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Variation of morphological response of cayenne pepper cultivars to phenoxaprop-p-ethyl herbicide

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ABSTRACT

In the cultivation of cayenne pepper (*Capsicum frutescens* L.), there is a problem with weeds. The use of herbicides for weed control can also trigger phytotoxic reactions in cultivated plants. The purpose of this study was to determine the morphological response of various cultivars of cayenne pepper to exposure to the Phenoxaprop-p-ethyl herbicide. This study employed a completely randomized design. The research data were analyzed using ANOVA and Kruskal-Wallis statistical tests. The study's results revealed a strong biphasic (hormesis) response pattern, where a dose of 55 g/L triggers growth, while a dose of 110 g/L causes phytotoxicity.

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INTRODUCTION

Cayenne pepper (*Capsicum frutescens* L.) is a member of the Solanaceae family with a shrubby habit that has small fruits with a spicy taste (Lelang et al., 2019). Cayenne pepper is one of the leading commodities in Indonesia and has a price that fluctuates with increasing demand (Rochyat, 2015; Assan et al., 2023). Based on data from the Indonesian Central Statistics Agency, the production of cayenne pepper in 2023 in Indonesia reached 1.506.762 tons. Provinces with the highest production are East Java (562.816 tons), Central Java (249.208 tons), and West Java (163.989 tons). The high rate of production of cayenne pepper is also influenced by the level of its needs. In 2023, the average consumption rate of cayenne pepper in Indonesia was 2,192 kg/capita/year. The provinces with the highest consumption rate of cayenne pepper in 2023 are Gorontalo with a consumption rate of 4,160 kg/capita/year and North Sulawesi with a consumption rate of 4,093 kg/capita/year (Sabarella et al., 2024).

Cayenne pepper is a horticultural crop that is quite easy to cultivate. In the cultivation process, cayenne pepper also faces several obstacles. One of the obstacles faced is the presence of weed disturbance (Lestari & Chitra, 2021). Weeds are defined as any plant that grows in an undesirable place and is considered a nuisance to the place where it grows (Sahrawat et al., 2020; Leguizamón, 2024).

Weeds are wild plants that can live in various places, even on less fertile land, and can reduce the productivity of cultivated plants (Lestari, 2018; Tarigan & Felicitas, 2023). According to Haq et al. (2023), in addition to nutrient competition factors, weeds can also cause losses in cultivated plant production because they act as hosts for pests and pathogens. Weeds that grow in cayenne pepper cultivation areas can harm cultivated plants because of competition for light, moisture, air, water, space, and nutrients (Ajibola & Angela, 2019).

The presence of plant disturbance organisms such as weeds can cause a decrease in the growth and production quality of cayenne pepper (Liwutang et al., 2024). Weeds that coexist with cultivated plants can result in reduced leaf counts and increased competition between cultivated plants and weeds (Imaniasita et al., 2020). Based on the research of Prabowo et al. (2020), cayenne pepper plant growth is hampered due to competition with weeds that are in the same cultivation environment.

One solution for weed control is that it can be done by chemical methods using herbicides. Herbicides are chemicals to damage weed growth to cause weed death (Gaines et al., 2020; Aditiya, 2021). This method is considered more practical and profitable compared to conventional methods, especially in terms of cost and relatively shorter implementation (Singh et al., 2020). The active ingredients of herbicides for chili plants generally contain Pendimethalin, Phenoxaprop-p-ethyl, and Glyphosate.

The selection of herbicides used for weed control must also be considered. Herbicides that basically contain chemicals can trigger phytotoxic reactions in cultivated plants. Herbicides that have a detrimental effect on chili plants or other cultivated plants generally are herbicides that are at high risk of causing phytotoxicity, or it could be because the herbicides are non-selective. This can lead to reduced yields, increased crop damage, and deterioration in quality. Phytotoxicity effects of herbicide exposure are also determined by the genetic tolerance of each cultivar and environmental factors (Barbaś et al., 2023).

Phenoxaprop-p-ethyl is a systemic herbicide that works by inhibiting acetyl-CoA carboxylase (ACCase) to prevent the process of fatty acid biosynthesis (Wang et al., 2024). Phenoxaprop-p-ethyl with a certain concentration showed effective results in weed control in rice and onion areas (Nalfin et al., 2018; Singh et al., 2017). In addition to having advantages in terms of weed control effectiveness, Phenoxaprop-p-ethyl also has the disadvantage that it can cause resistance in weeds (Yin et al., 2024). Phenoxaprop-p-ethyl residues can also adversely affect soil ecosystems (Jing et al., 2018). Against the background of these problems and the absence of research conducted, it is necessary to study the morphological response of cayenne pepper cultivars to exposure to Phenoxaprop-p-ethyl herbicide.

