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Investigation Note

Assessment of tolerance to glyphosate and glufosinate in genetically modified cotton shoots

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Abstract

Destruction of the harvest of cotton stalks should be done after it. However, destruction by ploughing prevents continuing with direct sowing, which makes chemical management an ally in soil conservation. The objective was to identify the most effective dose of 2,4-D, associated with different herbicides and the timing of administration for the control of transgenic cotton shoots for tolerance to glyphosate and glufosinate. The treatments consisted of the use of the herbicide 2,4-D, alone at doses of 670 and 1 340 g ha^{-1}, and associated with the herbicides carfentrazone, flumiclorac, chlorimuron, flumioxazin and imazethapyr at three application times: 0 days after mechanical mowing (0 DAMM), 25 DAMM, and 0 DAMM + 25 DAMM. Regrowth evaluations were performed at 15, 30, and 45 days after the first and second applications, determining the dry biomass of the shoots. In terms of herbicide use time, the best results are obtained when they applied at 0 DAMM + 25 DAMM. Higher doses of 2,4-D (1 324 g ha^{-1}) make it more efficient; in relation to herbicides, variations were perceived in their behavior depending on the time of evaluation, the application, and the dose of 2,4-D used. During the last measurement period, 45 days after application, 2,4-D+carfentrazone and 2,4-D+flumiclorac had the lowest dry shoot masses. The experiment was conducted in 2014. It was concluded that there is a lower rate of cotton regrowth when the application of the herbicides is repeated at 0 DAMM and 25 DAMM. The 1 324 g ha^{-1} dose of 2,4-D is more efficient. 2,4-D+carfentrazone and 2,4-D+flumiclorac promoted lower dry mass 45 days after administration of the treatments.

Keywords:

Gossypium hirsutum, chemical destruction, glytol, regrowth.

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Unlike other cultivated agricultural plants, the cotton plant serves as a host for pests and diseases in the vegetative and reproductive stages and even after harvest (Azevedo *et al*., 2004). Thus, the destruction of cotton stumps is a mandatory practice under Law No. 8.589 of December 19, 2006 (Brasil, 2008). This practice is carried out with the aim of reducing the potential for pests and diseases, by suppressing their food and shelter in the low season.

The herbicides most commonly used in the destruction of shoots are 2,4-D and glyphosate; however, with the advent of transgenic varieties, tolerant to non-selective herbicides, the use of chemicals is restricted because glytol varieties do not use glyphosate (Andrade Júnior *et al*., 2015).

The experiment was carried out under field conditions after harvesting the cotton plant, cultivar FiberMax 982 GL (GlyTol LibertyLink), on a property located in the municipality of Campo Novo do Parecis - MT, Brazil, during the second harvest of the 2013-2014 agricultural year. The climate of the region is tropical humid megathermal (Aw) (Vianello and Alves, 2004).

The experimental design used was randomized blocks, in a 2x6x3 factorial arrangement, with four repetitions. The plots consisted of 6 rows 6 m long, spaced at 0.8 m. Experimental treatments were based on the combination of two doses of 2,4-D (670 and 1 324 g ha^{-1}), alone or associated in mixture with the herbicides carfentrazone (30 g ha^{-1}), chlorimuron (0.32 g ha^{-1}), flumiclorac (60 g ha^{-1}), imazethapyr (80 g ha^{-1}), flumioxazin (25 g ha^{-1}) and three application times.

In the first season, the application was made immediately 0 days after mechanical mowing (0 DAMM) on the stems of freshly cut plants. The application of treatments in the second period was carried out at 25 DAMM. In the third season, one dose was administered at 0 DAMM and another at 25 DAMM. Mowing was carried out at a height between 0.15 and 0.2 m, after harvesting the cotton with the help of a triton-type mechanical disintegrator.

