Effectiveness of Fomesafen and Its Mixtures for Weed Control in Bean Crops

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ABSTRACT

Objective: To assess the effectiveness of the herbicide fomesafen both alone and in combination with other herbicides in controlling weeds and toxicity to beans, and to compare it with other chemical and manual treatments.

Design/methodology/approach: The experiment was established in Ignacio de la Llave, Veracruz, in January 2024. A randomized block experimental design with 10 treatments and four replications was employed: fomesafen at 125, 187.5, and 250 g ha^{-1}, fomesafen+fluazifop-p-butyl at 187.5+125 g ha^{-1}, fomesafen+clethodim at 187.5+118 g ha^{-1}, bentazone at 720 g ha^{-1}, imazethapyr at 100 g ha^{-1}, one hoe weeding, two hoe weedings, and a control with no application. Weed control and bean toxicity were evaluated at 10, 20, 30 and 42 days after the application of the treatments (DAT), and grain yield was quantified.

Results: At 42 DAT, the most effective treatments for controlling *Melampodium divaricatum* were bentazone at 720 g ha^{-1} and fomesafen at 187.5 and 250 g ha^{-1}. Control of *Rottboellia cochinchinensis* was most efficient with fomesafen+fluazifop-p-butyl and fomesafen+clethodim. The best treatment for total weed control, was two hoe weedings. All herbicides caused slight toxicity to the bean, which disappeared after 10 DAT.

Limitations on study/implications: The recommendations can be applied by both small and large bean growers.

Findings/conclusions: The highest grain yields were obtained with two hoe weedings, the mixtures of fomesafen+fluazifop-p-butyl and fomesafen+clethodim and fomesafen at 187.5 and 250 g ha^{-1}.

Keywords: *Melampodium divaricatum*, *Rottboellia cochinchinensis*, herbicides, weeding, yield.

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INTRODUCTION

In the state of Veracruz, 36,130 ha of beans were cultivated in 2023, primarily black beans (*Phaseolus vulgaris* L.) under rainfed and residual moisture production systems (SIAP, 2024). The average bean yield in the region is around 800 kg ha^{-1}, due to various technical, biotic, and abiotic factors affecting the crop. Among the most notable factors are the scarce and erratic distribution of rainfall, pest and disease attacks, and the presence of high weed populations. It is considered that competition with weeds is the factor that most contributes to yield reduction (Esqueda *et al.*, 1997).

Weeds primarily originate from the soil seed bank, and thus appear from the emergence of the crops. If not controlled in a timely and proper manner, they compete with the beans for water, light, and nutrients, resulting in reduced growth and grain yield losses (Horvath *et al.*, 2023). The intensity of the competition is related to the genotype and growth habit of the beans (Teixeira *et al.*, 2009), as well as the type and density of the weeds present (Sankula *et al.*, 2024). In bean plantings in the central region of Veracruz, the butter daisy [*Melampodium divaricatum* (L. C. Rich.) D. C.] is considered the predominant weed species. The main methods for weed control in bean crops are hoe weeding, chisel plowing, and the application of selective herbicides (Hernández-Ríos *et al.*, 2022). In Veracruz, post-emergence application of herbicides formulated with fomesafen and bentazone is common (López-Salinas *et al.*, 2015). These herbicides primarily target broadleaf weeds (dicotyledons); however, when grassy weeds (monocotyledons) are also present, these herbicides are usually mixed with fluazifop-p-butyl, which exclusively controls grasses (Galon *et al.*, 2018). Although there are reports of bean toxicity caused by fomesafen, the damage is generally mild and temporary, with its intensity depending on the bean variety and weather conditions (Cieslik *et al.*, 2014; Marchioretto and Dal Magro, 2017).

Currently, the number of selective herbicides for post-emergence control of broadleaf weeds in beans is very limited, with fomesafen and bentazone being the most widely used. Imazethapyr can also be used in beans (Amini *et al.*, 2023), and unlike the previously mentioned herbicides, it is effective against both broadleaf and grassy weeds (Rheman *et al.*, 2023). It is worth noting that bentazone, fomesafen, and imazethapyr were developed in 1968, 1977, and 1985, respectively. The last experiments to evaluate the biological effectiveness of fomesafen for weed control in beans in Veracruz were conducted over 30 years ago, highlighting the need to update its effectiveness. The objective of this research was to determine the effect of this herbicide, both alone and in combination with herbicides that exclusively control grassy weeds, on weed control and bean toxicity, and to compare it with the control provided by bentazone and imazethapyr, as well as one and two hoe weedings.

