

MAY 23 1997

**MEMORANDUM**

**SUBJECT:** **Carbofuran.** Magnitude of the Residue in Grapes and Strawberries.  
DP Barcode: D231094 and D231095; CBRS Nos. 17765 and 17766; MRID No.:  
440611-01 and 440631-01; Case No. 0101.

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Health Effects Division (7509C)

**THRU:** R.B. Perfetti, Ph.D., Acting Branch Chief  
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**TO:** Paula Deschamp, Section Head  
Risk Characterization and Analysis Branch  
Health Effects Division (7509C)

Attached is a review of the registrants "Magnitude of the Residue" submission for carbofuran in grapes and strawberries. This information was reviewed by Dynamac Corporation under the supervision of CBRS/HED. The data assessment has undergone secondary review in the Branch and has been revised to reflect Agency policies.

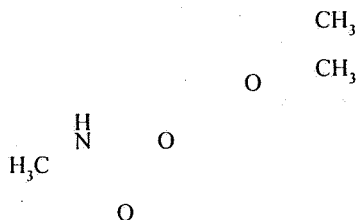
CBRS understands that FMC has requested cancellation of the use of flowable carbofuran on grapes and strawberries (see FR dated 2/13/97, 62 FR 6775). Unless this request is withdrawn, these use deletions will become effective on May 14, 1997.

FMC has submitted the current grape and strawberry study for use if any other registrant or state requests in the future that these uses be reinstated. At this time, the current tolerances for carbofuran on grapes and strawberries are scheduled for revocation.

If you need additional information, please advise.

cc: RF, SF, List A Rereg. File, Circ., DJM.  
RDI: Pilot Team: 3/9/97;RPerfetti:5/14/97.

# CARBOFURAN



Shaughnessy No. 090601; Case No. 0101

(CBRS No. 17765; DP Barcode D231094)

(CBRS No. 17766; DP Barcode D231095)

## REGISTRANT'S RESPONSE TO RESIDUE CHEMISTRY DATA REQUIREMENTS

### BACKGROUND

FMC Corporation has requested voluntary cancellation of the use of carbofuran on grapes and strawberries for the overall purposes of avian risk mitigation. Because some states may wish to support use of carbofuran on these crops through SLN registrations, FMC has submitted data depicting the magnitude of carbofuran residues in/on grapes (1984; MRID 44061101) and strawberries (1995; MRID 44063101). Data from these submissions are evaluated herein for adequacy in fulfilling residue chemistry data requirements for the reregistration of carbofuran. The Conclusions and Recommendations stated below pertain only to the above submissions. All other residue chemistry data requirements stated in the Carbofuran Update, dated 1/9/91, are not addressed herein.

The qualitative nature of carbofuran residues in plants is not adequately understood; additional data regarding the components in an extract of soybean hay are required. The qualitative nature of the residue of carbofuran in animals is adequately understood based on acceptable studies conducted on ruminants and poultry. CBRS tentatively concluded, pending receipt of the outstanding plant metabolism data, that the residues of concern in plant and animal commodities are the residues which are currently regulated, i.e., parent carbofuran and its metabolites 3-hydroxy-carbofuran, 7-phenol-carbofuran, 3-hydroxy-7-phenol carbofuran, and 3-keto-7-phenol-carbofuran. The HED Metabolism Committee has concluded that field trials must include analysis for the regulated metabolites as well as the metabolite 3-ketocarbofuran.

Tolerances are established [40 CFR §180.254 (a), (b), and (c), §185.600, and §186.600] for the combined residues of carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranyl-N-

methylcarbamate), its carbamate metabolite 3-hydroxy carbofuran (2,3-dihydro-2,2-dimethyl-3-hydroxy-7-benzofuranyl-*N*-methylcarbamate), and its phenolic metabolites 7-phenol carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranol), 3-keto-7-phenol carbofuran (2,3-dihydro-2,2-dimethyl-3-oxo-7-benzofuranol), and 3-hydroxy-7-phenol carbofuran (2,3-dihydro-2,2-dimethyl-3,7-benzofurandiyl), in or on various raw agricultural commodities, food, and feed items. All tolerances, except those for bananas, sugar beets, coffee beans, rice, sorghum grain, and sugarcane, specify a maximum level for carbamate residues in or on the commodity.

