Journal of Medicinal Plants Studies

www.PlantsJournal.com

ISSN (E): 2320-3862
ISSN (P): 2394-0530
Impact Factor (RJIF): 5.94
www.plantsjournal.com
JMPS 2025; 13(5): xx-xx
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Received: 21-05-2025
Accepted: 25-06-2025

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Allelopathic effect of sesame on the germination and seedling growth of *Melochia corchorifolia* L.

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DOI: https://www.doi.org/10.22271/plants.2025.v13.i5b.1944

Abstract
A significant infestation of *Melochia corchorifolia* L. (commonly known as Chocolate weed) has been observed in sesame (*Sesamum indicum* L.) fields within the Kuthulia tract of Rewa (M.P.), India. This situation prompted an investigation into the allelopathic effects of leachates and blended extracts from various sesame plant parts on the germination and seedling growth of *M. corchorifolia*. The findings indicated that the tested concentrations of sesame leachate and blended extract displayed a stimulatory impact on the germination and growth of this weed. Notably, sesame leachate demonstrated a stronger stimulatory effect compared to the blended extract. Among the tested concentrations, the highest (1:2.5 w/v) yielded the most pronounced stimulatory impact. This heightened effect of sesame leachate on the germination and growth of *M. corchorifolia* is likely contributing to the severe infestation of Chocolate weed within sesame fields.

Keywords: Allelopathy, chocolate weed, Germination, *Melochia corchorifolia*, seedling vigour, Sesame, weed ecology

Introduction
Sesame (*Sesamum indicum* L.), one of the oldest native oilseed crops, is widely cultivated in tropical regions of India for its edible seeds. Boasting a high oil content ranging between 46-64% and providing significant dietary energy at 6355 kcal/kg, it has become a popular food ingredient across the globe (Kaul *et al.* 2020) [1]. Sesame has been a prominent oilseed crop in Kerala since ancient times, especially cultivated as a summer crop in the rice fallows of the Kuthulia tract. This region, a key sesame-growing area located in Madhya Pradesh, spans approximately 2,200 hectares across three main tehsils: Huzur, Sirmour, and Gurh in the Rewa district. However, farmers in the Vindhyan region are currently facing a significant challenge posed by *Melochia corchorifolia* L., commonly known as Chocolate weed, a member of the Sterculiaceae family. This invasive weed has been rapidly spreading through sesame fields, creating serious concerns for agricultural productivity. Its seeds closely resemble those of sesame, germinating simultaneously and gaining a competitive edge over the crop, ultimately leading to drastic reductions in yield.

Allelopathy refers to the direct or indirect impact one plant has on others through the release of chemical substances (Subtain *et al.* 2014) [2]. Allelopathic effects exhibit a selective nature, are influenced by concentration levels, and can either promote or hinder the growth and development of neighboring plants (Cheema *et al.* 2004) [3]. The use of diluted sorghum water extracts demonstrated improved germination and growth characteristics in wheat, according to Anwar *et al.* (2003) [4]. Sesame also exhibits strong allelopathic potential, as it contains various allelochemicals such as saponins, flavonoids, tannins, phenols, and alkaloids, as noted by Fasola and Ogunsola (2014) [5].

The occurrence of *M. corchorifolia* weed was observed to be comparatively lower in lowland paddy fields and upland crop areas. This variation in its presence sparked interest in exploring the potential allelopathic influence of sesame on the germination and growth of *M. corchorifolia*. With this in mind, the current study aimed to examine the allelopathic effects of sesame on the germination and developmental characteristics of *M. corchorifolia*.

Sesame plants utilized in the experiment were cultivated between March and June 2023 at the Kuthulia Agricultural Research Station in Rewa, Madhya Pradesh, India. Fresh samples of sesame plants were meticulously collected during their active growth stage, specifically at 30 days after sowing (DAS), ensuring the roots remained intact and undamaged. The roots were thoroughly cleaned with clean water to remove any dirt or soil particles. The allelopathic study was performed using both blended extracts and leachates obtained from sesame plants.

