STRATEGIES FOR MANAGEMENT OF THE COTTON APHID, *Aphis gossypii* (HOMOPTERA: APHIDIDAE) UNDER "CERRADO" CONDITIONS IN BRAZIL

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Abstract

The objective of this work was to evaluate the performance of thiamethoxam, in different dosagens, formulations and application strategies, aiming the aphid management and the reduction of foliar applications in cotton. Two experiments were deployed, the first in the 98/99 season and the second in the 99/00 season, both in the Brazilian cerrado, and with the cotton cultivar Delta Pine Ita-90. The design was of randomized blocks, with 8 treatments and 4 replications. Plot size was 12 rows by 15m length ($162m^2$). In the first experiment the treatments consisted of: thiamethoxam (Cruiser 700 WS) applied as a seed treatment at the dose of 300 g c.p./100 kg of seeds + thiamethoxam (Actara 10 GR), applied at covering (granulated) at the doses of 15 and 20 kg c.p./ha, 35 and 45 days after planting; thiamethoxam (Actara 10 GR), at the doses of 15 and 20 kg c.p./ha and aldicarb (Temik 150) at 8kg p.c. /ha, applied in-furrow. In the second experiment the treatments consisted of: thiamethoxam (Cruiser 700 WS) applied as a seed treatment at the dose of 300 g c.p./100 kg of seeds + thiamethoxam (Actara 10 GR), applied at covering (granulated) at the dose of 20 kg c.p./ha, in different times for each treatment (at 10, 15, 20 and 30 days after planting); thiamethoxam (Actara 10 GR), at the dose of 20 kg c.p./ha, aldicarb (Temik 150) at 8 kg c.p./ha, applied in-furrow and imidacloprid (Gaucho 700 PM) applied as a seed treatment at 500 g c.p./100 kg + carbosulfan (Marshal 200) in foliar applications at 10-day interval, at dose of 600 ml c.p./ha. Results showed that the combination: seed treatment + application of granulated at covering was efficient for the control of the cotton aphid, and it reduced the number of diseased plants and it provided increment in the productivity in relation to the control treatment, being viable as a part of the cotton aphid management, as a replacement to sequential foliar applications.

Introduction

Cotton crop is cultivated in more than seventy countries worldwide. The main purpose of cotton production is related to the need of fibers and seeds. In Brazil, after successive years of production losses, cotton shows signs that it is being recovered. Currently, cotton crop in Brazil occupies an area of approximately 849 thousand hectares. The central-west region is responsible for 50.48% of the national production of cottonseed, followed by the southeast region with 29.71% and the south with 14.24% (Richetti & Melo Filho, 1998).

Due to the great amount of pests attacking cotton crop that require the adoption of rational management by the producers, only highly professionalized producers were able to continue cultivating cotton. On the region of Chapadão do Sul/MS, where cotton crop has expanded, where planted area increased from 12000 ha on 96/97 harvest to approximately 30000 ha on 98/99 harvest, the intensity of aphid attack on cotton plantation has increased each year and today it is the main pest attacking cotton crop on Brazilian Cerrado, where cultivars susceptible to the viruses transmitted by the species are planted (Santos, 1998). Cotton aphid normally appears at the initial stage of the crop, when the plants are 20-cm height approximately. They are small in size and live under the leaves and new sprouts of the plants where they suck the sap. Cotton aphid has a high reproduction potential, which in the Brazilian climate exclusively occurs by parthenogenesis thelytokous, that is, without male participation, being both the winged and the apterous forms constituted by larviparous females. On cotton, damages caused by the aphid can reach approximately 44%, considering the qualitative and quantitative losses (Gallo *et al.,* 1988). The main problem of aphid occurrence is due to the transmission of the virus that causes diseases in the plants, as the mosaic, which is responsible for more severe symptoms and greatly reduces the yield. This virus disease can occur in all development phases of the plants, impeding the growth and can even cause total loss of yield (Santos, 1999).

In Brazil, 97/98 season presented some areas planted with cotton on Goiás State that had losses of approximately 50% due to the occurrence of virus diseases. On 98/99 season, there were areas planted with cotton on the region of Chapadão do Sul/MS, where the plants presenting virus diseases symptoms had already reached 10% in plantations aged 45 days. Thus, the cultivars planted on the Brazilian Cerrado region, which are susceptible to virus diseases, have aroused an uncontrolled process of insecticide application, with the use of 15 spray applications of non-selective insecticides, such as organophosphorus and carbamate insecticides in each cycle of the crop, for the control of the aphid. In this region, the aphid was responsible for approximately 80% of the spray operations conducted, which did not resulted in an adequate control (Ortiz *et al.*, 1999).

