INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 3, No. 3, p. 9-14, 2013

RESEARCH PAPER OPEN ACCESS

Allelopathic effects of some Lamiaceae on seed germination and seedling growth of dodder (*Cuscuta campestris* Yunck.)

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Key words: Allelopathy, dodder, Lamiaceae, seed germination, seedling growth.

doi: http://dx.doi.org/10.12692/ijb/3.3.9-14 Article published on March 28, 2013

Abstract

Dodder (*Cuscuta campestris* Yunck.) is one of the parasitic weeds that cause yield losses of many crops and orchards. Control of this weed is very difficult. This experiment was carried out to assay the effects of different concentrations [0 (distilled water as a control), 1.25%, 2.5%, and 5% (gram powder of plant per 100 ml of distilled water)] of lavender (*Lavandula vera* DC.), rosemary (*Rosmarinus officinalis* L.), garden sage (*Salvia officinalis* L.), thyme (*Thymus vulgaris* L.), and common balm (*Melisa officinalis* L.) on dodder seed germination and seedling growth. Results showed that all of these medicinal plants had significantly effect on dodder seed germination and seedling growth. So that the highest concentration of lavender, thyme, garden sage, common balm, and rosemary, respectively; dodder seed germination was reduced 58.25%, 25.25%, 25%, 23. 5%, and 11.25%, respectively. Seedling growth of dodder was more sensitive than that of germination against extract concentration of all medicinal plant. The present study shows that the inhibitory effect of lavender aqueous extract on germination and seedling growth of dodder was more than that of other medicinal plant tested in this experiment. These results showed inhibitory effects of these medicinal plants extract on dodder seed germination and seedling growth.

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Introduction

Medicinal plants are becoming integral components of many subsistent farming systems in most developing nations of Asia due to the increasing awareness of human needs for wild indigenous plants as herbal remedies. Weeds are unwanted, undesirable and non-economic plants that compete with crops for water, nutrients and sunlight (Batish *et al.,* 2005). Weeds are responsible for the decline in crop yield. Losses caused by weeds can be as high as 24% of yield compared with 16.4 and 11.2% for disease and pest, respectively (An *et al.,* 2001). Existing weed control methods are either expensive or hazardous. Heavy use of chemical herbicides in most integrated weed management systems is a major concern since it causes serious threats to the environment, public health and increase cost of crop production.

Scientists have focused on the increase of food production needed for the fast expansion of the world's population. Weeds are the major problem in world agriculture because they cause losses in crop yields. Whenever two or more plants occupy the same niche in nature, they compete with each other for various life support requirements (Caton *et al.,* 1999). A successful establishment of a weed in any ecosystem is attributed to several reasons, such as high growth rate, high reproductive potential, adaptive nature and above all interference by resource depletion and allelopathy (Kohil and Rani, 1994).

In common definition, the allelopathy is any direct or indirect, useful or useless effects of plants on other ambient plants by germinating and growing via created chemical material and transmittal (Rice, 1984). Allelopathy is characterized by a reduction in plant emergence or growth reducing their performance in the association (Sánchez-Moreiras, 2004). Many species of weeds, as well as crop plants, are known to be allelopathic. Allelochemicals are secondary metabolites present as soluble compounds or in a volatile state in different plant organs (Rice, 1984).

Allelochemicals may be used to develop new tools to combat the evolution of herbicide resistance in weeds (Anjum and Bajwa, 2005). An equally promising way to use allelopathy in weed control is using extracts of allelopathic plants as herbicides (Singh *et al.*, 2005). Because biosynthesized herbicides are easily biodegradable, they are believed to be much safer than synthesized herbicides (Duke *et al.,* 2000). Many authors reported employ plants extracts for controlling weeds with variable success (Hussain *et al.*, 2007; Iqbal *et al.*, 2009; Naseem *et al.*, 2009).

Materials and methods

A factorial experiment in completely randomized block design with four replications was conducted under laboratory conditions to evaluate the effects of some medicinal plants [lavender (*Lavandula vera* DC.), rosemary (*Rosmarinus officinalis* L.), garden sage (*Salvia officinalis* L.), thyme (*Thymus vulgaris* L.), and common balm (*Melisa officinalis* L.)] on seed germination and seedling growth of dodder (*Cuscuta campestris* Yunck.), in the University of Tehran in Iran.

