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Efficacy of herbicides applied to *Commelina benghalensis* in the west of the state of Paraná

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ABSTRACT

Ragweed (*Commelina* spp.) is considered a genus tolerant to glyphosate, with reduced control of this herbicide in advanced stages. Thus, the aim of this study was to evaluate the effectiveness of controlling associations of glyphosate with herbicides with different mechanisms of action in *Commelina benghalensis*. The experiment was carried out, after the harvest of the off-season corn in 2018, in Palotina-PR. The experimental design was randomized blocks with 12 treatments (Control, glyphosate + 2,4-D, glyphosate + 2,4-D (aminol 806), glyphosate + dicamba, saflufenacil + glyphosate, glyphosate + dicamba + saflufenacil, diclosulam + glyphosate + saflufenacil, glyphosate + dicamba + chlorimuron, glyphosate + dicamba + glufosinate, glyphosate + dicamba + diclosula, glyphosate + dicamba + (sulfentrazone + diuron) and glyphosate + dicamba + (imazethapyr + flumioxazin) and 4 replicates. 7, 14, 21 and 28 days after application (DAA) and through dry mass at 28 DAA. Regardless of the treatment, at 7 DAA there was no effective control. The scores increased over time, and at 28 DAA, treatments glyphosate + 2,4-D for both doses (1025+975 and 1080+1005); diclosulam + glyphosate + saflufenacil; glyphosate + dicamba + diclosulam and glyphosate + dicamba + (imazethapyr + flumioxazin) were the most effective in the control and reduction of dry mass, reducing the possible associations in the control of ragweed.

Keywords: Glyphosate, Mechanism of action, Combination, Weed control

Eficácia de herbicidas aplicados em trapoeraba (*Commelina benghalensis)* na região oeste do Estado do Paraná

RESUMO

A trapoeraba (*Commelina* spp.) é considerada um gênero tolerante ao glyphosate, apresentando controle reduzido a esse herbicida em estádios avançados. Assim, o objetivo do trabalho foi avaliar a eficácia de controle das associações de glyphosate com herbicidas de diferentes mecanismos de ação em *Commelina benghalensis*. O experimento foi conduzido, após a colheita do milho safrinha em 2018, em Palotina-PR. O delineamento experimental foi de blocos casualizados com 12 tratamentos (Testemunha, glyphosate + 2,4-D, glyphosate + 2,4-D (aminol 806), glyphosate + dicamba, saflufenacil + glyphosate, glyphosate + dicamba + saflufenacil, diclosulam + glyphosate + saflufenacil, glyphosate + dicamba + chlorimuron, glyphosate + dicamba + glufosinato, glyphosate + dicamba + diclosula, glyphosate + dicamba + (sulfentrazona + diuron) e glyphosate + dicamba + (imazetapir + flumioxazina) e 4 repetições. O controle de *C. benghalensis* foi avaliado por notas visuais aos 7, 14, 21 e 28 dias após a aplicação (DAA) e por meio da massa seca aos 28 DAA. Independente do tratamento, aos 7 DAA não houve controle eficaz. As notas foram crescentes ao longo do tempo, sendo que aos 28 DAA, os tratamentos glyphosate + 2,4-D para ambas as doses (1025+975 e 1080+1005); diclosulam + glyphosate + saflufenacil; glyphosate + dicamba + diclosulam e glyphosate + dicamba + (imazetapir + flumioxazina) foram os mais eficazes no controle e redução de massa seca, indicando ser potenciais associações no controle da trapoeraba.

Palavras-chave: Glyphosate, Mecanismo de ação, Associação, Controle de plantas daninhas.

1. Introduction

Weeds are all species of plants occurring in an unwanted location, either spontaneously in agricultural environments or spaces of human activity, directly or indirectly harming these activities (Shaw, 1982). In the case of crops, they interfere with development and, on average, reduce crop productivity by 30 to 40%, in addition to indirectly affecting agricultural efficiency and raising production costs (Galon et al., 2020).

According to Pitelli (1985) and Vasconcelos et al. (2012), the factors affecting the degree of interference between weeds are linked to the crop (species, spacing, and planting density), the weed community (species composition, density, and distribution), the specific conditions in which the crop/infesting community association occurs, edaphoclimatic conditions, agricultural practices and, finally, the time and length of the association period, since the longer the period of coexistence, the greater the degree of interference.

