Alternative herbicides to high developed *Conyza* spp. control in soybean's pre-sowing.

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Abstract. *Conyza* spp. is one of the main weeds in soybean's crop. Its management becomes complex as a result of resistant biotypes to 2,4-D associated to its high development. In this scenario, the purpose of this work was to evaluate the efficacy of alternative herbicides to 2,4-D followed by sequential application in *Conyza* spp.'s control with phenological state superior to 10cm. The experiment was conducted at field in experimental delineation of casualized blocks and in homogeneous and natural infestation's area of *Conyza* spp. The first application was constituted by the treatments: (fluroxypyr + clethodim) + glyphosate; dicamba + glyphosate; triclopyr + glyphosate; chlorimuron-ethyl + glyphosate; (mesotrione + atrazine) + glyphosate; (halauxifen-methyl + diclosulam) + glyphosate; (mesotrione + atrazine) + glyphosate + 2,4-D; tembotrione + atrazine + glyphosate and tembotrione + atrazine + 2,4-D + glyphosate besides the witness with no herbicide application. At 14 days after treatments application, it was done the sequential application through ammonium glufosinate. The percentual control of *Conyza* spp. was evaluated through visual evaluations at 7, 14, 21, 28 and 35 days after the application – DAA. The statistical analyze of the results was conducted by the F test for fixed effect factors and applied the Tukey's test to compare the level among treatments. The best results at 35 DAA were dicamba + glyphosate and triclopyr + glyphosate, while the less effective, was chlorimuron-ethyl + glyphosate.

Keywords. Horseweed, Phenology, Sequential.

1. Introduction

In recent years, weeds from the genre *Conyza* spp. have shown gradual infestation's growth in Brazil cultivable areas [1]. Infesting approximately 16,207,463 hectares of areas planted with soybean, these plants were the main target of control in herbicide's application in Brazil's south and southeast region [2]. Still, it's estimated that *Conyza's* infestation of 0,16 and 0,62 plants/m^2 may result in respective losses of 12,54 and 13,72% in soybean's productivity [3]. This way, its management must be conducted at soybean's dissecation pre-sowing in order to avoid the weed competition and minimize its consequences [4].

At regional scenario, the occurrence of temperatures near 20ºC – frequents in June, July and august – in the south of Mato Grosso do Sul [5] favor the emergence of this weed, which germinative flux persists continuously, resulting in significant development until dates near soybean's sowing [6, 7].

This scenario demands the weeds management to be positioned in two different ways. To control plants in early stages of development – height less than 10cm – the control is done through a single application of isolated products and/or in association [8]. However, to control plants in higher development stages, it's necessary a herbicides sequential application [9], which is frequently done by the application of a systemic product followed by a contact product, like ammonium glufosinate, which by its turn, can help increasing the controls efficacy [10].

Pursuing to obtain a satisfactory control of this weed, one of the most used methods is the application of an auxinic herbicide (2,4-D) associated to glyphosate and followed by a sequential application of a dissection herbicide for posteriorly position of a pre-emergent one [11]. However, the appearance of *Conya* spp. resistant to herbicides inhibitors of ALS, photosystem 1 and ALS end up limiting herbicides options to its control in soybean's dissecation pre-sowing [12].

Given the scenario, the expressive dissemination of *Conyza's* resistant biotypes to 2,4-D – and consequent limitation of efficient products to its control – becomes essential the conduction of researches focused in this thematic, this way, the purpose of the present work was to evaluate the efficacy of alternative herbicides to 2,4-D positioned with a second application of ammonium glufosinate in the control of high developed phonological states *Conyz*a spp.

2. Research Methods

2.1 Local of conduction

The experiment was conducted in the city of Dourados – MS, Brasil; which coordinates are 22° 18' 22"S 54°, 51' 26"W and an altitude of 413 m. The city has Koppens climatic classification of Cwa (clima mesothermic humid, hot summers and dry winters) and medium temperature of 22,7ºC [13]. In the moment of the experiment's instalation, it was colected soil samples of 0-20cm produndity to analyze its physical-chemical properties, which are allocated in Table 1 and Table 2 in cmol/dm^3 unity.

Tab. 1 – Physical and chemical analysis of the soils sample in the experimental area.

Ca	Mg	H+Al	T	Al
4,56	2,08	7,08	13,82	0,12
K	**P**	**V (%)**		**pH**
18	40,73	48,8		5,77

Font: TECSOLO's laboratory.