The chemicals were supplied by coastal sprinkler equipment pressurized with carbon dioxide (CO_2), a spray volume of 150 L ha^{-1}. Applications in the first and third seasons were carried out in up to 20 minutes AMM, according to the methodology described by Siqueri *et al*. (2020). The regrowth evaluations were carried out at 15, 30 and 45 days after the first and second applications by means of three samplings within the useful area of the plot, with leaf samples taken from the regrowth of 5 plants for the determination of dry biomass and subsequent delimitation of the collection point.

The shoots were placed in kraft paper bags for drying and taken to a forced air circulation oven at ±60 °C until a constant mass was reached. Subsequently, the material was weighed on a 0.0001 g precision balance to determine the dry mass. The data obtained were subjected to analysis of variance and comparison of means performed by Tukey's test at 5% probability ($p< 0.05$). The ASSISTAT statistical software was used (Silva and Azevedo, 2009).

When evaluating the dry mass of the collected shoots, 15 days after application, a difference can be seen between the treatments when they were applied 25 DAMM, where the treatment with carfentrazone presented less dry mass of shoots. By analyzing the times within the combinations, it was possible to verify that only for the 2,4-D+carfentrazone combination, there was no difference ($p< 0.05$) between the times. For the other combinations, application at 25 DAMM produced the largest dry mass of regrowth.

According to Andrade Júnior *et al*. (2015), in their research they found that the best results were obtained in treatments with two applications, one after mechanical mowing and the other in the escape, with the use of 2,4-D at a dose of 1 324 g ha^{-1}, associated with the herbicides flumiclorac, carfentrazone and saflufenacil, which obtained 1.3%, 5.2%, and 9.9% of shoots, respectively. The authors also observed that when an application was made to plants that had reshot, the percentage of regrowth was higher, as was verified in this work.

A difference was observed in the values obtained when analyzing the dry mass of the aerial part 15 days after the administration of the treatments, with lower values when the dose of 2,4-D was divided within the application periods and also at a dose of 1 324 g ha^{-1} of this same herbicide. On the other hand, there was also a difference ($p< 0.05$) between the application times in the two doses of 2,4-D, the administration at 0 DAMM when using the dose of 670 g ha^{-1} provided less dry mass

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of shoots (2.42 g). The dose of 1 324 g ha^{-1}, supplied at 0 DAMM, did not differ from the others (0 DAMM and 25 DAMM), but it showed less dry mass of the shoots than at 25 DAMM.

The research by Corrêa and Gomes (2005), when evaluating the regrowth data at 15 days after the first administration, showed more than 37.9% regrowth when using 2,4-D in doses of 670 g ha^{-1}, while at 1 324 g ha^{-1}, the regrowth was 21%. The lowest result (18.7%) was observed by the authors when making two applications of 2,4-D at 1 324 g ha^{-1}, corroborating data from the present study, in which the best control occurred with the same dose, regardless of the time at which the herbicide was administered.

Authors such as Andrade Júnior *et al*. (2016), when studying the chemical destruction of cotton stumps in Mato Grosso, found that the best treatments, which showed 0% regrowth in the last evaluation, were two applications of 2,4 D+glyphosate (2 L ha^{-1} + 1 kg ha^{-1}) and two applications of 2,4 D+glyphosate (2 L ha^{-1} + 2 kg ha^{-1}), which showed, as in the present work, greater efficiency when two applications are made.

These data are consistent with those reported by Embrapa (2004), which evaluated the control of regrowth of herbaceous cotton stumps under zero tillage, where it was verified that higher doses of glyphosate (4 L ha^{-1} and 5 L ha^{-1}), 2,4-D (4 L ha^{-1}), and the mixture of the two products in the ratio of 2 L ha^{-1} of glyphosate to 2 L ha^{-1} of 2,4-D significantly reduced the biomass.

