EFFECT OF AERATION ON DEGRADATION AND EFFICIENCY TO COMMON STORED GRAIN INSECTS OF MALATHION AND DELTAMETHRIN IN SOUTH CHINA

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INTRODUCTION: The use of grain protectants in China was begun in 1950s, but the development had been suspeneded over 20 years oweing to the lack of practically feasible means and facilities for application. Since the last ten years, while the handicaps were eliminated in succession, as a new starting point, it was being developed gradually.

At now, malathion has been widely popularized both in state and farmer's storages. Fenitrothion, chlorpyrifos-methyl are expected to be registered recently. K-obil has obtained temporary registration in 1989. Because grain protectants is an insecticide with more extensive adaptability, the scope of use will also be much wider than fumigants in China.

We are grateful to the forerunners for their widespread and profound achievements. A lot of available theoretical and practical accomplishments will accelerate the use of grain protectants. It is reported there are many factors as grain temperature and moisture content(1,2), the species of grain(3,4,5), the harvest time(6), the impurities of grain(7) as well as the formulation of insecticide(8) affects the efficacy of grain protectants. Reports published by Bengston et al.(as 10,11,12) possess practical and directive significance. Desmarchelier et al.(13) creatively advanced a half-life model which can be used to calculate the effective and safety application rate for grains with fixed storage time under given temperatures and relative humidities, and also reported that the efficacy of most organophosphorus compounds increases as temperature increases but the reverse is true for most synthetic pyrethroids. Deltamethrin is more effective at lower temperatures.

These published papers have identically shown that temperature and relative humidity are the major factors influencing the efficacy of grain protectants. In China, the legal maximun moisture content of stored paddy is 13.5%. Generally it is ranged 12-13% in south China. Under normal bulk storage conditions, it will be decreased averagely to 12% or so as the storage period extended, so relative humidity of interstitial air is relatively stable, whereas grain temperature will be varied greatly under different storage and management conditions. Therefore, control of grain temperature may be an important measure for improving the efficacy of grain protectants.

As everyone knows south China is located in subtropical zone. There are only a few months of ambient air are utilizable for reducing grain temperature effectively by aeration. Generally it is also difficult to maintain reduced temperatures. The present study is aimed to investigate the local realistic effect of aeration on the efficiency of popularized malathion and potentially acceptable deltamethrin(K-obil) against common stored grain insects.

MATERIALS AND METHODS: Field trails were conducted from 1987 to 1989 at Heshun Grain Station, Nanhai County. Duplicate experiments were carried out from 1987 to 1988 and 1988 to 1989 for malathion. The experiments of deltamethrin were conducted from 1987 to 1989 which lasted 17 months.

The capacity of each treated brick constructed flat storehouse for comparative experiments between aeration and unaeration were 300 ton bulks of paddy with height of 3.1M.

Experimental grain was newly harvested early rice with moisture content of 11.2-12.3% and impurities averaged 0.5%.

The application rate of malathion and deltamethrin for both aerated and unaerated treatments were 40ppm and 1ppm by weight of grain respectively. Emulsifiable concentrate formulations were used for both malathion and deltamethrin(K-obil). The water diluted insecticide were calculated to one litre for one ton of grain and sprayed into the grain stream during the turnning from one storehouse to another.

Aeration treated storehouse were aerated with two 2.2kw centrifugal blowers on both side in turn. The selected moment for aeration was begun while the ambient temperature is 8-10°C below the average grain temperature and stopped while the temperature difference is less than 2°C.

Grain were sampled using a vacuum probe to draw samples from three layers and five points. Samples from 15 sampling points of each treatment were bulked and subdivided for the test of moisture content, insect density, residue and residual effectiveness against insects. Insecticide residues were determined by gas chromatography method. Insects for bioassay were laboratory reared susceptible strains of stored grain insects.

RESULTS AND DISCISSION:

Effect of aeration on degradation of grain protectants

Malathion

The residues of malathion determined two weeks after application were 14.8ppm and 19.5ppm for aerated and unaerated grain respectively. Here it expresses the actual deposited rate were less than 50% of the calculated application rate. Figure 1 shows though the aerated grain was still inevitably affected by the change of weather, its temperature maintained lower than unaerated grain throughout the experiments. The maximun difference of temperature between aerated and unaerated grain reached 8°C in

winter and reduced gradually to 3°C at the end of the experiments.