The experimental design was casualized blocks, in which, were positioned 10 treatments with 4 repetitions each. The experimental unities were constituted by parcels of 3x5m dimensions. The target-plants were plants from the genre *Conyza* spp. with height superior to 10cm and the treatments were allocated in a first herbicide's application followed by a sequential application of ammonium glufosinate at 4 days after application – DAA.

2.2 Treatments application

The applied treatments were: (1) (fluroxipir + clethodim) + glyphosate (250 + 175 + 1000 g a.i. ha^{-1}); (2) dicamba + glyphosate (384 + 1000 g a.i. ha^{-1}); (3) triclopir + glyphosate (1190 + 1000 g a.i. ha^{-1}); (4) chlorimurom + glyphosate (17,5 + 1000 g a.i. ha^{-1}); (5) (mesotrione + atrazine) + glyphosate (100 + 1000 + 1000 g a.i. ha^{-1}); (6) (halauxifen + diclosulan) + glyphosate (4,85 + 25,52 + 1000 g a.i. ha^{-1}); (7) (mesotrione + atrazine) + glyphosate + 2,4-D (100 + 1000 + 1000 + 1209 g a.i. ha^{-1}); (8) tembotrione + atrazine + glyphosate (84 + 1000 + 1000 g a.i. ha^{-1}); (9) tembotrione + atrazine + 2,4-D + glyphosate (84 + 1000 + 1209 + 1000 g a.i. ha^{-1}) e (10) witness with no herbicide application. The sequential application at 14 DAA was effected through ammonium glufosinate (400 g a.i. h^{-1}).

The herbicides were applied through a CO_2 spray with pressure of 2,0 bar and pulverization bar with six Teejet 110.015 tips spaced in 0,5m and with application volume of 175 L.ha^{-1}. Climatic conditions like temperature, air's relative humidity and wind's velocity were affered in the moment of application. In the first experimental application the air's relative humidity was 64,8%, temperature was 23,9ºC and wind's velocity was 1,3 Km⁄h.

2.3 Treatments application

The experimental area presented homogeneous infestation of *Conyza spp.* at a density of 28,4 plants/m^2 and verage height of 13,8cm, which was previously measured through the inventory's square method, which consists in randomly throwing a hollow square with area of 1m^2 in the area for posterior identification and quantification of *Conyza spp.* The visual evaluations of Conyza's control were done at 7, 14, 21, 28 and 35 days after the application – DAA according to the the ALAM's scale [14] in which, it was atributted 0% in cases of symptons ausence and 100% for death of plants.

