NEW FORMULATIONS WITH BETACYFLUTHRIN: RESIDUAL EFFICACY AGAINST ANTS AND COCKROACHES OF A TABLET AND A SUSPENSION CONCENTRATE

U. SCHNEIDER[1], K. MRUSEK[1], R. POSPISCHIL[1], G. STOREY[2] & G. SMITH[3]

[1]Bayer AG, Germany; [2]Bayer Corp., USA; [3]Bayer Australia Ltd., Australia

Abstract—A betacyfluthrin SC containing 12.5% active ingredient was introduced to the pest control market (Responsar SC®). Applications by pest control professionals have shown good efficacy against *Blattella germanica*. On porous surfaces the particles stay more on the surface and are not so readily absorbed.

Based on experience in the formulation technology of suspension concentrates and tablets, research was continued to improve product performance including longer lasting efficacy combined with easier handling and mixing. A new 40 % tablet and a new 2.5 % suspension concentrate were therefore formulated.

The residual efficacy of the tablet and the SC formulation against German cockroaches (*Blattella germanica*), American cockroaches (*Periplaneta americana*) and Argentine ants (*Linepithema humile*) was tested in the laboratory on different surfaces with an application rate of only 7.5 mg a.i./m^2. Both formulations remained effective for at least 32 and 8 weeks, respectively, and showed that they offer the best combination of properties with respect to efficacy and application rate.

Furthermore, the SC formulation was evaluated in field trials against German cockroaches. Excellent results were obtained with an application rate of 12.5 mg a.i./m^2 with control lasting over several months, confirming the laboratory findings even under quite difficult field conditions.

INTRODUCTION

A new generation of pyrethroids with long lasting action appeared in 1974, in the form of the α-cyano pyrethroids. In 1976 the α-cyano pyrethroid cyfluthrin was developed. According to numerous tests this compound is effective against both public health and agricutural pests (Hammann and Fuchs, 1981; Behrenz *et al.*, 1983; Williams, 1995).

Cyfluthrin consists of almost equal quantities of four enantiomers (Arlt *et al*, 1985; Naumann, 1990). In studies of the relative efficacy of the individual isomers it was found that the biological efficacy is due predominantly to two of the four enantiomers.

Based on these results a "purified" form of cyfluthrin was developed, in which the two inactive enantiomers were almost eliminated. This purified active ingredient, called betacyfluthrin, is twice as effective as the original active ingredient, cyfluthrin. Betacyfluthrin is a crystalline substance in contrast to cyfluthrin which is a waxy tar-like material.

Due to this fact, betacyfluthrin can be formulated as a water-based suspension concentrate (SC) as well as a tablet.

A betacyfluthrin SC containing 12.5 % active ingredient was introduced to the pest control market (Responsar SC®). Applications by pest control professionals have been reported as having good efficacy against *Blattella germanica* (Gleinich and Pischel, 1992; Müller, 1992, Pospischil and Smith, 1995; McDonald, 1995). Even on porous surfaces the particles stay more on the surface and are not so readily absorbed.

Based on experience in formulation technology of suspension concentrates and tablets, research was continued to improve product performance including longer lasting efficacy combined with easier handling and mixing. A new 40 % tablet formulation and a new 2.5 % SC formulation were therefore formulated.

The efficacy of these formulations against German cockroaches (*Blattella germanica*), American cockroaches (*Periplaneta americana*) and Argentine ants (*Linepithema humile*) was evaluated in laboratory and field trials, conducted in Germany, USA and Australia.

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MATERIAL AND METHODS

Insecticide

The structural formula of betacyfluthrin and the stereochemistry of cyfluthrin and betacyfluthrin is given in Figure 1 and Table 1, respectively.

Betacyfluthrin prevents the sodium ion channels from closing, particularly in arthropods (Osborne and Pepper, 1991) so that the cell's resting potential cannot be re-established after an action potential. The cell remains permanently overexcited and eventually ceases to function, leading to complete paralysis of the pest's nervous system.

Because of its lipophilic properties, betacyfluthrin is rapidly absorbed through the wax-coated cuticle of arthropods. Within a short time it blocks signal transmission in the peripheral nerve fibres. Because of the over excitation of the nerve cells the first symptoms occur very quickly. As a result, the pests often come out of their hiding places (flushing effect).

As the peripheral nervous system is blocked, the pests are very soon incapable of co-ordinated movement. This is the basis of the insecticide's rapid knockdown action. After a slight delay the pest's central nervous system is also blocked. Death follows in minutes or hours, depending on the circumstances.

