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Herbicide selectivity in teak seedlings (*Tectona grandis* L.f.).

Seletividade de herbicida em mudas de teca (Tectona grandis L.f.).

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A B S T R A C T

One of the factors that interfere in the productivity of a forest culture, the knowledge of the selectivity of the product to the culture is essential to eliminate or limit the injuries caused by the product to the species of interest. The experiment was installed at the IFAL campus Maceió, in Maceió, Alagoas, with the objective of evaluating the selectivity of saflufenacil and glyphosate in teak seedlings from seeds, through morphological, physiological and visual analysis. With Entirely Random Blocks (DBC) with five repetitions; the treatments were: Saflufenacil (100 gha^{-1} of active ingredient), Glyphosate (1000 gha^{-1} ia), association of Saflufenacil and Glyphosate (100 gha^{-1} ia + 1000 gha^{-1} ia) and the control (control without application of herbicides). The results obtained in the variables allow us to conclude that there is selectivity between the treatments observed in the evaluation period.

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R E S U M O

Um dos fatores que interferem na produtividade de uma cultura florestal, o conhecimento da seletividade do produto à cultura é essencial para eliminar ou limitar as injúrias causadas pelo produto à espécie de interesse. O experimento foi instalado no IFAL campus Maceió, em Maceió, Alagoas, com o objetivo de avaliar a seletividade de saflufenacil e glyphosate em mudas de teca provenientes de sementes, através de análise morfológicas, fisiológicas e visuais. Com blocos inteiramente ao acaso (DBC) com cinco repetições; os tratamentos foram: Saflufenacil (100 gha^{-1} de ingrediente ativo), Glyphosate (1000 gha^{-1} ia), associação de Saflufenacil e Glyphosate (100 gha^{-1} ia + 1000 gha^{-1} ia) e a testemunha (o controle sem aplicação de herbicidas). Os resultados obtidos nas variáveis permitem concluir que existe seletividade entre os tratamentos observados no período de avaliação.

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Introduction

A *Tectona grandis* L.f., popularly known as teak, large tree, native to tropical forests. It belongs to the botanical family Verbenaceae, appreciated for the quality of its wood and rusticity (ANGELI; STAPE, 2020). It usually presents good adaptability, has durability, lightness, resistance and easy to be worked (DELGADO et al., 2008).

One of the factors that interfere in the productivity of a forest crop is the presence of pests, diseases and weeds (SCHUMACHER et al., 2017). In this sense, weeds compete with forest species for water, light, nutrients, when they still have allelopathic effects and pathogen hosts (PEREIRA et al., 2011). Chemical control is the main strategy for weed management in the conventional system (HARKER; O'DONOVAN, 2013), through the use of herbicides. In Brazil there are 21 herbicides registered for forest crops, but none for teak, according to Agrofit of the Ministry of Agriculture and Livestock (*Ministério da Agricultura e Pecuária* - MAPA). Tibúrcio et al., (2012) state that the extension of the use of registered products for other crops is important for weed management in forest crops, thus enabling the rotation of products in production.

For the use of chemicals in weed control, care and attention are necessary so that there is no damage to the crop (AGOSTINETTO et al., 2010). The knowledge of the selectivity of the product to the crop is essential to eliminate or limit the injuries caused by the product to the species of interest, since the use of a non-selective product can be harmful than the interference promoted by weeds. Some factors may influence selectivity, such as the stage of development of the genetic material crop of plants and the edaphoclimatic conditions at the time of application (REIS et al., 2021).

In this sense, the objective of this work was to evaluate the selectivity of saflufenacil and glyphosate in teak seedlings from seeds, through morphological, physiological and visual analysis.

Material and Methods

The teak seedlings were produced from seeds in plastic bags of 10 L. The place for production was in GIPA - Interdisciplinary Group of Environmental Research (*Grupo Interdisciplinar de Pesquisas Ambientais*). Considering the technical recommendations of germination, development and growth of seedlings. We selected 20 with 03 (three) months the observation criterion were healthy seedlings with the same size and number of sheets for assembly of the experiment.

