SPRAYING OF SURFACES WITH DIFFERENT CONCENTRATIONS OF PESTICIDES

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Abstract—Concrete, wood, glass and ceramic tiles were treated with the same quantity of active ingredient applied at different concentrations. The active ingredients, permethrin, alpha-cypermethrin and bendiocarb were used. The formulations were diluted in water. Either 1 litre; 0.6 or 0.5 litre; 0.3 or 0.25 litre of water/10 m^2 was used for spraying. The treating was done by using the knapsack sprayer without manometer. The nozzle was conical. According to this, 10 m^2 were sprayed 3 or almost 4 times till one litre of solution was applied. If 0.5 or 0.6 l of water was used, it was necessary to spray the same surface twice. The same surface was covered 0.9 times or once with 0.25 or 0.3 litre respectively. Also, 1 litre, 0.6 litre and 0.3 litre of water was mixed with the same quantity of bendiocarb and different number of square meters were treated. The initial and the residual action of insecticides after 30 and 60 days was determined.

Beside the studies in the laboratory there was some spraying in natural situations. The efficacy was evaluated in the treated buildings as well as in the laboratory, if this was possible.

The insects, *Sitophilus* spp., *Rhizopertha dominica* and *Tribolium* spp. were used in the laboratory experiments. The efficacy of the insecticides used in the buildings was evaluated by the mortality of *Blatta orientalis L.* and *Blattella germanica* (L.).

INTRODUCTION

Very often there are complaints of the efficacy of applied insecticides. Some people accuse the product or active ingredient of not being effective. Sometimes the resistance of insects is mentioned as the cause of poor results. However, inadequate application is rarely stressed as a cause of poor efficacy.

That's why it is important to know the biological and ecological characteristics of the insects, as well as characteristics of the knapsack sprayer and the type of the surface that should be treated.

METHODS AND MATERIALS

The experiments were conducted in the laboratory and in the natural situations, in buildings.

a) In the laboratory 10 m^2 of uneven concrete surface was marked. Small plates of concrete, glass, wood and ceramic tiles were placed on this surface. Then the treatment with insecticide was performed. When the small plates were dry the insects were placed on them. 100 mg permethrin/m^2 (0.4 g Neopitroid WP 25) was used. The insecticide was diluted in 1 litre, 0.5 l and 0.25 l of water and applied on the marked surface. A knapsack sprayer (Koplast) with piston pump but without manometer was used. The nozzle was conical. The distance between the nozzle and the surface was about 30 cm during the treatment. The insecticide trace was about 110 cm to 130 cm long and 15 cm to 20 cm wide. The efficacy of insecticide was evaluated by the mortality of *Sitophilus granarius*, *Tribolium confusum* and *T. castaneum*. The experiment lasted for 60 days. The initial and residual efficacy was established. The evaluation of results was 5 and 7 days after setting up the insects in the inital test, whereas at the residual test the evaluation was done after 6, 8 or 10 days.

b) The same method of work was used when alpha-cypermethrin (Fendona 6 SC) was applied. The differences were that the other person applied the insecticide and only initial efficacy was established. The test insects were *Sitophilus granarius, Rhizopertha dominica* and *Tribolium confusum*. The initial efficacy of alpha-cypermethrin was evaluated 1, 2 and 3 days after the treatment.

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c) The third test was when 30 g or 15 g Ficam W were mixed with different quantity of water 0.3 l, 0.6 and 1 litre. With defined quantity of suspension diffierent number of square metres was treated. The surface was treated only once the same as the ceramic tiles which were used to establish the efficacy. *Sitophilus granarius, Rhizopertha dominica* and *Tribolium confusum* were used. The efficacy was evaluated after 2 and 3 days.

d) The fourth test was done by application of alpha-cypermethrin (Fendona 6 SC) and permethrin (Neopitroid WP 25) in a chocolate factory. The dosages were 50 g and 25 g of Neopitroid WP 25, and 75 ml and 37.5 ml of Fendona 6 SC. The 5 l knapsack sprayer was used for application. Also two glass plates were treated during the treatment (the appliers were not informed where the plates were placed). The efficacy was evaluated by caught individuals on the pheromone trap and the mortality of *Blatta orientalis* around the traps and on the treated surfaces in the factory. The efficacy was studied 30 and 60 days after the treatment. The dead *Sitophilus granarius, Rhizopertha dominica* and *Tribolium confusum* were counted in the laboratory experiment. The test lasted for three months.

