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Effect of Tank-Mix Adjuvants on the Efficiency of Chlorpyrifos and Cyhalothrin Formulations against Cotton Bollworms

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ABSTRACT

Reduction infestation percentages of spiny bollworm (SBW), *Earias insulana* (Boisd.), and pink bollworm (PBW), *Pectinophora gossypiella* (Saund.), on cotton treated with some chlorpyrifos and cyhalothrin formulations alone or/and mixed with Top Film or Tritone K adjuvants were investigated under field conditions. Adjuvants/insecticides mixtures enhanced the reduction percentages of *E. insulana* infestation, compared with individually applied insecticides. Mixtures of Top Film with chlorpyrifos or cyhalothrin formulations gave the highest reduction percentages of infestation, where general reduction average ranged between 81% and 89.7%, and between 86.5% and 93.2%, respectively. Moreover, Tritone K mixed with cyhalothrin formulations displayed adequate infestation reduction, as general reduction averages ranged between 80.6% and 88.1%. In general, tank mixing of both adjuvants with cyhalothrin formulations enhanced the efficiency of formulation greater than mixing adjuvants with chlorpyrifos formulations against *E. insulana*. On the other hand, the infestation percent of *P. gossypiella* was lower than that of *E. insulana* in untreated cotton plants. The formulations alone or their mixtures with adjuvants gave good reduction of infestation, where the general reduction averages ranged between 88% and 93.5%, and between 70.6% and 87.1% for formulations/adjuvants mixtures and formulations alone, respectively.

Keywords: Chlorpyrifos, Cyhalothrin, adjuvants, formulation, *Earias insulana*, *Pectinophora gossypiella*, efficiency

INTRODUCTION

The activity of pesticide formulations can be improved substantially by the addition of certain biologically inactive ingredients, known collectively as adjuvants. Such products may be built into a formulation at the time of manufacture or used separately for tank mixing with a formulation prior to spray application. Adjuvant choice varies according to the properties of the pesticide, its mode of action and the type of formulation, as well as the nature of the intended target (Holloway, 1998).

Adjuvants increase the efficiency of pesticides by ensuring better leaf spreading/wetting and leaf penetration, by enhancing deposition on plants and by prolonging the protection of plants (Beck et al., 2012). They can also reduce the amount of active ingredients applied. They can diminish drift of active ingredients and reduce off-target movement (Ryckaert et al., 2007).

Cotton is one of the major fibre crops of global importance. It is cultivated in tropical and subtropical regions of more than eighty countries of world occupying nearly 33 million hectare with an annual production of 19 to 20 million tons of bales. China, USA, India, Pakistan, Uzbekistan, Australia, Brazil, Greece, Argentina and Egypt are major cotton producing countries. These countries contribute nearly 85% of the global cotton production (Mayee et al., 2001).

In Egypt, cotton is attacked by numerous pests. However, the most distractive insects are Egyptian cotton leafworm, *Spodoptera littoralis* (Boisd.), spiny bollworm, *Earias insulana* (Boisd.) and pink bollworm, *Pectinophora gossypiella* (Saund.). These three insect species cause a severe reduction in cotton yield and quality (Emara, 1999; Hosny et al., 1986; Lohag and Nahyoon, 1995).

The objectives of this study were to evaluate the efficiency of some chlorpyrifos and cyhalothrin formulations against *E. insulana* and *P. gossypiella,* and examine the effect of adjuvants (Top Film and Tritone K) on the efficacy of the these formulations.

MATERIALS AND METHODS

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1. Insecticides:

2.1. Chlorpyrifos

Common name: Chlorpyrifos, Chemical name: O,O-diethylO-(3,5,6-trichloro-2-pyridinyl) phosphorothioate, Rate/Feddan: 1 L. Two commercial formulations (Dursban H (Dow Chemical Company, Midland, USA) and Pyrifos El Nasr (El Nasr Company for Intermediate Chemicals, Cairo-Alexandria Desert Road km 28, Industrial Area, Abou-Rawash, Giza) of chlorpyrifos (48% EC) were purchased and used in this study.