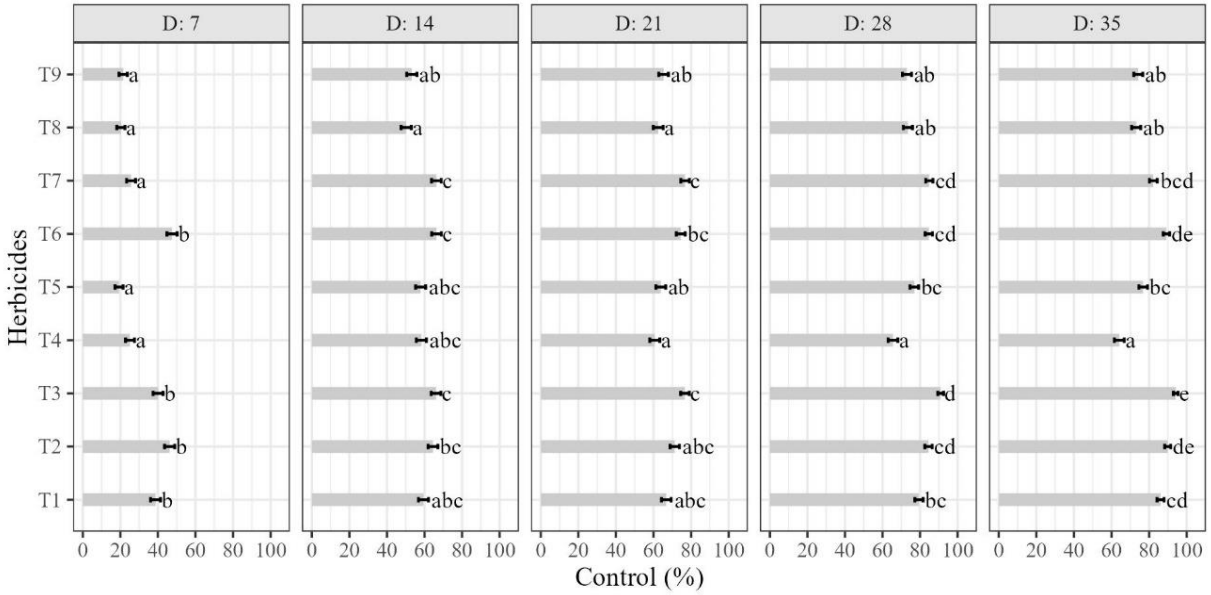
2.4 Statistical analysis

For statistical analysis purposes, it was done the Deviance's analysis, in which it was used the Generalized Additive Model for Location, Scale and Shape (GAMLSS). To verify the distribution's adequation to the model's residues it was applied the Shapiro-Wilk's test, while the F Deviance's analysis was applied to verify the factors allocated as fix effect's significance. To compare the treatments levels it was applied the Tukey's test. The logistic model was utilized to adjust the variables responses for the DAA. In all of the tests, it was adopted a level of 5% significance and every statistical analysis was perfomed in the R's software (R Core Team) with the support of GAMLASS's libraries, emmeans and ggplot2.

3. Results and discussion

In the Figure 1, the *Conyza*'s control data were arranged over the evaluations periods. At 7 DAA – it was noticed that the level of the treatments: (2) dicamba + glyphosate, (3) triclopyr + glyphosate and (6) (halauxifen-methyl + diclosulam) + glyphosate didn't differed among itselves, however, it was significant when compared to the other treatments presenting better control's values yet not satisfactory. At 14 DAA, the same treatments continued to present the highest control's statistics and it was not significant when compared to (1) fluroxypyr + clethodim + glyphosate, (4) chlorimuron-ethyl + glyphosate; (5) mesotrione + atrazine + glyphosate and (7) mesotrione + atrazine + glyphosate + 2,4-D. It must be highlighted that in this same period it was done the sequential application of ammonium glufosinate.

Figure 1. Results of Tukey's test for treatments comparison in each DAA when evaluated the control of *Conyza spp.* in the experiment



In the first evaluation after the sequential application, at 21 DAA, the treatments: (1) fluroxypyr + clethodim + glyphosate, (2) dicamba + glyphosate, (3) triclopyr + glyphosate, (6) (halauxifen-methyl + diclosulam) + glyphosate, (7) atrazine + mesotrione + glyphosate + 2,4-D weren't significant among itselves and presented the highest control values. In the evaluations done at 7, 14 and 21 DAA, neither one of the treatments presented control considered satisfactory (80%).

In the evaluation done at 28 DAA, the treatments (4) chlorimuron + glyphosate, (8) tembotrione + atrazine + glyphosate and (9) tembotrione + atrazine + glyphosate + 2,4-D weren't significant among itselves. It's noticed that all the other treatments presented values nearby 80% except the treatment (4) chlorimuron + glyphosate. Finally, at the fifth and last visual evaluation, the treatments (2) dicamba + glyphosate, (3) triclopyr + glyphosate and (6) (halauxifen-methyl + diclosulam) presented the best results.

In the Figure 2 are allocated the regression analysis, demonstrating the control evaluation of *Conyza spp.* over the evaluation periods. It is noticed that the control effets from the analyzed treatments presented continuous growing through time. The treatments (1) fluroxypyr + clethodim + glyphosate, (2) dicamba + glyphosate, (3) triclopyr + glyphosate and (6) (halauxifen-methyl + diclosulan) + glyphosate presented significant evolution, which ocasionated in the excelent curve adjustment with R^2 inferior to 0,88. To (4) chlorimuron + glyphosate, even presenting similar effect, its maximum evolution was 5% after 14 DAA, which ocasionated in R^2 inferior to 0,66, indicating low curve's adjustment.

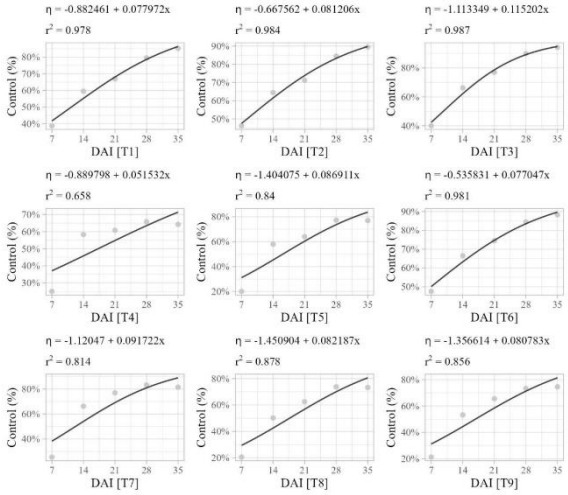


Figure 2. Regression analysis when evaluated the control in the experiment for the DAT. The black line indicates the Beta's regression adjustment with function of *logit* connection, 1/{1 + exp[-η η]}.

