

Efficiency and quality of glyphosate + carfentrazone application in controlling *Commelina diffusa* depending on the spray nozzles and Triunfo Flex™ adjuvant¹

Eficiência e qualidade da aplicação de glyphosate + carfentrazone no controle de Commelina diffusa em função da ponta de pulverização e do adjuvante Triunfo Flex™

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Abstract - The study aimed to evaluate the efficiency and the quality of technology application of the tank mixture of glyphosate + carfentrazone-ethyl in *Commelina diffusa* control. The experiment was conducted in plastic greenhouse and the experimental units were represented by vessels with four plants of *C. diffusa*. The experimental design was the entirely randomized, with nine treatments in a factorial scheme (4x2)+1, being four spray nozzles, (XR11002; DG11002; TT11002 and AI11002), two spray solutions of glyphosate + carfentrazone-ethyl at 480 + 8 g ha⁻¹ (with and without Triunfo Flex™ adjuvant at 0.05% v v⁻¹) and a check without application. In the spray solution was added the FD&C-1 dye (1500 ppm), and applied over natural (15 replications of four leaves of *C. diffusa*) and artificial targets (4 replications of two plastic blades over the soil). The tracer quantification on the targets was realized by spectrophotometry, beyond evaluated the pH, static surface tension and conductivity of the solutions and control of *C. diffusa* at 5, 10 and 15 days after application. The Triunfo Flex™ adjuvant reduced the surface tension and the pH of carfentrazone-ethyl + glyphosate mixture. There was significant interaction between nozzles and glyphosate + carfentrazone-ethyl solution with the adjuvant for the deposit on the leaves of *C. diffusa*. With the exception of TT11002 model, the other nozzles promoted significant increase of the deposition on *C. diffusa* when combined with the adjuvant. For solution deposition in plastic blades the best performances were characterized by DG11002 nozzle with and without adjuvant and AI11002 nozzle with adjuvant. The initial control of *C. diffusa* with glyphosate + carfentrazone-ethyl was improved when associated with the adjuvant, mainly for AI11002 and TT11002 nozzles.

Keywords: application technology, climbing dayflower, tank mixture, deposition

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Resumo - O trabalho teve como objetivo avaliar a eficiência e a qualidade da tecnologia de aplicação da mistura em tanque de glyphosate + carfentrazone-ethyl no controle de *Commelina diffusa*. O experimento foi conduzido em estufa plástica e as unidades experimentais representadas por vasos com quatro plantas de *C. diffusa*. O delineamento experimental foi o inteiramente casualizado, com nove tratamentos em fatorial (4x2)+1, sendo quatro pontas de pulverização (XR11002; DG11002; TT11002 e AI11002), duas caldas de pulverização de glyphosate + carfentrazone-ethyl a 480 + 8 g ha⁻¹ (com e sem o adjuvante Triunfo FlexTM a 0,05% v v⁻¹) e uma testemunha sem aplicação. Nas caldas de pulverização foi adicionado o corante FD&C-1 (1500 ppm), e aplicadas sobre alvos naturais (15 repetições de quatro folhas de *C. diffusa*) e artificiais (4 repetições de duas lâminas de plástico sobre o solo). A quantificação do traçante nos alvos foi realizada por espectrofotometria, além de avaliado o pH, tensão superficial estática e condutividade das soluções e o controle da *C. diffusa* aos 5, 10 e 15 dias após aplicação. O adjuvante Triunfo FlexTM reduziu a tensão superficial e o pH da mistura glyphosate + carfentrazone-ethyl. Houve interação significativa entre pontas e calda de glyphosate + carfentrazone-ethyl com o adjuvante para o depósito nas folhas de *C. diffusa*. Com exceção do modelo TT11002, as demais pontas promoveram incremento significativo da deposição sobre a *C. diffusa* quando associadas ao adjuvante. Para deposição das soluções nas lâminas de plástico caracterizou-se como as melhores performances a ponta DG11002 com e sem adjuvante, e AI11002 com adjuvante. O controle inicial de *C. diffusa* com glyphosate + carfentrazone-ethyl foi favorecido quando associado ao adjuvante, principalmente para as pontas AI11002 e TT11002.

