Allelopathic Effect of Aqueous Extracts of *Lantana camara* and *Chromolaena odorata* on Germination and Seedling Growth of *Leucaena leucocephala*

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**Abstract:** The effect of aqueous extracts of leaf and stem of *Lantana camara* and *Chromolaena odorata* at concentrations of 0, 25, 50, 75 and 100% on germination and seedling growth of *Leucaena leucocephala* were investigated under laboratory conditions. Results of the study revealed that aqueous extracts of the two donor plants caused significant inhibitory effect on germination, shoot and root length of seedling of *Leucaena leucocephala*. The leaves of the two donor plants were more inhibitory to germination and seedling growth of *Leucaena leucocephala* than their stems. Inhibitory effect of extract of *Chromolaena odorata* leaf was higher than *Lantana camara* leaf extract, but inhibitory effect of their stem was not significantly different. The inhibitory effect was proportional to the concentrations of the extract and higher concentrations had the stronger effect while the lower concentration of 25% showed stimulatory effect in some cases. The study also revealed that inhibitory effect was more pronounced in root elongation rather than shoot elongation.

**Keywords:** *Lantana camara*, *Chromolaena odorata*, allelopathy, *Leucaena leucocephala*

1. **Introduction**

Soil degradation is one of the major constrain to development of tropical grassland that threatening ecosystem services and food security for people in tropical developing countries (Herrero et al., 2010). Grassland degradation as resulted from the decline of production and its ecological function leading not only to a decline of biodiversity, grass and animal production in pasture, but also to deteriorating of our living environment (Zhang, 1995). In grassland area, the major causes of soil degradation are overgrazing and lack of proper management such as inadequate fertilizer, bad soil conservation, etc. In Indonesia, lack of available forage as effect of high stocking rates is exacerbated by invasion of unpalatable alien species like *Chromolaena odorata* and *Lantana camara* that tend to replace existing forage species and preventing the establishment of useful species. In South Sulawesi, Indonesia, the two weed species and some other unpalatable minor weeds have covered more than 50% of many grassland areas.

Leakey (1998) noted that agro-forestry system is a more sustainable form of land use that has a greater potential of improving grassland productivity through increasing forage availability and enhanced soil fertility. *Leucaena leucocephala* with its agroforestry potentials fits into this role because it can grow very fast, palatable to livestock, has a large nitrogen fixing capacity and its roots can reach to deep soil layer that allow the plant to exploit more water and nutrients and tolerates to wide array of soil and climatic conditions. However, introduction of *L. leucocephala* into *L. camara* and *C. odorata* dominated grassland may pose problems, because interaction between *L. leucocephala* and the two weeds dominated grassland ecosystem is rather complex. These interactions, among which is allelopathy, either promotes or inhibits the growth of the component species. There is a limited study concerning the allelopathic effect of the two weed species on the growth of forage plants, including on *L. leucocephala*. Therefore this study was conducted to determine allelopathic effects of leaf and stem of *L. camara* and *C. odorata* on seed germination and shoot and seedling growth of *L. leucocephala*.

2. **Materials and Method**

**Preparation of Plant Extracts**

The experiment was conducted at the Laboratory of Forage and Grassland Management, Faculty of Animal Science Hasanuddin University, Indonesia from April to June 2015. Fully mature *L. camara* and *C. odorata* plants were collected from Hasanuddin University campus and separated into leaf and stem. The plant parts were crushed into small fractions with hand or knife. Seeds of *L. leucocephala* were also harvested from plant growing naturally at Hasanuddin University campus. Before using, the seeds were soaked in distilled water for 24 hours; hard and malformed seeds were discarded. The aqueous extracts of the two weed species (donor plants) were prepared by addition of 30 g crushed fresh plant parts in 150 ml of distilled water, soaked for 24 hours at room temperature. The mixtures then were filtered through filter paper. This filtrate was regarded as 100% concentration. Different concentrations were prepared by adding distilled water to make 25, 50 and 75% concentrations.

**Bioassay**

Germination test was conducted in sterile petri dish (8 cm diameter) lined with one filter paper. Twenty uniform seeds of *L. leucocephala* were placed in each petri dish. The seeds then treated with 10 ml of the 25, 50, 75 and 100% concentrations of donor plant extract and 10 ml of distilled water used as control. The experiment was laid out in completely randomized design with three replications. The petri dishes were kept at room temperature (28 – 32°C) on a laboratory bench. The seed was considered as germinated.
when radicle emerged. Germination, root and shoot length was recorded after seven days.

Ratio of germination and elongation were calculated according to Rho and Kil (1986):

\[
\text{Relative germination ratio = } \frac{\text{Number of seeds germinated}}{\text{Number of seeds on the petri dish}} \times 100
\]

\[
\text{Relative elongation ratio of shoot = } \frac{\text{Mean shoot length of treated plant}}{\text{Mean shoot length of control}} \times 100
\]

\[
\text{Relative elongation ratio of root = } \frac{\text{Mean root length of treated plant}}{\text{Mean root length of control}} \times 100
\]

**Statistical Analysis**

The data for seed germination percentage were statistically analyzed using analysis of variance of SPSS version 16 and means of parameters measured were tested using Least Significant Difference.