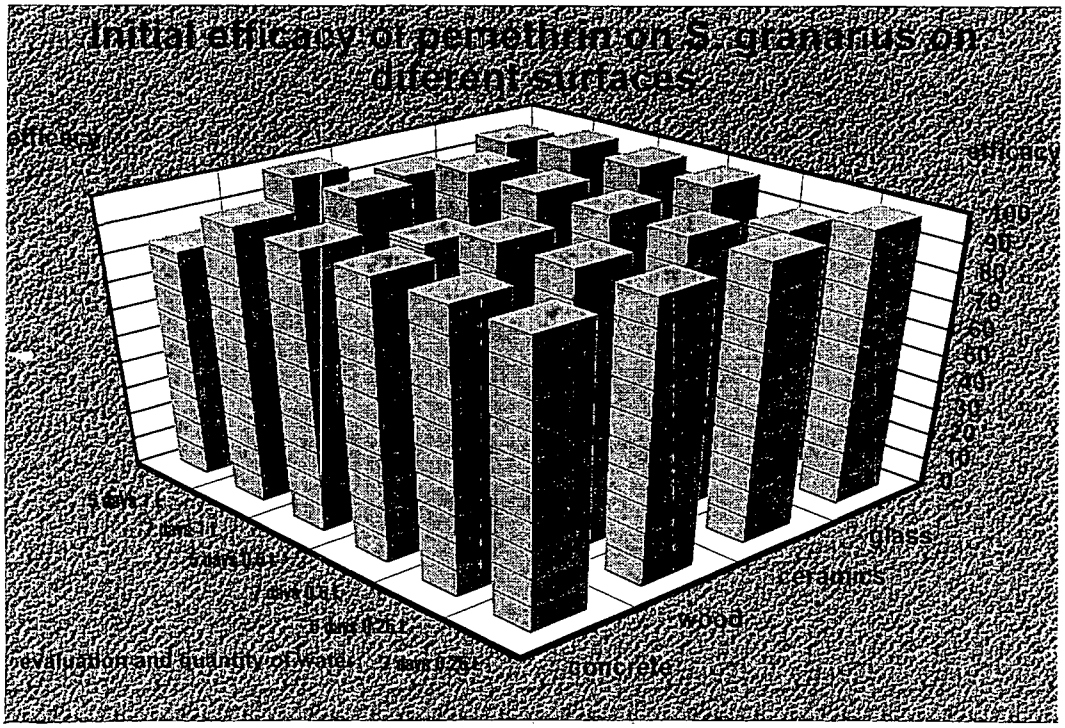
e) The fifth test was provided with three dosages of bendiocarb (Ficam W) in restaurant and hotel kitchens where the walls and the floor were covered with ceramic tiles. The first dosage was 0.3% (30 g/10 l of water), the second 0.6% (60 g/10 l of water) and the third 1.2 % (120 g/10 l of water). The evaluation of results was done by counting of dead *Blattella germanica.* The experiment lasted for two weeks.

RESULTS AND DISCUSSION

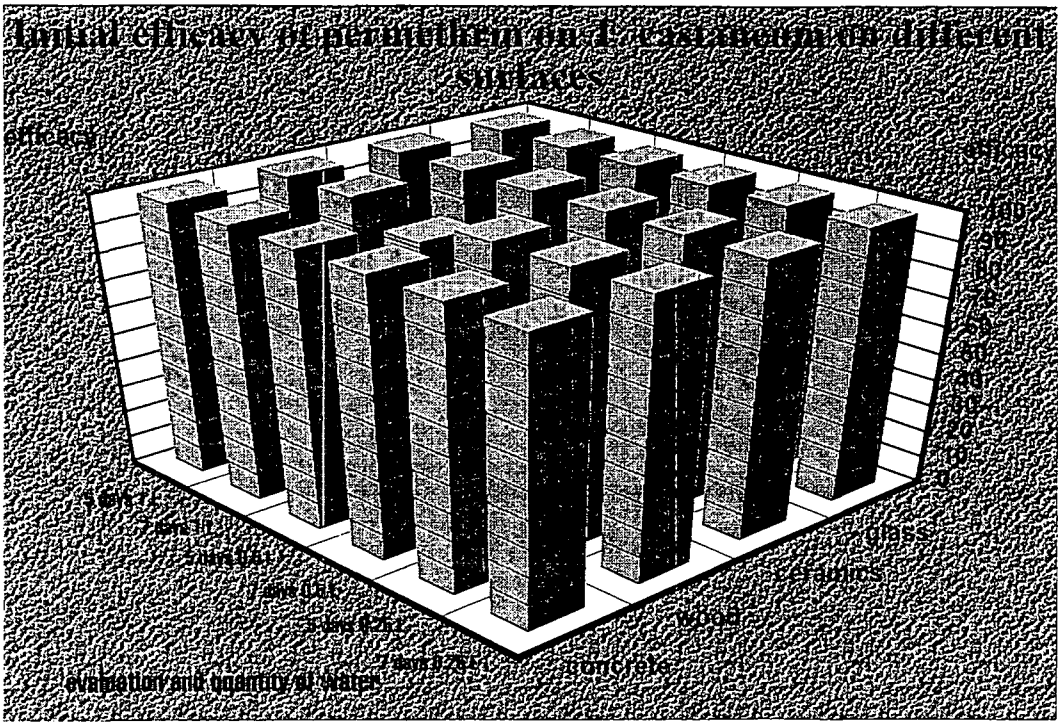
a) The results of the efficacy of permethrin on surfaces are presented in graphs 1 to 7. The initial efficacy (graph 1 and 2) evaluated after 5 days was higher to *T. castaneum* than to *S. granarius.* The efficacy was 100% to both species after 7 days. The residual (30 days) efficacy evaluated after 6 days was the highest for *S.granarius.* At the same time the insecticide was less effective to *T. castaneum* especially on the concrete and wooden surface. In this experiment the most resistant species was *T. confusum.* After 6 days 100% mortality was obtained only on wooden surface treated with 0.25 l of suspension (graph 3, 4 and 5). When the efficacy was tested after 60 days *S. granarius* was more sensitive than *T. confusum* (graph 6 and 7). The lowest efficacy was obtained on all surfaces treated with 0.25 l of suspension. 100% mortality was obtained with more applied suspension (0.5 l or 1 l) on all treated surfaces after 8 days except on concrete. According to the obtained results it can be seen that there is practicaly no difference in initial efficacy of permethrin on the insects no matter which quantity of suspension was used (concentration) for treating of surfaces. If the lowest concentration was applied there were some differences between absorbing and nonabsorbing surfaces in the residual efficacy after 30 days and especially after 60 days.

b) The initial efficacy of alpha-cypermethrin evaluated after one day was very low on all tested species. The results after two days were better. After three days the best efficacy was obtained on *R. dominica* whereas the efficacy on *S. granarius* was still very high. The mortality of *T. confusum* was still very high but not as high as with the other two species (graph 8 to 10). The low efficacy after 1 and 2 days could be explained by the acting of alpha-cypermethrin the same as other pyrethroids that the insect must be exposed longer on the treated surface to achieve complete efficacy. The low efficacy on *T. confusum* could be explained by less sensitivity of this species to pyrethroids (Korunic and Hamel, 1985). The most important conclusion is that it is necessary to use different concentrations of insecticide on different absorbing surfaces.