From the family Commelinaceae, known as ragweed, the most important species is *Commelina benghalensis* because it infests crops in tropical and subtropical regions (Leon et al., 2022). In Brazil, this species is an important problem plant in citrus (Nunes et al., 2012), coffee (Silva et al., 2019), soybean (Anselmo et al., 2022), and corn (Matte et al., 2018). The importance of ragweed as a weed plant is due to its efficient reproduction, ability to survive in adverse conditions, and difficulty in control (Wilson, 1981), which is why Holm et al. (1977) include it among the difficult-to-control weeds.

According to Wilson (1981), the difficulty in controlling Commelinaceae species can be attributed to their double mechanism of reproduction (seeds and node rooting). In addition, the recurrent use of one or a few mechanisms of action and lack of rotation between these mechanisms, promote the selection of herbicide-resistant weed biotypes, due to selection pressure (Agostinetto et al., 2015). In this specific case, ragweed plants are considered tolerant to glyphosate and are described in the literature as difficult-to-control plants (less than 30%) (Ronchi et al., 2002).

The difference between tolerance and resistance must be known since there are different degrees of plant susceptibility to the herbicide, which can lead to different levels of control throughout its development and growth (Pereira et al., 2020). Tolerance is not the result of a selection pressure process caused by the successive use of herbicides. Tolerant weeds have the innate ability to survive after the application of an herbicide at the recommended dose, which would be lethal to other species. In turn, resistance is linked to the heritable capacity of certain biotypes to survive and reproduce after the application of doses that would be lethal for susceptible individuals (Christoffoleti et al., 2008).

Differences in weed susceptibility to herbicides have been attributed to the stage of plant development, morphology (area and shape of the blade, angle or orientation of the leaves relative to the spray jet), leaf anatomy (presence of stomata on the adaxial surface, presence of hairs, thickness and composition of the cuticular layer) and differences in absorption, translocation, compartmentalization, and metabolism of the herbicide molecule (Wyrill and Burnside, 1976; Osipe et al, 2017).

For some years, *C. benghalensis* was difficult to control with the existing herbicides and, so the invasive species spread. Furthermore, this plant has become a problem in the western region of the state of Paraná, probably as a result of a selection process promoted by the control methods and herbicides used. Thus, the species has not been controlled in areas where glyphosate has been repeatedly applied. According to Santos et al. (2001) and Jerônimo et al. (2021), *C. benghalensis* is more susceptible to glyphosate than *C. difusa*.

The combination of some herbicides can enhance the control of this genus. Thus, studying the effectiveness of herbicide combinations can contribute to the management of this plant, especially in agricultural regions such as the west of the state of Paraná, as well as proposing efficient chemical control management, reducing the selection pressure for resistant biotypes. Therefore, the objective of this study was to evaluate the control efficiency of combinations of glyphosate and herbicides with different mechanisms of action in *Commelina benghalensis.*

2. Material and Methods

The experiment was conducted in a commercial field during the 2018 off-season, after the off-season corn harvest, between August and September, in Palotina, western region of the state of Paraná, located at coordinates -24º11'39” S and 53, 50'21” W, at 458 m altitude, in a Red Eutroferric Latosol, with clayey texture, whose properties are listed in Table 1.

Table 1. Soil properties at the 0-20 cm layer of the experimental area in Palotina, state of Paraná.

pH	CEC	sand	silt	clay	O.M.
		-------------------%------------------			g/dm^3
5.2	14.64	17.5	16.25	66.25	37.15

The climate of the environment, according to Köppen, is characterized as subtropical hot humid (Cfa), with hot summers (average temperature above 22 °C) and mild winters (average temperature below 18 °C).

