

# The Potential Use of CME 134 for the Control of Vegetable Pests

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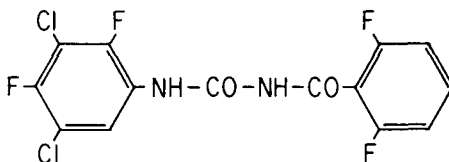
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## Abstract

CME 134 is an insect growth regulator of the benzoyl urea group. Its proposed common name is teflubenzuron. CME 134 is active as a stomach poison, interfering with chitin formation. It has ovicidal properties and may influence the fecundity of adult beetles and to a certain extent also of moths. It also controls insecticide-resistant insect strains. Its extremely low acute mammalian toxicity and its species-specific activity make it an interesting insecticide which also fits into IPM programs. A broad spectrum of beneficial arthropods is not harmed at concentrations that are considered for practical use. Preliminary residue data indicate that withholding periods in edible crops can be expected to fall in the range of conventional insecticides, and may even be shorter. Due to the excellent rain fastness of the SC formulation, the number of sprayings can be reduced in some crops.

## Introduction

CME 134, 1-(3, 5-dichloro-2, 4-difluorophenyl)-3-(2, 6-difluorobenzoyl)-urea, is an insect growth regulator belonging to the benzoyl urea group. It is being produced by Celamerck GmbH & Co. KG and is formulated as a suspension concentrate containing 150 g AI/liter. Its proposed common name is teflubenzuron and it has the following chemical structure:



It is a stomach poison and interferes with chitin synthesis in immature lepidopterous and coleopterous insects and is relatively non-toxic to most beneficial arthropods (Becher et al 1983).

In laboratory studies, CME 134 appeared to be more active at lower dosages than was diflubenzuron against diamondback moth (DBM), *Plutella xylostella* L (Lepidoptera: Yponomeutidae) and *Spodoptera littoralis* larvae (Becher et al 1983). In several registration trials conducted in Asia (Kohyama 1985, Sagenmueller and Rose 1985) and elsewhere, CME134 has given excellent control of DBM. This report gives brief basic information on the compound and the results obtained on certain vegetable pests.

## Toxicology

Studies concerning the acute toxicity, the skin and eye irritation potential, the teratogenicity, and the mutagenicity (Ames-test and micronucleus test) are completed.

CME 134 is not acute toxic ( $LD_{50}$  for rats being greater than 5000 mg/kg) and skin and eye irritations are not induced. It is not mutagenic or teratogenic in rats up to 250 mg/kg body weight, the highest rate tested. In the 90 days feeding study with rats, the no-effect level was 100 ppm AI.

In ecotoxicological studies with fish (carp and rainbow trout) and algae,  $LC_{50}$  and  $EC_{50}$  figures could not be determined as CME 134 proved to be non-toxic to these organisms.

## Mode of Action

### Stomach poison activity

CME 134 interferes with chitin synthesis after ingestion and is active mainly against the larval stages of insects. The formation of the exoskeleton is disturbed, and as a result during moulting the larvae cannot free themselves from the old cuticle. Due to this mode of action the chemical has slow initial activity. Its activity is also dependent on environmental conditions like temperature which influences feeding activity and metabolism in the larvae. Full activity, therefore, can only be seen about seven to eight days after treatment. The treated larvae, however, show symptoms of CME 134 treatment a few days after chemical application. Their movement and feeding activity are reduced which results in reduced crop damage by these insects.

Due to this mode of action it is necessary to apply CME 134 as early as possible, especially to control freshly hatched larvae which do not cause heavy damage. When moulting to the next larval stage, the effect of the treatment will be visible, provided the larvae have ingested lethal doses of the chemical.

It has not yet been possible to determine which of the larval stages is most sensitive to CME 134 treatment. If the chemical is applied just before moulting, the ecdysis passes symptomless as the necessary chitin synthesis has already taken place. These larvae, however, show distinct CME 134 poisoning, provided, that they continue feeding on treated surface, soon after moulting.

It has been observed that the phenology of the host plant, and prevailing temperature, greatly influence the effectiveness of the treatment.

### Ovicidal activity

In addition to the stomach poison activity in larvae, CME 134 also shows ovicidal activity which is species-specific and is dependent on the age of the eggs. In laboratory tests, the ovicidal effect was evaluated with *Carpocapsa pomonella* L eggs of various ages. Serial dilutions of CME 134 15 SC were prepared into which young (two-day to three-day old) and older (five-day to seven-day old) eggs were dipped for five seconds and incubated at 21 to 23°C and 80% RH. The results of the twice replicated tests (Figure 1) indicate that hatching was completely suppressed with 5 ppm AI in young eggs, whereas with older eggs 100% reduction in hatchability could only be achieved when mineral oil was added to the CME 134 dilution. For practical use, this means that spraying should be done at the beginning of egg-laying in order to take full advantage of the ovicidal potential of CME 134.

