained during validation of method RAM 415/01 for mandipropamid in wort and spent hops (Transition m/z = 412.0→328.0)

Matrix	Fortification (mg/kg)	Number of Analyses	Mean Recovery (%)	RSD (%)	Recovery Range (%)
Hops (Wort)	0.01	5	110	10	99–127
	0.1	5	94	1.3	92–95
	Overall	10	102	11	92–127
Hops (Spent hops)	0.02	5	79	3.5	74–81
	0.2	5	65	7.5	58–70
	8.0	1	84	–	–
	Overall	11	73	12	58–84

Table 3 Recovery results obtained during validation of method RAM 415/01 for mandipropamid in wort and spent hops (Transition m/z = 412.0→125.0)

Matrix	Fortification (mg/kg)	Number of Analyses	Mean Recovery (%)	RSD (%)	Recovery Range (%)
Hops (Wort)	0.01	5	109	11	100–130
	0.1	5	93	1.2	92–95
	Overall	10	101	11	92–130
Hops (Spent hops)	0.02	5	90	4.6	85–95
	0.2	5	65	6.5	59–69
	8.0	1	86	–	–
	Overall	11	78	18	59–95

The S19 multi-residue method was not applicable for hops. The independent laboratory validation of RAM 415/02 was performed with fortifing mandipropamid at level of 0.5 mg/kg and 100 mg/kg. The recoveries obtained are summarized in Table 4 to Table 7.

Table 4 Recovery results obtained during an Independent Laboratory Validation of Method RAM 451/02 for mandipropamid in hops by Filtration Method (Transition m/z 412.0→328.0)

Matrix	Fortification (mg/kg)	Number of Analyses	Mean Recovery (%)	Coefficient of Variation (%)	Recovery Range (%)
Hops	0.5	5	99	3.5	95–103
	100	5	102	2.7	100–107
	Overall	10	101	3.3	95–107

Table 5 Recovery results obtained during an Independent Laboratory Validation of Method RAM 451/02 for mandipropamid in hops by Filtration Method (Transition m/z 412.0→125.0)

Matrix	Fortification (mg/kg)	Number of Analyses	Mean Recovery (%)	Coefficient of Variation (%)	Recovery Range (%)
Hops	0.5	5	94	8.3	82–102
	100	5	100	3.5	95–104
	Overall	10	97	6.7	82–104

Table 6 Recovery results obtained during an Independent Laboratory Validation of Method RAM 451/02 for mandipropamid in hops by SPE Method (Transition m/z 412.0→328.0)

Matrix	Fortification (mg/kg)	Number of Analyses	Mean Recovery (%)	Coefficient of Variation (%)	Recovery Range (%)
Hops	0.5	5	87	1.3	85–88
	100	5	111	11.9	93–125
	Overall	10	99	15.6	85–125

Table 7 Recovery results obtained during an Independent Laboratory Validation of Method RAM 451/02 for mandipropamid in hops by SPE Method (Transition m/z 412.0→125.0)

Matrix	Fortification (mg/kg)	Number of Analyses	Mean Recovery (%)	Coefficient of Variation (%)	Recovery Range (%)
Hops	0.5	5	76	14.8	64–93
	100	5	110	12.3	92–123
	Overall	10	93	22.9	64–123

Method RAM 415/02 was successfully and independently validated for the analysis of mandipropamid residues in hops. Method RAM 415/02 is suitable to be used in support of pre-registration data requirements and post-registration monitoring of hops.

Stability of residues in stored analytical samples

The Meeting received information on the stability of residues of mandipropamid in tomatoes, grapes, potatoes, lettuce, cucumbers, wheat and soya beans.

A study on the stability of mandipropamid residues in crop commodities was conducted during 2004 to 2006 (Hamilton LS, Joseph T, 2006, NOA446510/0921). Stability of mandipropamid residues was tested in both raw agricultural commodities and in processed commodities. Commodities used were tomatoes (fruit and paste), grapes (fruit and juice), potatoes (tubers and granules/flakes), lettuce, cucumbers, wheat (forage, grain and straw) and soya beans (beans, hulls, meal and oil). These include representatives of the four crop types specified in the EU guidance, i.e., predominantly water, oil, protein and starch containing materials.

