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Original Article

Influence of spray volume on the control of *Conyza* spp. in soybean pre-sowing with burndown

Influência do volume de calda no controle de *Conyza* spp. na pré-semeadura de soja com burndown

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Abstract

The herbicide mixture diclosulam + halauxifen appears to be an alternative for the control of *Conyza* spp.*;* however, the spray volume may result in different spray deposition effects on the target and, therefore, on the control. Therefore, the objective of this study was to evaluate the impact of different spray volumes of diclosulam + halauxifen on the control of and damage to the leaf surface of *Conyza* spp. The experiment was conducted in the field in a randomized block design with four replications. Diclosulam + halauxifen (23.52 g ai ha^{-1} + 6.32 g ae ha^{-1}) was applied to *Conyza* spp. at average heights greater than 10 cm, followed by sequential application of glufosinate ammonium (500 g ai ha^{-1}) after 14 days. Different spray volumes (200, 150, 100, 80 and 50 L ha^{-1}) were used. The percentage of droplet coverage was evaluated using hydrosensitive paper and analyzed using DropScan software. After 24 hours of initial application, the leaves were collected for scanning electron microscopy (SEM). Although the different spray volumes did not affect the control, faster necrosis effects were observed at 150 and 200 L ha^{-1}. Moreover, the trichome and stomatal density decreased at a spray volume of 200 L ha^{-1}, indicating greater initial damage at this spray volume. Thus, increased spray spray volumes result in increased spray spray deposition, damage to leaf structures and consequently increased control speed.

Keywords: fleabane, spray flow rate, scanning electron microscopy, diclosulam + halauxifen.

Resumo

O herbicida diclosulam + halauxifen parece ser uma alternativa para o controle de *Conyza* spp.; no entanto, o volume de pulverização pode resultar em diferentes efeitos de deposição do spray no alvo e, portanto, no controle. Portanto, o objetivo deste estudo foi avaliar o impacto de diferentes volumes de pulverização de diclosulam + halauxifen no controle e danos à superfície foliar de *Conyza* spp. O experimento foi conduzido a campo em um delineamento de blocos ao acaso com quatro repetições. Diclosulam + halauxifen (23.52 g ia ha^{-1} + 6.32 g ea ha^{-1}) foi aplicado em *Conyza* spp. em alturas médias maiores que 10 cm, seguido de aplicação sequencial de glufosinato de amônio (500 g ia ha^{-1}) após 14 dias. Foram utilizados diferentes volumes de pulverização (200, 150, 100, 80 e 50 L ha^{-1}). A porcentagem de cobertura de gotículas foi avaliada usando papel hidrossensível e analisada usando o software DropScan. Após 24 horas da aplicação inicial, as folhas foram coletadas para microscopia eletrônica de varredura (MEV). Embora os diferentes volumes de pulverização não tenham afetado o controle, foram observados efeitos de necrose mais rápidos em 150 e 200 L ha^{-1}. Além disso, a densidade de tricomas e estômatos diminuiu em um volume de pulverização de 200 L ha^{-1}, indicando maior dano inicial neste volume de pulverização. Assim, o aumento dos volumes de pulverização resulta em aumento da deposição de spray, danos às estruturas foliares e, consequentemente, aumento da velocidade de controle.

Palavras-chave: buva, vazão de pulverização, microscopia eletrônica de varredura, diclosulam + halauxifen.

1. Introduction

In Brazil, three species of *Conyza* spp. were identified in agricultural areas (*Conyza bonariensis*, *Conyza canadensis* and *Conyza sumatrensis*) (Correa, 2020), with soybean infestations estimated at between 40.8% and 49% of the planted areas, extrapolating to an area of 16,207,463 ha (Lucio et al., 2019; Piasecki et al., 2019). It would be nice to

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include here what the presence of horseweed represents as a result of soybean losses.

In southern and southeastern Brazil, infestations of *Conyza* spp. plants occur frequently in agricultural crops, representing 81% of herbicide applications (Lucio et al., 2019; Piasecki et al., 2019). This dynamic is the result of numerous reports of simple (*Conyza* spp. biotypes resistant to glyphosate, chlorimuron, paraquat, diuron and saflufenacil) and multiple resistance (chlorimuron, glyphosate and paraquat) (The International Herbicide-Resistant Weed Database, 2024).

These cases represent the potential for dissemination to other agricultural production areas, such as the border region of Mato Grosso do Sul, as shown by Albrecht et al. (2020). Resistance mapping studies conducted by Albrecht and Albrecht (2021) identified biotypes resistant to glyphosate and chlorimuron in Mato Grosso do Sul, with resistance also recorded in biotypes in Paraná. Mendes et al. (2021) reported that the state of Mato Grosso do Sul has the greatest number of biotypes of *Conyza* spp. resistant to the herbicide chlorimuron.

Thus, Mato Grosso do Sul is a potential region for the establishment of *Conyza* spp. because there are average temperatures close to 20 °C, which are frequently observed in June, July and August (Embrapa, 2024) and favor the staggered emergence of *Conyza* spp. Therefore, *Conyza* spp. has different germination flows, which begin at the end of the corn cycle and/or after harvest and continue continuously, resulting in plants with different phenological stages close to soybean sowing (Silva et al., 2023a, b; Cantu et al., 2021; Albrecht et al., 2019, 2020; 2021).