Similar findings were obtained from tests with *Cryptophlebia leucotreta* Meyr on citrus. Dipping of citrus fruit on which female moths had laid eggs did not reduce the hatchability to the same degree as could be achieved when females deposited their eggs on fruits already dipped in CME 134.

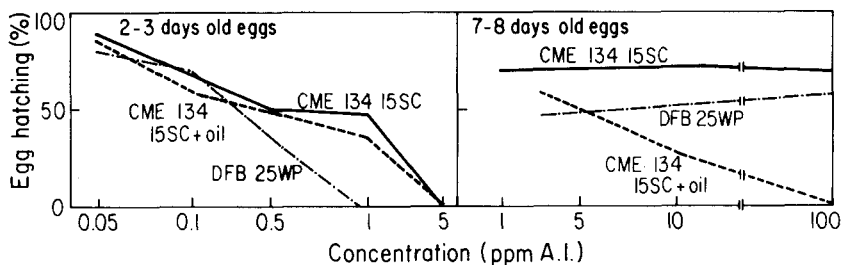


Figure 1. Ovicidal activity of CME 134 15SC on codling moth eggs of various ages

**Contact toxicity**

Although for chitin synthesis inhibition activity CME 134 must be ingested, a certain contact activity was also observed with *Spodoptera littoralis* Boisd larvae of two larval weight groups. Exposing 100 mg larvae for 90 min to CME 134 residues in petri dishes resulted in 73% larval mortality with 0.0005 g AI/m<sup>2</sup> (ED<sub>50</sub> being 0.00033 g AI/m<sup>2</sup>). Two hundred milligram larvae were not affected at the larval stage, but the ED<sub>50</sub> for cumulative percentage mortality up to the adult stage was 0.00017 g AI/m<sup>2</sup> (Ascher and Nemny 1984). The same authors also demonstrated the contact activity of CME 134 to *S. littoralis* by topical application.

Contact activity has also been observed to a certain extent in other insects, but the effect of this mode of action is of lesser magnitude than the effect from feeding.

**Influence on reproduction**

That CME 134 influences reproduction in insects was first observed in laboratory tests with *Epilachna varivestis* Muls when adults, after feeding on CME 134 treated beans, layed sterile eggs (Becher et al 1983). Similar effects were observed in laboratory tests with *Anthonomus grandis* Boh, *Sitophilus granarius* L, and *Carpophilus hemipterus* L. The results from tests with *Leptinotarsa decemlineata* Say are given in Figure 2. After feeding for two days on CME 134 treated potato foliage, females layed sterile eggs.

Although CME 134 treatment results in complete inhibition egg hatching in Coleoptera, in Lepidoptera, until now, the level of sterilization has proved to be only

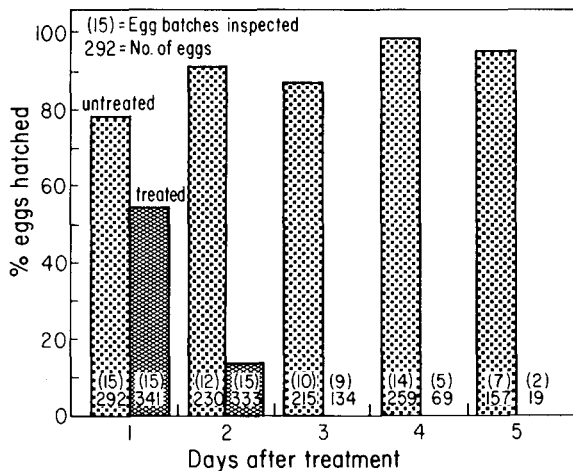


Figure 2. Influence of CME 134 on the reproduction in *Leptinotarsa decemlineata*

moderate. This is probably correlated to the specific feeding behavior of adult moths, which do not take up enough of the chemical to effect complete sterilization. Tests with *Cnaphalocrocis medinalis* Guen achieved 55-79% sterility of eggs after keeping females for two days in contact with CME 134 in a petri dish. Whether oral uptake of the chemical by the female moth will result in more complete sterility of eggs needs to be investigated.

