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SHORT COMMUNICATION

Impact of *Parthenium hysterophorus* leaf extract on seed germination and seedling growth in mung bean and finger millet

K. Ashokkumar[1*], S. Pravinkumar[1], M. Harish[1], N. Karthikeyan[1], P. Kavinesan[1], M. Murugan[2], and M. Saravanan[3]

[1]School of Agriculture and Animal Sciences, The Gandhigram Rural Institute (Deemed to be University), Gandhigram, Dindigul, Tamil Nadu, India.

[2]Cardamom Research Station, Kerala Agricultural University, Pampadumpara, Idukki, Kerala, India.

[3]ICAR- Krishi Vigyan Kendra, The Gandhigram Rural Institute (Deemed to be University), Gandhigram, Dindigul, Tamil Nadu, India.

Edited by:

M. Mobarak Hossain, IRRI Bangladesh, Dhaka, Bangladesh.

Reviewed by:

K.S. Shashidhar, Department of Agronomy, BHU, Mirzapur, U.P, India; C.O. Ossai. IITA, Ibadan, Nigeria.

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ABSTRACT

The present study aimed to estimate the allelopathic effect of *Parthenium hysterophorus* on seed germination and seedling growth of mung bean and finger millet. The concentrations used were 0, 2, 3, and 5% leaf extract of *P. hysterophorus*. The 5% concentration significantly inhibited the germination of both mung bean and ragi seeds compared to the control (0%), 2, and 3% concentrations of the aqueous leaf extract of *P. hysterophorus*. At higher concentrations, there was a reduction in seed germination, shoot length, root length, and overall biomass production. It was found that higher concentrations of *Parthenium* leaf extract in mung bean and finger millet. plants hurt their growth, root length, shoot length, and biomass production compared to the control group. The leaf extract has a stronger inhibitory effect on root growth than the shoot growth. Finger millet exhibits a higher tolerance level to parthenium allelopathy in crops compared to mung bean.

Keywords: allelopathic effect, aqueous leaf extract, germination, growth inhibitor, parthenium, seedling growth

*Corresponding author e-mail address: biotech.ashok@gmail.com
(Dr. K. Ashokkumar)

INTRODUCTION

Invasive species have increasingly challenged the agricultural landscape in recent years, posing a threat to crop productivity and biodiversity. Among these invasive species, *Parthenium hysterophorus*, commonly known as Parthenium weed, has emerged as a particularly problematic weed in many regions around the world (Nasim & Shabbir, 2012; Rai & Singh, 2020). Known for its vigorous growth and prolific seed production, Parthenium not only competes with crops for resources but also exerts allelopathic effects, inhibiting the growth of one species by another on surrounding plants (Tanveer et al., 2015).

Mung bean [Vigna radiata (L.) R. Wilczek], commonly referred to as green gram, is a significant legume crop and it is known for its exceptional nutritional profile (Ashokkumar et al., 2019). Mung beans are an excellent source of essential nutrients, making them an important component of a healthy diet. They contain high levels of dietary fibre and antioxidants, which contribute to various health benefits, including improved digestion and reduced risk of chronic diseases. Additionally, mung beans play a crucial role in sustainable agriculture due to their ability to fix nitrogen in the soil (Huppertz et al., 2023). Through a symbiotic relationship with nitrogen-fixing bacteria, mung beans convert atmospheric nitrogen into a form that plants can use. This process enriches the soil with nitrogen, reducing the need for synthetic fertilizers and enhancing soil fertility (Shahrajabian et al., 2019). Consequently, mung beans support the growth of subsequent crops, making them an integral part of crop rotation systems. A recent study has highlighted these dual benefits, underlining the value of mung beans not only in human nutrition but also in maintaining and improving soil health. This makes them a vital crop in both nutritional and agricultural contexts (Huppertz et al., 2023).