Crop samples (10 g) were fortified with mandipropamid at 0.5 mg/kg. Immediately after fortification, sample sets were stored in a freezer at approximately -20 °C until analysed. At the desired storage intervals of approximately zero, three, six, twelve and twenty-four months a sample set of each substrate, consisting of a control sample, two freshly fortified samples and two freezer stored fortified samples, were analysed for residues of mandipropamid using method RAM 415/01. Analysis of the soya bean oil samples required a modification of this method, using hexane in the homogenization process instead of acetonitrile/water and replacing the solid phase extraction clean-up with a liquid-liquid partition.

Table 8 Stability of mandipropamid residues in crop commodities following storage at -20 °C (Hamilton LS, Joseph T, 2006, NOA446510/0921)

Commodity	Storage Period (Months)	Mandipropamid Concentration—Uncorrected (mg/kg)	Mean Procedural Recovery (%)
Tomatoes—Fruit	0	0.44	91
	3	0.46	97
	6	0.47	103
	12	0.42	99
	24	0.54	97
Tomatoes—Paste	0	0.45	87
	3	0.48	90
	6	0.49	104
	12	0.46	95
	24	0.48	108
Grapes—Fruit	0	0.48	95
	3	0.48	96
	6	0.47	94
	12	0.42	92
	24	0.50	84
Grapes—Juice	0	0.46	90
	3	0.47	88
	6	0.36	85
	12	0.46	88

Commodity	Storage Period (Months)	Mandipropamid Concentration—Uncorrected (mg/kg)	Mean Procedural Recovery (%)
	24	0.52	98
Potatoes—Tubers	0	0.51	100
	3	0.55	98
	6	0.57	108
	12	0.47	89
	24	0.49	104
Potatoes—Granules/ Flakes	0	0.47	90
	3	0.50	97
	6	0.48	102
	12	0.52	97
	24	0.49	108
Lettuce—Head	0	0.45	94
	3	0.44	81
	6	0.48	80
	12	0.41	102
	24	0.52	101
Cucumbers—Fruit	0	0.44	90
	3	0.49	104
	6	0.47	103*
	12	0.48	89
	24	0.59	114
Wheat—Forage	0	0.49	95
	3	0.46	88
	6	0.41	99
	12	0.41	90
	24	0.44	89
Wheat—Straw	0	0.37	82
	3	0.49	121
	6	0.58	113
	12	0.57	114
	24	0.42	80
Wheat—Grain	0	0.35	71*
	3	0.27	92
	6	0.48	100
	12	0.51	83
	24	0.52	97
Soya bean—Beans	0	0.45	91
	3	0.44	96
	6	0.46	88
	12	0.42	83
	24	0.44	109
Soya bean—Meal	0	0.46	93
	3	0.42	92
	6	0.46	99
	12	0.41	100
	24	0.55	93
Soya bean—Hulls	0	0.44	87
	3	0.47	89
	6	0.45	104
	12	0.41	94
	24	0.55	112
Soya bean—Oil	0	0.48	94
	3	0.47	94
	6	0.51	91
	12	0.41	100
	24	0.53	104

USE PATTERN

Mandipropamid is registered in the EU and the USA for the control of downy mildew on hops. The most critical Good Agricultural Practices (GAP) for the foliar application of mandipropamid on hops from Germany and USA are summarised in Table 9.

Table 9 Registered field uses of mandipropamid in Germany and USA. Labels for the following use on hops were available to the Meeting

						Application			
Crop	Country or Region	Enduse product	F/G/I [a]	Method	No. per crop season min. max.	Min. Interval (days)	Max. Rate (g ai/ha per application)	Max. Water Volume (L/ha)	PHI [days]
Hops	Germany	SC, 250 g/L	F	spraying	2	10	400 [b]	– [b]	14
Hops	USA	SC, 250 g/L	F	spraying [c]	3	7–10	100–145	– [d]	7

[a] F = field use, G = glasshouse application, I = indoor application.