Regarding management, for a very long period, the control of *Conyza* spp. in Mato Grosso do Sul has been based on the application of a combination of 2,4-D + glyphosate, followed by a sequential application, commonly performed after 10 to 15 days, using additional contact products (Albrecht et al., 2020). However, the emergence and spread of 2,4D-resistant biotypes, together with rapid necrosis, especially in the southern part of the state, are posing substantial challenges to the effectiveness of this herbicide in controlling *Conyza* spp. (Hrac-Br, 2023).

Faced with this challenging scenario, diclosulam + halauxifen has emerged as a promising alternative for the management of *Conyza* spp. By controlling both emerged weeds and new germination flows, i.e., post- and preemergence control, using two distinct mechanisms of action: acetolactate synthase (ALS) inhibitors and auxin mimics (AGROFIT, 2024). It is important to note that although halauxifen is involved in the mechanism of action of synthetic auxins, it is associated with the chemical group of aryloxyphenoxypropionic acids, a group that is different from 2,4 D (The International Herbicide-Resistant Weed Database, 2024).

Biological control, as greater assertiveness in plants results in higher percentages of control (Adegas et al., 2019). A factor that is directly associated with the correlation between assertiveness *x* target coverage *x* control effectiveness is the volume of herbicide spraying solution (Griesang and Ferreira, 2021) because the quality of an application, among other factors, can be associated with the deposition of the spray solution on a target and the effectiveness of the desired control (Ahmad et al., 2020).

In weed management, the spray volume is crucial because it can impact both the environment and operational efficiency. Several factors should be considered when choosing the spray volume, but the most important factor is the ideal coverage of the target to be sprayed, which varies according to the type of product to be applied. Thus, in theory, systemic herbicides such as halauxifen and diclosulam, which are translocated to plants via the xylem and phloem, do not need high coverage due to their redistribution to different organs of the plant (Krenchinski et al., 2019). Contact herbicides, in theory, need a high coverage rate (Silva et al., 2009).

In this sense, the herbicide diclosulam + halauxifen represents a possibility for the management of *Conyza* spp.; however, aiming at greater efficacy and assertiveness of the biological target, it is necessary to study its use in different spray volumes, including analysis through qualitative and quantitative methodologies. Therefore, this study aimed to evaluate the influence of spray volume on the control and leaf surface damage of *Conyza* spp. through the herbicide diclosulam + halauxifen.

2. Materials and Methods

2.1. Locations of experiments

The experiment was conducted in the field at the Experimental Farm of Agricultural Sciences (FAECA) of the Federal University of Grande Dourados - UFGD, located in the municipality of Dourados in the state of Mato Grosso do Sul, at the following geographical coordinates: 21°57'14.6"S 46°512' 14.2"W. The characteristic Köppen climate classification type is Cwa (humid mesothermic climate, hot summers and dry winters), and the average annual temperature is 22.7 °C (Figure 1) (Fietz et al., 2017).

At the time of the experiment, soil samples with a clayey texture whose physical-chemical properties are shown in Table 1 were collected at a depth of 0-20 m (Santos et al., 2018).

The experimental units consisted of 3 x 5-meter plots. The experimental design used was a randomized block

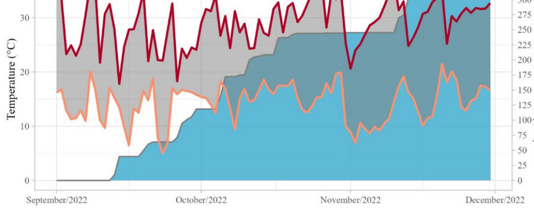

Figure 1. Climogram of daily minimum and maximum temperatures and the accumulated amount of rainfall in the municipality of Dourados, Mato Grosso do Sul, Brazil, from September 1, 2022, to November 30, 2022. The highlighted rectangle represents the period of the experiment.

with four replications. All treatments involved the first application of diclosulam + halauxifen (Paxeo - 23.52 g ai ha^{-1} + 6.32 g ae ha^{-1}) followed by the sequential application of glufosinate ammonium (Finale® - 500 g ai ha^{-1}) 14 days after application (DAA). The treatments were applied with the following spray volumes: 200, 150, 100, 80 and 50 L ha^{-1}, thus totaling five treatments in addition to the control without herbicide application (and without variation in spray volume). The spray volumes were maintained at constant levels for each initial and sequential application.

At the time of application, the infestation of *Conyza* ssp. showed homogeneity of distribution with a density of 42 plants m^2. The plants of *Conyza* spp. had an average height of 12.4 cm, and the average height indicates that there were plants with different heights in the field, but the evaluations and control and scanning electron microscopy were directed to plants with heights greater than 10 cm. According to the BBCH scale (Hess et al., 1997), the plants were in the 30-39 phenological stage.

