U. S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

PC Code No. 056801
DP Barcode: D290953

MEMORANDUM **Date:** October 30, 2003

SUBJECT: EFED Review of References Cited in Bayer CropScience *"Position Paper for Sevin XLR Plus Toxicity to Bees"*

TO: Anthony Britten, PM Team Reviewer
Michael Goodis, Product Manager
Special Review and Reregistration Division

FROM: Thomas M. Steeger, PhD., Senior Biologist
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THROUGH: Elizabeth Behl, Chief
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The Environmental Fate and Effects Division (EFED) has completed its review of the position paper (MRID 460658-01) on Sevin XLR Plus® [carbaryl; PC Code 056801] toxicity to bees **(ATTACHMENT 1)** and the supporting open literature studies submitted by Bayer CropScience. The position paper is in response to the Agency's proposed label language regarding bees in the interim reregistration eligibility decision (IRED) document for carbaryl that reads *"this product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area."* EFED has been requested by the Special Review and Reregistration Division to review the position paper and its associated references to determine whether the submission addresses Agency concerns regarding the acute toxicity of carbaryl and uncertainties surrounding the potential chronic toxicity of carbaryl. While the registrant is correct in noting that the intrinsic [acute] toxicity of carbaryl to bees is well known, the potential chronic toxicity of the pesticide to bees remains an uncertainty.

In addition, Bayer is correct in its comment that "the number of reports of bee incidents with Sevin XLR Plus® is very small"; however, incident data rarely provide formulation information. Recent information received from Washington state suggests that bee kill incidents have been grossly underestimated by the Agency because of under-reporting by states. Bee kill incidents in Minnesota were not initially reported to the Agency; however, they were investigated by the Minnesota Department of Agriculture on a case-by-case basis. Although carbaryl residues were not detected in all of the incidents, several of the incidents where

Seven XLR Plus® was used did reveal carbaryl residues. It is important to note though that the incidents captured in the Ecological Incident Information System are often not associated with residues; like many ecological incidents involving pesticides, carbaryl's potential association with the incidents results from its use in relatively close proximity to the site of bee kills.

The references (see **Attachment 2** for reviews) support Bayer's contention that the Sevin XLR Plus® formulation is less toxic than other formulations of carbaryl; however, the open literature refers to the chemical's acute toxicity, not its chronic toxicity. Although Hanney and Harvey (1982) look at carbaryl residues in pollen combs, it is unclear whether the study could accurately measure chronic toxicity given the precipitous decline in bee numbers observed across carbaryl-treated and control bees. Additionally, bee keepers have expressed concerns (personal communication: Jeff Anderson 2003) that toxicity studies of Sevin XLR Plus® conducted in dry climates may yield substantially different results had the studies been conducted under more humid conditions.

The registrant is correct that the previous label for Sevin XLR Plus® indicated that the chemical was less [acutely] toxic than other carbaryl formulations; however, the chronic toxicity of carbaryl and specifically the Sevin XLR Plus® formulation is an uncertainty. Neither the position paper nor its supporting documentation address this uncertainty.

If the Agency's risk management decision requires a greater degree of certainty in the ecological risk assessment for carbaryl than is possible from currently available data, then additional data would be needed to evaluate the potential chronic toxicity of Sevin XLR Plus® to bees. If additional data are needed to reduce uncertainty, EFED recommends that chronic toxicity data are submitted to address whether Sevin XLR Plus® poses a chronic risk to honey bees.

ATTACHMENT 1. BAYER CROPSCIENCE POSITION PAPER (MRID 460658-01) ON SEVIN XLR PLUS® TOXICITY TO BEES.

SEVIN® XLR PLUS Carbaryl Insecticide
Toxicity to Bees

Introduction:

In the recently issued IRED, the EPA is requesting that the following label statement be added to all carbaryl formulations:

This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.

This language is already present on most carbaryl products labels. On the label for Sevin® XLR Plus, there is a much more detailed bee statement:

BEE CAUTION

This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. However, field studies have shown that SEVIN® brand XLR PLUS Carbaryl Insecticide is less hazardous to honey bees than other carbaryl products when direct application to bees is avoided and the spray residues have dried. For maximum honey bee hazard reduction, apply from late evening to early morning or when bees are not foraging. Do not apply this product or allow it to drift to blooming crops or weeds if bees are foraging in the treatment area. However, applications may be made during foraging periods if the beekeeper takes one of the following precautionary measures prior to bee flight activity on the day of treatment:
Confine the honey bees to the hive by covering the colony or screening the entrance or;
(2) locate hives beyond bee flight range from the treated area.
Precautionary measures may be discontinued after spray residues have dried. Contact your cooperative Agricultural Extension Service or your local Bayer CropScience representative for further information.

Replacing these detailed instructions with the more generic statement suggested above will do little or nothing to protect bees, but could be interpreted in such a way as to severely restrict the use of Sevin® XLR Plus on crops in which it has been used for many years without significant problems. The absence of differential hazard labeling may also lead growers to use alternate formulations of carbaryl or other products that are more toxic to bee colonies in cases where they previously selected the less hazardous Sevin® XLR Plus as an additional safeguard.

Background:

The intrinsic toxicity of carbaryl to bees is well known. The acute LD_{50} has been measured in a number of studies, with results indicating an oral LD_{50} ranging from 0.14 ìg/bee [1] to 1.49ìg/bee[2], and a contact LD_{50} ranging from 1.3 ìg/bee[1] to 33.9 ìg/bee[2]. However, it has been widely established that different formulations of carbaryl can have widely different levels of bee toxicity. In particular, the XLR Plus formulation has repeatedly been shown to exhibit significantly reduced bee toxicity over other formulations of carbaryl.

SEVIN® XLR PLUS

Sevin® XLR Plus contains microfine particles suspended in water. It is formulated with a unique sticker system that adheres carbaryl particles to the plant surface, thus providing resistance to wash-off by rain or

overhead irrigation. These properties appear to have the added benefit of reducing the amount of carbaryl available to bees. Earlier formulations had larger particles (>20 microns), which were very similar in size to pollen grains and therefore more likely to be 'picked up' by bees [3]. The particles in the Sevin® XLR Plus formulation are approximately 5 microns.