Formulations

The tablet formulation containing 40 % betacyfluthrin was developed as a convenient, user-friendly formulation with rapid dissolution in water within two minutes of mixing. The tablet has the advantages of no absorption into porous surfaces, no odour, no organic solvents and no staining. Additionally, the tablet formulation reduces the potential for visible residues, dust inhalation and associated irritancy during mixing and allows for easy accurate dosing. Each tablet weighs 2.38 grams and is intended to be mixed with 4 litres of water.

The 2.5 suspension concentrate formulation containing 2.5% betacyfluthrin, in which the active ingredient is coated onto inorganic carrier, was developed in order to achieve an optimum average

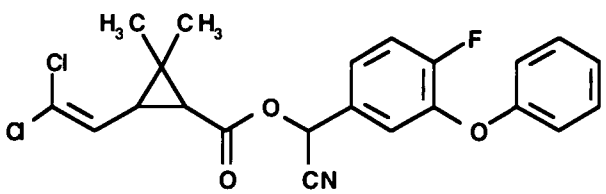

Figure 1. Structural formula of betacyfluthrin

Table 1. Composition of cyfluthrin and betacyfluthrin

	Enantiomer Pairs	Cyfluthrin	Betacyfluthrin
I	1R – 3R – αR 1S – 3S – αS	25%	–
II	1R – 3R – αS 1S – 3S – αR	25%	50%
III	1R – 3S – αR 1S – 3R – αS	25%	50%
IV	1R – 3S – αS 1S – 3R – αR	25%	–

particle size of about 10 m. Besides the advantages of a lower concentration formulation (low dosing and low acute toxicity), it demonstrates all the other advantages of a waterbased SC formulation, such as no absorption into surfaces, convenient handling and storage, no organic solvents, no odour, non flammability, no staining and very little visible residues.

Laboratory trials

Laboratory trials in Germany

Tests were carried out with both formulations against the German cockroach 5th instar under following conditions:

Test surfaces (size 225 cm^2, painted plywood, glazed tiles, unglazed tiles) were sprayed in a fume cupboard. Test formulations were dissolved or suspended in tap water and sprayed using glass spray nozzles with an air pressure of 0.1 bar, from a distance of 20 cm. The amount of solution was 2.5 ml/surface, corresponding to 100 ml/m^2. The quantities applied were 7.5 and 12.5 mg $a.i./m^2$. Five insects were confined on the treated panels.

Mortality of the cockroaches was assessed at defined time intervals up to 24 hours after initial exposure. Residual efficacy against the cockroaches was assessed at defined time intervals up to 32 weeks after treatment of the surfaces.

Laboratory trials in USA

Studies were carried out with the betacyfluthrin tablet against the German cockroach, the American cockroach and the Argentine ant by Anderson and Zungoli (1995) at Clemson University.

Test surfaces (latex painted plywood, pine bark mulch) were treated with 10.22 mg $a.i./m^2$.

Mortality of the insects was assessed after initial exposure of 5 minutes, 30 minutes and 2 hours, respectively. Residual efficacy was recorded at 1 day, 2, 4 and 8 weeks after initial exposure.

Field trials in Australia

Tests with betacyfluthrin 2.5 SC were conducted by Miller and Peters (1996) in government housing in Sydney which was heavily infested with German cockroaches. Cockroach populations were assessed using sticky trap counts, before application as well as one day and 1,2,3 and 12 months after treatment. Treatments were replicated in 8 dwellings. Flushing action was assessed by estimating the number of cockroaches visible at the end of treatment.

Cupboards were emptied and treatment was carried out using a pneumatic sprayer to treat cracks and crevices in cupboards as well as spraying the walls and surfaces on which cockroaches were observed. The application rates amounted to 5 and 10 ml formulation/litre, corresponding to about 12.5 and 25.0 mg $a.i./m^2$, respectively.

RESULTS

Laboratory trials

Laboratory trials in Germany

The detailed results obtained after treatment with the low rate of 7.5 mg $a.i./m^2$ and with the high rate of 12.5 mg $a.i./m^2$ are shown in table 2. Figure 2 summarized the results obtained with an exposure time of 4 hours.

The results in Figure 2 show that at the low application rate both formulations had a residual effect on painted plywood of 8 and 4 weeks, respectively. At the application rate of 12.5 mg $a.i./m^2$ a residual efficacy of 24 weeks could be observed.

On glazed tiles both formulations were efficacious for 32 weeks at both application rates. Values obtained from unglazed tiles with the SC formulation showed an efficacy of 8 weeks (7.5 mg $a.i./m^2$) and 32 weeks (12.5 mg $a.i./m^2$), respectively. The tablet formulation had a long lasting effect for 24 and 32 weeks (7.5 and 12.5 mg $a.i./m^2$).