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Original Research Article

Selective Influence of *Chromolaena odorata* Extracts on the Germination and Growth of Vegetable Crops: A Comparative Study of Aqueous and Methanolic Solutions

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Abstract: This study conducted a thorough assessment of how germination and growth of shoots and roots in eight vegetable crops are influenced by aqueous and methanolic extracts from *Chromolaena odorata*. Findings reveal a broad spectrum of germination responses to leaf extracts (13.3% to 86.7%), signaling the intricate dynamics at play between the plant's chemical compounds and the germination mechanism. Notably, *Cucumis sativus (*70% at AQE 5%) and *Phaseolus vulgaris* (56.70% at AQE 10%), displayed remarkable resilience and even stimulation of germination under specific extract concentrations, suggesting a potential selective stimulatory effect. For root extracts, the introduction of AQE and MTE decreased germination percentages across crops. *A. esculentus* had the highest germination rate at AQE 20%, significantly lower than the control (60%). *Solanum. melongena* tolerated AQE 5% best, while MTE 20% was most inhibitory. Conversely, *Solanum lycopersicum* experienced complete germination inhibition in both AQE and MTE of leaf and root extracts, indicating species-specific vulnerability to the allelopathic compounds within the extracts. Shoot growth mostly declined with higher extract concentrations, except in *Solanum melongena*, *Capsicum annuum*, *and Zea mays*, which saw increased shoot lengths under certain conditions. Root growth responses were mixed; *Abelmoschus esculentus* and *Zea mays* showed growth increases at some concentrations, in contrast to *Cucumis sativus* and *Solanum melongena*, which had limited growth. Methanolic extracts had a stronger inhibitory effect, likely due to their potent bioactive compounds. These findings highlight the importance of extract type, concentration, and crop species in weed management, providing insights for sustainable agricultural practices.

Keywords: *Chromolaena odorata,* Leaf extract, Root extract, Crops.

INTRODUCTION

Cromolaena odorata, commonly known as the "Siam weed" or "Christmas bush," is a fast-growing and invasive plant species native to the neotropical regions of Central and South America (Liogier, 1995; Day and McFadyen, 2003). This invasive weed is a fast-growing, herbaceous plant that can reach heights of up to 3 meters (Pasiecznik, and Gautier, 2022). It possesses an upright growth habit with densely packed leaves. However, over the years, it has spread to various parts of the world, particularly in tropical and subtropical regions, where it has become a major ecological and agricultural nuisance (Lowe, 200, Yu *et al*., 2016)). One of the remarkable aspects of *Cromolaena odorata* is its allelopathic activity, a phenomenon in which the plant releases biochemical compounds that influence the growth and development of neighboring plants and organisms. Allelopathy is the ecological process by which a plant, through the release of chemicals into its environment (Li *et al*., 2005; Sing *et al.*, 2021). These allelochemicals are a diverse group of secondary metabolites that can have both stimulatory and inhibitory effects on neighboring plants, depending on their concentration and specific compounds involved (Rashidi *et al.*, 2021; *Cromolaena odorata* releases allelopathic compounds such as sesquiterpene lactones and flavonoids, which can inhibit the germination and growth of nearby plant species. These chemicals disrupt key physiological processes in competing plants, leading to reduced seedling establishment and growth (Kato-Noguchi and Kato, 2023). The continuous presence of *Cromolaena odorata* in an area can lead to

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soil degradation. The allelopathic chemicals leached into the soil can alter its physical and chemical properties, making it less hospitable for other plant species (Motmainna *et al.*, 2023). This can result in a decline in biodiversity and the displacement of native vegetation (Heringer *et al.*, 2019; Gioria *et al.*, 2023). By suppressing the growth of neighboring plants, *Cromolaena odorata* gains a competitive advantage, allowing it to colonize and dominate ecosystems rapidly.

In contemporary times, there has been a burgeoning interest in harnessing the latent potential of allelochemicals for the purpose of weed management. This heightened attention arises from the stark realization that weed infestations wield a substantial and detrimental influence on both the quantity and quality of crop yields. The allelopathic attributes of numerous weed species have been subjected to rigorous scrutiny, revealing the presence of allelopathic substances within them. Ali *et al.*, (2012) found that methanol extracts from 22 weed species inhibited the germination of various plants. Additionally, fifty potential allelochemicals were identified in different chemical solvent extracts of *Humulus scandens* (Wang *et al*., 2021). These findings not only highlight the broad spectrum of allelopathic interactions but also accentuate the potential for leveraging allelopathy as a tool in weed management strategies.

The use of herbicide poses challenges like resistance, pollution, and health risks (Damalas and Eleftherohorinos, 2011). These concerns highlight the unsustainability of herbicide-based practices, prompting the need for alternative approaches. Before herbicides became widespread, weed control primarily relied on cultivation techniques and crop rotation (Casimero, 2022). In response to the limitations of conventional herbicide use, allelopathy emerges as a promising alternative strategy. Allelopathic methods offer a way to address these issues while promoting sustainability in agriculture and safeguarding the environment for future generations (Ofosu *et al*., 2023). This approach aims to mitigate environmental pollution and maintain ecological balance, particularly concerning Soil organisms and plants. It reduces reliance on chemical herbicides, replacing them with natural alternatives (Weisberger, 2024). Beneficial allelopathic traits can also be reintroduced through conventional breeding and modern techniqies (Ain, 2023).

