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Allelopathic Effect of Aqueous Extracts of *Lantana camaraand Chromolaenaodorata* on Germination and Seedling Growth of *Leucaenaleucocephala*

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Abstract: ***The effect of aqueous extracts of leaf and stem of Lantana camara and Chromolaenaodorata at concentrations of 0, 25, 50, 75 and 100% on germination and seedling growth of Leucaenaleucocephala 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 lengthof seedling of Leucaenaleucocephala. The leaves of the twodonor plants were more inhibitory to germination and seedling growth of Leucaenaleucocephala than their stems. Inhibitory effect of extract of Chromolaenaodorata leaf was higher than Lantanacamaraleaf 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*, *Chromolaenaodorata*, allelopathy, *Leucaenaleucocephala*

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 in-adequate fertilization, bad soil conservation, etc. In Indonesia, lack of available forage as effect of high stocking rates is exacerbated by invasion of unpalatablealien species like *Chromolaenaodorata* 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 enhancedof soil fertility. *Leucaenaleucocephala* 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 inhibitsthe 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 June2015. Fully mature *L.camara* and *C.odorata*plant 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^{o} 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):

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds on the petri dish}} \times 100$$

$$\text{Relative germination ratio} = \frac{\text{Germination percentage of treated plant}}{\text{Germination percentage of control}} \times 100$$

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

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

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) and 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 allelo chemicals that reduced the germination of *L. leucephala* seeds.

Table 1: Effects of extract of *L. camara* and *C. odorata* on germination and seedling growth of *Leucaenaleucocephala*

Plants	Concentration (%)	Germination		Shoot		Root	
		(%)	Ratio	Length (cm)	Elongation ratio (%)	Length (cm)	Elongation ratio (%)
Control	0	91.8a	100.0a	6.1a	100.0a	9.0	100.0b
L.camara leaves	25 50 75 100	91.6a 86.7ab 76.7b 73.3b	99.8a 94.4ab 83.7b 79.8b	5.7a 5.5ab 5.4b 4.7c	93.4a 90.2ab 88.5b 77.0c	10.6a 9.3b7.3c 6.9c	117.7a 103.3b 81.1c 76.6c
L.camara stem	25 50 75 100	90.0a 90.0a 86.3a 82.6a	98.0a 98.0a 94.2a 92.6a	6.0a 5.8a 5.7a 5.6a	98.4a 95.1a 93.4a 91.8a	10.3a 8.9b 8.7b 7.0c	114.4a 98.9b 96.7b 77.8c
*C.odorata*leaves	25 50 75 100	91.6a 75.0b 51.6a 40.0d	99.8a 81.7b 56.2c 43.6d	4.7c 3.6d 3.2de 2.8e	77.1c 59.0d 52.5de 45.9e	7.7c 4.9d 4.6d3.6e	85.6c 54.4d 51.1d 40.7e
*C.odorata*stem	25 50 75 100	90.0a 90.0a 86.7a 86.7a	98.0a 98.0a 94.4a 94.4a	5.2b 5.4b 5.2b 4.3c	88.2b 88.4b 84.2b 75.1c	7.8c 7.1c 7.0c 5.7d	86.7c 78.9c 77.9c 63.3d

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 that 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 prevented 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 effectsof 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 lengthsand seedling

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 a*l. (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 Masum*et a*l. (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 aqueous leaf extract of both weed species inhibited seed germnationand 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.

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