Preparation of blended extract: The plants were cut into small pieces, approximately 2 cm in length, using a fodder cutter. The chopped material was then ground with distilled water in a blender to create a slurry. Each sample was weighed to 100 g and combined with varying volumes of distilled water-250 mL, 500 mL, 1000 mL, and 2000 mL- to produce extract solutions of four different concentrations: 1:2.5, 1:5, 1:10, and 1:20 (w/v). The samples were agitated for 24 hours at room temperature using an orbital shaker (model S01, Stuart Scientific Co. Ltd) set at 100 RPM. Following agitation, the mixtures were filtered through four layers of cheesecloth to remove solid residues. The resulting extracts were stored in sealed plastic bottles and refrigerated at 4°C until further use.

Preparation of leachate: The plants were finely chopped into small pieces measuring about 2 cm in length using a fodder cutter. To prepare the leachate, 100 g of the chopped plant material was soaked for 48 hours in varying quantities of distilled water: 250 mL, 500 mL, 1000 mL, and 2000 mL. This resulted in leachates of four distinct concentrations with ratios of 1:2.5, 1:5, 1:10, and 1:20 (w/v). After soaking, the collected leachates were carefully filtered and utilized for treating seed samples of *M. corchorifolia*.

Germination bioassay: Seeds of *M. corchorifolia* were harvested from mature plants and left to dry for two weeks at a temperature of 25°C. Following the drying period, they were sieved to remove any impurities and stored in airtight plastic containers. For the experiment, mechanically scarified seeds were utilized, with the scarification process performed on the day of testing. This involved spreading the seeds on a wooden board and rubbing them with an emery cloth by moving it 10 cm up and down three times, as described by Mobli *et al.* (2020) [6]. The emery cloth used for scarification was supplied by John Oakey and Mohan, featuring a grit range of 16-220.

Twenty-five mature *M. corchorifolia* seeds were placed in 9 cm diameter petri dishes containing a layer of filter paper. Separate experiments were conducted using blended extract and leachate. The study employed a completely randomized design with four treatments representing varying concentrations: 1:2.5, 1:5, 1:10, 1:20 (w/v), alongside a control. Each treatment was replicated four times. The filter paper in the petri dishes was moistened with 5 mL of the respective concentrations of blended extract or leachate, while control treatments utilized distilled water. Germinated seeds were counted every 24 hours over a seven-day period, with seeds possessing a radicle ≥2 mm considered germinated. All experiments were conducted simultaneously, and the protocol was repeated for validation. On the eighth day, seedlings were carefully harvested to avoid root damage. Measurements were taken for fresh seedling weight as well as root and shoot lengths, and corresponding averages were calculated. The samples were then dried in a hot air oven at 65 ± 5°C until reaching a constant weight, with the dry weight expressed in grams per plant. Using these observations, key metrics such as seedling emergence percentage, speed of germination (Bartlett, 1973) [7], and seedling vigor indices I and II (Abdul-Baki and Anderson, 1973) [8] were calculated.

1. Germination %

$$Germination\ \% = \frac{Total\ number\ of\ seeds\ emerged}{Total\ number\ of\ seeds} \times 100$$

2. Speed of germination (SG) = $n_1/d_1 + n_2/d_2 + \ldots\ldots\ldots + n_x/d_x$

Where, n_1 is the number of seeds germinated on 1st day, n_2 is the number of seeds germinated on 2nd day……… n_x is the number of seeds germinated on xth day, d_1 is the 1st day, d_2 the 2nd day and dx the xth day.

3. Seedling vigor index I (SVI I) = Seedling length (cm) × Germination percentage

4. Seedling vigor index II (SVI II) = Seedling dry weight (g) × Germination percentage

The experimental data were statistically analyzed using the analysis of variance (ANOVA) method tailored for Completely Randomized Design (CRD), as outlined by Cochran and Cox (1965) [8]. The significance of the results was assessed using the F-test, and for cases where the F values indicated significance, the critical difference was determined at a 5% probability level.