RESEARCH METHODS

Research Design

The research was carried out from May to August 2025, at the Green House of Sebelas Maret University and the MIPA Laboratory of Sebelas Maret University. This study is an experimental study. This study used a complete randomized design with 3 herbicide treatment doses (dose 0 or control, dose 55 g/l, and dose 110 g/l) for the three cultivars (Bara, Bhaskara, Ori 212) with 3 replications, so there were 27 experimental units.

Table 1. Research Design

Cultivar \ Doses	Dose 0 (g/l)	Dose 55 (g/l)	Dose 110 (g/l)
Bara (T_1)	T_1D_0	T_1D_1	T_1D_2
Bhaskara (T_2)	T_2D_0	T_2D_1	T_2D_2
Ori 212 (T_3)	T_3D_0	T_3D_1	T_3D_2

Population and Samples

The samples in this study were 3 cultivars of cayenne pepper, namely Bara cultivar, Bhaskara cultivar, and Ori 212 cultivar. The total sample is 27 experimental units with details in the form of 3 variations of herbicide treatment doses and 3 replications.

Instruments

The tools used in this study are a tray and a polybag as planting media, a hand sprayer for herbicide application, a ruler and stationery for measuring root length and plant height, and millimeter paper for measuring leaf area. The materials used in this study were the seeds of cayenne pepper cultivar Bara, cultivar Bhaskara, and cultivar Ori 212, soil, manure, water, and herbicide Phenoxaprop-p-ethyl with trademark Rumpas.

Procedures

The stages of the study include the following steps: 1) preparation of planting media by mixing soil and manure in a ratio of 1:1 and then stirring evenly until mixed; 2) seeds of each cultivars are selected by soaking in water for 3 hours, sinking seeds will be selected for the seeding process; 3) seeding seeds are carried out on a tray that has been filled with planting media. Seeding will be carried out for 30 days or up to grow 3-4 leaves and then transferred to the experimental planting media; 4) cayenne pepper plants that have grown and aged 30 days will be planted in polybags; 5) herbicide treatment is divided into several doses using commercial herbicides Rumpas brand that is 0 doses, dose of 55 g/l, and a dose of 110 g/l. Herbicide treatment was conducted at the age of 30 DAP by spraying using a hand sprayer; 6) the harvesting stage of cayenne pepper cultivars was carried out at the age of 60 DAP.

Data Analysis

The data were tested using a normality test. Normally distributed research data, including plant height parameters, were analyzed using Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT). Non-normally distributed data, including root length, number of leaves, and leaf area, were analyzed using the Kruskal-Wallis test and the Mann-Whitney test. The significance level used in this statistical analysis was 5%.

RESULTS

Normality Test Result

Based on the normality test conducted (Table 2), it was found that the parameters of root length, number of leaves, and leaf area have a p-value smaller than 5%. This indicates the data is not normally distributed, so the Kruskal-Wallis and the Mann-Whitney test are needed. For normally distributed data, the plant height parameters were analyzed by the ANOVA test and DMRT test (Martopani et al., 2022).

Table 2. Normality test result

	Shapiro-Wilk		
	Statistic	df	Sig.
Root length	.844	27	.001
Plant height	.957	27	.321
Number of leaves	.872	27	.003
Leaf area	.795	27	.000

Effect of Phenoxaprop-p-ethyl herbicide and Cayenne Pepper Cultivars on Root Length

Phenoxaprop-p-ethyl herbicide treatment and cayenne pepper cultivars significantly affected Root Length. It can be known from the p-value (0,001) is smaller than 5%. Mann-Whitney test results are presented in Table 3.

Table 3. Effect of Phenoxaprop-p-ethyl herbicide and cayenne pepper cultivars on root length

Cayenne Pepper Cultivars	$\bar{x} \pm$ SD (cm)			Average (cm)
	Dose 0 (g/l)	Dose 55 (g/l)	Dose 110 (g/l)	
Bara	1,63 ± 0,11^{a}	1,70 ± 0,10^{ab}	2,27 ± 0,15^{b}	1,87
Bhaskara	6,30 ± 0,10^{b}	4,53 ± 0,25^{b}	2,93 ± 0,32^{b}	4,59
Ori 212	7,80 ± 0,30^{b}	9,83 ± 0,21^{b}	2,13 ± 0,32^{b}	6,59
Average (cm)	5,24	5,35	2,44	

Description: 1) x: average; 2) SD : standard deviation; 3) numbers followed by the same letter (notation) showed no significant difference in the Mann-Whitney Test 5%.

