



Effect of *Gliricidia sepium* and *Macaranga peltata* leaves on seed germination and seedling growth of Cowpea

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ABSTRACT: *Gliricidia sepium* (Jacq.) Kunth and *Macaranga peltata* (Roxb.) Mull. Arg. are two multipurpose trees in agroforestry system. The allelopathic effect of leaf leachates of these trees on germination and growth of three selected varieties of cowpea (*Vigna unguiculata* L. Walp.) were examined. The germination studies were conducted using two different concentrations of leaf leachates. Data regarding seed germination, shoot length and root length were collected. The experimental data obtained was statistically analysed using ANOVA and LSD at 5% level of significance. The results showed that seed germination was significantly inhibited by *G. sepium* leaf leachates. Among the seedling growth parameters, shoot length and root length were significantly inhibited by *G. sepium* leaf leachates whereas stimulatory effect was observed for *M. peltata* leaf leachates. Considering the inhibitory effect of *G. sepium* on cowpea, it is further recommended that farmers should be cautious while including the plant as a part of agroforestry system. *M. peltata* can be chosen as a suitable agroforestry component for cowpea cultivation, after further field studies.

Research Communication

ARTICLE INFO

Received: 24.03.2025

Accepted: 25.09.2025

Keywords:

Agroforestry,
Vigna unguiculata,
Allelopathy,
Mulching

1. INTRODUCTION

Allelopathy modulates plant growth and plays a significant role in agricultural ecosystems. The secondary metabolites produced and released by plants, algae, bacteria and fungi affect the growth and biological functions of another plant or microbes (De Albuquerque *et al.*, 2011). Plants release allelochemicals to soil by volatilisation, leaching, root exudation and decomposition of plant residues (Min *et al.*, 2003). Agroforestry system comprises the integration of woody vegetation with agricultural crops which enables the capture and utilization of resources more efficiently. *Gliricidia sepium* (Jacq.) Kunth belonging to family Leguminosae and *Macaranga peltata* (Roxb.) Mull. Arg. belonging to family Euphorbiaceae are two traditionally grown agroforestry trees. Leguminous trees including *Gliricidia* have been grown in tropical regions as a part of agricultural systems (Dominguez-Nunez, 2022). *Macaranga peltata* is a disturbance tolerant pioneer species preferred for its soil reclamation and land restoration potentials (Cynthia *et al.*, 2023). The fresh leaves from these trees are commonly used for mulching while cultivating vegetable crops. Besides the enrichment of organic matter by these trees, the release of phytochemicals especially from the leaf litter influence the growth of groundstorey crops.

Phytochemical screening on these two species have shown the presence of tannins, flavonoids, terpenoids, alkaloids, steroids, phenolic compounds, anthraquinones, leucoanthocyanin, saponins, coumarins and flavonol glycosides (Cruz & Lim, 2016; Cherian & Thambi, 2019). Phytohormones such as auxin, gibberellin and cytokinins intervene in different plant growth phases (Asaduzzaman *et al.*, 2015).

Secondary metabolite derivatives like abscissic acid, trans-sinapinic acid, coumaric acid (p-coumaric acid, m-coumaric acid, o-coumaric acid etc. inhibit phytohormones and affect seed germination, root growth and elongation, enzyme activity and photosynthesis (Liu *et al.*, 2017). Water soluble allelochemicals released to the soil affect the growth of surrounding plants (Babaahmadi *et al.*, 2013). Legumes have an integral role in global food production (Li *et al.*, 2024). Cowpea is a vital source of protein and it is widely cultivated in Asia, Africa and South America (Jati *et al.*, 2013). Cultivation of cowpea in agroforestry systems is a common practice in tropics. The nature of interaction between trees and crops in agroforestry systems have an important role in growth and yield of crop plants (Osman *et al.*, 2020). The present work was designed to examine the allelopathic effect of leaf leachates of *Gliricidia sepium* and *Macaranga peltata* on germination and growth of three commonly cultivated cowpea (*Vigna unguiculata* L. Walp.) varieties in Kerala, namely *Vigna unguiculata* L. cv. YLB, *Vigna unguiculata* L. cv. Red Gold and *Vigna unguiculata* L. cv. Kaveri.

