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# EFFECT OF CONTROLLED RELEASE CHLORPYRIFOS FORMULATIONS ON THE DEVELOPMENT OF *CULEX Pipiens quinquefasciatus (SAY)* POPULATIONS IN THE LABORATORY

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## ABSTRACT

Laboratory evaluations were conducted for 8 weeks to compare the residue levels *maintained in water* treated with eight chlorinated polyethylene pellet formulations of chlorpyrifos.The eight formulations were of four Particle sizes, each at two chlorpyrifos concentrations. All Pellets were cylindrical in shape, had a specific gravity > 1.O and each was *evaluated at dosages of* 1.O *ppm* and 2.0 ppm in laboratory test jars.

In the laboratory tests, average weekly residues for all formulations increased significantly through week 4, leveled off through week 7, and showed a second significant increase at week 8; *and the 2.0 ppm dosage resulted in* significantly higher residues than the 1.0 ppm dosage, except at week 1 after treatment. For each formulation there was no significant differences due to percent chlorpyrifos therein.

The effects of low-level concentration of chlorpyrifos on *the development of Culex pipiens quinquefasciatus (Say)* populations from the time of hatching until adult emergence. The low-level concentrations were determined below the $LC_{50}$ (0.9 ppb) by treating laboratory test jars with various numbers of polyvinyl chloride (PVC) pellets containing 0.1 percent chlorpyrifos. Control average of the laboratory populations were 47.3 % *in jars* containing average residues of < 0.10 ppb; 72.2 % in jars containing average residues of 0.14 ppb; and 99.7 % in jars containing average residues of 0.32 ppb.

## INTRODUCTION

A novel system has been developed for the slow release of pesticides with advantages of being more practical and less costly than materials currently used. Thermoplastic polymers and copolymers employed as the slow-release encapsulating agent. *These polymers degrade to natural materials* that are harmless to the environment and , in doing so, slowly release encapsulated pesticides. There is need for the development of safe and effective controlled release formulation (CRF) of pesticides. Experience to date suggests that such formulations could make it possible to use smaller amounts of pesticides and perhaps even *improve performance efficiency* Technology of this kind would also be of value in making pesticides safe in the environment (Kydonieus, 1980; Pfister and Bahadir,1985 and El-Naggar *et al.*, 1991)

Conventional methods of applying pesticides specially in aquatic system expensive, require repettion may not be entirley successful and intoxication of aquatic *non-target organism too.* (Bahadir, 1983).

Chlorpyrifos is one of several organophsphorus compounds developed in 1960 to replace persistent organochlorine pesticides. It is the active ingredient in various products designed to control a variety of pests including fire ants, turf and ornamental plant insects, mosquito, cocharoackes, termites, lice and hornflies.. *It was directly applied to aquatic environments* in mosquito, midge.

Chlorpyrifos is available for pesticide applications as emulsifiable concentrates, wettable powders, dusts, granules and controlled release polymers.

Granules and controlled- release forms do not produce as rapid an increase in the concentration in water, but resulting concentration has been a longer duration.

Evans (1977) found concentrations of chlorpyrifos that were still toxic to mosquito larvae one year after application of a slow-release polymer formulation to a natural pond.

Studies by Wilkinson *et al.* (1971); Miller *et al.* (1973a, 1973b); and Roberts *et al.* (1973) have demonstrated the feasibility of obtaining long-term control of larval mosquito populations slow-release formulations of chlorpyrifos through single application. In all of these studies, however, the large amount of formulation (kg/hectare) required for control may be prohibitive from the standpoint of large-scale larviciding operations. Therefore, tests were conducted to explore ways of improving the efficiency of chlorinated polyethylene formulations of chlorpyrifos, and thus diminishing the amount of formulation required on a hectare basis. Stockman *et al.* (1970) reported the theoretical effects of pellet size on release rate of tributyltin oxide from rubber, and showed that the concentration released from formulations of different pellet size increased geometrically with decreasing pellet size.

Stockman *et al.* (1970) also reported a linear relationship between percent concentrations of pesticide in a polymer and release rate.
(Nelson *et al.*, 1970) showed that increases in percent composition of chloride formulations of chlorpyrifos caused a nearly linear increase rates, and residue levels maintained in water. Additional studies were conducted at this Agency to determine if the same theoretical relationship applied to chlorinated polyethylene formulations of chlorpyrifos.

The biological effectiveness of residues maintained were determined by Wilkinson (1971) and Miller *et al.* (1973a) against the 4$^{th}$ instar of mosquito larvae.

