Proceedings of the 16th International Pepper Conference
Tampico, Tamaulipas, Mexico. November 10 – 12, 2002

RATIONAL USE OF LOW RISK INSECTICIDE MIXTURES AGAINST CHEWING AND SUCKING INSECT PESTS: LEVERAGE (IMIDACLOPRID + CYFLUTHRIN)

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In Mexico, during the last two decades, there was a negative attitude toward the use of insecticides in mixture against insect pest of cultivated plants, due to the false assumption that they accelerate the rate at which pest populations develop multiple resistance. However, it is recognized that the use of mixture constitute a complex and delicate activity because some important factors should be understood before using them: degree of compatibility among components of the mixture, biological efficacy, relative proportions of toxicants in the mixture, damage to crop, pest susceptibility to all components in the mixture, and risk to human health and environment.

To use a mixture, there must be physical, chemical and biological compatibility among all the components (Wadley, 1945; Sun and Johnson, 1960). Otherwise the level of control will decrease; and more important, the risk to human health could increase dramatically.

Physical compatibility: the mixture should not produce any gelling, curdling, or separation of products. A non-compatible mixture may clog nozzles or produce an heterogeneous mixture, then causing damage to crop and high human health risk when applying the most concentrated part; or low control when applying the least concentrated one. Unfortunately, sometimes is not easy to detect some of these problems in advance.

Chemical compatibility: this type of interaction is practically impossible to detect by farmers. Some undesirable compounds may be produced when mixture components are no compatible. The consequences may be enormous: lack of control, economic losses and more important, the potential risk of being exposed to carcinogenic substances.

Biological compatibility: There are three types of biological interactions in a mixture of insecticides: antagonism, similar action and potentiation (Lagunes, 1980). When antagonism is observed, the effectiveness of the mixture is lower to the sum of the effectiveness of all the components considered separately. Lack of control usually implies more spraying, thus increasing economic cost and delivering unnecessary amounts of toxicants to the environment.

When a mixture exhibits similar action, the biological efficacy of the mixture is similar to the sum of the biological efficacy of the components used alone. Most of the insecticide mixtures fall in this category (Carrillo 1984).

Potentiation implies higher toxicity of mixture in comparison to the toxic effect that is predictable from the separate action of each component. The mechanisms by which one component enhances the toxicity of the other, and vice versa, have not been clearly explained; however, some of the possibilities have been discussed by several authors (Bliss 1939; Hewlett and Plackett 1952, 1964; Sakai 1969). The most obvious benefit of potentiation would be: a) reduction in the total amount of insecticides used, b) delay in the appearance of resistance if the target pest is fully susceptible to all toxicants in the mixture. Unfortunately, there are few pairs of compound that exhibit this phenomenon.

Aside from the degree of physical, chemical and biological compatibility, one wonders about the best proportion of component "A" and component "B" in the mixture. Usually, farmers use intuition to determine these values and this action is far from the best option. In addition, the biological interactions among components in mixture may change according to the relative proportion used. It is possible to observe antagonism, similar action or potentiation at different proportions in the mixture or at different levels of mortality (Bliss, 1939; Gallegos, 1982). To determine the best relative proportion, a detailed research in both laboratory and field, should be conducted.

We considered two types insecticide mixtures: field mixture and factory mixtures. Regardless of the mixture type, all the components must have different mode of action and different detoxification routes (Mani 1985).

Field or tank mixtures: they are prepared in the field directly by farmer little time before using them. This type of mixture implies several problems. Firstly: it is common that farmers lack of information about the compatibility level of the components. Secondly: usually there is no idea about the most adequate proportion of the components; consequently the used proportions arise from intuition and ignorance. Thirdly: the amount of diluents in the tank increases; for example, suppose that one liter of insecticide "A" and one liter of insecticide "B" is mixed in a tank and that each one contains 650 mL of diluents; then the amount of diluents is duplicated. In consequence, the crop is receiving an overdose of diluents without having any idea about its consequences on produce quality or any negative interaction with the toxicants when there is no compatibility. The problem becomes more complicated because mixing toxicants generally implies certain order. For example Bohmont (1990) provide some suggestions.

1. Dry materials should be added before liquids.
2. If a dry floable (DF) or water-dispersible granules (WDG) are involved, they go second.
3. Liquid floables should be added third (except when using Furadan 4F, this material should be put in last).
4. Emulsifiable concentrates (EC), should be combined last.

In many situations, it is not possible to follow these rules because of the lack of precise information. To avoid unnecessary complications, it is better to use factory mixtures because government regulations usually obligate chemical companies to prepare mixtures in a compatible manner.

We introduce in this document a classification of mixtures based on the risk of developing resistance: low risk and high risk insecticide mixtures. A high risk mixture is used to control the same biological stage and type of insect species. This type of mixture is justified only when the target population is fully susceptible to all toxicants in the mixture; otherwise a useless compound is being sprayed and the biological efficacy may be masked by the effective one.

