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Control of *Sitophilus zeamais* Mots., 1958 and *Sitophilus oryzae* (L., 1763) weevils (Coleoptera, Curculionidae) in stored corn grain (*Zea mays* L.) with insecticide pirimiphos methyl (Actellic 500 CE)

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Abstract

The protection of stored corn grains with the insecticide pirimiphos-methyl was studied. The experiment was conducted at the Ponta Grossa State University, PR, in the 2005/06 season. The treatments tested were: pirimiphos-methyl (Actellic 500 CE), at 4, 8, 12, 16 and 32 mL c.p./ton (commercial product) (2, 4, 6, 8 and 16 ppm); bifenthrin (Prostore 25 CE), at 16 mL c.p./ton (0,4 ppm); deltamethrin (K-obiol 25 CE), at 20 mL c.p./ton) (0,5 ppm) and Control. Each plot consisted of a glass bottle filled with grains of corn treated with the insecticides. Each plot was infested with 20 non-sexed adults of the weevils *Sitophilus Zeamais* and *S. oryzae*, in separate tests. The infestations were done monthly and up to 240 days after treatment applications (DAT). The efficacy was evaluated at 15 and 45 days after the infestation, for the adults and immature forms, respectively. The insecticide pirimiphos methyl (PM), at rate of 4 mL c.p./ton was efficient to the adults of both weevil species up to 60 DAT; while the rate of 8 mL c.p./ton was efficient up to 180 DAT and the rates from 12 to 32 mL c.p./ton, up to 240 DAT, reaching 100 % efficacy. The young forms of the two weevils were controlled up to 120 DAT by PM rates from 4 to 32 mL c.p./ton; up to 120 and 180 DAT by the rate of 8 mL c.p./ton, for *S. zeamais* and *S. oryzae*, respectively, and during all the experimental period for the rates of 12 to 32 mL c.p./ton of the insecticide, with efficacy superior of 80 %. The standard pyrethroid bifenthrin was efficient to the adults of the two weevils up to 150 DAT and to young forms, up 180 and 120 DAT, respectively.

Key words: Stored grain, pirimiphos methyl, chemical control, stored grain pest and organophosphate insecticide.

Introduction

Aware of its multiple uses in human and animal feeding, corn becomes an important source for biofuel production. The increased demand already is reflected in the worldwide stocks of the cereal, which has been constantly decreasing, with no stopping, for the last five years. The world is consuming more corn than it is producing, and this persistence raises an issue about the possibility of increasing the production in such speed and proportion, as to

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satisfy the increase of consumption and additionally, allows reset the worldwide stocks. For its real possibilities to contribute for an increase of the worldwide offer of the grain, Brazil takes part of the answer to this question. In the last years, the country has fixing itself as a product exporter and the assiduity is a crucial condition for the international market. Broad perspectives may be open for one more Brazilian product occupy a highlighted place in the worldwide market of agricultural commodities, just like soya (Agrianual, 2005).

Among the main problems in the conservation of stored corn, the pests stand out; these pests are mainly represented by the Sitophilus zeamais Mots., 1865 and *S. oryzae* (L., 1763) weevil (Coleoptera, Curculionidae). The maize weevil *S. zeamais* can be found in all the world's warm and tropical areas; it is the primary pest for maize, wheat, rice and sorghum. It can also grow in processed cereals, such as pasta, cassava, etc. (Pacheco and De Paula, 1995). The adults for this species are little bugs with 3-4 mm lenght, dark brown color, with four reddish stains on the elytra, visible after emergency. The larvae are light yellow in color with a darker head, and the pupas show a milky white color. Adult females lay in average of 282.2 eggs in 104.3 days of oviposition and they can live in average 140.5 days. The egg incubation ranges from 3 to 6 days and the cycle from egg to adult is approximately 34 days (Gallo et al., 2002).

The rice weevil *Sitophilus oryzae* is a cosmopolite insect, supposedly originated in India and spread all around the world through infested and ship-transported grains (Metcalf & Flint, 1962). Its morphological and biological characteristics are similiar to the *S. zeamais* species (Gallo et al., 2002).