Based on the root length measurement results, it can be seen that the dose of 55 g/l becomes a stable dose by supporting the increase in root length. However, the results of root length measurement in Bhaskara cultivar with a dose of 55 g/l decreased root length significantly. In contrast to the 55 g/l dose, the 110 g/l dose was seen to decrease root length very significantly in the Bhaskara and ORI 212 cultivars.

Effect of Phenoxaprop-p-ethyl Herbicide and Cayenne Pepper Cultivars on Plant Height

Herbicide treatment Phenoxaprop-p-ethyl and cayenne pepper cultivars significantly affect plant height. It can be known from the p-value (0,001) is smaller than 5%. Further test results of DMRT are presented in Table 4.

Table 4. Effect of Phenoxaprop-p-ethyl herbicide and cayenne pepper cultivars on plant height

Cayenne Pepper Cultivars	$\bar{x} \pm$ SD (cm)			Average (cm)
	Dose 0 (g/l)	Dose 55 (g/l)	Dose 110 (g/l)	
Bara	5,27 ± 0,68^{b}	8,33 ± 0,35^{d}	5,90 ± 0,26^{bc}	6,50
Bhaskara	10,60 ± 2,08^{e}	6,70 ± 0,50^{c}	9,67 ± 0,35^{de}	8,99
Ori 212	5,00 ± 0,43^{b}	5,17 ± 0,15^{b}	2,47 ± 0,30^{a}	4,21
Average (cm)	6,96	6,73	6,01	

Description: 1) x: average; 2) SD : standard deviation; 3) numbers followed by the same letter (notation) shows no real difference in the DMRT 5% Advanced Test.

Based on the results of plant height measurement, it can be seen that the dose of 55 g/l becomes a stable dose by supporting the increase in plant height. However, the results of plant height measurement on Bhaskara cultivar with a dose of 55 g/l decreased plant height significantly in line with the decrease in root length. A dose of 110 g/l showed a significant decrease in plant height in the Bara and ORI 212 cultivars, while the Bhaskara cultivar showed almost the same increase in plant height as the control.

Effect of Phenoxaprop-p-ethyl Herbicide and Cayenne Pepper Cultivars on The Number of Leaves

Phenoxaprop-p-ethyl herbicide treatment and cayenne pepper cultivars significantly affect the number of leaves. It can be known from the p-value (0,004) smaller than 5%. Mann-Whitney test results are presented in Table 5.

Table 5. Effect of Phenoxaprop-p-ethyl herbicide and cayenne pepper cultivars on the number of leaves

Cayenne Pepper Cultivars	$\bar{x} \pm$ SD			Average
	Dose 0 (g/l)	Dose 55 (g/l)	Dose 110 (g/l)	
Bara	$5,33 \pm 0,58^{ae}$	$11,00 \pm 0,00^{b}$	$7,00 \pm 1,00^{ac}$	7,78
Bhaskara	$12,33 \pm 4,04^{b}$	$7,67 \pm 1,15^{c}$	$10,33 \pm 2,08^{bcd}$	10,11
Ori 212	$6,00 \pm 1,00^{acf}$	$5,00 \pm 1,00^{adg}$	$5,00 \pm 0,00^{efg}$	5,33
Average	7,89	7,89	7,44	

Description: 1) x: average; 2) SD : standard deviation; 3) numbers followed by the same letter (notation) showed no significant difference in the Mann-Whitney Test 5%.

Based on the measurement of the number of leaves, it can be seen that the dose of 55 g/l becomes a stable dose by supporting the increase in the number of leaves. However, the measurement results on cultivar Bhaskara with a dose of 55 g/l decreased the number of leaves is quite significant in line with a decrease in root length and plant height. A dose of 110 g/l showed a decrease in the number of leaves in the Bara cultivar and a stable result in the Ori 212 cultivar, while the Bhaskara cultivar showed an increase in the number of leaves.

Effect of Phenoxaprop-p-ethyl Herbicide and Cayenne Pepper Cultivars on Leaf Area

Phenoxaprop-p-ethyl herbicide treatment and cayenne pepper cultivars significantly affect the leaf area. It can be known from the p-value (0,001) smaller than 5%. Mann-Whitney test results are presented in Table 6.