The purpose of this study was to determine the effect of particle size and percent composition dosage on the efficiency of chlorinated polyethylene formulations of chlorpyrifos in maintaining residues in water, and to evaluate the effect of chlorpyrifos formulations on the development of populations of *C. pipiens quinquefasciatus (Say)*, when such populations were exposed to continuous low-level concentrations from the time of hatching untile adult emergence in the laboratory

## MATERIALS AND METHODS

**Laboratory evaluation of selected polyethylene formulations of chlorpyrifos:**

**Formulations:**

Eight chlorinated polyethylene pellet formulations (4 Particle sizes, each at two concentrations of chlorpyrifos [o,o-diethyl-o-(4,5,6-trichloro-2-pyridyl) phosphorothioate] were evaluated in this study. All pellets were cylindrical in shape and had specific gravities > 1.0 Other pertinent physical characteristics are shown in Table 1.

**Table (1): Physical characteristics of chlorinated polyethylene pellet formulations containing chlorpyrifos**

| Formulation* | Percent chlorpyrifos | Diameter (mm) | Length (mm) | Volume (V) ($mm^3$) | Surface (S) ($mm^2$) | S/V |
|---|---|---|---|---|---|---|
| M-3460 | 9.4 | 1.59 | 3.17 | 6.37 | 19.92 | 3.12 |
| DB-I-4758-II4 | 15.0 | 1.59 | 3.17 | 6.37 | 19.92 | 3.12 |
| DB –4758-II6A | 9.4 | 1.59 | 1.59 | 3.19 | 11.98 | 3.75 |
| DB –4758-II6D | 15.0 | 1.59 | 1.59 | 3.19 | 11.98 | 3.75 |
| DB –4758-II6E | 9.4 | 1.59 | 1.02 | 2.02 | 9.12 | 4.50 |
| DB –4758-II6B | 15.0 | 1.59 | 1.02 | 2.02 | 9.12 | 4.50 |
| DB –4758-II6C | 9.4 | 1.59 | 0.79 | 1.58 | 7.96 | 5.00 |
| DB –4758-II6F | 15.0 | 1.59 | 0.79 | 1.58 | 7.96 | 5.00 |

*Coded designations provided by Dow Chemical Company, Midland, Michigan.

The eight formulations were evaluated in the laboratory at dosages of 1.0 and 2.0 ppm active ingredient based on a theoretical total initial release. Treatments were replicated three times in individual glass jars containing 3 liters of distilled water (pH 6.5) at room temperature (22.2-25 °C). Three replicate jars containing only distilled water served as controls. Jars were sealed with aluminum foil liners and screw-cap lids to minimize loss of water due to evaporation. Water samples (10 ml), water temperature, and pH measurements were taken from 1 through 8 weeks after treatment. Each 10-ml water sample was subjected to hexane extraction and electron capture gas chromatographic analysis as described by Miller *et al.* (1973). The minimum detectable quantity measured in the water during the present study was 0.1 ppb chlorpyrifos.

**Effects of continuous low-level chlorpyrifos residues on the development of populatiopns, *C. pipiens quinquefasciatus* (say):**

**Test Formulations:**

The polymer formulation used to maintain continuous low-level residues during this study consisted of polyvinyl chloride (PVC) pellets containing 0.1 percent analytical grade chlorpyrifos. The pellets weighed an average of 84.0 mg, had specific gravity>1.0, and were prepared according to the methods reported by Miller *et al.* (1973a).

**Preliminary Biological Response Tests:**

Eighteen glass jars, each containing 3000 ml of distilled water, were set up in an environmental chamber that maintained the water temperature at 27.5 C. Dosages for the various test jars are shown in Table 2.

Following treatment, the water in each of the jars was bioassayed weekly with 20 fourth instar *C. p. quinquefasciatus* larvae. When mortality was no longer observed in the bioassay, the jars were considered to contain low-level chlorpyrifos residues *C. p quinquefasciatus* egg rafts (each <12 hours old and containing a known number of eggs) were added to the jars, along with small quantities of ground Wayne® Rabbit Ration pellets. Thereafter, small quantities of ground or whole rabbit pellets were added daily throughout the study. Since all of the eggs in a given egg raft were not necessarily fertile, a determination of the number of eggs per raft was not always a valid measure

of the number of larvae that actually hatched into the best jars. Therefor, the following method was used to estimate the number of larvae hatching into the test jars. The total numbers of eggs in each of the rafts was counted. The egg rafts were placed in the test jars and kept for 48 hours to permit hatching, since it was known that hatching occurred subsequent to the 36 hours after oviposition. The rafts were then removed from the jars and the total number of eggs recounted. This second count was necessary because in some instances eggs became detached from the rafts and the total raft was not retrieved from the jars.