There are a number of literature reports describing the reduced toxicity of Sevin® XLR to honeybees. Experiments by Atkins et al [4,5] demonstrated that Sevin® XLR was 4 to 17 times less toxic to honeybees than other Sevin® formulations – this translates to a change of classification from 'highly toxic' to 'moderately' or 'slightly' toxic. Similar results were reported by Mayer and Johansen[6]. In their experiments on corn and alfalfa, Sevin® 80%WP was classified as 'hazardous' in cage tests, and caused significant bee mortality in the field. Sevin® XLR, however, was only 'moderately hazardous' in cage tests, and caused no abnormal mortality in the field.

In experiments on field corn Hanny and Harvey observed significant reduction in carbaryl residues in bees and bee mortality (5x and 6x, respectively) when Sevin® XLR was used instead of Sevin® 80 sprayable (wettable powder) [7]. They also measured the amount of carbaryl residue in the combs and found that there were no detectable residues in combs from the XLR treatments, while carbaryl residues were found in combs from the 'Sevin® sprayable' (wettable powder) treatment up to nine days after treatment. The authors suggest that the reduced bee hazard of the Sevin® XLR formulation is due both to the 'sticker' and to the decreased particle size.

The tests referred to above were carried out using Sevin® XLR. In December 1984 EPA approved the alternate brand name Sevin® XLR Plus for this product. A recent field study of Sevin® XLR Plus carried out for Bayer CropScience in Europe investigated the effects on bees when Sevin® XLR Plus was sprayed in an orchard. No significant effects of Sevin® XLR Plus on bee mortality, behavior, flight intensity or weight of hives were observed [8].

Important Considerations

We believe that the requirement to change the very detailed statement already present on the Sevin® XLR Plus label is not justified. This product has been used extensively for >10 years on a wide variety of crops (see appendix) yet there have been very few reports of bee mortality or effects. The recently issued IRED notes only five reports in the Ecological Incident database, and at least one was due to mis-application. If there were a widespread problem with the formulation or the labeling, it would almost certainly have been identified by now. Making changes at this point could have the effect of removing a valuable insecticide from many uses, leaving farmers or growers with few (or more toxic) alternatives. One example is the forestry industry, where there are no other cost-effective alternatives for control of several potentially devastating pests. Carbaryl is the only product presently labeled and efficacious for bark beetles on forest sites in the western US, and is the primary control for Cottonwood Leaf Beetle in poplar/cottonwood plantations in the South and Midwest.

In addition, it is important to remember that the language on the Sevin® XLR Plus label was added specifically because this formulation was proven to be less hazardous to bees than other formulations. If this differentiation is removed, farmers and growers may revert to using other, more 'bee hazardous' formulations, and the long-term effect on bees will be much more negative than if the existing label statement is used.

SUMMARY

Sevin® XLR Plus is significantly less toxic to bees than other formulations of carbaryl; this property has been confirmed by extensive field testing.

Detailed language on the label exists to minimize the danger to bees, and also helps to distinguish these products from other formulations which pose a greater danger to bees.

The number of reports of bee incidents with Sevin® XLR Plus is very small, despite the widespread use on a multitude of crops for many years.

Any reports of adverse effects in specific crops/uses (eg Minnesota forestry) should be investigated and addressed on a 'case by case' basis. The weight of evidence clearly shows that Sevin® XLR Plus, if used according to the current label, poses a small and manageable risk to bees.

The proposed label changes would have a severe negative impact on large numbers of farmers and growers while doing little, if anything, to protect bees.

Prepared by Alison Chalmers
August 28, 2003

(Document no. B004420)

APPENDIX – Labeled Uses of Sevin® XLR PLUS

Asparagus
Brassica Leafy Vegetable Crops
Cereal Grain Crops (Field and Pop Corn; Grain Sorghum; Rice; Sweet Corn; Wheat and Proso Millet)
Cucurbit Vegetables
Flax
Forage Crops (Alfalfa, Clovers, Birdsfoot Trefoil; Pasture and Grasses Grown for Seed; Rangeland)
Fruiting Vegetables
Leafy Vegetables
Legume Vegetables
Noncropland (Conservation Reserve Program; Wasteland; Rights-of-Way; Hedgerows; Ditchbanks; Roadsides)
Okra
Peanuts
Prickly Pear Cactus
Root and Tuber Crops (Root and Tuber Crops except Sugar Beets and Sweet Potatoes; Sugar Beets; Sweet Potatoes)
Small Fruits and Berries
Sunflower
Tobacco
Tree Fruit Crops (Citrus Fruits; Olives; Pome Fruits; Stone Fruits)
Tree Nut Crops (Pistachios; Tree Nuts)
Forested Areas and Rangeland Trees
Trees and Ornamentals
Turfgrass
Control of Specific Pests Across Multiple Sites
- Grasshoppers
- Ticks which Vector Lyme Disease
- Imported Fire Ants
- Adult Mosquito Control

Nuisance Pest Control

References:

[1]Stevenson, J.H. Pl. Path 1978, **27**, 38-40
[2]Beran, F. Gesunde Pflanzen, 1970, **22**,21-31
[3]Amer. Bee J. 1983 Volume 123, p. 642-645
[4]Atkins, E.L. Proc. 1981Crop Protection Conference, 43-49
[5] Atkins, E.L. Kellum, D. and Atkins K.W. 1981. U. of CA. Coop.Extension Services Leaflet 2883.
[6] Insecticide and Acaricide Tests Volume 8, 1983, ESA.
[7]Amer. Bee J. 1982 vol.122,p. 506-508)
[8] Barth, M. 2002, Assessments of side-effects of AE F054158 00 SC44 A102 on the honey bees (*Apis mellifera L.*) in pome fruit orchards (BBCH 71) after application during bee-flight. BioChem agrar. Project No. 01 10 48 016. Agredoc No. C019430. January 28, 2002. 29pp. MRID 457854-08.

ATTACHMENT 2. REVIEW OF LITERATURE CITED IN BAYER CROPSCIENCE POSITION PAPER ON SEVIN XLR PLUS® TOXICITY TO BEES.

Stevenson, J. H., 1978. The acute toxicity of unformulated pesticides to worker honey bees (*Apis millifera* L.) Plant Pathology 27: 38 - 40.