They are considered as the main stored corn pests in Brazil due to the fact that they present a high biotic potential, cross-infestation, are a deep pest, have a high number of hosts and also due to the fact that both larvae and adults cause damage (Gallo et al., 2002). Puzzi (1986) additionally cites other damages caused by weevils in stored grains, such as: formation of heat cavities in the grain mass, polution of the grain mass, dissemination of molds in the grain mass and depreciation of the product. Pinto Jr. et al. (1997), reports that, due to the poor storage status of grains in Brazil, the losses caused by insects range from 0.2 to 30 % of the grain production. Santos (1993) goes more further, reporting that losses caused by insects, either quantitative or qualitative, reach around 50 % of the production.

To control stored grain pests, it has been used insecticides both preventively and curatively. After cleaning, drying and expurgating, the grains must be stored in clean and hygienized warehouses for a variable period of time, depending on the consumption and concern of each warehouse. In storage periods over 60 days, it can be performed the preventive treatment of grains in order to protect against pests. This treatment consists in applying liquid insecticides on the grains, in the conveyer belt while carrying the warehouse, and homogenize them in such a way that the entire grain gets inseticide. This inseticide will protect the grain against the attack of pests trying to fix themselves into the grain mass. The inseticides Pirimiphos methyl, deltamethrin and bifenthrin alone or mixed are recommended according to the infesting species-pest.

Several publications show the efficacy of pirimiphos methyl in the control of coleopteran pests in stored corn. Sgarbiero et al. (2003) studied the residual effect of pirimiphos methyl in the control of *Sitophilus zeamais* in corn grains and popcorn for 12 months of storage; Hamacher et al. (2002) studied the persistence of pirimiphos methyl in different temperatures of storage of corn grains, having been observed that variable temperatures in the storage affect the persistence and activity of the insecticide in the control of *S. zeamais*; Arthur (1995) and Arthur & Throne (1994) report the efficacy of 100 % of control of corn pests *Tribolium castaneum, Sitophilus zeamais* and *Plodia interpunctella*, with insecticides pirimiphos methyl and chlorpiriphos; Morallo Rejesus & Obra (1993) observed the good performance of pirimiphos methyl and

deltamethrin in the control of Callosobruchus chinensis in bean and *S. zeamais* in corn; while Kriengkrai (1992) obtained periods of protection of the stored corn against *S. zeamais* of 6, 10 and 12 months, with the dose of 5 mg/kg, of the insecticides methacriphos, pirimiphos methyl and chlorpiriphos methyl, respectively, and Pensook et al. (1992), periods of protection of the corn for 10 months, against the weevil, with insecticides pirimiphos methyl or parathion, at 10 ppm, or periods inferior with lower doses or with the insecticides malation ou thiodicarb.

As pirimiphos methyl has been an insecticide broadly employed to control stored grain pests in the last years, this may allow the appearance of foci of pest resistance to it in the commercially recommended doses. Thus, the objective of the present work was to reevaluate this insecticide, aiming to preserve the stored corn grains from the attack of *Sitophilus zeamais* and *S.oryzae*.

Material and methods

The experiment was performed by the Phytotechnical Laboratory of the School Farm "Capão da Onça" of the Ponta Grossa State University, Ponta Grossa, PR, during the period from April 2005 to January 2006. The hybrid corn D766 was used, which had not been treated with insecticides and presented approximately 13 % of moist. Before using the grains, a fumigation with phosphine was performed, in the dose of 2.0 g a.i./m^3 for 120 h, to eliminate completely all biological forms of insects present. The application of insecticides was performed with a sprayer coupled to an air compressor, with constant work pressure of 1.5 kg/cm^2, using a broth volume of 4 mL for each 2.0 kg of grains (2.0 L/ton); the pulverization was performed in plastic bags with dimensions of 40 x 50 cm. The grains were put in 5-liter paper bags and stored in a ventilated place under environmental conditions.