Utilizing allelochemicals strategically in agriculture offers potential in addressing parasitic weed issues by influencing seed germination, either inhibiting or stimulating it (Macias, 2019). Additionally, integrated weed management involves the use of catch-and-trap crops, capitalizing on the allelopathic mechanism to control parasitic species. Historically viewed as nuisances, weeds are now considered in terms of their ecological impact. In modern agriculture, allelopathic crops serve various purposes, including as cover crops, intercropping systems, green manure, and in crop rotations (Adebayo, S. A., and Oladelem 2014; Angon, 2023). This study investigates the allelopathic effects of *Cromolaena odorata* on various agricultural crops, particularly focusing on the impact of leaf and root extracts on seed germination and subsequent plant growth. Through a comprehensive examination, this research seeks to demonstrate the potential of allelopathy as an effective and sustainable weed management strategy in agriculture.

MATERIALS AND METHODS

Sample Collection and Processing

In this study, we evaluated the seed viability of eight distinct vegetable crops: *Abelmoschus esculentus, Capsicum annum, Phaseolus vulgaris, Solanum melongena, Solanum lycopersicum, Zea mays, Cucumis sativus,* and *Cicer arietinum* using a floatation method. A total of 100 seeds from each crop were submerged in a 200 ml beaker filled with distilled water for a period of 5 to 10 minutes. Viability assessment was based on buoyancy criteria, with seeds that floated being classified as non-viable and those that sank as viable. Concurrently, fresh Ageratum conyzoides leaves and roots were harvested from the botanical garden of the University of Chittagong. All experimental procedures were conducted within the premises of the Department of Botany, University of Chittagong, Chattogram, Bangladesh.

Preparation of Extracts

This experiment involved the preparation of extracts from 400 grams of fresh *C. odorata* leaves and roots. Initially, the samples were rinsed with distilled water to remove any surface contaminants. They were then air-dried at ambient temperature (28-30°C) for 24 hours in a location shielded from direct sunlight to ensure the removal of all moisture. Following this, the samples were oven-dried at 80°C for 48 hours. The dried leaves and roots were subsequently ground into a fine powder using an electric grinder and sieved through an 8.0 mm mesh to achieve a uniform particle size. To maintain sterility, all glassware utilized was heat-sterilized in an oven at 180°C for 15 minutes. The powdered samples were stored in airtight glass jars for further use.

For the extraction, measured quantities of 5, 10, 15, and 20 grams of the powdered leaves and roots were infused in 100 ml of distilled water and 80% methanol, respectively, and stirred continuously at room temperature for 24 hours. The mixtures were then filtered through a 2 mm mesh sieve to remove undissolved particles, followed by centrifugation at 3500 rpm for 15 minutes. The supernatants obtained from both the aqueous and methanolic extractions were stored in conical flasks and refrigerated at 4°C for subsequent experimental use.

Seed Culture Preparation for Aqueous and Methanol Extracts from Leaves and Roots

The experimental setup included the preparation of Petri dishes, each with a diameter of 9 cm, which were sterilized before use. A Whatman No.1 filter paper was placed in each dish followed by an addition of an appropriate soil medium. Ten seeds from the selected crop types were sown in each dish with uniform spacing. The entire experiment was carried out under controlled environmental conditions, maintaining a constant temperature of 23°C over a 12-day period to promote germination. Eight treatment groups (T1 to T8), encompassing both aqueous and methanolic extracts of C. odorata leaves and roots, were established alongside a control group (T0) that utilized seeds soaked in distilled water. Each dish was irrigated with 5 ml of distilled water to preserve soil moisture. Germination success was determined by the emergence of a radicle longer than 2 mm. Post 12 days, germinated seed counts, as well as root and shoot growth, were recorded to calculate the Final Germination Percentage (FGP).

Data Analysis

Data analysis was performed in three times using Microsoft Excel 2010, with the results being presented as mean values ± Standard Error of Mean (SEM).

RESULTS AND DISCUSSION

Variable in Germination Rates

Table 1: Germination percentage of eight vegetable crops to different concentrations of aqueous and methanolic leaf extract of *Chromolaena odorata* at 12 days