Rainfall is distributed in all months of the year, reaching 1,600 mm average annual rainfall. The dry season is not well-defined (Caviglione et al., 2000). For the year 2018, the temperature and rainfall in ten days can be seen in Figure 1. The experiment was a randomized block design with 12 treatments (control; glyphosate + 2,4-D; glyphosate + 2,4-D (aminol 806); glyphosate + dicamba; saflufenacil + glyphosate; glyphosate + dicamba + saflufenacil; diclosulam + glyphosate + saflufenacil; glyphosate + dicamba + chlorimuron; glyphosate + dicamba + glufosinate; glyphosate + dicamba + diclosulam; glyphosate + dicamba + (sulfentrazone + diuron), and glyphosate +dicamba + (imazethapyr + flumioxazin), and 4 repetitions (Table 2).

The treatments were applied on August 4, 2018, when ragweed reached between 40 and 50 cm in height, using a CO_2 pressurized backpack sprayer equipped with a bar with 6 AIXR 110015 spray nozzles, working with 1.4 kgf/cm^2 of pressure, and spray volume of 150 L ha^{-1}, at a temperature of 23°C, relative humidity of 45.1%, and wind speed of 5 km/h. The evaluations were made by visual scores of control percentages at 7, 14, 21, and 28 days after herbicide application (SBCPD, 1995), in which 0% indicates no control and 100%, total control. At the end of the 28 days after herbicide application, ragweed plants inside 1 m^2 of a representative area of the plot were collected for dry mass analysis. Samples were placed in paper bags, identified, and taken to a forced air oven, at 60ºC for 72 hours.

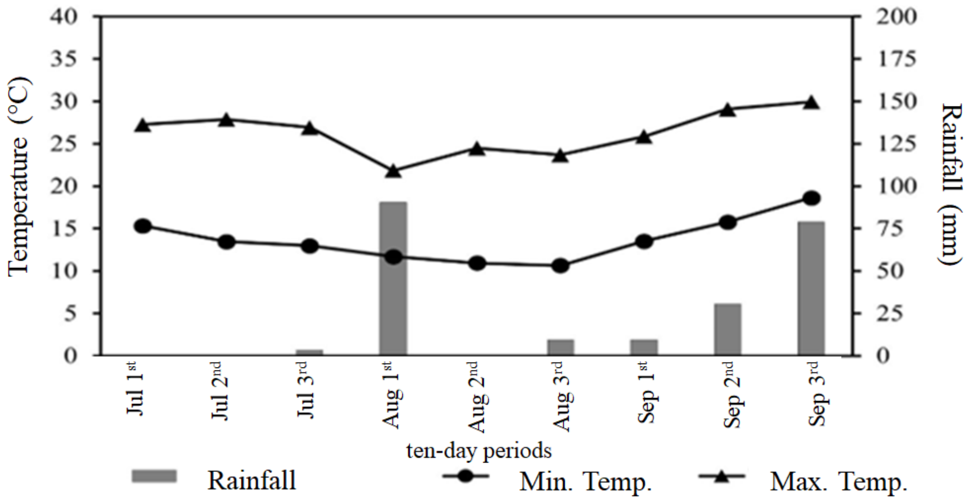

Figure 1. Rainfall and maximum and minimum temperature in the municipality of Palotina, state of Paraná.

Table 2. Doses of herbicide combinations applied to ragweed.

Treatment*	Active ingredient	Dose (L ha-[1] P.C)	Dose g a.i. ha-[1]
Control	Control without application	ND	ND
gly + 2,4-D (1)	(glyphosate + 2,4-D)	5.0 L	1,025 + 975
gly +2,4-D (2)	glyphosate + 2,4 D	3.0 + 1.5 L	1,080 + 1,005
gly + dic	glyphosate + dicamba	3.0 + 1.0 L	1,080 + 480
Saf + gly	saflufenacil + glyphosate[1]	50 g + 3.0 L	35 + 1,080
gly + dic + saf	glyphosate + dicamba + saflufenacil[1]	3 L + 1.0 L + 50 g	1,080 + 480 + 35
diclo + gly + saf	diclosulam + glyphosate + saflufenacil[1]	42 g + 3.0 L + 50 g	35 + 1,080 + 35
gly + dic + chlo	glyphosate + dicamba + chlorimuron[2]	3.0 L+ 1.0 L + 80 g	1,080 + 480 + 20
gly + dic + glu	glyphosate + dicamba + glufosinato[3]	3.0 + 1.0 + 2.5 L	1,080 + 480 + 0.5
gly + dic + diclo	glyphosate + dicamba + diclosulam[2]	3.0 L + 1.0 L + 42 g	1,080 + 480 + 35
gly + dic + (sulf + di)	glyphosate + dicamba + (sulfentrazona + diuron)[2]	3.0 L + 1.0 L + 1.4 g	1,080 + 480 + 1.0
gly + dic + (ima + flu)	glyphosate + dicamba + (imazetapir + flumioxazina)[2]	3.0 L + 1.0 L + 0.6 L	1,080 + 480 + 0.12