According to Silva [15], in scenarios where *Conyza spp.* is at high developed phenological stage and/or inefficient weeds control with only one herbicide application, the sequential application turns into a demand to its efficient management. This demand is noticed at the evaluations done at 7 and 14 DAA due to the fact that the sequential application wasn't done until then, and, therefore, wih no satisfactory control. Its efficiency starts to become perceptible at 21 DAA as the control values approach to the satisfactory (80%). Similarly to Cantu [16] report, the treatments with the herbicides dicamba and triclopir in association to glyphosate are highlighted in effective control of *Conyza spp.* Converserly, the treatment (4) chlorimuron + glyphosate presented the lowest control values, which can be explained by its incorrect positioning as noted by Santos [17], which work, demonstrated that the herbicide chlorimuron presented better control of *Conyza spp.* when applied

in plants in lower phenological stages, reducing its efficacy as the plant develops.

At 35 DAA, the treatments (2) dicamba + glyphosate, (3) tryclopyr + glyphosate and (6) (halauxifen-methyl + diclosulam) + glyphosate obtained greater control's percentages at 90%, which was considered highly satisfactory. These were expected results due to the fact that these products are highlighted as the maine herbicides for *Conyza*'s control in pre-sowing dissecation. It's worth pointing out that a common feature to all these treatments is the presence of a syntetic auxinic's mechanism of action herbicide, which were positioned as 2,4-D's alternatives after the appearance of *Conyza*'s resistant byotipes to rapid necrosis as emphasized by Queiroz [18]. This fact is corroborated by Cantu [16], which reported the high efficiency of herbicides such as dicamba and triclopir to *Conyza*'s control in pre-sowing dissecation.

However, it's highlighted that there is certain positioning difference in these treatments regards the time interval between its application and soybean's sowing due to the fact that dicamba, triclopir and halauxifen must present, respectively, 70, 20 and 7 to 14 days of interval [19]. This time must be respected in order to avoid the *Carryover* effect, which, can ocasionate in significant phytotoxic effects in soybean's crop. Among these treatments, dicamba must be highlighted since the opening of the soybean's planting window associated to the inherent delay of maize's harvest, in many areas there may not exist timely manner for this product's application, which is corroborated by last year's harvest, which, according to Famasul [20] data, at the end of october aproximattedely 50% of the stadual area had been planted.

The treatments (1) fluroxipir + clethodim and (7) mesotrione + atrazine + glyphosate + 2,4-D presented control's percentages higher than 80%. However, it''s noticed a lower efficacy in the mesotrione + atrazine association with no addition of an auxinic herbicide, which by its turn, is indispensable for the obtainment of higher control's percentages of *Conyza.* Conversely, in relation to the comercial association: fluroxipir + clethodim, researchers such as Tahmasebi [21], proved the lower efficieny of fluroxipir in *Conyza*'s control when compared to other mechanisms of action.

Finally, it's compreehended that the treatments: (5) mesotrione + atrazine + glyphosate, (7) mesotrione + atrazine + 2,4-D + glyphosate and (8) tembotrione + atrazine + glyphosate were not effective in the control of *Conyza spp.* These results show that many herbicides frequently used in other cultures – maize – may not present effective controle in soybean's pre-sowing dissecation. However, it must be pointed out that many of the herbicides analyzed in this experiment were repositioned since it were utilized in pasture, such as dicamba, 2,4-D, triclopir and fluroxipir, and some of these, like dicamba and triclopir, presented efficient control scenarios as demonstrated by Cantu [16].

4. Conclusion

It is concluded that for *Conyza spp.,* in plants in high developed phenological stages, the sequential application occasionated in significant variance for its efficient management. After 35 DAA, the treatments triclopir, dicamba, halauxifen-methyl + diclosulam and mesotrione + atrazine associated to glyphosate presented control values superior to 80%. Triclopr was the treatment with the highest percentage of control and the herbicide chlorimuron-ethyl, associated to glyphosate, was positioned as the treatment with lower efficacy.

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