The paper represents a compilation of acute oral and acute contact toxicity (LD50) studies of honey bees conducted at Rothamsted Experimental Station, Harpenden, Herfordshire (UK). Median lethal doses were determined by probit. Toxicity studies were conducted using acetone as a co-solvent; however, the concentration of acetone is not provided. Oral toxicity studies were conducted in 20% sucrose and fed (0.2 mL) to groups of 10 bees; at least two groups of 10 bees per group were used for each concentration of technical grade (≥95% purity) pesticide (three exceptions: natural pyrethrum 20% a.i., demephion 70% a.i., and triazophos 60% a.i.). According to the report, standard errors within individual tests were small and averaged 23% for contact tests and 33% for oral toxicity tests. The larger error associated with oral toxicity tests is attributed to 10 bees competing for the test solution whereas contact toxicity studies, a specific amount (dose) is applied to each bee.

EFED Comment:

The paper is intended to provide the relative acute toxicity of a range of pesticides and recommends that in cases where a pesticide is likely to result in acute risk, field studies of the formulated product should be initiated. The author notes that there is a correlation between relative toxicity determined in the laboratory and the effect of insecticides on honey bees in the field. The study reports the acute oral and acute contact toxicity of carbaryl as 1.3 and 0.14 μg/bee, respectively. Both the oral and contact toxicity estimates were based on the results of two separate studies for each route of exposure. No information is presented on the toxicity of Sevin XLR Plus® to bees.

Atkins, E. L., 1981. New carbaryl formulations reducing hazards of field applications to honeybees. Proceedings 1981 Crop Protection Conference– Pests and Diseases, November 16 th - 19th, Brighton, UK: 43 - 49.

Laboratory testing utilized a bell-jar vacuum duster to measure the contact toxicity of pesticides. Worker honeybees of uniform age (not reported) transferred from a colony and placed in a stock-bee cage. Bees are then transferred (aspirated) into a dusting cage that is placed in a duster. A watch glass containing 200 mg of pesticide dust and air is then imploded across dust to uniformly disperse the pesticide on to the caged bees. Treated bees are then transferred into a clean 12.7 x 12.7 x 12.7 cm holding cases covered with 3.2 mesh/cm hardware cloth. Bees are fed a 1:1 honey:water solution. Treated bees kept at 26.7 °C and 65% relative humidity. Mortality recorded at 24, 48, 72 and 96 hours.. Each pesticide evaluated using a series of dust dilutions using 3 reps with 25 - 30 bees per rep. The dosage series was repeated 3 times using a different colony each time. According the author, this provided nine replicates at each dosage. Median mortality (LD_{50}) values were determined using linear regression.

Field tests utilized on various crops to compare different treatment conditions. Parameters measured included:

- Colony strength (number of cm^2 of uncapped and capped brood, number of frames covered with bees, condition of the queen, workers, drones eggs and larvae and the amount of pollen and honey store.
- Dead bees at the colony: entrance traps were attached to 5 colonies in each plot to collect and retain bees dying at the hive.
- Bee visitation in the field: two counters each made five bee visitation counts in each plot three times daily at 10 AM, 1 PM and 5 PM for several days before and after pesticide application and until the end of the test. The count constituted the number of bees foraging in 18.5 m^2 of crop/min.
- Caged bees in the field: three cages of honeybee workers confined in 12.7 x 12.7 x 12.7 cm 3.175 mesh/cm wire hardware cloth cages and provided with honey-water solutions were placed in the plot at time of application to measure initial contact poison effect. The cages were removed 15-min post-treatment and mortality of bees was determined after 24 hours.
- Foliage residue bioassay: Foliage and blossoms were systematically collected from ten areas within each plot, chopped into 2.5-cm lengths, blended and placed in three 475-ml cardboard cans covered with nylon netting containing 25 - 35 worker bees. Bees fed honey:water solution. Mortality of the bees in the cages determined after 24 hours. Bioassays on the foliage residues continued until no bee mortality observed

Weather conditions were recorded "as necessary." Initially tests conducted in 250-ha commercial alfalfa fields in full bloom and with honeybee colonies located in the center of each 6.5 ha test plot. Later tests were conducted in 8-ha bearing Valencia orange groves in full bloom using 0.5 ha plots with honeybee colonies located in the center of each plot.

The author concludes that based on laboratory tests,, Sevin 4-oil and Sevinol 4 formulations were intermediate in toxicity (LD50 = 3.6 and 9.4 μg/bee, respectively, compared to the more toxic 80S formulation (LD50 = 1.5 μg/bee). Sevin SL and XLR were the least toxic to bees with LD50 values of 13.7 μg/bee and 26.5 μg/bee, respectively. According to the author, field tests revealed that Sevil 4 oil and Sevinol 4 were 39 and 17% less hazardous, respectively, to bees than 80S. Field studies conducted in alfalfa showed XLR and SL to be 13.6 and 3.5 fold safer, respectively, to bees than 80S. And that XLR was 3.9-fold safer to bees than SL. Studies in citrus showed that increasing the quantity of spray from 935 to 2338 l/ha did not change honeybee mortality statistically ($p<0.05$); however increasing the quantity of spray to 4676 l/ha decreased bee mortality caused by the two lower spray quantities. In a repeat of the alfalfa field studies, XLR was 4.5-fold safer and SL, 2-fold safer to honeybees, respectively, than 80S. The author speculates that modifications in the XLR formulation impart the quality of resisting wash-off by rain and overhead irrigation and thus reduced the quantity of carbaryl bee foragers picked up and transported to their colonies to be store with pollen for food resulting in significant reduction of hazard to forager and hive bees (cites Ross and Harvey 1981).

EFED Comment:

This study examines acute mortality and while it alludes to potential transport back to the hive, no residues are measured. Additionally, the reported doses are nominal. The method of dust application may provide a uniform exposure, the actual exposure is not quantified in the study. Thus, exposure is not adequately documented. Table 3 provides comparative field test toxicity data and shows that the highest number of bees killed (2931) over 6 days was observed with the 80S formulation. The percentage suppression of bee visits to the field was 67% in the 80s-treated bees. Using XLR, the number of bees killed averaged 610 bees and was on average associated with a 62% suppression of visits. Given that the mortality due to 80S was roughly five-times greater than that observed using XLR, the suppression of visits was similar to the two

formulations. It is possible that mortality was actually higher than recorded for the XLR but that the mortality did not occur near the hive where this parameter was measured. Additionally, the estimated reduction in the XLR "harzard" seemed to vary considerably on the same crop. For example, the author claims that there was a 13.6-fold difference between XLR and 80S in early studies but only a 4.5-fold difference in later studies conducted on alfalfa.