Analytical methods are available for the determination of carbofuran and its regulated metabolites. These methods (Methods I through X and Methods A through C) are located in PAM Vol. II Section 180.254.

Codex MRLs are expressed as the sum of carbofuran and 3-hydroxy carbofuran. Issues pertaining to compatibility of U.S. tolerances with Codex MRLs will be addressed at the issuance of the RED.

## CONCLUSIONS AND RECOMMENDATIONS

1. A notice of the receipt of a request from FMC Corporation for amendments to delete the use of flowable carbofuran on grapes and strawberries was recently published in the Federal Register (2/13/97, 62 FR 6775). Unless the request is withdrawn, these use deletions will become effective on May 14, 1997.

### Magnitude of the Residue in Grapes

- 2a. The submitted data indicate that the combined carbofuran residues of concern were <0.05- <0.36 ppm [including <0.02-0.15 ppm carbamates] in/on grapes harvested at maturity following multiple drip irrigation applications of the 4 lb/gal FIC formulation at 1-2 lb ai/A/application. The submitted data do not reflect the maximum use pattern of carbofuran on grapes registered under SLN CA850059 (preharvest applications to grapes at 2-3 lb ai/A using drip irrigation equipment, and postharvest applications at 3-6 lb ai/A using drip irrigation equipment; preharvest application rate may not exceed 2 lb ai/A if any postharvest applications were made the previous year).
- 2b. If any registrant wishes to support SLN CA850059 for use of carbofuran on grapes, the product label must be modified to agree with the application patterns used with the existing residue trial data.
- 2c. These data do not address the requirement specified in the Carbofuran Update for grapes; the registrant was required to provide an explanation for a tolerance-exceeding residue (<0.57 ppm including <0.19 ppm carbamates) in a single sample of grapes treated at 1x the maximum Section 3 registered rate used to generate samples for a processing study.

However, because the registrant has requested cancellation of use of carbofuran on grapes, these data are no longer required. If any registrant wishes to support the current Section 3 registration of carbofuran on grapes (a single broadcast soil-incorporated application at 10 lb ai/A with a 200-day PHI), an increase in the established tolerance for grapes from 0.4 ppm (0.2 ppm carbamates) to 0.6 ppm (0.2 ppm carbamates) must be proposed.

### Magnitude of the Residue in Strawberries

3. Residues of carbofuran and its carbamate and phenolic metabolites were nondetectable (<0.01 ppm each) in/on strawberries harvested at maturity following a single postharvest banded application of the 4 lb/gal FIC formulation to the soil at 2 lb ai/A. The submitted data are adequate to support the use of carbofuran on strawberries as currently registered. If any registrant wishes to support the currently registered use of carbofuran on strawberries, no additional data would be required.

## DETAILED CONSIDERATIONS

### Residue Analytical Methods

Grape samples from the field trial study were analyzed by FMC (Richmond, CA) for residues of carbofuran and 3-hydroxy-carbofuran (3-OH) using a GC method with nitrogen-phosphorus detection (NPD), and for residues of 7-phenol-carbofuran (7-Ph), 3-hydroxy-7-phenol-carbofuran (3-OH-7-Ph), and 3-keto-7-phenol-carbofuran (3-keto-7-Ph) using a GC method with mass selective detection (MS). These methods were discussed in the Carbofuran Update (MRID 00160770). The limits of quantitation (LOQs) for carbamates and phenols were 0.05 ppm and the limits of detection (LODs) were 0.01 ppm.

