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Tolerance of two pitaya species to post-emergence herbicides

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Abstract - Pitaya production has been expanding in several regions of Brazil despite the lack of technical information on plant management. To obtain good crop productivity, weed control is essential; however, the use of herbicides can cause phytotoxicity and reduce plant growth and production. Thus, the present work aimed to evaluate the tolerance of red (*Selenicereus polyrhizus*) and white (*S. undatus*) pitaya seedlings to different herbicides applied after emergence. Two experiments were installed, one with red pitaya and the another with white pitaya, on August 15, 2020 in the Fruit Production Sector of the Federal University of Lavras. Experiments were arranged in a randomized block design, with four and three replicates, respectively, eight treatments and three plants per plot in both experiments. Treatments consisted of control, fomesafen, ammonium glufosinate, glyphosate, clethodim, carfentrazone-ethyl, imazethapyr and chlorimuron. Visual phytotoxicity symptoms were evaluated at 7, 14, 21 and 28 days after herbicide application. At 30 and 60 days after application, percentage of necrosis, cladode length and number of new shoots were evaluated. Herbicide fomesafen caused greater damage to red pitaya seedlings and fomesafen and glyphosate caused greater damage to white pitaya seedlings. For both pitaya species, herbicide clethodim can be an alternative for controlling narrow-leaf weeds without causing visual damage to the growth and development of pitaya plants.

Index terms: weed control, phytotoxicity, *Selenicereus polyrhizus, Selenicereus undatus*.

Tolerância de duas espécies de pitaia a herbicidas pós-emergentes

Resumo - A produção de pitaia vem-se expandindo em várias regiões do Brasil apesar da carência de informações técnicas sobre o manejo das plantas. Para obter boa produtividade na cultura, o controle de plantas daninhas é fundamental; porém, o uso de herbicidas pode causar fitotoxicidade e redução do crescimento e da pro-

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dução das plantas. Assim, o presente trabalho teve como objetivo avaliar a tolerância de mudas de pitaia de polpa vermelha (*Selenicereus polyrhizus*) e polpa branca (*S. undatus*) a diferentes herbicidas aplicados em pós-emergência. Foram instalados dois experimentos: um com pitaia-vermelha e outro com pitaia-branca, em 15 de agosto de 2020, no Setor de Fruticultura da Universidade Federal de Lavras. Os experimentos foram dispostos em delineamento em blocos casualizados, com quatro e três repetições, respectivamente, oito tratamentos e três plantas por parcela, em ambos os experimentos. Os tratamentos foram constituídos por testemunha, fomesafem, glufosinato de amônio, glifosato, cletodim, carfentrazona-etílica, imazetapir e clorimurom. Foram avaliados sintomas visuais de fitotoxicidade aos 7; 14; 21 e 28 dias após a aplicação dos herbicidas. Aos 30 e 60 dias após a aplicação, avaliaram-se a porcentagem de necrose, comprimento dos cladódios e o número de brotos novos. O herbicida fomesafem causou maiores danos às mudas de pitaia-vermelha, e fomesafem e glifosato causaram maiores danos às mudas de pitaia-branca. Para ambas as espécies de pitaias, o herbicida cletodim pode ser uma alternativa para controle de plantas daninhas de folha estreita sem provocar danos visuais no crescimento e no desenvolvimento das plantas de pitaia.

Termos para indexação: controle de plantas daninhas, fitotoxicidade, *Selenicereus polyrhizus*, *Selenicereus undatus*.

Introduction

Pitaya, a fruit cactus native to the Americas, has great agronomic and economic potential due to its rusticity. Fruits are highly appreciated due to their exotic appearance and their organoleptic characteristics (SANTOS et al., 2023). The most cultivated species belong to the genus *Selenicereus* and are distinguished mainly based on fruit morphology, pulp color, areole characteristics and number and shape of thorns (KOROTKOVA et al., 2017).

In recent years in Brazil, pitaya production has been growing and spreading to several regions, with emphasis on the state of São Paulo, which has the largest fruit production in the country, around 586 tons distributed over 186 ha (IBGE, 2017). Average productivity varies from 10 to 30 tons ha^{-1}, depending on climatic conditions, soil type, cultural practices and orchard age (RUTHS et al., 2019). The Southeastern region is responsible for most of national production, estimated at 1,459 tons, followed by the Southern and Northern regions. In the Southeastern region, the quantity produced in orchards corresponds to more than 50% of Brazilian production, while the Southern and Northern regions, production represent 29.13% and 10.42%, respectively (IBGE, 2017).