The paper does mention several ways in which the toxicity of pesticides to bees can be reduced:

- night application instead of daytime;
- lower dosages and/or less toxic and/or less persistent formulations;
- applying combinations of selective pesticides;
- adding bee repellents to toxic pesticides;
- covering colonies during pesticide applications;
- utilizing the distance honey-producing bee colonies are located from a treated crop;
- utilizing modified pesticide formulations that have reduced toxicity to bees.

Hanny, B. and J. Harvey. 1982. Sevin Sprayable® versus Sevin XLR® applied to field corn (Zea mays L.) at Pine Bluffs, Wyoming - effects on honey bees (Apis millifera L.). American Bee Journal 122: 506 - 508.

Two forty-acre field corn plots were treated with Sevin Sprayable and Sevin XLR, respectively, during pollen dehiscence. Each field received one aerial application of 2.24 kg a.i./ha (2 lbs a.i./A) at 5 AM. Three weeks prior to treatment, 18 colonies of honey bees were moved to the location. Six colonies were placed adjacent to the Sevin XLR field; six colonies were place adjacent to the Sevin Sprayable field and six colonies were placed at an insecticide-free field seven miles from either treatment site. At each location, three colonies were equipped with Todd dead bee traps and three with modified OAC pollen traps. The night before treatments, three clean drawn combs were placed in the vicinity of the brood in each of the three colonies at each location. Dead bees and pollen were collected twice daily one day pre- and seven days post-treatment. Weight (gms) and percent corn pollen per colony collection were recorded. Combs placed in colonies the night before treatement were collected at three, six and nine-day intervals following treatment. Brood measurements were made five days before treatment and at 10, 20 and 34 days following treatment.

An 11-fold increase in the adult bee kill was observed for three days following treatement of field corn with Sevin Sprayable with a gradual return to normal six days following treatment; however, only a two-fold increase in bee kill the day of treatment occurred in the Sevin XLR field and returned to normal the day after treatment. Averaged over seven days post treatment, bee kills were 6-fold higher in the Sevin Sprayable compared to XLR treated fields. Mean carbaryl residue (ppm) in dead bees was five times greater in the Sevin Sprayable treatment compared to the XLR treatment for seven days following treatment. Carbaryl residues were detected for seven days in sprayable compared to four days following XLR traetment and residues were 3.5 times higher in the bee collected pollen for sprayable compared to the XLR treated fields. The authors state that negative correlations for percent corn pollen and pollen carbaryl residues (ppm) of -0.57 and -0.59 for Sevin Sprayable and Sevin XLR, respectively, suggests a degree of repellency. A mean concentration of carbaryl detected in combs containing pollen was 0.30 ppm in Sevin Sprayable versus below detection for Sevin XLR treatments.. There was no significant reduction in mean brood (in2) found after treatments for either formulation of Sevin

Carbaryl residues averaged 0.82 ppm in Sevin S compared to 0.17 ppm in Sevin XLR-treated bees. Carbaryl residues in Sevin S and Sevin XLR-treated pollen the day of treatment were 1.90 ppm and 0.95 ppm (**Figure 1**). Although the mean number of bees killed 7-days posttreatment was 278 and 48 for Sevin Sprayable and Sevin XLR, respectively, the pollen collected averaged 66 grams from Sevin Sprayable bees versus 62 grams from Sevin XLR.

EFED Comment:

It is unclear from the brood measurements why there was a marked decline in both Sevin-treated and control colonies (**Figure 2**). On average, brood size declined 65.8% in all three groups (2 carbaryl treated and control) between August 18 and September 21 (last measurement). With such precipitous declines in brood across both control and treated colonies, it's difficult to differentiate any treatment effects. The protocol does not mention how brood size was determined (*i.e.* whether the total number of bees were counted relative to the area of the hive). It is possible that cooler temperatures at the study site (Pine Bluff, WY) had resulted in the bees clustering toward the center of the hive, thus making it appear as though fewer bees were present. It is more likely that the bees were no longer equally distributed in the hive.

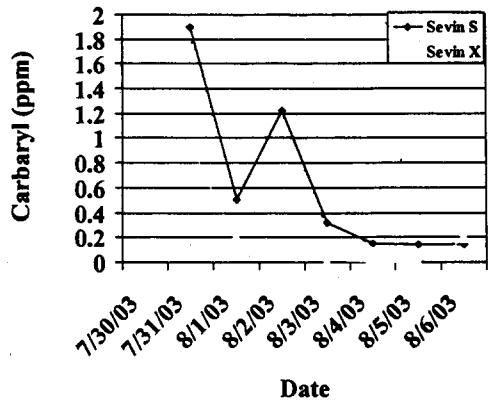

Figure 1. Carbaryl residues (ppm) in pollen collected from hives adjacent to corn fields treated with Sevin S or Sevin XLR.

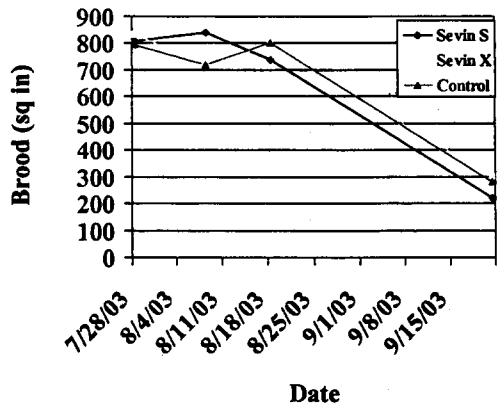

Figure 2. Bee brood size (in2) before and after Sevin S and Sevin XLR treatments..

Annoymous. 1983. Pesticide Risk to Beekeeping Industry Reduced. American Bee Journal 126: 642 - 645.