The herbicide treatments were applied with a backpack sprayer pressurized with CO_2 at a pressure of 2.0 bar, with a spray bar containing six Teejet 110015 fan nozzles spaced 0.5 m apart and with an application volume of 50, 75, 100, or 150 200 L ha^{-1}. At the time of each application, the climatic conditions (temperature, relative humidity, and wind speed) were verified, with a relative humidity of 73% in the first application, a temperature of 23 °C and a wind speed of 1.9 km/h. On Monday, the relative humidity was 71%, the temperature was 30.4 °C, and the wind speed was 1.8 km/h.

Droplet deposition was measured after the application of diclosulam + halauxifen and glufosinate ammonium through water sensitive (WS) paper with a diameter of 30 mm × 30 mm × 80 mm. The papers were collected, and analysis was performed using a Dropscan device and software to determine the percentage of droplet coverage, as shown in Figure 2.

The percentage control of *Conyza* spp. was evaluated at 7, 14, 21, 28, 35 and 42 days after treatment (DAT) according to the visual scale of ALAM (1974), in which 0% was assigned in the absence of herbicide symptoms and 100% for the herbicide. plant control.

2.2. Scanning electron microscopy (SEM)

SEM analyses were performed at the Materials Microscopy and Characterization Laboratory located at

Table 1. Chemical and physical analysis of the soil was performed at the experimental site.

Chemical and physical analysis of the soil									
Ca	**Mg**	**H+Al**	**SB**	**T**	**Al**	**K**	**P**	**V**	**pH**
				cmol/dm³				**%**	**PRM***
4.56	2.08	7.08		13.82	0.12	18.0	40.73	48.8	5.77

*Provisional Replacement Material. Source: TECSOLO Laboratory.

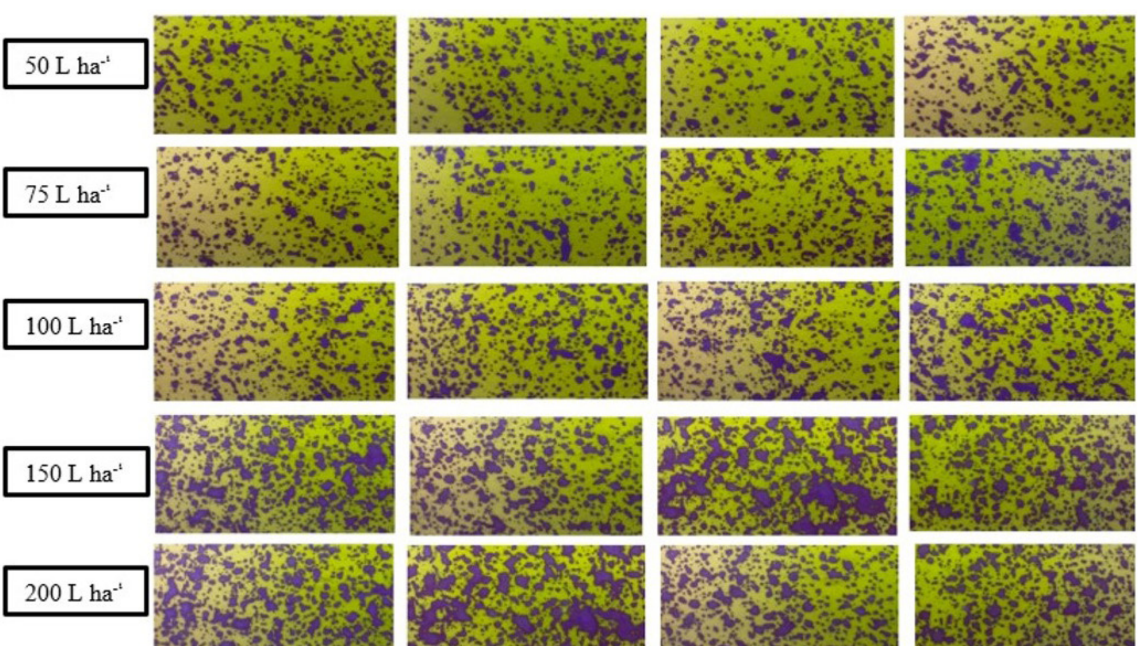

Figure 2. Deposition of drops on water-sensitive paper from grouts treated with different volumes of diclosulam + halauxifen.

the Agricultural Sciences Center of the Federal University of São Carlos.For scanning electron microscopy analysis, two segments of approximately 50 mm^2 in length were removed from the middle region of the young leaves and completely from the plants of the spp. The samples were taken from the adaxial and abaxial surfaces of *Conyza* spp. 48 hours after application of the treatments. The plants were also collected from the control without herbicide application. All samples were stored in 1.5 ML Eppendorf tubes and kept in fixative solution-modified Karnovsky fixative (2.5% glutaraldehyde, 2.5% formaldehyde in 0.05 M sodium cacodylate buffer, pH 7.2, $CaCl_2$ per 20.001 M) until the time of microscopy analysis.

The dried samples were then mounted on stubs and taken to the metallizer in a Leica EM ACE200 vacuum coating device, where they were coated with a thin layer of 15 nm gold to avoid rehydration and observed under a scanning electron microscope. Thermo Fisher Scientific Prism E was used for morphological characterization at 250x, 500x, 1000x and 2000x magnification for each treatment and leaf surface.

