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Efficacy of florpyrauxifen-benzyl and other herbicides in the control of *Commelina benghalensis*[1]

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ABSTRACT

Commelina benghalensis has become one of the main weeds in the second-crop soybean–corn system, and the use of auxinic herbicides is essential for its control. The objective of this study was to evaluate the control efficacy of treatments applied in off-season management before soybean cultivation using the herbicides florpyrauxifen-benzyl and other synthetic auxins in the control of *C. benghalensis*. Experiment 1 consisted of the application of florpyrauxifen-benzyl + glyphosate, triclopyr + glyphosate, [halauxifen + diclosulam] + glyphosate, [halauxifen + diclosulam] + glufosinate, [halauxifen + diclosulam] + glyphosate + saflufenacil, and [halauxifen + diclosulam] + glyphosate + carfentrazone; Experiment 2 consisted of the application of florpyrauxifen-benzyl + glyphosate, triclopyr + glyphosate, halauxifen + glyphosate, [halauxifen + diclosulam] + glyphosate, [halauxifen + diclosulam] + glyphosate + glufosinate, and [halauxifen + diclosulam] + glyphosate + carfentrazone. At 60 days after application, florpyrauxifen-benzyl + glyphosate reached 73.8% efficacy in the control of *C. benghalensis* in Experiment 1 and 92% in Experiment 2, whereas the other treatments presented a maximum control of 55.5%. The application of florpyrauxifen-benzyl + glyphosate effectively controlled *C. benghalensis* when applied during off-season management before soybean sowing. Florpyrauxifen-benzyl was superior in efficacy to treatments involving the application of other synthetic auxins.

Keywords: Benghal dayflower; arylpicolinates; synthetic auxins; halauxifen; off-season management.

[1] This work derives from experiments related to master's thesis of Cecília Inês Zambrini.

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INTRODUCTION

Chemical control consists of the application of recommended herbicides, which can be used before or after sowing crops. Applications performed in advance during the off-season, aiming at better early control, are intended to eliminate weeds, thus preventing initial weed competition. At this stage, it is important to note that the use of preemergent herbicides is a tool that helps in the control process because it reduces the seed bank.[1,2]

With the increase in herbicide-resistant biotypes, the use of herbicide mixtures with various mechanisms of action and the application of sequential and/or herbicide mixtures have become necessary for control. The increase in the population of resistant biotypes may lead these weeds to dominate the crop.[3]

In addition to known resistant weeds, tolerant plants are a major challenge for crops. It is known that tolerance is possibly related to the developmental stage and morpho-physiological characteristics of the plant.[4] The dayflower (*Commelina* spp.) is an example of a glyphosate-tolerant weed that requires a mixture of other herbicides with glyphosate to increase control effectiveness.[5]

The weed Benghal dayflower (*Commelina benghalensis*) occurs at relatively high frequencies in agricultural areas and must be controlled before soybean cultivation during presowing desiccation. Synthetic auxins such as triclopyr and halauxifen, among others, are used in mixtures with glyphosate for control. In the case of high infestation rates, sequential applications or additions of contact herbicides are needed for better control effectiveness.[6-9]

In this context, a new herbicide, florpyrauxifen-benzyl (Rinskor™), which was developed for weed control in rice and other crops, is now available. In Brazil, this herbicide is registered for use in corn, rice, or soybean presowing, depending on the commercial product used.[10] It is a member of a new family of synthetic auxin herbicides (Group 4 – HRAC/WSSA), the arylpicolinates.[11,12] Studies indicate the selectivity of this herbicide for rice, with a broad spectrum of action on weeds.[11,13] Florpyrauxifen-benzyl is a postemergence herbicide with foliar absorption, systemic action, and little activity in the soil.[12]

The first herbicide of arylpicolinate chemical group to be used was halauxifen, which was approved in Europe in 2015, in Argentina in 2016, and in Paraguay in 2017. It received commercial registration in Brazil in 2021, with the main focus being the control of *Conyza* spp. resistant to 2,4-D.[14,15] Florpyrauxifen-benzyl has been used in rice cultivation, with a broad spectrum of control[16] and has similar characteristics to those of halauxifen but with greater persistence in the soil.[12]

Currently, three commercial products based on florpyrauxifen-benzyl are registered for use in Brazil, one of which is registered for use before soybean sowing. The interval between application and sowing is 60 days, which characterizes the product as an option in off-season weed management, in advance. In comparison, commercial products based on halauxifen + diclosulam require an interval of 7 to 14 days depending on the soil texture.[10] In Brazil's main production system, second-crop corn is harvested between June and August and soybeans are sown between September and October, thus leaving a large interval for weed management.