The residual activity study of insecticides on *S. zeamais* e *S. Oryzae* adults was performed taking a corn grain sample of approximately 100 grams, of each repetition (2.0 kg), which was placed in a 300-ml-volume glass bottle, with screened lid and infested with 20 non-sexed adults of each laboratory-bred weevil species, whose tests were conducted separately. Each bottle of grains represented a experimental plot. The infestations were made monthly and up to 240 days after the application. After 15 days of weevil infestation in the experimental plots, the number of living and dead insects was evaluated through sieve. After counting and removing the adult weevils, the grains were returned to the respective bottles and these were left in the breeding room until the emergency of F_1 generation adults, for a new counting of emerged insects, with the data being used to calculate the treatment efficacy on adult and immature weevil's biological forms.

Treatments used in the assay, active ingredient and commercial product doses/ton, ways of action, as well as concentrations and formulations, can be found in Table 1.

Data were submitted to analysis of variance by the F test and differences between the treatments's averages were compared by the Tukey 5 % test, after the data have been transformed into $\sqrt{X + 0,5}$. The efficacy % of the treatments was calculated by the Abbott's formula.

Results and discussion

Results have shown that the dose of 4.0 mL c.p./ton (commercial product) of the organophosphorated pirimiphos methyl 500 CE (Actellic 500 CE) was efficient in the control of *Sitophilus zeamais* and *S. oryzae* adults up to 60 days after application (DAA). The dose of 8.0 ml c.p./ton was efficient up to 180 DAA, while the average commercial dose of 12.0 mL c.p./ ton (6.0 ppm) controlled adults of two weevils up to 240 DAA, with 83.8 and 80.8 %, respectively. The doses of pirimiphos methyl 500 CE of 16.0 and 32.0 mL c.p./ton were efficient up to 240 DAA (Tables 2 and 4). From the standards used for comparison, pyrethroid

bifenthrin (Prostore 25 CE) (16.0 mL c.p./ton) was efficient up to 150 DAA and 90 DAA, respectively, for the two species, being deltamethrin (K-obiol 25 CE) (20.0 mL c.p./ton) inefficient during the whole experimental period. The treatments with efficient doses of pirimiphos methyl 500 CE differed from the standards in all the evaluations, showing superiority of this insecticide as protector of the corn grain from the attack of these pest species, which, considering the average commercial dose of 6.0 ppm, have showed equally susceptible to the insecticide.

The immature forms of *S. zeamais* and *S. oryzae* of F_1 generation were controlled in corn grains with the dose from 4.0 mL to 32.0 mL c.p./ton of pirimiphos methyl 500 CE up to 120 DAA. Specifically, the dose of 8.0 mL c.p./ton of the insecticide was efficient up to 120 and 180 DAA, respectively, while the average commercial dose of 12.0 mL c.p./ton (6,0 ppm) kept the population of the two species of weevil under the damage level for the entire experimental period (240 DAA), with more than 80 % of control. Efficient results of control of the F_1 generation of the two weevil species was also observed with the doses of 16.0 and 32.0 mL c.p./ton of the insecticide (Tables 3 and 5). The standard pyrethroid bifenthrin 25 CE was efficient for S. zeamais up to 180 DAA and up to 120 DAA for *S. oryzae*, while the pyrethroid deltamethrin 25 CE did not provide satisfactory control of the two pests during the entire experimental period. The standard deltamethrin 25 CE differed from the other treatments in all evaluations, while bifenthrin 25 CE did it, after 150 DAA, according to the species of weevil in question, showing as well that for the control of young forms of these weevils, pirimiphos methyl 500 CE is superior. No susceptibility difference of *S. zeamais* and *S. oryzae* was noted with the average commercial dose of 12.0 mL c.p./ton of pirimiphos methyl 500 CE.

These results prove that stored corn pests *Sitophilus zeamais* and *S. oryzae* can be efficiently controlled, in all their development phases, with the residual insecticide pirimiphos methyl 500 CE (Actellic 500 CE), in doses from 8.0 mL c.p./ton of grains (4.0 ppm), according the period of protection desired to be given to grains.

Table 1. Treatments, doses, ways of action, concentrations, and formulations of the products used in the treatment of corn grains. Ponta Grossa - PR, 2005.

