International Journal of Wetlands Ecosystem & Environmental Restoration
Vol. 2, Issue, 4, pp.65-70, 2025
https://insight.ecorightfoundation.org/authors-guideline/
https://insight.ecorightfoundation.org/current-volumes/

Insight Ecoright: IE-WEER
IE-WEER [P] - ISSN: 2971 - 5660
[E] - ISSN: 2971 - 7183

RESEARCH ARTICLE

EFFECT OF MANGO LEAF EXTRACTS ON MAIZE SEED GERMINATION AND EARLY SEEDLING GROWTH: A COMPARATIVE ANALYSIS OF DIFFERENT CONCENTRATIONS

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Authors' contributions

This research work was in collaboration among the Authors. AUTHOR ETC contributed to the design of the study, wrote protocol, performed preliminary. Author OEB supervised the project, analysed the Data and interpreted the data set. Author UIG contributed to the design of the project, made corrections and contributions to the initial draft. All Authors read and approved the work

ABSTRACT

This study investigated the effects of mango (*Mangifera indica*) leaf extracts on maize (*Zea mays*) seed germination and early seedling growth. The experiment employed seed priming techniques, using 20 Petri dishes lined with Whatman No. 1.5 filter paper. Five maize seeds were placed in each dish and moistened daily with 5 mL of different concentrations of mango leaf aqueous extract (5 g, 10 g, 15 g, and 20 g), except for the control group. The results showed that lower concentrations (5 g and 10 g) of mango leaf extract did not inhibit germination, radicle, or plumule growth. However, higher concentrations (15 g and 20 g) exhibited significant inhibitory effects on germination rate, radicle, and plumule length. Statistical analysis ($P < 0.05$) confirmed a significant difference between the 15 g and 20 g treatments compared to the control, while the 5 g and 10 g treatments showed no significant difference. These findings suggest that mango leaf extract exerts concentration-dependent allelopathic effects on maize seed germination and early growth.

Key Words*:* *Allelochemicals, Concentrations, Inhibition, Maize seedlings, Mango Leaves*,

Citation: *Ezekwe, T. C., Ochekwu, E.B. and Ugiomoh, I.G.* (2025). Effect of mango leaf extracts on maize seed germination and early seedling growth: a comparative analysis of different concentrations. *INSIGHT ECORIGHT: International Journal of Wetlands Ecosystem & Environmental Restoration*, Vol. 2 (4):65-70. **https://insight.ecorightfoundation.org/current-volumes/**

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Article History:
Received 11th October, .2024
Received in revised form: 15TH May, 2025
Accepted 20th May, 2025
Published online: 23th May, 2025

1.1. INTRODUCTION

Mango is widely cultivated in Nigeria and is highly favoured as a garden crop. The use of mango leaves litters as compost is a commendable and environmentally friendly approach to managing organic waste. Mango generates a wide array of phytochemicals, which are organic compounds that do not directly partake in metabolism or possess apparent functions in cellular operations. Initially considered waste products, these compounds actually play crucial roles within the plant. Some of these organic molecules serve as protective mechanisms against herbivores, insects, or pathogens, while others attract pollinators or exhibit allelopathic properties to compete with other plants (Hadacek, 2002). Maize (*Zea mays* L.) belong to the family Poaceae (also known as the grass family), one of the largest and most important plant families in the world. Maize is also considered the third most crucial cereal crop globally, following wheat and rice (Farooq *et al*., 2013).