Treatment	*A. esculentus*	*S. melongena*	*S. lycopersicum*	*P. vulgaris*	*C. annuum*	*Z. mays*	*C. arietinum*	*C. sativus*
Control	60±0.81	76.7±0.47	60±0.82	66.7±0.47	86.7±0.47	46.7±0.47	60±0.82	86.7±0.47
AQE 5%	40±0.81	40±0.82	33.3±0.47	46.7±0.47	23.3±0.47	23.3±0.47	46.7±0.47	70±0.82
AQE 10%	23.3±1.89	26.7±0.47	50±0.82	56.7±0.47	13.3±0.47	16.7±0.47	33.3±0.47	60±
AQE 15%	16.7±0.47	26.7±1.25	0	43.3±0.47	16.7±0.47	23.3±0.47	40±0.82	66.7±1.24
AQE 20%	20±0.81	16.7±0.47	0	30±0.82	23.3±0.47	30±0.82	43.3±0.47	40±0.82
MTE 5%	16.7±0.47	20±0.82	0	20±0.82	33.3±0.47	23.3±1.25	30±0.82	40±0.82
MTE 10%	23.3±0.47	13.3±0.47	0	40±0.82	16.7±0.47	36.7±0.47	16.7±0.47	20±0.82
MTE 15%	23.3±1.25	30±0.82	0	16.7±0.47	23.3±0.47	13.3±0.47	13.3±0.47	13.3±0.47
MTE 20%	20±0.82	16.7±0.47	13.3±0.47	13.3±0.47	30±0.82	20±0.82	16.7±0.94	16.7±0.47

AQE: Aqueous extract, and MTE: Methanol extract

Table 2: Germination percentage of eight vegetable crops to different concentrations of aqueous and methanolic root extract of *Chromolaena odorata* at 12 days

Treatment	*A. esculentus*	*S. melongena*	*S. lycopersicum*	*P. vulgaris*	*C. annuum*	*Z. mays*	*C. arietinum*	*C. sativus*
Control	60±0.82	76.7±0.47	60±0.82	66.7±0.47	86.7±0.47	46.7±0.47	60±0.82	86.7±0.47
AQE 5%	26.7±0.47	46.7±0.47	20±0.82	56.7±0.47	36.7±0.47	30±0.82	30±0.82	70±0.82
AQE 10%	30±0.82	26.7±0.47	30±0.82	43.3±0.47	16.7±0.47	36.7±0.47	60±0.82	40±0.82
AQE 15%	26.7±1.24	20±0.82	23.3±1.24	66.7±0.47	23.3±0.47	43.3±0.47	63.3±0.47	50±0.82
AQE 20%	43.3±0.47	16.7±0.47	26.7±0.47	40±0.82	26.7±0.47	36.7±0.47	40±0.82	50±0.82
MTE 5%	26.7±0.47	13.3±0.47	0	50±0.82	23.3±0.47	33.3±0.47	36.7±1.24	46.7±0.47
MTE 10%	26.7±0.47	20±0.82	0	40±0.82	16.7±0.47	16.7±0.47	16.7±0.47	20±0.82
MTE 15%	30±0.82	40±0.82	0	40±0.82	30±0.82	13.3±0.47	26.7±0.47	40±0.82
MTE 20%	23.3±0.47	30±0.82	26.7±0.47	20±0.82	20±0.82	20±0.82	13.3±0.47	23.3±0.47

AQE: Aqueous extract, and MTE: Methanol extract

The germination response of eight different vegetable crops to aqueous and methanolic leaf and root extracts of *Chromolaena odorata* has been comprehensively evaluated in this study (Table 1 and 2). Germination percentages ranged from as low as 13.3% to as high as 86.7%, (Table 1) stressing the complex interaction between the chemical constituents of *Chromolaena odorata* leaf extracts and the germination mechanisms of different vegetable seeds. Remarkably, *Cucumis sativus* and *Phaseolus vulgaris* demonstrated significant resilience and even stimulation under certain concentrations, with germination percentages peaking at 70% and 56.7% at treatments AQE 5% and AQE 10%, respectively. This suggests a potential selective stimulatory effect of lower concentrations of the extracts on these crops. Conversely, *Solanum lycopersicum* experienced complete germination inhibition during treatments AQE 5%to MTE 1 5%, highlighting a species-specific vulnerability to the allelopathic compounds present in the extracts. The lowest germination rates were distinctly observed at higher concentrations, particularly at treatment MTE 10% for *Solanum melongena* and treatment MTE 15% for *Cicer arietinum* and *Cucumis sativus,* alongside treatments T7 and T8 for *Solanum lycopersicum* and *Phaseolus vulgaris.*

Used for root extracts, the introduction of AQE and MTE significantly reduced the germination percentages across all crops, with more pronounced

inhibition at higher concentrations (Table 2). For *A. esculentus*, the highest germination rate observed in treatments was at AQE 20% (43.3±0.47), which was significantly lower than the control (60±0.82). Similarly, *S. melongena* showed the highest tolerance to AQE at 5% (46.7±0.47), while MTE at 20% (30±0.82) was most inhibitory. *S. lycopersicum* was particularly sensitive to both extracts, with no germination occurring at MTE 5% and above. *P. vulgaris* showed moderate tolerance to AQE with the least inhibition at AQE 10% (43.3±0.47), but was severely affected by MTE 20%. The germination of C. annum was also significantly inhibited, with MTE at 5% (23.3±0.47) showing the least reduction compared to the control. Z. mays showed a moderate response to the treatments, with AQE 20% (36.7±0.47) being the least inhibitory among the treated groups. *C. arietinum* showed a germination rate of 63.3±0.47 at AQE 15%, which was the least affected treatment, while *C. sativus* showed a germination percentage of 70±0.82 at AQE 5%, indicating a high level of tolerance compared to other treatments (Table 2).