Finger millet, also known by its scientific name *Eleusine coracana* Gaertn., is a staple cereal crop that's celebrated for several reasons. This hardy plant thrives even in challenging growing conditions where other crops might struggle. It's particularly noted for its ability to withstand drought and grow in soils with low fertility, making it a reliable food source in regions prone to harsh environmental conditions (Ashokkumar et al., 2019). The finger millet grains are packed with essential nutrients, including high levels of calcium, dietary fibre, and several important amino acids. This nutrient-dense profile makes finger millet an excellent choice for improving diets, particularly in areas where malnutrition is a concern. Finger millet crop has been the focus of various studies, including those by Ashokkumar et al. 2020; Kaur et al., 2024; Venkatesh et al. (2024), which have highlighted its benefits and potential as a sustainable food source. These studies reinforce the idea that finger millet is not only a resilient crop but also a vital component of food security and nutritional health in many parts of the world.

Both crops are crucial to the food security and agricultural economy of many developing regions. Understanding the allelopathic interactions between Parthenium and these crops is essential for developing effective management strategies to mitigate the adverse effects of this invasive weed (Adkins & Shabbir, 2014). There is a need to clarify the scope of Parthenium's allelopathic impacts to guide agricultural practices and weed control strategies that can maintain productivity (Bashar et al., 2023). Therefore, the present study focuses on estimating the allelopathic impact of *Parthenium* on two economically important crops, mung bean and finger millet.

MATERIALS AND METHODS

The mung bean variety VBN-5 (Vamban 5) and finger millet variety, CO-15 was obtained from ICAR-KVK, Gandhigram, Dindigul. The *Parthenium hysterophorus* plant samples were collected at the flowering stage. Leaves were separated from the plant and soaked in distilled water for 24 hours. After soaking, the water was drained, and the leaves were ground into a paste using a mixer. The leaf paste was then filtered using filter paper or tissue paper to obtain the leaf extract.

To prepare the extract concentrations, 10 ml, 15 ml, and 25 ml of the leaf extract were diluted in 500 ml of distilled water. The diluted extract was then refiltered through a layer of Whatman No. 1 filter paper. The final concentrations of the extract were 0, 2, 3, and 5% (Figure 1). The final filtrate was stored in a dark, cool place for use and was generally used within a week, following the method of Singh et al. (1989). Four treatments were prepared, including three concentration levels (0, 2, 3, and 5%) of the leaf extracts, each with two replications. Seeds and filter papers were moistened with 10 ml of each extract concentration. For the untreated control (0%), 10 ml of distilled water was added.

Figure 1. Various concentrations of parthenium leaves aqueous extract preparation.

The treatments were arranged in a complete randomized design (CRD) with two replications. Twenty seeds of each crop variety, VBN-5 (mung bean) and CO-15 (finger millet) were placed in each Petri dish with germination paper. A separate control series was set up using distilled water only. The Petri plates were kept at room temperature under lab conditions with two replications. After 7 days after sown (DAS), the germination percentage of the seeds was determined. The root length (cm) and shoot length (cm) were measured manually. The dry weight (mg) of the seedlings was measured using an electronic digital balance. The statistical analysis utilized the WASP 2.0 software. A one-way analysis of variance (ANOVA) was performed with three replicates for each treatment across all evaluated parameters. The critical difference was calculated at a significance level of 5%.

RESULTS AND DISCUSSION

Germination Percentage

Germination percentage indicates the proportion of seeds that successfully sprout and establish seedlings under different concentrations of Parthenium leaf extract. For mung bean, the germination percentage was 100%, 90%, 50%, and 45% at 0%, 2%, 3%, and 5% concentrations of extracts, respectively (Figure 1). Similarly, finger millet recorded germination percentages of 90% in the control (0%), 67.5% at 2%, and 60% at 5% concentration. The germination percentage for both mung bean and finger millet decreased markedly with higher concentrations of Parthenium solution, indicating the sensitivity of these species to allelopathic compounds. Previous studies reported similar trends, where higher concentrations of allelochemicals from Parthenium significantly inhibited seed germination and early seedling establishment (Tanveer et al., 2015; Bachheti et al., 2020; Ain et al., 2023).