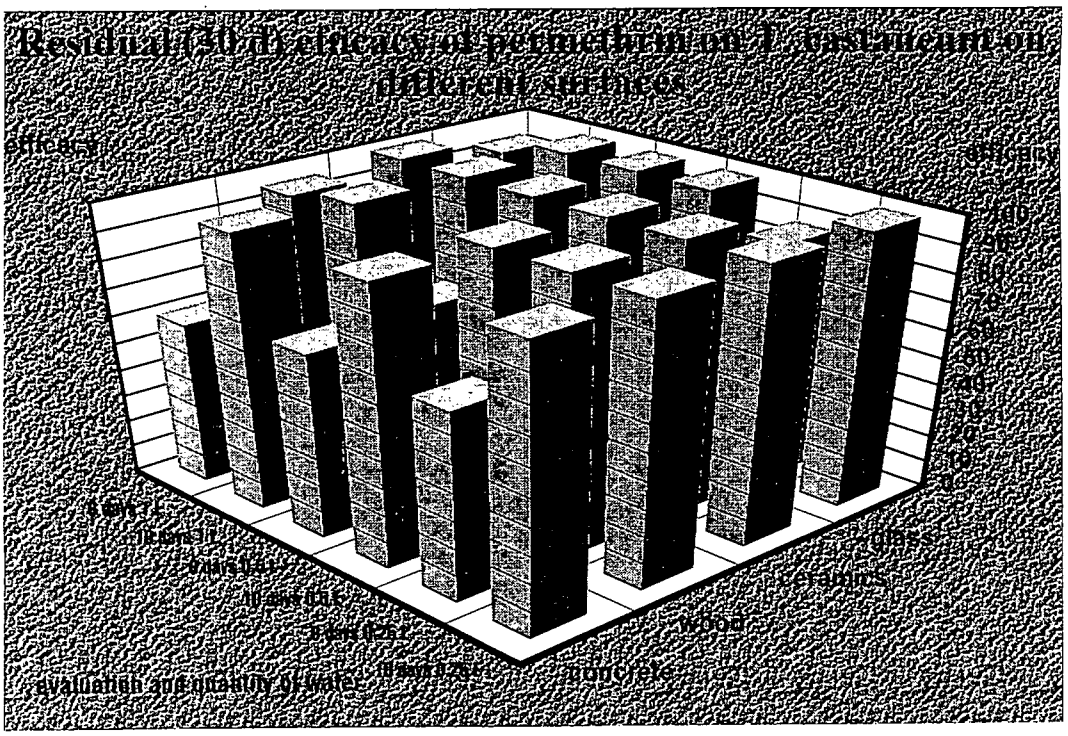
c) To prove earlier obtained results, different concentrations (same quantity of Ficam W and different quantities of water) of Ficam W were applied on the ceramic tiles. With 1 litre of suspension approximately 30 m^2 was treated. The quantity of 0.6 l was enough to treat 20 m^2 whereas 0.3 l was enough to treat 10 m^2. Each ceramic tile was sprayed once. The quantity of bendiocarb per square metre is shown in Table 1.