Table 6. Effect of Phenoxaprop-p-ethyl herbicide and cayenne pepper cultivars on leaf area

Cayenne Pepper Cultivars	$\bar{x} \pm$ SD (mm^2)			Average (mm^2)
	Dose 0 (g/l)	Dose 55 (g/l)	Dose 110 (g/l)	
Bara	$8,67 \pm 0,14^{a}$	$35,92 \pm 0,38^{b}$	$18,00 \pm 0,25^{b}$	20,86
Bhaskara	$42,25 \pm 0,50^{b}$	$22,92 \pm 0,38^{b}$	$39,58 \pm 0,38^{b}$	34,92
Ori 212	$40,25 \pm 0,25^{b}$	$43,58 \pm 0,14^{c}$	$39,92 \pm 0,38^{bc}$	41,25
Average (mm^2)	30,39	34,14	32,5	

Description: 1) x: average; 2) SD : standard deviation; 3) numbers followed by the same letter (notation) showed no significant difference in the Mann-Whitney Test 5%.

Based on the measurement of leaf area, it can be seen that the dose of 55 g/l becomes a stable dose by supporting an increase in the number of leaves. However, the measurement results on the cultivar Bhaskara with a dose of 55 g/l decreased leaf area is quite significant as in other parameters. A dose of 110 g/l showed a decrease in leaf area in the cultivars of Bara and ORI 212, while the Bhaskara cultivar showed an increase in leaf area.

DISCUSSION

Effect of Phenoxaprop-p-ethyl Herbicide and Cayenne Pepper Cultivars on Root Length

Based on Table 1, it can be noted that the average root length had a slight increase at a dose of 55 g/l compared to the control. However, at a dose of 110 g/l there is a sharp decrease to 2,44 cm. A decrease in root length at a dose of 110 g/l indicates the presence of a phytotoxic effect of the herbicide. This herbicide is absorbed by the leaves and translocated to the root meristem tissue, inhibiting cell division and elongation, resulting in significantly inhibited root growth (Shaner, 2014). An increase in Root Length at a dose of 55 g/l compared to a dose of 0 g/l (control) showed a hormesis-stimulating effect at low concentrations, although the difference was very small. Hormesis is a phenomenon of a stimulatory response at low doses of toxic substances (Jalal et al., 2020).

Differences in the level of tolerance or sensitivity to chemical compounds such as herbicides, for example, can be caused by genetic variation between cultivars (Barbás et al., 2023; Ranjan et al., 2020). Cultivar Ori 212 has the highest average root length followed by Bhaskara and Bara with the lowest average root length. This average value indicates that overall, the Ori 212 cultivar was the most tolerant cultivar or had the most vigorous root growth under treatment conditions. While Bara cultivar are the most sensitive cultivar or have the lowest root growth.

The root length of Bara cultivar tended to be low at all doses, but there was a significant increase at the 110 g/l dose compar`ed to the 0 g/l dose (control). This increase indicates that the herbicide reacts differently or the Ember cultivar is sensitive from the start which is indicated by a low control value. Bara cultivar at Dosis 110 g/l differed markedly (longer) from the dose of 0 g / l (control).

Bhaskara cultivar showed a significant reduction in root length as the dose increased from a dose of 0 g/l (control) to a dose of 110 g/l. This confirms the presence of a phytotoxic effect against high doses of herbicides. Bhaskara cultivar there is no significant difference between the three doses marked with the same notation. Although the numerical value decreases, this indicates that statistically, the decline in growth is not sharp enough to be considered as significantly different between groups.

Ori 212 cultivar at dose of 55 g/l showed hormesis that triggered excessive self-defense mechanisms or activated certain growth pathways (Jalal et al., 2020). But statistically it does not differ markedly from the control. At a dose of 110 g/l, the Ori 212 cultivar showed phytotoxicity of the optimal value at a dose of 55 g/l, but statistically did not differ from the dose of 0 g/l (control) and the dose of 55 g/l.

Phenoxaprop-p-ethyl herbicide at a dose of 110 g/l is generally phytotoxic and inhibits the length of the roots of cayenne pepper. This is consistent with its mechanism of action as an ACCase inhibitor (Wang et al., 2024). Its mechanism of action is to disrupt the formation of cell membranes, especially in meristematic tissues (Gaines et al., 2020). Cayenne pepper cultivars showed varying tolerance, with Ori 212 cultivar showing the best overall root growth and hormesis response seen at a dose of 55 g/l.