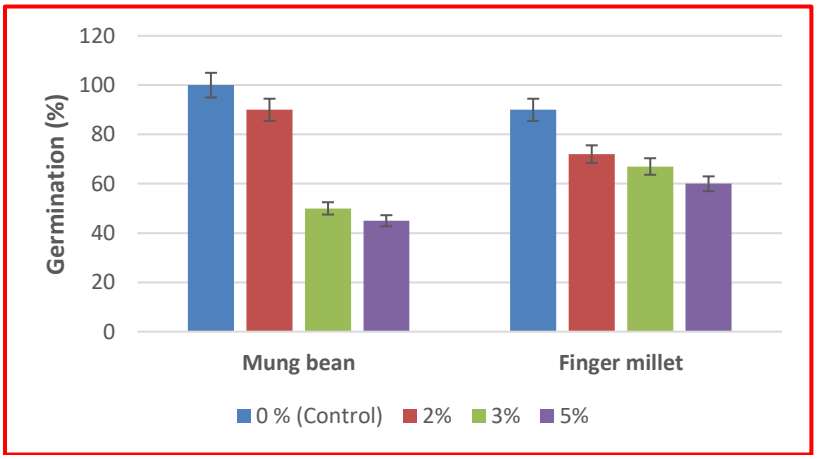

Figure 2. The effect of different concentrations of parthenium leaf extract on germination percentage of mung bean and finger millet.

Root Length

Root length measures the initial growth of seedlings' primary roots. Longer root lengths indicate better root development, which is essential for nutrient absorption and anchorage in the soil. The reduction in root length under the influence of parthenium leaf extract signifies impaired root growth due to allelopathic interference, impacting overall seed vigour and resilience (Parthasarathi et al., 2012). The average root length for mung bean seedlings was 9.1, 10.3, 5.5, and 4.1 cm at 0% (control), 2%, 3%, and 5% concentrations, respectively. For finger millet, the root lengths were 14.1 cm in the control, 9.7 cm at 2%, 9.3 cm at 3%, and 7.6 cm at 5% concentration. The results showed a clear trend of decreasing root length with increasing concentrations of Parthenium solution. Similar findings were reported in green gram, black gram, and groundnut (Parthasarathi et al., 2012). The allelochemical parthenin from Parthenium can significantly inhibit root growth, affecting nutrient uptake and overall seedling development (Kaur et al., 2021).

Table 1. Effect of various concentrations of parthenium leaf extract on root length and shoot length at 7 DAS

	Root length (cm)		Shoot length (cm)	
Concentration	Mung bean	Finger millet	Mung bean	Finger millet
0 % (control)	9.1^{b}	14.1^{a}	19.3^{a}	3.1^{ab}
2 %	10.3^{a}	9.7^{b}	20.2^{a}	3.4^{a}
3 %	5.5^{c}	9.3^{b}	14.0^{b}	2.5^{bc}
5 %	4.1^{d}	7.6^{b}	13.0^{b}	2.0^{c}
CV	3.96	10.57	9.19	7.50
CD (0.05)	0.92	3.43	4.87	0.66

Shoot length

Shoot length is a critical measure in plant growth studies, as it evaluates the development of the shoot above the cotyledons. This early stage of shoot growth is essential because it sets the foundation for the plant's overall health and productivity. Proper shoot development is vital for the plant's ability to perform photosynthesis, which is the process by which plants convert light energy into chemical energy. Photosynthesis is crucial for biomass accumulation, the total mass of living material within a given area and ultimately for the crop's productivity. When shoot length is decreased, as observed in plants exposed to Parthenium extract, it signals that the plant's growth is being hindered. Parthenium extract is known to have allelopathic effects, meaning it can release chemicals that inhibit the growth of neighbouring plants. A reduction in shoot length means the plant has a reduced capacity to intercept light, which is critical for photosynthesis.