The percent hatch, therefore, was based on a number hatched divided by the total number from the second counting, and the number of larvae hached into the jars was estimated by multiplying the total number of eggs originally in the raft by the percent hatch. Larvae which hatched into the jars were allowed to complete their development and the effect of the low-level chlorpyrifos dues was measured by determining the relative numbers reaching the pupal and adult stages. To compensate for evaporation, quantities of distilled water were added to the jars daily to maintain the level at 3000 ml. These preliminary biological response tests were conducted twice by introducing one set of eggs rafts into the test jars when low-level chlorpyrifos residues were present, allowing the larvae to complete their development, and then introducing a second set of egg rafts into the same test jars. Data concerning percent hatch of egg rafts, percent pupation, and percent adult emergence were analyzed by Analysis of Variance at the 0.5 level of probability (Miller *et al.*, 1973a and 1973b).

**Table 2: Dosages for test jars used to determine preliminary biological response .**

| Type of test jars | Average weight of pellets [a] (mg) | Average weight of chlorpyrifos [b] (mg) | Average dosages (ppm chlorpyrifos) |
|---|---|---|---|
| Control w/32 pellets | 2695.5 | ... | ... |
| 1 pellet | 82.5 | .08 | .02 |
| 4 pellets | 334.4 | 0.33 | 0.11 |
| 8 pellets | 672.9 | 0.67 | 0.22 |
| 16 pellets | 1366.4 | 1.36 | 0.45 |
| 32 pellets | 2698.4 | 2.69 | 0.89 |

**a- Average weight of the total number of pellets added to each of three replicate jars.**
**b-Average weight of chlorpyrifos contained in the total number of pellets added to each of three replicate jars.**

**Comparative Chlorpyrifos Residue and Biological Response Tests.**

Fifteen glass jars, each containing 300 ml of distilled water, were set up in an environmental chamber that maintained the water temperature at 22-25 °C. Dosages for the various test jars are shown in Table 3.

Following treatment, water in each of the jars was bioassayed weekly with 20 fourth instar *C. p. quinquefasciatus* larvae. When mortality was no longer observed in the bioassays, the jars were considered to contain low-level chlorpyrifos concentrations. Small quantities of ground rabbit pellets were added about 24 hours before 100 first instar larvae (< 2 hours old) were

introduced into each of the jars. Small quantities of ground or whole pellets were added daily thereafter. The larvae were allowed to complete their development and effects of the low-level chlorpyrifos residues were measured by determining the relative numbers reaching the pupal stage. Beginning with the day the first instar larvae were added to the jars, chlorpyrifos residues in the test jars were determined by electron capture gas chromatography as reported by Miller *et al. (1973b)*. The minimum detectable quantity measured in water during the present study was 0.1 ppb chlorpyrifos. To compensate for both the removal of water samples and evaporation, quantities of distilled water were added to the jars daily to maintain the level at 3000 ml. These comparative tests were conducted three times by introducing an initial set of 100 first instar larvae into each of the test jars, followed by two successive sets of 100 first instar larvae, each set being introduced into the same test jars after the previous set had completed development.

**Table 3: Dosages for test jars used to complete chlorpyrifos residue levels and biological response .**

| Type of test jars | Average weight of pellets [a] (mg) | Average weight of chlorpyrifos [b] (mg) | Average dosages (ppm chlorpyrifos) |
|---|---|---|---|
| Control w/o pellets | ..... | ... | ... |
| Control w/16 pellets | 1346.6 | ... | ... |
| 4 pellets | 330.0 | 0.33 | 0.11 |
| 8 pellets | 661.5 | 0.66 | 0.22 |
| 16 pellets | 1332.1 | 1.33 | 0.44 |

**a- Average weight of the total number of pellets added to each of three replicate jars.**
**b Average weight of chlorpyrifos contained in the total number of pellets added to each of three replicate jars.**

## RESULTS

### Laboratory evaluation of selected polyethylene formulations of *chlorpyrifos:*

**Laboratory Tests-Formulations And Dosages:**

Results of treatments with the series of 9.4 percent chlorpyrifos formulations are shown in Table 4.

Results in Table (4) showed a both dosages, average 8-week residues increased with each increase in surface to volume ( S/V). At the 1.0 ppm dosage, the 9.4 percent formulations with S/V equal to 3.75 and 4.50 produced average 8-week residues which did not differ from each other, but which were significantly higher than those produced by the 9.4 percent formulations with S/V equal to 3.12 . The 9.4 percent formulation with S/V equal to 5.00 produced an average 8-week residue which was significantly higher than all other formulations. At the 2.0 ppm dosage, the 9.4 percent formulations with S/V equal to 3.12, 3.75, and 4.50, showed average 8-week residues which increased significantly with each increase in S/V. The average 8-week residue for the 9.4 percent formulation with S/V equal to 5.00 was significantly higher than all other 9.4 percent formulations, except the one with S/V equal to 4.50. Results of treatments with the series of 15.0 percent chlorpyrifos formulations

are shown in Table 4. Each increase in S/V resulted in an increase in average 8-week residue. At the 1.0 ppm dosage, the 15.0 percent formulations with S/V equal to 3.12, 3.75, and 4.50 produced average 8-week residue which increased significantly with each increase in S/V. The average 8-week residue for the 15.0 percent formulation with S/V equal to 5.00 was significantly higher than all other 15.0 percent formulations, except the one with S/V equal to 4.50. At the 2.0 ppm dosage, average 8-week residues increased significantly with each increase in S/V. For each formulation (both the 9.4 and the 15.0 percent series) the average 8-week residue at the 2.0 ppm dosage was significantly above the average for the 1.0 ppm dosage.