2.2. Cyhalothrin

Common name: Cyhalothrin, Chemical name: (S)-α-cyano-3-phenoxybenzyl (Z)-(1R,3R)-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate, (R)-α-cyano-3-phenoxybenzyl(Z)-(1S,3S)-3-(2-chloro-3,3,3-rifluoroprop-1enyl)-2,2-dimethylcyclopropanecarboxylate, Rate/Feddan: 400 cm^3. Two commercial formulations (Halothrin Gold El Nasr (El Nasr Company for Intermediate Chemicals, Cairo-Alexandria Desert Road km 28, Industrial Area, Abou-Rawash, Giza) and Lambada Mox (Alexandria for Chemicals Company-AREX. Kilo 33 Alexandria-Cairo Desert Highway, Amiriyha, Alexandria) of cyhalothrin (5% EC) were supplied by pesticide companies.

2. Adjuvants:

Two spreading and sticking materials (Top Film (El-Helb Misr for Pesticides and Chemicals Company, Industrial Zone Area-Near Arab Contractors, New Damietta City) and Tritone K (Chema Industries, 37 Victor Emmanuel Sq., Smouha, Alexandria) were used at 30 cm^3/100 L water were used as tank-mixtures.

3. Design of experiments

The experiments were conducted at Faculty of Agriculture Farm, Abees, Alexandria Governorate to evaluate the efficiency of tested insecticide formulations and adjuvant mixtures against *E. insulana* and *P. gossypiella*. The field area was cultivated with Giza-86 cotton variety during 2010 and 2011. The experimental area was about 1.75 feddan. The area of each plot was 42 m^2. The treatments were arranged in randomized complete blocks design (RCBD) with four replicates in each treatment. The application of the formulations was carried out by using Knapsack sprayer (CP-3) equipped with one nozzle. Each replicate was thoroughly sprayed with 6 liters of each formulation dilution. Control plants were sprayed with an equal volume of water.

4. Efficiency of insecticides formulations against *Earias insulana* and *Pectinophora gossypiella*.

One hundred of green bolls were collected before treatment and continued at weekly intervals after treatment till the last application. The formulations were sprayed four times every two weeks. Samples were taken randomly from both diagonals of the inner square area of each treatment according to the method of Shaaban and Radwan (1974). Samples were kept in tightly closed cloth tissue bags and transferred to the laboratory for examination. The bolls were inspected and dissected to determine the larval population density of both bollworms as well as the percent of infestation of bolls at the same day of sampling. The reduction percents of bollworm infestation were calculated according to Henderson-Tilton equation (Henderson and Tilton, 1955) as follow:-

$$\% \text{ Reduction} = [1- (T_a \times C_b/T_b \times C_a)] 100$$

Where:

T_a and T_b: No. of alive larvae/100 bolls in the treatment after and before application, respectively.

C_b and C_a: No. of alive larvae/100 bolls in check before and after application, respectively.

5. Statistical analysis

Statistical design was a randomized complete block design (RCBD). Data were subjected to one-way analysis of variance followed by Student–Newman–Keuls test; Cohort software Inc. (Anonymous, 2004) to determine significant differences among mean values at the probability levels of 0.01.

RESULTS AND DISCUSSION

1. Efficiency of insecticides and their mixtures with adjuvants against *E. insulana*

The reduction percentages of *E. insulana* infestation on cotton treated with different insecticides and their mixtures with adjuvants in season 2010 are shown in Table 1. The results revealed that all tested insecticides reduced the infestation percent of *E. insulana* compared with control. On the other hand, reduction percentages of Top Film and Tritone K were zero after 1st, 2nd, 3rd and 4th sprays. It is worth mentioning that, the insecticides were less effective in reduction of infestation than insecticides mixed with adjuvants. According to general reduction average, Top Film and Tritone K mixed with cyhalothrin formulations gave the highest reduction percentages of infestation, followed by Top Film mixed with Dursban as reduction percent of infestation ranged between 88.1% and 93.2%. However, there were no significant differences between these treatments. Cyhalothrin formulations (Lambada Mox and Halothrin Gold El Nasr) exhibited the lowest efficacy with 78.5% and 72.9% infestation reduction, respectively.

Reduction percentages of *E. insulana* infestation on cotton treated with different insecticides/adjuvant mixtures in season 2011 are shown in Table 2. All tested insecticides reduced the number of *E. insulana* infestation. Reduction of the general average of infestation after four sprays revealed that Top Film mixed with either chlorpyrifos or cyhalothrin formulations gave the highest reduction percentages of infestations as well as Tritone K mixed with cyhalothrin formulation, which ranged from 80.6 to 91.5%. On the other hand, cyhalothrin formulations alone (Lambada Mox and Halothrin Gold El Nasr) caused the lowest reduction of infestation (70.8% and 66.6%, respectively).