The experiment was installed at the IFAL Campus Maceió, in the county of Maceió, Alagoas, Brazil, altitude 4 m, latitude 9°40' south and longitude 35°44' west. Conducted in blocks entirely at random (DBC) with 5 repetitions. The treatments were Saflufenacil (100 gha^{-1} of active ingredient), Glyphosate (1000 gha^{-1} ia), combination of Saflufenacil and Glyphosate (100 gha^{-1} ia + 1000 gha^{-1} ia) and the control (control without herbicide application). The

variables that were observed according to Agostinetto et al., (2010) and Azania & Azania (2014): a) phytotoxicity - visual evaluation considering the EWRC scale - European Weed Research Council; b) Physiological Analysis: the canopy of seedlings divided into 3 (three) thirds, being chosen one leaf per third, from each leaf will be analyzed the second pair of leaflets through the Chlorofilog - Portable fluorometer; c) Morphological Analysis: biometric evaluations: number of leaves, height (cm) and neck diameter (cm); d) Determination of fresh and dry matter: at the end of the experiment the seedlings were cut close to the ground and will measure their weight (fresh matter) and then placed the material in an oven at 65°C by forced ventilation for 72 hours. Then the dry weight (dry matter) was measured.

Physiological and morphological analyses were performed at 01, 02, 03, 07, 15, 30 and 60 days after application (DAA), while visual evaluation at 01, 02, 03, 07, 15, 30 and 60 days after application (DAA). The fresh and dry matter at the end of the experiment. The results were submitted to analysis of variance (ANOVA), physiological and morphological analyses to the design in plots subdivided in time, while fresh and dry matter to the randomized block design, in all situations to the F test and when necessary Tukey's test of comparison between the means of the treatments in each period observed.

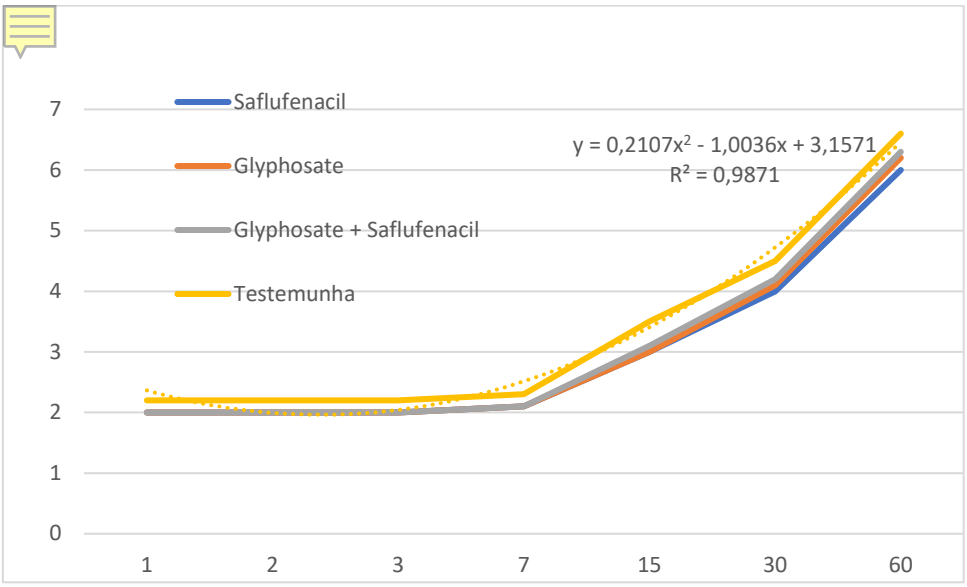
For application was used a pressurized costal sprayer with CO_2 with Teejet tip, model TTI 11002, with volume of syrup of 200 Lha^{-1}. The atmospheric conditions at the time of application were evaluated.