Strawberry samples from the field trial study were analyzed by FMC (Princeton, NJ) for residues of carbofuran, 3-OH, and 3-keto-carbofuran (3-keto) using an HPLC method with fluorescence detection, and for residues of 7-Ph, 3-OH-7-Ph, and 3-keto-7-Ph using a GC/MS method. These methods have been described previously (see CBRS Nos. 16638, 16694, 16695, 16914, and 17452; DP Barcodes D221465, D221469, D221473, D221476, and D223210, 1/28/97, D. Miller). The LOQs for carbamates and phenols were 0.05 ppm and LODs were 0.01 ppm.

Concurrent method recovery analyses were conducted by FMC to determine the suitability of the methods for residue data collection purposes. Untreated samples of RACs from the field trials were separately fortified with carbamates and phenols at various levels. Representative chromatograms, sample calculations, and standard curves were provided. The recovery data are presented in Table 1. These data suggest that the methods are adequate for data collection for carbofuran and its carbamate and phenolic metabolite residues in/on grapes and strawberries.

Table 1. Concurrent method recoveries of carbofuran and its carbamate and phenolic metabolites from fortified samples of grapes and strawberries from the submitted field trial studies.

Commodity	Fortification Level (ppm)		Percent Recovery <sup>a</sup>					
			Carbamates			Phenols		
	Carbamates	Phenols	Carbofuran	3-keto	3-OH	7-Ph	3-keto-7-Ph	3-OH-7-Ph
Grapes <sup>b</sup>	0.05-0.30	0.05-0.20	60,62,64,68; 70-81	N/A <sup>c</sup>	60,64; 74-90	74-102	98-117; 126,138	50-68; 74
Strawberries <sup>d</sup>	0.05	0.05	77-82	76-94	73-84	104-114	84-86	54-60

<sup>a</sup> Recovery values outside the acceptable 70-120% range are listed separately.

<sup>b</sup> For grapes, reported recovery values represent 12 samples for carbamate analyses and 9 samples for phenol analyses.

<sup>c</sup> N/A: Not analyzed.

<sup>d</sup> For strawberries, reported recovery values represent 3 samples.

### Storage Stability Data

The grape samples from the field trials were shipped (temperature unspecified) to FMC (Richmond, CA) where they were stored frozen (-18 C) prior to analysis. The dates of sample analysis were not provided; however, based on the date on which the study report was written, samples were stored for a maximum of 6 months prior to analysis.

The strawberry samples from the field trials were frozen promptly after harvest, and were shipped frozen to FMC (Princeton, NJ) where they were stored frozen until homogenization and acid hydrolysis. Following acid hydrolysis, hydrolysates were stored in a refrigerator (~8 C) until residue analysis. Strawberry samples were acid hydrolyzed within 17-62 days of collection. The storage intervals between acid hydrolysis and carbamate analysis were 26-27 days and the storage intervals between acid hydrolysis and phenol analysis were 32-33 days.

The available storage stability data indicate that carbofuran and its carbamate metabolites are generally stable in raw agricultural commodities for up to 24-26 months of frozen storage (CBRS Nos. 16634, 16637, 16639, 16640, 16641, 16693, 16697, 16702, 16912, 16913, and 16915; DP Barcodes D221443, D221430, D221471, D221447, D221439, D221463, D221470, D221462, D222845, D222844, and D222861, 1/9/97, D. Miller), and that the phenolic metabolites are generally stable for up to 11 months of frozen storage (Carbofuran Update). In addition, residues of carbofuran and its carbamate metabolite were found to be stable in the acid hydrolysates of plant commodities for up to 8 months of refrigerated storage, and residues of carbofuran phenolic metabolites were found to be stable in the acid hydrolysates of plant commodities during up to 6 months of frozen storage (CBRS Nos. 16638, 16694, 16695, 16914, and 17452; DP Barcodes D221465, D221469, D221473, D221476, and D223210, 1/28/97, D. Miller). No additional storage stability data are required to support the submitted grape and strawberry field trial data.