The technology for using soil granule and seed treatment insecticides for cotton crop has significantly helped the preventive control not only of the aphid, but also of other initial pests such as thrips and the whitefly, avoiding the decay and wrinkle of plants and diseases dissemination, and contributing to ensure crop yield and viability. The current technological advancements on the chemical area has provided the introduction of safer and more adequate insecticide molecules to be used on agriculture, contributing to a more rational management of pests control and safety to farmers. The objective of this work was to evaluate the performance of the insecticide thiamethoxam at different doses, formulations and application strategies, aiming the management of aphids and the decrease of foliar application on cotton crop.

Materials and Methods

Two no-till systems experiments were installed; the first for 1998/1999 season and the second for 1999/2000 season, both at the Experimental Area of Chapadão Foundation, on Chapadão do Sul/MS, region of the Brazilian Cerrado. Both experiments were conducted with Deltapine Ita-90 cultivar, using the design of randomized blocks, with 8 treatments and 4 replicates. Each plot was formed by 12 rows of 15m in length ($162m^2$), at the spacing of 0.9m and density of 12 plants/m. The fertilizer used at planting was NPK formula 4-18-12 + micronutrients, at the dose of 450 kg/ha, and for covering fertilization, K_2O was used at the dose of 60 kg/ha. Tables 1 and 2 describe the treatments used on experiment 1 (98/99 season) and experiment 2 (99/00 season), respectively. The insecticides used were thiamethoxam (Cruiser 700 WS^R, for seeds treatment, Actara 10 GR^R, granules to be applied in-furrow and/or covering), aldicarb (Temik 150 G^R, granules to be applied in-furrow), imidacloprid (Gaucho 700 PW, for seed treatment) and carbosulfan (Marshal 200 SC, to be applied on foliar spray). For covering treatment the granules was placed about two inches to a side of the row and two inches deep.

Evaluations were conducted weekly, from the emergence of the plants until 90 days after planting, being the following parameters observed: Number of aphids (apterous and winged forms) in 10 plants per plot.- Number of plants presenting symptoms of virus diseases (mosaic), by observing all plants of each plot.- At the end of the crop cycle, a yield evaluation was made by harvesting and weighting the fibers and the seeds produced by the 8 central lines of each plot.

The data collected were subjected to variance analysis through the F test, comparing the averages through the Tukey test at 5%.

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Discussion

Experiment 1 (98/99 season)

The results obtained from efficacy evaluations of the aphid *Aphis gossypii* control (Table 3) show that 10 days after planting, seed treatment with thiamethoxam at the dose of 300 g of c.p./100 kg of seeds, resulted in a control higher than 80%. The treatments with the granule formulation of thiamethoxam and aldicarb applied in-furrow, at the doses of 20 and 8 kg c.p./ha, resulted in an efficacy of 90 and 95%, respectively. Twenty-five days after planting, seed treatment with thiamethoxam at the dose of 300 g c.p./100 kg of seeds, showed an average efficacy of 60% for the control of the aphid, while the granule formulations applied in-furrow (thiamethoxam 10 GR at the doses of 15 and 20 kg c.p./ha and aldicarb 150 at the dose of 8 kg c.p./ha), showed an efficacy higher than 80% for the control of *A. gossypii*. Forty-five days after planting, it was verified that thiamethoxam 700 WS, applied as seed treatment, followed by the application of thiamethoxam 10 GR, applied as covering treatment 35 days after planting at the doses of 15 and 20 kg c.p./ha, showed an efficacy of 82 and 88%, respectively, for the control of the aphid, while the treatments with thiamethoxam and aldicarb as granule formulation applied in-furrow and thiamethoxam 700 WS, applied as seed treatment only, showed an average efficacy of 60%. Sixty days after planting, it was verified that the treatment with thiamethoxam 700 WS applied as seed treatment, followed by thiamethoxam as the granule formulation applied as covering treatment at the dose of 20 kg c.p./ha, 45 days after planting, showed an efficacy higher than 80%. The others treatments presented an average efficacy lower than 70%.