2.3. Statistical analysis

For the percentage of control, the GAMLSS model was fitted with an inflated beta distribution of 1's and logit linkage function. The plot effect was entered into the model as a random effect. Block, volume, DAA and interaction factors were considered fixed effects, and significance was assessed using the F test of deviance analysis. The volume and DAA are quantitative factors, and their results are evaluated by means of scatter plots and adjusted lines with polynomial degrees of three and four due to the variable behavior of the control as a function of each of these factors, suppressing the equations because they did not present practical interpretations.

The SEM data were subjected to initial analysis via graphical representation in a Cartesian coordinate system. A kernel estimator was developed to evaluate the spatial homogeneity of the points identified in the images. In addition, to verify the possibility that these points followed a completely random distribution, Ripley's K function was used, and 500 Monte Carlo simulations were conducted to establish the corresponding confidence bands (Baddeley et al., 2014).

All the statistical evaluations were conducted using R software (R Core Team, 2023). To perform the deviation analysis, the gamlss package was used (Stasinopoulos et al., 2017). Point process analysis was subsequently performed using the spatstat package (Baddeley et al., 2013). For the visual representation of the results, we used ggplot2 (Wickham, 2016).

3. Results

The F test of the variance analysis revealed a significant effect of the interaction between volume and DAA (F = 1.734; P = 0.046). Figure 3a shows the percentage of the control as a function of each of the spray volumes used in the experiment (50, 75, 100, 150 and 200 L ha^{-1}). to observe the results of *Conyza* spp. control, as a function of the evaluation days - DAA (7, 14, 21, 28.35 and 42 DAA).

Figure 3a shows that the greatest influence (200 L ha^{-1}) occurred at 7 and 14 DAA. For these evaluation periods, the control was superior to the others, which represents a higher initial control speed when compared to the other volumes. Notably, for the other spray volumes of 50, 75, 100 and 150 L ha^{-1}, regardless of the evaluation period, the variations in the control percentages were considered insignificant.

Figure 3b shows that the use of 200 L ha^{-1} resulted in the highest control rate up to 14 DAA, indicating that a greater volume of spray solution promoted more effective coverage of diclosulam + halauxifen and, consequently, a greater control rate. Notably, in this period, none of the spray volumes resulted in control percentages greater than 80%, and only after 28 DAA was a control greater than 80% observed (for all spray volumes). It is worth noting that the sequential application of glufosinate ammonium

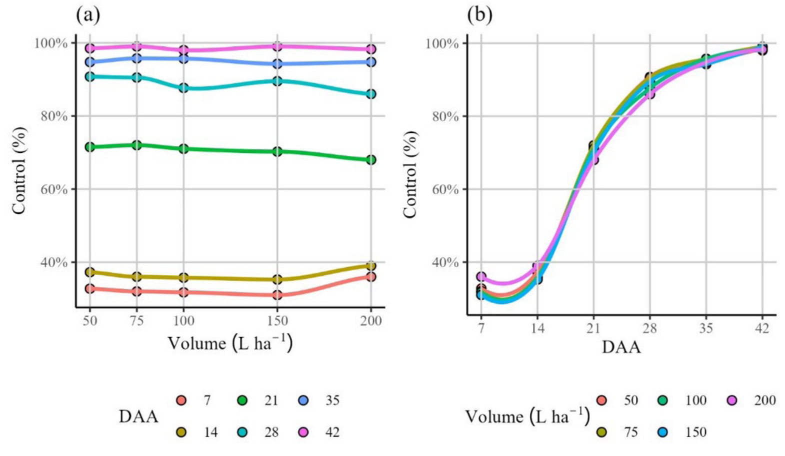

Figure 3. Percentages of *Conyza* spp. control, (a) as a function of each spray volume and (b) as a function of evaluation days – 7, 14, 21, 28, 35 and 42 DAA.

was performed at 14 DAA, and in the evaluation following 21 DAA, it was already possible to observe a control increase close to 30%, regardless of the spray volume, indicating that for the control of plants of *Conyza* spp., when the height exceeds 10 cm, a sequential application of contact herbicide is necessary.

Regarding the coverage rate of the target in Figure 4, it is possible that there was a gradual increase in the spray volume, resulting in increased assertiveness in the target. The behavior was similar for the combination of diclosulam + halauxifen and glufosinate ammonium. Another relevant aspect is that in both Figure 4a and 4b, the maximum values of assertiveness were considered low, below 40% for both herbicides.

In the evaluation of the leaf surface of *Conyza* spp., it was observed that the leaves of the plants were amphistomatic, with anomocytic stomata present on both abaxial and adaxial sides (Figure 5A, 5B, 5C, 5D, 5E, 5F and Figure 6A, 6B, 6C, 6D, 6E, 6F). An important aspect to be highlighted is the greater density and frequency of long tector trichomes on the upper surface of the leaf. Figure 5 shows the integrity of the structures on the leaf surface in the control without herbicide application and the highest level of damage with plasmolyzed structures in Figure 5F, where there was greater target assertiveness and coverage rate due to the greater volume. of the solution was 200 L ha^{-1}.