Article refers to research conducted by E. L. Atkins (University of California, Riverside) showing that the Sevin XLR formulation of carbaryl "greatly reduced the level of honey bee hazard when compared to other carbaryl products." It sites data indicating that honey bee hazard for Sevin XLR (LD_{50} = 26.5 μg/bee) was 17 times less than Sevin 80S (LD_{50} = 1.5 μg/bee). The article notes that serveral studies did not have bee kills with any carbaryl formulation [tested] indicating that specific crop, environmental and foraging conditions are required for carbaryl applications to cause significant bee mortalities. Field trials conducted between 1979 and 1982 showed that carbaryl applied at 1 to 2 lbs a.i./acre was at least seven times less hazardous to honey bees than similar rates for Sevin 80S. The reduced toxicity of the XLR formulation was reported due to the combination of the microfine suspension and sticker making the pesticide less readily transported back to the hive. The reduced hazard to bees though does not reduce it efficacy on target pests when compared to other carbaryl formulations. Factors influencing the susceptibility of honey bees include:

- colony population density (higher density, greater loss);
- availability of pollen and nectar (loss of flowering weeds may make bees more dependent on treated agricultural crops);
- age of bees (younger bees more susceptible);
- presence of disease;
- application timing (applications during foraging periods are more hazardous);
- insecticide formulation (hazard due to dusts > sprays > granules);
- drift; hive placement in relation to crop treated;
- improved communication between beekeepers and growers/applicators.

EFED Comment:

The article makes note of the bee caution statement on the label of Sevin XLR which reflects the reduced honey bee hazard. However, this article does not provide any new data regarding the acute and/or chronic toxicity of carbaryl.

Atkins, E. L., D. Kellum and K. W. Atkins. 1981. Reducing Pesticide Harzards to Honey Bees: Mortality Prediction Techniques and Integrated Management Strategies. Division of Agricultural Sciences, University of California Leaflet 2883.

Article reviews comparative laboratory studies on the toxicity of pesticides to honey bees. Over 65 pesticides and pesticide combinations were evaluated using differing application techniques in large commercial fields of crops in bloom. Most test crops were alfalfa but also included ladino clover, cotton, milo, onions, sweet corn, peach and citrus. Parameters measured included

- colony strength (number of square inches of capped and uncapped brood, number of frames covered with bees, condition of bees (queen, work drones, eggs, larvae), pollen and honey;
- dead bees using Todd dead bee hive entrance trap;
- bee visitations in the field (ten counts of the number of bees foraging in 200 ft^2 of crop min^{-1}) before and after treatment; caged bees in field (bees confined to 12.7 x 12.7 x 12.7 cm cage covered with 3.2-mm mesh hardware cloth) at time of application followed by new cages with bees at different intervals post-application;
- foliage residue bioassay (foliage collected from 10 areas within each plot, chopped into 2.5-cm lengths and then placed in 475-ml cardboard cans containing 25 worker bees; mortality of bees determined at 24 hours);

- weather conditions (temperature, humidity, wind, cloud condition and rainfall);
- bee behavior (flight and behavioral activity)

The report notes that some pesticides are carried back to the hive on contaminated pollen where developing brood feed on the pollen and die. Additionally, repellents are being developed that have reduced toxicity of some pesticides by as much as 50%. Night application also reduced bee kills by approximately 50%. The reduction was attributed to pesticides dissipating to less toxic levels in the hours leading up to sunrise.

Based on LD_{50} values, pesticide bee toxicity was divided into three groups: Group I highly toxic ($LD_{50} < 2$ μg/bee; Group II moderately toxic (LD_{50} 2 - 11 μg/bee); Group III relatively nontoxic ($LD_{50} >11$ μg/bee). Most of the defoliants, herbicides, and fungicides and 60% of the acaricides and insecticides evaluated were classified as relatively nontoxic to bees.

The report provides estimates of anticipated honey bee mortality when a pesticide with an LD_{50} value of 1.0 is applied at selective slope values and increasing and decreasing dosages. Thus, the information contained in the review provides a means of predicting bee mortality in the field when a pesticide is applied as an early morning spray. The report notes that pesticides with low (≤4) probit slope values, subtle changes in application rates result in moderate changes in the percent mortality; however, pesticides with larger probit slope values (>4), subtle changes in application rates can result in marked differences in predicted mortality. The report also makes note of factors that may influence the toxicity of pesticides to bees and practices that can reduce potential risks. These factors include:

- bee behavior– bees forage during daylight when temperature are between 13 - 16oC and will usually enter the hive and cluster when temperatures when temperatures lower to 21oC or when it is windy; crowded hives are more likely to cluster.
- location of bees – pesticide injury is usually "not significant" to colonies 0.25 miles or more away from applications unless the crop is the only attractive field in the area in which case injury may occur to colonies several miles away.
- time of application and location of colonies – treating when bees are foraging is the most hazardous and treating over colonies when bees are clustering on the outside of the hive may cause severe loses. (treatments at night or early morning prior to when bees are foraging is safest). Treating sites adjacent to flowering crops (foraging areas) is hazardous.
- *pesticide formulation*– dusts are more hazardous than sprays; wettable powder formulations are more hazardous than either emulsifiable or water soluble concentrate formulations. Fine sprays are less toxic than course sprays; granular formulations are generally the safest. Combinations of pesticides are less hazardous than the same pesticides used separately
- covering colonies – reduces foraging activity
- Notify county on location of hives so that adequate precautions can be implemented.

EFED Comment:

While the paper provides useful information on the acute toxicity of a range of pesticides and ways to reduce acute toxicity, it does not provide any information on chronic toxicity potential.

Beran, F. 1970. Der gegenwärtige Stand unserer Kenninisse über die Bienengiftigkeit und Bienengefährlichkeit unserer Pflanzenschutzmittel. Gesunde Pflanzen 22(2): 21 - 31.

Article in German and no translation provided; therefore, no review was conducted.

Barth, M. 2002. Assessments of side-effects of AE F054158 00 SC44 A102 on the honey bees (*Apis mellifera L.*) in pome fruit orchards (BBCH 71) after application during bee-flight. BioChem agrar. Project No. 01 10 48 016. Agredoc No. C019430. January 28, 2002. 29pp. MRID 457854-08

EFED Comment:

A data evaluation record for this study has already been completed (**Attachment 3**). However, the study does not represent the potential toxicity of Sevin XLR Plus since carbaryl SC (soluble concentrate) was used. Secondly, the study states that there was no source of pollen or nectar in the treated orchards so there would be little opportunity for honey bees to be exposed. Third, it is difficult to understand how hive weight measurements after only seven days could discriminate any treatment effects given the large weights that hives (supers, combs, honey, pollen and bees) would have and the likely variability the large weights would encompass.

