DOI: 10.4025/actasciagron.v33i4.11160

Simulate rain about action insecticide flonicamid in the control of the cotton aphid

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ABSTRACT. The cotton production system in Brazil concentrates on the area of the cerrado, characterized by frequent rains that interfere in the effectiveness of the necessary sprays during its cycle. The objective of the work was to evaluate simulate rain of 15 mm in 4 hours after spraying in the control of *Aphis gossypii* with insecticide flonicamid. Plants of *Gossypium hirsutum* were cultivated in pots containing soil as substrate in greenhouse conditions. The pots were arranged in randomized complete design with seven treatments and five replicates, consisting of: test without insecticide spraying, without insecticide spraying with rain, flonicamid spraying with simulate rain of 15 mm after 30 minutes, 1, 2 and 4 hours after spraying. Equivalent insecticide was sprayed 75 g of flonicamid by hectare. The efficiency evaluation was accomplished through the individuals of *A. gossypii* count which started from an artificial infestation 6 days before the application of the treatments. The results were: a 15-mm precipitation during the first four hours after flonicamid spraying interfered negatively in the control of *A. gossypii*.

Keywords: pest management, chemical control, precipitation.

RESUMO. Chuva simulada sobre ação inseticida flonicamid no controle do pulgão-do-algodoeiro. O cultivo do algodoeiro no Brasil concentra-se na Região do Cerrado, caracterizada por chuvas freqüentes que interferem na eficácia das pulverizações necessárias durante seu ciclo. O objetivo do trabalho foi avaliar chuva simulada de 15 mm nas 4h iniciais após pulverização no controle de *A. gossypii* com inseticida flonicamid. Plantas de *Gossypium hirsutum* foram cultivadas em vasos contendo solo como substrato em condições de casa-de-vegetação. Cada parcela foi constituída de um vaso com duas plantas. Utilizou-se delineamento experimental inteiramente casualizado com sete tratamentos e cinco repetições, consistindo de: testemunha sem pulverização de inseticida, testemunha sem pulverização de inseticida com presença de chuva e pulverização de flonicamid com chuva simulada de 15 mm aos 30 min., 1, 2 e 4h após aplicação. Foi pulverizado inseticida equivalente a 75 g de flonicamid por hectare. A avaliação de eficiência foi realizada por contagem de indivíduos de *A. gossypii* a partir de infestação artificial realizada 6 dias antes da aplicação dos tratamentos. De acordo com os resultados conclui-se que: as precipitações nas quatro horas inicias após aplicação de flonicamid, interferem negativamente no controle de *A. gossypii*.

Palavras-chave: manejo de pragas, controle químico, precipitação.

Introduction

The cotton crop (*Gossypium hirsutum* L.) is characterized by suffering from frequent attack of pests during growning season. Among the components of the production costs, the pest control represents approximately 50% of the cost with pesticides in the main areas that produce cotton in Brazil (RICHETTI et al., 2005), which demands discerning analysis for employment of pests chemical control. Among the main pests are the cotton aphids (*Aphis gossypii*) that demand a lot of control interventions. This pest causes indirect damages through the viruses transmission and direct damages, suction sap, contaminating the fibers with sugary excrement in the end of the season.

The climatic conditions of the Brazilian Cerrado, which concentrates the cotton production, are characterized by periods with frequent precipitation during the growing season. This request attention at the moment of the sprays, because the rain can reduce the control efficiency removing part of the product of the leaf, thus reducing your absorption and the protection period (EDWARDS, 1975; PICK et al., 1984; STEFFENS; WIENEKE, 1975).

New insecticides have been developed seeking the aphids control, among them the flonicamid – an insecticide that acts interfering in the alimentary behavior of the insects, quickly inhibiting feeding. According to Morita et al. (2007), about 30 min. are enough to inhibit the feeding of insects submitted to this product. They point out, however, that one possible mechanism is the inhibition of the penetration of the insect estylet in the cells of the plant.

As for handling crop protection management, it esteems that a very small amount of the applied products in the chemical control, less than 0,1%, reach your action site (PIMENTEL, 1995). One of the best tools to increase the efficiency in general of pesticides would be to increase the penetration of the active ingredient inside of the tissues, in the case of systemic products, where foliate absorption has an important factor for their effectiveness. The leaf uptake involves complex processes which depend on the characteristics of the leaf surface, physical-chemical properties of the pesticides, and mainly the environmental conditions (EDWARDS, 1975; WANG; LIU, 2007).

Among the environmental factors, the rain assumes importance as one of the failure factors in the spraying of pesticides, because it is directly related to the mechanical effect because it results in washing leaf surface. Hence, intense rains end up washing the leaf surface, interfering in the uptake of the product (EDWARDS, 1975). The great subject is quantifying the real effect of the precipitation on effectiveness of systemic insecticides application in the control of a given pest.