Effect of Phenoxaprop-p-ethyl Herbicide and Cayenne Pepper Cultivars on Plant Height

Based on Table 2, it is known that the Bhaskara cultivar shows the highest average plant height, while the Ori 212 cultivar shows the lowest average plant height. This reflects differences in genetic potential for growth between cultivars. In addition, there is also a tendency that increasing the dose of herbicide shows a decrease in average plant height from a dose of 0 g/l to a dose of 110 g/l.

In Bara cultivar, a 55 g/l dosed treatment resulted in higher plant height and significantly different from the 0 g/l treatment. This indicates the presence of hormesis, where low doses of herbicides can stimulate growth. The phenomenon of hormesis in Ember cultivars is a common biphasic biological response in plants to toxic chemicals. A dose of 55 g/l can act as a mild stressor that triggers defense or adaptation mechanisms in plants, for example increased hormone production or secondary metabolites that indirectly stimulate cell division and stem elongation, thereby increasing plant height (Erofeera, 2024).

Bhaskara cultivar at a dose of 0 g / l produced the highest plant height compared to the other two treatments. The Bhaskara cultivar shows good tolerance, even at doses of 110 g/l. This value does not differ markedly from the optimal conditions at the control dose. This indicates Bhaskara cultivar are most tolerant to Phenoxaprop-p-ethyl herbicides in maintaining plant height growth. The ability of Bhaskara cultivar to maintain plant height that hardly differed between doses of 0 g/l and doses of 110 g/l showed superior genetic tolerance. This is likely due to the herbicide's very fast metabolic rate, such as glucose conjugation or hydroxylation, which converts Phenoxaprop-p-ethyl into a non-toxic form before it can damage the apical meristem of the stem.

The Ori 212 cultivar showed the most extreme decrease in growth at a dose of 110 g/l. These results differ markedly from all other treatments. This indicates that the Ori 212 cultivar is most susceptible to herbicide toxicity at a dose of 110 g/l against plant height. The susceptibility of Ori 212 cultivar at dose of 110 g/l showed limitations in the detoxification mechanism, causing a strong accumulation of phytotoxins, thereby significantly suppressing cell division and elongation (Yu & Powles, 2014).

Based on Table 2, it can be seen that there is a significant interaction between cultivars and herbicide doses on plant height. Bhaskara cultivar showed fairly high tolerance, Bara cultivar showed hormesis effects at doses of 55 g/l, and Ori 212 cultivar were highly susceptible to herbicide dose of 110 g/l.

Effect of Phenoxaprop-p-ethyl Herbicide and Cayenne Pepper Cultivars on The Number of Leaves

Based on Table 3, the average number of leaves at dose of 0 g/l (control) and 55 g/l showed the same results. While the average number of leaves at a dose of 110 g/l is lower than both. In general, exposure to herbicides at an average level did not show a significant impact on the number of leaves, except for a slight decrease in the dose of 110 g/l.

Plant tolerance to herbicides can also be influenced by cultivar genetic factors, which determine the rate of metabolism, absorption, or detoxification of chemical compounds. The Bhaskara cultivar has the highest average number of leaves, followed by the Bara cultivar which has a medium average number of leaves, and the Ori 212 cultivar with the lowest average number of leaves. In the treatment conditions tested, Bhaskara cultivars showed the strongest vegetative growth or best tolerance in maintaining leaf count, while Ori 212 cultivars tended to have the least number of leaves.

Bara cultivar showed a very significant increase in the number of leaves at a dose of 55 g/l. At this dose, the Bara cultivar differed markedly from the control and dose of 110 g/l. This is a strong indication of the phenomenon of hormesis. The sublethal dose of 55 g / l herbicide acts as a mild stressor agent that triggers defense or adaptation mechanisms in plants, one of which is to trigger new vegetative growth such as the addition of the number of leaves (Jalal et al., 2020).

The Bhaskara cultivar shows a decrease in the number of leaves as the dose increases. The dose of 0 g/l (control) was statistically significantly different from the dose of 55 g / l. This indicates a significant phytotoxic effect of the herbicide, even at a dose of 55 g/l. At a dose of 110 g/l the number of leaves again increased and statistically did not differ from the control.

The Ori 212 cultivar shows a relatively stable and low leaf count. Statistically, the three doses in these cultivars did not differ markedly from each other. This indicates that the Ori 212 cultivar has a stable tolerance level or does have a genetic trait with a lower growth in the number of leaves, so the herbicide does not cause significant changes in this parameter.

