RESEARCH PAPER

Investigation on the Allelopathic Impact of Blanket Weed (*Galenia secunda*) as a Distributed Invasive Weed in Some Natural Grasslands

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**Abstract:**

The broad leaf perennial weed, *Galenia secunda* forms large colonies that reduced the abundance of native vegetation in many natural grasslands. Although rapid growth and prolific reproduction (both sexual and asexual) clearly contribute to its successful invasion, its might be have a strong allelopathic effects beside the competition capability on native plants. Therefore, we conducted a study to investigate the allelopathic effects of *G. secunda* weed on seed germination and seedling growth of lettuce (as a model plant test). Stem, root and leaf aqueous extracts of *G. secunda* at 0, 1, 5, 10, and 15 % concentrations were applied to determine their effect on lettuce seed germination and seedling growth under laboratory conditions. Increasing concentrations of aqueous extracts of *G. secunda* from leaf and stem inhibited seed germination and greater than 78 % of seeds were failed to germinate when the extract concentration from the leaf part was 15 %. In contrast, aqueous extracts from root had no effect on lettuce seed germination. Extracts from root and stem had a stimulatory effect on shoot length at all concentration levels, as against an inhibitory effect of leaf extracts. Root extracts at low concentration (1 and 5 %) promoted root length but aqueous extracts from leaf and stem inhibited root length. The results from this study show that *G. secunda* produces chemicals that can inhibit the growth of neighbouring plant species.

**Key Words:** Allelopathy, Aqueous extracts, Germination, Seedling growth

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**1. Introduction:**

Most plants exhibit allelopathic effects on seed germination, growth and development of other plants by releasing allelochemicals into the soil, either as exudates from living organs or by decomposition of plant residues (Singh et al. 2003; Kato Noguchi and Ino 2005; Mutlu and Ati Sangeetha and Baskar, 2015). Allelochemicals are present in almost all plants and their tissues such as leaves, stems, roots, flowers, seeds, bark, and buds (Weston and Duke 2003; Marichali et al. 2014).

Allelopathic plant interactions can have either a harmful or beneficial effect and are generally evaluated by testing some physiologic mechanisms that result in the inhibition/stimulation of seed germination, plant growth and development due to the presence of another plant (Suman et al. 2002; Weston and Duke 2003). Several classes of allelopathic substances, such as monoterpenes and phenols, are produced naturally by most plant species (Jefferson and Pennacchio, 2003).

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Those compounds are usually synthesized in the leaves, which fall to the ground during periods of stress. Rain assists with the leaching of allelopathic substances into the soil, where they may affect the germination and growth of other plants (Rice, 1974; Jefferson and Pennacchio, 2003). The influence of allelopathy on the germination and growth of plants may occur through a variety of mechanisms, including decreased activity mitotic in roots and hypocotyls, suppress hormonal activity, low absorption ion rate, preventing photosynthesis and respiration, inhibited the formation of the protein, decreased permeability of cell membranes and/or inhibiting an enzyme action (Rice 1974). Through these actions, allelopathic substances may play a role in shaping plant community structure in semi-arid and arid environments.

*Galenia secunda* (Eckl. &Zeyk) Druce (carpet weed) is a woody, prostrate perennial weed belonging to the Aizoaceae family. This species is native to South Africa (Arnold and De Wet 1993), but it has been introduced and has become well established in other regions such as California, USA (Ross 1994), southern Spain (Garcia-de-Lomas et al. 2010), central Chile (Leuenberger and Eggli 2002), and various states and territories in Australia (Prescott and Venning 1984; Carr et al. 1992; Cook 2013). 

*G. secunda* has spread fast enough to cover substantial areas within a few years in those countries and is now putting pressure on their natural resources. *G. secunda* is an aggressive colonizer of over-grazed pastures, railway sides, dry coastal vegetation, and around field crops under varied environmental conditions (Carr et al. 1992; Garcia-de-Lomas et al. 2010; Cook 2013). It has brought remarkable changes in the structural opposition and dynamics of vegetation by adversely affecting the density and diversity of natural flora and has caused substantial losses in native vegetation, and its strong competitiveness towards crop or pasture species for soil moisture and nutrients.

Several bioactive compounds have been identified in the leaves of *G. secunda*, including alkaloids, nitrates, soluble oxalates, terpenes, steroids and phenols (Williams, 1979). Nevertheless, there have been no studies of its allelopathic potential. I hypothesised that allelochemicals of *G. secunda* negatively affect germination, growth and physiological aspects of model test species. Therefore, the main goal of this study was to investigate the allelopathic effects of *G. secunda* on the seed germination and seedling growth of lettuce plant under laboratory conditions.

2. MATERIALS AND METHODS

2.1 General procedure

The *Galenia secunda* (whole mature plant) grown naturally were collected in their flowering stage from several populations during October 2015 in heavily infested field in the surrounding areas in western Melbourne, Australia (37° 49' 5.63" S 144° 34' 58.77" E), at an altitude of 66 m, to determine if this weed contained chemicals inhibitory to the germination and growth of neighbouring species. Plant materials were collected from areas considered visually homogeneous with respect to shoot density and age. All samples were placed into sealable plastic bags for transportation to the seed ecology laboratory at the faculty of science, Federation University Australia.