[1] - Added with 0.5% Dash® adjuvant; [2] – added with 0.5% Assist® adjuvant; [3]- added with 0.1% Aureo® adjuvant. Active ingredients between parentheses indicate the use of a formulated product. *Treatments with their respective trade names: EnlistDuo (gly + 2,4-D (1)), Gli over + Aminol 806 (gly +2,4-D (2)), Gli over + Atectra (gly + dic), Heat + Gli over + Dash (Saf + gly), Gli over + Atectra + Heat + Dash (gly + dic + saf), Spider + Gli over + Heat + Dash (diclo + gly + saf), Gli over + Atectra + Classic + Assist (gly + dic + chlo), Gli over + Atectra + Finale + Aureo (gly + dic + glu), Gli over + Atectra + Spider + Assist (gly + dic + diclo), Gli over + Atectra + Stone + Assist (gly + dic + (sulf + di)), Gli over + Atectra + Zhetamax + Assist (gly + dic + (ima + flu)).

After samples were placed in paper bags, identified, and taken to a forced air oven, at 60ºC for 72 hours, the dry mass of the samples was determined on a precision scale. Data were tested by analysis of variance and, when significant, the means were compared by Tukey's test at 5% probability using the statistical software Agroestat (Barbosa; Maldonado Júnior, 2009). Pearson's correlation analysis was run using the MiniTab software.

3. Results and Discussion

Table 3 was prepared from the results obtained in the visual control analysis. In the first evaluation (7 DAA), no effective control of ragweed was observed, but in general, in this evaluation, the first effects of the application could be observed in treatments gly + 2,4-D (2 doses) and gly + dic + (sulf + di). Throughout the evaluations, there was an increase in control, that is, the symptoms were more severe. Even at 28 DAA, treatments gly+dic; saf+gly; and gly+dic+glu were the least expressive for ragweed control, presenting, respectively, 55.5; 59.75, and 63.25% control. Studies show that applications of glyphosate + dicamba herbicides are effective in controlling ragweed when higher doses are used (960 g a.e. ha^{-1} glyphosate and 200 g a.e. ha^{-1} dicamba) (Osipe et al., 2017).

The probable inefficiency of the gly + dic treatment may also be related to the possible resistance of ragweed to herbicides. In this context, Pereira et al. (2020) report that the addition of an auxin mimic increases control efficiency, which was observed in treatment gly+2,4-D (2 doses), which showed better control at 28 DAA, together with diclo+gly+saf; gly+dic+chlo; gly+dic+diclo; gly+dic+(sulf+dic); gly+dic+(ima+flu). These last three treatments have, in addition to a post-emergence effect, a pre-emergence effect as well, due to their composition with selective systemic action herbicides such as Spider, Stone, and Zethamaxx, respectively.

In general, the treatments containing herbicides 2,4-D and glyphosate reached high control efficiency; this is due to the synergistic effect of this mixture, that is, the control of the herbicides in combination is greater than when isolated. This synergism of glyphosate and 2,4-D has also been reported by Takano et al. (2013); this probably occurs due to increased absorption and translocation of herbicides, as also observed in *Conyza bonariensis* (Pretto et al., 2020). In each treatment, the percentage of dry mass in relation to the control was calculated. Treatments gly+2,4-D (2 doses); gly+dic+saf; diclo+gly+saf; and gly+dic+chlo resulted in lower dry mass of ragweed, indicating a better result in weed control (Figure 3). However, only the treatments with glyphosate + 2,4-D, in both doses and the mixture glyphosate + dicamba + imazethapyr + flumioxazin reached levels of mass reduction close to 80%, corroborating the previously observed control effect.