The plants of *Conyza* spp. exhibited long, unicellular tector trichomes with conical tips, which are notably abundant in the leaf structure, particularly at high density in the abaxial and adaxial regions, as shown in Figure 5A, 5B, 5C, 5D, 5E, 5F, and Figure 6A, 6B, 6C, 6D, 6E, and 6F.

Table 2 presents the exploratory analysis of the point process of the treatments, including the control for the lower abaxial and upper adaxial parts. In the lower abaxial part, 21 points/mm^2 were observed for the control, which was the highest number of points. For 150 L ha^{-1}, the value was 17 points/mm^2. At a spray volume of 200 L ha^{-1},

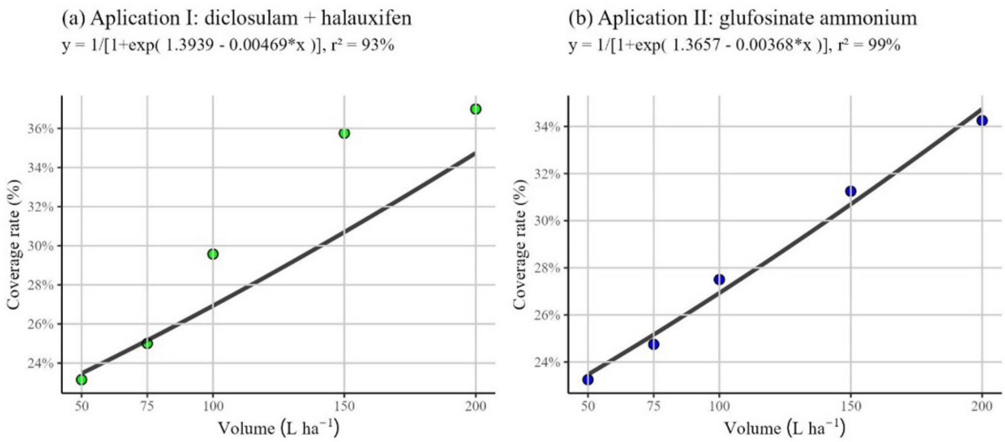

Figure 4. Coverage rate of the target products diclosulan + halauxifen and glufosinate ammonium.

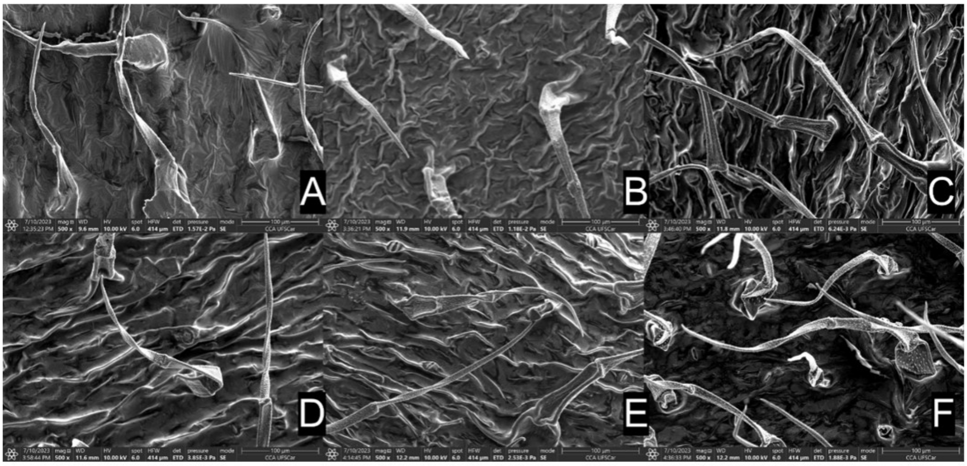

Figure 5. Adaxial surface of *Conyza* spp. at 500x magnification. (A) Control; (B) 50 L ha^{-1}; (C) 75 L ha^{-1}; (D) 100 L ha^{-1}; (E) 150 L ha^{-1}; (F) 200 L ha^{-1}.