Low risk mixtures: they are used against two different insect pests such as chewing + sucking individuals. The compound "A" controls chewing insects and the compound "B" controls sucking insects. In addition, the compound "A" may interfere with the normal physiology of sucking pests, making them more susceptible to compound "B" and vice versa; thus potentiation is observed. Benefits to farmers increase when low risk formulations are made by reputable chemical companies. This is the case of LEVERAGE®

(ciflutrina + imidacloprid) in which all components are highly compatible in the formulated mixture. Cyfluthrin controls mainly chewing insects and the imidacloprid exert control mainly against sucking insects. The positive interactions between imidacloprid and cyfluthrin in this high quality mixture allow the use of lower amount of insecticides to control both type of insect pests. In consequence, when chewing and sucking pests coexists, farmers are able to control them at a low er economic cost. To demonstrate the benefits of using LEVERAGE® (ciflutrina + imidacloprid), we evaluate the field efficacy of this mixture against *Myzus persicae* (Sulzer) and *Spodoptera exigua* (Hübner) in Jalapeño Chili. This study was carried out in Guasave, Sinaloa, Mexico during 2000. LEVERAGE was evaluated to three dosages (200, 250 and 300 mL/ha), imidacloprid (CONFIDOR® 25 CS) at the dosage of 110.85 mL/ha, and cyfluthrin (BAYTROID® 50 EC) at the dosage of 536 mL/ha, plus an untreated check. The dosage of imidacloprid and cyfluthrin were used at the same proportion as they exist in LEVERAGE, 200 mL/ha; this values are below the commercial rates.

A random block design with three replications was used. The experimental unit consisted of five beds of double row (1.80 m of distance between beds) by 5 m long (45 m^2). The sampling plot was constituted by the three central beds, excluding 0.5 m to each extreme. The evaluated variables were number of aphids in a random sample of five plants, the number of *Sopodptera exigua* larvae in to segments of 0.5 x 1.0 m (larvae that fell upon shaking the adjacent foliage), and toxicity to plant. Spraying was repeated at interval of seven days. To achieve normality, the measured variables were transformed, before statistical analysis, to its log10(x+1) function and submitted to an analysis of variance (ANOVA, = 0.05). Then, data were subjected to a multiple test of comparison (TUKEY, = 0.05). No toxic effects were observed on chili plants.

Efficacy against *Sopodptera exigua* larvae: imidacloprid did not control this species. However, cyfluthrin exerted an 86.5% control. LEVERAGE at the dosage of 200 mL/ha showed a significantly higher field efficacy (100%) than its components used separately. Leverage at the medium and high dosage produce 100% efficacy (Figure 1).

Efficacy against *Myzus persicae*: Imidacloprid showed 75.4% of efficacy and cyfluthrin 67.7%. When both compounds are mixed as the same rate, as happens in LEVERAGE (200 mL/ha), the efficacy increases up to 90.8%. The medium (250 mL/ha) and high dosage (300 mL/ha) of LEVERAGE gave and efficacy of 95.4 and 100%, respectively (Figure 2).

Similar results were observed in red tomato and potato against the same species of insect pests. This data reveal the usefulness of LEVERAGE in comparison of its components used separately. The LEVERAGE formulation is prepared in such a way that all types of compatibilities are optimized and experience have shown that is not possible to achieve the same results by mixing in the field CONFIDOR® and BAYTROID® at the proportions found in this mixture.

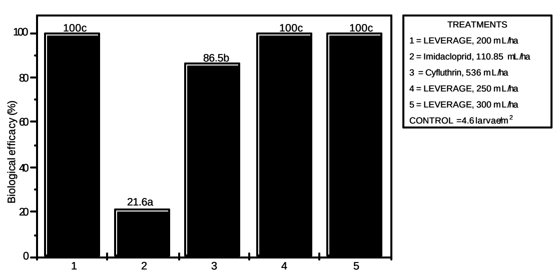

Figure 1. Biological efficacy ,14 days after treatment, of several insecticides against *Spodoptera exigua* (Hübner). Parameter: total number of larvae in a sample of two m^2 per plot Jalapeño Chili. Imidacloprid and cyfluthrin were used at the same rate they are in LEVERAGE, 200 mL/ha. Letter on top of the bar indicate statistical significance (Tukey, a=0.05). Guasave, Sinaloa, Mexico. March 2000.

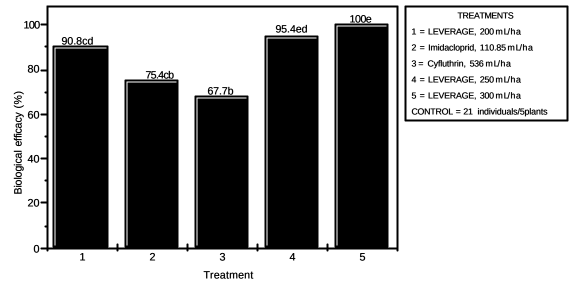

Figure 2. Biological efficacy ,14 days after treatment of several insecticides against *Myzus persicae* (Sulzer). Parameter total number of individuals in a random sample of five plants. Jalapeño Chili. Imidacloprid and cyfluthrin were used at the same rate they are in LEVERAGE, 200 mL/ha. Letter on top of the bar indicate statistical significance (Tukey, a=0.05). Guasave, Sinaloa, Mexico. March 2000.

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