Treatment	Dose/ton[1] g a.i.	Dose/ton[1] mL c.p.	Commercial Name	Chemical Group	Formulation
1. Pirimiphos methyl 500 CE	2.0	4.0	Actellic 500 CE	Organo-phosphorated	CE[2]
2. Pirimiphos methyl 500 CE	4.0	8.0			
3. Pirimiphos methyl 500 CE	6.0	12.0			
4. Pirimiphos methyl 500 CE	8.0	16.0			
5. Pirimiphos methyl 500 CE	16.0	32.0			
6. Bifenthrin 25 CE[3]	0.4	16.0	Prostore 25 CE	Pyrethroid	CE
7. Deltamethrin 25 CE[3]	0.5	20.0	K-obiol 25 CE		
8. Control	-	-	-	-	-

1 Grams of the active ingredient or milliliters of the commercial product per corn grain ton;

2 Emulsionable Concentrate;

3 Products used as standards.

Table 2. Adults of *Sitophilus zeamais* sieved from corn grains after 15 days of infestation and long-term treatment efficiency % (average of 4 repetitions) (Adult control). Ponta Grossa. PR. 2005.

Treatment	Dose/ton[1] g a.i. mL c.p.		1 DAA[2]		30 DAA		60 DAA		90 DAA		120 DAA	
			Mean	%EF[3]	Mean	% EF	Mean	% EF	Mean	% EF	Mean	% EF
1. Pirimiphos methyl 500CE	2.0	4.0	0.0 c	100.0	1.3 c	91.9	2.5 c	87.0	4.8 b	67.8	4.8 b	74.7
2. Pirimiphos methyl 500CE	4.0	8.0	0.0 c	100.0	0.5 d	96.8	0.0 d	100.0	1.0 c	93.2	1.5 c	92.0
3. Pirimiphos methyl 500CE	6.0	12.0	0.0 c	100.0	0.0 d	100.0	0.0 d	100.0	0.3 c	98.3	0.0 d	100.0
4. Pirimiphos methyl 500CE	8.0	16.0	0.0 c	100.0	0.0 d	100.0	0.0 d	100.0	0.0 c	100.0	0.0 d	100.0
5. Pirimiphos methyl 500CE	16.0	32.0	0.0 c	100.0	0.0 d	100.0	0.0 d	100.0	0.0 c	100.0	0.0 d	100.0
6. Bifenthrin 25 CE[4]	0.4	16.0	0.0 c	100.0	0.0 d	100.0	0.5 d	97.4	0.8 c	94.9	0.0 d	100.0
7. Deltamethrin 25 CE[4]	0.5	20.0	2.8 b	85.3	7.3 b	53.2	12.0 b	37.7	10.5 a	28.8	6.0 b	68.0
8. Control	-	-	18.8 a	-	15.5 a	-	19.3 a	-	14.8 a	-	18.8 a	-
C.V. %[5]	-	-	7.42		13.83		7.65		15.04		12.54	

Treatment	Dose/ton[1] g a.i. mL c.p.		150 DAA		180 DAA		210 DAA		240 DAA	
			Mean	%EF	Mean	% EF	Mean	% EF	Mean	% EF
1. Pirimiphos methyl 500CE	2.0	4.0	4.3 bc	71.2	12.8 b	32.0	7.8 b	58.1	11.8 b	36.5
2. Pirimiphos methyl 500CE	4.0	8.0	2.5 c	83.1	3.0 d	84.0	4.5 cd	75.7	8.0 c	56.8
3. Pirimiphos methyl 500CE	6.0	12.0	0.0 d	100.0	0.0 e	100.0	2.3 d	87.8	3.0 d	83.8
4. Pirimiphos methyl 500CE	8.0	16.0	0.3 d	98.3	0.0 e	100.0	0.0 e	100.0	0.0 e	100.0
5. Pirimiphos methyl 500CE	16.0	32.0	0.0 d	100.0	0.0 e	100.0	0.0 e	100.0	0.5 e	97.3
6. Bifenthrin 25 CE	0.4	16.0	2.8 c	81.4	7.8 c	58.7	7.3 bc	60.8	6.8 c	63.5
7. Deltamethrin 25 CE	0.5	20.0	6.5 b	55.9	12.3 b	34.7	10.5 b	43.2	8.5 bc	54.1
8. Control	-	-	17.8 a	-	18.8 a	-	18.5 a	-	18.5 a	-
C.V. %	-	-	15.51		12.53		11.36		9.34	

Means followed by the same letter in the column do not differ statistically between each other. Tukey 5 %.
[1] Grams of the active ingredient or milliliters of the commercial product per corn grain ton; [2] Days after application; [3] Treatment efficiency % according to Abbott's formula; [4] Products used as standards; [5] Coefficient of variance for the transformed data.