Results and Discussion

The results obtained in the experiments observe that there was significant interaction at the level of 1% probability by the F test for treatments and evaluation periods and their interaction (treatments x evaluation periods). The morphological characteristics in graphs 1, 2 and 3; the physiological characteristics in Graph 4 and in Tables 1 and 2 and the visual characteristics in Graph 04.

Graph 1.

Number of leaves (unit) according to the selectivity of herbicides in teak - Maceió - AL, 2020-21.

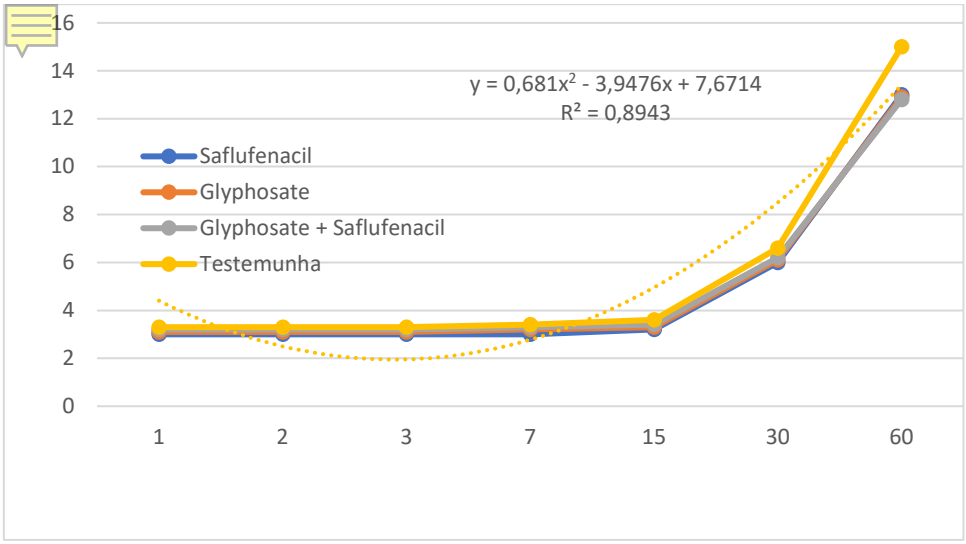


Source: Research data (2021).

It´s observed in graph 01, number of leaves (unit) that there was no significant difference between the treatments by Tukey's test at 5% probability. There were no differences for the number of leaves in the observed period. The best explained model was the second-degree equation with the R^2 of 98,71%.

Graph 2.

Plant height (cm) according to herbicide selectivity in teak. Maceió - AL, 2020-21.



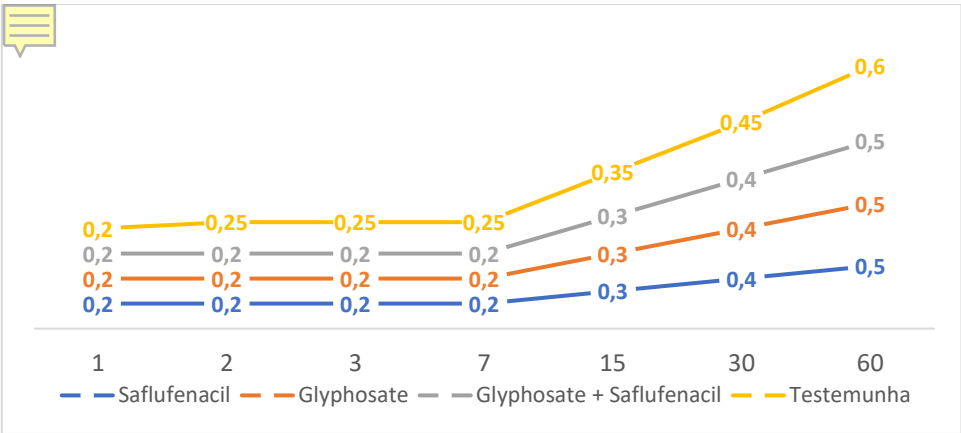
Source: Research data (2021).