[b] A maximum of two applications of mandipropamid are made to hops. The rates and volumes of application are dependent upon the growth stage of the crop at the time of application. For hops, proven water application rates are 1300 to 2800 L water/ha.

[c] Applied by ground, chemication or aerial application.

[d] For best results, use sufficient water volume to provide thorough coverage.

RESIDUES RESULTING FROM SUPERVISED TRIALS

The Meeting received information on supervised field trials for mandipropamid uses on the following crops.

Crop	Country	
Hops:	France, Germany, UK	Table 10
Hops:	USA	Table 11

Where residues were not detected, they are reported as below the LOQ. Residue data, application rates and spray concentrations have generally been rounded to two significant figures or, for residues near the LOQ, to one significant figure. Residue data are recorded unadjusted for % recovery. Multiple results are recorded in the data tables where the trial design included replicate plots and where separate samples have been identified as being from these replicate plots. Results used to estimate STMRs are double underlined.

A total of 10 residue trials were carried out according to GAP (± 30%) in France, Germany and UK in 2005, 2006 and 2009 (Elliott, A, 2007, NOA 446510/1151; Gizler, A, Lakaschus, S, 2008, NOA 446510/1342; Lakaschus, S, Gizler, A, 2009, A12946B_10718). In all trials, mandipropamid was applied two times as an SC formulation containing 250 g ai/L at about 10 days intervals at a nominal rate of 300 g ai/ha as a foliar application to hops. The water rate was between 1500–2000 L/ha. The PHI was 14 days. The residue data from the supervised trials is summarised in Table 10.

Table 10 Results of residue trials with mandipropamid conducted as a foliar application to hops in France, Germany and UK in 2005, 2006 and 2009

HOPS	Application					PHI	Crop part	Residues mg/kg,	Ref. Reg.DocID.
country, year (variety)	Form. (g ae/L)	kg ai/ha	water, L/ha	Growth stage	no.	days	Cones	mandiprop amid	(Trail No.)
Germany, 2005	250 SC	0.336	2152	BBCH 75–82	2	0 [a]	green	< 0.01	NOA
(Hallertauer		0.352	2255	BBCH 85–89		7 [a]	dried	< 0.01	446510/1151
Mittelfruher)						0 [b]	green	3.1	DE-FR-05-0353
						0	green	6.2	
						3	green	6.7	
						7	dried	23.3	