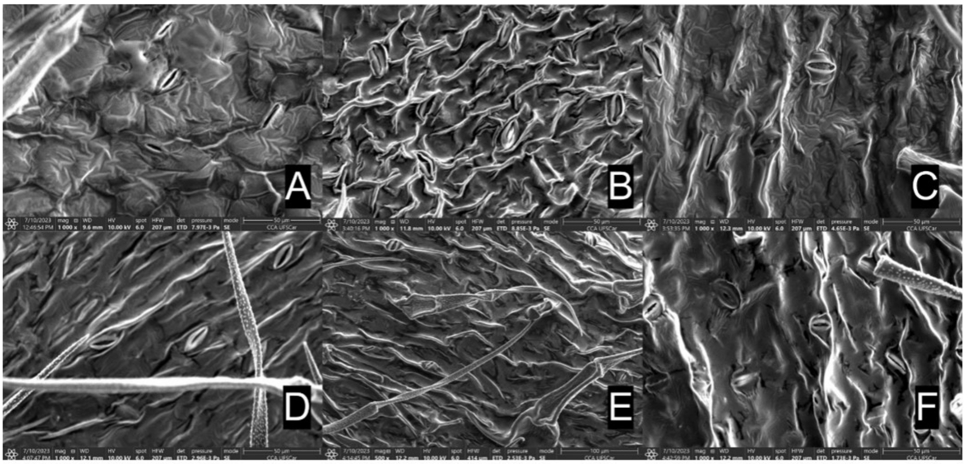

Figure 6. Magnification of the abaxial surface of *Conyza* spp. at 1000x magnification. (A) Control; (B) 50 L ha^{-1}; (C) 75 L ha^{-1}; (D) 100 L ha^{-1}; (E) 150 L ha^{-1}; (F) 200 L ha^{-1}.

Table 2. Results of the number and intensity of points considering a total area of 45.6 mm^2 in the lower adaxial and upper adaxial parts in experiment 1.

Part	Herbicide	Number of points (n)	Average intensity (square millimeters)
Abaxial	Control	21	0.4605
	50 liters	15	0.3289
	75 liters	15	0.3289
	100 liters	15	0.3289
	150 liters	17	0.3728
	200 liters	9	0.1974
Adaxial	Control	26	0.5702
	50 liters	10	0.2193
	75 liters	11	0.2412
	100 liters	17	0.3728
	150 liters	15	0.3289
	200 liters	14	0.3070

9 points/mm^2 were observed. Regarding the observations in the adaxial part of the leaves of *Conyza* spp., the control without herbicide application had 26 points/mm^2, whereas the other spray volumes had 10, 11, 17, 15, and 14 points/mm^2 for 50, 75, 100, 150, and 200 L ha^{-1}, respectively. Thus, there were more points observed on the adaxial part than on the abaxial part.

These values indicate a trend toward a greater number of points observed in the absence of exposure to the herbicide in plants of *Conyza* spp. A lower number of points was also observed at the flow rate of 200 L ha^{-1}, indicating greater damage to the structures present on the leaf surface of this plant, such as the unicellular long tector trichomes. However, analyzing only the number of observed points should not be adopted as a parameter because the intensity of damage to leaf structures must be analyzed.

Figure 7 shows the points observed in the leaf structure in all treatments, both in the abaxial (A) and adaxial (B) parts. spray solution and the control without the application of herbicides. The distribution of observation points on the leaf surfaces showed a tendency toward nongrouping for the treatments with herbicide application at different spray volumes; however, the control treatment tended to cluster. Another comparative observation between the results of the adaxial and abaxial parts was that, regardless of the volume of spray used, a greater intensity of stitches was observed in the abaxial part than in the adaxial part. This is due to the higher herbicide coverage rate on the upper part of the leaf surface, resulting in greater contact with the herbicide spray solution and, consequently, reducing the intensity of the spots on the adaxial surface.

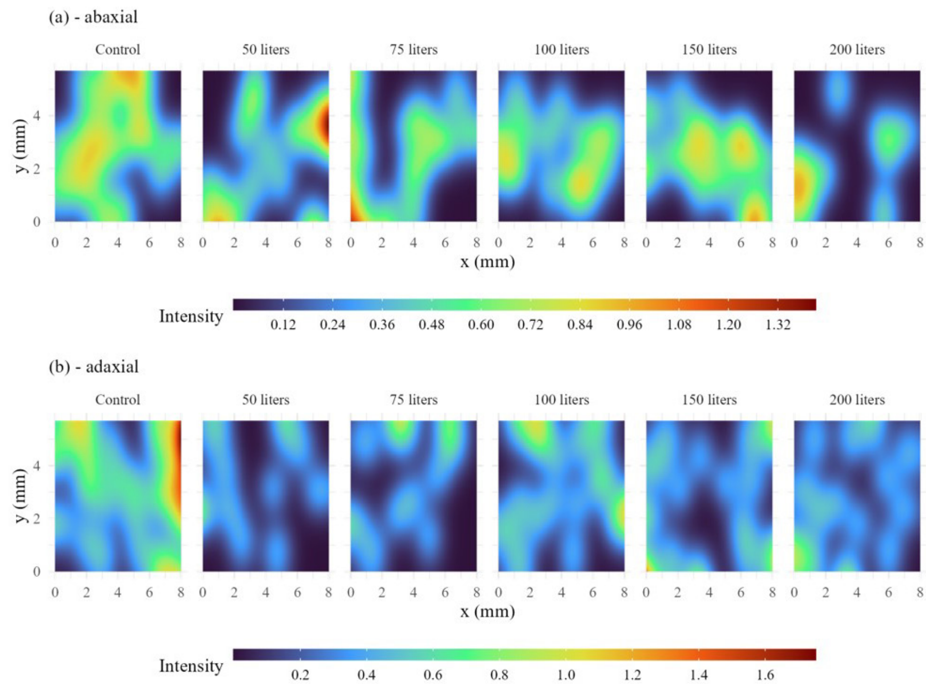

Figure 7. Kernel point process estimator for the analysis of the points in the lower abaxial part (a) and in the upper adaxial part (b).