Table 3. Adults of *S. zeamais* F_1 generation sieved from corn grains and long-term treatment efficiency % (Average of 4 repetitions) (Immature form control). Ponta Grossa. PR. 2005.

Treatment	Dose/ton[1] g a.i. mL c.p.		1 DAA[2]		30 DAA		60 DAA		90 DAA		120 DAA	
			Mean	%EF[3]	Mean	% EF	Mean	% EF	Mean	% EF	Mean	% EF
1. Pirimiphos methyl 500CE	2.0	4.0	2.0 c	92.1	2.0 c	91.5	2.0 c	91.7	4.0 c	91.8	0.0 c	100.0
2. Pirimiphos methyl 500CE	4.0	8.0	0.0 d	100.0	0.0 c	100.0	0.0 d	100.0	0.5 d	99.0	0.0 c	100.0
3. Pirimiphos methyl 500CE	6.0	12.0	0.0 d	100.0	0.0 c	100.0	0.0 d	100.0	0.0 d	100.0	0.0 c	100.0
4. Pirimiphos methyl 500CE	8.0	16.0	0.0 d	100.0	0.0 c	100.0	0.3 cd	99.0	0.0 d	100.0	0.0 c	100.0
5. Pirimiphos methyl 500CE	16.0	32.0	0.0 d	100.0	0.0 c	100.0	0.3 cd	99.0	0.0 d	100.0	0.0 c	100.0
6. Bifenthrin 25 CE[4]	0.4	16.0	0.0 d	100.0	0.5 c	97.9	0.8 cd	96.9	0.0 d	100.0	0.0 c	100.0
7. Deltamethrin 25 CE[4]	0.5	20.0	10.3 b	59.4	8.0 b	66.0	13.0 b	45.8	21.8 b	55.2	4.5 b	77.8
8. Control	-	-	25.3 a	-	23.5 a	-	24.0 a	-	48.5 a	-	20.3 a	-
C.V. %[5]	-	-	12.98		22.44		20.05		10.44		8.92	

Continue...

Table 3. Continue.

Treatment	Dose/ton[1] g a.i.	mL c.p.	150 DAA Mean	150 DAA %EF	180 DAA Mean	180 DAA % EF	210 DAA Mean	210 DAA % EF	240 DAA Mean	240 DAA % EF
1. Pirimiphos methyl 500CE	2.0	4.0	8.3 b	71.3	12.8 b	52.3	31.0 b	52.7	59.0 b	43.3
2. Pirimiphos methyl 500CE	4.0	8.0	7.0 b	75.7	8.3 bc	69.2	25.8 b	60.7	25.8 c	75.2
3. Pirimiphos methyl 500CE	6.0	12.0	2.8 c	90.4	4.3 cd	84.1	12.3 c	81.3	18.8 c	82.0
4. Pirimiphos methyl 500CE	8.0	16.0	1.3 cd	95.7	2.0 de	92.5	7.0 cd	89.3	3.0 d	97.1
5. Pirimiphos methyl 500CE	16.0	32.0	0.0 d	100.0	0.5 e	98.1	3.5 d	94.7	0.5 d	99.5
6. Bifenthrin 25 CE	0.4	16.0	3.0 c	89.6	4.8 cd	82.2	26.3 b	59.9	62.0 b	40.4
7. Deltamethrin 25 CE	0.5	20.0	10.8 b	62.6	13.8 b	48.6	38.8 b	40.8	99.3 a	4.6
8. Control	-	-	28.8 a	-	26.8 a	-	65.5 a	-	104.0 a	-
C.V. %	-	-	11.92		13.58		10.72		9.32	

Means followed by the same letter in the column do not differ statistically between each other. Tukey 5 %.
[1] Grams of the active ingredient or milliliters of the commercial product per corn grain ton; [2] Days after application; [3] Treatment efficiency % according to Abbott's formula; [4] Products used as standards; [5] Coefficient of variance for the transformed data.