HOPS	Application					PHI	Crop part	Residues mg/kg,	Ref. Reg.DocID.
country, year (variety)	Form. (g ae/L)	kg ai/ha	water, L/ha	Growth stage	no.	days	Cones	mandipropamid	(Trail No.)
						7	green	6.0	
						10	dried	21.2	
						10	green	4.4	
						14	dried	26.0	
						14	green	7.1	
Germany, 2005	250 SC	0.310	1990	BBCH 82	2	0 [a]	green	< 0.01	NOA
(Hallertauer		0.346	2215	BBCH 85		7 [a]	dried	< 0.01	446510/1151
Tradition)						0 [b]	green	1.9	DE-FR-05-0354
						0	green	6.0	
						3	green	4.5	
						7	dried	25.6	
						7	green	5.3	
						10	dried	28.0	
						10	green	6.6	
						14	dried	19.6	
						14	green	4.6	
France, 2006	250 SC	0.370	1851	BBCH 87	2	0 [a]	green	< 0.01	NOA
(Strisselpalt)		0.366	1828	BBCH 88		7 [a]	dried	< 0.01	446510/1342
						0 [b]	green	1.6	FR-FR-06-0267
						0	green	3.5	
						3	green	3.4	
						7	dried	18.0	
						7	green	2.2	
						10	dried	15.0	
						10	green	1.4	
						14	dried	14.0	
						14	green	1.9	
France, 2006	250 SC	0.418	1851	BBCH 83–85	2	0 [a]	green	< 0.01	NOA
(Strisselpalt)		0.409	1828	BBCH 87		7 [a]	dried	< 0.01	446510/1342
						0 [b]	green	3.2	FR-FR-06-0268
						0	green	8.7	
						3	green	5.2	
						7	dried	29.0	
						7	green	4.5	
						9	dried	28.0	
						9	green	3.9	
						14	dried	26.0	
						14	green	3.5	
France, 2006	250 SC	0.379	1851	BBCH 76–81	2	0 [a]	green	< 0.01	NOA
(Perle)		0.395	1828	BBCH 81		7 [a]	dried	< 0.01	446510/1342
						0 [b]	green	3.2	FR-FR-06-0269
						0	green	6.7	
						3	green	7.3	
						8	dried	35.0	
						8	green	6.8	
						10	dried	29.0	
						10	green	3.5	
						14	dried	34.0	
						14	green	6.4	
Germany, 2006	250 SC	0.386	1851	BBCH 76–81	2	0 [a]	green	< 0.01	NOA
(Perle)		0.388	1828	BBCH 81		7 [a]	dried	< 0.01	446510/1342
						0 [b]	green	4.3	FR-FR-06-0270
						0	green	7.3	
						3	green	7.2	
						8	dried	38.0	
						8	green	5.9	
						10	dried	30.0	
						10	green	3.7	
						14	dried	31.0	
						14	green	4.3	
Germany, 2006	250 SC	0.422	1851	BBCH 75–82	2	0 [a]	green	< 0.01	NOA

HOPS	Application					PHI	Crop part	Residues mg/kg,	Ref. Reg.DocID.
country, year (variety)	Form. (g ae/L)	kg ai/ha	water, L/ha	Growth stage	no.	days	Cones	mandipropamid	(Trail No.)
(Spalter)		0.408	1828	BBCH 79–85		7 [a]	dried	< 0.01	446510/1342
						0 [b]	green	3.3	FR-FR-06-0271
						0	green	6.0	
						3	green	6.3	
						8	dried	25.0	
						8	green	6.0	
						10	dried	26.0	
						10	green	3.7	
						14	dried	32.0	
						14	green	5.7	
Germany, 2006	250 SC	0.415	1851	BBCH 75–82	2	0 [a]	green	< 0.01	NOA
(Hallertauer		0.406	1828	BBCH 79–85		7 [a]	dried	< 0.01	446510/1342
Mittelfruher)						0 [b]	green	3.9	FR-FR-06-0272
						0	green	12.0	
						3	green	11.0	
						7	dried	19.0	
						7	*Pre-process*	27.0	
						7	*Malt Grain*	< 0.2	
						7	*Spent Hops*	3.3	
						7	*Wort (cooked)*	0.096	
						7	*Spent Yeast*	0.58	
						7	*Young Beer*	0.062	
						7	*Beer*	0.063	
						7	*Malt Grain*	< 0.20	
						7	*Beer*	0.061	
						7	*Malt Grain*	< 0.20	
						7	*Beer*	0.062	
						7	*Malt Grain*	< 0.20	
						7	*Beer*	0.049	
						7	green	6.0	
						10	dried	40.0	
						10	green	5.9	
						14	dried	34.0	
						14	green	4.8	
UK, 2006	250 SC	0.408	1540	BBCH 67	2	7 [a]	green	< 0.10	NOA
(Pioneer)		0.384	1449	BBCH 67–70		7 [a]	dried	< 0.10	446510/1342
						0	green	4.7	S09-01505-01
						3	green	7.4	
						7	green	5.5	
						7	dried	15.4	
						10	green	9.6	
						14	green	4.2	
Germany, 2009	250 SC	0.432	2267	BBCH 81–83	2	7 [a]	green	< 0.10	NOA
(Hallertauer		0.415	2180	BBCH 85–87		7 [b]	dried	< 0.10	446510/1342
Mittelfruher)						0	green	7.8	S09-01505-02
						3	green	10	
						7	green	5.7	
						7	dried	12.0	
						10	green	5.5	
						14	green	5.6	

[a] Control residue value.