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2. MATERIALS AND METHODS

The leaves of *Gliricidia sepium* and *Macaranga peltata* were collected from farmlands of Pathanamthitta district, for preparation of leachates. The leaves were washed under tap water and air dried to uniform moisture content. Two different leachate concentrations were used to investigate the possibility of variation in germination and growth rates through dilution. The leaves of both species were soaked separately in distilled water in 10% concentration (10g leaf in 100ml distilled water) and 20% concentration (20g leaf in 100ml distilled water) for 24 hours. After 24 hours, the leachates were filtered through Whatman No.2 filter paper and stored in sterile glass bottles, at 5°C in Refrigerator until the bioassay. The experiments were carried out from November 2022 to March 2023, at the laboratory of Postgraduate and Research department of Botany, Catholicate College, Pathanamthitta, Kerala. Ten uniformly sized, healthy seeds of test varieties were placed in petri dishes (15 cm diameter), lined with one sheet of filter paper saturated with 5ml leaf leachate. The treatment samples were kept uniformly and adequately moist by adding 5ml leachate on a daily basis, for seven days. The following treatments were used in the experiment: Control- seeds grown in distilled water; GT1- seeds grown in *G. sepium* leaf leachate of 10% concentration; GT2- seeds grown in *G. sepium* leaf leachate of 20% concentration; MT1- seeds grown in *M. peltata* leaf leachate of 10% concentration and MT2- seeds grown in *M. peltata* leaf leachate of 20% concentration. The germination data was recorded on 7th day after sowing and germination percentage was calculated for control and treated seeds. All the experiments were done in triplicates and repeated thrice. The observations recorded were subjected to Single factor ANOVA using MS EXCEL. Treatment means were analyzed with Least Significant Difference (LSD) test at 5% significance level.

Germination percentage was calculated for control and treated seeds using the formula,

Germination % = $(n/t) \times 100$, where n is the number of seeds germinated and t is the total number of seeds (Shanker *et al.*, 2014).

The percentage of inhibitory effect on germination and growth of seedlings was calculated using the formula,

$I = 100 - (E2 \times 100 / E1)$, where I = % of inhibition, E1 = response of seeds in control,

E2 = response of treated seeds (Surendra and Pota, 1978)

3. RESULTS AND DISCUSSION

Seed germination rate:

During laboratory bioassay the seed germination

rate declined for all the three cowpea varieties treated with *G. sepium* leaf leachate. Seed germination of Red gold variety was more affected with increase in leachate concentration compared to other two varieties. The germination percentage reduced to 46.4% in seeds of Red gold variety treated with 20% concentration of *G. sepium* leaf leachate. Similar inhibition in seed germination of cowpea by *Azardirecta indica*, *Vitellaria paradoxa* and *Parkia biglobosa* have been reported by Alamu *et al* (2014). Ayeni (2016) reported that the aqueous extract of *G. sepium* inhibited the seed germination of *Bidens pilosa*. YLB variety exhibited enhanced seed germination for 10% and 20% concentrations of *M. peltata* leaf leachate (Fig. 1). Negative values were obtained for inhibition percentage on treatment of YLB in both concentrations of *M. peltata* leaf leachate (Table 1), and this indicates the stimulatory effect. Germination experiment conducted on *V. unguiculata* L. using leaf leachates of *Eucalyptus camaldulensis* showed inhibitory effect whereas *Albizia lebbek* showed stimulatory effect (Sobola *et al.*, 2022). Allelochemicals interfere with seed germination by suppressing gibberellin and indole

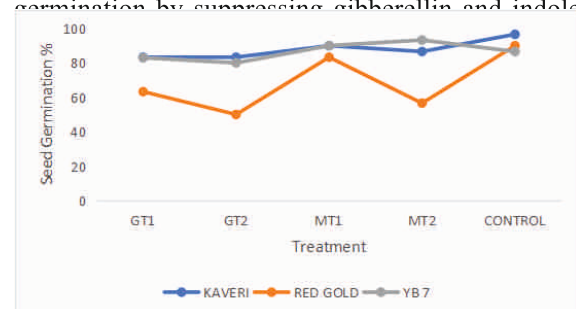


Fig. 1- Allelopathic effect of *Gliricidia sepium* and *Macaranga peltata* on seed germination percentage of pea varieties.