The lowest rates of plants presenting disease (mosaic), caused by the virus transmitted by the aphid, were obtained with treatments of thiamethoxam 700 WS applied as seed treatment, followed by an application of thiamethoxam 10 GR, at the doses of 15 and 20 kg c.p./ha, applied as covering treatment 35 days after planting, that showed an efficacy of 71 and 74%, respectively, in relation to the control treatment. The others treatments showed an average efficacy of 60% for the control of the mosaic, when compared to the occurrence of the disease in the control treatment, where the incidence of mosaic reached 30% of the plants.

Harvest evaluation (Table 4) evidenced the increased yield obtained with the treatments that resulted in an efficient control of the aphid in relation to the yield obtained in the control areas, which plants were severely affected by the disease, and the plants showing severe symptoms of the virus, developed at the initial phase of the crop cycle, had their growth stopped and presented losses of 100% of yield. The treatments made at planting with thiamethoxam as seed treatments, combined with the application of thiamethoxam as the granule formulation, applied as covering treatment, 35 days after planting, showed a lower rate of occurrence of the disease and a higher yield, when compared to the treatments in which covering application was made 45 days after planting. Therefore, for experiment 2, installed for the next cotton season (99/00), covering applications were adjusted to be made until 30 days after planting.

Experiment 2 (99/00 Season)

The results obtained at the evaluations of aphid control (Table 5) showed that 13 days after planting aphid control was 100% for the treatments of imidacloprid as seed treatment and thiamethoxam at both seed treatment and granule formulation applied in-furrow. The treatment with aldicarb applied in-furrow presented an efficacy of 82%, however it did not significantly differ from the treatments with thiamethoxam. At 20 and 27 days after planting, the treatments with thiamethoxam applied as seeds treatment and without the application of the granule formulation as covering treatment and also the treatments combining seed treatment and granule formulation as covering treatment and imidacloprid applied as seed treatment, followed by foliar application of carbusulfan each 10 days, showed an average efficacy higher than 90% for the control of *A. gossypii*, exceeding the treatment with aldicarb applied in-furrow, that showed a significant decreased efficacy for the aphid control. Thirty-seven days after planting, the treatments with thiamethoxam applied in the combinations: seed treatment plus granule as covering treatment and imidacloprid applied as seed treatment, followed by foliar application of carbusulfan each 10 days, showed an average efficacy higher than 85% for the aphid control. The treatment with aldicarb applied in-furrow was not efficient for the control of the pest and did not significantly differ from the control. The results obtained at the efficacy evaluations for the control of the aphid at 48, 55, 62 and 69 days after planting (Table 6) showed that the treatments with thiamethoxam applied as seed treatments, followed by the application of thiamethoxam as granule formulation applied as covering treatment 10, 15 and 20 days after planting, presented a significantly lower control of the aphid comparing to that obtained where covering application was made 30 days after planting, that presented efficacy of control higher than 80%. Seventy-days after planting, imidacloprid applied as seed treatment, followed by sequential spraying of carbosulfan each 10 days and thiamethoxam as seed treatments, combined with the application of thiamethoxam as the granule formulation, applied as covering treatment, 30 days after planting were the only treatments that significantly differed from the control. The other treatments were not efficient for the control of the aphid.

Counting of diseased plants (Table 7), 70 days after planting, showed a high incidence of plants showing severe symptoms of mosaic in the plants of the control areas. These plants had their growth stopped at the beginning of crop development, reaching a height lower than half of the height of the healthy plants, indicating that at the harvest evaluation will be made on May, the yield of the plants on treated plots, that showing an adequate control of the aphid, will be significantly higher than the control areas.

The period of higher efficacy for the control of the aphid, *A. gossypii*, with a consequent better control of virus diseases, was obtained with the treatment with thiamethoxam 700 WS, applied as seed treatment, combined with covering application of thiamethoxam as granule formulation, 30 days after planting. This treatment provided an efficient control of the aphid and of the mosaic, the main problem of cotton crop in the Brazilian Cerrado, and it can be used as a substitute for the sequential application of broad-spectrum insecticides, which have caused biological unbalance in favor of other pests on cotton crop in the Brazilian Cerrado.

Disclaimer

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Table 1. Treatments used on experiment 1. Name of the insecticides, application time and dose used.