[b] Sample taken prior to last application.

Three independent supervised trials were conducted on hops according to the US GAP in Washington state (two) and Idaho (one) during 2005 (Joseph T 2007, NOA446510/1076). The trials account for 94% of total US hops production based on acreage. In each trial, mandipropamid formulated as a suspension concentrate (SC) containing 250 g mandipropamid per litre, was applied three times at rates of 151 to 166 g ai/ha (nominally 0.135 lb ai/acre), i.e. within 25% of the nominal maximum rate of 145 g ai/ha. The application intervals were 7 days. The water volumes during applications were in the range from 235 to 433 L/ha in the trials conducted in Washington state, and about 20 L/ha in the trial conducted in Idaho to simulate an aerial application rate. Duplicate samples of fresh hop cones were collected with PHIs of 7 and 14 days from all trials. The green hops samples were kiln dried using simulated commercial technique to produce dried hops of commercial quality. Dried hops samples were analysed for residues of mandipropamid using analytical method RAM 415/01 with minor modifications. The residue data from the supervised trials is summarised in Table 11.

Table 11Results of residue trials with mandipropamid conducted as a foliar application to hops in USA in 2005

HOPS	Application					PHI	Crop part	Residues mg/kg,	Ref. Reg.DocID.
country, year (variety)	Form. (g ae/L)	kg ai/ha	water, L/ha	Growth stage	no.	days	Cones	mandipropamid	(Trail No.)
USA, 2005	250 SC	0.151	325	BBCH 79	3	0 [a]	dried	< 0.01	NOA
(Warrior)		0.152	327	BBCH 81–82		0	dried	1.5	446510/1076
		0.152	326	BBCH 85		3	dried	3.1	WF-FR-05-6060
						5	dried	3.6	
						7	dried	5.4	
						9	dried	3.3	
						14	dried	0.02	
						16	dried	0.5	
USA, 2005	250 SC	0.153	419	immature	3	0 [a]	dried	< 0.01	NOA
(Warrior)		0.158	427	immature		7	dried	4.3	446510/1076
		0.155	433	Preharvest		14	dried	4.4	WF-FR-05-6061
USA, 2005	250 SC	0.166	21	maturing	3	0 [a]	dried	< 0.01	NOA
(Warrior)		0.160	20	maturing		7	dried	10.6	446510/1076
		0.153	19	mature		14	dried	8.5	WF-FR-05-6062

[a] Control residue value.

FATE OF RESIDUES IN STORAGE AND PROCESSING

In processing

The Meeting received information on the fate of mandipropamid residues during processing into beer.

Six residue trials were performed in Germany and northern France (Gizler, A, Lakaschus, S, 2008, NOA 446510/1342). Samples from one of the trials in Germany were taken for processing into beer. In this trial, mandipropamid formulated as a suspension concentrate (SC) containing 250 g mandipropamid per litre, was applied to hops. Two applications, at growth stages BBCH 75–82 and BBCH 79–85 and separated by an interval of 7 days, were made at 415 and 406 g ai/ha (nominal 400 g/ha for each application). Seven days after the final application, samples (approximately 2.5 kg) of treated and untreated dry hop cones were collected and transported frozen to the processing facility. The mandipropamid residues in hop cones prior to processing and in beer is presented in Table 10. The summary of processing factors was listed in Table 12.

Table 12 Summary of processing factors for mandipropamid residues

Raw agricultural commodity (RAC)	Processed commodity	Calculated processing factors	Median or best estimate
	Beer	0.002, 0.002, 0.002, 0.002	0.002

APPRAISAL

Mandipropamid was first evaluated by JMPR in 2008 when an ADI of 0–0.2 mg/kg bw was established and decided that an ARfD was unnecessary. At the Forty-fourth Session of the CCPR, mandipropamid was scheduled for the evaluation of 2013 JMPR for additional uses on hops.