Steffens and Wieneke (1975) observed that the increase of the relative humidity favors the absorption and metabolism of the insecticides. However, the rain easily removed azinphos-methyl of the bean plant leaves. Furthermore, they point out that removal should be related with the intensity of the rain and the time after the spray. This is similar to the result obtained by Dejonckheere et al. (1982), when they verified that the rain affected the absorption and the final residue of aldicarb in beet leaves. Few studies were accomplished seeking to know the interaction between precipitation and the behavior of insecticides in pest control in the Brazilian Cerrado. Therefore, a comprehensive study is necessary in order to seek the understanding of the insecticide behavior, especially, in what refers to the effects of the rain in the *A. gossypii* control. The objective of the work was to evaluate simulate rain in the *A. gossypii* control with insecticide flonicamid.

Material and methods

The present study was carried out at the greenhouse (28 ± 2ºC) and (65 ± 5% RH) of the Agricultural Sciences College (FCA) of the Federal University of Grande Dourados (UFGD), Dourados, State of Mato Grosso do Sul, Brazil, from December 8, 2007 to January 25, 2008.

The experiment consisted of potted cotton plants allocated to seven insecticide spraying treatments, each replicated five times. The treatments included a control with no insecticide application, and four treatments which involved application of the insecticide followed at different intervals by simulated rain. Flonicamid, was applied as the product 'Turbine® 500 WG' at a rate of 150 g ha^{-1} (providing 75 g of flonicamid) with a pressurized CO_2 sprayer containing four Conejeet® nozzles. The volume and operating pressure of the sprayer was 130 L ha^{-1} and 2.5 bar, respectively. The simulated rain was applied to the plants via to provide 15 mm of precipitation, which was simulated 30 min., 1, 2, and 4h after spraying (Figure 1).

The cotton cultivar 'Delta Opal®' was cultivated in pots containing soil as a substrate, and four seeds were placed in the pots at the time of sowing being left 2 uniform plants within a period of 10 days after emergency (DAE).

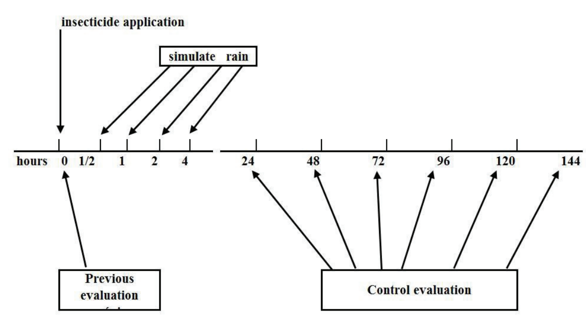

Figure 1. Schematic of the experimental design.

The aphids were collected from the cotton crop in the experimental area at the Agricultural Science College of UFGD. Artificial infestation of the cotton plants was performed when the plants were in stage B2 (MARUR; RUANO, 2001) and possessed an average height of 60 cm. In total, 10 adult individuals of *A. gossypii* were placed by the plant. Six days after infestation, the insecticide was applied, and the plants received 15 mm of simulated rainfall (intensity of 45 mm h^{-1}), according to the time intervals established in the treatments.

The number of individual *A. gossypii* that were observed after 24, 48, 72, 96, 120, and 144h were determined, and the control efficiency was calculated according to the methodology described by Henderson and Tilton (1955). The data were analyzed through an analysis of the variance and were submitted to a Tukey test at a probability level of 5%. Moreover, the standard error for the average control efficiency was determined.

Results and discussion

During the first evaluation period (24h), significant differences among treatments were not observed. However, differences began to appear as the mortality of the insects increased due to the application of the insecticide (Table 1).

Table 1. Statistical analysis of the mean number of aphids per plants 24, 48, 72, 96, 120 and 144 hours after insecticide application.

	Previous evaluation
Variation factors	Prob. (F: α 5%)
Treatments	1.3651 < 2.45 *
	24h
Variation factors	Prob. (F) α = 5%
Treatments	4.1314 > 2.45 **
	48h
Variation factors	Prob. (F) α = 5%
Treatments	9.802 > 2.45 **
	72h
Variation factors	Prob. (F) α = 5%
Treatments	10.1538 > 2.45 **
	96h
Variation factors	Prob. (F) α = 5%
Treatments	8.24 > 2.45 **
	120h
Variation factors	Prob. (F) α = 5%
Treatments	8.361 > 2.45**
	144h
Variation factors	Prob. (F) α = 5%
Treatments	8.361 > 2.45 **

*Not significant ($p \leq 0.05$). **Significant ($p \leq 0.05$).