MATERIALS AND METHODS

On January 15, 2024, an experiment was established in the locality of Rincón del Tigre, municipality of Ignacio de la Llave, Veracruz. Sowing was carried out manually by dropping seeds continuously into the furrow lines with the Rubí bean variety at a density of 250,000 plants per hectare. Ten treatments were evaluated: Fomesafen at 125, 187.5, and 250 g ha^{-1}; Fomesafen+fluazifop-p-butyl at 187.5+125 g ha^{-1}; Fomesafen+clethodim at 187.5+118 g ha^{-1}; Bentazone at 720 g ha^{-1}; Imazethapyr at 100 g ha^{-1}; one hoe weeding; two hoe weedings; and a control without application. A randomized block experimental design was used with four replications and experimental plots consisting of five furrows, each 5 m in length and spaced 0.60 m apart.

To determine the weed population density, a 1 m×1 m quadrat was randomly placed in the plots corresponding to the untreated controls immediately before the application of the treatments. The weed species within the quadrat were counted, and the height of five plants per replication was measured. Nineteen days after bean emergence (DAE), the seven chemical treatments were applied using a motorized sprayer equipped with a boom containing four flat fan nozzles, calibrated to deliver 392 L ha^{-1}. A non-ionic adjuvant was added to these chemical treatments at a concentration of 250 mL per 100 L of water. The three central rows of each experimental unit were treated, leaving the two lateral rows untreated to serve as weedy controls for weed control evaluations. At the time of application, the height of the bean plants ranged from 11 to 26 cm (average 18.65 cm), and the number of trifoliate leaves ranged from three to six (average 4.15). The first hoe weeding was also performed, while the second hoe weeding was conducted 39 DAE. Fertilization and pest control were carried out following INIFAP recommendations for bean cultivation in Veracruz (López-Salinas *et al.*, 2015). In addition to the germination irrigation, seven additional sprinkler irrigations were applied during the crop's development, with intervals of six to ten days between each irrigation, depending on soil moisture conditions.

At 10, 20, 30, and 42 days after application (DAA), visual evaluations were conducted to estimate the percentage of control for the dominant weed species, as well as the overall weed control percentage, including all species present. The evaluations involved observing the effect of each treatment on the weeds, comparing it to the weeds in the untreated lateral control plots flanking each experimental unit. A percentage scale (0-100%) was used, where 0 indicated no effect of the treatment on the weeds, and 100 indicated complete elimination of the weeds. At the same time the control evaluations were conducted, the toxicity of the treatments to the bean plants was assessed using a percentage scale, where 0 indicated that the treatment caused no toxic effect on the beans, and 100 indicated that the crop was completely eliminated.

The bean harvest was carried out at 91 DAE. The harvested grain was cleaned, its moisture content was determined, and it was weighed. Subsequently, the necessary conversions were made to obtain the grain yield in kilograms per hectare at 14% moisture content. To homogenize the variances, the weed control percentage data were transformed to their arcsine value, and the toxicity data to the square root equivalent (Dey and Pandit, 2020), while the grain yield data did not require transformation. Subsequently, analysis of variance was conducted for these three quantified variables, and in cases where significance was detected, the mean separation test based on the Least Significant Difference (LSD, $\alpha=0.05$) was applied. For clarity, in the Results and Discussion section, the field data are presented with the letters obtained in the mean separation tests of the transformed data.

RESULTS AND DISCUSSION

Five weed species were found at the experimental site: *Melampodium divaricatum* (L. Rich.) D.C. (Asteraceae), *Rottboellia cochinchinensis* (Lour.) Clayton (Poaceae), *Amaranthus hybridus* L. (Amaranthaceae), *Lagascea mollis* Cav. (Asteraceae), and *Cyperus rotundus* L. (Cyperaceae). At the time of treatment application, the average weed coverage was 42.88%, and the total population density was 1,452,500 plants per hectare, of which 1,160,000 (79.89%) were *M. divaricatum*. The height of *M. divaricatum* ranged from 5 to 24 cm, with an average of 15.5 cm.

Weed control and toxicity to beans

In the first evaluation period, bentazone at 720 g ha^{-1} provided total control of *M. divaricatum*, being statistically superior to the other treatments (Table 1).