Methods of analysis

The Meeting received descriptions and validation data for analytical methods for residues of mandipropamid in hops and processed hop samples.

Hop samples were extracted with acetonitrile:water (80:20 v/v). Extracts are centrifuged and aliquots diluted with water prior to being cleaned-up using polymeric solid-phase extraction cartridges. Residues of mandipropamid were quantified with HPLC-MS/MS. Validated LOQs was 0.01 mg/kg.

Stability of residues in stored analytical samples

The Meeting received information on the stability of residues in crop commodities in tomatoes, grapes, potatoes, lettuce, cucumbers, wheat and soya beans for two years.

The commodities in which stability was tested were both raw agricultural commodities and processed, such as tomatoes (fruit and paste), grapes (fruit and juice), potatoes (tubers and granules/flakes), lettuce, cucumbers, wheat (forage, grain and straw), and soya beans (beans, hulls, meal and oil). There was no significant change in the mandipropamid residue levels in any commodity during the 24 months of storage at -20 °C with any apparent losses being < 30%. These commodities contained representatives of the four crop types, i.e., predominantly water, oil, protein, and starch containing materials. Therefore, residues of mandipropamid are expected to be stable in all crop commodities including hops stored under these conditions for at least two years.

Supervised residue trials on crops

The Meeting received supervised trials data for mandipropamid uses on hops.

Hops

Ten trials were conducted on hops in Europe (maximum German GAP: 0.40 kg ai/ha, two applications, 14-day PHI) in 2005 and 2006 and in the USA (maximum USA GAP: 0.145 kg ai/ha, three applications, 7-day PHI). In eight trials conducted at the maximum German GAP, the ranked order of concentrations in dry cone, median underlined, were: 14, 20, <u>26</u>(2), <u>31,</u> 32 and 34(2) mg/kg. In three trials conducted at the maximum US GAP, the ranked order of concentration in the dry cones was: 4.3, 5.4 and 10.6 mg/kg.

Noting that European trials resulted in higher residues in dry cones, the Meeting estimated a maximum residue level and an STMR value for mandipropamid in hops, dry of 90 and 28.5 mg/kg on the basis of European dataset.

Fate of residues during processing

The Meeting received information on the fate of mandipropamid residues during the food processing of hops.

The processing factor for beer (0.002) was applied to the estimated STMR for dry cone (28.5 mg/kg) to produce an STMR-P value for beer (0.057 mg/kg).

RECOMMENDATIONS

On the basis of the data from supervised trials, the Meeting concluded that the residue concentrations listed below are suitable for establishing MRLs and for assessing IEDIs.

Definition of the residue (for compliance with the MRL and for estimation of dietary intake for plant and animal commodities)*: mandipropamid.*

CCN	Commodity	MRL, mg/kg	STMR or STMR-P, mg/kg
DH 1100	Hops, dry	90	28.5
-	Beer	-	0.057

DIETARY RISK ASSESSMENT

Long-term intake

The Meeting noted that the new estimation of dry hops did not result in a significant change of the long term dietary intake and concluded that the long-term intake of residues of mandipropamid resulting from its uses that have been considered by JMPR is unlikely to present a public health concern.

Short-term intake

The 2008 JMPR decided that an ARfD was unnecessary. The Meeting therefore concluded that the short-term intake of mandipropamid residues is unlikely to present a public health concern.

REFERENCES

Code	Author	Year	Title, Institute, Report reference
NOA446510/0160	Crook, SJ	2004	Mandipropamid: Residue Analytical Method for the Determination of Residues of NOA446510 in Crop Samples. Final determination by LC-MS/MS. Syngenta Crop Protection AG, Basel, Switzerland. Syngenta—Jealott's Hill, Bracknell, United Kingdom, RAM415/01. Syngenta File No NOA446510/0160. Not GLP, unpublished, issued 05.11.2004.
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