It is shown in Figure 1 that lower temperatures delayed the degradation rate of malathion. This is also illustrated by the higher initial residue of unaerated grain reduced nearly to the same level as the lower initial residue of aerated grain at the end of the experiments.

Seeing that both of the residue curve in Figure 1 are similar to a straight line, the half-life of malathion were roughly estimated at 20 and 28 weeks under unaerated and aerated conditions respectively. To be sure, this is only a preliminary attempt proceeded from the aim of further illustration. In practice, we still consider 'effective period' obtained by the accumulation of specified practical experiences is the most reliable measure for evaluating the effectiveness of grain protectants.

Deltamethrin

The residues of deltamethrin determined two weeks after application were 0.562ppm and 0.518ppm for aerated and unaerated grain respectively. Figure 2 shows that even if the temperature of aerated grain lower than that of unaerated grain all along the experiments, especially the difference reached 10°C in winter, both of the residues degradated rapidly at the initial two months and then decreased very slowly. The level of residues were nearly the same(less than 0.1ppm) at the end of experiments. The shape of the residue are very resemble each other. Therefore, no difference was found between the treatments of aeration and unaeration. It appears the difference of temperature obtained by aeration was not enough to affect the degradation rate of deltamethrin compared with unaeration.

The speedy degradation of deltamethrin initially which caused a great loss of deposited dose is a problem concerning its effectiveness and persistence as well as the calculation of application rate.

Effect of aeration on the efficacy of protectants against insects

Malathion

Data on the monthly highest insect density occured among 15 sampling points are drawn as Figure 3.

It is clear the insect density of lower malathion deposited(14.8ppm) and aerated grain was much lower than that of higher deposited(19.5ppm) grain without aeration, particularly it gave good suppression on Cryptolestes ferrugineum and Rhizopertha dominica. Of course, this results was acquired both by the delayed effectiveness of malathion and the lowered temperature itself.

Deltamethrin

Data on the monthly highest insect density occured among 15 sampling points are drawn as Figure 4.

It is shown deltamethrin gave very good protection at least for 17 months against common insects except Lophocateres pussilus and Troctes divinatorius both under and without aeration conditions. Survivors occured occasionally in unaerated grain

throughout the experiments showed again that deltamethrin is less effective against Sitophilus zeamais than against other major insect species as formerly demonstrated in China.

With regard to the occurance of more alive insects at the initial stage, we think that was due to the infestations prior the treatments.

Judging by the effectiveness on major insect species, no difference was found between the treatments of aeration and unaeration. Based on the properties of deltamethrin, this result might be attributed to its thermal stability.

Effect of aeration on residual efficacy of protectants against major insects

Bioassay of subdivided samples from 15 sampling points of each treatment were carried out in laboratory monthly at 25 C and 70% r.h. by using laboratory reared susceptible strains of adult R. domonica and T. castaneum. Mortality of tested insects were calculated after 14 days exposure. The results are given in Table 1.

Both of the residual effectiveness of malathion treated grain gave no complete kill of tested insects throughout the ex-experiments. It stated clearly that the deposited dose were not enough to give complete protection of reinfestations, so the actual deposited dose should be raised in practice. On the contrary, both of the deltamethrin treated grain nearly gave complete protection of tested insects all along the experiments.

The series data in Table 1 were compared by 'symbol test' which proved there are no dominant difference between aeration and unaeration. The result reflects that either the inhomogeneity of applied insecticide is inevitable in practice as reported by Samson (14) or the time of present experiments were not enough.

CONCLUSIONS: With the objective of improving the efficacy of grain protectants in south China, field trails has demonstrated that even if only a few months in a year can be used for cooling aeration, the temperature of aerated grain could be lowered significantly than unaerated grain. The lowered temperature could be maintained to a certain extent in a whole year if some heat insulation measures is adopted.

Lower grain temperatures may play the role of delaying the degradation rate and extending the effective period of malathion. Therefore, to make full use of existing aeration systems as a measure of management for protectants treated grain is profitable and feasible.

The property of thermal stable of deltamethrin showed again in this paper that it is also an insecticide suitable to stored grains without aeration.

The reason of speedy degradation of water diluted deltamethrin(K-obil) during the initial two months after application is a problem closely related to practical use. Further work remains to be done.