Control percentages of 90% or higher were obtained with fomesafen at 187.5 and 250 g ha^{-1}, the mixtures of this herbicide with fluazifop-p-butyl and clethodim, and with two hoe weedings. With the lowest dose of fomesafen (125 g ha^{-1}) and one hoe weeding, the control of this species ranged between 80 and 89%, while with imazethapyr at 100 g ha^{-1}, the control was slightly above 50%, surpassing only the untreated control. Fomesafen at its different doses and bentazone at 720 g ha^{-1} had no effect on *Rottboellia cochinchinensis*, as these herbicides primarily control dicotyledonous weeds and occasionally cyperaceae, but not grasses. The latter species was controlled between 85 and 91.3% with fluazifop-p-butyl and clethodim in combination with fomesafen, as well as with one and two hoe weedings. Control with imazethapyr at 100 g ha^{-1} was slightly below 50%. The total control of the present weeds was slightly over 90% with fomesafen at 250 g ha^{-1} and two hoe weedings, being statistically similar to the treatments with fomesafen at 187.5 g ha^{-1} and the mixtures of fomesafen with fluazifop-p-butyl and clethodim, whose controls ranged between 85 and 90%. Slightly higher than 80% control was achieved with fomesafen at 125 g ha^{-1} and one hoe weeding, while with imazethapyr at 100 g ha^{-1}, the control was slightly above 50%. On the other hand, all herbicide treatments caused toxicity to the bean, which consisted of small chlorotic or necrotic areas on the leaves. The greatest damage was observed with imazethapyr at 100 g ha^{-1} (6.5%) and fomesafen at 250 g ha^{-1} (6%), while damage between 2.5% and 3.5% was observed in the plants of the treatments with fomesafen at 125 and 187.5 g ha^{-1}, the mixtures of fomesafen with fluazifop-p-butyl and clethodim, and bentazone at 720 g ha^{-1} (Table 1). At 20 days after application (DAA), except for the treatment with imazethapyr at 100 g ha^{-1}, a slight reduction in the control of *M. divaricatum* was observed in all herbicide treatments. Bentazone at 720 g ha^{-1}, along

Table 1. Effect of treatments on weed control (%) and bean toxicity at 10 DAT. Rincón del Tigre, municipality of Ignacio de la Llave, Ver. Winter-Spring 2024.

Treatment (g ha^{-1})	*Md*	*Rc*	Total	Tox.
Fomesafen (125)	86.3de	0.0d	81.3b	2.5b
Fomesafen (187.5)	90.0cd	0.0d	87.5ab	3.0b
Fomesafen (250)	96.5b	0.0d	92.5a	6.0a
Fomesafen+fluazifop-p-butyl (187.5+125)	92.5bc	91.3a	88.8ab	3.5b
Fomesafen+clethodim (187.5+118)	95.0b	86.3ab	88.8ab	3.5b
Bentazone (720)	100a	0.0d	82.5b	3.0b
Imazethapyr (100)	55.0f	47.5c	52.5c	6.5a
One hoe weeding	83.8e	85.0b	82.5b	0.0c
Two hoe weedings	94.5b	91.3a	92.5a	0.0c
Control without application	0.0g	0.0d	0.0d	0.0c

The letters on the right represent the DMS test (α=0.05). Quantities with the same letter are not statistically different. The comparison is between treatments for each variable. *Md*=*Melampodium divaricatum*, *Rc*=*Rottboellia cochinchinensis*, Tox.=Toxicity.

with two hoe weeding treatments, remained the most effective treatments with 99.5% and 100% control, respectively, and showed statistical superiority over the rest of the treatments (Table 2).

Fomesafen at 250 g ha^{-1} and the mixtures of this herbicide with fluazifop-p-butyl and clethodim provided control of this species between 90 and 95%, while with the medium and low doses, the control values ranged between 80 and 90%. With one hoe weeding, the control was slightly over 70%, while with imazethapyr at 100 g ha^{-1}, although the control of *M. divaricatum* increased, it was slightly over 60%, making it the herbicide treatment with the lowest effectiveness.