Mango and maize are two crops that are typically grown together in the same field during a growing season (Ofori and Stern, 1987). Curiously, there is a lack of extensive research on the allelopathic influence of mango leaf extracts on maize seed germination and early seedlings growth. Consequently, it is crucial to investigate whether mango exact influence on maize seed germination and early seedlings growth, as such insights can contribute to a deeper comprehension of this system. Considering the economic significance of maize as a stable crop, this research aimed to shed light on the potential effects of allelochemicals from mango leaves on the germination and growth of maize seedlings and also uncover the potential of crop-to-crop allelopathy. Plants possess diverse arrays of secondary metabolites, many of which have been harnessed by humans for their beneficial roles in various biological functions (Balandrin *et al*., 1985). One plant species that stands out in this regard is the mango plant, which serves as a rich source of a wide range of polyphenolic compounds. Among the major polyphenols found in mango, several compounds are particularly noteworthy (Martin and Qian, 2008). Some of these compounds include: mangiferin, catechins, quercetin, kaempferol, rhamnetin, anthocyanins, gallic and ellagic acids, propyl and methyl gallate, benzoic acid, and protocatechuic acid. Of these, mangiferin, a special polyphenol specific to mango, has gained considerable attention due to its demonstrated nutraceutical and pharmaceutical significance (Martin and Qian, 2008).

Other studies and records have provided evidence that the leaves of *M. indica* (mango) sourced from Nigeria contain a diverse array of compounds. Aiyelaagbe and Osamudiamen (2009) documented the presence of diverse compounds, including saponins, steroids, tannins, flavonoids, reducing sugars, and cardiac glycosides. Additionally, El-Rokiek *et al*. (2010) identified phenolic compounds such as ferulic acid, coumaric acid, benzoic acid, vanillic acid, chlorogenic acid, caffeic acid, gallic acid, hydroxybenzoic acid, and cinnamic acid. It is noteworthy that some of these compounds have been observed to exhibit active allelopathic properties. The confirmation of active allelochemicals in mango leaves extracts has been achieved through the use of High-performance liquid chromatography (HPLC), providing further support to the findings of Aiyelaagbe and Osamudiamen (2009). The HPLC analysis unveiled the presence of several compounds, such as ferulic acid, coumaric acid, benzoic acid, vanillic acid, chlorogenic acid, caffeic acid, gallic acid, hydroxybenzoic acid, and cinnamic acid. In this study, water was chosen as the extracting medium due to the fact that allelochemicals are commonly soluble in water and are released into the environment through root exudation (Tawaha and Turk, 2003). This research was aimed at exploring the use of allelochemicals as potential germination/growth regulators, promoters or inhibitor and also as natural herbicides. The article aligns with the scope and focus of *IE-WEER.* The research addresses a critical gap in the literature and contributes valuable insights to the field of plant biology and agriculture. The potential for practical applications, environmental sustainability, and the scientific methodology employed make this manuscript suitable for consideration by this esteemed journal.

2.0. MATERIALS AND METHODS

2.1 *Experimental Design*:

This study involves a controlled experiment where maize seeds were exposed to different concentrations of mango leaf extracts. The experiment comprised of four treatments, including an untreated control. A completely randomized design (CRD) was employed in this study, where each treatment was replicated five times.

2.2 *Source of Materials and processing:*

Matured mango leaves were gathered from a mango tree in a farm located at Eneka Port Harcourt Rivers State Nigeria. These leaves were washed with water to eliminate dust and soil particles. Afterwards, they were air-dried on a tray for 20 days at room temperature to prevent undesired reactions caused by direct sunlight exposure. Once dried, the mango leaves were manually crushed into powder form and stored in plastic bottles until needed. 0ne hundred (100) Seeds of hybrid maize (DK-919) obtained from the Agricultural Development Programme in Port

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Harcourt, Rivers State, Nigeria, were subjected to surface sterilization using a sodium hypochlorite (NaOCl) solution. This sterilization process involved agitating the 100 seeds in the solution for 2 minutes to minimize fungal infections. Following sterilization, the maize seeds were rinsed with deionized water and stored at room temperature until they were ready for use.

2.3. *Seed Priming*

This experiment was carried out under room temperature range of 20- 25°C. Hybrid Maize seed (DK-919) obtained from the Agricultural Development Programme (ADP) Port Harcourt were subjected to seed pre-germination testing.