It could be concluded that, all tested insecticides reduced infestation of *E. insulana* population. Top Film mixed with chlorpyrifos or cyhalothrin formulations gave the highest reduction percentages of infestation as well as Tritone K mixed with cyhalothrin formulations. However, cyhalothrin formulations alone revealed the lowest reduction of infestation. These results are in agreement with those of other researchers. For example, Mahar et al. (1987) reported that fenpropathrin and chlorpyrifos gave a pronounced reduction in *Earias* spp. Mourad et al. (1988) found that spraying profenofos after deltamethrin gave the highest reduction of bollworms infestation. Chlorpyrifos and profenofos showed superiority in infestation reduction of cotton bollworms (Rawale et al., 2002). In addition, Aslam et al. (2004) reported that Lorsban 40% EC (chlorpyrifos) was highly effective against *E. insulana* up to 7 days after treatment. Ali et al. (2005) found that Bifenthrin and cyhalothrin registered lowest number of *Earias* spp. larvae 48 hr after spray. Similarly, Khan et al. (2007) stated that deltaphos and cypermethrin recorded minimum number of larvae (alive) of *E. insulana.* Rodriguez et al. (1966) reported that the use of oil/insecticide spray combinations for the control of the coffee leaf miner lengthen the residual activity of the treatment. In addition, Brady et al. (1980) mentioned that Nu-film and Triton X-100, increased the persistence of chlorpyrifos. Similarly, Wills and McWhorter (1982) stated that adjuvants can be used to increase the bioactivity of pesticides. Moreover, Osipow (1964) indicated that the decrease in surface tension causes an increase in wetting and spreading characteristics. El-Bakry (2013) mentioned that the enhancement of insecticides efficiency caused by adding Top Film or Tritone K adjuvants may be attributed to their effects on increasing atomization and droplet sizes of insecticide, retention of insecticides on the treated surfaces, spreading and coverage of insecticide solutions, uptake and translocation of insecticides and their effect of decreasing the surface tension between insecticide and treated surface.

2. Efficiency of insecticides and their mixtures with adjuvants against *P. gossypiella*

Reduction percentages of *P. gossypiella* infestation on cotton treated with different insecticides and their mixtures with adjuvants in seasons 2010 and 2011 are shown in Tables 3 and 4. It was observed that, the infestation percent of pink bollworm larvae (*P. gossypiella*) was lower than that of spiny bollworm (*E. insulana*) larvae. All tested insecticides reduced the infestation of *P. gossypiella.* The insecticides alone or their mixtures with adjuvants gave good reduction of infestation. The general reduction averages ranged between 76.9 and 93.5% in 2010 and between 70.6 and 89.3% in 2011. These results are in agreement with the findings of Younis et al. (2007) who mentioned that the population of pink bollworm was much lower compared to the spiny bollworm, and also they found that, synthetic pyrethroids exhibited the greatest reduction in bollworms infestation. In addition, El-Sorady et al. (1998) reported that chlorpyrifos and lambda-cyhalothrin gave a pronounced reduction of the pink bollworm infestation. Mahar et al. (2004) stated that chlorpyrifos was more effective up to 3 weeks and caused 71.54% reduction of *P. gossypiella* population. Moreover, Dursban exhibited reduction of infestation (74%) of *P. gossypiella* (Massoud et al., 2009). In addition, Zidan et al. (2012) reported that the insecticides α-cypermethrin, lambda-cyhalothrin, profenophos and chlorpyrifos recorded satisfactory reduction of *P. gossypiella* population with infestation reduction of 81.45, 71.91, 66.75 and 62.58%, respectively. These results indicated that adjuvants enhanced the toxicity of chlorpyrifos and cyhalothrin commercial formulations. It has been reported that adjuvants exhibited potentiation effect on the toxicity of some insecticides such as pirimiphos-methyl, carbosulfan and malathion (El-Sobki, 2010). Similarly, the additive effect of some surfactants on the toxicity of organophosphorous insecticides against *gammarus italicus* were described (Pantani *et al.,* 1990).

In conclusion, the results of this study indicated that the use of adjuvants (Top Film and Tritone K) as tank mixtures increased the efficiency of cyhalothrin and chlorpyrifos commercial formulations. Therefore, it is possible to recommend the use of these adjuvants as tank mixtures with cyhalothrin and chlorpyrifos formulations in cotton bollworms control program in future.