**Table 4 : Effects of formulation and dosages on 8 week average residues maintained in water treated with polymer formulations of chlorpyrifos .**

| Formulation[a] | 1.0 ppm dosage | 2.0 ppm dosage | S/V |
|---|---|---|---|
| **9.4 percent series** | | | |
| M-3460 | 38.0 ab | 57.8 cd | 3.12 |
| DB-4758-II6A | 57.3 cd | 91.3 f | 3.75 |
| DB-4758-II6B | 64.4 de | 115.6 h | 4.50 |
| DB-4758-II6C | 104.1 g | 122.1 hi | 5.00 |
| **15.0 percent series** | | | |
| DB-I-4758-II4 | 32.2 a | 43.9 b | 3.12 |
| DB-4758-II6D | 48.4 bc | 72.2 e | 3.75 |
| DB-4758-II6E | 69.4 e | 93.7 fg | 4.50 |
| DB-4758-II6F | 71.7 e | 126.8 i | 5.00 |

a Coded designations provided by Dow Chemical Company .
b Values represent ppb chlorpyrifos : those followed by a common letter do not differ significantly at the 0.01 level of probability .

**Laboratory Tests-Percent Composition.**

At equivalent pellet sizes, the average 8-week residues produced by the 9.4 percent and 15.0 percent formulations did not differ significantly from each other (Table 5). However, at each pellet size, the average residues for the 15.0 percent formulations was always below that of the 9.4 percent formulations.

**Table 5: Effects of percent composition on 8 week average residues maintained in water treated with polymer formulations of chlorpyrifos .**

| Formulation[a] | Percent chlorpyrifos | S/V | 8-week average residue |
|---|---|---|---|
| M-3460 | 9.4 | 3.12 | 47.9 a |
| DB-4758-114 | 15.0 | 3.12 | 38.0 a |
| DB-4758-116A | 9.4 | 3.75 | 74.3 b |
| DB-4758-116D | 15.0 | 3.75 | 60.3 ab |
| DB-4758-116B | 9.4 | 4.50 | 90.1 cd |
| DB-4758-116E | 15.0 | 4.50 | 81.6 bc |
| DB-4758-116C | 9.4 | 5.00 | 113.1 d |
| DB-4758-116F | 15.0 | 5.00 | 99.2 cd |

a Coded designations provided by Dow Chemical Company .
b-Values represent ppb chlorpyrifos : those followed by a common letter do not differ significantly at the 0.01 level of probability

**Laboratory Tests-Weeks After Treatment.**

Effects of week after treatment on average residue levels are shown in Table 6. For each dosage, average weekly residues increased significantly through week 4, then leveled off through week 7. A second significant increase occurred at week 8 for both dosages. The average 8-week residues for the 1.0 and 2.0 ppm dosages (60.7 ppb and 90.4 ppb, respectively) differed significantly. The average weekly residues for the 1.0 and 2.0 ppm dosages differed from each other during all weeks except week 1. Specific average weekly residues maintained by each formulation, at each dosage, are shown in Figures 1 and 2 .

**Table (6): Effects of week after treatment on average residiues maintained in water treated with polymer formulations of chlorpyrifos**

| Week after Treatment | Average chlorpyrifos residue (ppb)[a] | |
|---|---|---|
| | 1.0 ppm dosages | 2.0 ppm dosages |
| 1 | 28.0 a | 37.0 ab |
| 2 | 38.0 ab | 62.0 c |
| 3 | 47.8 b | 76.2 de |
| 4 | 72.5 cd | 103.3 f |
| 5 | 73.8 d | 104.7 f |
| 6 | 68.3 cd | 104.8 f |
| 7 | 72.0 cd | 114.6 fg |
| 8 | 85.1 e | 120.8 g |
| Average b | 60.7 | 90.4 |

**a- Average followed by a common letter do not differ significantly at the 0.01 level of probability .**

**b- These averages (60.7 and 90.4 ) differ significantly at the 0.01 level of probability .**

**Effect of continuous low-level chlorpyrifos residues on the development of populations, *Culex pipiens quinquefasciatus:***