For the analysis of quantitative SEM data of the abaxial part of *Conyza* spp., a high intensity of regularly shaped spots at the ends of the leaf was observed (Figure 7a). In addition to the clustering pattern, the other spray volumes (50, 75, 100, 150 and 200 L ha^{-1}) tended to decrease the intensity of the points in the following order: control < 50 L ha^{-1} < 75 L ha^{-1} < 100 L ha^{-1} < 150 L ha^{-1} < 200 L ha^{-1}, indicating that the greater the spray volume was, the greater the damage level was.

For the upper adaxial part (Figure 7b), the intensity of the points at the edges of the leaf increased for all treatments. There was also a trend of clustering of the points in the control and not clustering of the different spray volumes (50, 75, 100, 150 and 200 L ha^{-1}). It is not possible to establish a level of damage growth on the leaf surface as a function of the spray volume. This behavior indicates that the greatest contact of the leaf with the herbicide spray occurs in the adaxial part, resulting in greater damage to the leaf structure and hence greater difficulty in establishing a correlation of damage levels.

In the lower abaxial region (Figure 8a), we observed that the observed curve was below the theoretical line for the treatments with radii up to 1.00 mm. This indicates a trend of regularity in the point pattern. However, in all treatments, the observed curve remained within the simulation envelope. This suggests that the spatial patterns do not exhibit significant differences compared to the patterns expected in a scenario of complete spatial randomness. This, in turn, indicates that the distribution of the points was completely random.

In the upper adaxial part (Figure 8b), the observed line was found to be below the theoretical line in the treatments for a radius of up to 2.5 mm, suggesting a trend of regularity in the point process. However, in all treatments in the upper adaxial part, the observed curve remained within the simulated envelope. This finding indicates that the spatial patterns do not show significant differences in relation to those expected in a scenario of complete spatial randomness. Therefore, it is concluded that the distribution of the points was entirely random.

4. Discussion

The results obtained indicate that the use of higher spray volumes (150 and 200 L ha^{-1}) is associated with greater control speeds up to 14 DAA. However, after application of the contact herbicide, no significant differences were observed between treatments, leading to two findings. First, the greater control speed obtained with the use of higher spray volumes had a maximum duration of up to 21 DAA, with negligible differences in the control rates. Second, there was no significant difference between treatments after the application of the contact herbicide.

Importantly, although a greater percentage of the control was observed at higher spray volumes (150 and 200 L ha^{-1}), this difference was not significant compared to that at the other tested spray volumes. This aspect is important because very high spray volumes can lead to possible environmental impacts and the intensification of operating activities due to the greater amount of water used in spraying, while excessive reduction of the spray volume optimizes operating efficiency by reducing consumption of water (Oliveira Neto et al., 2018).

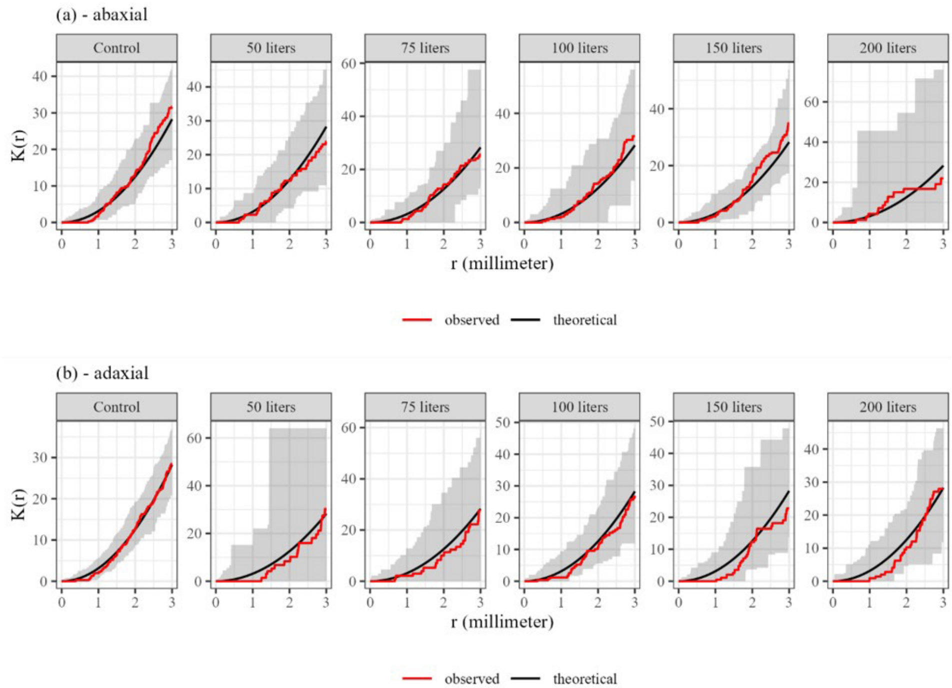

Figure 8. Representation of the analysis by point process in the lower abaxial part (a) and in the upper adaxial part (b).