2.4. *Preparation of Extracts*

In this method, portions of 5g, 10g, 15g, and 20g at 1% (w/v) of manually crushed mango leaves samples were measured out using Digital balance, SF-400, China. Each portion was soaked in 200mL deionized water in a plastic bottle. The mixtures were agitated intermittently for 24hrs. The extracts for each residue portion was sieved and the filtrates reserved in a refrigerator for further usage. Five (5) seeds of sterilized maize were plated in Petri dishes containing two layered Whattman No. 1.5 filter paper. Each of the Petri dish were humidified daily with 5ml of different extracts concentrations (i.e., 5g, 10g 15g and 20g) using syringe and needle except for the control group. 5ml of deionized water was also used to moisten the control group. Data such as germination percentage, mean germination time, radical and plumule length were recorded for seven (7) days after the establishment of the experiment. The maize seedlings were deemed germinated upon radicle and plumule emergence.

2.5. *Data Collections and Assessment*

Counting germinated seeds as to determine germination percentage was carried out after 24 hours of sowing till 6th day. To determine the length of the radical and plumule, the seedling was carefully selected using forceps. A thread was employed to measure the length, and the corresponding value was read from a centimeter rule. This measurement was then recorded for further analysis.

Parameters under study: The following parameters were measured and recorded:

- Maize Seedling Germination Rate: To determine the percentage of germinated seeds, the process involved counting the number of seeds that showed signs of germination from 24 hours after sowing until the 6th day.

  **Percentage Germination = (Number of Seeds Germinated / Total Number of Seeds Sown) x 100

- Radical and Plumule Length: The length of the root (radical) and shoot (plumule) of the seedlings was measured by carefully picking the seedlings with forceps and using a thread to measure their length. The equivalent value was then read on a centimeter rule and recorded.

2.6. *Data Analysis*.

The data collected from the experimental setups were compared statistically with the data obtained from the control group using the Analysis of Variance (ANOVA) procedure. The statistical analysis was performed using the Statistical Analysis System software.

3.0 RESULTS

3.1 *Germination rate*

After 48 hours, the germination rates of *Zea mays* treated with mango leaf extracts (5g, 10g, 15g and 20g treatments) were rapid including the control group (Fig. 1). Following 144 hours of plating, the germination rates of seeds demonstrated further declines as the extract concentrations increased. Statistical analyses ($P < 0.05$) revealed notable variations in the germination rates of maize seeds at 144 hours, particularly with higher extract concentrations (15-20g), compared to the control experiment. On the other hand, the 5g and 10g treatment concentrations did not exhibit any significant difference in germination rate compared to the control groups.

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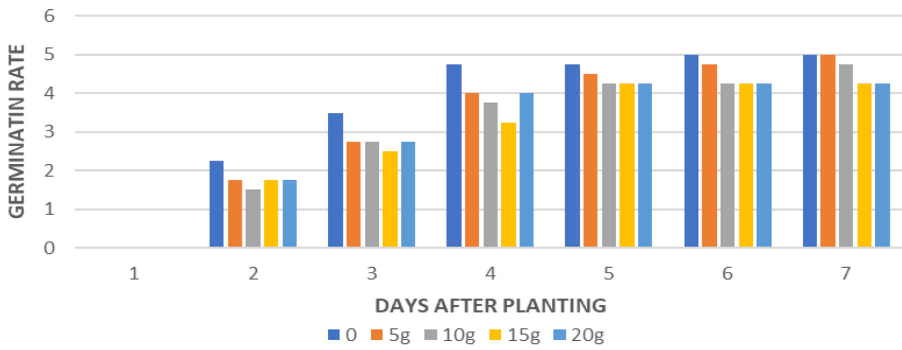

Fig.1: Germination rate of *Zea mays* treated with mango leaves extracts

3.2. *Radicle length*

Statistical analysis (*P<0.05*) revealed no significant differences on the radicle length of *Zea mays* between the 5g and control group. Same trend was observed for 15g and 20g treatments (Table 1, Fig.2). Nonetheless, significance differences were observed for 5g and 10g concentrations (Table 1).