**3. Results and Discussion**

Aqueous extracts of *L. camara* and *C. odorata* suppressed germination of *L. leucocephala* seeds. The allelopathic effects varied between plant parts and among extract concentration levels. The highest inhibitory effect was recorded in *C. odorata* leaf extract with 100% concentration that reduced germination ratio by 43.6% and the lowest was control (Table 1). Inhibitory effects of *L. camara* on seed germination had also been reported by Ahmed et al. (2007) and Hussein (2011) in *C. odorata* by Devy and Dutta (2012) and Sahid and Yusoff (2014), but there was no report of allelopathic effect of *L. camara* and *C. odorata* on germination of *L. leucocephala* seeds. This indicated that leaf and stem extracts of the two weed species contained allelochemicals that reduced the germination of *L. leucocephala* seeds.

<table>
<thead>
<tr>
<th>Plants</th>
<th>Concentration (%)</th>
<th>Germination (%)</th>
<th>Ratio</th>
<th>Length (cm)</th>
<th>Elongation ratio (%)</th>
<th>Length (cm)</th>
<th>Root</th>
<th>Elongation ratio (%)</th>
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<tbody>
<tr>
<td>Control</td>
<td></td>
<td>91.8a</td>
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<td>6.1a</td>
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<td>75.1c</td>
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Means within the same column followed by the same letter are not significantly different at 0.05 probability level.

In the present study, inhibitory effect was found to be higher in *L. camara* leaf extracts and *C. odorata* leaf extracts than in their stem extracts. Irrespective of their concentrations, the mean germination percentage was lower in *L. camara* leaf treated seeds (81.23%) than in *L. camara* stem treated seeds (87.23%). The mean germination percentage was also lower in *C. odorata* leaf treated seeds (64.55%) than in *C. odorata* stem treated seeds (88.35%). There was no significant difference in seed germination between *L. camara* stem treated seeds and *C. odorata* treated seeds (Table 1).

The higher inhibitory effect of *L. camara* and *C. odorata* leaf extracts over their stems on seed germination is in conformity with the findings of some other workers. In *L. camara*, it had been reported by Choyal and Sharma (2011) and Kar et al. (2014) andin *C. odorata* by Suwal et al. (2010) and Rusdy et al. (2015). This indicated that inhibitory effect of leaf extract was more powerful than stem extract and this might be attributed to high amounts of allelochemicals in the leaves of the two weed species (Eze and Gill, 1992; Kong et al., 2006). Reduction in seed germination might be attributed to the allelochemicals that inhibited the process of germination. Allelochemicals in the extracts might prevent the growth of seed embryo and caused its death (Abugre et al., 2011). According to Armstrong et al. (1970), some of the biological processes
that may respond to allelochemicals are: cell membrane permeability, cell division, seed germination, internode elongation, leaf expansion, dry weight accumulation, respiration, nutrient absorption and development.

Results from the present study also showed that inhibitory effects of the two donor plant extracts were concentration dependent, as concentration level increased, degree of inhibition also increased. Aqueous extract of the two donor plants at higher concentration levels induced the highest inhibitory effects as indicated by the low percent of germination. This results are in agree with Fariba et al. (2015) that allelochemicals stimulated or inhibited plant growth depending on their concentration.

Effects of leaf and stem extracts on shoot and root lengths and seedling growth

Both leaf and stem extracts from L. camara and C. odorata plants inhibited shoot and root elongation of germinated seed of L. leucocephala, except for root elongation which was promoted by L. camara extracts at 25% concentration (Table 1). This results supports the finding of Rice (198) that chemicals inhibiting the growth of some species at certain concentration could stimulate the growth of the same or different species at lower concentrations.

In the present study, the highest inhibitory effect was found in C. odorata leaf extract with mean shoot root elongation ratio of 58.5 and 57.0%, followed by C. odorata stem extract (83.9 and 76.9%). L. camara leaf extract (81.3 and 91.9%) and L. camara stem extract of 94.9 and 96.9%, respectively (Table 1). The highest inhibitory effect of C. odorata leaf extract on shoot and root length of L. leucocephala seedling might be due to high accumulation of allelochemicals in the top meristem of the plant that were able to inhibit the synthesis of growth hormone which in turn prevented cell division and differentiation in shoot and root of germinated plants (Abugre et al., 2011). The inhibitory effect of L. camara extract on seedling growth of other plants is in agree with Ahmed et al. (2007) and Hussain et al. (2011) and in C. odorata is in agree with Devi and Dutta (2012) and Hu and Zhang (2013).

The present study also show that C. odorata leaf extract reduced shoot and root elongation more than L. camara leaf extract. Increase in extract concentration of C. odorata from 25 to 100% reduced shoot and root elongation ratio by 31.2 and 44.9%, whilst in L. camara it reduced shoot and root elongation ratio by 16.4 and 41.1%, respectively. This might be attributed to the higher concentrations of allelochemical in C. odorata leaf than in L. camara leaf. The more sensitive of root over shoot of maize as affected by C. odorata had also reported by Masumet al. (2012) and Devi and Dutta (2012). This is because root is the first organ that absorbs the allelochemicals from the environment. Besides, root tissue has greater permeability compared to shoot tissue (Nishida et al., 2005).

4. Conclusion

Present results showed that concentrated aeous leaf extract of both weed species inhibited seed germination and seedling growth of L. leucocephala. Keeping the above in view, it can be suggested that seeds of L. leucocephala should not be planted close to the two weed species due to adverse effect on their growth. However, whether biomass of the two weed species can be used as compost, it needs further experimentation.

References