To obtain good productivity in crops of economic interest, weed control is essential, considering that these plants often have a competitive advantage over cultivated plants and have characteristics such as rapid growth, great reproductive capacity and high capacity to exploit soil nutrients and light, ensuring permanence in highly competitive locations (ANTONENKOA; ZUBKOVB, 2024; BRAZ et al., 2016).

Chemical control is the method most used in agricultural areas due to its effectiveness and practicality (HAMUDA et al., 2016). Weed management with herbicide application is a good option in the short term due to its practicality combined with good efficacy and stability in weed control, but dependence on this technology as a single tool generates the risk of selecting weed biotypes resistant to herbicides (PAZUCH et al., 2017).

The use of herbicides to control weeds can eventually cause phytotoxicity in crops due to several factors such as crop sensitivity to the herbicide (CORREIA; CARVALHO, 2019; SILVA et al., 2022). The lack of selective herbicides registered for pitaya cultivation (AGROFIT, 2023) makes explicit the pressing need for research aimed at advancing knowledge in this area. The indiscriminate use of herbicides can cause reduction in productivity due to damage caused by phytotoxicity, in addition to increasing the selection pressure for weed biotypes resistant to commonly used products.

Therefore, the aim of this study was to evaluate the tolerance of red (*Selenicereus polyrhizus*) and white (*S. undatus*) pitaya seedlings to different herbicides applied after emergence.

Material and Methods

Experiments were conducted in the Fruit Production Sector of the Department of Agriculture -Federal University of Lavras (UFLA), located at 21°13' South latitude, 44°58' West longitude and 893 meters a.s.l., with climate characterized as Cwa, warm temperate with dry period in winter (MARTINS et al., 2018). The soil used in the work was classified as Red-Yellow Oxisol.

Two experiments were carried out: the first with red pitaya seedlings (*Selenicereus polyrhizus*) and the second with white pitaya seedlings (*Selenicereus undatus*), installed on August 15, 2020. Seedlings were obtained using 25-cm cuttings planted in polyethylene bags with 3 dm^3, filled with substrate composed of a mixture of 50% clay soil, 25% sand and 25% cattle manure, arranged in screens with 40% shading. Daily irrigations were carried out in accordance with soil moisture monitoring, trying to always keep it close to field capacity.

Experiments were carried out in a randomized block design (RBD), with eight treatments, four replicates for red pitaya and three for white pitaya, with three plants per plot in both experiments. Treatments in the two experiments consisted of: control without herbicide application, fomesafen (250 g a.i. ha^{-1}), ammonium glufosinate (400 g a.i. ha^{-1}), glyphosate (960 g a.i. ha^{-1}), clethodim (96 g a.i. ha^{-1}), carfentrazone-ethyl (20 g a.i. ha^{-1}), imazetapyr (100 g a.i. ha^{-1}) and chlorimuron (15 g a.i. ha^{-1}). About 5 mL L^{-1} of vegetable oil were added to sprays to aid in the spreading and penetration of herbicides on the surface of cladodes.

Herbicide application was carried out 90 days after the planting of cladodes using manual knapsack sprayer with capacity of 5 L, equipped with a four-nozzle bar with fan tip model TT-11002, working at height of 40 cm from the target and spray volume of 200 L ha^{-1}.

For visual assessments of plant phytotoxicity, scores were assigned using the EWRC scale (EWRC, 1964), where values range from 1 to 9, in which 1 indicates absence of symptoms and 9 indicates plant death (Table 1). Scores were assigned at 7, 14, 21, and 28 days after herbicide application (DAA) by three evaluators and the average scores were subsequently calculated.

Table 1. Evaluation scores and their corresponding phytotoxicity descriptions.

EI	Phytotoxicity description
1	No damage
2	Small changes (discoloration, deformation) visible in some plants
3	Small changes (chlorosis and curling) visible in several plants
4	Strong discoloration or reasonable deformation, without necrosis
5	Necrosis of some leaves, accompanied by deformation in leaves and shoots
6	Reduction in plant size, leaf curling and necrosis
7	More than 80% of the leaves destroyed
8	Extremely severe damage, leaving small green areas in plants
9	Plant death

Source: EWRC (1964). EI: Evaluation index

The number of shoots, seedling's main cladode length (cm) and percentage of necrosis

(%) at 30 and 60 after herbicide application were also evaluated. Cladode length and percentage of necrosis, assessed by measuring the lesion area in relation to the total cladode area, were measured using a millimeter ruler.