### Timing of Application

The timing of CME 134 application influences its effectiveness. Comparative trials were carried out in 1983 and 1984 in field corn against *Ostrinia nubilalis* Hubn using different application dates. The results show that with too early spraying (when the moths first appear) the full insecticidal potential is not achieved. This is attributed to the dilution effect caused by the growth of the plant after spraying until the hatching of the young larvae. Drawing on this experience, it appears necessary to apply CME 134 strictly according to official spraying recommendations (Table 1).

Table 1. Influence of timing on the effectiveness of CME 134 against *Ostrinia nubilalis*

Chemical	Rate l/ha	Control (%) when sprayed at <sup>ab</sup>	
		Beginning of moth flight activity	Two weeks after start of moth flight activity
CME 134 SC 15	1.0	71.9 (2)	87.3 (2)
Deltamethrin EC 25 g/l	0.5	75.7 (1)	91.3 (1)
Tetrachlorvinphos EC 700 g/l	3.0	—	76.9 (1)

<sup>a</sup> In untreated check plots, 539 live larvae were found in 200 maize plants. <sup>b</sup> Figures in the brackets indicate the number of trials.

### Rain Fastness of the CME 134 Formulation

The rain fastness of the SC formulation of CME 134 was studied under laboratory and field conditions in the United States. Tender oak seedlings were sprayed in a laboratory chamber using five seedlings per CME 134 treatment dose. After two hours of drying, 20 newly moulted 2nd instar larvae of gypsy moth, *Lymantria dispar* L, were introduced onto each treated plant. Simultaneously another group of CME-134 treated oak seedlings was subjected to simulated rainfall after the insecticide spray layer had been allowed to dry for two hours. After the 'rainfall', the plants were dried again before 2nd instar larvae of gypsy moth were introduced. The results, given in Table 2, indicate that one week after spraying there was no difference in the insect mortality between two treatments.

Table 2. Effectiveness of CME 134 against *Lymantria dispar* after artificial rainfall<sup>a</sup>

CME 134 Al kg/ha	Rainfall (mm)	Mortality (%) at days after treatment		
		2	3	7
0.073	0	16	56	100
0.073	25.6	6	38	100
0.036	0	5	48	100
0.036	25.6	3	50	100
check	—	3	3	3

<sup>a</sup> Source: Dr. W. H. McLane, USDA, Otis Air National Guard Base, MA, USA, unpublished data.

Ascher and Nemny (1984) also report excellent resistance to weathering, when in controlled field and laboratory tests the residual activity of CME 134 SC 15 was tested against *S. littoralis*. Their findings confirm our laboratory test results with *S. littoralis*. In our study, sprayed bean plants were exposed to normal weather conditions for a period of five weeks during which 52.5 mm rainfall was recorded. The leaves were sampled at 0, 2, 3, 4, and 5 weeks of weathering and fed to *S. littoralis* caterpillars. Insect mortality data were recorded at two and five days after feeding. The results are summarized in Table 3. CME 134 gave 100% insect mortality from leaf samples taken up to 5 weeks of weathering.

Table 3. Influence of weathering of dried CME 134 spray layers under field conditions on its effectiveness against *Spodoptera littoralis* in the laboratory

Formulation	Spray concentration (ppm AI)	Insect mortality (%) at weeks of aging <sup>a</sup>				
		0	2	3	4	5
CME 134 15 SC	10	100	100	100	98	100
"	50	100	100	100	100	100
Diflubenzuron 25 WP	10	96	47	42	33	4
"	50	100	66	70	56	37
untreated check		3	3	3	0	0

<sup>a</sup> Mortality counts were taken at five days after the caterpillars were fed on treated bean leaves.

## Toxicity of CME 134 to Beneficial Arthropods

According to laboratory and field trials, CME 134 has not shown any adverse effects on a wide range of beneficial arthropods when applied at rates which are considered practical. Beneficial arthropods which were not harmed by the chemical were: *Aphytis holoxanthus*, *Camponotus* sp, *Coccophagus rusti*, *Coccygomimus turionellae* L, *Drino inconspicua* Meig, *Geocoris* sp, *Nabis* sp, *Orius* spp, *Typhlodromus pyri* and spiders. Laboratory tests with *Encarsia formosa* Gah indicate that, although certain larval mortality could be observed, severe damage of this parasite by CME 134 is unlikely to occur (Oomen and Wiegiers 1984). Although laboratory tests with the honey-bee, *Apis mellifera* L, showed that at concentrations considered practical, CME 134 will not harm the brood. However, erratic results from field trials indicate that there is need for more detailed investigations into possible effects under field conditions. The effect of CME 134 on larval coccinellids also needs further investigation.