## Magnitude of the Residue in Plants

### Grapes

*Established tolerance:* A tolerance of 0.4 ppm (of which no more than 0.2 ppm is carbamates) has been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on grapes [40 CFR §180.254(a)].

*Registered use patterns:* The 4 lb/gal FIC formulation (EPA Reg. No. 279-2876) is registered for use on grapes grown in CA. A single broadcast soil-incorporated application may be made between the vine rows at 10 lb ai/A. A PHI of 200 days is in effect.

The 4 lb/gal FIC formulation is also registered for use on grapes in CA under SLN CA850059. Preharvest applications to grapes may be made at 2-3 lb ai/A using drip irrigation equipment, and postharvest applications may be made at 3-6 lb ai/A using drip irrigation equipment. If any postharvest applications were made the previous year, the preharvest application rate may not exceed 2 lb ai/A. Preharvest applications may not be made after May 1 or within 60 days of harvest. Postharvest applications are to be made before December 1. No maximum number of applications per season or maximum seasonal rate is specified.

*Discussion of the data:* FMC Corporation has submitted data (1984; MRID 44061101) from 18 trials conducted at four locations in CA during 1983 and 1984 depicting residues of carbofuran and its carbamate metabolite (3-OH), and its phenolic metabolites (7-Ph, 3-keto-7-Ph, and 3-OH-7-Ph) in/on grapes. Grape samples were collected at normal harvest following multiple applications of the 4 lb/gal FIC formulation (EPA Reg. No. 279-2876) by drip irrigation in the fall and/or spring according to one of the following treatment schedules: (i) three applications, with 7- to 14-day retreatment intervals, in the fall at 2 lb ai/A/application; grapes harvested in the spring 238-294 days following final application; (ii) one application in the spring at 4 lb ai/A, followed (178 days later) by three applications, with 9- to 21-day retreatment intervals, in the fall at 2 lb ai/A/application; grapes harvested in the spring 209 or 218 days following final application; (iii) three applications, with 7- to 17-day retreatment intervals, in the spring at 1 lb ai/A/application; grapes harvested 54-139 days following final application; or (iv) three applications, with 7- to 14-day retreatment intervals, in the fall at 2 lb ai/A/application, followed (126-199 days later) by two applications, with a 7- to 32-day retreatment interval, at 1 lb ai/A; grapes harvested 59-153 days following final application.

Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated samples were determined using the GC/NPD and GC/MS methods described above. Apparent residues of carbofuran, 3-OH, 7-Ph, 3-keto-7-Ph, and 3-OH-7-Ph were less than the LOD (<0.01 ppm each) in/on six samples of untreated grapes; detectable residues of 3-OH were observed in/on one sample of untreated grapes at 0.01 ppm. Residues in/on treated samples are presented in Table 2. Residue values were corrected by the registrant for average method recovery.

Table 2. Residues of carbofuran and its carbamate and phenolic metabolites in/on grapes harvested following multiple applications of the 4 lb/gal FIC formulation using drip irrigation equipment.

Treatment <sup>a</sup> (Number of samples)	Residues, ppm <sup>b</sup>							
	Carbamates			Phenols				Combined
	Carbofuran	3-OH	Total	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	
1 (4)	<0.01	<0.01-(0.02)	<0.02-<0.03	(0.02)-(0.04)	<0.01-(0.02)	<0.01-(0.03)	<0.04-0.07	<0.06-<0.10
2 (4)	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.03	<0.05
3 (12)	<0.01-(0.02)	(0.03)-0.13	<0.04-0.15	(0.02)-0.07	(0.02)-0.06	(0.02)-0.12	0.06-0.24	<0.10-<0.36
4 (4)	<0.01-(0.03)	0.08-0.12	<0.09-0.15	(0.04)-(0.06)	(0.02)-0.05	(0.03)-0.11	0.09-0.22	<0.23-<0.34

