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Allelopathic effect of *Lantana camara* and *Chromolaena odorata* on germination and seedling growth of *Centroma pubescens*

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Abstract

An experiment was conducted to determine the inhibitory effect of aqueous extracts of *Lantana camara* and *Chromolaena odorata* leaf on germination and seedling growth of *Centrosema pubescens*. The effects of different concentrations of *Lantana camara* and *Chromolaena odorata* leaf extracts (2, 4, 6, 8 and 10%) were recorded and compared with distilled water (control). Results showed that different concentrations of the two weed extracts had significant inhibitory effect on germination, root, shoot length and dry matter yield of *Centrosema pubescens*. The inhibitory effect was generally increased with increasing extract concentrations, and was more pronounced with the Lantana extract than the Chromolaena extract. These results suggest that allelopathic substances produced by both weed species, especially by *Lantana camara* may hinder the success of introduction of of Centrosema into grassland invaded by both weed species. Therefore, both weeds in large quantities should not be used as cover crop or mulch and should be removed from the area where *Centrosema pubescens* seed will be sown.

INTRODUCTION

In many developing countries of the tropics like Indonesia, productivity of ruminant animals is mostly hampered by decrease of forage availability from grassland area as resulted from conversion of grassland to cash crop cultivation and invasion of noxious exotic plants. Invasion of world's grassland by shrub plants is among dominant changes in the earth vegetation during the last two centuries (Polley *et al*., 2003). In

grassland area of Indonesia, *Lantana camara* (hereafter is called Lantana) and *Chromolaena odorata* (Chromolaena) are two of the most pernicious weed because they can reducing forage productivity and biodiversity, and harming livestock health. Both weeds are not only invade grassland but they also invade forest, riverbanks, roadsides, unused and agricultural lands.

Lantana and Chromolaena are the rapid-growing perennial woody shrub, native to tropical and subtropical South and Central America and at present they are widely distributed in many countries where they have been considered as noxious weed. Both weeds have high competitive ability and can form a dense thicket that shade out the neighboring plants. A part of their high competitive ability is due to its allelopathic traits. Different parts of Lantana (Ambika *et al*., 2003), Hussain *et al*., 2011) and Chomolaena (Eze and Gill, 1992, Sahid and Yusoff, 2014) contain allelochemicals which can interfere with seed germination and early growth of many plant species.

In grassland area, Lantana and Chromolaena have a variety of impacts including reduction forage yield, and species diversity, decline or increase in soil fertility, and allelopathic alteration of soil properties as well as ecosystem process. Persistent of Lantana and Chromolaena infestation can lead to a reduction in biodiversity because it has the potential to block succession and reducing species richness (Goodal and Zacharias, 2000, Taylor *et al*., 2012).

The improvement of grassland invaded by the two weed species can be achieved by eradicating the weeds followed by planting of improved forage species or maintaining existing forage species followed by oversowing with forage legume species. Replacing existing forage species with improved species by full cultivation needs high cost, therefore, in natural grassland, oversowing with forage legume may be the most realistic way to improve the productivity and quality of forage. Under soil and climatic conditions of Indonesia, apparently the most successful legume herb suitable to be introduced into grassland is *Centrosema pubescens* (Centrosema).

Oversowing legume species like Centrosema into grassland invaded by the two weeds may pose problems, because the possibility of allelopathic effects of the two weeds to Centrosema seeds. Therefore, this study was conducted to determine the effects of aqueous extract of Lantana and Chromolaena leaf on seed germination and seedling growth of Centrosema.

MATERIALS AND METHODS

Collection and extraction of plant materials

This study was conducted under laboratory conditions in August 2016. Fresh leaves of Lantana and Chromolaena in the vegetative growth stage and mature seeds of Centrosema were collected from plants growing naturally inside the campus of

Hasanuddin University, Indonesia. The leaves of Lantana and Chromolaena were left to dry under shade conditions for 48 hours. After drying, the leaves were ground using electric blender.. The aqueous extracts of Lantana and Chromolaena leaves were prepared by soaking 10 g of blended materials in 100 ml distilled water and kept for 24 hours at 26^{o} C. The mixtures were filtered through a layer of filter paper This extract was considered as 10% concentration. From this stock solution, a series of dilutions with distilled water was prepared to make concentrations of 2, 4 , 6, 8, and 10%. These solutions, in addition to the control (0%) were used to test their effects on germination and seedling growth of Centrosema. The leaf of both weeds were used as plant materials because preliminary study indicates the higher phytotoxic activity of leaf of both plants over their stem or root extracts (El-Kenany and El-Darier, 2013, Suwal *et al*., 2010, Rusdy *et al*, 2015).