The shoot length of mung bean was 19.3, 20.2, 14, and 13 cm at 0, 2, 3, and 5% concentration, respectively. For finger millet, the shoot lengths were 3.1 cm at 0%, 3.4 cm at 2%, 2.5 cm at 3%, and 2 cm at 5% concentration (Table 1). The data reveal a significant reduction in shoot length with increasing concentrations of Parthenium solution, consistent with findings that allelochemicals from Parthenium inhibit shoot growth, essential for photosynthesis and early seedling establishment (Bashar et al., 2021).

Dry Matter Accumulation

Dry weight measurement quantifies biomass accumulation in seedlings and serves as an indicator of overall plant growth and vigor. Reduced dry weight under higher concentrations of Parthenium extract suggests compromised physiological processes, nutrient uptake efficiency, and potential yield losses in affected crops (Weston, 1996; Tanveer et al., 2015). Dry matter accumulation in green gram was 250, 220, 115, and 110 mg at 0, 2, 3, and 5% concentrations of Parthenium solution. For finger millet, the dry matter accumulation was 550 mg in the control, 560 mg at 2%, 450 mg at 3%, and 410 mg at 5% concentration. The results show a decrease in biomass production with increasing concentrations of Parthenium solution, consistent with the findings by Tanveer et al. (2015), which reported significant reductions in dry matter accumulation due to allelopathic effects.

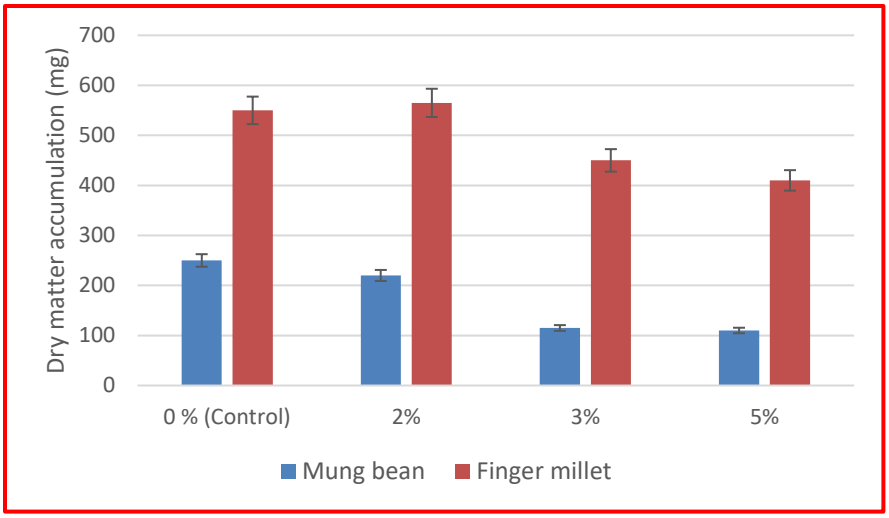

Figure 3. The effect of different concentrations of parthenium leaf extract on dry matter accumulation of mung bean and finger millet.

CONCLUSION

The comparative analysis of mung bean and finger millet under different concentrations of Parthenium solution reveals a clear inhibitory effect on germination and early growth parameters. Both species experienced a significant reduction in germination percentage, root length, shoot length, and dry matter accumulation as the concentration of Parthenium solution increased. The germination percentage for both mung bean and finger millet decreased markedly with higher concentrations of Parthenium solution, indicating the sensitivity of these species to allelopathic compounds. The reduction in root and shoot lengths suggests impaired root and shoot development, which is crucial for early seedling growth and establishment. Dry matter accumulation, a critical indicator of biomass production, also decreased with higher concentrations of Parthenium solution, suggesting a potential decrease in overall yield. These findings emphasize the importance of managing Parthenium infestations to minimize their allelopathic impact on crop productivity.

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ETHICAL APPROVAL

Not applicable

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AUTHORS CONTRIBUTION STATEMENT

All the authors played a vital role in conceiving, designing, and carrying out the study and analysis of the results. Dr. K. Ashokkumar wrote the manuscript.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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