Palavras-chaves: tecnologia de aplicação, trapoeraba, mistura em tanque, deposição

Introduction

The introduction of genetically modified soybean varieties for resistance to glyphosate has created large changes in the chemical control of weeds. In this sense, the successive application of glyphosate in agricultural areas has selected some species of difficult control, such as *Spermacoce latifolia*, *Commelina benghalensis*, *Tridax procumbens* and *Synedrellopsis grisebachii* (Procópio et al., 2007).

In Brazil, the species *C. benghalensis* (COMBE), *C. villosa* (COMVI), *C. diffusa* (COMDI) and *C. erecta* (EAT) are commonly known as spiderwort, and often, confused among themselves. Incorrect identification of these four species can cause difficulties in chemical control, by presenting different behavior considering the herbicide and it can even occur simultaneously in large agricultural areas (Rocha, 2001, Rocha et al., 2007), raising the costs for the grower. Santos et al. (2001) verified that, in areas of frequent application of glyphosate, the population of *C. benghalensis*

and *C. diffusa* increased due to the tolerance to this herbicide.

Efficient control of species of *Commelina* genus, with tank mixtures of glyphosate + carfentrazone-ethyl was found in studies conducted by Ronchi et al. (2002), Rocha et al. (2007) and Maciel et al. (2011). However, studies with application technology for this tank mixture in order to control *Commelina* genus are fundamental to enable many different management systems, because of the occurrence of a great diversity of species infesting from annual crops to perennial crops. Soares Filho (2008) evaluating the spray solution deposition in four species of *Commelina* found that larger volumes of application do not necessarily determine the largest deposits in plants; as well as the angle of spray nozzles in +30° can enhance the deposition and the uniformity of the solution, but they are dependent on the volume application and on the species studied.

The study aimed to evaluate the efficiency and quality of technology application

of tank mixture glyphosate + carfentrazone-ethyl to control *Commelina diffusa* due to the spray nozzle and the action of Triunfo Flex™ adjuvant.

Material and Methods

The experiment was conducted in plastic greenhouse of State University of Maringá/UEM, at the Regional Campus of Umuarama/PR, located at the latitude 23°47'28.4" South, longitude 53°15'24.0" West and altitude of 379 m.

The experimental units consisted of pots with capacity of 8 kg of soil classified as typical Red Latosol dystrophic, sandy texture (Embrapa, 2006), with four plants of *Commelina diffusa* at the stage of branches with 20 cm long. The experimental design used was entirely randomized with nine treatments arranged in factorial scheme (4x2)+1, where four experimental units were used to evaluate the level of *C. diffusa* control, as well as fifteen replications represented by the set of four leaves of *C. diffusa* and four replications for two plastic blades, located in a horizontal position on the ground.

The treatments were represented by four spray nozzles (XR11002; DG11002; TT11002 and AI11002) and two spray solution conditions (glyphosate + carfentrazone-ethyl 480 + 8 g ha⁻¹, with and without Triunfo Flex™ adjuvant at 0.05% v v⁻¹) and a check without application. It was also added 1500 ppm of FD&C-1 dye in the spray solution as a tracer of deposition according to the methodology described by Souza et al. (2007) and Maciel et al. (2007; 2013).

The spraying was carried out on 11/11/2010, using a CO₂ pressured costal sprayer maintained at work pressure of 2.1 kgf cm⁻², equipped with two nozzles (TeeJet™ manufacturer) spaced apart in 0.5 m and 0.5 m high of the plants, with spray volume of 200 L ha⁻¹ for all treatments. The quantification of the tracer on the leaves of *C. diffusa* and plastic blades was developed by spectrophotometry,

with the values of deposits subsequently transformed in μL g⁻¹ of dry matter and μL cm⁻², respectively. The physico-chemical characteristics related to pH, static surface tension and conductivity of the herbicide solutions, with and without adjuvant, were also evaluated using the methodology described by Maciel et al. (2010).

The *C. diffusa* control was evaluated at 5, 10 and 15 days after application (DAA), considering a scale where 0% means no control and 100% plant death (SBCPD, 1995). At the time of application, the plants of *C. diffusa* had ramifications of approximately 40 cm, and the weather conditions of mean temperature, air relative humidity and wind speed were 32°C, 45.9% and 0.4 m s⁻¹, respectively.

C. diffusa control data were submitted to variance analysis and their means compared by Tukey test at 5% probability level.