Graph 1



Graph 2



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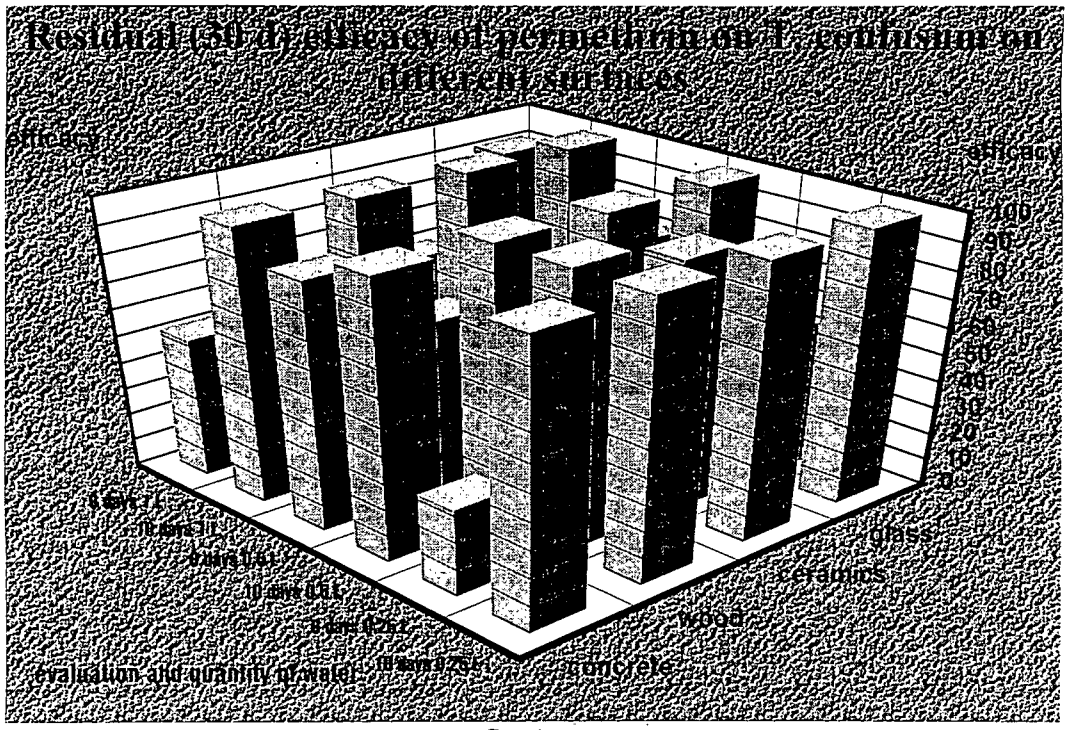
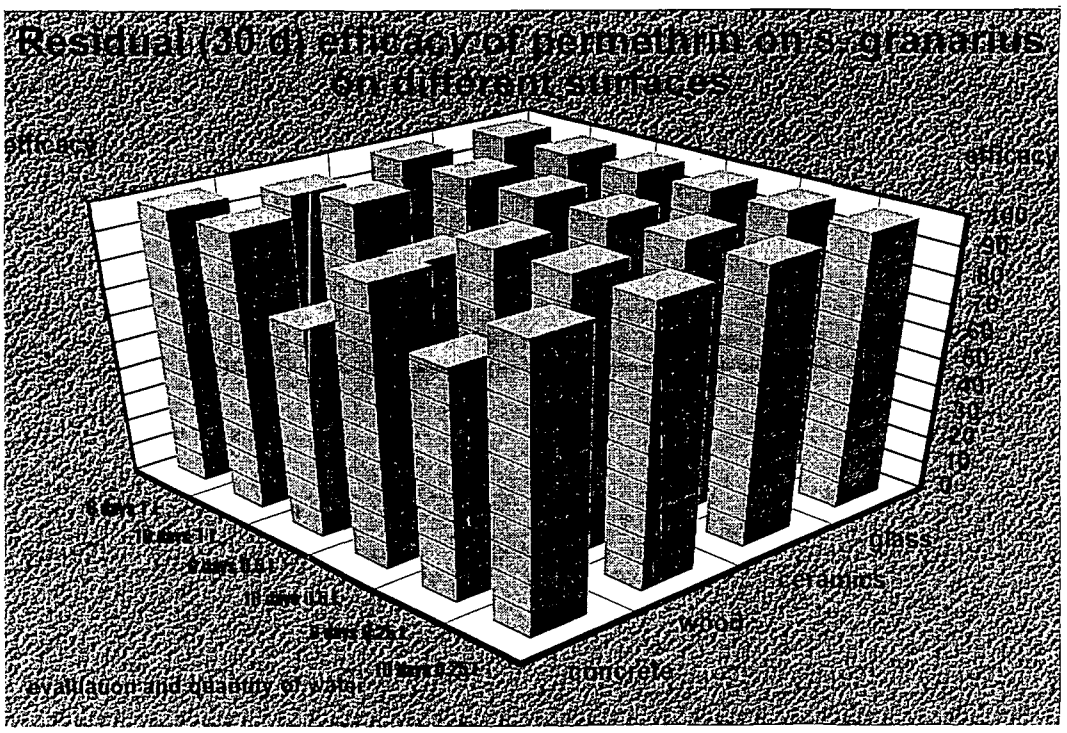
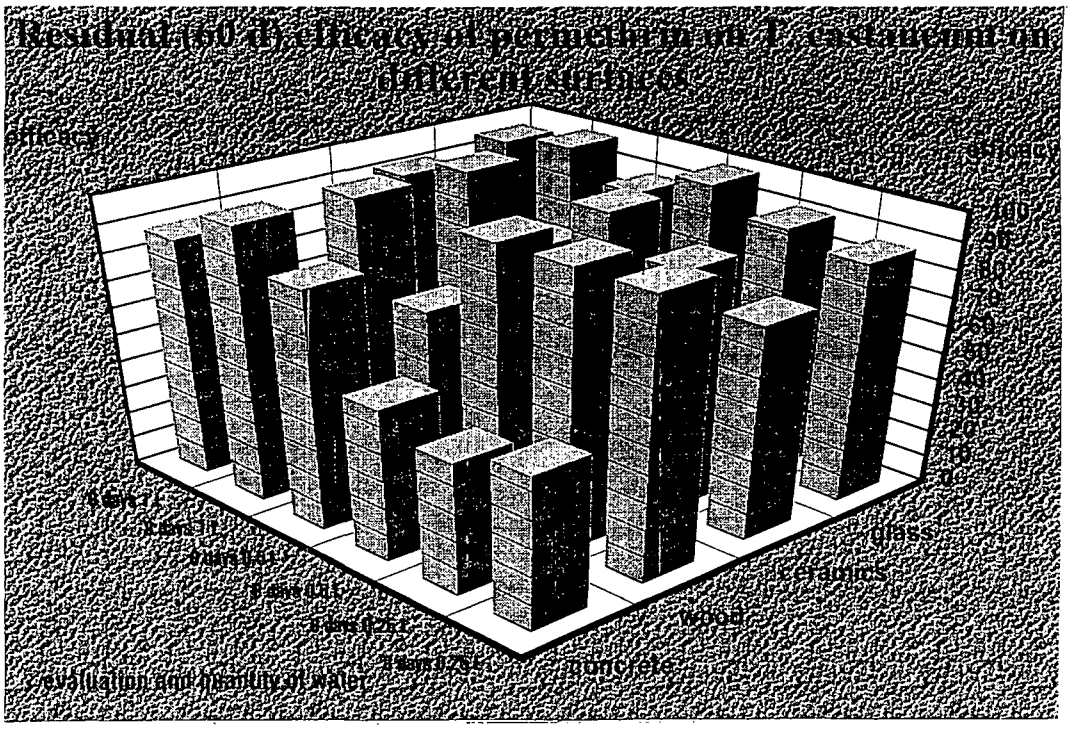