Total control of *R. cochinchinensis* was achieved with two hoe weedings, a treatment that was significantly superior to the rest of the treatments. Controls above 90% were observed with the mixtures of fomesafen with fluazifop-p-butyl and clethodim, and slightly over 85% with imazethapyr at 100 g ha^{-1}, whose highest effectiveness was observed after 10 DAA (Esqueda *et al.*, 2006). With one hoe weeding, the control of this species was slightly below 80% (Table 2).

The highest control of the weed complex (100%) was achieved with two hoe weedings, a treatment that was statistically superior to the rest. With the treatments of fomesafen at 250 g ha^{-1} and the mixtures of fomesafen with fluazifop-p-butyl and clethodim, the controls ranged between 85 and 90%. Controls between 70 and 80% were obtained with fomesafen at 125 and 187.5 g ha^{-1}, bentazone at 720 g ha^{-1}, and one hoe weeding, while the lowest controls, around 60%, were provided by imazethapyr at 100 g ha^{-1}. During this evaluation period, no toxicity damage was observed in the beans in any of the treatments (Table 2).

At 30 DAA, slight reductions in the control of *M. divaricatum* were observed in all treatments compared to the previous evaluation. Bentazone at 720 g ha^{-1} provided control of this species close to 98%, which was statistically superior to the rest of the treatments (Table 3).

Table 2. Effect of the treatments on weed control (%) and bean toxicity at 20 DAA. Rincón del Tigre, municipality of Ignacio de la Llave, Veracruz. Winter-Spring 2024.

Treatment (g ha^{-1})	*Md*	*Rc*	Total	Tox.
Fomesafen (125)	82.5c	0.0f	72.5d	0.0
Fomesafen (187.5)	87.5bc	0.0f	78.8bcd	0.0
Fomesafen (250)	92.0b	0.0f	85.0bc	0.0
Fomesafen+fluazifop-p-butyl (187.5+125)	90.0bc	95.0b	84.5bc	0.0
Fomesafen+clethodim (187.5+118)	91.3b	91.3c	88.0b	0.0
Bentazone (720)	99.5a	0.0f	75.0cd	0.0
Imazethapyr (100)	61.3d	86.3d	58.8e	0.0
One hoe weeding	71.3d	78.8e	76.3cd	0.0
Two hoe weedings	100a	100a	100a	0.0
Control without application	0.0e	0.0f	0.0f	0.0

The letters on the right represent the DMS test (α=0.05). Values with the same letter are not statistically different. The comparison is between treatments for each variable. *Md*=*Melampodium divaricatum*, *Rc*=*Rottboellia cochinchinensis*, Tox.=Toxicity.

Table 3. Effect of treatments on weed control (%) and bean toxicity at 30 DAA. Rincón del Tigre, municipality of Ignacio de la Llave, Ver. Winter-Spring 2024.

Treatment (g ha^{-1})	*Md*	*Rc*	Total	Tox.
Fomesafen (125)	78.8b	0.0e	71.3b	0.0
Fomesafen (187.5)	86.3b	0.0e	76.3ab	0.0
Fomesafen (250)	89.5b	0.0e	82.5ab	0.0
Fomesafen+fluazifop-p-butyl (187.5+125)	89.5b	95.0a	85.0a	0.0
Fomesafen+clethodim (187.5+118)	89.5b	95.0a	87.0a	0.0
Bentazone (720)	97.8a	0.0e	70.0b	0.0
Imazethapyr (100)	52.5c	90.0b	51.3c	0.0
One hoe weeding	47.5c	52.5d	40.0c	0.0
Two hoe weedings	83.8b	87.5c	81.3ab	0.0
Control without application	0.0d	0.0e	0.0d	0.0

The letters on the right represent the DMS test (α=0.05). Values with the same letter are not statistically different. The comparison is between treatments for each variable. *Md=Melampodium divaricatum*, *Rc=Rottboellia cochinchinensis*, Tox.=Toxicity.

Controls between 80 and 90% were observed with fomesafen alone at 187.5 and 250 g ha^{-1}, and the treatments in which this herbicide was mixed with fluazifop-p-butyl or clethodim, as well as with two hoe weedings. All treatments showed statistical similarity among themselves and also with fomesafen at 125 g ha^{-1}, whose control of *M. divaricatum* was slightly below 80%. The lowest controls (around 50%) were provided by imazethapyr at 100 g ha^{-1} and one hoe weeding, slightly above the untreated control.