The germination of vegetable crops was adversely affected by both aqueous and methanolic extracts of *Chromolaena odorata*. The impact was dose-dependent, with higher concentrations generally resulting in lower germination percentages (karim *et al*., 2017). The investigation supports the hypothesis that allelopathic effects from plant extracts vary significantly with concentration, crop species, and the nature of the extract (aqueous vs. methanolic) (Poonpaiboonpipat, 2021; Hamidi *et al.,* 2015). The observed germination patterns align with the notion that leaf extracts, rich in allelochemicals, exert a more pronounced inhibitory effect on seed germination compared to other plant parts (Julio *et al*., 2019; Popoola *et al.,* 2020). These findings illustrate a general trend where increased extract concentrations negatively impact germination rates, likely due to the elevated phytochemical content which may disrupt the germination process (Bashar *et al.,* 2023). These findings also suggest that the root extracts of *Chromolaena odorata* have phytotoxic effects on the germination of vegetable crops, with potential implications for their use in agricultural weed management (Macias, 2019).

Allelopathic Influence on Shoot Growth

Table 3: Shoot length of eight vegetable crops to different concentrations of aqueous and methanolic leaf extract of *Chromolaena odorata* at 12 days

Treatment	*A. esculentus*	*S. melongena*	*S. lycopersicum*	*P. vulgaris*	*C. annuum*	*Z. mays*	*C. arietinum*	*C. sativus*
Control	19.1±0.08	6.13±0.12	6.4±0.08	32.4±0.08	7.3±0.22	8.1±0.08	11.33±0.12	12.1±0.08
AQE 5%	15.37±0.12	7.17±0.17	3.43±0.04	24.1±0.08	8.17±0.17	7.13±0.09	9.37±0.12	10.1±0.08
AQE 10%	13.43±0.09	5.7±0.21	4.1±0.08	20.1±0.08	5.57±0.17	10.1±0.08	7.33±0.12	8.4±0.08
AQE 15%	8.4±0.08	4.1±0.08	0	15.1±0.08	9.23±0.21	7.1±0.08	9.1±0.08	9.5±0.08
AQE 20%	12.4±0.08	6.23±0.17	0	16.27±0.21	5.33±0.17	10.13±0.09	3.17±0.12	4.1±0.08
MTE 5%	10.03±0.04	4.4±0.21	0	16.1±0.08	6.67±0.12	8.37±0.12	4.4±0.08	12.1±0.08
MTE 10%	11.5±0.08	5.6±0.16	0	18.13±0.12	8.73±0.17	7.8±0.08	2.33±0.17	6.13±0.12
MTE 15%	11.07±0.09	5.4±0.16	0	11.17±0.12	8.37±0.29	8.4±0.08	3.33±0.12	11.37±0.12
MTE 20%	9.03±0.04	5.37±0.21	5.1±0.08	11.37±0.12	7.1±0.08	3.1±0.08	3.23±0.12	8.13±0.12

AQE: Aqueous extract, and MTE: Methanol extract

Table 4: Shoot Length of eight vegetable crops to different concentrations of aqueous and methanolic root extract of *Chromolaena odorata* at 12 days

Treatment	*A. esculentus*	*S. melongena*	*S. lycopersicum*	*P. vulgaris*	*C. annuum*	*Z. mays*	*C. arietinum*	*C. sativus*
Control	19.13±0.12	6.13±0.12	6.37±0.12	32.33±0.12	7.3±0.16	8.1±0.08	11.4±0.08	12.1±0.08
AQE 5%	10.33±0.12	6.43±0.21	4.1±0.08	25.1±0.08	7.33±0.17	5.77±0.09	8.1±0.08	9.5±0.08
AQE 10%	14.33±0.17	6.73±0.17	5.1±0.08	20.1±0.08	9.33±0.16	6.47±0.12	3.1±0.08	8.4±0.08
AQE 15%	14.33±0.12	6.13±0.12	4.1±0.08	24.33±0.12	5.63±0.17	8.33±0.12	6.43±0.05	12.37±0.1
AQE 20%	13.33±0.12	5.33±0.21	3.3±0.12	11.17±0.12	7.23±0.21	10.17±0.12	7.37±0.09	6.1±0.08
MTE 5%	10.33±0.17	6.37±0.17	0	20.3±0.12	7.17±0.12	9.47±0.12	5.1±0.08	10.1±0.08
MTE 10%	13.13±0.09	6.27±0.17	0	20.1±0.08	5.77±0.12	7.5±0.08	3.4±0.08	5.4±0.08
MTE 15%	8.33±0.12	5.47±0.17	0	22.1±0.08	6.43±0.12	7.8±0.08	4.37±0.12	12.4±0.08
MTE 20%	5.1±0.08	5.5±0.30	3.3±0.12	14.1±0.08	7.17±0.17	3.4±0.08	3.4±0.08	12.1±0.08

AQE: Aqueous extract, and MTE: Methanol extract

Table 3 provides the inhibitory effect both of aqueous and methanolic leaf extracts of *Chromolaena odorata* on the shoot length of eight vegetable crops. In this study, the control group (T0) exhibited the highest shoot length growth. Notable exceptions to this trend were *Solanum melongena* (7.17cm) at AQE 5%, *Capsicum annuum* (9.23cm) at AQE 15%, and *Zea mays* (10.13cm) at treatment MTE 20%, which showed greater shoot length growth compared to their respective controls. Conversely, the minimum shoot length was recorded, for *Cicer arietinum* (2.33cm), and 3.10 cm for Z. mays, at MTE 20%. As the concentration

of the leaf extract increased, a corresponding decrease in shoot length growth was observed.