It´s observed in graph 2, for plant height (cm) that there was no significant difference between the treatments by Tukey's test at 5% probability. There were no differences in the height of plants in the observed period, with the growth rate occurring up to 60 days. Criterion for evaluation of biometrics between treatments. This result was also observed by Gonçalves et al., (2016) in coffee and citrus with saflufenacil and glyphosate in association. The equation

that best explains the interaction between treatments x period observed was second-degree with the R^2 ofe 89,43%.

Graph 3.

Plant diameter (mm) according to herbicide selectivity in teak. Maceió - AL, 2020-21.

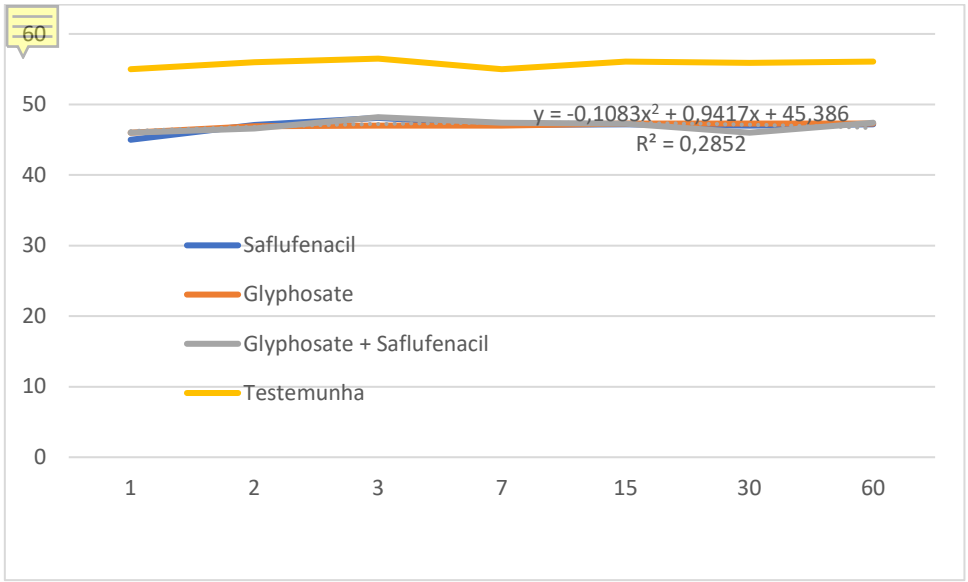


Source: Research data (2021).

It´s observed in graph 3, for leaf diameter (mm) that there was no significant difference between the treatments by Tukey's test at 5% probability. There were no differences in the diameter of plants in the period observed. The diameter increments ensuring the support of the culture regardless of the product applied.

Graph 4.

ICF of leaves according to the selectivity of herbicides in teak. Maceió - AL, 2020-21.

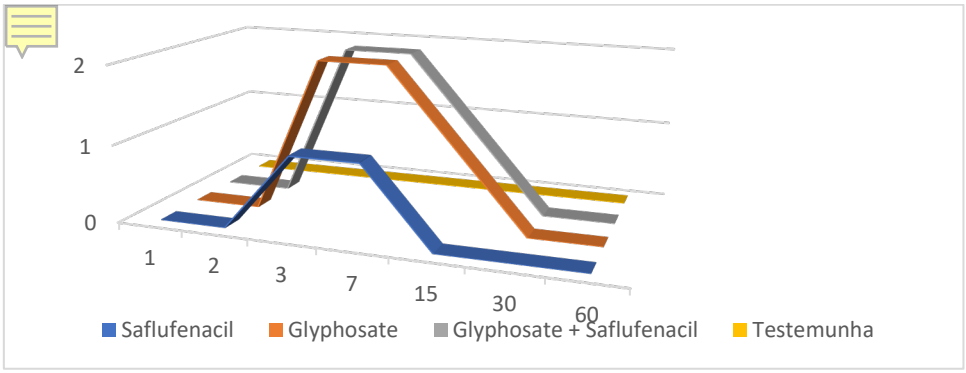


Source: Research data (2021).