In *R. cochinchinensis*, 95% control was observed with the mixtures of fomesafen with fluazifop-p-butyl and clethodim, which were significantly superior to the rest of the treatments. Among them, the control with imazethapyr at 100 g ha^{-1} was 90%, 87.5% with two hoe weedings, and slightly above 50% with one hoe weeding. The highest overall weed control was obtained with the mixtures of fomesafen with fluazifop-p-butyl and clethodim, although these were statistically similar to the doses of 187.5 and 250 g ha^{-1} of fomesafen and to two hoe weedings. At the same time, the control provided by the last three treatments was similar to the 125 g ha^{-1} dose of fomesafen and bentazone at 720 g ha^{-1}. Although bentazone at 720 g ha^{-1} provided the highest control of *M. divaricatum*, its effect on *A. hybridus* was null (data not shown), so its total control was only 70%. As observed with *M. divaricatum*, the lowest controls were seen with imazethapyr at 100 g ha^{-1} and a hoe weeding. No toxicity was observed in the beans with any of the treatments (Table 3).

Finally, at 42 DAA, the control of *M. divaricatum* with bentazone at 720 g ha^{-1} was over 90%, being statistically similar to fomesafen at 187.5 and 250 g ha^{-1}, whose controls ranged between 85 and 90%; these, in turn, had a control similar to the fomesafen+fluazifop-p-butyl mixture, which was 80% (Table 4).

Controls between 70 and 80% were achieved with two hoe weedings and the mixture of fomesafen+clethodim; fomesafen at 125 g ha^{-1} only provided control of this species close to 60%, while with imazethapyr at 100 g ha^{-1} and one hoe weeding, controls were only between 30 and 35%. The mixtures of fomesafen with fluazifop-p-butyl and clethodim maintained controls of *R. cochinchinensis* at 95%, statistically surpassing the rest of the treatments. Controls between 80 and 85% were achieved with imazethapyr at 100 g ha^{-1} and two hoe weedings, while with only one hoe weeding, control was close to 40%. The highest total control (75%) was achieved with two hoe weedings, which was statistically similar to the three doses of fomesafen and the mixtures of this herbicide with fluazifop-p-butyl or clethodim. Bentazone at 720 g ha^{-1} provided control of less than 60%, while the lowest controls were obtained with imazethapyr and one hoe weeding. No toxicity to the bean was observed with any of the treatments (Table 4).

Grain Yield

The highest grain yields were close to 1,000 kg ha^{-1}, and were obtained with two hoe weedings; the yield of this treatment was statistically similar to that obtained with the mixture of fomesafen+fluazifop-p-butyl, as well as to those of the mixture of fomesafen+clethodim and fomesafen at 185.5 and 250 g ha^{-1}.

It is known that the critical period of competition between weeds and beans occurs between 24 and 40 days after emergence (Blanco and Leyva, 2011); for this reason, the treatments with the best controls during this period also achieved the highest grain yields. With the application of bentazone and fomesafen at 720 and 125 g ha^{-1}, respectively, yields between 750 and 800 kg ha^{-1} were obtained, while with imazethapyr at 100 g ha^{-1}, a yield of less than 600 kg ha^{-1} was obtained, mainly due to its limited effect on *M. divaricatum*, and with one hoe weeding, the yield was less than 500 kg ha^{-1}, although both treatments were statistically similar (Table 5).

Performing two hoe weedings resulted in a 54% higher grain yield compared to performing a single weeding. All treatments had significantly higher grain yields than the untreated control, which produced less than 50 kg ha^{-1} (Table 5). The control of *M. divaricatum* showed significant variations with the herbicide treatments applied. Fomesafen,

Table 4. Effect of the treatments on weed control (%) and bean toxicity at 42 DAA. Rincón del Tigre, municipality of Ignacio de la Llave, Ver. Winter-Spring 2024.

Treatment (g ha^{-1})	*Md*	*Rc*	Total	Tox.
Fomesafen (125)	58.8d	0.0d	63.8ab	0.0
Fomesafen (187.5)	85.0abc	0.0d	66.3ab	0.0
Fomesafen (250)	88.8ab	0.0d	70.0ab	0.0
Fomesafen+fluazifop-p-butyl (187.5+125)	80.0bc	95.0a	70.0ab	0.0
Fomesafen+clethodim (187.5+118)	76.3c	95.0a	67.5ab	0.0
Bentazone (720)	92.0a	0.0d	56.3b	0.0
Imazethapyr (100)	32.3e	85.0b	32.5c	0.0
One hoe weeding	31.3e	37.5c	31.3c	0.0
Two hoe weedings	77.5c	83.8b	75.0a	0.0
Control without application	0.0f	0.0d	0.0d	0.0

The letters to the right represent the DMS test (α=0.05). Quantities with the same letter are not statistically different. The comparison is between treatments for each variable. *Md*=*Melampodium divaricatum*, *Rc*=*Rottboellia cochinchinensis*, Tox.=Toxicity.