Results and Discussion

For physico-chemical characteristics of spray solution, was found that the Triunfo Flex™ adjuvant (0.05% v v⁻¹), in the tank mixture of glyphosate + carfentrazone-ethyl (480 + 8 g ha⁻¹), reduced the surface tension and the solution pH in the range of 10.4 mN m⁻¹ and 0.5, respectively, as well as increased the conductivity in 110 μS cm⁻¹ (Figure 1).

Changes in physico-chemical properties of herbicides spray by adjuvant may modify application solutions, and thus influence both droplets sprayed size (Ruiter, 2002; Carbonari et al., 2005), and undesirable drift formation, draining and evaporation (Roman et al., 2007; Felsot et al., 2010). However, besides the fact that adjuvant are substances capable of improving solutions physico-chemical properties, without presenting direct biological action over targets (Azevedo, 2015), are still restricted in literature papers that assess interactions among the main associations and/or herbicides tank mixtures traditionally used with adjuvant.

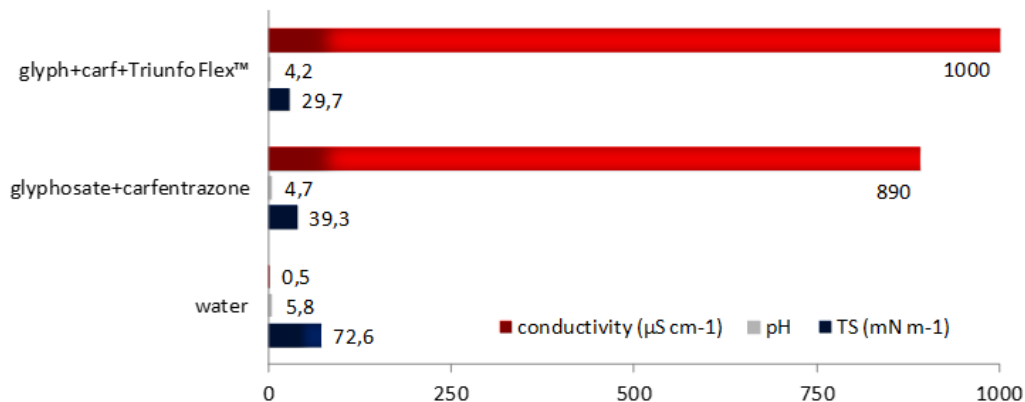


Figure 1. Physico-chemical characteristics of the spray solutions with glyphosate + carfentrazone-ethyl ($480 + 8 \text{ g ha}^{-1}$) with and without Triunfo Flex™ adjuvant. Umuarama/PR, 2010.

The interaction between nozzles and the spray solution with Triunfo Flex™ adjuvant was significant for the deposit on the leaves of *C. diffusa*, indicating the dependency between the two factors (Table 1). With the exception of TT11002, the other nozzles promoted significant increases of glyphosate + carfentrazone-ethyl deposition on the leaves of *C. diffusa* when associated with Triunfo Flex™ adjuvant, approximately to 42.7%, 39.5% and 30.3%, respectively, for XR11002, AI11002 and DG11002 models. However, AI11002 and XR11002 nozzles provided superior spray deposition on *C. diffusa* leaves in relation to DG11002 and TT11002 models. For plastic blades, the deposition of glyphosate + carfentrazone-ethyl application did not show significant interaction between nozzles and adjuvant, but it was characterized by the best performance of the nozzle DG11002 with and without adjuvant, and AI11002 with Triunfo Flex™ adjuvant (Table 1). The results corroborate with the ones observed by Cunha et al. (2010), which reported that the effect of the adjuvant in the droplet spectrum depends on the spray nozzle and the product.

Besides the values of sprayer solution deposition have indicated distinct results for natural and artificial targets, AI11002 nozzle was the only treatment that provided a

significant increase in deposited medium amount for both targets when associated with Triumph Flex™ adjuvant, differently of TT11002 model. Second to Antuniassi e Boller (2011), appropriate use and selection of spray nozzles may consider several factors, among them, include plant and the product to be applied.