In Table 4 results showed that when treated with AQE, A. esculentus showed an increase in shoot length at all concentrations, peaking at 10% AQE (14.33±0.17 cm) before a decline at higher concentrations. *S. melongena* showed an increase up to 15% AQE (6.13±0.12 cm) then a decrease at 20% AQE (5.53±0.30 cm). *S. lycopersicum* responded positively to AQE, with the highest shoot length at 5% AQE (5.1±0.08 cm). P. vulgaris presented an increased shoot length at lower concentrations, peaking at 15% AQE (24.33±0.12 cm). *C. annum* displayed a consistent increase in shoot length up to 10% AQE (9.33±0.17 cm), with a slight decrease at 15% and 20% AQE. *Z. mays* experienced a radual increase with peak at 20% AQE (10.17±0.12cm). C. arietinum showed an overall increase, with a maximum shoot length at 15% AQE (6.43±0.05 cm). Lastly, *C. sativus* exhibited increased shoot lengths up to 15% AQE (12.37±0.1cm) with a decrease at 20% AQE (6.1±0.08 cm). Under MTE treatments, *A. esculentus* experienced a decline in shoot length across all concentrations. *S. lycopersicum* had no recorded shoot length at any concentration of MTE. *P. vulgaris* had an increase in shoot length with the highest at 5% MTE (22.1±0.08 cm). *C. annum* displayed an increase in shoot length, peaking at 15% MTE (7.17±0.17 cm). *Z. mays* had increased shoot lengths with the highest at 5% MTE (9.47±0.12 cm). *C. arietinum* showed a consistent increase across MTE concentrations, with the highest at 15% MTE (4.37±0.12 cm). *C. sativus* had increased shoot lengths at all concentrations, with the highest at 15% MTE (12.4±0.08 cm (Table 4).

These findings are consistent with prior studies by Jabeen and Ahmed (2009), which documented growth inhibition in response to allelopathic plant extracts. Shoot length in this study ranged from 3.1cm to 19.1cm, highlighting the variability in growth responses among the tested vegetable crops under different extract concentrations (Table 3) (Wardiniet. *et al*., 2018). The data suggest a concentration-dependent effect of *Chromolaena odorata* root extracts on the shoot length of the studied vegetable crops. Both AQE and MTE demonstrated varying degrees of promotion and inhibition of shoot length, indicating a potential allelopathic effect (Hamidi *et al.*, 2014).

Methanolic root extract treatments showed a more pronounced inhibitory effect compared to the aqueous extract, with complete inhibition of shoot length in S. melongena and S. lycopersicum at all tested concentrations. This outcome could suggest a stronger allelopathic effect of the methanolic extract on certain species, which might be attributed to the presence of more potent bioactive compounds being extracted by the methanol solvent (Muscolo *et al*., 2001; Godlewska, *et al.*, 2021). Conversely, *C. arietinum* and *Z. mays* showed an overall increase in shoot length, indicating a selective effect of the methanolic extract that could be advantageous for these crops (Jabran and Farooq 2012).

Allelopathic Influence on Root Length

Table 5: Root Length of eight vegetable crops to different concentrations of aqueous and methanolic leaf extract of *Chromolaena odorata* at 12 days

Treatment	*A. esculentus*	*S. melongena*	*S. lycopersicum*	*P. vulgaris*	*C. annuum*	*Z. mays*	*C. arietinum*	*C. sativus*
Control	6.13±0.12	6.13±0.12	2.15±0.08	12.17±0.04	3.33±0.12	14.4±0.08	11.03±0.04	5.1±0.08
AQE 5%	4.7±0.08	4.47±0.21	2.35±0.082	7.13±0.12	3.2±0.16	18.13±0.12	7.13±0.09	5.4±0.08
AQE 10%	6.4±0.08	5.4±0.16	6.05±0.05	6.1± 0.08	3.37±0.29	25.03±0.05	11.4±0.08	2.4±0.05
AQE 15%	6.47±0.04	4.4±0.16	0	10.37±0.12	2.4±0.16	22.1±0.08	25.13±0.12	5.43±0.05
AQE 20%	5.03±0.04	1.47±0.12	0	7.5±0.08	5.47±0.12	11.1±0.08	10.13±0.12	2.1±0.08
MTE 5%	7.06±0.09	4.5±0.16	0	8.07±0.09	4.7±0.16	22.07±0.09	19.1±0.08	3.3±0.17
MTE 10%	6.03±0.04	5.17±0.17	0	7.53±0.04	4.3±0.16	27.7±0.08	7.1±0.08	1.36±0.12
MTE 15%	2.1±0.08	5.5±0.16	0	6.33±0.12	2.27±0.17	9.1±0.08	2.3±0.16	2.4±0.05