Table 5. Effect of the treatments on grain yield. Rincón del Tigre, municipality of Ignacio de la Llave, Ver. Winter-Spring 2024.

Treatment (g ha^{-1})	Grain yield (kg ha^{-1})
Fomesafen at 125	774.23b
Fomesafen at 187.5	886.61ab
Fomesafen at 250	915.75ab
Fomesafen+fluazifop-p-butyl at 187.5+125	957.38a
Fomesafen+clethodim at 187.5+118	932.40ab
Bentazone at 720	782.55b
Imazethapyr at 100	532.80c
One hoe weeding	457.88c
Two hoe weedings	994.84a
Control without application	41.63d

The letters to the right represent the DMS test (α=0.05). Quantities with the same letter are not statistically different. The comparison is between treatments for each variable.

both at 187.5 g ha^{-1} and 250 g ha^{-1}, either alone or in combination with fluazifop-p-butyl and clethodim, achieved control rates above 90%, which is also comparable to the findings of Cano and López (1996), who used fomesafen at 250 g ha^{-1} in combination with fluazifop-p-butyl, although in this study similar results were achieved with a lower dose (187.5 g ha^{-1}).

There are reports of toxic effects on beans due to the application of fomesafen, bentazone, and imazethapyr (Procopio *et al.*, 2009; Galon *et al.*, 2018), but as observed in this study, the damage was mild and temporary. On the other hand, the results obtained with the fomesafen and clethodim mixture are consistent with those reported by Marchioretto and Dal Magro (2017). Fomesafen can remain residual in the soil, potentially harming crops planted after the crop where this herbicide was applied (Rector *et al.*, 2019). For this reason, if a crop that is not tolerant to fomesafen is to be planted after beans, the use of bentazone is preferable.

It is important to note that although both bentazone and fomesafen generally provided good to excellent control of *M. divaricatum*, this did not necessarily translate into grain yield, as the elimination of the dominant species allowed for greater development and competition from *R. cochinchinensis*, a species not affected by either of these herbicides. For this reason, the fomesafen mixtures with fluazifop-p-butyl and clethodim generally resulted in the highest yields, as they are effective at controlling both weed species.

Regarding the control of *R. cochinchinensis*, the mixtures of fomesafen with fluazifop-p-butyl and clethodim were the most effective, achieving control above 90%. This result is consistent with the findings reported by Galon *et al.* (2018) and Hernández-Ríos *et al.* (2022), who highlighted the high efficacy of these herbicide combinations for the management of grasses.

Some of the advantages of using herbicide mixtures compared to single herbicides are: a broader spectrum of weed control, reduced risk of the development of herbicideresistant weed biotypes, synergy, reduced application doses, time savings, and reduced costs (Diggle *et al.*, 2003; Barbieri *et al.*, 2022; Teymourinia *et al.*, 2023). Finally, although manual weeding provided efficient weed control, as also observed by Badgujar *et al.* (2003), this method has significant limitations due to high costs and labor demands.

CONCLUSIONS

Fomesafen at 187.5 g ha^{-1} can efficiently control *M. divaricatum* up to 42 DAA, being similar to bentazone at 720 g ha^{-1} and superior to imazethapyr at 100 g ha^{-1}, as well as to one and two hoe weedings.

To control both dicot and monocot weeds, fomesafen should be mixed with fluazifop-p-butyl or clethodim. The control of the weed complex with fomesafen at 250 g ha^{-1} or in mixtures of fomesafen+fluazifop-p-butyl and fomesafen+clethodim was only efficient (>80%) up to 30 DAA, being comparable to two hoe weedings. Fomesafen caused slight toxicity to the bean, which disappeared between 10 and 20 DAA. The application of fomesafen at 250 g ha^{-1}, as well as its mixtures with fluazifop-p-butyl and clethodim, resulted in grain yields similar to those obtained with two hoe weedings.

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