TABLE 1. Comparative residual effectiveness of malathion and K-obil on the mortality of insets between aeration and unaeration

months after application	malathion				K-obil			
	R. dominica		T. castaneum		R. dominica		T. castaneum	
	aerated	unaerated	aerated	unaerated	aerated	unaerated	aerated	unaerated
initial	66	64	37	15	100	99	99	99
1	19	14	5	4	86	85	98	98
2	21	36	37	42	100	94	100	100
3	36	20	9	10	100	100	100	100
4	44	24	30	29	100	100	100	100
5	40	38	52	28	100	100	100	100
6	31	29	42	29	100	100	100	100
7	46	46	48	39	100	100	100	100
8	38	40	40	34	100	100	100	100
9	48	23	37	16	100	100	100	96
10	45	36	73	72	100	100	98	92

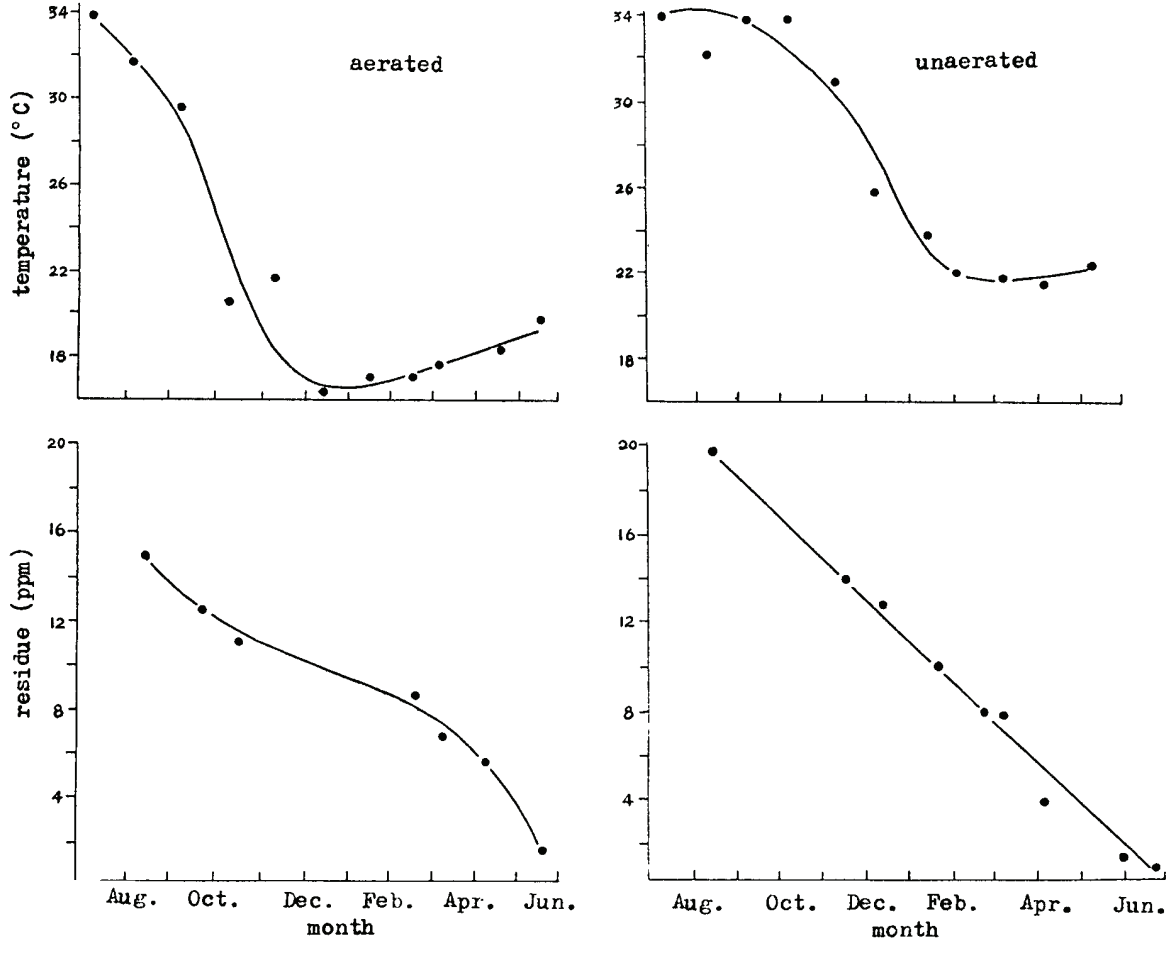

Figure 1. A comparison of degradation of malathion on stored paddy between aeration and unaeration.