Seedling growth:

Among the seedlings tested the shoot length was more negatively affected by *G. sepium* leaf leachate. The Red Gold variety exhibited a significant decline in shoot length (*G. sepium* leaf leachate 20% concentration) compared to other varieties (Fig. 2). This indicates the inhibitory effect of the *G. sepium* leaf leachate. Kaboneka *et al* (2020) reported seedling growth inhibitory effect by *G. sepium* on bean (*Phaseolus vulgaris* L.) and maize (*Zea mays* L.) under laboratory and greenhouse conditions. The stimulatory effect of *M. peltata* leaf leachate on shoot length and root length of Red gold and YLB seed varieties noted (Table 1). Among the tested varieties root growth of Kaveri and Red Gold varieties were significantly suppressed by *G. sepium* leaf leachate (Fig. 3). The root elongation was more inhibited in

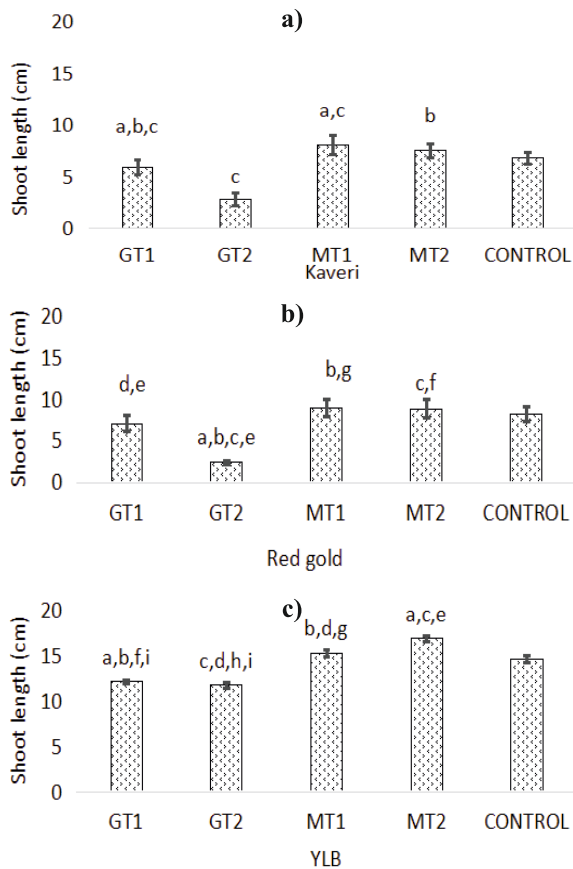


Fig. 2- Comparative analysis of allelopathic effect of *Gliricidia sepium* and *Macaranga peltata* on seedling shoot length of pea varieties. *† The bars with different letters indicates the presence of statistically significant difference ($p \leq 0.05$) as determined by LSD test.

seeds of Red Gold variety treated with *G. sepium* leaf leachate. However, the *M. peltata* leaf leachate exhibited stimulatory effect on root elongation in Red Gold and YLB varieties.

Among the two species tested, the leaf leachates of *G. sepium* showed significant inhibitory ($p \leq 0.05$) in seed germination and seedling growth on comparison with that of *M. peltata*. Similar finding was reported by Ayeni (2016), where application of aqueous leaf and bark extracts of *G. sepium* caused a significant decline in radicle length and plumule length in *Bidens pilosa* seedlings. Allelochemicals inhibit cell division and cell elongation, thereby affecting the early growth of seedlings (Saber *et al.*, 2013). The methanol extract of fresh leaves of *G. sepium* yielded 11.6mmol kg⁻¹ Coumarin and exhibited 50% inhibition on radicle growth in lettuce (Takemura *et al.*, 2013). The assays conducted using *M. peltata* exhibited mild stimulatory effect on seedling growth of Red Gold and YLB varieties ($p \leq 0.05$). Rosamah *et al.* (2023) reported the presence of triterpenoids, sterols, glycosides, flavonoids and tannins in leaf extracts of *Macaranga peltata*. The inhibitory as well as stimulatory effects observed in the present study reveals the complexity in