- <sup>a</sup> **Treatment 1:** three applications, with 7- to 14-day retreatment intervals, in the fall at 2 lb ai/A/application; grapes harvested in the spring 238-294 days following final application  
**Treatment 2:** one application in the spring at 4 lb ai/A, followed (178 days later) by three applications, with 9- to 21-day retreatment intervals, in the fall at 2 lb i/A/application; grapes harvested in the spring 209 or 218 days following final application  
**Treatment 3:** three applications, with 7- to 17-day retreatment intervals, in the spring at 1 lb ai/A/application; grapes harvested 54-139 days following final application  
**Treatment 4:** three applications, with 7- to 14-day retreatment intervals, in the fall at 2 lb ai/A/application, followed (126-199 days later) by two applications, with a 7- to 32-day retreatment interval, at 1 lb ai/A; grapes harvested 59-153 days following final application.
- <sup>b</sup> Residues in/on treated samples were corrected by the registrant for average method recovery. Residue values in parentheses are estimates; ≥ LOD (0.01 ppm) but ≤ LOQ (0.05 ppm).

Geographic representation is adequate to support an SLN use in CA; field trials were conducted in four locations in CA.

*Study summary:* The submitted data indicate that the combined carbofuran residues of concern were <0.05-<0.36 ppm [including <0.02-0.15 ppm carbamates] in/on grapes harvested at maturity following multiple drip irrigation applications of the 4 lb/gal FIC formulation at 1-2 lb ai/A/application. The submitted data do not reflect the use pattern of carbofuran on grapes registered under SLN CA850059 (preharvest applications to grapes at 2-3 lb ai/A using drip irrigation equipment, and postharvest applications at 3-6 lb ai/A using drip irrigation equipment; preharvest application rate may not exceed 2 lb ai/A if any postharvest applications were made the previous year). If any registrant wishes to support SLN CA850059 for use of carbofuran on grapes, the product label must be modified to coincide with any of the treatment rates tested in the current study.

These data do not address the requirement specified in the Carbofuran Update for grapes; the registrant was required to provide an explanation for a tolerance-exceeding residue (<0.57 ppm including <0.19 ppm carbamates) in a single sample of grapes treated at 1x the maximum



Section 3 registered rate used to generate samples for a processing study. However, because the registrant has requested cancellation of use of carbofuran on grapes, these data are no longer required. If any registrant wishes to support the current Section 3 registration of carbofuran on grapes (a single broadcast soil-incorporated application at 10 lb ai/A with a 200-day PHI), an increase in the established tolerance for grapes from 0.4 ppm (0.2 ppm carbamates) to 0.6 ppm (0.2 ppm carbamates) must be proposed.

### Strawberries

*Established tolerances:* A tolerance of 0.5 ppm (of which no more than 0.2 ppm is carbamates) has been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on strawberries [40 CFR §180.254(a)].

*Registered use patterns:* The 4 lb/gal FIC formulation is registered for use on strawberries grown in OR and WA (EPA Reg. No. 279-2876) and CT (SLN CT940002), MI (SLN MI920003), MN (SLN MN830013), MO (SLN MO890002), NH (SLN NH820004), OH (SLN OH900001), TN (SLN TN870008), VA (SLN VA840007), and VT (SLN VT800009). In MI, MN, MO, OR, TN, and WA, a single soil banded application of the 4 lb/gal FIC formulation may be made at 1-2 lb ai/A (0.08-0.16 lb ai per 1,000 feet of row for 42-inch row spacing) after last harvest but before October 1. In CT, NH, OH, VA, and VT, a single application of the 4 lb/gal FIC formulation may be made at 2 lb ai/A following renovation immediately after harvest; application must be made before September 1. Applications when berries are present are prohibited.