REFERENCES

Ali, M. A., Rehman, R., Tatla, Y. H., Ali, Z., 2005. Efficacy of different insecticides against spotted bollworms (*Earias* spp.) at Karor, Layyah. Pak. Entomol. 27: 1-4.

Anonymous, 2004. Cohort Software Inc. Costat user's manual. Version 6.303. Monterey. California, USA.

Aslam, M., Razaq, M., Rana, S., Faheem, M., 2004. Efficacy of different insecticides against bollworms on cotton. J. Res. Sci. Bahauddin Zakariya Univ. Multan. Pakistan. 15: 17-22.

Beck, B., Steurbaut, W., Spanoghe, P., 2012. How to define green adjuvants. Pest Manag. Sci. 68: 1107–1110.

Brady, U. E., Berisford, C. W., Hall, T. L., Hamiton, J. S., 1980. Efficacy and persistence of chlorpyrifos, chlorpyrifos-methyl and lindane for preventive and remedial control of the Southern pine beetle. J. Econ. Entomol. 73: 639-641.

El-Bakry, A. M., 2013. Studies on formulations, specifications and biological efficacy of certain pesticides. Ph.D. Thesis. Fac. of Agric. Univ. of Alex. Egypt. pp. 125.

El-Sobki, A. E. A., 2010. Enhancement of pesticide activity using certain adjuvants and application systems. PhD Thesis, Department of Plant Protection, Faculty of Agriculture, Zagazig University, Egypt.

El-Sorady, A. E. M., El-Zanan, A. A. S., Abo-Shloa, M. K. A., El-Dahan, A. A., 1998. Influence of some insecticide sequences on natural and artificial infestation with pink bollworm *Pectinophora gossypiella* (Saund.). Egyptian J. Agric. Res. 76: 585-596.

Emara, S. A., 1999. Developmental biology, thermal requirements and prediction models for cotton leafworm, *Spodoptera littoralis* (Biosd) in cotton fields. The 2nd Conf. of Pest Control. Mansoura. Egypt. September: 731-736.

Henderson, D. F., Tilton, E. W., 1955. Tests with acaricides against the brown wheat mite. J. Econ. Entomol. 48: 157-161.

Holloway, P. J., 1998. Improving agrochemical performance: possible mechanisms for adjuvancy. Chemistry and Technology of Agrochemical Formulations. Knowles D. A. Kluwer Academic Publishers. London: 232-263.

Hosny, M. M., Topper, C. P., Moawad, G. G., El-Saadany, G. B., 1986. Economic damage thresholds of *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) on cotton in Egypt. Crop Protec. 5: 100-104.

Khan, R. R., Ahmed, S, Saleem, M. W., Nadeem M., 2007. Field evaluation of different insecticides against spotted bollworms *Earias* spp. at district Sahiwal. Pak. Entomol. 29: 129-133.

Lohag, M. G. M., Nahyoom, Y. M., 1995. Comparative efficacy of Hostathion, Sumicidin and Sevin xl R against cotton bollworms Sarhad. J. Agric. Res. 11: 963-368.

Mahar, A. N., Lohar, M. K., Abro, G. H., 1987. Field evaluation on the efficacy of endosulfan, chlorpyrifos and fenpropathrin against cotton bollworms. Proceedings of Pakistan Congress of Zoology. publ. 1991. No. 7. 113-118.

Mahar, A. N., Munir, M., Darban, D. A., Mahar, A. Q., Markhand, G. S., 2004. Field evaluation of different insecticides against pink bollworm on four cotton varieties in Sindh, Pakistan. Indus Cottons. 1: 65-72.

Massoud, M. A. Z., Ibrahim, M. M., Shekeban, M. M, Ebed, H. M., 2009. Effect of three insecticides and two insecticide alternatives on the pink bollworm, *Pectionophora Gossypiella* (Sand.) and quality of cotton yield. Alex. J. Agric. Res. 54: 155-163.

Mayee, C. D., Singh P., Dongre, A. B., Rao, M. R. K., Sheo, R., 2001. Transgenic *Bt* cotton. Central Institute Cotton Res. Nagpur (CICR) Technical Bulletin. No: 22. (www.cicr.org.in.).

Mourad, M. A., Omar, M. E., Mahran, A. A., 1988. Evaluation of sequential use of insecticides against cotton leafworms and bollworms. Agric. Res. Review. 66: 9-17.

Osipow, L. I., 1964. Surface Chemistry. Theory and industrial applications. Reinhold Publ. Crop. New York. pp. 473.