Germination and bioassay studies

Before used, the seeds of Centrosema were immersed in sulfuric acid (96%) for 12 minutes, then rinsed and cleaned. Twenty of sulfuric acid treated seeds were placed in a Petri dish (9 cm diameter) lined with one layer of filter paper. The seeds then were treated with 7 ml of 2, 4, 6, 8 and 10% extract concentrations of the two weeds and with 7 ml of distilled water as control. The treatments were laid out in completely randomized design with four replications. Seeds were observed every day and number of germinated seeds were recorded. The seed was considered as germinated when radicle emerged from the seeds. The Petri dishes were kept undisturbed at room temperature (26 to 34^{o} C). After seven days of study, data on final germination, shoot and root length, and dry matter yield, were taken. Shoot and root length were measured using a ruler by taking five seedling per Petri dish at random. However, when number of seedling was less than five, all seedlings were used as sample. Dry matter yields were measured by weighing seedling after placing them in the oven at temperature of 100^{o} C for 24 hours.

Statistical analysis

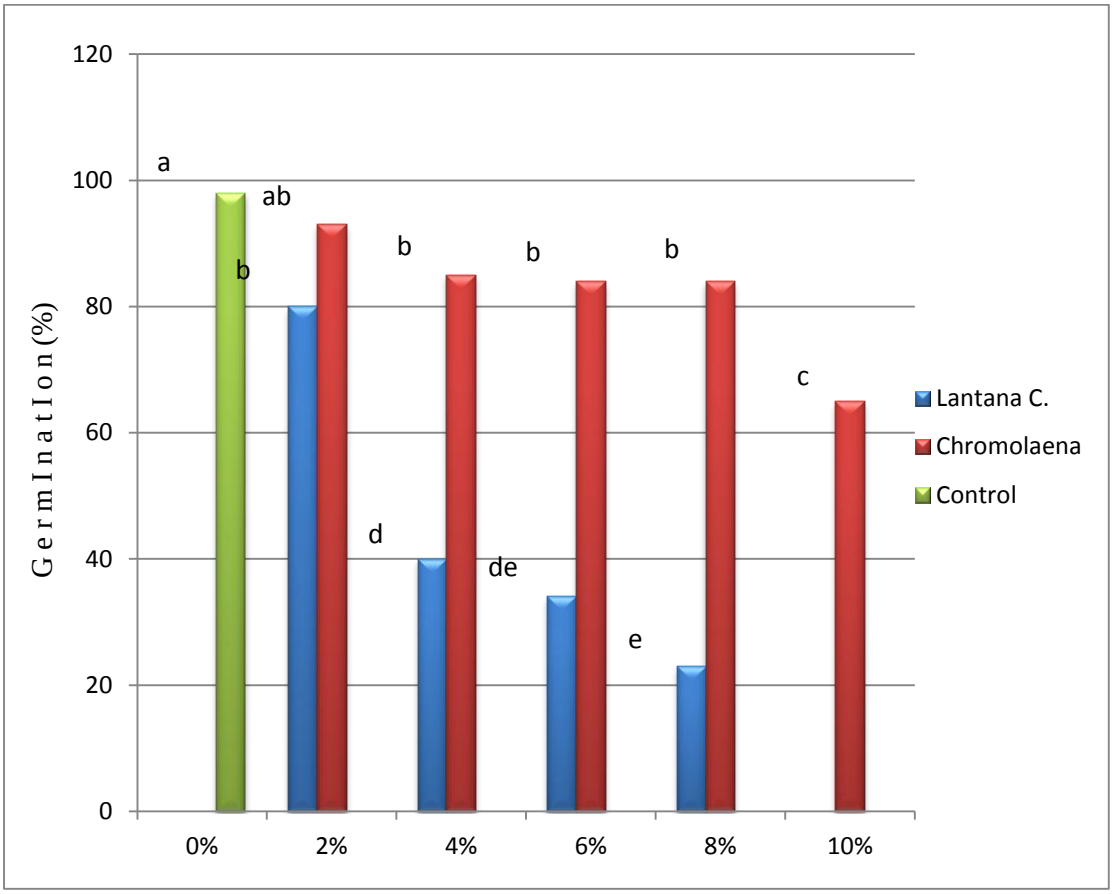
Data were analyzed according to completely randomized design using SPSS software version 17. Differences between means were separated by Least Significant Difference test.

RESULTS AND DISCUSSION

Effect of extracts of Lantana and Chromolaena on Germination

Aqueous extracts of Lantana and Chromolaena leaf exhibited allelophatic effect on

seed germination of Centrosema. (Fig.1). Phytotoxic effect of Lantana and Chromolaena on germination had been widely reported. Using Lantana extracts, similar results had been reported in *Pennisetum americanum, Setaria italica* and *Lactuca sativa* (Hussain *et al*. (2011), garden pea (*Pisum sativum*) (Kar *et al*., 2014), and *Phalaris minor* and *Sorghum bicolor* (El-Kenany and El-Darier, 2013). Reduction in seed germination as affected by Chromolaena extracts had also been reported in *Zea mays* (Devi and Dutta, 2012), *Eleusine indica, Cyperus iria* and *Ageratum conyzoides* (Sahid anf Yusoff, 2014) and paddy and barnyard grass (Suwal *et al*., 2010).



Note: Means germination of Centrosema along the row with different superscript are significant different

Figure 1: Allelopathic effect of Lantana and Chromolaena extract on germination of Centrosema

Reduction in seed germination may be attributed to the presence of allelochemicals that inhibited the process of germination. Allelochemicals in Lantana were mainly aromatic alkaloids and phenolic compounds (Ambika *et al*., 2003) while in Chromolaena were alkaloids and amino acids (Ambika and Jayachandra, 1984). Presence of some allelochemicals in the two plant extracts may prevented the growth of seed embryo or caused its death (Abugre *et al*., 2011).