For statistical analysis of data, the SISVAR software was used (FERREIRA, 2019). Averages between treatments were submitted to analysis of variance, using the F test, and compared by Tukey at 5% probability. The data on the number of shoots, length of the seedling's main cladode and percentage of necrosis were transformed by $(x+1)^{1/2}$.

Results and Discussion

There was statistical difference among herbicides for all characteristics evaluated in both experiments.

For red pitaya, treatment with the application of fomesafen was the one that presented the highest phytotoxicity score, with symptoms of strong discoloration and reasonable deformation, without necrosis of cladodes occurring at 7 DAA. From 14 days to 28 DAA, the final period of evaluations, necrosis was observed, accompanied by deformation in cladodes and shoots of seedlings submitted to fomesafen (Table 2). From 14 DAA onwards, phytotoxicity increased, and at 28 DAA, seedlings showed strong discoloration and reasonable deformation. The appearance of these phytotoxicity symptoms are related to the herbicide's mechanism of action. It is noteworthy that, 28 days after application, the herbicides fomesafen, ammonium glufosinate, glyphosate and chlorimuron were those that showed the greatest damage and did not show statistically significant differences between them.

The increase in visual phytotoxicity of seedlings for treatment with fomesafen can be explained by the herbicide's mechanism of action, which initially inhibits the protoporphyrinogen oxidase enzyme (PROTOX), which affects the chlorophyll precursor enzyme, causing desiccation and necrosis of seedling tissues over time after treatment application (OLIVEIRA, 2011).

Table 2 - Phytotoxicity of red pitaya seedlings (*S. polyrhizus*) submitted to post-emergence herbicide application.

Treatment	Assessments (DAA)			
	7	14	21	28
Fomesafen	4.50 a	5.50 a	5.50 a	5.50 a
Ammonium Glufosinate	2.00 bc	3.00 b	4.25 ab	4.50 ab
Glyphosate	1.25 c	3.00 b	3.75 ab	4.50 ab
Clethodim	1.00 c	1.00 c	1.00 c	1.00 c
Carfentrazone-ethyl	3.00 b	3.75 ab	3.75 ab	3.75 b
Imazetapir	1.75 bc	3.00 b	3.00 b	3.00 b
Chlorimurom	1.50 c	4.00 ab	4.00 ab	4.00 ab
Control	1.00 c	1.00 c	1.00 c	1.00 c
CV (%)	28.35	25.10	23.19	20.16

Means followed by the same letter in the column do not differ from each other using the Tukey test at 5% probability. CV= coefficient of variation

On the other hand, Silva et al., (2019) evaluated the selectivity of post-emergence herbicides in beans (*Vigna radiata*) and found that fomesafen treatment did not express phytotoxicity effects during the experimental period.

Treatment with clethodim application did not cause damage to seedlings during all evaluation periods, corroborating results found by Fontes et al. (2021), who worked with selectivity and efficacy of herbicides for the control of weeds in cassava, and found that clethodim application did not cause phytotoxicity symptoms in 'BRS Purus' plants throughout the 60 DAA evaluation period. This result was already expected, since the clethodim molecule is a specific graminicide that acts on the inhibition of the ACCase enzyme, which is present in different conformation within the plastids of non-grass plant cells.

For white pitaya, greater damage to seedlings was observed at 28 DAA when herbicides glyphosate and fomesafen were applied although they did not differ statistically from ammonium glufosinate and carfentrazone-ethyl herbicides (Table 3). PROTOX inhibitor herbicides have the characteristics of altering plant physiology and consequently photosynthetic capacity, transpiration, carboxylation efficiency and water use (altering stomatal closure mechanisms), causing destruction of cell membranes (TAIZ et al., 2017). This causes dysregulation of porphyrin in plants due to its abnormal accumulation in cells, forming reactive oxygen species and lipid peroxidation, which can lead to plant death (KIM et al., 2014). Thus, sensitivity of seedlings to herbicides fomesafen (PROTOX inhibitor) and glyphosate (EPSPs inhibitor) can be observed during all evaluation periods from 7 DAA and 14 DAA onwards respectively (Table 3). This can be explained by the slower action of the herbicide on the plant, which takes longer for symptoms to appear. For fomesafen, as there is formation of ROS, flooding and necrosis symptoms appear faster.