ATTACHMENT 3. DATA EVALUATION RECORD FOR STUDY ENTITLED: Assessments of side effects of AE F054158 00 SC44 A102 on the honeybee (*Apis mellifera* L.) in pome fruit orchards (BBCH 71) after application during bee-flight.

EPA DP Barcode: D288750
OECD Data Point: EPPO Standard PP 1/170(2) (1990)
EPA Guideline: 70-1 (special study)

Test material: **Purity:** 44.35%
Common name Carbaryl SC (water miscible suspension concentrate) 479 g/L
chemical name: IUPAC 1-naphthyl methylcarbamate
CAS name 1-naphthylenol methylcarbamate
CAS No. 63-25-2

synonyms: methyl-carbamic acid 1-naphthyl ester;
1-naphthylenol N-methylcarbamate; Sevin®

Primary Reviewer: Thomas M. Steeger, PhD., Biologist **Date:** 02/16/03
ERB 4, Environmental Fate and Effects Division, U. S. Environmental Protection Agency

Secondary Reviewer: John E. Ravenscroft, Biologist **Date:**
ERB 4, Environmental Fate and Effects Division, U. S. Environmental Protection Agency

Company Code: NA
Active Code: NA
EPA PC Code 056801

Date Evaluation Completed: {02-16-03}

CITATION: Waltersdorfer, A. 2002. Assessments of side effects of AE F054158 00 SC44 A102 on the honeybee (*Apis mellifera* L.) in pome fruit orchards (BBCH 71) after application during bee-flight. BioChem agrar, Labor für biologische und chemische Analytik GmbH, Kupferstraße 6, D-04827 Gerichshain. Study ID number:01 10 48 016. Sponsor: Aventis CropScience Gmbh, Ecotoxicology, Industriepark Höchst, G 836, D-65926 Frankfurt am Main, FDG.

EXECUTIVE SUMMARY:

In a 7-day field study, honey bees *Apis mellifera* were exposed to Carbaryl SC (water miscible concentrate) applied by mist blower at a rate of 1.875 L carbaryl/ha (0.80 lbs./acre) in 1000 l/ha (106.91 gal/acre) of tap water to apple orchards (10,400 m^2 control and 12,830 m^2 treated) for the purposes of fruit thinning. Plots were approximately 5 km from one another and were separated by 10 - 12 ha apple growing areas. Six hives containing approximately 50,000 - 80,000 bees/hive were placed in each plot. Bee mortality and behavior was monitored for two days prior to application and for 7 days following application. Based on the study conditions, there were no significant differences between bees in carbaryl treated and control sites.

This study is classified as supplemental since it is a nonguideline study. Additionally, tap water was used as dilution water.

I. MATERIALS AND METHODS

GUIDELINE FOLLOWED:

EPPO Guidelines for efficacy evaluation of plant protection products (1999): Side-effects on honeybees; EPPO Standards Vol. 1,, PP 1/170(2).

COMPLIANCE:

This study was conducted in compliance with the Principles of Good Laboratory Practice (as revised in 1997) ENV/MC/CHEM(98)17.

A. MATERIALS:

1. Test Material Carbaryl SC (480 g/L)

Description:	White, opaque liquid
Lot No./Batch No.:	AE F054158 00 SC44 A102 / Batch 60220102(Feb01) / OP210560
Purity:	44.35%
Stability of Compound Under Test Conditions:	Expiration Date April 2003
Storage conditions of test chemicals:	chemically stable under standard conditions; room temp (max 30°C), dark and dry.

2. Test organism:

Species: honey bee, *Apis mellifera* carnica P.
Age at test initiation: Not specified.
Source: Beekeeper Mr. H. Schieferdecker, D-04668 Dürrweitzschen
Date of collection: Not specified.
Cultural Background: each bee hive was made up of two-three stacked supers; each colony covered 11 frames in the brood super (includeing 6 - 11 frames covered with brood) and empty or honey filled frames in the super above the brood super. Hive type: magazine hives/ normal size / 11 frames/super.

B. STUDY DESIGN:

1. Experimental Conditions

b) Definitive Study:
Two apple tree orchards were selected as test fields. The ground under the apple trees was mulched according to the cultivation system as usual in the IPM practice. The mulching interval was about 14 days (to keep down vegetation between the rows). Six honeybee colonies with at least 6 well developed brood combs were placed in every test plot. During early stages of fruit development one plot was treated once with carbaryl SC, the other plot (control) was not treated. The test endpoints were mortality (dead bees in

the trap and around the hives), flight intensity, brood status, behavior of bees and weight of hives compared before and after application until 7 days after application.

Table 1 . Experimental Parameters/Design

Parameter	Value	Remarks *Criteria*
Acclimation: Duration: Feeding: Health of bees	3 days before application the bees were placed near the test site	Bees were removed from the hives shortly before the start of the experiment The health of bees was not described.
Cage - description and size	Hive type: magazine hives/ normal size / 11 frames/super. each bee hive was made up of two-three stacked supers; each colony covered 11 frames in the brood super (includeing 6 - 11 frames covered with brood) and empty or honey filled frames in the super above the brood super.	*EPA : Test chambers may be constructed of metal, plastic, wire mesh, or cardboard. A vial containing sugar water must be attached.*
Test conditions Field location and description Weather	Test conducted in Germany near Grimma (Sachsen) in the pome fruit growing area (Dürrweitzschen), plot size 12,830 m^2 (carbaryl treated) and 10,400 m^2 (control); 130 - 140 m above sea level, sandy loam soil. Approximately 5 km between plots separated by 10 - 12 ha of apple growing area. 19°C, 60% relative humidity; 5 mm of rainfall the day after application.	
Solvent/dispersant control, if used Name: Concentration:	Test item mixed with tap water	**EFED recommends against the use of chlorinated drinking water** EPA/OECD prefer acetone as a solvent *EPA: negative and solvent controls required. Positive control not required.*