[We note that in transmittal letter 44063100 the registrant lists the following SLN registrations that they believe will be affected by the cancellation of uses on strawberries: CA820076, CT940002, ME880004, MI920003, MN830013, MO890002, NH820004, OH900001, PA890003, TN870008, VA840007, and VT800009. According to REFS (search dated 02/14/97), SLNs CA820076, ME880004, and PA890003 are no longer registered for use on strawberries.]

*Discussion of the data:* FMC has submitted data (1995; MRID 44063101) from three trials conducted in MI, NY, and VA depicting residues of carbofuran and its carbamate metabolites (3-keto and 3-OH), and its phenolic metabolites (7-Ph, 3-keto-7-Ph, and 3-OH-7-Ph) in/on strawberries. A single banded soil application of the 4 lb/gal FIC formulation was made to strawberries postharvest at 2 lb ai/A. Strawberries were harvested at maturity (225-270 days following application). Applications were made in ~13-20 gal/A of water using ground equipment.

One control and duplicate treated samples were collected from each test site. Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated samples were determined using the HPLC and GC/MS methods described above. Residues of carbamates and

phenols were less than the LOD (<0.01 ppm each) in/on three samples of untreated strawberries and six samples of treated strawberries.

Geographic representation of the submitted residue data is adequate to support the registered uses. The test sites of MI, NY, and VA, in combination with OR for which data were reviewed in the Carbofuran Reregistration Standard (dated 8/9/83), are sufficient to represent the states in which use of carbofuran on strawberries is allowed.

*Study summary:* Residues of carbofuran and its carbamate and phenolic metabolites were nondetectable (<0.01 ppm each) in/on strawberries harvested at maturity following a single postharvest banded application of the 4 lb/gal FIC formulation to the soil at 2 lb ai/A. The submitted data are adequate to support the use of carbofuran on strawberries as currently registered. If any registrant wishes to support the currently registered use of carbofuran on strawberries, no additional data would be required.

#### AGENCY MEMORANDA CITED IN THIS REVIEW

CBRS Nos.: 16634, 16637, 16639, 16640, 16641, 16693, 16697, 16702, 16912, 16913, and 16915  
DP Barcodes: D221443, D221430, D221471, D221447, D221439, D221463, D221470, D221462, D222845, D222844, and D222861  
Subject: Carbofuran. Storage Stability in Various Laboratory Fortified Crop and Animal Matrices, Magnitude of the Residue in Field Corn, Bell Peppers, Rice, and Sugarcane, and Magnitude of the Residue in Processed Commodities of Field Corn, Potatoes, Rice, and Sugarcane  
From: D. Miller  
To: P. Deschamp  
Dated: 1/9/97  
MRID(s): 43842601, 43842701, 43842901, 43851001, 43851601, 43851701, 43852301, 43852401, 43907601, 43907701, and 43907801

CBRS Nos.: 16638, 16694, 16695, 16914, and 17452  
DP Barcodes: D221465, D221469, D221473, D221476, and D223210  
Subject: Carbofuran. Storage Stability in Various Crops, Magnitude of the Residue in Non-Bell Peppers and Sorghum, and Magnitude of the Residue in/on Processed Commodities of Sorghum and Sugar Beets  
From: D. Miller  
To: P. Deschamp  
Dated: 1/28/97  
MRID(s): 43842501, 43842801, 43851901, 43852201, and 43907101

MASTER RECORD IDENTIFICATION NUMBERS

44061101 Pejovich, R. (1984) Determination of the Carbamate and Phenol Metabolite Residues of Carbofuran in Grapes Following Multiple Drip Irrigation Applications of Furadan 4F Insecticide: Lab Project Number: RAN-0143: S-078-84-07. Unpublished study prepared by FMC Corp. 46 p.

44063101 Shevchuk, N. (1995) Magnitude of the Residue of Carbofuran and its Carbamate and Phenolic Metabolites in/on Strawberry Treated with Furadan 4F: Lab Project Number: 078STR94R1: P-3058: 05. Unpublished study prepared by FMC Corp. 76 p.