In the collection carried out 45 days after application, when evaluating the behavior of herbicides at doses of 2,4-D and application times, a significant difference ($p< 0.05$) was observed between treatments of 670 g ha^{-1} at 25 DAMM, with 2,4-D+carfentrazone, 2,4-D+flumiclorac, 2,4-D +imazethapyr, and 2,4-D+flumioxazin showing the lowest values of dry mass of the shoot (3.23; 3.32; 2.96, and 3.1, respectively).

Carfentrazone, as well as flumioxazin and flumiclorac, belongs to the chemical group of triazolinones and its mechanism of action acts by inhibiting protoporphyrinogen oxidase, and causes rapid desiccation of susceptible species and symptoms can be observed shortly after chemical treatment (Dayan *et al*., 1997).

With the application at 0 DAMM, only in the 2,4-D+carfentrazone treatment was there no difference ($p< 0.05$) among the 2,4-D doses, and in the other treatments, the dose of 1 324 g ha^{-1} was effective. When the application was made at 25 DAMM, in the 2,4-D alone, 2,4-D+carfentrazone, and 2,4-D +chlorimuron treatments, the highest doses of 2,4-D also showed less dry mass of shoots (4.19 g), and in the other treatments, no difference ($p< 0.05$) was found among the doses of 2,4-D.

At 0 DAMM and 25 DAMM, the highest dose of 2,4-D (1 324 g ha^{-1}) in treatments with 2,4-D alone, 2,4-D+chlorimuron, and 2,4-D+flumiclorac was more effective, with less dry mass of shoots. This behavior showed that there is variation in the control of regrowth and depends on the time of application and treatment used for doses of 2,4-D. According to Oliveira Júnior *et al*. (2006), there is a consistent trend that sequential applications provide more effective weed control.

In the evaluation of the mass of the shoots at 45 days after application, with the dose of 2,4-D (670 g ha^{-1}), a significant difference ($p< 0.05$) was observed between the treatments for the different times of application, where 2,4-D alone showed less dry mass of shoots when was applied on the DAMM (Table 1). The 2,4-D+imazethapyr and 2,4-D+flumioxazin treatments did not differ in application at 25 DAMM or 0 DAMM and 25 DAMM and showed the lowest values of dry shoot mass.

Table 1. Display of the significant interaction between application times, herbicides, and doses of 2,4-D, for dry mass of FM 982 GL cotton shoots, determined at 45 days after application.

Herbicide (H)	2,4-D (670 g ha^{-1})			2,4-D (1 324 g ha^{-1})		
	0 DAMM	25 DAMM	0 y 25 DAMM	0 DAMM	25 DAMM	0 y 25 DAMM
2,4-D	3.23 b	6.23 a	7.37 a	2.23 b	4.19 a	3.08 ab
2,4-D + carfentrazone	2.42 ab	3.23 a	1.65 b	2.13 a	1.66 a	1.05 a

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Herbicide (H)	2,4-D (670 g ha^{-1})			2,4-D (1 324 g ha^{-1})		
	0 DAMM	25 DAMM	0 y 25 DAMM	0 DAMM	25 DAMM	0 y 25 DAMM
2,4-D + chlorimuron	4.52 ab	4.8 a	3.56 b	2.41 ab	3.26 a	1.6 b
2,4-D + flumiclorac	3.12 a	3.32 a	3.16 a	2.05 ab	2.89 a	1.25 b
2,4-D + imazethapyr	5.45 a	2.96 b	2.74 b	3.6 a	3.62 a	2.34 a
2,4-D + flumioxazin	4.67 a	3.1 b	2.43 b	2.65 a	2.96 a	2.86 a
LSD Tukey (5%) E(H x 2,4-D) = 1.72						
CV(%) = 18.39						

Means followed by the same letter, lowercase in columns and uppercase in rows, do not differ from each other at the level of 5% by Tukey's test.