Results and discussion

Effect of sesame on germination of *M. corchorifolia*

Leachate of sesame was observed to have stimulatory effect on the germination of *M. corchorifolia* seeds. But blended extract of sesame did not have any significant effect (Table 1). A germination percentage of 49.34% was observed with leachate of 1: 2.5 (w/v) concentration and was on par with the concentration of 1:5 (w/v). Control recorded the lowest germination percentage (41.34%). Speed of germination was also influenced by sesame leachates of different concentrations (Table 1). Higher values of 4.66 and 4.56 were observed by leachates of concentration 1: 2.5 (w/v) and 1: 5 (w/v), respectively and the control treatment recorded the lowest value (4.033). The highest value for seedling vigour index I was exhibited by 1: 2.5 (w/v) concentration and was at par with 1: 5 (w/v) concentration. Seedling vigour index II was found to be significantly higher (5.58) for leachate of 1: 2.5 (w/v) concentration. Control treatment recorded the lowest value for both seedling vigour index I and II. Blended extract did not have any significant effect.

Stimulatory effect *M. corchorifolia* might be due to the selective permeability of seed coat of *M. corchorifolia* to the allelochemicals present in the sesame leachate. Wang *et al.* (2010) [9] observed that leachates of wheat stubbles at higher concentration (100% and 50%) enhanced the seed germination and seedling fresh weight and radicle length of cucumber seedlings due to the presence of allelochemicals present in the leachates which stimulated á- amylase activity. Root exudation, leaching from the above ground plant parts, volatilization and decomposition of plant parts are the ways by which allelochemicals are released in to the rhizosphere of the plant. Stimulatory effect of sesame leachate on the germination and seedling growth of *M. corchorifolia* might be the reason for severe infestation of *M. corchorifolia* in sesame fields of Kuthulia, Rewa (M.P.) India.

Effect of sesame on growth attributes of *M. corchorifolia*

Bioassay studies demonstrated that sesame leachate and blended extract significantly stimulated the growth attributes of *M. corchorifolia* seedlings. The response, however, was dependent on concentration, with higher concentrations yielding greater improvements in growth metrics. Sesame leachate at its highest concentration (1:2.5 w/v) produced the highest seedling fresh weight (0.137 g), closely matched by the leachate at 1:5 (w/v), which resulted in a fresh weight of 0.132 g. In contrast, the lowest concentration yielded the smallest fresh weight (0.120 g), remaining comparable to the control group. Overall, the seedling fresh weight observed at the highest leachate concentration (1:2.5 w/v) was 14.16% higher compared to the control.

The blended sesame extract demonstrated a positive impact on the seedling fresh weight of *M. corchorifolia*, as indicated in Table 1. However, this effect was less pronounced compared to that observed with the leachate. Among the tested concentrations, the higher ratio (1:2.5 w/v) yielded the greatest seedling fresh weight at 0.127 g, which was comparable to the results for 1:5 and 1:10 w/v concentrations. The control group exhibited the lowest seedling fresh weight, measuring 0.120 g. The higher concentration of blended extract (1:2.5 w/v) resulted in a 5.8% increase in the weed's seedling fresh weight compared to the control.

The seedling dry weight of *M. corchorifolia* exhibited a pattern similar to its fresh weight. As the leachate concentration decreased, a reduction in dry weight was observed (Table 1). The highest dry weight was obtained at the highest sesame leachate concentration (1:2.5 w/v), which was statistically comparable to the dry weight recorded at the 1.5 w/v concentration. In contrast, the control yielded the lowest dry weight. A 13.4% increase in seedling dry weight was noted at the 1:2.5 w/v concentration compared to the control. Likewise, the most concentrated blended sesame extract (1:2.5 w/v) produced the highest seedling dry weight, which was comparable to the results from the 1:5 w/v and 1:10 w/v concentrations. The lowest dry weights were registered with the 1:20 w/v concentration and the control group.