Studies like this should be frequent in the literature, because according to normative instruction 18 of October 11, 2018, the tank mix was released, making the agronomist responsible for the prescription. In addition to assisting in weed management, this also favors product sustainability, as it expands the range of options and minimizes the occurrence of resistant weeds (Oliveira; Constantin; Inoue, 2011).

Table 3. Visual evaluation of control at 7, 14, 21, and 28 days after application (DAA).

Treatments	Control			
	7 DAA¹	14 DAA	21 DAA	28 DAA
Control	0 d	0 d	0 e	0 d
gly + 2,4-D (1)	40.75 ab	69.25 ab	87 a	90 a
gly +2,4-D (2)	41.75 ab	73 ab	87.5 a	94.5 a
gly + dic	15 cd	25 cd	45 d	55.5 c
Saf + gly	35 abc	57.25 abc	60.25 cd	59.75 bc
gly + dic + saf	33.25 abc	75.5 ab	75.5 abc	78.75 ab
diclo + gly + saf	35 abc	86.25 a	86 ab	90.25 a
gly + dic + chlo	24.25 abc	66 ab	82.25 abc	85.5 a
gly + dic + glu	33.5 abc	50 abc	62.5 bcd	63.25 bc
gly + dic + diclo	22.5 bc	75.5 ab	84.25 abc	90 a
gly + dic + (sulf + di)	46.25 a	85.5 ab	85.75 ab	89 a
gly + dic + (ima + flu)	24.25 abc	48.75 bc	81 abc	90 a

*Means followed by different letters, in the same column, are significantly different; [1] Days after application. Active ingredients between parentheses indicate the use of a formulated product. [1] - Added with 0.5% Dash® adjuvant; [2] – added with 0.5% Assist® adjuvant; [3]- added with 0.1% Aureo® adjuvant.*Treatments with their respective trade names: EnlistDuo (gly + 2,4-D (1)), Gli over + Aminol 806 (gly +2,4-D (2)), Gli over + Atectra (gly + dic), Heat + Gli over + Dash (Saf + gly), Gli over + Atectra + Heat + Dash (gly + dic + saf), Spider + Gli over + Heat + Dash (diclo + gly + saf), Gli over + Atectra + Classic + Assist (gly + dic + chlo), Gli over + Atectra + Finale + Aureo (gly + dic + glu), Gli over + Atectra + Spider + Assist (gly + dic + diclo), Gli over + Atectra + Stone + Assist (gly + dic + (sulf + di)), Gli over + Atectra + Zhetamax + Assist (gly + dic + (ima + flu)).

To better understand the relationship between the effects observed for the control evaluation and the dry mass of the treatments, a correlation analysis was carried out between the two variables, considering the control response at 28 DAA. Figure 4 evidences the significant (p<0.001) and negative correlation, with a correlation of -0.90 between the variables. Therefore, in general, the treatments that resulted in the greatest control also had the lowest dry mass of plants. Although glyphosate is recommended for the control of several weeds, including ragweeds, the product alone often does not achieve a satisfactory effect (Rocha et al., 2007). However, in this study, management for field control of this genus was elaborated, using combinations of herbicides that increase the control efficiency.

Martins et al. (2012) examined the application of products associated with the control of some species of *Commelina* spp. and observed that the saflufenacil mixtures resulted in good control of *C. villosa* plants. The application of 2,4-D (720 g ha^{-1}) and 2,4-D + glyphosate (720 + 720 g ha^{-1}) provided the best visual control of *C. benghalensis* and *C. villosa* plants. Ramos and Durigan (1996) tested a mixture of glyphosate + 2,4-D and verified that this treatment presented superior control compared to the isolated treatments in *C. virginica*. Combinations of herbicides with different mechanisms of action can reduce the selection pressure of resistant weed biotypes (Maciel et al., 2011) and, in most cases, are used to increase the weed control spectrum. Another advantage is that the use of mixtures allows for a reduction of doses, which implies a lower risk of crop phytotoxicity, a lower residual effect on the soil, and a reduction in control costs (Souza et al., 1985).