Insecticides (active ingredient name)	Application time	Dose of the commercial product
1- Thiamethoxam 700 WS + Thiamethoxam 10 GR	ST + 35 days*	300 g/100 kg + 15 kg/ha
2- Thiamethoxam 700 WS + Thiamethoxam 10 GR	ST + 35 days*	300 g/100 kg + 20 kg/ha
3- Thiamethoxam 700 WS + Thiamethoxam 10 GR	ST + 45 days*	300 g/100 kg + 15 kg/ha
4- Thiamethoxam 700 WS + Thiamethoxam 10 GR	ST + 45 days*	300 g/100 kg + 20 kg/ha
5- Thiamethoxam 10 GR	Planting	15 kg/ha
6- Thiamethoxam 10 GR	Planting	20 kg/ha
7- Aldicarb 150	Planting	8 kg/ha
8- Control	--	--

ST: application through seed treatment at planting
*days after planting, when the thiamethoxam were applied on covering.

Table 2. Treatments used on experiment 2. Name of the insecticides, application time and dose used.

Insecticides (active ingredient name)	Application time	Dose of the commercial product
1- Thiamethoxam 700 WS + Thiamethoxam 10 GR	ST + 10 days*	300 g/100 kg + 20 kg/ha
2- Thiamethoxam 700 WS + Thiamethoxam 10 GR	ST + 15 days*	300 g/100 kg + 20 kg/ha
3- Thiamethoxam 700 WS + Thiamethoxam 10 GR	ST + 20 days*	300 g/100 kg + 20 kg/ha
4- Thiamethoxam 700 WS + Thiamethoxam 10 GR	ST + 30 days*	300 g/100 kg + 20 kg/ha
5- Thiamethoxam 10 GR	Planting	20 kg/ha
6- Imidacloprid 700 PM + Carbosulfan 200 SC	ST + foliar spray**	500g/100kg + 600ml/ha
7- Aldicarb 150	Planting	8 kg/ha
8- Control	--	--

ST: application through seed treatment at planting
*days after planting, when the thiamethoxam were applied on covering
** foliar spray with carbosulfan each 10 days, as from 20 days after planting (farmer's standard treatment).

Table 3- Effect of Thiamethoxam for the control of the cotton aphid, *Aphis gossypii*. Efficacy percentage (%E) of treatments at 10, 25, 45 and 60 days after planting. Chapadão do Sul/MS. January to March/1999.

Treatments	Time of applic.	Dose C.P.	%E 10 dap	%E 25 dap	%E 45 dap	%E 60 dap
Thiameth.WS +Thiameth.GR	ST + 35 days	300g+ 15 kg	82 b	73 b	82 bc	54 a
Thiameth.WS +Thiameth.GR	ST + 35 days	300g+ 20 kg	86 b	66 b	88 c	64 b
Thiameth.WS +Thiameth.GR	ST + 45 days	300g+ 15 kg	81 b	70 b	64 b	73 b
Thiameth.WS +Thiameth.GR	ST + 45 days	300g+ 20 kg	88 b	73 b	58 ab	84 b
Thiameth. GR	Planting	15kg	75 b	84 b	61 b	50 a
Thiameth. GR	Planting	20 kg	90 b	84 b	65 b	57 ab
Aldicarb 150	Planting	8 kg	95 b	86 b	60 b	43 a
Control	--	--	39* a	47* a	37* a	52* a
CV (%)	--	--	17.70	20.02	26.47	22.12

dap: days after planting
ST: application through seed treatment at planting
Efficacy calculated by Abbott formula (Abbott, 1925)
* Average number of aphids in 10 plants

Table 4. Effect of Thiamethoxam on the incidence of plants diseases (mosaic), on cotton. Average number of plants with severe symptoms of virus, efficacy percentage (%E) of the treatments 90 days after planting and yield. Chapadão do Sul/MS. March/1999.

Treatments	Time of applic.	Dose C. P.	Plants disease*	%E	Yield kg/ 100m^2	% Yield increase
Thiameth.WS+ Thiameth.GR	ST + 35 days	300g+ 15 kg	155 b	71	30 b	166
Thiameth.WS+ Thiameth.GR	ST + 35 days	300g+ 20 kg	140 b	74	33 b	183
Thiameth.WS+ Thiameth.GR	ST + 45 days	300g+ 15 kg	206 b	62	25 b	139
Thiameth.WS+ Thiameth.GR	ST + 45 days	300g+ 20 kg	181 b	67	26 b	144
Thiameth.GR	Planting	15kg	258 a	52	22 a	122
Thiameth.GR	Planting	20 kg	211 b	61	28 b	155
Aldicarb 150	Planting	8 kg	196 b	64	24 b	133
Control	--	--	542 a	--	18 a	100
CV (%)	--	--	24.17	--	16.56	--

Efficacy was calculate according to Abbott formula (Abbott, 1925)
ST: application through seed treatment at planting
*Average number of plants showing disease (mosaic)

Table 5. Effect of Thiamethoxam for the control of the aphid, *Aphis gossypii*, on cotton. Efficacy percentage of treatments at 13, 20, 27 and 37 days after planting. Chapadão do Sul/MS. January-March/2000.