Number of bees per colony	50,000 - 80,000	*EPA requires at least 25 bees per treatment* *OECD prefers 10 bees per cage*
Number of treatment groups	2	*EPA: One cage per each treatment level and each control.*
Number of hives per treatment Solvent/dispersant control, if used: Treated:	 6 6	*OECD requires at least three replicate, each of ten bees* *EPA: Replications are not required.*
Doses used Nominal Carbaryl	1.875 L product/ha in 1000 L / ha of water	*EPA requires at least five dosage levels, spaced geometrically at least 60% of the next higher level* *OECD requires five doses in a geometric series, with a factor not exceeding 2.2*
Method of test material application	mist blower (Myers (1600 L) with Albuz blue spray nozzle	*EPA: Test material administered as single topical dose (topical drop) or whole body exposure to impregnated dust.*
Duration of the study	7 days	*EPA: 48 hours with observation for mortality and signs of intoxication at 4, 24, and 48 hours after exposure to test material.*
Reference chemical, if used Name:. Triazophos Concentration(s):	N	

2. Observations:

Table 2: Observations

Parameters	Details	Remarks *Criteria*
Parameters measured including sublethal effects/toxicity symptoms	mortality, behavior (foraging activity, bee flight intensity), intoxication (anomalous behavior), weight of each hive.	*EPA requires less than 20% mortality in the controls* *OECD requires less than 10% mortality in the controls*
Observation intervals	-2 days before application, -0.5 hour, 1, 2, 4, 6 hours after application, then daily for 7 days.	*EPA /OECD require observation intervals of 4, 24 and 48 h after dosing*
Were raw data included?	Yes	
Other observations, if any	-	

II. RESULTS AND DISCUSSION:

A. MORTALITY:

Mortality was observed starting two days before application until day 7 after the application. The number of dead bees (found in dead bee traps and around the hives) were generally on the same level in both the carbaryl treated and the control hives. The small differences between the control and test item colonies were observed before and after application of carbaryl SC were considered in the normal range of biological variability. On the day of application there were no significant differences in the number of dead bees between control and treated compared to the day before application. On the days following application the average number of dead bees was generally lower than the number assessed before application, with the exception of exposed colony 4 with a slightly increased average number of dead bees assessed after application. After application over the whole test period, there was no obvious major mortality observed for any bee colony (in the dead bee trap, around hives and on line sheets in the field) compared to the average of day 0, -1, and day -2 before application and compared to the mortality in the control group.

Table 3. Number of dead bees in bee trap and on linen in front of traps days before application (dba) and days after application (daa) of carbaryl SC to apple orchards.

Time	Number of Dead Bees in Dead Bee Trap										Number of Dead Bees on Linen in Front of Colonies	
	Control					Carbaryl SC					Control	Carbaryl
	1	2	3	4	5	1	2	3	4	5		
-2 dba	9	12	13	6	6	12	8	22	6	12	15	6
-1 dba	84	76	17	56	32	81	54	32	20	22	44	12
0	7	25	10	8	10	15	8	12	6	5	22	11
0 - 6 hrs aa	7	14	0	7	9	4	4	1	3	3	20	18
1 daa	15	8	5	5	6	19	12	8	8	7	14	10
0 - 7 days (average)	17.9	22	8	12.5	14	21.3	11.9	9.8	15.0	9.5	11.9	9.1

B. SUB-LETHAL TOXICITY EFFECTS:

After application, bees showed no behavioral impacts (irritations, discoordinated movements, restlessness). The flight activity at the entrances of the hives was not disturbed. No treatment-related effect on the brood development of the test colonies was evident. Flight activity in the trateted and untreated plots before and after application. This was not considered surprising since there was nearly no nectar or pollen source in the treated or untreated plot. During the test the control and test colonies collected pollen in amounts normal for well-developed bee colonies. Because no pollen sources were available in the apple orchards, bees collected pollen outside the control or test plot.

C. REPORTED STATISTICS:

No statistical tests per se are mentioned in the study. The report simply compared values in what appears to be a qualitative assessment.

D. VERIFICATION OF STATISTICAL RESULTS BY THE REVIEWER:

Proc Means and Proc ANOVA procedures of SAS (Statistical Analysis System, Cary, NC) Release 8.1 (see attached analyses) used to calculate means, standard errors, and run analysis of variance for control versus carbaryl SC-treated bees. Comparisons run 2, 1, 0 and 0 - 7 days before and after treatment for dead bees and for 2 days before treatment and 7 days after treatment for hive weight. There were no significant differences ($P > 0.05$) for bee mortality or hive weight over the study period for control and treated bees.

E. STUDY DEFICIENCIES:

Age of bees is not reported. Use of chlorinated tap water as dilution water.

F. REVIEWER'S COMMENTS: This is a nonguideline study and is classified as supplemental.

Chlorinated drinking water was used as the dilution water. Calculation of application rate in pounds per acre
(1.875 L/ha)*(479 g a.i./L)= 898.125 g/ha
(898.125 g/ha)*(lbs/453.59 g)*(ha/2.4711 acres) = 0.8013 lbs a.i./acre

G. CONCLUSIONS:

Under the conditions tested, following treatment of apple orchards at a rate of 1.875 L carbaryl SC/ha in 1000 l/ha of water, bee mortality and behavior did not differ significantly from pretreatment of control values. Weight of hives were not significantly ($P > 0.05$)different between control and carbaryl treated plots.

AVERAGE NUMBER OF DEAD BEES BY DAY FOR CONTROL (0) AND CARBARYL TREATED (T) 17

Obs	DAY	TREAT	_TYPE_	_FREQ_	MEAN	STDERR
1	-2	0	0	5	9.20	1.4629
2	-2	T	0	5	12.00	2.7568
3	-1	0	0	5	53.00	12.7201
4	-1	T	0	5	41.80	11.5083
5	0	0	0	5	7.40	2.2494
6	0	T	0	5	3.00	0.5477
7	1	0	0	5	7.80	1.8815
8	1	T	0	5	10.80	2.2226
9	7	0	0	5	21.48	8.5285
10	7	T	0	5	13.50	2.1833

ANOVA FOR NUMBER OF BEES DEAD 18

---------- DAY=-2 ----------

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	0 T

Number of observations 10

Dependent Variable: DEAD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	19.6000000	19.6000000	0.80	0.3958
Error	8	194.8000000	24.3500000		
Corrected Total	9	214.4000000			

R-Square	Coeff Var	Root MSE	DEAD Mean
0.091418	46.55257	4.934572	10.60000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	19.60000000	19.60000000	0.80	0.3958

---------- DAY=-2 ----------

The ANOVA Procedure

Dunnett's t Tests for DEAD

NOTE: This test controls the Type I experimentwise error for comparisons of all treatments against a control.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	24.35
Critical Value of Dunnett's t	2.30601
Minimum Significant Difference	7.1968

Comparisons significant at the 0.05 level are indicated by ***.