Regarding the level of *C. diffusa* control, it is possible to point out that the relatively low dose of glyphosate (480 g ha^{-1}) used in the work evidenced adjuvant potential effects on the action of the mixture, as well as highlighted potential in quality application for the spray nozzles that produce droplet spectrum with distinct characteristics. The Triunfo Flex™ adjuvant improved significantly the speed of initial action of glyphosate mixture + carfentrazone-ethyl, especially for AI11002 and TT11002 nozzles (Table 2). From 10 DAA, on efficient control of *C. diffusa* ($> 86\%$) was found for all spray nozzle models when used Triunfo Flex™ adjuvant, and just to AI11002VS without the use of the adjuvant. Miller e Butler Ellis (2000) related that nozzles with air induction are more sensible to changes of spray solution physic characteristic and that its performance does not follow the same pattern in relation to conventional hydraulic nozzles.

Table 1. Average deposition of glyphosate + carfentrazone-ethyl application with or without Triunfo Flex™ in leaves of *C. diffusa* ($\mu\text{L g}^{-1}$ Dry Matter) and plastic blades ($\mu\text{L cm}^{-2}$), depending on the technology application. Umuarama / PR, 2010.

Treatments	Leaves of <i>C. diffusa</i> ($\mu\text{L g DM}$)		Plastic blades ($\mu\text{L cm}^{-2}$)	
	Without adjuvant	With adjuvant	Without adjuvant	With adjuvant
1. XR11002	2.03 ab B	2.89 a A	150.8 ab A	163.2 b A
2. DG11002	1.67 b B	2.17 b A	209.5 a A	245.2 a A
3. TT11002	1.77 b A	1.84 b A	157.8 ab A	166.5 b A
4. AI11002	2.32 a B	3.24 a A	126.7 b B	183.3 b A
Nozzle (N)	27.185**		8.645**	
Adjuvant	44.896**		5.739*	
N x A	4.916**		0.888 ^{ns}	
CV%	11.12		36.93	

Means followed by the same capital letter in the line and lowercase in the column do not differ by Tukey test at 5% probability. ** = $P < 0.001$; * = $P < 0.05$; ^{ns} = not significant

At 15 DAA, and only the XR11002 and DG11002 nozzles when were not associated with the adjuvant showed unsatisfactory levels of *C. diffusa* control, differing from the other nozzles in the presence or absence of the adjuvant, which reached optimum levels of

efficiency (> 94.5%). However, it is important to point out that Triunfo Flex™ adjuvant besides did not favor sprayer deposition of XR11002 e DG11002 nozzles, influenced significantly the quality application, promoting efficient control of *C. diffusa*.

Table 2. Control *C. diffusa* (%) with glyphosate + carfentrazone-ethyl with or without Triunfo Flex™ to 5, 10 and 15 days after application (DAA), depending on the technology application. Umuarama / PR, 2010.

Treatments	5 DAA		10 DAA		15 DAA	
	Without adjuvant	With adjuvant	Without adjuvant	With adjuvant	Without adjuvant	With adjuvant
1. XR11002	8.3 b B	23.8 c A	68.8 ab B	92.0 a A	81.3 b B	97.3 a A
2. DG11002	5.3 b B	22.5 c A	61.5 b B	86.0 a A	78.3 b B	96.8 a A
3. TT11002	10.3 ab B	36.3 b A	67.8 b B	97.3 a A	94.5 a A	98.8 a A
4. AI11002	19.0 a B	54.5 a A	90.8 a A	95.8 a A	96.8 a A	99.5 a A
5. Check	0.0		0.0		0.0	
Nozzle (N)	30.97**		3.92*		5.97**	
Adjuvant (A)	161.08**		25.32**		23.05**	
N x A	6.12**		1.72 ^{NS}		3.45*	
CV%	23.37		14.02		6.58	

Means followed by the same capital letter in the line and lowercase in the column do not differ by Tukey test at 5% probability. ** = $P < 0.001$; * = $P < 0.05$; ^{ns} = not significant.

Conclusions

The Triunfo Flex™ adjuvant (0.05% v v⁻¹), especially reduced the surface tension of glyphosate + carfentrazone-ethy mixture (480 + 8 g ha⁻¹).

The XR11002, AI11002 and DG11002 nozzles associated to Triunfo Flex™ promoted significant increase of the deposition on the leaves of *C. diffusa*, with different characteristics of plastic blades, which stood out



DG11002 with and without adjuvant, and AI11002 with adjuvant.

The initial control of *C. diffusa* with glyphosate + carfentrazone-ethyl was favored when associated with Triunfo Flex™, mainly for AI11002 and TT11002.

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