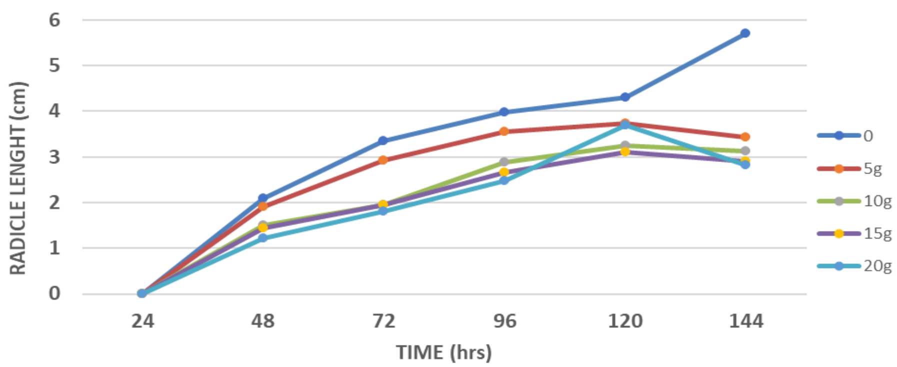

Fig. 2: Radicle length of *Zea mays* treated with mango leaves extract

3.3. *Plumule length*

Statistical analysis (P < 0.05) revealed no significant difference in Plumule length of *Zea mays* treated with mango leaf extracts (5g, 10g, 15g, and 20g) compared to the control groups at 48hrs and 72hrs experimental time (Fig. 3). However, at 120-144 hrs, significant differences were observed in 20g treatments as against 5g, 10g and 15g treatments which appeared to be non-significantly different from each other within same experimental time.

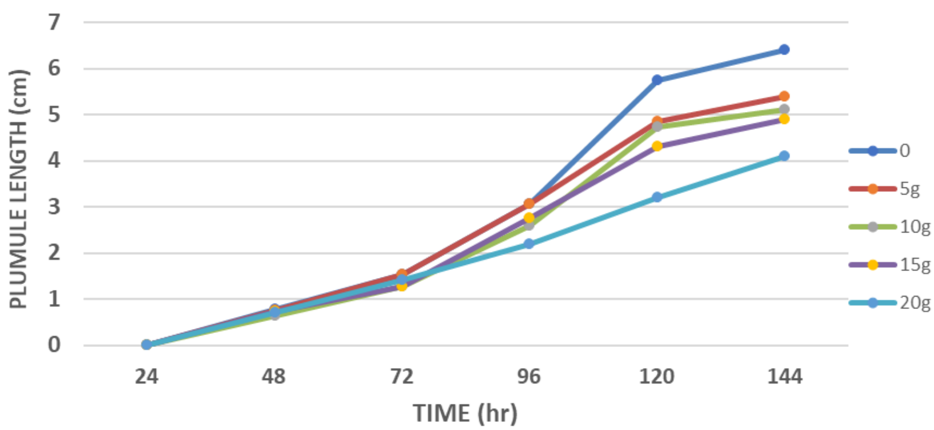

Fig. 3: Plumule length of *Zea mays* treated with mango leaves extract

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Table 1: Effects of different extracts concentration of Mango leaves on the radicle length (cm) and plumule length (cm) of maize (*Zea mays*) seedlings.

TREATMENTS(g)	RADICAL LENGTH	PLUMULE LENGTH
0	2.77[c]	2.5[b]
5	2.94[c]	2.94[b]
10	3.24[b]	3.48[a]
15	3.87[a]	4.13[a]
20	4.57[a]	4.52[a]
LSD	**0.74**	**0.83**

Mean with similar superscript are non-significantly different at $P<0.05$

4. DISCUSSION

The seed priming test on *Zea mays* using mango leaves extract revealed that while the extracts did not significantly inhibit the growth of maize seedlings at higher extract concentrations, there were noticeable increase in inhibition with higher extract concentrations. After 48 hours, the germination rates for both the control group and the 5g and 10g treatments were rapid. However, for 15g and 20g concentrations, the germination rates declined, indicating a decrease in germination as the extract concentration increased. Following 144 hours of plating, the germination rates demonstrated further declines as the extract concentrations increased. The statistical analyses ($P<0.05$) revealed notable variations in the germination of maize seeds at 144 hours, particularly with higher extract concentrations (15-20g), compared to the control experiment. However, no significant differences were observed in the other treatments compared to the control. Furthermore, statistical analysis ($P<0.05$) demonstrated a significant difference in germination rate between the 15g and 20g treatments compared to their respective control groups. On the other hand, the 5g and 10g treatment did not exhibit any significant difference in germination compared to the control group. This analysis suggests that the negative effects of the extracts on germination rate were only significant at the higher concentrations (15-20g), while the lower concentrations (5g and 10g) did not produce noticeable effects.