Pantani C., Ghetti, P. F., Cavacini, A., Muccioni, P., 1990. Acute toxicity of equitoxic binary mixtures of some metals, surfactants and pesticides to the freshwater amphipod *gammarus italicus* goedm. Environ. Technol. 11: 1143-1146.

Rawale, B. N., Kausale, P. P., Munde, A. T., Kedar, P. B., Sonkamble, M. M., Waghmode, D. B., 2002. Efficacy of insecticides and neem seed extract against cotton bollworms on NHH-44. J. Soils Crops. 12: 75-77.

Rodriguez, J. G., Campbell, J. M., Evelens, K. G., 1966. Effect of some oil-insecticide combinations on coffee leaf miner. J. Econ. Entomol. 59: 373-379.

Ryckaert, B., Spanoghe, P., Haesaert, G., Heremans, B., Isebaert, S., Steurbaut, W., 2007. Quantitative determination of the influence of adjuvants on foliar fungicide residues. Crop Prot. 26:1589-1594.

Shaaban, A. M., Radwan, H. S., 1974. Population dynamics of the pink bollworm, *Pectinophora gossypiella* (Saund.) in relation to blooming and fruiting curves of cotton plants. Pflanzen Krankheiten. 4: 206-211.

Wills, G. D., McWhorter, C. G., 1982. The effect of adjuvants on biological activity of herbicides. 5th Int. Conf. Pesticide Chemistry. 1: 289-294.

Younis, A. M.., Hamouda, S. H. H., Ibrahim, S. A., Zeitoun, Z. A. M., 2007. Field evaluation of certain pesticides against the cotton bollworms with special reference to their negative impact on beneficial arthropods (2006 cotton season, Minia region, Egypt). African Crop Sci. Conf. Proceedings. 8: 993-1002.

Zidan, N. E. A., El-Naggar, J. B., Aref, S. A., El-Dewy, M. E., 2012. Field evaluation of different pesticides against cotton bollworms and sucking insects and their side effects. J. American Sci. 8: 128-136.

الملخص العربي

تأثير خلط المواد المساعدة في تنك الرش على كفاءة تجهيزات الكلوربيريفوس والسيهالوثرين ضد ديدان اللوز في القطن

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تم تقدير نسب الخفض في الإصابة لكلا من دودة اللوز الشوكية والقرنفلية بعد معاملة نباتات القطن ببعض تجهيزات الكلوربيريفوس والسيهالوثرين مفردة، وخلائطها مع المواد المساعدة من Top Film وTritone K تحت الظروف الحقلية. أظهرت النتائج أن خلط تجهيزات المبيدات مع المواد المساعدة أدت لخفض نسب الإصابة بدودة اللوز الشوكية بالمقارنة بالتجهيزات المطبقة بصورة منفردة. وكانت أفضل النتائج المتحصل عليها عند خلط Top Film مع كلا من تجهيزات الكلوربيريفوس والسيهالوثرين، حيث تراوح متوسط الخفض العام في الإصابة من ٨١-٨٩.٧% و٨٦.٥-٩٣.٢% لـ Top Film خلطا مع كلا من الكلوربيريفوس والسيهالوثرين على التوالي. هذا بالإضافة إلى أن خلط Tritone K مع تجهيزات السيهالوثرين أظهر خفضاً ملموسا في نسبة الإصابة مقارنة بالتجهيزات منفردة، حيث تراوح متوسط الخفض العام في الإصابة من ٨٠.٦-٨٨.١%. بصفة عامة فقد أدى خلط المواد المساعدة في تنك الرش مع تجهيزات السيهالوثرين إلى تحسين الفعالية بدرجة أكبر من خلطها مع تجهيزات الكلوربيريفوس ضد دودة اللوز الشوكية. من ناحية أخرى فقد كانت نسبة الإصابة بديدان اللوز القرنفلية قليلة مقارنة بديدان اللوز الشوكية، وفقد أعطت التجهيزات المطبقة بصورة منفردة أو خلطا مع المواد المساعدة نتائج جيدة في خفض نسبة الإصابة بديدان اللوز القرنفلية، حيث تراوح متوسط الخفض العام في الإصابة من ٨٨-٩٣.٥% ومن ٧٠.٦-٨٧.١% لكلا من التجهيزات خلطا مع المواد المساعدة، والتجهيزات المطبقة بصورة منفردة على التوالي.