Table 3 - Phytotoxicity of white pitaya seedlings (*S. undatus*) submitted to post-emergence herbicide application.

Treatment	Assessments (DAA)			
	7	14	21	28
Fomesafen	3.33 a	3.66 a	3.66 a	4.33 a
Ammonium Glufosinate	2.00 b	2.00 bc	2.33 ab	3.00 ab
Glyphosate	1.00 b	2.66 ab	3.66 a	4.33 a
Clethodim	1.00 b	1.00 c	1.00 b	1.00 c
Carfentrazone-ethyl	2.00 b	2.00 bc	2.33 ab	2.66 abc
Imazetapir	1.00 b	1.33 bc	1.33 b	2.00 bc
Chlorimurom	1.00 b	1.00 c	1.33 b	2.00 bc
Control	1.00 b	1.00 c	1.00 b	1.00 c
CV (%)	27.86	26.95	34.94	24.47

Means followed by the same letter in the column do not differ from each other using the Tukey test at 5% probability. CV=coefficient of variation.

Treatment with glyphosate, an inhibitor of the EPSPs enzyme (5-enolpyruvylshikimate-3-phosphate synthase), resulted in increase in visual phytotoxicity symptoms, with strong discoloration and reasonable deformation, without showing necrosis in seedlings until 28 DAA (Table 3). The observed phytotoxicity is not a function of the lack of aromatic amino acids, caused by the inhibition of the EPSPs enzyme, but rather of the deregulation of carbon flow in the plant due to the accumulation of intermediate compounds that are toxic to plants, which leads growth to stop.

In studies with guarana (*Paullinia cupana*) cultivars, using low glyphosate doses (0.324 and 432 g a.e. ha^{-1}) for 7 days, no changes in physiological characteristics were identified. It is important to mention that the symptoms of glyphosate phytotoxicity are prolonged in nature, since it is a systemic herbicide and can cause the death of seedlings several days or even weeks after application (LEITE et al., 2020).

Herbicide carfentrazone-ethyl did not show major changes in the average phytotoxicity scores during experimental periods. It remained with small visible changes such as discoloration and deformation in some seedlings. In contrast, for ammonium glufosinate, increase at 28 DAA was observed. These herbicides act mainly through contact, that is, they do not translocate or do so to a limited extent in plants (LINS et al., 2018), remaining on the external surface of plants.

The application of herbicide clethodim throughout the evaluation period did not show visual damage to seedlings due to phytotoxicity, a result similar to the control treatment and those obtained for red pitaya. According to the results obtained, clethodim can be an alternative for controlling grassy weeds in white pitaya.

For treatments with herbicides imazetapyr and chlorimuron up to 21 DAA, seedlings did not show visual damage. At 28 DAA, small changes were observed, such as visible discoloration and deformation in some seedlings (Table 3). These effects can be attributed to the mechanism of action of these herbicides, which inhibits the ALS enzyme and, consequently, the synthesis of amino acids important for the primary and secondary metabolism of plants.

The percentage of necrosis resulting from the application of herbicides on red pitaya seedlings is illustrated in Table 4. There was no statistical difference between treatments for the percentage of necrosis at 30 DAA. Although the herbicides fomesafen, ammonium glufosinate, glyphosate and chlorimuron caused more severe necrotic damage than clethodim, carfentrazone-ethyl and imazethapyr, regardless of evaluation time (Table 4).

Table 4 - Percentage of necrosis in red pitaya seedlings (*S. polyrhizus*) at 30 and 60 days after herbicide application (DAA). 1- Fomesafen; 2- Ammonium Glufosinate; 3- Glyphosate; 4- Clethodim; 5- Carfentrazone-ethyl; 6- Imazetapyr; 7- Chlorimuron; 8- Control.

Herbicides	Days after herbicide application	
	30	60
Fomesafen	30.47 a	35.17 a
Ammonium Glufosinate	32.92 a	41.42 a
Glyphosate	24.87 a	48.18 a
Clethodim	1.25 a	1.39 b
Carfentrazone-ethyl	1.48 a	1.13 b
Imazetapir	2.71 a	1.69 b
Chlorimurom	23.76 a	22.93 ab
Control	0.14 a	0.43 b
CV	58.28	40.27

Means followed by the same letter in the column do not differ from each other using the Tukey test at 5% probability. CV=coefficient of variation.