Cunha et al. (2022) reported that for the control of *Conyza* spp., variations in spraying tips and volumes did not affect the effectiveness of dicamba combined with glyphosate, but the results were not significantly different. The authors observed similar control efficacy for TTI and MUG spray nozzles regardless of the spray volumes used (100 and 125 L ha^{-1}). In the same study, it was reported that for systemic herbicides, a reduction in spray volume may result in inadequate spraying solution deposition, especially when associated with ultracoarse droplets. In contrast, higher spraying volumes can culminate in spraying liquid. However, the authors emphasize this behavior as a trend because, as in the present experiment, no statistically significant differences were observed.

Notably, diclosulam + halauxifen was effective at controlling *Conyza* spp., regardless of the spray volume used. This result underscores the ability of this herbicide to meet the current demands of environmental sustainability because effective control of this weed was observed even at ultralow volumes. However, it is important to note that for plants at an advanced phenological stage, sequential applications with contact products are necessary because a single application of diclosulam + halauxifen did not result in percentages of control close to 80%. Similar results were found by Albrecht et al. (2022), who obtained a control greater than 85% when performing the sequential application of halauxifen + diclosulam + glyphosate in *Conyza* spp. at heights between 12-25 cm, followed by the addition of glufosinate ammonium salt at 42 DAA.

In a study conducted by Zobiole et al. (2018), it was observed that the mixture of diclosulam + halauxifen + glyphosate, when combined with ammonium-glufosinate, paraquat, or saflufenacil in sequential applications, at a spray volume of 100 L ha-1, proved to be an important tool for controlling *Conyza* spp. at different stages of development, with plants ranging from 20 to 60 cm in height. Similarly, according to Krenchinski et al. (2019), at the V6 stage of soybean, the treatments that showed the highest control were those containing halauxifen-methyl + diclosulam. These treatments also resulted in a reduction of 87 to 90% in the dry biomass of *Conyza* spp. plants.

It was observed in the deposition of the spray solution on *Conyza* spp. that, regardless of the herbicide used, the maximum percentage of assertiveness was lower than 40%, that is, a value that can be considered low. This can be attributed to the high density of *Conyza* spp. (average density of 42 plants/m^2) at an advanced phenological stage, resulting in a decrease in the deposition of spray droplets on the target plants (Kramer and Legleiter, 2022). In addition, the assertiveness values for diclosulam + halauxifen were lower than those for glufosinate ammonium due to the greater plant mass in the first application and the more open area after sequential application (facilitating the deposition of the solution).

Scanning electron microscopy (SEM) analysis of the adaxial surface of the leaves revealed that in the absence of diclosulam + halauxifen, no damage to the structures present on the leaf surface was detected. However, with the application of 200 L ha^{-1} spray solution, more significant damage was observed to the leaf structure, including complete plasmolysis of the long tector trichomes. This occurs because the adaxial leaf surface is the region with the greatest exposure to spray solution. In addition to the damage observed on the adaxial surface, a greater number of observation points were observed on the adaxial surface than on the abaxial surface.

The observation of a greater density of trichomes on the adaxial surface of *Conyza* spp., as reported by Okumu et al. (2022), is consistent with the results obtained by scanning electron microscopy (SEM). Trichomes play a key role in the interaction with herbicides, directly influencing their effectiveness in controlling *Conyza* spp. Thus, dense coverage of trichomes, as described by Mendes et al. (2022), results in a cuticle surface highly repellent to moisture. Thus, the trichomes observed on the adaxial surface in this study acted as a physical barrier that not only influenced the physiological regulation of the plant but also had a direct impact on the effectiveness of herbicide control.

Thus, the greater the number of observations, the lower the impact of herbicides on these structures, such as trichomes (Alves et al., 2015). This pattern was evidenced in this experiment, where regardless of the leaf surface (adaxial or abaxial), the treatment without herbicide application presented a greater number of observations. The adaxial part, which receives greater spray deposition and, therefore, greater contact with the herbicide, showed greater damage, while the abaxial part, which has less spray contact, exhibited less damage.

Thus, the use of different spray volumes does not affect the effectiveness of the final control of *Conyza* spp., but the use of higher spray volumes and control percentages at acceptable levels at higher speeds, as a result of the greater damage caused to the surface leaves of these weeds. However, the main results of this experiment are related to the efficacy of diclosulam + halauxifen in the control of *Conyza* spp. in a scenario with high dissemination of biotypes resistant to the herbicide 2,4-D. The possibility of using smaller volumes of solution efficiently in the control of *Conyza spp*. favors agricultural and logistical sustainability due to the lower water requirement and number of operations in applications in the pre-sowing burndown of soybeans.

5. Conclusion

The study revealed that a spray volume of 200 L ha^{-1} resulted in higher levels of phytotoxicity in *Conyza* spp. up to 14 days after application (DAA) of diclosulam + halauxifen, indicating a faster efficiency of the herbicide. It became evident that higher spray volumes led to greater efficacy in *Conyza* spp. Additionally, a higher density and frequency of long tector trichomes were observed on the adaxial surface of *Conyza* spp. plants.

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