Table 4. Adults of *Sitophilus oryzae* sieved from corn grains after 15 days of infestation and long-term treatment efficiency % (Average of 4 repetitions) (Adult control). Ponta Grossa. PR. 2005.

Treatment	Dose/ton[1] g a.i.	mL c.p.	1 DAA[2] Mean	1 DAA[2] %EF[3]	30 DAA Mean	30 DAA % EF	60 DAA Mean	60 DAA % EF	90 DAA Mean	90 DAA % EF	120 DAA Mean	120 DAA % EF
1. Pirimiphos methyl 500CE	2.0	4.0	0.0 c	100.0	1.0 c	94.0	2.3 c	88.0	4.8 c	71.2	6.0 bc	63.6
2. Pirimiphos methyl 500CE	4.0	8.0	0.0 c	100.0	0.5 c	97.0	0.0 d	100.0	1.0 d	93.9	1.0 d	93.9
3. Pirimiphos methyl 500CE	6.0	12.0	0.0 c	100.0	0.0 c	100.0	0.0 d	100.0	0.3 d	98.5	0.0 d	100.0
4. Pirimiphos methyl 500CE	8.0	16.0	0.0 c	100.0	0.0 c	100.0	0.0 d	100.0	0.0 d	100.0	0.5 d	97.0
5. Pirimiphos methyl 500CE	16.0	32.0	0.0 c	100.0	0.0 c	100.0	0.0 d	100.0	0.0 d	100.0	0.0 d	100.0
6. Bifenthrin 25 CE[4]	0.4	16.0	0.0 c	100.0	0.0 c	100.0	0.5 d	97.3	0.8 d	95.5	4.5 c	72.7
7. Deltamethrin 25 CE[4]	0.5	20.0	2.8 b	85.3	7.0 b	58.2	12.5 b	33.3	11.3 b	31.8	9.3 b	43.9
8. Control	-	-	18.8 a	-	16.8 a	-	18.8 a	-	16.5 a	-	18.3 a	-
C.V. %[5]	-	-	7.42		14.16		10.50		15.76		14.05	

Treatment	Dose/ton[1] g a.i.	mL c.p.	150 DAA Mean	150 DAA %EF	180 DAA Mean	180 DAA % EF	210 DAA Mean	210 DAA % EF	240 DAA Mean	240 DAA % EF
1. Pirimiphos methyl 500CE	2.0	4.0	5.5 b	71.4	11.0 b	42.9	7.5 b	59.5	9.8 b	46.6
2. Pirimiphos methyl 500CE	4.0	8.0	2.0 c	89.6	1.5 cd	92.2	4.0 cd	78.4	6.3 c	65.8
3. Pirimiphos methyl 500CE	6.0	12.0	0.5 d	97.4	2.3 c	88.3	3.0 d	83.8	3.5 d	80.8
4. Pirimiphos methyl 500CE	8.0	16.0	0.0 d	100.0	0.5 de	97.4	0.0 e	100.0	0.0 e	100.0
5. Pirimiphos methyl 500CE	16.0	32.0	0.0 d	100.0	0.0 e	100.0	0.0 e	100.0	0.0 e	100.0
6. Bifenthrin 25 CE	0.4	16.0	6.0 b	68.8	10.0 b	48.1	5.8 bc	68.9	12.8 b	30.1
7. Deltamethrin 25 CE	0.5	20.0	6.3 b	67.5	12.0 b	37.7	6.3 b	66.2	6.5 c	64.4
8. Control	-	-	19.3 a	-	19.3 a	-	18.5 a	-	18.3 a	-
C.V. %	-	-	10.69		9.83		8.18		9.92	

Means followed by the same letter in the column do not differ statistically between each other, Tukey 5 %.
[1] Grams of the active ingredient or milliliters of the commercial product per corn grain ton; [2] Days after application; [3] Treatment efficiency % according to Abbott's formula; [4] Products used as standards; [5] Coefficient of variance for the transformed data.