Importantly, the gly + 2,4-D (1) and gly +2,4-D (2) treatments were equivalent to the tank mix of 2,4-D + glyphosate with the ready mix (EnlistDuo), which was a product launched in 2018. The control results of dicamba (Atectra) were explored in several combinations in the present study, as this product was sold again in 2018, after decades outside the Brazilian market, and although it is an excellent product for the management of horseweed (*Conyza bonariensis*), there is still a lack of results in the literature for the control of ragweed.

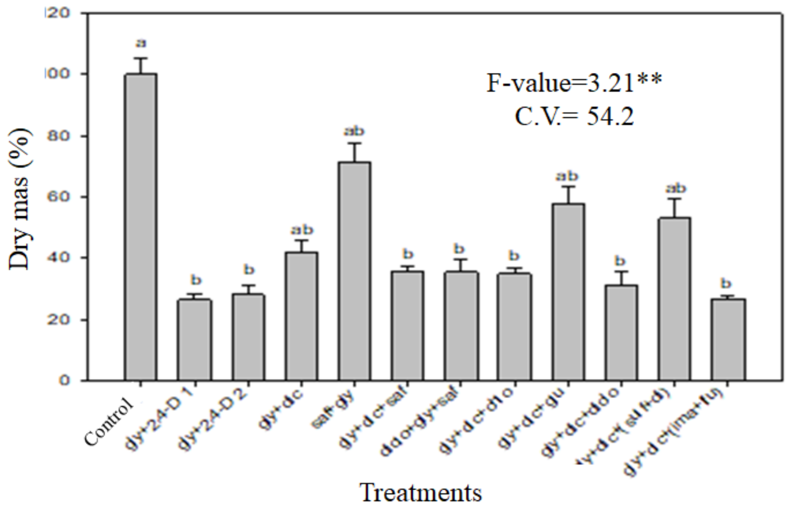

Figure 3. Dry mass of ragweed plants 28 days after application of herbicides in combinations

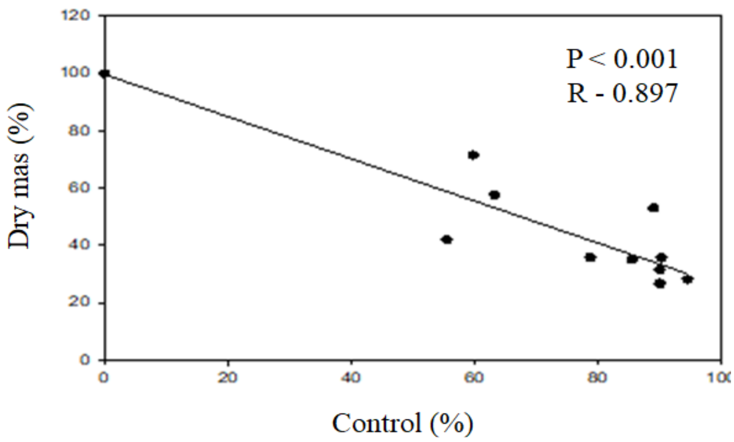

Figure 4. Pearson correlation between dry mass and ragweed plant control. r: degree of correlation (above 0.7 indicates correlation); p: probability of significance).

4. Conclusions

Treatments glyphosate + 2,4-D for both doses (1,025+975 and 1,080+1,005); diclosulam + glyphosate + saflufenacil; glyphosate + dicamba + diclosulam and glyphosate + dicamba + (imazethapyr + flumioxazin) were the most effective both for control evaluation, greater than 90%, and for reducing the mass of ragweed plants, indicating that they are potential mixtures for the control of this plant in the west region of the state of Paraná.

Authors' Contribution

Matheus Moreira Perissato: installation, conduction, and evaluations of the experiment. Alfredo Junior Paiola Albrecht: project guidance, experiment evaluations, statistical data analysis, and writing corrections. Leandro Paiola Albrecht: project guidance, experiment evaluations, and contributions in writing. Willian Bosquette Rosa: data organization, writing adjustments, submission, and corrections. Samara Moreira Perissato: help with statistical analysis of data and contributions in writing. Natalia Heimerdinger: conducting and evaluating the experiment. Willian Felipe Larini: conducting and evaluating the experiment.