Herbicide Phenoxaprop-p-ethyl at a dose of 55 g/l was shown to trigger a significant phenomenon of hormesis in Bara cultivar, characterized by an increase in the number of leaves doubled compared to controls. The Bhaskara cultivar was the most sensitive to the herbicide at a dose of 55 g/l, showing a marked decrease in the number of leaves. The Ori 212 cultivar showed stability, with the number of leaves not significantly affected by the herbicide, albeit at the highest doses. The use of Phenoxaprop-p-ethyl herbicide has the potential to have different side effects, ranging from growth stimulation (hormesis) to phytotoxicity, depending on the genetic susceptibility of the cayenne pepper cultivar.

Effect of Phenoxaprop-p-ethyl Herbicide and Cayenne Pepper Cultivars on Leaf Area

Based on Table 4, Ori 212 cultivar has the highest average leaf area, followed by Bhaskara cultivar with medium average leaf area and Bara cultivar with the lowest average leaf area. When viewed from the average leaf area per treatment dose, it is known that the highest average leaf area is at a dose of 55 g/l treatment. While the lowest average leaf area is at a dose of 0 g/l treatment (control). On average, herbicides at a dose of 55 g/l tend to increase leaf area compared to controls. This increase was also seen in the root length parameter of Ori 212 cultivar and the number of Leaves of Bara cultivar which showed the potential of stimulating effect (hormesis). Mild stress generated by sublethal doses of herbicides can activate adaptation or defense mechanisms, one of which manifests itself as increased vegetative growth (Erofeeva., 2024).

Bara cultivar show the most extreme hormesis response. Leaf area at a dose of 55 g/l differed markedly from a dose of 0 g/l (control). This increase indicates that the Ember cultivar strongly responds to sublethal doses of the herbicide Phenoxaprop-p-ethyl as a growth trigger. At a dose of 110 g/l there is a drastic decrease. But statistically it does not differ markedly from the dose of 55 g/l. This confirms that despite the numerical decrease in phytotoxicity at high doses, the dose of 55 g / l remains the optimal trigger for the hormesis response in Bara cultivar.

In the Bhaskara cultivar there was a decrease from a dose of 0 g/l (control) to a dose of 55 g/l. While at a dose of 110 g/l there was a slight increase than at a dose of 55 g/l. Based on these data, there was a large numerical decrease between each treatment. But the Mann-Whitney test showed that these three doses were not significantly different from the same letter notation.

The Ori 212 cultivar shows good tolerance to herbicide exposure. Although there was a slight increase in leaf area at doses of 55 g/l, in general, leaf area values were stable at all doses. The dose of 55 g/l differs markedly from the dose of 0 g / l (control), which indicates the presence of a slight stimulating effect. However, at a dose of 110 g/l did not differ markedly from the control. This shows that this cultivar is able to metabolize or deactivate herbicides efficiently, so that the effect of phytotoxicity on leaf area can be minimized (Yu & Powles, 2014).

The phenomenon of hormesis was the most prominent finding in leaf area parameters, especially in Ember cultivars with a dose of 55 g / l. The Ori 212 cultivar showed the most stable and best overall leaf area performance, proving the highest tolerance to the Phenoxaprop-p-ethyl herbicide. A dose of 55 g/l can potentially be used to modify growth in certain cultivars, but this dose can also trigger phytotoxicity in other cultivars although it is not statistically significantly different in Bhaskara cultivar.

CONCLUSION

Three cultivars of cayenne pepper showed different morphological responses. Bara cultivar showed the most significant hormesis response at a dose of 55 g/l which led to an increase in the parameters of plant height, number of leaves and leaf area. A dose of 110 g/l caused inhibition of morphological growth except in the parameter of root length. Bhaskara cultivar showed morphological sensitivity that is decreased growth at a dose of 55 g/l. At a dose of 110 g/l Bhaskara cultivar tends to show stable results. Ori 212 cultivar at a dose of 55 g/l showed a stable growth stimulating effect on all parameters. At a dose of 110 g/l cultivar Ori 212 showed a decrease in growth. For growth optimization and weed control, specific herbicide doses can be used for each cultivar. A dose of 55 g/l is recommended for Ori 212 and Bara cultivars, while Bhaskara may be able to tolerate higher doses if needed. Proper selection of cultivar and dosage can avoid phytotoxicity and maximize crop yield.

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