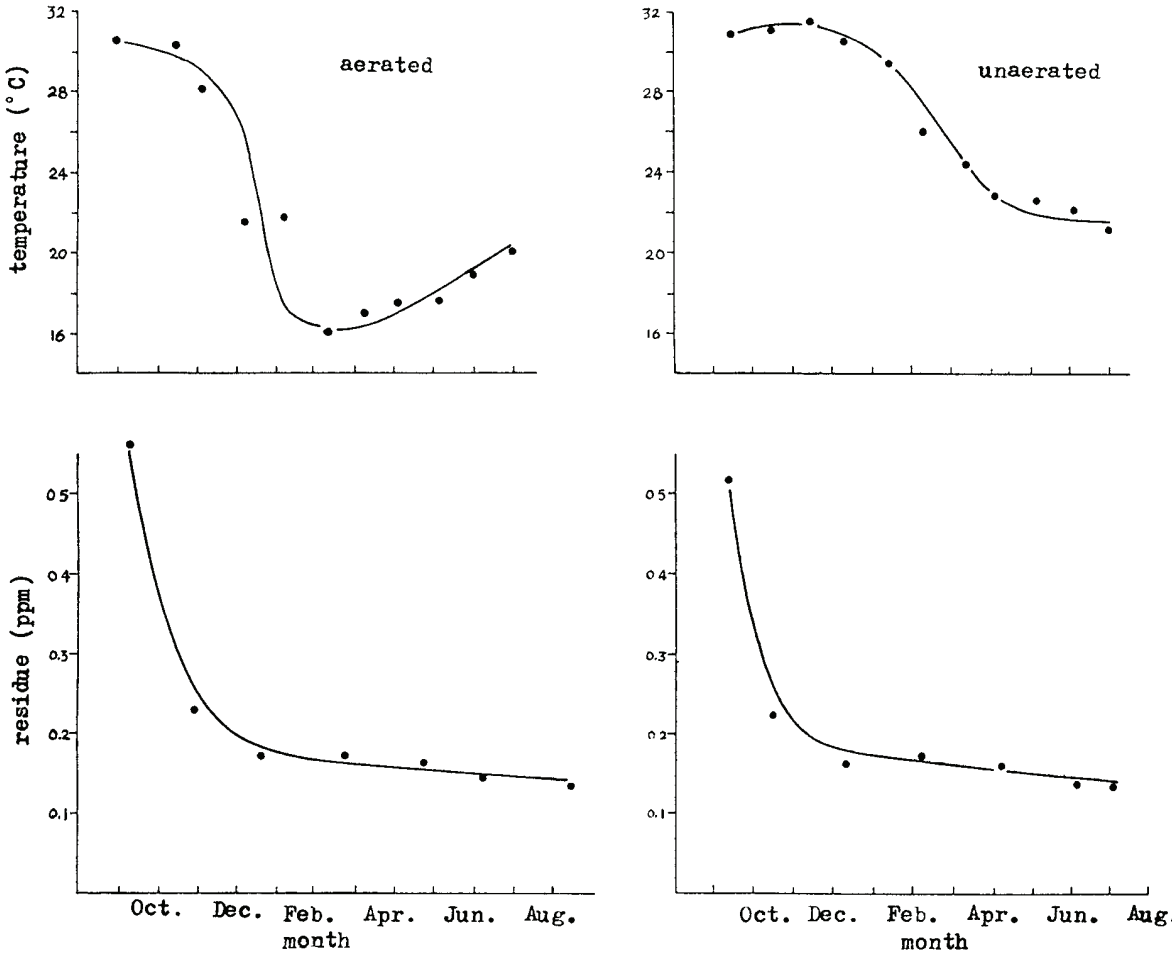

Figure 2. A comparison of degradation of deltamethrin(K-obil) on stored paddy between aeration and unaeration.