The study by Andrade Júnior *et al*. (2015) also observed the importance of a new herbicide administration to eliminate regrowth escapes from the first application, using 2,4-D (1 324 g ha^{-1}) + glyphosate (540 g ha^{-1}) and 2,4-D (1 324 g ha^{-1}) + glyphosate (720 g ha^{-1}). These authors obtained 11.4% and 5% regrowth, while performing two treatments using the same herbicides and doses, there was no regrowth.

Conclusions

Lower cotton regrowth rates are obtained as a function of the time of application of the herbicide when it is repeated twice, 0 DAMM and 25 DAMM. The higher dose of 2,4-D (1 324 g ha^{-1}) is more efficient. Regarding herbicides, variations in their efficiency were observed depending on the time of evaluation, application, and dose of 2,4 D used, with 2,4-D + carfentrazone and 2,4-D+flumiclorac promoting lower dry mass over time. From the last evaluation, 45 days after the administration of the treatments.

Future research that seeks to delve into other herbicides and doses are essential for better cultural management actions of this important fiber-producing species.

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Bibliografía

1 Andrade-Júnior, E. R.; Cavenaghi, A. L. and Guimarães, S. C. 2015. Destruição química da soqueira em variedades de algodoeiro resistentes ao glifosato. Primavera do Leste, IMAmt. Circular Técnica. 8-17 pp.

2 Andrade-Júnior, E. R.; Cavenaghi, A. L. and Guimarães, S. C. 2016. Destruição química de soqueira em variedades resistentes ao glifosato safra. Primavera do Leste, IMAmt. Circular Técnica. 8-29 pp.

3 Azevedo, D. M. P.; Cortez, J. R. B. and Brandão, Z. N. 2004. Uso de desfolhantes, maturadores e dessecantes na cultura do algodoeiro irrigado. Campina grande, Embrapa. Circular técnica. 7-78 pp.

4 Brasil. 2008. Instrução normativa núm. 1524. Regulamento da defesa sanitária vegetal. Dou, 20/08/2008, Seção. 1-2 pp.

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5 Corrêa, J. C. and Gomes, A. C. 2005. Manejo das soqueiras do algodoeiro herbáceo em plantio direto com rotação de culturas nos cerrados. R Ceres. 52(1):739-749. https://www.redalyc.org/pdf/3052/305242983009.pdf

6 Dayan, F. E.; Duke, S. O.; Weete, J. D. and Hancock, H. G. 1997. Selectivity and mode of action of carfentrazone-ethyl, a novel phenyl triazolinone herbicide. Pest Sci. 51(1):65-73. https://doi.org/10.1002/(SICI)1096-9063(199709)51:1<65::AID-PS598>3.0.CO;2-9.

7 Embrapa. 2004. Empresa brasileira de pesquisa agropecuária. Boletim de pesquisa e desenvolvimento. Planaltina, Embrapa Cerrados. 1-15 pp.

8 Oliveira-Júnior, R. S.; Constantin, J. A.; Costa, J. M.; Cavalieri, S. D.; Arantes, G. Z.; Alonso, D. G.; Roso, A. C. and Biffe, D. C. 2006. Interação entre sistemas de manejo e de controle de plantas daninhas em pós emergência afetando o desenvolvimento e a produtividade da soja. Planta Daninha. 24(4):721-732. https://doi.org/10.1590/S0100-83582006000400013.

9 Silva, F. A. S. and Azevedo, C. A. V. 2009. Principal components analysis in the software ASSISTAT-statistical assistance. 393-396 pp.

10 Siqueri, F. V.; Martin, J. B. and Guedes, H. C. 2020. Avaliação de herbicidas para a destruição química de soqueiras do algodoeiro. www.cnpa.embrapa.br/produtos/algodao/publicacoes/trabalhos-cba4/311.pdf 1-3 pp.

11 Vianello, R. L. and Alves, A. R. 2004. Meteorologia básica e aplicações. Viçosa, Universidade Federal de Viçosa. ISBN 85-7269-073-5. 448 p.

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