**Preliminary Biological Response Tests :**

Estimated numbers of 1st instar larvae which hatched into the test jars are shown in Table 7. The presence of low-level chlorpyrifos residues had no apparent effect on percent hatch, and it was decided that subsequent tests would be conducted by introducing newly-hatched 1st instar larvae, rather than egg rafts, into the jars. Table 8 shows that relative numbers reaching the pupal and adult stages were each inversely proportional to the dosage (i.e., the number 0.1 percent chlorpyrifos pellets, and presumably the chlorpyrifos concentration, in the jars). At each dosage, there were no significant effects on sex ratio and the differences emerging as adults were not significant. It was decided that in subsequent tests, a determination of the relative number pupating would, in itself, be adequate to measure the effects of the low-level chlorpyrifos residues.

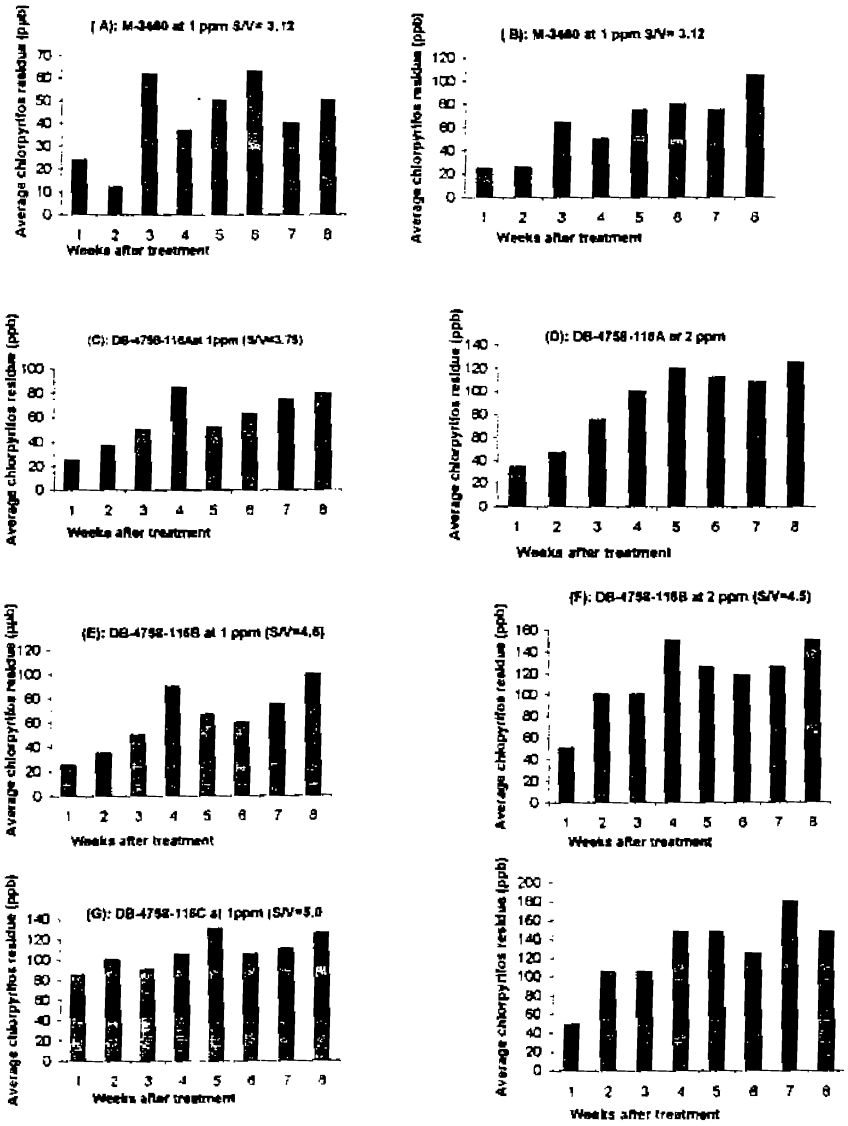



Fig. 1: Average weekly residues observed in laboratory jars dosed at 1.0 and 2 ppm withchlorinated polyethylene pellets containing 9.4% chlorpyrifos and having various surface to volume ratios

