Carfentrazone-Ethyl (F8426): a New Low-Dose Cotton Defoliant

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ABSTRACT

Carfentrazone-ethyl is a new low dose Protox inhibitor that is currently under development as a post-emergence broad-leaf herbicide in a wide range of crops. It has an excellent toxicological and environmental profile and is already registered for use in cereals in many countries, e.g. Germany, UK and France. Field trials conducted in Greece and Spain in 1996 and 1997 have demonstrated that carfentrazone-ethyl shows excellent potential as a cotton defoliant. Dose rates of 40 to 60 g ai/ha, tank-mixed with an oil based adjuvant (e.g. Actirob), have given outstanding results on defoliation, inhibition of re-growth, boll opening and destruction of escaped weeds. Overall, the performance of carfentrazone-ethyl was equal or superior to that of parallel applications of commercial cotton defoliants.

Introduction

Cotton is the world's number one industrial crop and contributes substantially to the national income of many countries. However, unavailability and high costs of manual labour in some countries has driven producers to use mechanical picking. To make this process efficient, bolls should be open and the plants virtually free of leaves. There are several products registered for cotton defoliation but they often require high dose rates, need favourable temperatures and sometimes produce less than satisfactory results regarding the speed and level of defoliation.

This paper presents carfentrazone-ethyl (F8426), a new low dose compound that shows great potential as a highly effective cotton defoliant. Carfentrazone-ethyl is a triazolinone protoporphyrin oxygenase (Protox) inhibitor that is being developed as a post-emergence contact herbicide (Van Saun *et al.*, 1993) for the control of key broad-leaf weeds in cereals (Shires *et al.*, 1997), maize (Tutt *et al.*, 1995), rice, and grassland. It is also under development as a desiccant for potatoes (Genot *et al.*, 1998) and canola and as a synergist to enhance the action and broad-leaf spectrum of total vegetation control products.

Extensive laboratory and field studies have demonstrated that carfentrazone-ethyl has a very low acute and chronic toxicity to mammals, birds, fish and invertebrates. It is also not mutagenic, teratogenic or onchogenic. It is however, toxic to algae and *Lemna*, although adverse effects on such plants following normal commercial applications are unlikely. In soil, water and plants, the parent molecule is rapidly (within 1-3 days) hydrolyzed to an active metabolite that is quickly transformed to other compounds with little or no herbicidal activity. Carfentrazone-ethyl or its herbicidally active first metabolite, do not leach in soil or appear as detectable residues in harvested crops.

Registrations of carfentrazone-ethyl have already been obtained in Germany, UK, France, Belgium, Czech and Slovak Republics, Poland, Switzerland, China, Pakistan and South Africa. Approval in other countries is expected before the end of 1998, e.g. the USA, where the product has been granted "safer pesticide" status by the EPA . Finally, carfentrazone-ethyl is well advanced in evaluation for inclusion in Annex 1 of the EU registration directive.

Material and Methods

Two preliminary screening trials to evaluate the potential of carfentrazone-ethyl as a cotton defoliant were conducted in Greece in 1996. In both trials, two dose rates (40 and 80 g ai/ha) of a 50WG formulation (developed for cereals) were applied in a tank mix with 5 L of an oil adjuvant (Actirob). For comparative purposes, two commercial standards (tribufos and dimethipin+trycol) were used in parallel. Each treatment was applied at 500 L/ha spray volume, onto three replicated plots laid out in a randomized block design.

In 1997, four detailed field experiments were conducted in Greece and three in Spain, using a 240 g/l EC formulation of carfentrazone-ethyl with the following protocol:

• Treatments	Dose g ai/ha
Carf.-ethyl 24EC	60
Carf.-ethyl 24EC (+ Actirob)	40 (+5L)
Carf.-ethyl 24EC (+ Actirob)	60 (+5L)
Carf.-ethyl + Thidiazuron	40+200
Thidiazuron 50WP	200
Tribufos 72EC	1650
Thidiazuron + Tribufos	200+1650

- Trial locations: Greece (Larissa), Spain (Sevilla, Cordoba)
- Cotton cultivars: Pioneer 50, Sindos 80, Crema 111 and Acala (Zeta)

- Experimental design: randomized block with three replicates per treatment
- Plot sizes: Greece 20m2, Spain 27m2
- Application: knapsack sprayer at 400-500 L/ha and 3 atm. pressure.
- Timing: all treatments were applied at ±70% boll opening
- Dates of application: 20-30 Sept. (Greece), 5-10 Oct. (Spain)
- Assessments: % defoliation, % boll opening, % re-growth and green mass of leaves remaining on the plants at 7, 14 and/or 21 days after treatment (DAT)
- Statistical analysis of data: arcsine transformation of percentages, 2-way ANOVAR, followed by SNK multiple range test (Zar, 1996).
- Trials in Greece were assessed for side effects on weeds present at the time of defoliation.