Bibliographic References

Agostinetto, D., Vargas, L., Bianchi, M.A. Gazziero, D.L.P., Silva, A.A. 2015. Manejo e Controlo de Plantas Daninhas. UFV, Viçosa. https://www.alice.cnptia.embrapa.br/bitstream/doc/1022690/1/ID430702015trigodoplantioacolheitacap8.pdf

Anselmo, M.C., Oliveira de Almeida, U., Nogueira, A.E., Souza, R.C., Scalcon, J.L., Silva Saraiva, F.J. 2022. Levantamento Fitossociológico de plantas daninhas na cultura da soja, em Cujubim-Ro. Revista Científica da Faculdade de Educação e Meio Ambiente, 13(1), 1-15. DOI: https://doi.org/10.31072/rcf.v13i1.1057

Barbosa, J.C., Maldonado Júnior, W. 2009. Software AgroEstat: Sistema de análises estatísticas de ensaios agronômicos. Universidade Estadual Paulista, Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal.

Caviglione, J.H., Kiihl, L.R.B.; Caramori, P.H.; Oliveira, D. 2000. Cartas climáticas do Paraná. IAPAR, Londrina. CD-ROM.

Christoffoleti, P.J., Ovejero, L., Fernando, R. 2008. Resistência de plantas daninhas a herbicidas: definições, bases e situação no Brasil e no mundo. Associação Brasileira de Ação à Resistência de Plantas Daninhas aos Herbicidas, Piracicaba.

Galon, L., Gabiatti, L. Agazzi, L.R., Wwirich, N.S., Radunz, A.L., Brandler, D., Brunetto, L., da Silva, A.M.L., Aspiazú, I., Perin, G.F. 2020. Competição entre híbridos de milho com plantas daninhas. Agrárias South American Sciences, 2(1), 211- 221. DOI: https://doi.org/10.17648/sas.v2i1

Holm, L.G., Pluncknett, D.L., Herberger, J.P. 1977. The world's worst weeds – distribution and biology. West Center by the University Press of Hawaii, Honolulu.

Jerônimo, A.V., da Silva, R.P., dos Santos, P.H., Hirata, A.C.S., Monquero, P.A. 2021. Sequencial applications os herbicides in the managment os weeds at na advance stage osf development. Revista de Ciências Agrárias, 64(1) 1-10.

Leon, R.G., Creamer, N., Roberg-Horton, S.C., Franzluerbbers, A.J. 2022. Eradication of Commelina benghalensis in a long-term experiment using a multistakeholder governance model: a case of regulatory concerns defeating ecological management success. Invasive Plant Science and Management, 15(3), 152-159. DOI: https://doi.org/10.1017/inp.2022.23

Maciel, C.D.G. Pletine, J.P., Amstalden, S.L., Gazziero, M.A.R., Lima, G.R.G., Oliveira Neto, A.M., Guerra, N., Justiniano, W. 2011. Misturas em tanque com glyphosate para o controle de trapoeraba, erva-de-touro e capim-carrapicho em soja RR®. Revista Ceres, 58(1), 35-42. DOI: https://doi.org/10.1590/S0034-737X2011000100006

Martins, D., Santana, D.C., Souza, G. S., Bagatta, M.V.B. 2012. Manejo químico de espécies de trapoeraba com aplicação isolada e em mistura de diferentes herbicidas. Revista Caatinga, 25(2), 21-28. http://periodicos.ufersa.edu.br/index.php/sistema

Matte, W.D., Iliveira Jr, R.S., Machado, F.G., Constantin, J., Biffe, D.F., Guitierrez, F.S.D., Silva, V. 2018. Eficácia de [atrazine + mesotrione] para o controle de plantas daninhas na cultura do milho. Revista Brasileira de Herbicidas, 17(2), e587. DOI: http://dx.doi.org/10.7824/rbh.v17i2.587

Nunes, M.A., Lameiro, P., Calegario, R.F., Bergamin, M.P., Coerine, L.F., Kitajima, E.W., Bastianel, M., Novelli, V.M., Freitas-Astúa, J. 2012 Trapoeraba (Commelina benghalensis L.) como fonte de inóculo do vírus da leprose dos citros. Citrus Research e Technology, 33 (1), 1-9.