The action of glyphosate on plants varies according to species and dose used, acting as a growth inhibitor, which may result in plant death (PEREIRA et al., 2015). For red pitaya, greater sensitivity of seedlings to this herbicide was observed at 60 DAA.

Regarding the effects of herbicides on red pitaya seedlings, it was observed that clethodim, carfentrazone-ethyl and imazethapyr present little or no symptoms of necrosis. When choosing the molecule for a given crop, selectivity is a fundamental characteristic to be observed, since effective weed control is expected, without the crop of economic interest suffering injuries, that is, it does not imply in productivity reduction (OLIVEIRA JÚNIOR, 2011). Based on phytotoxicity data shown in Table 2 and Table 4, these herbicides can be considered potential molecules, and there is a need to evaluate the production of these plants in further studies due to the possibility of the existence of hidden phytotoxicity.

For white pitaya, herbicides fomesafen and glyphosate showed higher percentage of necrosis in seedlings at 30 DAA. On the other hand, ammonium glufosinate and glyphosate showed higher percentage of necrosis in seedlings at 60 DAA (Table 5). This result is explained by the higher phytotoxicity scores obtained (Table 3) with the increase in days after herbicide application, although these herbicides have different mechanisms and modes of action on plants. Herbicides clethodim, carfentrazone-ethyl, imazethapyr and chlorimuron did not show symptoms of necrosis, regardless of evaluation period, being similar with control (Table 5). These results are in accordance with those obtained in Table 2 regarding phytotoxicity scores.

Table 5 - Percentage of necrosis in white pitaya seedlings (*S. undatus*) at 30 and 60 days after herbicide application (DAA). 1- Fomesafen; 2- Ammonium Glufosinate; 3- Glyphosate; 4- Clethodim; 5- Carfentrazone-ethyl; 6- Imazetapyr; 7- Chlorimuron; 8- Control.

Herbicides	Days after herbicide application	
	30	60
Fomesafen	10.56 ab	12.77 b
Ammonium Glufosinate	0.67 b	54.58 a
Glyphosate	26.94 a	59.99 a
Clethodim	0.00 b	0.52 b
Carfentrazone-ethyl	1.23 b	4.70 b
Imazetapir	2.71 b	1.38 b
Chlorimurom	0.19 b	0.00 b
Control	0.00 b	0.00 b
CV	47.96	29.26

Means followed by the same letter in the column do not differ from each other using the Tukey test at 5% probability. CV=coefficient of variation.

Ammonium glufosinate acts by contact and causes changes in ammonia metabolism, by inhibiting the glutamine synthase enzyme (Gs), responsible for the reaction of ammonia formed in the cell with glutamic acid to form glutamine, resulting in increase in the ammonia concentration in the cell, stopping photosynthesis, destroying leaf tissues and potentially causing their death (CONCATO et al., 2022). The mechanism of action characterizes the first physical or biochemical damage that occurs to the plant and, from then on, a series of reactions will culminate in the appearance of symptoms and the death of sensitive plants.

The greatest cladode length of red pitaya seedlings occurred in treatments with application of herbicides fomesafen, glyphosate, clethodim, carfentrazone-ethyl, imazetapir, chlorimurom and control at 60 DAA. At 30 DAA, there was no significant difference among herbicides regarding growth (Table 6).

Table 6 - Cladode length (cm) of red pitaya (*S. polyrhizus*) seedlings at 30 and 60 days after herbicide application (DAA). 1- Fomesafen; 2- Ammonium Glufosinate; 3- Glyphosate; 4- Clethodim; 5- Carfentrazone-ethyl; 6- Imazetapyr; 7- Chlorimuron; 8- Control.

Herbicides	Days after herbicide application	
	30	60
Fomesafen	2.25 a	12.99 ab
Ammonium Glufosinate	0.00 a	1.83 b
Glyphosate	1.83 a	8.00 ab
Clethodim	4.87 a	24.91 ab
Carfentrazone-ethyl	4.16 a	14.41 ab
Imazetapir	8.12 a	24.33 ab
Chlorimurom	0.62 a	9.58 ab
Control	6.21 a	31.00 a
CV	43.17	42.75

Means followed by the same letter in the column do not differ from each other using the Tukey test at 5% probability. CV=coefficient of variation.