Results from the present study also showed that phytotoxicity of the two weed extracts were concentration dependent, because there were increment in inhibition with increasing concentration of extract (Fig.1). This result is in agree with Fariba *et al*. (2007) that allelochemicals stimulated or inhibited plant growth depending on their concentration. Ashrafi *et al*., (2008) also reported significant reductions in the seed germination of *Amaranthus rotundus, Cirsium arvense, Digitaria sanguinalis, Sinapsis arvensis, Lactuca sativa* and *Lolium ultiforum* as *Azadirachta indica* extract concentration increased.

The bioassay study also showed that aqueous extracts of Lantana leaf at all concentration levels, induced higher allelopathic effect than aqueous extract of Chromolaena, as indicated by the lower germination of Centrosema at all Lantana extract concentrations compared to Chromolaena ectracts and by complete failure of germination at Lantana extract concentration of 10% (Fig.1). This indicates that allelochemicals from Lantana were more toxic to germination of Centrosema compared to allelochemicals from Chromolaena. However, the result from this study is different with former study (Rusdy, 2015) that Chromolaena extract more powerful than Lantana extract in reducing germination of *Leucaena leucocephala*. This indicates that toxicity of allelochemicals from the two weeds depends on kind of seeds tested. This is in line with Gao *et al*. (2009) that different crops behaved differently in their response to the aqueous extract of *Hemistepta lyrata*, demonstrating that allelopathy is a selective mechanism.

Effect of Lantana and Chromolaena extract on seedling growth

Aqueous extract of Lantana and Chromolaena reduced the shoot length and root length of Centrosema (Table 1). Reduction in shoot and root length of seedlings of certain plants as affected by aqueous extract of Lantana had been reported by El-Kenany and El-Darier (2013), Kar et al. (2014), and Hussain et al., 2011) and in Chromolaena by Suwal et al. (2010), Devi and Dutta (2012), and Sahid and Yusoof, 2014). These may be attributed to the reduced rate of cell division and cell elongation due to the presence of allelochemicals in the aqueous extracts of the two species (Buckolova, 1971).

Table 1. Effects of aqueous extract of Lantana and Chromolaena on shoot and root length and dry matter yield of Centrosema.

Concen-tration (%)	Lantana				Chromolaena			
	Shoot Length (cm)	Root length (cm)	Shoot-Root Ratio	DM yield (g/plant)	Shoot length (cm)	Root length (cm)	Shoot root ratio	DM yield (g/plant)
0%	5.75	3.37	1.70	0.06	5.75	3.37	1.70	0.06
2%	5.15	2.07	2.49	0.06	5.60	3.27	1.71	0.06
4%	4.60	1.65	2.78	0.05	5.60	3.10	1.80	0.05
6%	4.30	1.27	3.38	0.04	5.10	2.93	1.74	0.05
8%	4.20	1.07	3.92	0.03	5.00	2.65	1.88	0.04
10%	0.00	0.00	0.00	0.00	4.10	2.65	1.54	0.04
LSD (5%)	1.75	0.80	1.04	0.03	1.75	0.80	1.04	0.03

Although both extracts reduced the length of shoot and root of seedling, Lantana extract exhibited more inhibitory effect on root than on the shoot length of seedlings than Chromolaena extract. This is evidenced by increasing shoot – root ratio of seedlinsg as increasing concentration of Lantana extract levels, while in Chromolaena extract treated seeds, shoot – root ratio of seedlings tended to be constant (Table 2). This indicates that Lantana extract, besides was more powerful in reducing germination, also more powerful in reducing shoot and root length. This may be attributed to differences in nature and concentration of allelochemicals present in the two weed species.

The non-significant allelopathic effect of Chrmolaena extract on shoot and root length of Centrosema in the present study is in contrast with findings of Rusdy *et al*. (2015) who reported the significant reduction of shoot and root length of Centrosema with increasing concentration of Chromolaena extract. This may be due to higher of concentrations of Chromolaena extract they used.

Both Lantana and Chromolaena extract reduced dry matter yield of seedling of Centrosema (Table 2). The presence more allelochemicals as increasing concentration of the two weeds might had caused more reduction in dry weight in dry weight of seedling. The results is in line with Ullah *et al*. (2013) that the water extract of *Fumaria indica* and *Polygonum plabejum* caused significant inhibitory effect on dry matter yield of wheat, chickpea and lentil compared to control.

CONCLUSION

The present study clearly indicates that allelochemicals present in Lantana and Chromolaena plants have the potential to suppress germination and seedling growth of Centrosema, however, Lantana extracts are more powerful in reducing germination and seedling growth of Centrosema than Chromolaena extracts. The difference in the sensitivity of Lantana and Chromolaena extract on germination and seedling growth of Centrosema may be useful in the development of new management methods for successful introduction of Centrosema into grassland area invaded by the two weeds.

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