TREAT Comparison	Difference Between Means	Simultaneous 95% Confidence Limits	
T - 0	2.800	-4.397	9.997

---------- DAY=-1 ----------

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	0 T

Number of observations 10

Dependent Variable: DEAD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	313.600000	313.600000	0.43	0.5321
Error	8	5884.800000	735.600000		
Corrected Total	9	6198.400000			

R-Square	Coeff Var	Root MSE	DEAD Mean
0.050594	57.21930	27.12195	47.40000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	313.6000000	313.6000000	0.43	0.5321

Dunnett's t Tests for DEAD

NOTE: This test controls the Type I experimentwise error for comparisons of all treatments against a control.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	735.6
Critical Value of Dunnett's t	2.30601
Minimum Significant Difference	39.556

Comparisons significant at the 0.05 level are indicated by ***.

TREAT Comparison	Difference Between Means	Simultaneous 95% Confidence Limits	
T - 0	-11.20	-50.76	28.36

ANOVA FOR NUMBER OF BEES DEAD 24

---------- DAY=0 ----------

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	0 T

Number of observations 10

Dependent Variable: DEAD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	48.4000000	48.4000000	3.61	0.0939
Error	8	107.2000000	13.4000000		
Corrected Total	9	155.6000000			

R-Square	Coeff Var	Root MSE	DEAD Mean
0.311054	70.39617	3.660601	5.200000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	48.40000000	48.40000000	3.61	0.0939

Dunnett's t Tests for DEAD

NOTE: This test controls the Type I experimentwise error for comparisons of all treatments against a control.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	13.4
Critical Value of Dunnett's t	2.30601
Minimum Significant Difference	5.3388

Comparisons significant at the 0.05 level are indicated by ***.

TREAT Comparison	Difference Between Means	Simultaneous 95% Confidence Limits	
T - 0	-4.400	-9.739	0.939

ANOVA FOR NUMBER OF BEES DEAD 27

---------- DAY=1 ----------

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	0 T

Number of observations 10

ANOVA FOR NUMBER OF BEES DEAD

Dependent Variable: DEAD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	22.5000000	22.5000000	1.06	0.3331
Error	8	169.6000000	21.2000000		
Corrected Total	9	192.1000000			

R-Square	Coeff Var	Root MSE	DEAD Mean
0.117126	49.50909	4.604346	9.300000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	22.50000000	22.50000000	1.06	0.3331

Dunnett's t Tests for DEAD

NOTE: This test controls the Type I experimentwise error for comparisons of all treatments against a control.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	21.2
Critical Value of Dunnett's t	2.30601
Minimum Significant Difference	6.7152

Comparisons significant at the 0.05 level are indicated by ***.

TREAT Comparison	Difference Between Means	Simultaneous 95% Confidence Limits	
T - 0	3.000	-3.715	9.715

---------- DAY=7 ----------

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	0 T

Number of observations 10

Dependent Variable: DEAD

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	159.201000	159.201000	0.82	0.3912
Error	8	1550.048000	193.756000		
Corrected Total	9	1709.249000			

R-Square	Coeff Var	Root MSE	DEAD Mean
0.093141	79.58620	13.91963	17.49000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	159.2010000	159.2010000	0.82	0.3912

Dunnett's t Tests for DEAD

NOTE: This test controls the Type I experimentwise error for comparisons of all treatments against a control.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	193.756
Critical Value of Dunnett's t	2.30601
Minimum Significant Difference	20.301

Comparisons significant at the 0.05 level are indicated by ***.

TREAT Comparison	Difference Between Means	Simultaneous 95% Confidence Limits	
T - 0	-7.980	-28.281	12.321

AVERAGE WEIGHT OF HIVES BY DAY FOR CONTROL (0) AND CARBARYL TREATED (T) 71

Obs	DAY	TREAT	_TYPE_	_FREQ_	MEAN	STDERR
1	-2	0	0	6	49.2500	0.71216
2	-2	T	0	6	48.3667	0.83971
3	7	0	0	6	47.0500	0.73745
4	7	T	0	6	46.7833	0.79600

ANOVA FOR WEIGHT OF BEE HIVES 72

---------- DAY=-2 ----------

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	0 T

Number of observations 12

Dependent Variable: WEIGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2.34083333	2.34083333	0.64	0.4410
Error	10	36.36833333	3.63683333		
Corrected Total	11	38.70916667			

R-Square	Coeff Var	Root MSE	WEIGHT Mean
0.060472	3.907219	1.907048	48.80833

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	2.34083333	2.34083333	0.64	0.4410

Dunnett's t Tests for WEIGHT

NOTE: This test controls the Type I experimentwise error for comparisons of all treatments against a control.

Alpha	0.05
Error Degrees of Freedom	10
Error Mean Square	3.636833
Critical Value of Dunnett's t	2.22816
Minimum Significant Difference	2.4533

Comparisons significant at the 0.05 level are indicated by ***.

TREAT Comparison	Difference Between Means	Simultaneous 95% Confidence Limits	
T - 0	-0.8833	-3.3366	1.5700

---------- DAY=7 ----------

The ANOVA Procedure

Class Level Information

Class	Levels	Values
TREAT	2	0 T

Number of observations 12

Dependent Variable: WEIGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.21333333	0.21333333	0.06	0.8108
Error	10	35.32333333	3.53233333		
Corrected Total	11	35.53666667			

R-Square	Coeff Var	Root MSE	WEIGHT Mean
0.006003	4.005933	1.879450	46.91667

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	1	0.21333333	0.21333333	0.06	0.8108

Dunnett's t Tests for WEIGHT

NOTE: This test controls the Type I experimentwise error for comparisons of all treatments against a control.

Alpha	0.05
Error Degrees of Freedom	10
Error Mean Square	3.532333
Critical Value of Dunnett's t	2.22816
Minimum Significant Difference	2.4178

Comparisons significant at the 0.05 level are indicated by ***.

TREAT Comparison	Difference Between Means	Simultaneous 95% Confidence Limits	
T - 0	-0.2667	-2.6845	2.1511