Results and Discussion

1996 Screening Trials

Very encouraging results were obtained with carfentrazone-ethyl+Actirob in both trials (Fig. 1). Mean defoliation was about 50% after 7 days, 88% at 14 days and 93% after 21 days. In general, there were no significant differences in performance between the two dose rates of carfentrazone-ethyl and/or the two commercial standards.

1997 Trials Programme

Defoliation: Results on cotton defoliation in the four Greek trials are summarized in Table 1. Carfentrazone-ethyl 24EC gave unsatisfactory levels of defoliation when used alone.

However, when tank mixed with an adjuvant like Actirob, excellent results were obtained that were generally superior to the commercial standards, both in terms of speed and final level of defoliation. The higher rate (60g ai/ha) of carfentrazone-ethyl also appeared numerically superior to the lower rate (40g ai/ha), although the difference was not statistically significant (p=0.05). A mixture of carfentrazone-ethyl plus tribufos was inferior compared with the mixtures with Actirob.

In the Spanish trials (Table 2) there was a significant amount of variation in the % defoliation achieved in the three trials. Although, carfentrazone-ethyl stand-alone was again numerically inferior to the other treatments, all of which were very similar to each other in terms of performance.

Crop regrowth: There was relatively little re-growth observed in the Greek trials, nevertheless at 21 DAT, all carfentrazone-ethyl treatments had less than 0.5 % crop re-growth, compared with between 0.6 to 2.5 % re-growth in the non-treated control and commercial standards.

In the Spanish trials, slight but more evident re-growth was observed at 14-17 DAT, when the commercial standards appeared to be more effective than carfentrazone-ethyl. However, at 21 DAT no clear differences were observed between carfentrazone-ethyl treatments and the commercial standards.

Residual green foliage: The percent of green leaves remaining on the crop were estimated in the Greek trials at 7, 14 and 21 DAT. Results obtained for the final assessment are shown in Figure 2, where it can be seen that carfentrazone-ethyl + Actirob was clearly the most effective.

Boll opening: The percent open bolls was estimated in the Greek trials at 7, 14, and 21 DAT. All treatments were generally numerically superior to the untreated control. However, the increase in open bolls was only statistically different in carfentrazone-ethyl+Actirob and thidiazuron+tribufos treatments (Table 3).

Control of Weeds: Observations in the Greek trials showed that treatments containing carfentrazone-ethyl either destroyed or severely damaged most broad-leaf weeds that had escaped the original herbicide control programme, e.g. *Solanum nigrum, Xanthium spinosum, Xanthium strumarium* and *Chenopodium album*.

Conclusions

Carfentrazone-ethyl showed excellent potential as a cotton defoliant but needs mixing with an appropriate adjuvant (e.g. Actirob) to obtain optimum results. Target dose rates appear to be between 40 to 60 g ai/ha. Further benefits of carfentrazone-ethyl include: enhanced boll opening; destruction of escaped broad-leaved weeds that may adversely affect mechanical harvesting and temperature independent activity. In the light of these encouraging results, full development and registration programmes are in progress in Greece, Spain, USA and Uzbekistan. Carfentrazone-ethyl will be marketed in Europe under the trade name of SHOCK and/or LEAFALL.

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Refererences

Genot, B., G. Fernandez, C. Deprez, M.L. Hullebroeck, B. Brasset and B. Maenhout. (1998): Carfentrazone-ethyl (Spotlight 24EC) : new perspective for potato haulm desiccation. International Symposium on Crop Protection, Ghent. Pp84.

Shires, S.W., L.A. Bourdouxhe, A.R. Crossman, B. Genot, J.P. Laffranque and J Leblanc. (1997): Carfentrazone-ethyl : a new herbicide for rapid control of cereal broad-leaf weeds. Brighton Crop Protection Proceedings, 3A-6:117-122.

Tutt, S.F., J.T. Bahr, F.W. Hotzman, W.A. Van Saun, L.A. Bourdouxhe, S.W. Shires, J.S. Casey, L.D. Hatfield, T.W. Mize and J.M. Thayer. (1995): F8426 - a new, low rate herbicide for the post-emergence selective control of broadleaf weeds in maize. Brighton Crop Protection Proceedings, 6C-18:731-736.

Van Saun, W.A., J.T. Bahr, L.A. Bourdouxhe, F.J. Gargantiel, F W. Hotzman, S.W. Shires, N.A. Sladen, S.F. Tutt and K.R. Wilson. (1993): F8426 - a new, rapidly acting, low rate herbicide for the post-emergence selective control of broad-leaved weeds in cereals. Brighton Crop Protection Conference Proceedings, 2-1:19-22.

Zar, J.A. (1996): Biostatistical Analysis (3rd Ed). Prentice Hall International Inc. pp 662.

Table 1 . Mean percent cotton defoliation in four trials in Greece during 1997.