Thus, it is believed that florpyrauxifen-benzyl is effective in controlling *C. benghalensis* during off-season management, before soybean sowing, at the same level as or superior to other auxinic herbicides. The objective of this study was to evaluate the effectiveness of soybean application in the off-season before the sowing of florpyrauxifen-benzyl and other synthetic auxins in different mixtures for the control of *C. benghalensis*.

MATERIALS AND METHODS

Description of the site and experimental design

Two experiments were conducted in the 2023-2024 season: Experiment 1 in Maripá, PR, Brazil (24°25'09.7"S, 53°51'56.4"W), and Experiment 2 in Campo Mourão, PR, Brazil (24°05'45.2"S, 52°21'36.5"W). The soils of both areas were classified as clayey (Experiment 1: 63.5% clay, 25.3% silt, 11.2% sand, and 2.9% organic matter [OM]; Experiment 2: 58.5% clay, 27.6% silt, 13.9% sand, and 2.6% OM).

The experiments were conducted during the off-season, after the second corn harvest and before soybean sowing. A randomized block design was used with seven treatments (Tables 1 and 2), with four replicates and 3 m × 5 m plots. In Experiment 1, the application occurred on 08/18/2023 under a temperature (T) of 22 °C, a relative humidity (RH) of 69.5%, and a wind speed of 3.6 km h^{-1}. In Experiment 2, the application occurred on 11/01/2023 under a T of 32 °C, an air RH of 62.5%, and a wind speed of 5.2 km h^{-1}.

The areas in both experiments were infested with *C. benghalensis*, with 33 plants m^{-2} and 14.5 cm tall in

Experiment 1 and with 28 plants m^{-2} and 9.5 cm tall in Experiment 2. A backpack sprayer was pressurized with CO_2 and equipped with AIXR 110.015 nozzles, and a constant pressure of 241 kPa and an application speed of 3.6 km h^{-1}, which provided an application volume of 150 L ha^{-1}, was used.

Evaluations and statistical analysis

The control of *C. benghalensis* was evaluated at 15, 30, 45, and 60 days after application (DAA). For these evaluations, grades were assigned through visual analysis to each experimental unit (0 for absence of injury, up to 100% for plant death), considering, in this case, symptoms significantly visible on the plants according to their development.[17]

The data obtained was subjected to analysis of variance via the F test ($p < 0.05$). The treatment means were compared via Tukey's test at the 5% probability level. The software Sisvar 5.6 was used for the analysis.[18]

RESULTS

Experiment 1

The application of [halauxifen + diclosulam] + glyphosate + carfentrazone was the most effective treatment (94.3%) for the control of *C. benghalensis* at 15 DAA in Experiment 1. A decrease in efficacy was observed for all treatments with [halauxifen + diclosulam] and combinations, as well as for the application of triclopyr + glyphosate; these treatments resulted in a maximum control efficacy of 36.3% at 60 DAA. However, the application of florpyrauxifen-benzyl + glyphosate was the most effective treatment for the control of *C. benghalensis* at 60 DAA, at 73.8%. Furthermore, at 30 and 45 DAA, this treatment was also among the most effective, at 79 and 78.3%, respectively (Figure 1).

Table 1: Treatments involving the application of herbicides in mixtures for the control of *C. benghalensis*. Experiment 1, Maripá, PR, 2023

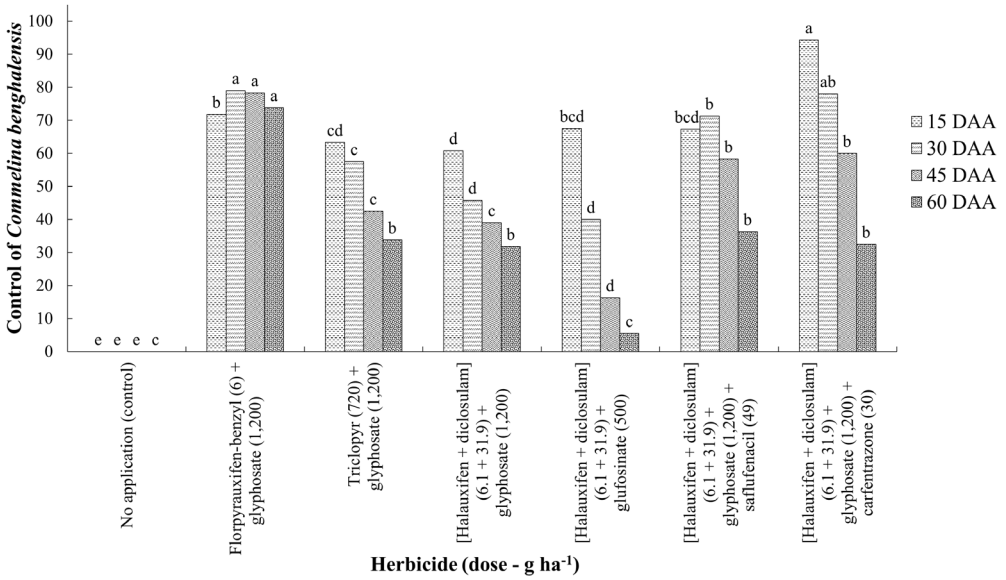
Herbicide	Dose
	g ha^{-1}
No application (control)	-
Florpyrauxifen-benzyl + glyphosate	6 + 1,200
Triclopyr + glyphosate	720 + 1,200
[Halauxifen + diclosulam] + glyphosate	[6.1 + 31.9] + 1,200
[Halauxifen + diclosulam] + glufosinate	[6.1 + 31.9] + 500
[Halauxifen + diclosulam] + glyphosate + saflufenacil	[6.1 + 31.9] + 1,200 + 49
[Halauxifen + diclosulam] + glyphosate + carfentrazone	[6.1 + 31.9] + 1,200 + 30