When insecticide was not applied to the plants, the presence of rain did not affect the behavior and survival of *A. gossypii*. Thus, the efficiency of the control treatment without insecticide and rain and the efficiency of the control treatment without insecticide in the presence of rain did not differ, indicating that both treatments could be used to calculate the control efficiency (Table 2).

Precipitation that occurred 30 minutes after insecticide application negatively affected the efficacy of the insecticide. Specifically, 48 hours after application, the control efficiency of the 30 min treatment differed from that of the other treatments. After 96 hours, the control efficiency of all of the treatments decreased (Table 2).

The occurrence of rain 1, 2, and 4 hours after flonicamid application negatively affected the control efficiency. However, significant differences were only observed 48 hours after application (Table 2). In a previous study, Pick et al. (1984) observed that 50% of the applied insecticide was removed after 5 mm of precipitation occurred 1 hour after insecticide application. Moreover, the authors concluded that the interval between insecticide application and the occurrence of rain should be increased as the volume of precipitation increases. Similarly, Mashaya (1993) observed that the biological activity of acephate and monocrotophos was reduced by 85% after 10 mm of precipitation occurred 1 hour after insecticide application.

Table 2. Control efficiency using based on the control treatment without rain (WwR) and control with rain (WR) using the Henderson and Tilton (1955) calculation.

24h after applications			48h after applications		
	Control efficiency (%)			Control efficiency (%)	
Treatments[1]	(WwR)	(WR)	Treatments	(WwR)	(WR)
I + wR	46.6 a*	42.5 a	I + wR	55.3 a	51.8 a
I + R ½ h	34.5 a	30.0 a	I + R ½ h	55.3 a	51.0 a
I + R 1h	40.7 a	36.7 a	I + R 1h	57.8 a	52.1 a
I + R 2h	42.6 a	38.6 a	I + R 2h	57.4 a	52.9 a
I + R 4h	44.1 a	40.2 a	I + R 4h	52.8 a	48.4 a
72h after applications			96h after applications		
	Control efficiency (%)			Control efficiency (%)	
Treatments	(WwR)	(WR)	Treatments	(WwR)	(WR)
I + wR	80.1 a	80.9 a	I + wR	86.8 a	85.1 a
I + R ½ h	55.4 a	57.8 a	I + R ½ h	50.8 a	48.3 a
I + R 1h	56.9 a	59.5 a	I + R 1h	65.5 a	62.0 a
I + R 2h	65.4 a	66.8 a	I + R 2h	69.2 a	63.6 a
I + R 4h	66.3 a	65.2 a	I + R 4h	68.4 a	60.8 a
120h after applications			144h after applications		
	Control efficiency (%)			Control efficiency (%)	
Treatments	(WwR)	(WR)	Treatments	(WwR)	(WR)
I + wR	79.5 a	82.1 a	I + wR	71.6 a	73.1 a
I + R ½ h	51.9 a	54.7 a	I + R ½ h	49.6 a	50.6 a
I + R 1h	67.7 a	68.0 a	I + R 1h	63.2 a	64.4 a
I + R 2h	65.6 a	66.5 a	I + R 2h	63.1 a	64.5 a
I + R 4h	67.0 a	68.8 a	I + R 4h	65.0 a	66.1 a

*Mean in the line followed by the same letter does not differ significantly, Tukey test ($p \leq 0.05$%.). 1 I + wR = Insecticide application without rain; I + R ½ h = Insecticide application with rain presence and respective interval time.

Several studies have demonstrated that the rate of absorption of systemic insecticides can favor its effectiveness. Pymetrozine, an insecticide with similar characteristics, was evaluated by Wyss and Bolsinger (1997) in the control of *Myzus persicae* and *Aphis craccivora* in tomatoes, beets, and peas. The results indicated that differences among cultures were related to the distribution of the insecticide in the tissue of the plant.

Under typical cropping conditions, insecticides are applied in the early morning, and daily precipitation occurs in the afternoon; thus, the maximum interval evaluated in the present study was 4 hours. Torres and Silva-Torres (2008) evaluated pimetrozine in the control of *A. gossypii*, and obtained high initial mortality rates, which decreased 6 days after application, demonstrating that the initial biological activity of flonicamid is lower than that of pimetrozine, which is an insecticide with an identical mode of action. Although pimetrozine is a fast-acting insecticide (MORITA et al., 2007), relatively long periods of time on the leaf are required for effective action, which may explain the negative effects of precipitation 4 hours after application.

Conclusion

The occurrence of 15-mm rain up to four hours after flonicamid application interferes negatively in the control of *A. gossypii*.

Acknowledgements

The first author is grateful to Fundect for a research grant.

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Received on September 14, 2010.
Accepted on January 16, 2011.