Treatments	Time of applic.	Dose C.P.	13 dap	20 dap	27 dap	37 dap
Thiameth.WS +Thiameth.GR	ST + 10 days	300g+ 20 kg	100 b	99 b	100 c	91 b
Thiameth.WS +Thiameth.GR	ST + 15 days	300 g +20kg	100 b	99 b	100 c	89 b
Thiameth.WS +Thiameth.GR	ST + 20 days	300 g +20kg	100 b	97 b	98 c	79 b
Thiameth.WS +Thiameth.GR	ST + 30 days	300 g +20kg	100 b	99 b	96 c	85 b
Thiameth. GR	Planting	20 kg	100 b	96 b	97 c	84 b
Imidacl.WP + CarbosulfanSC	ST+folia spray	500g+ 600ml	100 b	87 b	93 c	89 b
Aldicarb 150	Planting	8 kg	82 b	69 b	77 b	0,458
Control	-	-	33* a	79*a	425*a	200*a
CV (%)	--	--	30.09	33.38	24.25	28,33

Efficacy was calculate by Abbott formula (Abbott, 1925)
ST: application through seed treatment at planting
dap: days after planting
* Average number of aphids in 10 plants

Table 6. Effect of Thiamethoxam for the control of the cotton aphid, *Aphis gossypii*. Efficacy percentage (%E) of treatments at 48, 55, 62 and 69 days after planting. Chapadão do Sul/MS. January-March/2000.

Treatments	Time of applic.	Dose C.P.	48 dap	55 dap	62 dap	69 dap
Thiameth.WS +Thiameth.GR	ST + 10 days	300g+ 20 kg	58 a	65 b	61 b	41 a
Thiameth.WS +Thiameth.GR	ST + 15 days	300 g +20kg	62 ab	70 b	71 b	53 ab
Thiameth.WS +Thiameth.GR	ST + 20 days	300 g +20kg	74 b	83 bc	75 bc	70 b
Thiameth.WS +Thiameth.GR	ST + 30 days	300 g +20kg	94 b	90 c	86 c	85 c
Thiameth. GR	Planting	20 kg	74 b	27 a	62 b	0
Imidacl.WP + CarbosulfanSC	ST+foliar spray	500g+ 600ml	50 a	50 a	58 ab	67 b
Aldicarb 150	Planting	8 kg	66 ab	63 ab	0 a	0
Control	-	-	53 *	12* a	70* a	54 a
CV (%)	--	--	27.00	26.75	24.66	26,67

ST: application through seed treatment at planting
dap: days after planting
* Average number of aphids in 10 plants

Table 7. Effect of Thiamethoxam on the incidence of plants showing disease (mosaic), on cotton. Average number of plants with severe symptoms of virus and efficacy percentage (%E) of the treatments, 70 days after planting. Chapadão do Sul/MS. March/2000.

Treatments	Time of application	Dose c.p.	Plants diseases*	% E
Thiametham WS +Thiametham GR	ST + 10 days	300g + 20 kg	14.0 b	87
Thiametham WS + Thiametham GR	ST + 15 days	300 g + 20kg	11.5 b	89
Thiametham WS +Thiametham GR	ST + 20 days	300 g + 20kg	9.2 b	92
Thiametham WS +Thiametham GR	ST + 30 days	300 g + 20kg	8.0 b	93
Thiametham GR	Planting	20 kg	15.5 b	86
Imidacloprid WP +Carbosulfan SC	ST+foliar spray	500g+600ml	8.0 b	93
Aldicarb 150	Planting	8 kg	37.2 a	66
Control	-	-	110.0 a	-
CV (%)	--	--	27.63	-

ST: application through seed treatment at planting
Efficacy was calculate according to Abbott formula (Abbott, 1925)
*Average number of plants showing disease (mosaic)