Different concentration of medicinal plant prepared as, 1.5, 2.5, 3.75 and 5 g powder of those plants soluble in 100 ml distilled water and shaken for 24 hours by a horizontal rotary shaker in room temperature. In this experiment, 50 seeds of dodder were placed on Whatman filter paper in 9 cm petri dishes. Four ml of distilled water (control) and final aqueous extract concentrations of medicinal plants were added to each petri dish. Their solutions were applied where required during the course of experiment. Then, their petri dishes were incubated at 20±°C and germinated seeds (protrusion of radicle by 2 mm) were counted every day up to 7 days. Then percentage of germination was determined by Ellis and Roberts (1981) method.

At the end of test, length and fresh weight of seedling were measured. Seedlings of each sample were then dried in an oven at 80 °C for 24 hours (Perry, 1977)

and mean dry weight of seedling for each treatment at each replicate was determined.

Percentage inhibition or stimulation of germination was calculated according to according to the following equation:

$$Inhibition\ (-)\ or\ Stimulation\ (+) = \frac{GST - GSC}{GSC} \times 100$$

Where GST is germination seeds in treatments (different concentrations of medicinal plants) and GSC is germination seeds in control.

All the data were analyzed on the basis of experimental design, using SPSS-16 software. The means of each trait were compared according to Duncan multiple range test at P≤0.05 and standard error values. Excel software was used to draw figures.

Results and discussion

Extract concentration of all medicinal plant differently decreased germination percentage of dodder seeds (Fig. 1). Extract of lavender had the most effect on germination, as germination percentage of dodder declined from 80.5% up to 22.25%. In contrast, germination percentage of this parasitic weed had high tolerance against extract of Melisa, as only highest concentration (5%) of this medicinal plant was significantly reduced germination percentage of dodder. In total, aqueous extract concentrations of these medicinal plants had inhibitory effect on germination percentage of dodder, so that in lowest concentration (1.25%) of lavender, thyme, garden sage, rosemary, and common balm, 27.02%, 13.98%, 7.14%, 1.55%, and 0.62% reduction was observed, respectively (Fig. 2a). Also, in the highest concentration (5%) of these plants, 72.36%, 31.37%, 31.06%, and 13.98% inhibition was observed (Fig. 2d). In medial and high concentrations (2.5% and 3.75%), maximum and minimum inhibition was observed in the presence of lavender and common balm plants extract, respectively (Fig. 2b & 2c). These results indicated that the inhibitory effects of these medicinal plants are differently among species. An *et al.,* (2001) described seed germination as evaluable index in allelopathic studies. Exposure of seeds to one or combined influence of organic compounds such as phenolic acids, alkaloids and volatile terpenes in the extracts or essential oils of different medicinal species often results in negative physiological effects on the germination and seedling growth (Mungole *et al.,* 2010). During germination, the action of gibberellic acid which induces the production of α-amylase is disrupted by the phytotoxic chemicals (Aghajanzadeh *et al.,* 2007).

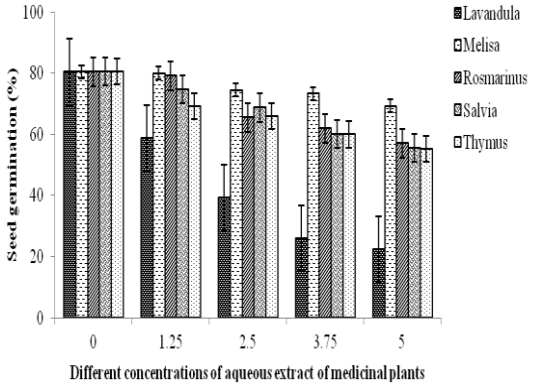

Fig. 1. Seed germination of dodder (*C. campestris* Yunck.) affected by different concentrations of aqueous extract of lavender (L. vera DC.), rosemary (*R. officinalis* L.), garden sage (*S. officinalis* L.), thyme (*T. vulgaris* L.), and common balm (*M. officinalis* L.)