Treatment	Dose	Mean % Defoliation		
	g ai/ha	7 DAT[1]	14 DAT[1]	21 DAT[1]
Carf.-ethyl 24EC	60	40$_b$	54$_{ab}$	69$_c$
Carf.-ethyl 24EC (+ Actirob)	40 (+5L)	57$_a$	77$_{ab}$	94$_{ab}$
Carf.-ethyl 24EC (+ Actirob)	60 (+5L)	63$_a$	85$_a$	95$_a$
Carf.-ethyl + Thidiazuron	40+200	43$_b$	51$_{ab}$	64$_{cd}$
Thidiazuron 50WP	200	11$_c$	29$_b$	51$_d$
Tribufos 72EC	1650	36$_b$	65$_{ab}$	82$_b$
Thidiazuron + Tribufos	200+1650	43$_b$	72$_{ab}$	88$_{ab}$

Different letter subscripts denote significant difference at P<0.05,
[1]DAT = days after treatment

Table 2 . Mean percent cotton defoliation in threetrials in Spain during 1997.

Treatment	Dose	Mean % defoliation	
	g ai/ha	7 DAT[1]	14 DAT[1]
Carf.-ethyl 24EC	60	62$_a$	70$_a$
Carf.-ethyl 24EC (+ Actirob)	40 (+5L)	77$_a$	87$_a$
Carf.-ethyl 24EC (+ Actirob)	60 (+5L)	73$_a$	85$_a$
Carf.-ethyl + Thidiazuron	40+200	80$_a$	88$_a$
Thidiazuron 50WP	200	79$_a$	88$_a$
Tribufos 72EC	1650	80$_a$	87$_a$
Thidiazuron + Tribufos	200+1650	84$_a$	90$_a$

Different letters denote significant at P<0.05,
[1]DAT = days after treatment

Table 3 . Mean % open cotton bolls in Greek trials during 1997.

Treatment	Dose	Mean % open bolls		
	g ai/ha	7 DAT[1]	14 DAT[1]	21 DAT[1]
Untreated control	-	79$_e$	88$_d$	94$_c$
Carf.-ethyl 24EC	60	81$_c$	91$_{abcd}$	96$_{bc}$
Carf.-ethyl 24EC (+ Actirob)	40 (+5L)	82$_b$	92$_{abc}$	98$_a$
Carf.-ethyl 24EC (+ Actirob)	60 (+5L)	85$_a$	94$_a$	98$_a$
Carf.-ethyl + Thidiazuron	40+200	81$_c$	90$_{bcd}$	96$_{bc}$
Thidiazuron 50WP	200	80$_d$	91$_{abcd}$	95$_{bc}$
Tribufos 72EC	1650	80$_d$	91$_{abcd}$	95$_{bc}$
Thidiazuron + Tribufos	200+1650	81$_c$	93$_{ab}$	96$_b$

Different letters denote significant at P<0.05,
[1]DAT = days after treatment

Figure 1 . Mean % cotton defoliation in 1996 screening trials in Greece.

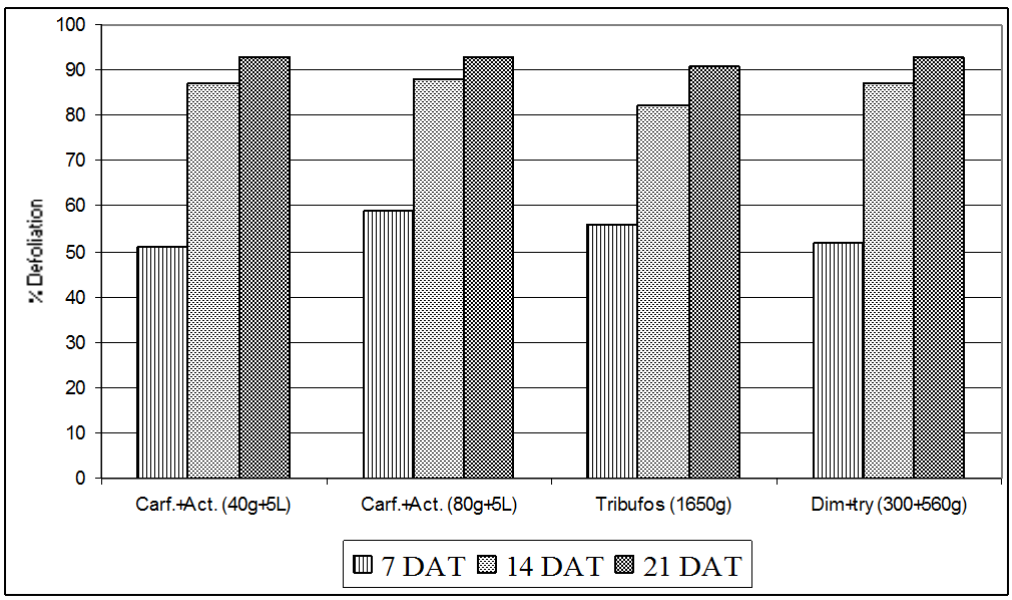

Figure 2 . Mean % of green leaves remaining 21DAT .