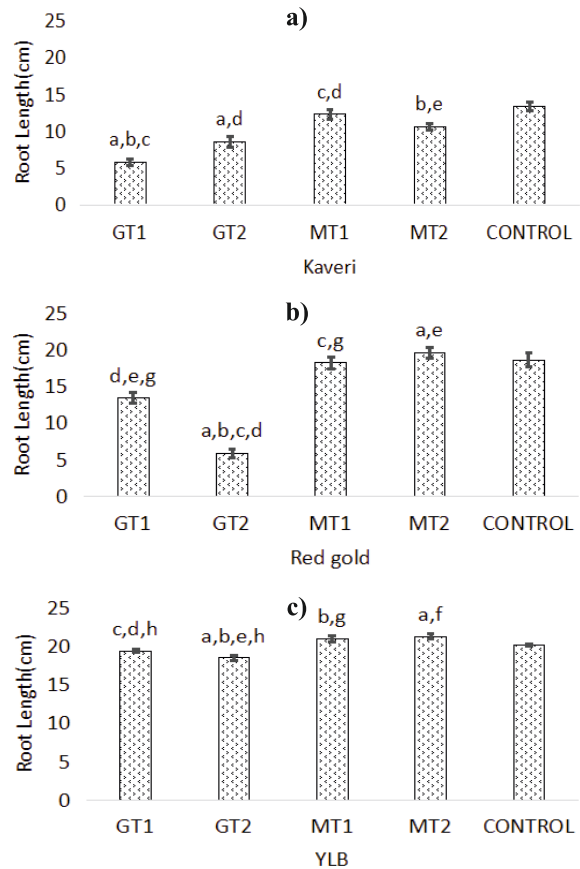


Fig. 3. Comparative analysis of allelopathic effect of *Gliricidia sepium* and *Macaranga peltata* on seedling root length of pea varieties. *† The bars with different letters indicates the presence of statistically significant difference ($p \leq 0.05$) as determined by LSD test.

mode of action of allelopathic secondary metabolites. Further field experiments might be helpful in validating the results and formulating strategies regarding inclusion of both plants in agroforestry systems.

4. CONCLUSION

Seed germination and seedling growth of all the three cowpea varieties tested were affected by *Gliricidia sepium* and *Macaranga peltata*. Seed germination was significantly inhibited by *G. sepium* leaf leachates in cowpea varieties tested. Among the seedling growth parameters, shoot length and root length was significantly reduced by *G. sepium* leaf leachates whereas *M. peltata* imposed a mild stimulatory effect. Considering the inhibitory effect of *G. sepium* on cowpea germination and seedling growth, it is further recommended that farmers should be cautious while including the plant as a part of agroforestry system and used for mulching. Due to the overall stimulatory effect of *M. peltata*, it shall be retained as a suitable agroforestry component and used for mulching in cowpea cultivation.

Table 1. Inhibitory effect of *Gliricidia sepium* and *Macaranga peltata* on germination, shoot length and root length of pea varieties.

Treatment	Seed Germination	Shoot Length	Root Length
Kaveri			
GT1	13.77	12.65	56.81
GT2	13.77	58.38	36.11
MT1	6.83	-18.68*	8.34
MT2	10.35	-10.59*	20.10
Red Gold			
GT1	32.15	28.05	24.31
GT2	46.4	70.61	66.91
MT1	3.07	-7.32*	-2.53*
MT2	14.55	-9.27*	-10.30*
YLB			
GT1	4.15	17.14	3.48
GT2	7.62	19.73	7.96
MT1	-3.93*	-4.08*	-4.68*
MT2	-7.74*	-15.03*	-5.97*
Kaveri			
GT1	13.77	12.65	56.81
GT2	13.77	58.38	36.11
MT1	6.83	-18.68*	8.34
MT2	10.35	-10.59*	20.10
Red Gold			
GT1	32.15	28.05	24.31
GT2	46.4	70.61	66.91
MT1	3.07	-7.32*	-2.53*
MT2	14.55	-9.27*	-10.30*
YLB			
GT1	4.15	17.14	3.48
GT2	7.62	19.73	7.96
MT1	-3.93*	-4.08*	-4.68*
Mt2	-7.74*	-15.03*	-5.97*

*Negative sign indicates stimulatory effect.

ACKNOWLEDGEMENTS

The authors are grateful to Department of Botany, Catholicate College, Pathanamthitta, Kerala for allowing the use of laboratory facilities in the present investigation.

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