AQE: Aqueous extract, and MTE: Methanol extract

Table 6: Root length of eight vegetable crops to different concentrations of aqueous and methanolic root extract of Chromolaena odorata at 12 days

Treatment	A. esculentus	S. melongena	S. lycopersicum	P. vulgaris	C. annuum	Z. mays	C. arietinum	C. sativus
Control	6.1±0.08	6.17±0.17	2.1±0.08	12.2±0.08	3.3±0.16	14.4±0.08	11.1±0.08	5.1±0.08
AQE 5%	7.1±0.08	2.23±0.21	4.4±0.08	5.4±0.08	4.33±0.17	25.6±0.08	21.13±0.12	2.1±0.08
AQE 10%	4.4±0.08	5.5±0.22	5.1±0.08	14.13±0.12	4.4±0.22	12.17±0.12	9.6±0.08	2.13±0.12
AQE 15%	4.5±0.08	5.4±0.22	5.4±0.08	7.13±0.12	5.17±0.17	7.1±0.08	12.4±0.08	4.1±0.08
AQE 20%	7.4±0.08	3.17±0.12	5.1±0.08	5.13±0.12	2.27±0.12	20.13±0.09	11.2±0.16	1.1±0.08
MTE 5%	2.2±0.08	5.47±0.17	0	16.4±0.08	3.27±0.12	11.1±0.08	23.4±0.08	1.13±0.12
MTE 10%	2.4±0.08	4.23±0.17	0	7.1±0.08	3.17±0.17	22.13±0.12	6.3±0.17	2.2±0.22
MTE 15%	3.13±0.12	3.33±0.25	0	11.17±0.12	3.33±0.17	13.1±0.08	10.4±0.08	5.1±0.08
MTE 20%	2.1±0.08	4.6±0.36	4.1±0.08	7.17±0.12	5.2±0.22	13.13±0.12	6.37±0.12	3.47±0.12

AQE: Aqueous extract, and MTE: Methanol extract

The study's findings in Table 5 exibited that the root lengths of the tested vegetable crops respond differently to aqueous and methanolic extracts of Chromolaena odorata. The control group revealed that *Solanum melongena and Phaseolus vulgaris* exhibited the most substantial root lengths, registering at 6.13 cm and 12.17 cm respectively. Across the spectrum of treatments, several crops displayed significant increases in root length, with *Abelmoschus esculentus* reaching 6.47 cm at AQE 15%) and *Zea mays* attaining a notable 27.7 cm at MTE 15%, both surpassing their control group measurements (Table 5).

Conversely, the lowest root growth observed was in *A. esculentus* at 2.1 cm at MTE 15%, indicating a possible inhibitory effect of the extract at certain concentrations (Table 6). Similarly, *S. melongena* and *C. sativus* showed minimal growth at various treatment levels, with *C. sativus* particularly affected, as demonstrated by the reduced root lengths of 2.1 cm at AQE 20%, and 2.06 cm at MTE 10%. These findings are consistent with the literature on the higher permeability of root tissues to allelochemicals, which may explain the enhanced sensitivity of root growth to the extracts (Table 6) (Ayeni and Kayode, 2009).

The data collected reveals a significant concentration-dependent relationship between extract application and root growth (Hoque *et al*., 2003, Seyyednejad, 2010) Lower concentrations of AQE were often associated with an increase in root length, indicating stimulatory effects, whereas higher concentrations frequently led to growth inhibition (Hoque *et al*., 2003). Methanolic extract, on the other hand, was predominantly associated with a reduction in root growth which might reflect the presence of more potent allelochemicals in the methanol-soluble fraction of the plant extract ((Tijani-Eniola and Fawusi, 1989; Aslani, *et al.*, 2014; Lopes *et al.*, 2023).

CONCLUSIONS

In conclusion, this study highlights the potential of *Chromolaena odorata* extracts as phytotoxic agents for weed management in vegetable crops. The observed variation in crop sensitivity and the dose-dependent nature of the effects emphasize the need for careful consideration when implementing these extracts in agricultural practices. Future research should focus on refining application methods, identifying the active compounds responsible for phytotoxicity, and assessing the long-term ecological impacts of using *Chromolaena odorata* extracts as natural herbicides. Ultimately, this work contributes to the ongoing exploration of sustainable and environmentally friendly approaches to weed control in agriculture.