2.2 Extraction procedure

At laboratory all plant samples immediately separated into leaf, stem, and root parts. Each part of the plant materials were dried at room temperature (25 °C) for seven days, then the materials dried further in an oven at 70 °C for 48 h. Dry materials were cut into 2–3 cm and ground separately with a pestle and mortar. One, 5, 10, 15 and 25 g of each part of the ground plant materials were weighed and put in 250 ml volumetric flasks and filled up to 100 ml with distilled water. Samples were left at room temperature 22 C for 24 hour. These solutions were filtered through four layers of cheesecloth to remove the fiber debris and centrifuged at a low speed (3000- revolution min-1) for 4 hour and designated as 1 %, 5 %, 10 % and 15% aqueous extract, respectively, as adopted from Uddin et al. (2012).

2.3 Bioassay with aqueous extract of dry plant parts on model seeds
Lettuce (Lactuca sativa L. var. Cos) was used as a model seed to test germination response in a dilution series in extracts generated by distilled water, because of its sensitivity and hypochlorite common use in bioassay. The seeds were surface sterilised with 1% (w/v) sodium hypochlorite for 1 min and subsequently washed (three times, 3 min per wash) with sterile distilled water. Each part extract (10 mL) was placed into a sterile 9-cm Petri dish underlain with two sterile filter papers (Whatman No. 10, Whatman International, Springfield Mill, Maidstone, UK), with distilled water used as a control. Four replicates (each having 25 seeds) were used for each treatment. The Petri dishes were sealed with plastic wrap (Glad wraps) to prevent the loss of moisture and avoid contamination. The prepared dishes were placed in a germination cabinet (Thermo line Scientific and Humidity Cabinet, TRISLH-495-1-SD, Vol. 240, Australia) at 25/18°C day/night in the 12:12 light/dark condition, which were equipped with cool-white fluorescent lamps that provided a photosynthetic photon flux of 40 μmol m⁻² s⁻¹. Germination was deemed to occur only after the radicle had protruded beyond the seed coat by at least 1 mm.

2.4 Experimental design and statistical analysis

Germination and seedling growth bioassays were conducted in a complete Randomized Design (CRD) with four replications. The experiment was repeated once. The average data obtained from two experiments were subjected to analysis using Minitab 16 computer software. Means were separated using Duncan’s Multiple Range Test at P < 0.05 probability level.

3. RESULTS

3.1 Germination percentage

Allelopathic effects of different concentrations of aqueous extract, which obtained from leaf, stem, and root parts of Galenia secunda on germination percentage of lettuce seeds are shown in (figure 1). The results showed that there was a gradual decrease in the germination percentage of lettuce seeds with the increasing concentration of the leaf extract of G. secunda. As compared to the control (0%), the 15% aqueous extract of G. secunda caused the maximum reduction in the germination percentage 21.3% compare to other concentrations and other aqueous parts. Greater than 78% of seeds were failed to germinate as a result of application 15% of aqueous extract from leaf (Figure 2). Aqueous extracts from stem and root had shown no adverse effect on seed germination. Leaf extracts at lower (1% and 5%) concentration had little impact on seed germination.
**Figure (1)** The effects of different concentrations of aqueous extract (0, 1, 5, 10, and 15 %) of *Galenia secunda* obtained from leaf, stem, and root parts on the germination of lettuce seeds. Vertical bars represent ± standard error of the mean.

**Figure (2)** The effects of different concentrations of aqueous extract (0, 1, 5, 10, and 15 %) of *Galenia secunda* obtained from leaf, stem, and root parts on the germination of lettuce (un-germinated seeds). Vertical bars represent ± standard error of the mean.

*3.2 Seedling growth*
There were significant differences (P < 0.05) between treatments influencing seedling hypocotyl and radicle length (Figure 3 and 4). Root extract in low concentration (1 % and 5 %) was promoted hypocotyl length and it was slightly decreased to 12.5 mm at 10 % concentration. At 15 % concentration, the leaf and stem extracts caused the greatest reduction in hypocotyl length (1.5 mm and 3.2 mm respectively). Similarly, Aqueous extracts from root at 1% and 5 % promoted radicle length compared to control. However, aqueous extracts at all concentrations from leaf caused a marked reduction in radicle length of lettuce seedlings (Figure 4). An especially high degree of inhibition occurred with leaf extracts at the highest concentration.

(Figure 3) Influence of various concentrations of different aqueous extract made from Galenia secunda plant parts on the shoot length of 10 days old lettuce seedlings. Vertical bars represent ± standard error of the mean.
(Figure 4) The effects of different concentrations of aqueous extract (0, 1, 5, 10, and 15 %) of Galenia secunda obtained from leaf, stem, and root parts on root length of lettuce seedlings. Vertical bars represent ± standard error of the mean.

4. CONCLUSIONS

Even though the effects obtained under laboratory conditions are not necessarily significant in the field, it can be concluded that there are compounds in the tissues of G. secunda which may cause allelopathic effects also under field conditions if the compounds are released in some way. The allelopathic mechanisms might have allowed the G. secunda weed to compete strongly with associate species in fields. The types and levels of concentration of the chemicals in different parts of the weed, however, need to be established.

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