It´s observed in graph 4, for HFI of leaves, that there was no significant difference between the treatments by Tukey's test at 5% probability. The treatments were not affected when evaluated by the leaf chlorophyll index in the observed period. Thus, the role of the photosynthetic activity allows to demonstrate that the application of the product did not interfere in the culture during the observed period. In this way the absorption, translocation and metabolism of the herbicide can affect the sensitivity of the plant, however, it needs to reach the site of action at an appropriate concentration (TAIZ et al., 2017). The model was better explained with the second-degree equation, but with the R^2 low of 28,52%.

Graph 5.

Escala de notas para seletividade de herbicidas em Teca. Maceió – AL, 2020-21.



Source: Research data (2021).

It´s observed in graph 5, scale of scores for selectivity that there was no significant difference between the treatments by Tukey's test at 5% probability. There were no differences between the treatments in the period observed. The application of the products that caused injuries in the period of 2 to 15 days for saflufenacil and 2 to 30 days for isolated glyfosate and the mixture of glyfosate and saflufenacil occurring its recovery. The use of herbicide mixture consists of a technique with advantageous expression due to weed control and biotype resistance. This is an interesting experiment to understand their behavior. The glyfosate, a systemic herbicide and has a low residual effect on the soil, acts on the enzyme enol-pyruvil-shikimate-phosphate-syntax, with great translocation capacity in the plant. Saflufenacil acts by inhibiting the enzyme protoporphyrinogen IX oxidase (protox), which in contact with light causes peroxidation of the membrane of sensitive plants causing necrosis (MELLO, 2020). For Silva et al., (2022) saflufenacil potentiates the absorption of glyfosate.

Table 1.

Leaf area in selectivity of herbicides in teak. Maceió - AL, 2020-21.

Treatments	Leaf area (cm^2)
Saflufenacil	183[a]
Glyphosate	171[a]
Glyphosate + Saflufenacil	176[a]
Witness	212[a]

Means followed by at least one letter that do not differ statistically from each other by the Tukey Test at 5%.

Source: Research data (2021).

Table 1 shows that there were no significant differences for leaf area between the treatments observed. These results corroborate the number of leaves per plant, plant height and plant diameter. Important tool to evaluate the growth characteristics, photosynthetic relationships and transpiration of plants, reinforcing the result of selectivity of the products applied for culture. Francisco et al. (2010) and Junior (2014) report that for isoxaflutole, msma, atrazine, flumioxazine the phytoxicity for culture was high, however, for chlorimuron-ethyl, hexazinone, haloxifop-R, methyl ester, fomessafunt fluezifope associated fluorofope-p-butyl the phytoxicity was low at the time of their experiments. Gonçalves et. al., (2016) observed that suflafenacil alone and in combination with glyphosate was selective for coffee and citrus plants at doses of 0,035 and 0,105 g i.a. ha^{-1} and glyphosate of 2,16 kg ha^{-1} not showing any visual symptoms of intoxication in the plants.

Table 2.

Dry Matter Weight (PMS) and Fresh Matter Weight (PMF) g.muda^{-1} in selectivity of teak herbicides. Maceió - AL, 2020-21.

Treatments	PMS	PMF
Saflufenacil	12,4[a]	24,1[a]
Glyphosate	11,2[a]	22,4[a]
Glyphosate + Saflufenacil	10,4[a]	21[a]
Witness	14,2[a]	26,3[a]

Means followed by at least one letter that do not differ statistically from each other by the Tukey Test at 5%.

Source: Research data (2021).

Table 2 shows the weight gains of dry and fresh matter for the treatments observed by seedlings. There were no significant differences between the treatments, translating into the selectivity of the products applied when compared with the control. The chemical treatments were selective because they did not affect the weights of dry matter and fresh matter.

Conclusions

The results obtained allow us to conclude that there is selectivity among the treatments observed in the evaluation period.

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