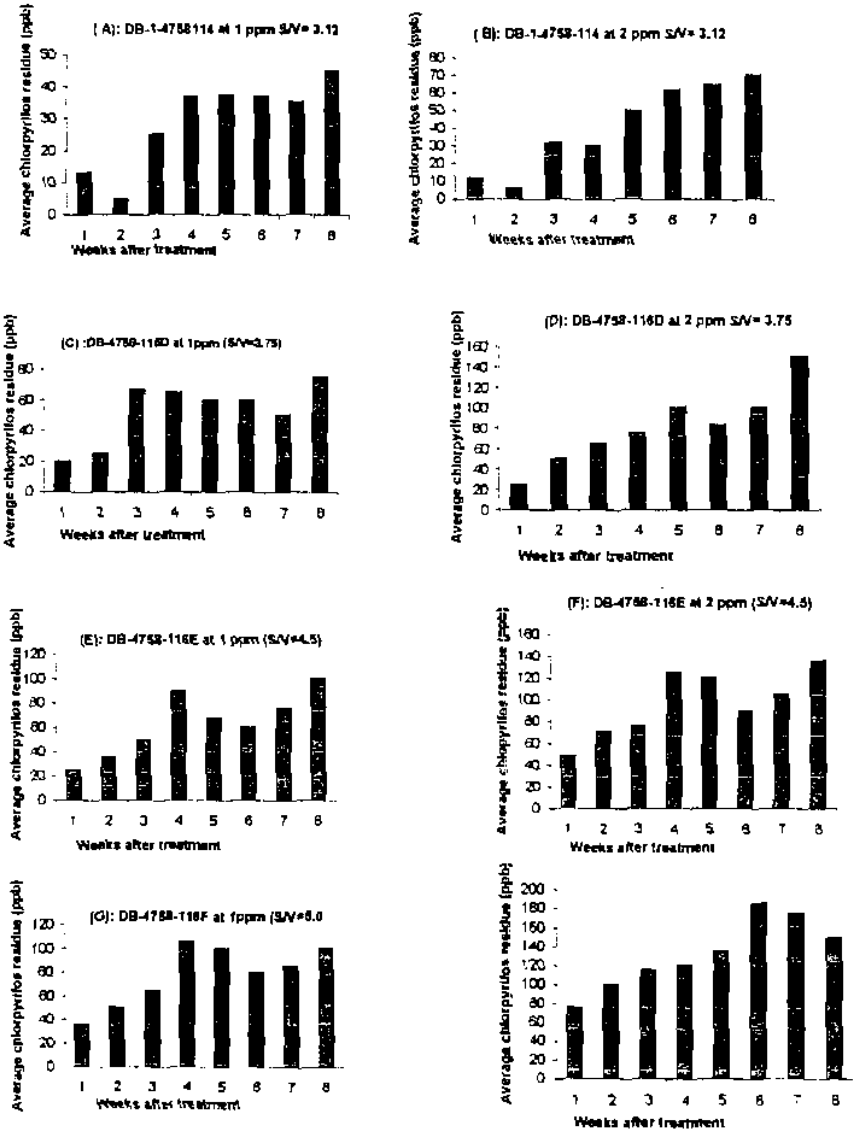



Fig. 2: Average weekly residues observed in laboratory jars dosed at 1.0 and 2 ppm withchlorinated polyethylene pellets containing 15% chlorpyrifos and having various surface to volume ratios

**Table 7: Estimated numbers of 1st instar *C.p quinquefasciatus* larvae hatched into test jars**

| Total number of eggs [a] | | | | | |
|---|---|---|---|---|---|
| Test jar type | Originally added | Recounted | Hatched on recount | Estimated percent [b] hatched | Estimated larvae [c] hatched |
| Control w/pellets | 1208 | 1082 | 956 | 88.3 | 1066 |
| 1 pellet | 1199 | 1102 | 1039 | 94.2 | 1129 |
| 4 pellet | 1037 | 933 | 731 | 78.3 | 812 |
| 8 pellet | 1092 | 947 | 580 | 61.2 | 668 |
| 16 pellet | 991 | 934 | 714 | 76.4 | 757 |
| 32 pellet | 1065 | 1032 | 913 | 88.4 | 941 |

a- Total of two tests of three replicates each .
b -Estimated Percent Hatched = Total Eggs Hatched on Recount/Total Eggs Recounted.
c -Estimated Larvae Hatched = Total Eggs Originally Added x Estimated Percent Hatched.

**Table 8 : Pupation and adult emergency by *C.pipiens quinquefasciatus* reared in test jars containing various numbers of 0.1 % chlorpyrifos PVC pellets *.**

| Test jar type | Estimated larvae hatched | Total Number pupating | Total number of adults emerging | | |
|---|---|---|---|---|---|
| | | | Male | Female | Both |
| Control w/32 pellets | 1066 | 817 | 405 | 355 | 760 |
| 1 pellet | 1129 | 892 | 398 | 385 | 783 |
| 4 pellets | 812 | 388 | 186 | 180 | 366 |
| 8 pellets | 668 | 229 | 103 | 122 | 225 |
| 16 pellets | 757 | 66 | 37 | 29 | 66 |
| 32 pellets | 941 | 0 | 0 | 0 | 0 |

*All data represent two tests of three replicates each.