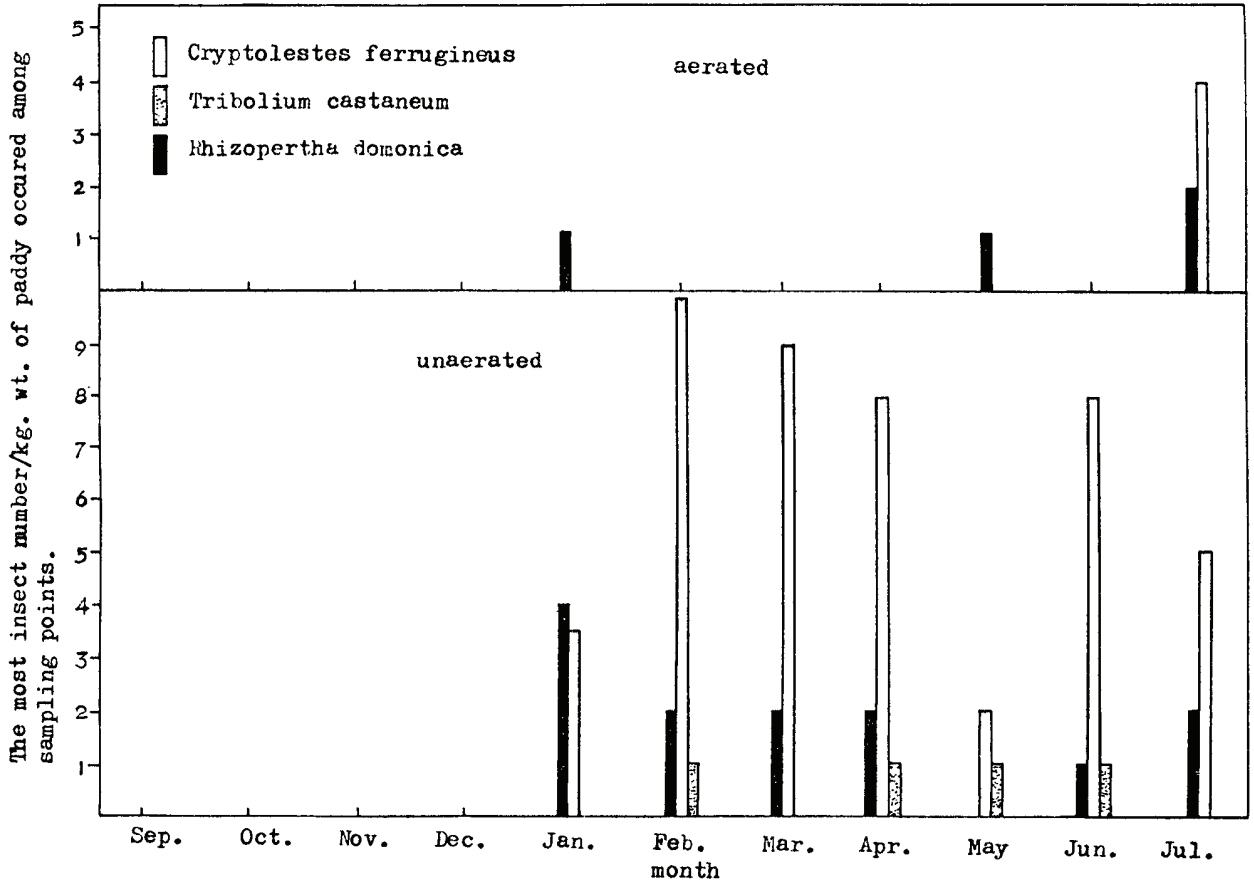

Figure 3. Comparative effectiveness of aerated and unaerated stored bulk paddy on insects treated with malathion (1988-89 trail at Nanhai County)