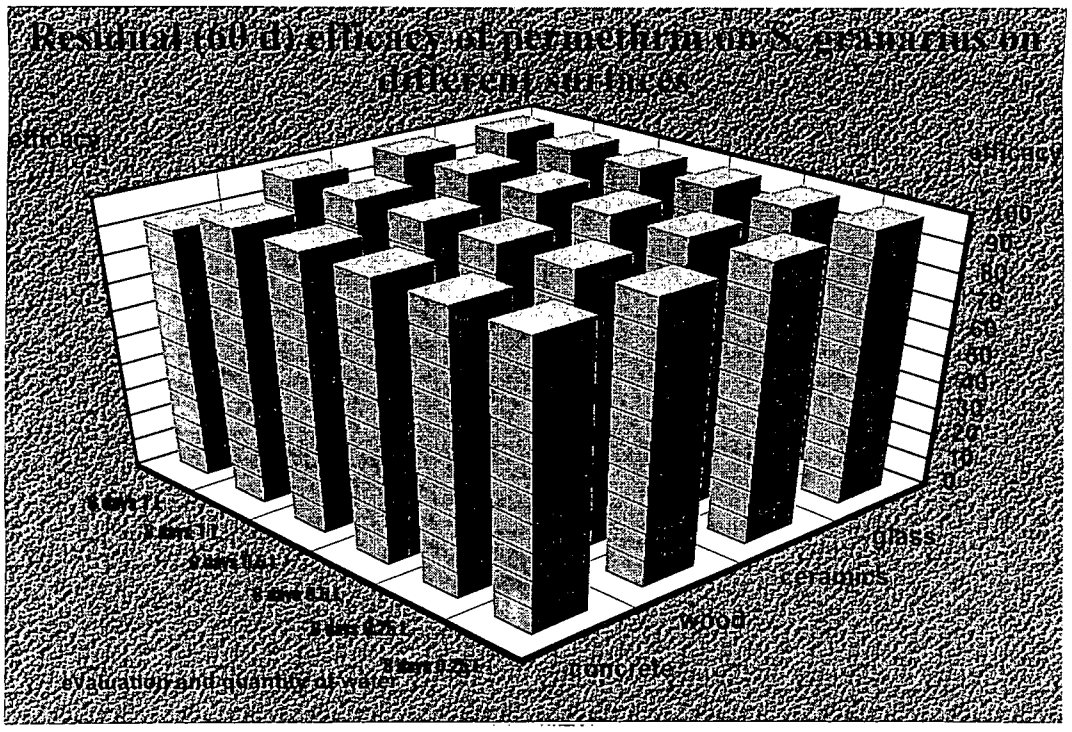
Graph 4



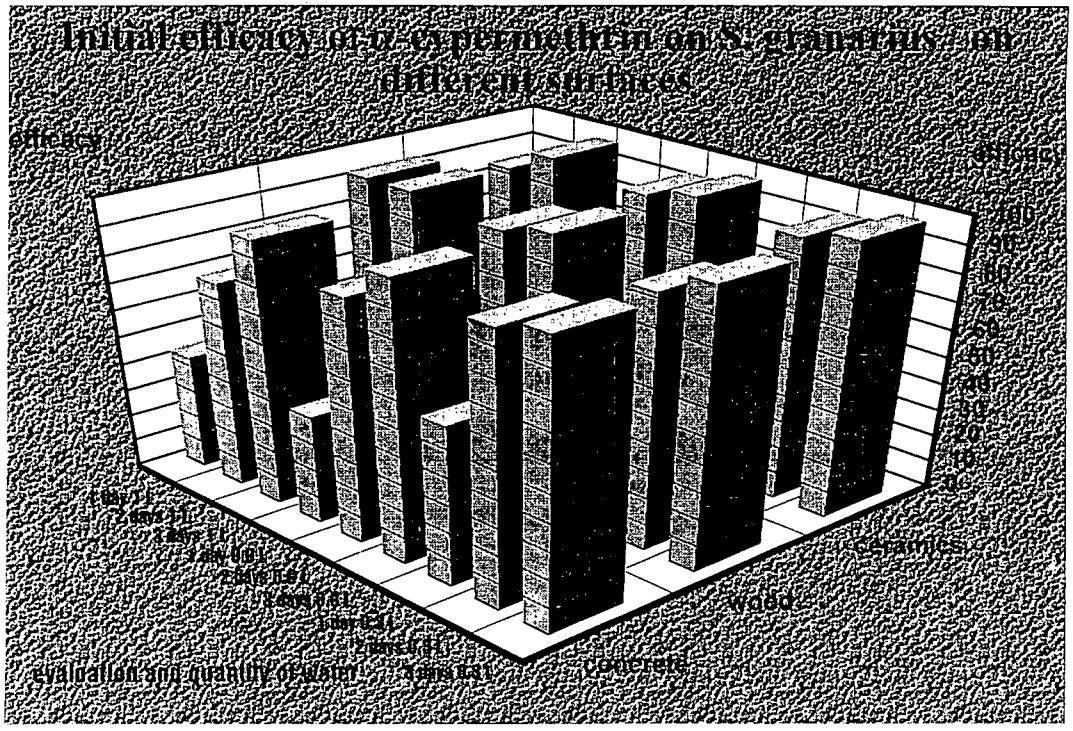
Graph 5



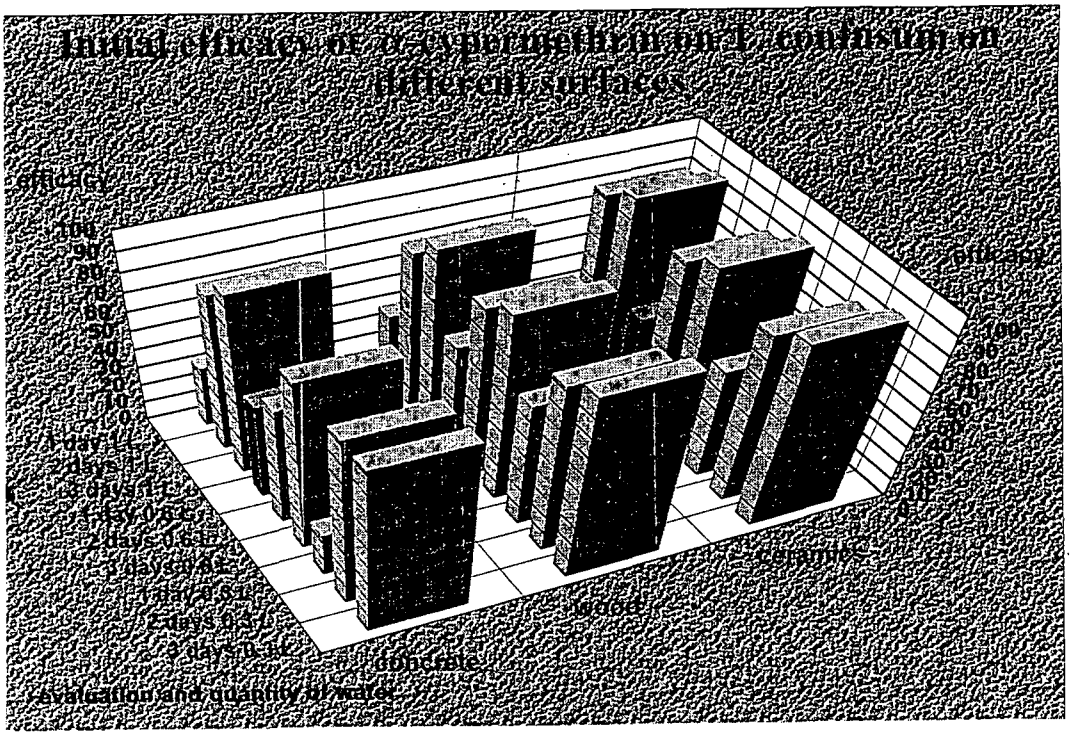
Graph 6



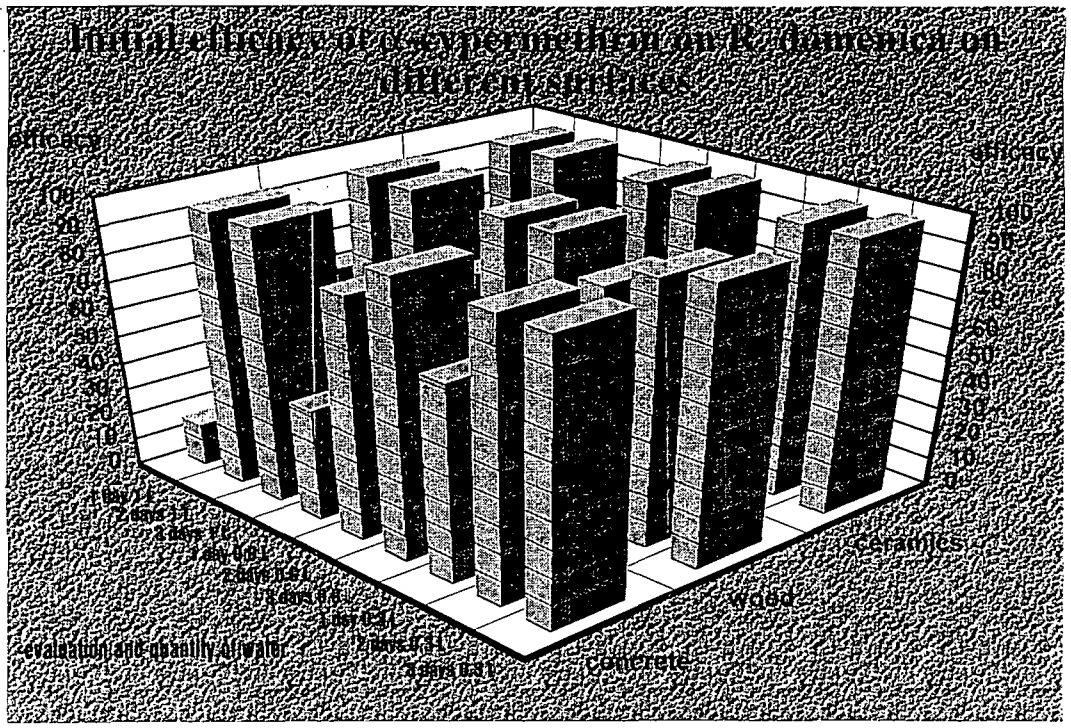
Graph 7



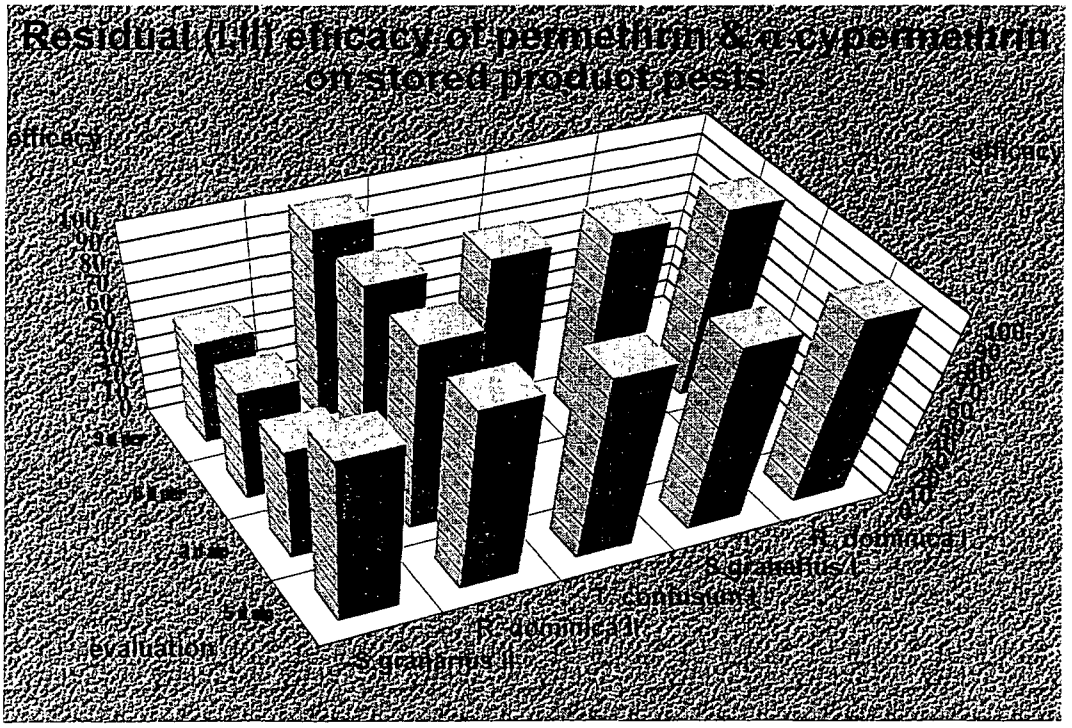
Graph 8



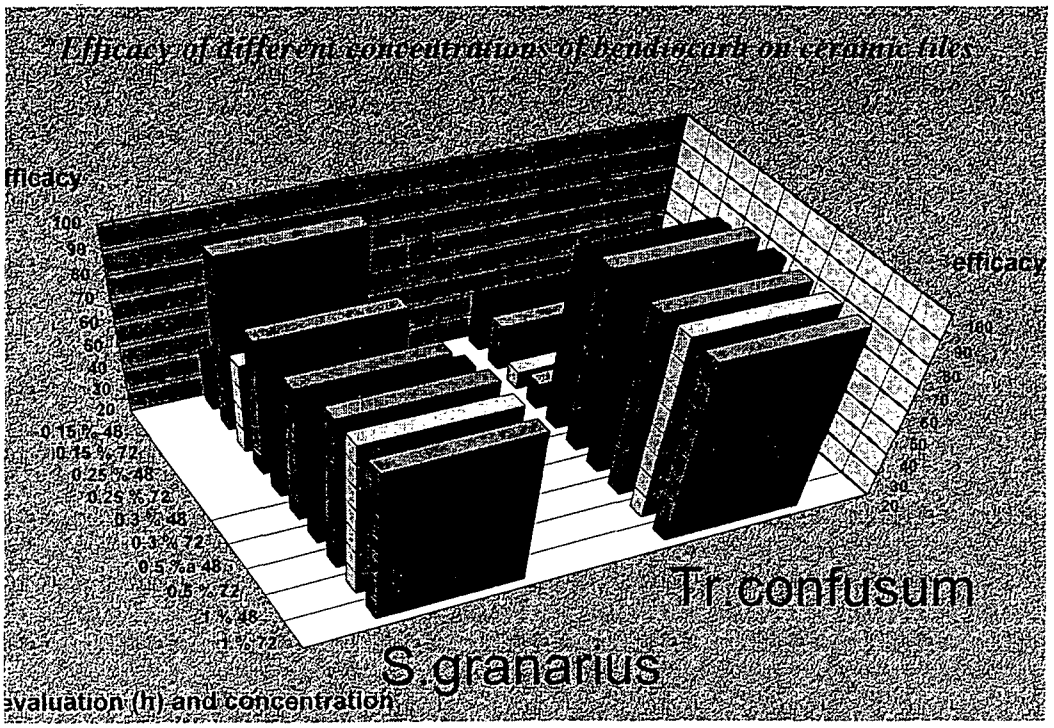
Graph 9



Graph 10



Graph 11



Graph 12

Table 1 Quantity of bendiocarb per square metre

bendiocarb (g/m^2),	water (l),	concentration (%)
0.04	1	0.15
0.06	0.6	0.25
0.08	1	0.3
0.12	0.6	0.5
0.24	0.3	1

From this data it is obvious that there are big differences in dosage/m^2 (figure 1), and naturally in efficacy (graph 12), if the same quantity of active ingredient in different quantity of water is used. Due to this it is very important that the appliers know precisely how much water they use for treating the defined unit of surface. This is the same as Barker (1993) pointed out. The results obtained show that the efficacy at lower concentration (quantity of active ingredient) is lower.

d) The average number of *B. orientalis* on the traps was 4 before the treatment in the chocolate factory. When the insects were counted three weeks later there were from 4 to 8 per trap. Seven weeks after the treatment, the number of insects was between 0 and 3. Many dead cockroaches were found around the traps even 7 weeks after the treatment. More insects on the traps after the treatment could be explained that insects were forced to come out (irritation) by the insecticide and were caught on the trap. What was very important, many dead cockroaches were found on the treated surfaces especially under tables, cupboards and conveyer belts where it is difficult to clean, even at the inspection three months after the treatment. It should be also pointed out that the results were much better than after earlier treatments because the appliers were informed to treat the same surface aproximately twice (this was due to the laboratory experiments). It was not possible to establish the difference in the efficacy on *B. orientalis* between higher and lower dosage. However the lower dosages should be enough to achieve the necessary efficacy. The higher dosages were used because *Oryzaephilus mercator* and *Corcyra cephalonica*, were present there. However the results were not satisfying and are not presented here.