Oliveira J., Silvério, R., Constantin, J.I., Hiroko, M. (2011). Biologia e manejo de plantas daninhas. Omnipax, Curitiba.

Osipe, J.B. Oliveita, J., Takano, H.K., Biffe, D.F. 2017. Spectrum of weed control with 2, 4-D and dicamba herbicides associated to glyphosate or not. Planta Daninha, 35(1) 1-10. DOI: http://dx.doi.org/10.1590/S0100-83582017350100053.

Pereira, L.S., Souza, G.D., Costa E.M., de Oliveira, G.S. Ventura, M.A., Cruz, D.C., Jakelaits, A. 2020. Controle de plantas daninhas tolerantes ao glifosato com 2,4 d e dicamba. Ciência Agrícola, 18(3), 22-28. DOI: https://doi.org/10.28998/rca.v18i3.10065

Pitelli, R.A. 1985. Interferência de plantas daninhas em culturas agrícolas. Informe agropecuário, 11(129), 16-27.

Pretto, M., Polito, R.A., Dysarz, R., Cinelli, R., Heck, T., Nunes, A.L. 2020. Desempenho da aplicação isolada ou em mistura de herbicidas mimetizadores de auxina no controle de Conyza spp. Brazilian Journal of Development, 6(7), 53083-53095. DOI: https://doi.org/10.34117/bjdv6n7-815

Ramos, H.H., Durigan, J.C. 1996. Avaliação da eficiência da mistura pronta de glyphosate + 2,4-D no controle de *Commelina virginica* L. em citros. Planta Daninha, 14(1), 33-41. DOI: http://dx.doi.org/10.1590/S0100-83581996000100004

Rocha, D.C., Rodella, R.A., Martins, D., Maciel, C.D.D.G. 2007. Efeito de herbicidas sobre quatro espécies de trapoeraba. Planta Daninha, 25(2), 359-364. DOI: https://doi.org/10.1590/S0100-83582007000200016

Ronchi, C.P., Silva, A.A., Miranda, G.V., Terra, A.A. 2002. Misturas de herbicidas para o controle de plantas daninhas do gênero Commelina. Planta Daninha, 20 (2), 311-318. DOI: https://doi.org/10.1590/S0100-83582002000200018

Santos, I.C., Silva A.A., Ferreira, F.A, Miranda, G.V., Pinheiro, R.A.N. 2001. Eficiência de glyphosate no controle de Commelina benghalensis e Commelina diffusa. Planta Daninha, 19(1), 135-143. DOI: https://doi.org/10.1590/S0100-83582001000100016

Shaw, W.C. 1982. Integrated weed management systems technology for pest management. Weed science, 30(1), 2-12. https://www.jstor.org/stable/4043545.

Silva, P.V., Barbosa, G.C., Ferrari, A., Tronquini, S.M., Monquero, P.A. 2019. Chemical Control Strategies Of Commelina Benghalensis In Coffee Crop. Coffee Science, 14(2), 231-239. http://www.coffeescience.ufla.br/index.php/Coffeescience/article/view/1576

Souza, J.F.; Melles, C.C.A.; Guimaraes, P.T.G. 1985. Plantas daninhas e seu controle. Informe Agropecuário. 11(126), 59-65.

Takano., Kagueyama, H. 2013. Efeito da adição do 2, 4-D ao glyphosate para o controle de espécies de plantas daninhas de difícil controle. Revista Brasileira de Herbicidas,12(1), 1-13. DOI: https://doi.org/10.7824/rbh.v12i1.207

Vasconcelos, M.C.C., da Silva, A.F.A., Lima, R, Silva. 2012. Interferência de Plantas Daninhas sobre Plantas Cultivadas, 8(1), 01-06.

Wilson, A.K. 1981. Commelinaceae - A review of the distribution, biology and control of the important weeds belonging to this family. Tropical Pest Management., 27(3), 405-418. DOI: https://doi.org/10.1080/09670878109413812

Wyrill, J.B.; Burnside, O.C. 1976. Absorption, translocation and metabolism of 2,4-D and glyphosate in commom milkweed and hemp dogbane. Weed Science, 24(6), 557-566. DOI: https://doi.org/10.1017/S0043174500062949