**Comparative chlorpyrifos residue and biological response tests**

Average numbers pupating were inversely proportional to the number of 0.1 percent chlorpyrifos pellets in the jars (Table 9). Average chlorpyrifos residues in the treated jars were proportional to the number of pellets

**Table 9: Pupating by C.*Pipiens quinquefasciatus* reared in test jars containing various low-level chlorpyrifos residues ***

| Test jar type | Total larvae added | Total number pupating | Average chlorpyrifos residue (ppb) |
|---|---|---|---|
| Control w/o pellets | 900 | 875 | ------- |
| Control w/16 pellets | 900 | 838 | ------ |
| 4 pellets | 900 | 442 | < 0.10 |
| 8 pellets | 900 | 198 | 0.14 |
| 16 pellets | 900 | 2 | 0.32 |

*All data represent three tests of three replicates each.

## DISCUSSION

**1- Laboratory evaluation of selected polyethylene formulations of chlorpyrifos:**

For the formulations evaluated in the laboratory, average chlorpyrifos residues maintained in water increased significantly with time after treatment, and significantly higher chlorpyrifos residues occurred in water whenever dosage or surface to volume (S/V )were increased. The effects of increasing S/V were in agreement with the theoretical considerations discussed earlier (Stockman *et al.*, 1970). The increases in residues which occurred with increased dosage were also expected. The fact that the 9.4 percent formulations consistently maintained residues greater than those for the 15.0 percent formulations may be explained on the basis of the formulations not differing sufficiently in percent composition. At equivalent particle sizes and dosages (i.e., active ingredients) the total amount of 15.0 percent formulation added to the test jars was approximately half the total amount added for the 9.4 percent formulation. This means that the total surface area of the 15.0 percent treatments was also half that of comparative 9.4 percent treatments. As discussed earlier, increases in surface area result in geometric increases in release rate, while increases in percent composition result in linear increases in release rate. It appears that, with two percentages evaluated in this study, relative surface area was more influential than relative percent composition. It also appears, on a theoretical basis, that increases in percent composition would not result in correspondingly higher residues, unless formulations were dosed on the basis of equivalent total amounts rather than equivalent active ingredients.

**2- Effect of contluous low-level chlorpyrifos residues on the development of populations, *Culex pipiens quinquefasciatus (Say)***

The effectiveness of continuous low-level chlorpyrifos residues is shown in Figures 3 through 6 as the percent of the various test populations reaching the pupal or adult stage, and as the corrected percent control 5 of the pupal or adult populations. In both the preliminary tests (Figure 4) and the comparative tests (Figure 5) the number of individuals reaching the pupal or adult stages was inversely proportional to the number of 0.1 percent chlorpyrifos pellets. Figure 5 shows that 0.00 percent of the test population survived in jars containing an average chlorpyrifos residue of 0.23 ppm, 22.0 percent survived in jars containing an average of 0.14 ppb chlorpyrifos, and 49.1 percent survived in jars containing an average chlorpyrifos residue of < 0.10 ppb. In terms of corrected percent control, the preliminary tests (Figure 3) showed that the control of pupal and adult populations was proportional to the number of 0.1 percent chlorpyrifos pellets. In the comparative tests (Figure 6) control of pupal populations averaged 47.3 percent in jars containing average chlorpyrifos residues < 0.10 ppb, 76.2 percent in jars containing average chlorpyrifos residues of 0.14 ppb, and 99.7 percent in jars higher than those which be expected at the respective residue levels.

Fig. 3: Corrected percent control of *C.p. quinquefasciatus* reared in test jars containing various numbers of 0.1% chlorpyrifos PVC pellets

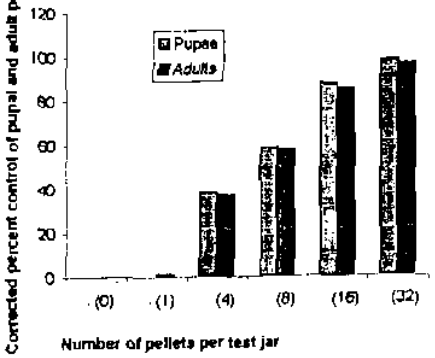



Fig. 4: Percent pupation and adultemergence by *C.P quinquefaciatus* populations reared in test jars containing various numbers of 0.1% chlorpyrifos PVC pellets

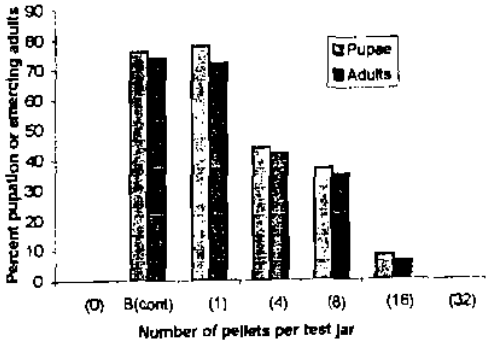



Fig. 5: Percent pupation by *C.P. quinquefaciatus* populations reared in test jars containing various continuous low-level concentrations of chlorpyrifos