In the course of evaluation of results there were some problems which are normal when the experiment is performed in natural situation. It was not possible to prevent workers from moving dead insects, or cleaning and removing the insecticide deposit.

The results obtained in the laboratory show high efficacy on all insects after 30 days (I) and decreased efficacy to *S. granarius* 60 days after the treatment (II) (graph 11). This results show that applied insecticides had good residual efficacy and that it is important to apply the insecticide precisely.

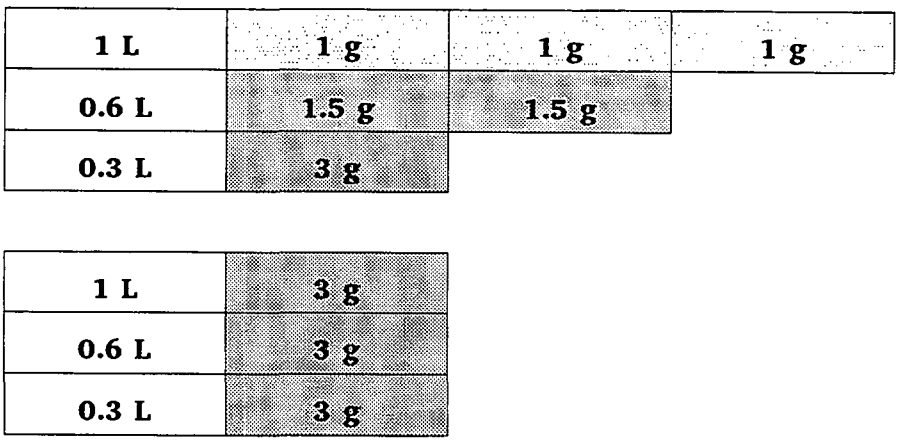


Figure 1 Distribution of pesticide if different concentrations are applied or surfaces treated

e) During and immediately after the treatment in kitchens, several cockroaches were flushed out from their shelters and were spread all around the walls even on the ceiling. Only few paralysed ones were found. Almost the same result was on the lowest dosage after 1, 3, 8 and 14 days. When the higher dosage of 60 g was applied the result was almost the same as in the first case. The best result was obtained when the highest dosage was applied. The flushing out effect was noticed and paralysed insects were found immediately after the treatment. The inspection after 24 hours showed that many insects were paralysed or dead but there were no alive ones. After two days only dead cockroaches were found the same as on the fifth day. After 8 days only two live cockroaches were found. The results obtained showed different efficacy. The problem was that in routine treatment ceramic tiles, as other nonabsorbant surfaces are sprayed only once. This is due to that if the surface is treated two or three times the insecticide is dropping down the wall and small plashes appear on the floor. That is why only at the highest dosage the good efficacy was obtained, the same as in the third experiment with bendiocarb.

In this experiment during the evaluation of results the problems were the same as those described earlier.

According to the results obtained and from practical point of view the efficacy on treated surfaces is important at least 30 days or better to say it lasts for aproximatly 30 days. This is, because after that time because of the normal cleaning several times there is almost no insecticide deposit on the surface or there is so much dust that insects can not be in contact with the treated surface.

A 5 litre pressure knapsack sprayer with a piston pump was used in the experiments. This type of sprayer with a conical nozzle was used because it is commonly used. The efficacy of the application with this kind of sprayer is very debatable. At the beginning the pressure in the tank is about 5 bars and later on it falls to 1.5–2 bars. The size of droplets depends on the pressure in the tank (Maceljski, 1992). It changes from 100 micrometres to 500 micrometres. The coverage depends on the size of the droplets. So the coverage changes according to the loss of pressure in the tank. The human factor must be considered as well. The speed of application is very important and workers with a greater experience (well trained) know exactly how to cover the surfaces of different types.

This way of insecticide application is rather imprecise but simple to operate.

Due to the results already mentioned there is no real need to use a lot of water on nonabsorbant surfaces because there will be too much active ingredient on some places and on the opposite side not enough. It is important to know that water is only a transporter of the active ingredient and it is needed to spread it. That is why every applier must be very well trained and must know the characteristics of the sprayer and ambient where the insecticide is applied. Also it is important that the applicator knows how much liquid is applied in the routine way for the defined surface.

CONCLUSIONS

Many problems during treatment arise because the instructions for pesticide application were not precise.

The obtained results show that when applying the insecticide on the surface it is important to know:

1. what kind of surface will be treated (absorbent or nonabsorbent
2. what is the quantity of active ingredient/ m^2 or ready made product/m^2 that should be applied
3. how much water should be used for defined surface
4. what insect species is the treatment against
5. characteristics of the sprayer

According to the results obtained it could be suggested that in instructions should be written the dosage of active ingredient or ready made product per defined unit (1 m^2 or 10 m^2). Also, non-absorbent surfaces can be treated with 0.3 l solution/10 m^2, normal absorbent surfaces (wood and smooth concrete) with 0.6 l/10 m^2 and very absorbent surfaces (uneven concrete) with 1 l/100 m^2, to provide the necessary efficacy in defined time.

Only if all mentioned parameters are known and respected, can the satisfatory results be obtained and insects controlled.

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