REFERENCES

- Adebayo, S. A., & Oladele, O. I. (2014). Organic agricultural practices among small holder farmers in South Western Nigeria. In InTech eBooks. https://doi.org/10.5772/57598
- Adebayo, S., & Oladele, I. O. (2014). Organic agricultural practices among small holder farmers in South Western Nigeria. *Organic agriculture towards sustainability*, 51-66. https://doi.org/10.5772/57598
- Ain, Q., Mushtaq, W., Shadab, M., & Siddiqui, M. B. (2023). Allelopathy: an alternative tool for sustainable agriculture. *Physiology and Molecular Biology of Plants*, 1-17.
- Ali, K. A., Sakri, F. Q., & Li, Q. X. (2012). Isolation and purification of allelochemicals from Cephalaria syriaca plant. *International Journal of Biosciences*, *2*(7), 90-103.
- Angon, P. B., Anjum, N., Akter, M. M., Kc, S., Suma, R. P., & Jannat, S. A. (2023). An overview of the impact of tillage and cropping systems on soil health in agricultural practices. *Advances in Agriculture*, 1–14. https://doi.org/10.1155/2023/8861216
- Aslani, F., Juraimi, A. S., Ahmad-Hamdani, M. S., Omar, D., Alam, M. A., Hashemi, F. S. G., ... & Uddin, M. K. (2014). Allelopathic effect of methanol extracts from Tinospora tuberculata on selected crops and rice weeds. *Acta Agriculturae Scandinavica, Section B–Soil & Plant Science*, *64*(2), 165-177. https://doi.org/10.1080/09064710.2014.898784.
- Ayeni, J. M., & Kyode, J. (2021). The effects of aqueous extracts from maize roots and sorghum stem on the germination and radicle growth of Sphenosylis sternocarpa Hochst ex. Rich.(African Yam beans). *African Journal of General Agriculture*, *5*(3).
- Bashar, H. K., Juraimi, A. S., Ahmad-Hamdani, M. S., Uddin, M. K., Asib, N., Anwar, M. P., ... & Hossain, A. (2023). Evaluation of allelopathic effects of Parthenium hysterophorus L. methanolic extracts on some selected plants and weeds. *Plos one*, *18*(1), e0280159. doi: 10.1371/journal.pone.0280159.
- Bhattacharya, S., & Haldar, P. K. (2010). Evaluation of in vitro cytotoxic effect of Trichosanthes dioica root. *Pharmacognosy Research*, *2*(6), 355.
- Casimero, M., Abit, M. J., Ramirez, A. H., Dimaano, N. G., & Mendoza, J. (2022). Herbicide use history and weed management in Southeast Asia. *Advances in Weed Science*, 40(spe1). https://doi.org/10.51694/advweedsci/2022;40:seventy-five013
- Damalas, C. A., Eleftherohorinos, I. G. (2011). Pesticide exposure, safety issues, and risk assessment indicators. *Int J Environ Res Public Health*, *8*(5), 1402-19. doi: 10.3390/ijerph8051402.
- Day, M. D., & McFadyen, R. E. (2003). Proceedings of the 6th International Workshop on

Biological Control and management of Chromolaena. Cairns, Australia, 8-1.