The research investigation revealed no radicle emergence occurrence until the 48-hour. By the 144-hour mark, the average radicle length in the control group was measured at 5.20 cm. In contrast, the radicle lengths for the 5g, 10g, 15g, and 20g treatments were recorded as 4.93 cm, 3.92 cm, 2.90 cm, and 2.82 cm, respectively. Significant differences ($P < 0.05$) were observed through statistical analysis between the treatments involving 15g and 20g concentrations of the extracts and the control experiment during the designated period. Nonetheless, no notable distinctions were observed for 5g and 10g concentrations in comparison to the control. These findings indicate that the effects of the extracts were dependent on their concentration, with higher concentrations resulting in reduced radicle lengths. Maize seedlings exposed to 15g and 20g extract treatments exhibited brownish radicles, resulting in the curling of the root axis and darkening of the seeds. This observation may indicate an inhibitory effect on root tip respiration, ultimately leading to reduced elongation. Similar outcomes were reported in the studies conducted by Nazim *et al*. (2005), Monica *et al*. (2011), and Komal (2011).

The effects of the extracts on plumule length were in line with the observations made for radicle lengths. It was observed that no plumule emergence took place until the 48-hour in all five treatments. At 144 hrs, the average plumule length in the control was recorded as 6.40 cm. For the 5g, 10g, 15g, and 20g treatments, the plumule lengths were measured as 5.40 cm, 5.12 cm, 4.91 cm, and 4.12 cm, respectively. Statistical analysis ($P<0.05$) revealed that there were no significant differences in plumule length between the 5g, 10g, 15g, and 20g treatments compared to the control experiment between 48 and 72 hours. However, at 120-144 hrs, significant differences were observed in 15g and 20g treatments when compared to the controls. The observed variations in plumule length, which were influenced by different concentrations of the extracts, can be attributed to the presence of various allelochemicals released by the Mango plant. These allelochemicals initiate primary events that impede nutrient uptake, subsequently impacting shoot lengths. These findings corroborate Oyun (2006), who documented decreased root and shoot length, as well as reduced seedling vigor in maize with increasing concentrations of *G. sepium*. Similarly, Shahid *et al.* (2006) also documented notable reductions in wheat and weed growth caused by varying concentrations of plant extracts. The effects observed in maize due to the aqueous extracts align with the findings that examined the influence of water-based extracts derived from maize roots and sorghum stems on the germination and radicle growth of *Sphenostylis sternocarpa.*

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5. CONCLUSION

The presence of allelochemicals can exert a substantial influence on the germination, growth and development of plants. This phenomenon could lead to diverse effects such as the inhibition of seed germination or the retardation/acceleration of seedling growth. The impact of allelochemicals in mango leaves can be identified through various indicators, which have been revealed by its significant impact on maize germination and growth, with the high concentrations of the compounds resulting in reduced maize germination, growth of seedlings, radicle and plumule length inhibition. This suggests that neglecting crop residues, such as mango residues and leaves, in the field can have similar deleterious effects on the germination and growth of crops. Therefore, it is essential to manage crop residues effectively and understand the allelochemical effects on plant growth and development to optimize crop growth and productivity. This can be achieved through sustainable agricultural practices, such as crop rotation, composting, and mulching, which can help reduce the impact of allelochemicals on plant growth and development.

ACKNOWLEDGEMENTS

I would like to extend my sincere gratitude to Professor E.B Ochekwu and Dr. I.G Ugiomoh for their valuable contributions, guidance and expertise throughout this research. I wouldn't have made it thus far if it weren't for their painstaking and meticulous supervision and push. I am immensely grateful

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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