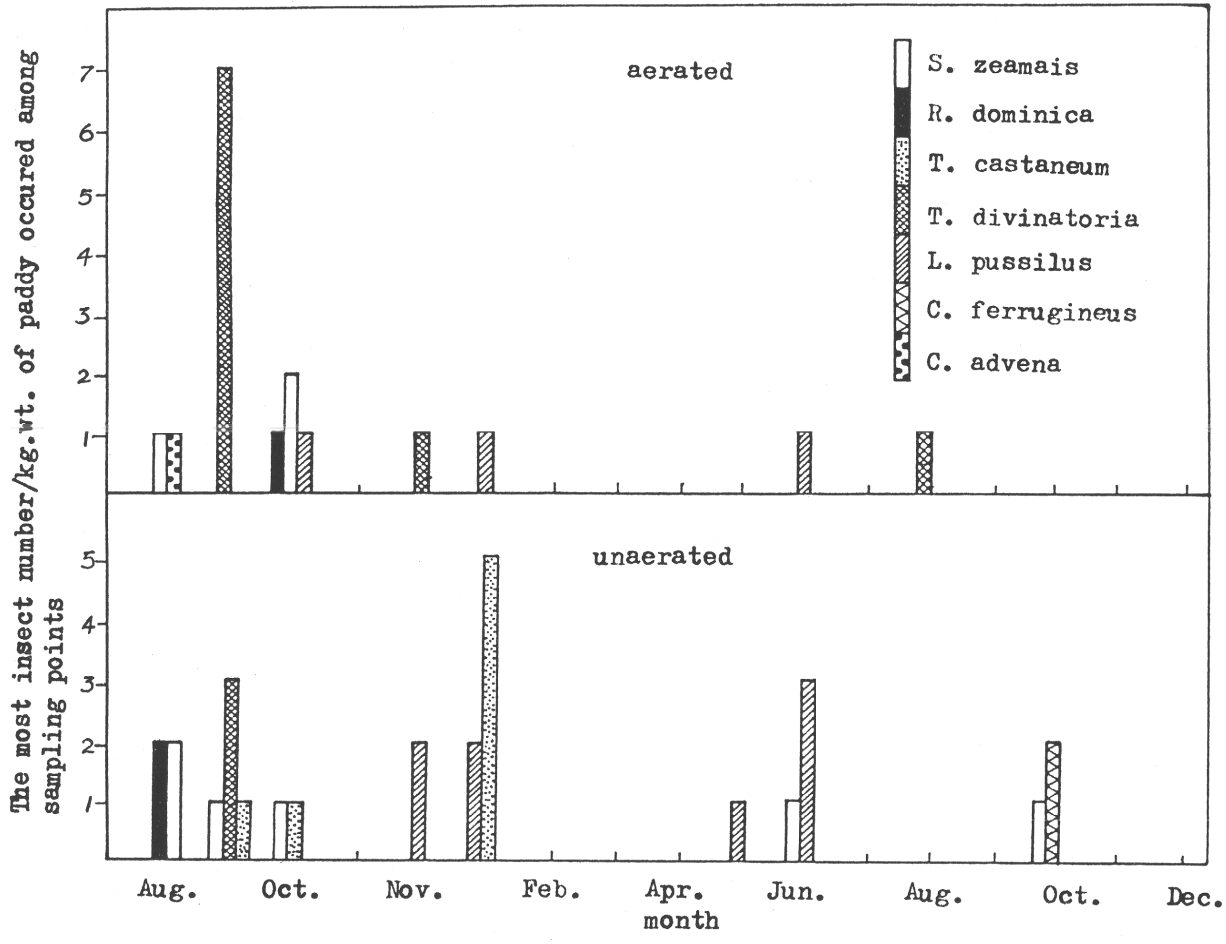

Figure 4. Comparative effectiveness of aerated and unaerated stored bulk paddy on insects treated with deltamethrin (K-obil) (1987-88 trail at Nanhai County).

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EFFETS DE L'AERATION SUR LA DEGRADATION ET L'EFFICACITE DU MALATHION ET DE LA DELTAMETHRINE SUR LES INSECTES DES STOCKS DE GRAIN DU SUD DE LA CHINE

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RESUME

Un essai comparatif de terrain portant sur la persistance d'efficacité du malathion et de la deltaméthrine sur les insectes des grains stockés a été entrepris avec du riz paddy en milieu aéré et en milieu clos, dans le comté de Manhai, province de Guangdong.

La demi-vie du malathion a été de 20 et 28 semaines en milieu aéré et en milieu clos, respectivement. Les effets du malathion ont persisté trois mois seulement à la dose de 40 ppm à la fois en milieu aéré et en milieu non aéré. La deltaméthrine n'a pas duré plus longtemps que le milieu soit aéré ou non. Les résultats sur le terrain et en laboratoire montrent aussi que la deltaméthrine (K-obiol) diluée dans l'eau a une période de dégradation rapide pendant les trois mois qui suivent l'application. Cependant, elle est demeurée hautement efficace contre les principaux ravageurs pendant 17 mois, à la dose d'application de 1 ppm et ceci à la fois en milieu aéré et en milieu clos.