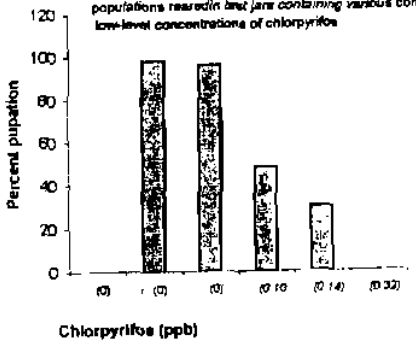
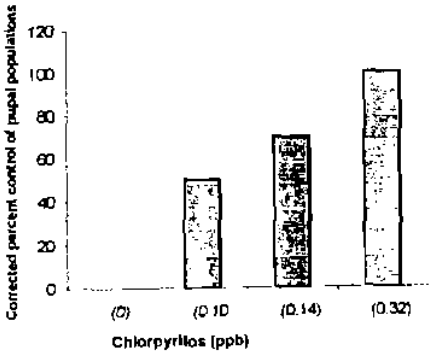



Fig. 6 Corrected percent control of *C.P.quinquefasciatus* populations reared in test jars containing various continuous low-level concentration of chlorpyrifos



Also various levels of control were achieved in the laboratory, when *Culex pipiens quinquefasciatus* populations were reared in water containing continuous low-levfel concentrations of chlorpyrifos; 47.0 percent control at < 0.10 ppb; 76.2 percent control at 0.14 ppb; and 99.7 percent control at o.32 ppb. Although control of the laboratory populations was achieved by exposure to the various continuous low-level concentrations, the residue levels (.0.10 – 0.32 ppb) were not considered sufficiently below the established $LC_{90}$ (0.9 ppb) to be significant from the standpoint of possibly reducing necessary field dosages.

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## تأثير تجهيزات مبيد الكلوربيريفوس مع البوليمرز البولى ايثيلين المكلور والبولى فينيل كلوريد على تطور حياة بعوضة الكيولكس Culex pipiens quinquefasciatus (Say) فى المعمل

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شملت هذه الدراسة جزئين :

١ – تقييم تجهيزات مبيد الكلوربيريفوس مع البوليمرز البولى ايثيلين المكلور والبولى فينيل كلوريد والمجهز فى صورة أقراص من حيث متبقى residue المبيد فى الماء لمدة ثمانية أسابيع وتأ ثير حجم الحبيبات على هذا المتبقى معمليا – قتم دراسية ثمانية تجهيزات ذات أحجام مختلفة وكل واحدة ذات تركيزين من المبيد ١ ، ٢ جزء فى المليون ( ppm) .

٢– دراسة تأثير التركيزات المنخفضة low-level concentrations لتجهيزات مبيد الكلوربيريفوس مع البوليمرز البولى ايثيلين المكلور والبولى فينيل كلوريد على تطور حياة بعوضة الكيولكس Culex pipiens quinquefasciatus (Say) فى المعمل من وقت الفقس حتى الوصول الى طور الحشرة الكاملة ؛ وتتلخص النتائج فى آلاتي :

وجد من الدراسة فى الجزء الأول أن متبقى residues المبيد يزيد بداية من الأسبوع الرابع حتى الأسبوع الثامن زيادة معنوية وأن تجهيزة المبيد التى تحتوى على تركيز ٢ جزء فى المليون (2 ppm) أعطت جرعة من متبقى المبيد أكبر معنويا من تجهيزة المبيد والتى احتوت على واحد جزء فى المليون (1 ppm) وكانت الفروق معنوية فيما عدا الأسبوع الأول بعد المعاملة.

ومن الدراسة فى الجزء الثانى وجد أن التركيزات المنخفضة والتى كانت ال $LC_{50}$ لها ( 0.9 ppb ) وكانت تحتوى على( 0.1 % ) من مبيد الكلوربيريفوس كان تأثيرها على تطور حياة بعوضة الكيولكس *Culex pipiens quinquefasciatus (Say)* هو :

فى اناء الاختبار الذى يحتوى على متبقى من مبيد الكلوربيريفوس أكبر من واحد جزء فى البليون (1 ppb) كانت النسبة المئوية فى مكافحة البعوضة ٤٧،٣ % وأن الاناء الذى احتوى متبقى من المبيد ٠،١٤ جزء فى البليون كانت النسبة المئوية ٧٢،٢ % والاناء الذى احتوى على ٠،٣٢ جزء فى البليون أعطى ٩٩،٧ % فى مكافحة أطوار حياة البعوضة.