The shoot length of *M. corchorifolia* seedlings was notably affected by sesame leachate and blended extract, as shown in Table 1. Similar to the results observed for seedling weight, the longest shoot length of 5.17 cm was recorded at the highest concentration of 1:2.5 (w/v), which showed comparable results to the 1:5 (w/v) concentration. A gradual decline in shoot length was noted with decreasing concentrations, with the control group exhibiting the shortest shoot length. The increase in shoot length at the higher concentration of sesame leachate (1:2.5 w/v) was 10.7% above the control. Similarly, the blended extract at higher concentrations (1:2.5 and 1:5 w/v) also promoted greater shoot length in seedlings, with the rise in shoot length at 1:2.5 (w/v) reaching 5.8% compared to the control.

Sesame leachate demonstrated a notable impact on the root length of *M. corchorifolia*, as shown in Table 1. Higher concentrations of the leachate [1:2.5 (w/v) and 1:5 (w/v)] produced increased root lengths of 2.62 cm and 2.52 cm, respectively, surpassing the values observed at lower doses. The control group recorded the shortest root length at 2.32 cm.

The leachate and blended extract of sesame demonstrated a stimulatory impact on the growth characteristics of *Melochia corchorifolia*, likely attributed to the growth-enhancing properties of allelochemicals contained within the sesame leachate and extract. Zhu *et al.* (2005) [10] reported that allelopathic effects of plants depend on their types and concentrations. The enhancement in shoot length and seedling fresh and dry weight of maize with fresh shoot aqueous extract of *Tithonia diversifolia* due to the accumulation of some allelochemicals in large amounts (Oyerinde *et al.* 2009) [11]; stimulated shoot and root growth of *Lactuca sativa* and *Cassia mimosoides* with leaf extracts of *Euphorbia serpens* (Dana and Domingo 2006) [12], *Phytolacca americana* (Kim *et al.* 2005) [13] and *Melochia corchorifolia* (Unnikrishnan *et al.* 2022) [14] respectively were reported earlier.

Table 1: Effect of sesame whole plant leachate and blended extract on germination and seedling growth of *M.corchorifolia* seedlings.

Sesame whole plant leachate and blended extract concentration (w/v)	Germination (%)		Speed of germination		Seedling fresh weight (g)		Seedling dry weight (g)		Shoot length (cm)		Root length (cm)	
	Leachate	Blended extract	Leachate	Blended extract	Leachate	Blended extract	Leachate	Blended extract	Leachate	Blended extract	Leachate	Blended extract
1:2.5	49.34	45.33	4.66	4.43	0.137	0.127	0.110	0.104	5.17	4.93	2.62	2.47
1:5	45.32	44.00	4.56	4.25	0.132	0.125	0.106	0.103	4.97	4.80	2.52	2.43
1:10	44.01	42.67	4.15	4.08	0.122	0.124	0.100	0.098	4.73	4.67	2.40	2.37
1:20	42.68	41.33	3.99	3.90	0.120	0.120	0.098	0.097	4.70	4.67	2.35	2.30
Control	41.33	41.33	4.00	4.00	0.120	0.120	0.097	0.097	4.67	4.66	2.33	2.30
LSD (p=0.05)	5.035	NS	0.404	NS	0.007	0.005	0.005	0.005	0.312	0.190	0.126	NS