Treatments with the application of herbicides fomesafen, ammonium glufusinate and glyphosate inhibited cladode growth in white pitaya seedlings. The greatest cladode growth was observed in treatments with clethodim, which is a graminicidal, systemic and highly selective herbicide, chlorimurom and control at 30 DAA. There was no statistical difference between treatments at 60 DAA for cladode length of white pitaya (Table 7).

Table 7 - Cladode length (cm) of white pitaya (*S. undatus*) seedlings at 30 and 60 days after herbicide application (DAA). 1- Fomesafen; 2- Ammonium Glufosinate; 3- Glyphosate; 4- Clethodim; 5- Carfentrazone-ethyl; 6- Imazetapyr; 7- Chlorimuron; 8- Control.

Herbicides	Days after herbicide application	
	30	60
Fomesafen	0.00 b	0.00 a
Ammonium Glufosinate	0.44 b	0.00 a
Glyphosate	0.00 b	0.00 a
Clethodim	1.66 a	4.94 a
Carfentrazone-ethyl	0.11 b	0.33 a
Imazetapir	0.22 b	1.16 a
Chlorimurom	0.55 ab	1.00 a
Control	0.55 ab	1.58 a
CV	12.05	51.94

Means followed by the same letter in the column do not differ from each other using the Tukey test at 5% probability. CV=coefficient of variation.

Herbicide clethodim has an ACCase-inhibiting mechanism of action, so, after penetrating the leaves, it translocates to the meristematic regions through the phloem, where the synthesis of lipids for the formation of membranes is very intense, affecting meristematic activity and restricting plant growth (FIOREZE et al., 2021).

According to the results obtained, white pitaya is not a species sensitive to clethodim as it provided lower phytotoxicity score and percentage of necrosis. Furthermore, clethodim did not interfere with cladode growth (Table 7), making it an option for managing narrow-leaf weeds in the white pitaya crop.

At 30 DAA, seedlings submitted to imazethapyr treatment showed greater amount of new shoots. This was accompanied by fewer visual phytotoxicity symptoms, as well as lower percentage of necrosis and greater cladode growth, respectively. Therefore, seedlings submitted to imazetapyr treatment showed minor damage to leaf tissues, which possibly did not affect the photosynthetic rate of plants, resulting in greater number of shoots (BETHKE et al., 2013). At 60 DAA, no differences were observed among treatments evaluated (Table 8).

Table 8 - Number of new shoots in red pitaya seedlings at 30 and 60 days after herbicide application (DAA). 1- Fomesafen; 2- Ammonium Glufosinate; 3- Glyphosate; 4- Clethodim; 5- Carfentrazone-ethyl; 6- Imazetapyr; 7- Chlorimuron; 8- Control.

Herbicides	Days after herbicide application	
	30	60
Fomesafen	0.33 ab	0.66 a
Ammonium Glufosinate	0.00 b	0.16 a
Glyphosate	0.25 ab	0.41 a
Clethodim	0.66 ab	0.83 a
Carfentrazone-ethyl	0.41 ab	0.58 a
Imazetapir	0.91 a	1.08 a
Chlorimurom	0.16 ab	0.66 a
Control	0.74 ab	1.16 a
CV	12.15	14.08

Means followed by the same letter in the column do not differ from each other using the Tukey test at 5% probability. CV=coefficient of variation.

It was not possible to evaluate the number of shoots for white pitaya because although treatments 4 (cletodim), 6 (imazetapir), 7 (chlorimurom) and 8 (control) showed cladode growth in the evaluated period, this occurred only in the main cladode, without the emission of new shoots.

In general, herbicide clethodim stands out as a promising alternative in the management of weeds in pitaya orchards, as it did not cause visible impacts on seedling growth and development. The results obtained suggest that clethodim can be an interesting tool for pitaya producers, contributing to optimize the production of this fruit crop.

Furthermore, it was observed that the response of red and white pitaya seedlings to different herbicides may vary, highlighting the differential tolerance between species and the importance of considering these particularities when managing weeds. It is important to point out that further studies should be carried out to evaluate the impact of using these products on the quantity and quality of produced pitaya fruits.

In short, the results presented here provide new information for pitaya cultivation, offering a solid basis for the development of sustainable weed management strategies, preserving the initial seedling growth.

Conclusion

Herbicide clethodim is an alternative for controlling weeds in red and white pitaya orchards, as it does not cause visible damage to seedling growth and development.

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