- Gautier, L. (1992). Taxonomy and distribution of a tropical weed: Chromolaena odorata (L.) R. King & H. Robinson. *Candollea*, *47*(2), 645-662.
- Gioria, M., Hulme, P. E., Richardson, D. M., & Pyšek, P. (2023). Why Are Invasive Plants Successful?. *Annual Review of Plant Biology*, *74*, 635-670. https://doi.org/10.1146/annurev-arplant-070522-071021
- Godlewska, K., Ronga, D., & Michalak, I. (2021). Plant extracts - importance in sustainable agriculture. *Italian Journal of Agronomy*, *16*(2).
- Hamidi, F. W. A., Ismail, A. M., Zainuddin, F. H. I., & Hasan, M. Y. (2014). Preliminary study on allelopathic effect from Chromolaena odarata (siam weed) leaves extract towards Vigna radiata. *Int. J. Eng. Res*, *3*, 406-411.
- Heringer, G., Thiele, J., Meira-Neto, J. A. A., & Neri, A. V. (2019). Biological invasion threatens the sandy-savanna Mussununga ecosystem in the Brazilian Atlantic Forest. *Biological Invasions*, *21*(6), 2045-2057. https://doi.org/10.1007/s10530-019-01955-5
- Hoque, A. T. M. R., Ahmed, R., Uddin, M. B., & Hossain, M. K. (2003). Allelopathic effects of different concentration of water extract of Eupatorium odoratum leaf on germination and growth behavior of six agricultural crops. *OnLine Journal of Biological Science*, *3*(8), 741-750. https://doi.org/10.3923/jbs.2003.741.750
- Jabeen, N., & Ahmed, M. (2009). Possible allelopathic effects of three different weeds on germination and growth of maize (Zea mays) cultivars. *Pak. J. Bot*, *41*(4), 1677-1683.
- Jabran, K., & Farooq, M. (2012). Implications of potential allelopathic crops in agricultural systems. In *Allelopathy: Current trends and future applications* (pp. 349-385). Berlin, Heidelberg: Springer Berlin Heidelberg.
- Julio, A., Carven Tandoc, W., Daniel Tipace, H., Franzine Vendivil, Y., Yanesa, Z., Tare, V. R., ... & Joseph Clemente, K. (2019). Allelopathic effect of Lantana camara and Chromolaena odorata leaf extracts on plant germination. *Asian Journal of Agriculture and Biology*, *7*(2), 190-196.
- Karim, S. R., Zahan, F., Naher, L., Osama, R., & Hakim, M. A. (2017). Inhibiting Effects Of Siam Weed (Chromolaena Odorata (L.) King & Robinson) On Seed Germination And Seedling Growth Of Four Crops. *Bangladesh Journal of Botany*, *46*(1), 473–480.
- Kato-Noguchi, H., & Kato, M. (2023). Evolution of the secondary metabolites in invasive plant species Chromolaena odorata for the defense and allelopathic functions. *Plants*, *12*(3), 521. doi: 10.3390/*plants*, 12030521. PMID: 36771607; PMCID: PMC9919186.
- Li, M., Ma, Y., & Shui, J. (2005). Allelopathic effects of cultured Cucurbita moschata root exudates. *Ying Yong Sheng tai xue bao= The Journal of Applied Ecology*, *16*(4), 744-749.
- Liogier, A. H. (1995). Descriptive flora of Puerto Rico and adjacent islands. La Editorial, UPR;
- Lopes, A. D., Faria, M. G. I., Francisco, J. P., & Santos, E. H. D. (2023). Potential allelopathic effect of species of the Asteraceae family and its use in agriculture. In IntechOpen eBooks. https://doi.org/10.5772/intechopen.10870
- Lowe, S., Browne, M., Boudjelas, S., & De Poorter, M. (2000). *100 of the world's worst invasive alien species: a selection from the global invasive species database* (Vol. 12). Auckland: Invasive Species Specialist Group.
- Macías, F. A., Mejías, F. J., & Molinillo, J. M. (2019). Recent advances in allelopathy for weed control: From knowledge to applications. *Pest management science*, *75*(9), 2413-2436.
- Motmainna, M., Juraimi, A. S., Ahmad-Hamdani, M. S., Hasan, M., Yeasmin, S., Anwar, M. P., & Islam, A. M. (2023). Allelopathic potential of tropical plants—a review. *Agronomy*, *13*(8), 2063. https://doi.org/10.3390/agronomy13082063
- Muscolo, A., Panuccio, M. R., & Sidari, M. (2001). The effect of phenols on respiratory enzymes in seed germination. *Plant Growth Regul*, *35*, 31–35.
- Ofosu, R., Agyemang, E. D., Márton, A., Pásztor, G., Taller, J., & Kazinczi, G. (2023). Herbicide Resistance: Managing Weeds in a Changing World. *Agronomy*, *13*(6), 1595. https://doi.org/10.3390/agronomy13061595
- Pasiecznik, N. (2022). Chromolaena odorata (Siam weed) CABI Compendium. doi: 10.1079/cabicompendium.23248.
- Poonpaiboonpipat, T., Krumsri, R., & Kato-Noguchi, H. (2021). Allelopathic and Herbicidal Effects of Crude Extract from Chromolaena odorata (L.) R.M.King and H.Rob. on Echinochloa crus-galli and Amaranthus viridis. *Plants* (Basel), 5, 10(8), 1609. doi: 10.3390/plants10081609.
- Popoola, K. M., Akinwale, R. O., & Adelusi, A. A. (2020). Allelopathic effect of extracts from selected weeds on germination and seedling growth of cowpea (Vigna unguiculata (L.) Walp.) varieties. *African Journal of Plant Science*, *14*(9), 338-349. https://doi.org/10.5897/ajps2020.2024
- Rashidi, S., Reza Yousefi, A., Goicoechea, N., Pouryousef, M., Moradi, P., Vitalini, S., & Iriti, M. (2021). Allelopathic interactions between seeds of Portulaca oleracea L. and crop species. *Applied Sciences*, *11*(8), 3539. https://doi.org/10.3390/app11083539
- Seyyednejad, S. M., Koochak, H., Najafabade, F. P., & Kolahi, M. (2010). Allelopathic effect of aquatic hull extract of rice (Oryza sativa L.) on growth of Silybum marianum and Echinochloa

crus-galli. *African Journal of Agricultural Research*, *5*(16), 2222-2226.

- Tijani-Eniola, H. A., & Fawusi, O. A. (1989). Allelopathic activities of crude methanol extract of siam weed and wild poinsettia on seed germination and seedling growth in tomato. *Nigerian Journal of Weed Science*, *2*(1-2), 15–20.
- Wang, K., Wang, T., Ren, C., Dou, P., Miao, Z., Liu, X., ... & Wang, K. (2022). Aqueous extracts of three herbs allelopathically inhibit lettuce germination but promote seedling growth at low concentrations. *Plants*, *11*(4), 486. doi: 10.3390/plants11040486.
- Wang, L., Liu, Y., Zhu, X., Zhang, Z., & Huang, X. (2021). Identify potential allelochemicals from Humulus scandens (Lour.) Merr. root extracts that induce allelopathy on Alternanthera philoxeroides (Mart.) Griseb. *Scientific Reports*, *11*(1), 7068. doi: 10.1038/s41598-021-86656-7
- Weisberger, D., Ray, M. A., Basinger, N. T., & Thompson, J. J. (2024). Chemical, ecological, other? Identifying weed management typologies within industrialized cropping systems in Georgia (US). *Agriculture and Human Values*, 1-19.
- Yu, F., Akin-Fajiye, M., Thapa Magar, K., Ren, J., & Gurevitch, J. (2016). A global systematic review of ecological field studies on two major invasive plant species, Ageratina adenophora and Chromolaena odorata. *Diversity and Distributions*, *22*(11), 1174-1185. doi: 10.1111/ddi.12481.

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