Commercial products: Gapper (florpyrauxifen-benzyl), Triclon (triclopyr), Paxeo (halauxifen + diclosulam), Glizmax Prime (glyphosate), Finale (glufosinate), Heat (saflufenacil), and Aurora 400 EC (carfentrazone). Doses in acid equivalent (ae) for halauxifen, glyphosate, triclopyr, and florpyrauxifen-benzyl and in the active ingredient (ai) for the others.

Table 2: Treatments involving the application of herbicides in mixtures for the control of *C. benghalensis*. Experiment 2, Campo Mourão, PR, 2023

Herbicide	Dose
	g ha^{-1}
No application (control)	-
Florpyrauxifen-benzyl + glyphosate	6 + 1,200
Triclopyr + glyphosate	720 + 1,200
Halauxifen + glyphosate	7.1 + 1,200
[Halauxifen + diclosulam] + glyphosate	(6.33 + 31.9) + 1,200
[Halauxifen + diclosulam] + glyphosate + glufosinate	[6.1 + 31.9] + 1,200 + 500
[Halauxifen + diclosulam] + glyphosate + carfentrazone	[6.1 + 31.9] + 1,200 + 30

Commercial products: Gapper (florpyrauxifen-benzyl), Triclon (triclopyr), Elevore (halauxifen), Paxeo (halauxifen + diclosulam), Glizmax Prime (glyphosate), Finale (glufosinate), Heat (saflufenacil), and Aurora 400 EC (carfentrazone). Doses in acid equivalent (ae) for halauxifen, glyphosate, triclopyr, and florpyrauxifen-benzyl and in the active ingredient (ai) for the others.



Doses in acid equivalent (ae) for halauxifen, glyphosate, triclopyr, and florpyrauxifen-benzyl and in the active ingredient (ai) for the others. Bars with same color and followed by the same letter did not differ from each other according to Tukey's test at 5% probability.

Figure 1: Control of *C. benghalensis* at 15, 30, 45, and 60 days after application (DAA), Experiment 1, Maripá, PR, 2023.

Experiment 2

Additionally, in Experiment 2, the application of florpyrauxifen-benzyl + glyphosate was the most effective at controlling *C. benghalensis* and was superior to all the other treatments at 30, 45, and 60 DAA, at 83.8, 90, and 92% control, respectively; however, at 15 DAA, the application of florpyrauxifen-benzyl + glyphosate was less effective (72.5%) than that of [halauxifen + diclosulam] + glyphosate + carfentrazone, with 79.5% efficacy. At 60 DAA, all the treatments except florpyrauxifen-benzyl + glyphosate had an efficacy of no more than 55.5% (Figure 2).