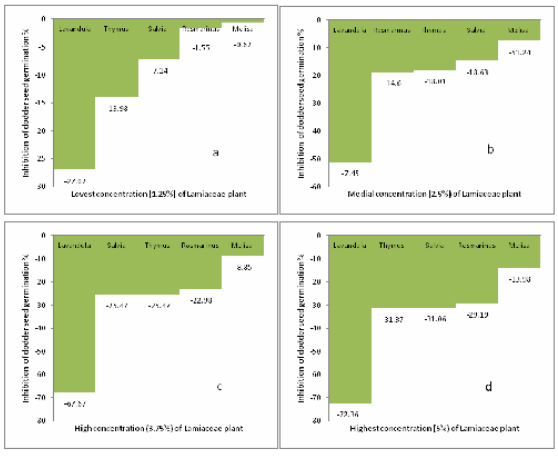

Fig. 2. Inhibitory effects of lavender (*L. vera* DC.), rosemary (*R. officinalis* L.), garden sage (*S. officinalis* L.), thyme (*T. vulgaris* L.), and common balm (*M. officinalis* L.) in different concentrations against seed germination of dodder (*C. campestris* Yunck.)

All medicinal plants in this experiment, significantly reduced seedling length of dodder (Fig. 3). Especially extract concentration of 2.5% until 5% had the most effect on seedling length. Lavender and thyme aqueous extracts, respectively had maximum and minimum effect of seedling growth of dodder. As a result, seedling growth of this parasitic weed was more sensitive to allelochemical in compared to germination. These observations conform to Hegazy and Fadl-Allah (1995) who reported that the impact of allelopathic plant extracts on seedling growth is more important than seed germination. Similarly Smith and Martin (1994) and Ben-Hammouda *et al.* (1995) found aqueous extracts of several species have suppressed seedling growth in target plants more than seed germination.

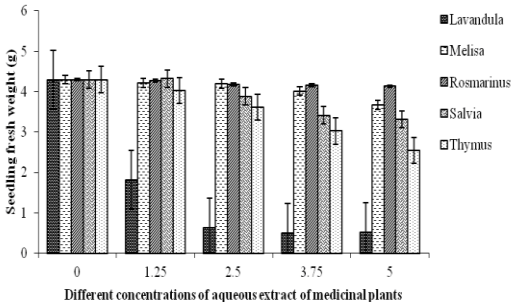

Fig. 3. Seedling fresh weight of dodder (*C. campestris* Yunck.) affected by different concentrations of aqueous extract of lavender (*L. vera* DC.), rosemary (*R. officinalis* L.), garden sage (*S. officinalis* L.), thyme (*T. vulgaris* L.), and common balm (*M. officinalis* L.)

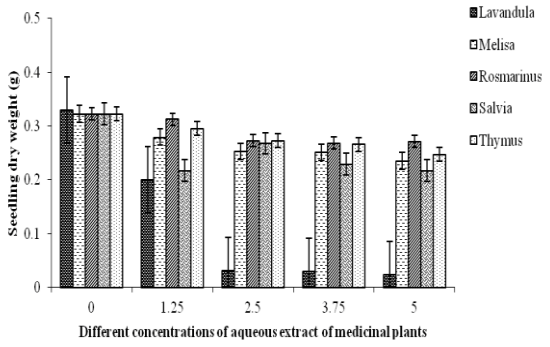

Fig. 4. Seedling dry weight of dodder (*C. campestris* Yunck.) affected by different concentrations of aqueous extract of lavender (*L. vera* DC.), rosemary (*R. officinalis* L.), garden sage (*S. officinalis* L.), thyme (*T. vulgaris* L.) and common balm (*M. officinalis* L.)

The effects of different concentrations of aqueous extract on seedling fresh (Fig. 4) and dry (Fig. 5) weight of dodder in some case was not significant. In both qualities, extract of lavender had the most effect on dodder. Fresh weight of this weed in 3.75 and 5%, and dry weight of that in 2.5, 3.75 and 5% of extract concentrations and of garden sage were significantly inhibited. Obviously, the degree of inhibition increased as the concentration increased. A number of previous studies have suggested that the degree of inhibition increases with increasing extract concentrations (Laosinwattana *et al.,* 2009 and 2010; Teerarak *et al.,* 2010). There is no common mode of action or physiological target site for all allelochemicals. However, known sites of action for some allelochemicals include cell division, pollen germination, nutrient uptake, photosynthesis, and specific enzyme function. Cell growth in plants depends upon normal mitotic processes. Following DNA synthesis, mitosis and cytokinesis occur. Cell division is a continuous process that occurs in plant meristematic regions (Singh, 2001). In conclusion, the present study shows that the inhibitory effect of lavender aqueous extract on germination and seedling growth of dodder was more than that of other medicinal plant tested in this experiment.

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