Table 5. Adults of *S. oryzae* F_1 generation sieved from corn grains and long-term treatment efficiency % (Average of 4 repetitions) (Immature form control). Ponta Grossa. PR. 2005.

Treatment	Dose/ton[1] g a.i.	mL c.p.	1 DAA[2] Mean	1 DAA[2] %EF[3]	30 DAA Mean	30 DAA % EF	60 DAA Mean	60 DAA % EF	90 DAA Mean	90 DAA % EF	120 DAA Mean	120 DAA % EF
1. Pirimiphos methyl 500CE	2.0	4.0	2.5 c	91.2	3.5 c	87.7	2.5 c	90.0	3.3 c	92.9	1.3 c	95.4
2. Pirimiphos methyl 500CE	4.0	8.0	0.0 c	100.0	0.0 d	100.0	0.0 d	100.0	0.5 cd	98.9	0.5 c	98.2
3. Pirimiphos methyl 500CE	6.0	12.0	0.0 c	100.0	0.0 d	100.0	0.0 d	100.0	0.0 d	100.0	0.0 c	100.0
4. Pirimiphos methyl 500CE	8.0	16.0	0.0 c	100.0	0.0 d	100.0	0.3 d	99.0	0.0 d	100.0	0.0 c	100.0
5. Pirimiphos methyl 500CE	16.0	32.0	0.0 c	100.0	0.0 d	100.0	0.3 d	99.0	0.0 d	100.0	0.0 c	100.0
6. Bifenthrin 25 CE[4]	0.4	16.0	0.0 c	100.0	1.0 cd	96.5	0.8 cd	97.0	0.0 d	100.0	0.8 c	97.2
7. Deltamethrin 25 CE[4]	0.5	20.0	12.0 b	57.5	8.0 b	71.9	12.8 b	49.0	20.5 b	55.4	9.3 b	66.1
8. Control	-	-	28.3 a	-	28.5 a	-	25.0 a	-	46.0 a	-	27.3 a	-
C.V. %[5]	-	-	11.82		19.40		17.32		21.99		16.35	

Treatment	Dose/ton[1] g a.i.	mL c.p.	150 DAA Mean	150 DAA %EF	180 DAA Mean	180 DAA % EF	210 DAA Mean	210 DAA % EF	240 DAA Mean	240 DAA % EF
1. Pirimiphos methyl 500CE	2.0	4.0	9.8 b	70.2	10.3 b	61.0	30.5 b	59.9	54.5 b	40.3
2. Pirimiphos methyl 500CE	4.0	8.0	4.5 cd	86.3	2.5 c	90.5	16.5 c	78.3	31.8 cd	65.2
3. Pirimiphos methyl 500CE	6.0	12.0	2.8 d	91.6	3.8 c	85.7	10.5 d	86.2	18.0 de	80.3
4. Pirimiphos methyl 500CE	8.0	16.0	1.5 de	95.4	1.5 c	94.3	7.5 d	90.1	9.8 e	89.3
5. Pirimiphos methyl 500CE	16.0	32.0	0.0 e	100.0	1.0 c	96.2	0.0 e	100.0	0.0 f	100.0
6. Bifenthrin 25 CE	0.4	16.0	8.5 bc	74.0	8.8 b	66.7	17.5 c	77.0	78.3 a	14.2
7. Deltamethrin 25 CE	0.5	20.0	11.5 b	64.9	12.8 b	51.4	30.8 b	59.5	42.5 bc	53.4
8. Control	-	-	32.8 a	-	26.3 a	-	76.0 a	-	91.3 a	-
C.V. %	-	-	14.07		15.41		7.56		9.97	

Means followed by the same letter in the column do not differ statistically between each other. Tukey 5 %.
[1] Grams of the active ingredient or milliliters of the commercial product per corn grain ton; [2] Days after application; [3] Treatment efficiency % according to Abbott's formula; [4] Products used as standards; [5] Coefficient of variance for the transformed data.

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