DISCUSSION

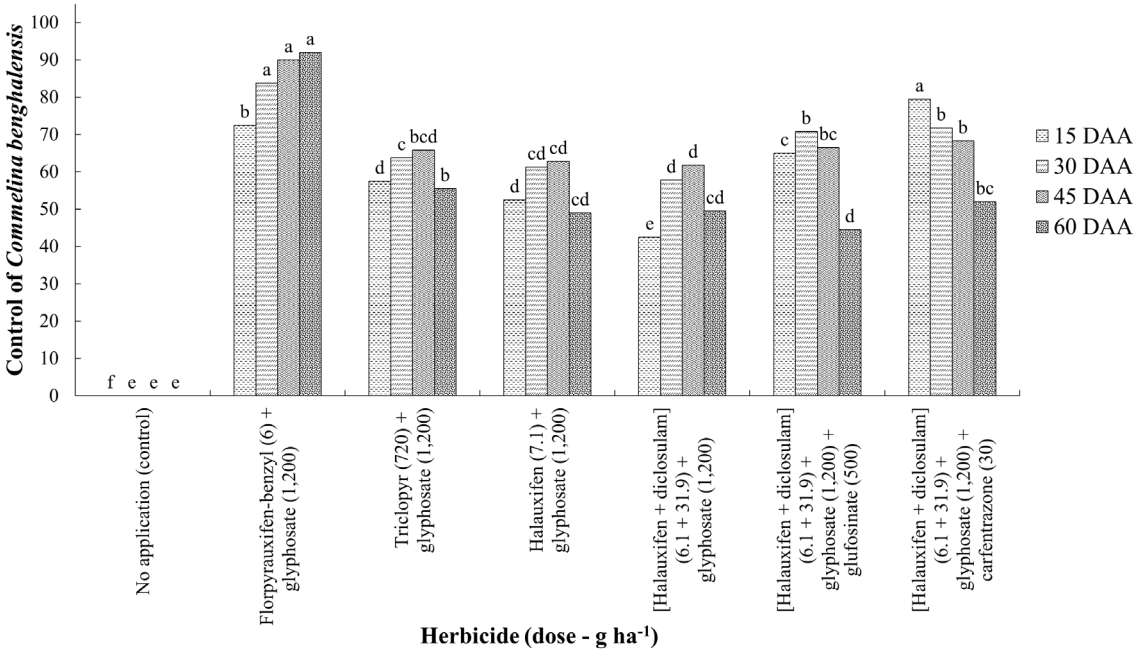
In the present study, florpyrauxifen-benzyl mixed with glyphosate was the most effective treatment for controlling *C. benghalensis*. Florpyrauxifen-benzyl has been used in rice cultivation and is effective in controlling many weeds, such as *Cyperus* spp., *Sesbania* spp. and *Echinochloa* spp.[16,19,20] Other studies have highlighted the efficacy of florpyrauxifen-benzyl in different management programs to control *Amaranthus palmeri*[21] and *Conyza* spp.,[22] which are also important weeds in soybean and corn crops.

Commelina benghalensis plants are common during the second crop of maize (late summer and early autumn). Infestations can persist during the off-season (autumn/winter), with new emergence flows before sowing and soybean cultivation (spring/summer).[23,24] However, few studies have evaluated the efficacy of florpyrauxifen-benzyl in this type of application or even on weeds of the Commelinaceae family, which reinforces the importance of the present study with florpyrauxifen-benzyl.

As options for the control of *Commelina* spp. and other weeds during this period, synthetic auxins such as 2,4-D, dicamba, triclopyr, halauxifen, or fluroxypyr can be used,[9,25-27] as can florpyrauxifen-benzyl. These herbicides can be used in the first application in a mixture with glyphosate, with the control being complemented by the sequential application of desiccant herbicides.[28,29] According to the data obtained in both experiments, the treatments presented a final control efficacy of no more than 55.5%, except for florpyrauxifen-benzyl + glyphosate, which presented a control efficacy of 73.8% and 92% for Experiments 1 and 2, respectively. A potential alternative for achieving higher levels of control would be sequential application with desiccant herbicides to increase their effectiveness in controlling *C. benghalensis*.

Halauxifen in a premix formulated with diclosulam is mainly used to control broadleaf weeds, such as horseweed, before soybean sowing[30] in sequential application with herbicides such as glufosinate and/or protoporphyrinogen oxidase (PPO) inhibitor herbicides.[31-33] Similar results have been reported in the literature for the application of triclopyr to control weeds during soybean presowing.[33-34]

Other synthetic auxins can be used to control *C. ben-*



Doses in acid equivalent (ae) for halauxifen, glyphosate, triclopyr, and florpyrauxifen-benzyl, and in the active ingredient (ai) for the others. Means followed by the same letter did not differ from each other according to Tukey's test at 5% probability.

Figure 2: Control of *C. benghalensis* at 15, 30, 45, and 60 days after application (DAA), Experiment 2, Campo Mourão, PR, 2023.

ghalensis; for example, Bottcher et al.[35] reported control efficacy greater than 95% for the application of dicamba, mixed with glyphosate and in sequential application. Albrecht et al.[7] reported a maximum of 60% control of *C. benghalensis* after the application of 2,4-D or dicamba in different mixtures with glyphosate, glufosinate, and PPO inhibitors; However, levels close to 100% were observed after sequential application of glufosinate + saflufenacil, which demonstrates the complexity of effective management of this weed.

CONCLUSIONS

Florpyrauxifen-benzyl + glyphosate effectively controlled *C. benghalensis* during off-season management before soybean sowing. Florpyrauxifen-benzyl was superior in efficacy to treatments involving the application of other synthetic auxins, such as triclopyr and halauxifen.

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