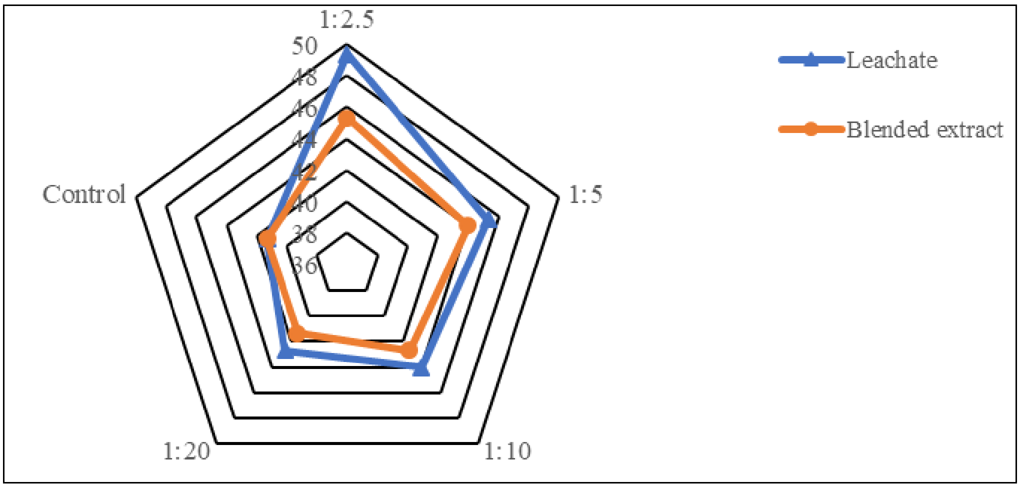

Fig 1: Effect of sesame whole plant leachate and blended extract on germination of *M.corchorifolia* seedlings.

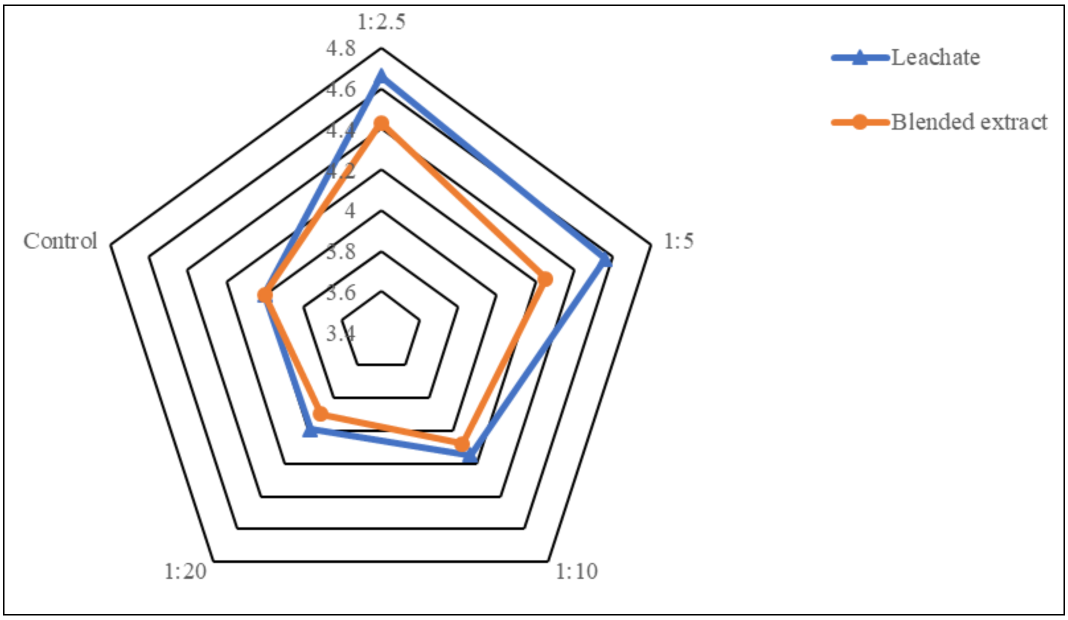

Fig 2: Effect of sesame whole plant leachate and blended extract on speed of germination of *M.corchorifolia* seedlings.

Conclusion
Sesame leachate and blended extracts exhibited a stimulatory effect on the seedling growth of *M. corchorifolia*. This suggests that leachates from decomposed sesame residues might play a role in enhancing the germination and growth of *M. corchorifolia*. Such an effect could potentially explain the high infestation of *M. corchorifolia* observed in sesame fields. Therefore, to mitigate this issue, it is recommended to rotate crops and cultivate alternative species for three to four years, aiming to diminish the weed seed bank of *M. corchorifolia*.

Acknowledgement
The authors are very thankful to authority of Govt. Model Science College Rewa (M.P.) to carry out this work.

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