## Biological Experience from Vegetable Trials

Results of CME 134 trials with forest trees, apples, pears, grapes, and field crops have been reported recently (Adlung et al 1984, Becker et al 1984, Holtmann et al 1984). Extensive experience on the performance of CME 134 has been gained with vegetable crops including cabbage, cauliflower, red cabbage, Chinese cabbage, brussels sprouts, and broccoli. In Europe the most important lepidopterous pests, like *Pieris brassicae* L, *P. rapae* L, *Mamestra brassicae* L, and DBM, can be controlled at reasonable dosages by CME 134.

Based on the encouraging results obtained in our own trials, official trials have been conducted since 1983 in Germany. Although, according to the existing trial procedures, evaluations have been carried out 1, 3, and 7 days after treatment — which in respect to the mode of action of an insect growth regulator would usually be too

short — the results are positive. In some cases, even during this short observation period up to 100% insect mortality was observed. Hommes (1984) reported that CME 134 at a rate of 60 g AI/ha was the most effective of the tested insect growth regulators. After three applications at fortnightly intervals it not only controlled detrimental caterpillars in round cabbage, but also reduced feeding damage with comparable effectiveness as a mixture of deltamethrin + pirimicarb.

In the Netherlands, where in 1983 CME 134 was tested at 90 g AI/ha against *Mamestra brassicae* on brussels sprouts, excellent control was achieved resulting in high quality marketable yields. The results indicated that lower rates could be expected to perform well. Therefore in 1984 rates from 30 to 60 g CME 134 AI/ha were tested. The results indicated that the higher rate gave a better reduction of feeding damage than the 30 g AI/ha. The addition of a spreader slightly increased the efficacy of the treatment, and this was also observed with red cabbage and cabbage in Germany. Nevertheless, it is not necessary to mix CME 134 with spreaders because of the excellent rain fastness of CME 134 15 SC.

In the United States CME 134 has also been tested since 1982. Rates from 16.5 to 33 g AI/ha in many cases were as effective as fenvalerate and metamidophos standards. The CME 134 treatments increased the percentage of marketable heads of cabbage. The major target insects were *Pieris rapae* and *Trichoplusia ni* Hubn.

*Spodoptera frugiperda* J. E. Smith, a leaf folder of tomato, was controlled by CME 134, whereas *Heliothis zea* Boddie may continue to cause damage when feeding inside the fruits. Preliminary results from trials for the control of *Liriomyza* spp on tomatoes are not very encouraging since the adults cannot be effectively controlled by an insect growth regulator. Due to the peculiar egg-laying behavior of this insect, ovicidal activity of CME 134 should not be expected. In none of these trial could aphids be controlled using this chemical. On leek, *Acrolepia assectella* Zell was better controlled by CME 134 than by methomyl.

## Residue Studies

Supervised trials in Germany have been carried out on potatoes, maize, Savoy cabbage, apples, and grapes. Generally the residues in food crops at harvest time are at a low level. In Savoy cabbage, CME 134 is only detectable during the initial phase after application; the highest level at application date amounted 0.99 ppm.

## Discussion and Outlook

CME 134 is a selective insecticide of low mammalian toxicity. It controls lepidopterous and coleopterous defoliators and mining insects of sawfly species. Its insecticidal activity, although slow in the initial stages, can in many cases be compared with that of conventional organophosphorous or pyrethroid insecticides. At the same time it is harmless to a large number of beneficial arthropods at rates which effectively control detrimental pre-imaginal stages of pests. Thus this insecticide fits well into integrated pest management programs.

Since the growing habit of the plant is of importance for the performance of CME 134, crops with especially reduced terminal growth give good results. In crops which do not grow rapidly after treatment, such as cabbage, soybeans, and potatoes, the grower can take advantage of the residual activity of this insect growth regulator.

CME 134 can be applied according to conventional recommendations and can be used effectively for the control of insecticide resistant insect strains. For a final estimation

of its performance, it is essential not only to evaluate its insecticidal activity as judged by insect mortality, but also to consider its potential in preventing crop damage and in increasing yields. Insect larvae, after feeding on the protective spray layer, stop feeding and become sluggish. This reduces crop damage without immediate insect kill.

In instances where a mixture of pest species need to be controlled but certain species, such as aphids, are not controlled by CME 134, a tank mixture of CME 134 with other insecticides can be utilized. It must be understood, however, that by mixing CME 134 with non-selective chemicals, certain advantages of this insect growth regulator may be lost. Care should be taken, therefore, when selecting a tank mixture chemical.

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