



**Biological activity of *Medicago sativa* L. (alfalfa) residues on germination efficiency, growth and nutrient uptake of *Lycopersicon esculentum* L. (tomato) seedlings**

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Received March 3<sup>rd</sup> 2011 Revised April 20<sup>th</sup> 2011 Accepted April 22<sup>nd</sup> 2011

**Abstract**

Aqueous extract (MSAE) and crude powder (MSCP) of *Medicago sativa* demonstrated inhibitory effects on seed germination, growth and the nutrient uptake of *Lycopersicon esculentum*. The results showed that the extracts brought about considerable inhibition in the germination of tomato seeds and in plumule and radicle length. The allelopathic effect of *Medicago sativa* decreased the germination percentage (GP) of tomato seeds aggravating phytotoxicity (PT) or inhibition percentage with the increase in extract concentration. The extracts also reduced the phytomass of leaves, stems and roots of tomato seedling. The uptake of N, P and K was highly affected and varied drastically by MSCP application. This study revealed that the inhibitory effect of MSAE and MSCP might be due to the presence of some allelochemicals which need further investigation.

**Keywords:** Dry matter, germination, *Lycopersicon esculentum*, *Medicago sativa*, nutrient content, phytotoxicity.

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## Introduction

Allelopathy which is regarded as a bio-chemical warfare is a natural process involving positive or negative influence of one plant on another through the release of allelochemicals (allelopathins) which are specific biomolecules released mainly through root exudation and biomass decomposition [1, 2] and are recognized to be phytotoxic [3, 4].

Applied allelopathy is believed to have the potential of being of great help for the management of agroecosystems [5]. It has been applied in several agricultural practices, such as cropping systems, weed control, intercropping, nutrient recycling, and low-external input farming practices [6]. Chemicals from the growth of adjacent plants, and therefore the role of allelochemicals in agro-ecosystem have attracted the attention of numerous scientists. Recently, researches demonstrated critical cases of seed and growth inhibition, nutrient uptake and biomass reduction by allelochemicals that influenced crop productivity [7, 8, 9, 10]. Those phytochemicals alter the growth or physiological functions that encounter them during growth. Previous assertion has been suggested that allelochemicals inhibit plant growth by blocking of nutrient reserve, cell division, cell differentiation, ion and water uptake, water stress, phytohormon metabolism, respiration, photosynthesis, enzyme function, signal transduction, as well as gene expression [11,12] thereby caused significant reduction in the growth of plumule and radicle of many crops [13,14].

Alfalfa has been shown to have suppressive effects on both its own species (autotoxicity) and different species (heterotoxicity) which is commonly used in forage crop systems. Saponins (glycosides) are being responsible for alfalfa heterotoxicity and have potential as herbicides [15]. Experimentally, alfalfa root exudates severely inhibited the dry weight of barley (*Hordeum vulgare*) and radish (*Raphanus sativus*) seedlings [16]. Additionally, the aqueous extracts of alfalfa herbage inhibited seed germination and seedling growth of dicotyledonous species more than monocotyledonous ones [17]. Furthermore, the addition of aqueous extract of alfalfa strongly affects the germination efficiency and growth characters of *lepidium sativum* [18].

The main objective of the current study was to investigate the possible allelopathic effects of alfalfa (*Medicago sativa* L., Family: Fabaceae) crop residues on germination, growth and nutrient uptake of tomato (*Lycopersicon esculentum* Mill., Family: Solanaceae).

## Materials & Methods

Field observations were set up during summer 2009 and extended to the next season during 2010 in an area of 6.3 hectare cultivated with tomato in traditional cropping systems after harvesting of alfalfa at El-Hammam region; about 75 km southwest of Alexandria city. These observations have confirmed that the performance of this crop species followed alfalfa residues was severely affected.

## 1. Preparation of *Medicago sativa* aqueous extract

Fresh complete samples (Aerial shoots + roots) of alfalfa were collected from natural agro-fields in summer 2009. The samples were air-dried then cut into 0.5 – 1 cm pieces. Stock aqueous extract was obtained by soaking air-dried plant material in 10% (w/v) distilled water at room temperature (20 ±2°C) for 24 hours with occasional shaking. The mixture was filtered through Whatman No. 1 filter paper and the purified extract was adjusted to pH 6.8 with 1M HCl. Subsequent dilutions (1, 2, 4 and 8%) were prepared from the stock solution in addition to the control (distilled water).

## 2. Germination bioassay

Twenty five seeds of tomato were arranged in 9-cm diameter Petri-dishes lined with two discs of Whatman No.1 filter paper under normal laboratory conditions with day temperature ranging from 19-22°C and night temperature from 12-14°C. 10 cm of each level of the alfalfa extract (1, 2, 4 and 8%) were added daily to three replicates. Before sowing, the seeds were surface sterilized with 2% sodium hypochlorite for 2 minutes then rinsed four times with distilled water. The sterilized seeds were soaked in aerated distilled water for 24 hours. Germination percentage (GP), plumule (PL) and radicle (RL) length were recorded after 15 days at the end of the experiment. Seed germination index (SGI) was calculated according to the following equation [19].

$$SGI = \sum Ti Ni / S$$

Where,

Ti = is the number of days after sowing

Ni = is the number of seeds germinated on day i

S = is the total number of seeds planted

Likewise, phytotoxicity (PT) of the target species extract was expressed as a percentage of growth (germination) of the test species in different concentration levels with respect to water control. Higher values indicate lower toxicity [20].

$$\text{Phytotoxicity (PT)} = [1 - (\text{allelopathic/control}) 100]$$

## 3. Pot experiment

Pot experiment was carried out to test the effect of different concentrations of *Medicago sativa* crude powder (MSCP) (w/w) on dry matter accumulation, nutrient concentration and uptake in sandy loam soil. Seeds of tomato were obtained from the Breeding Program of the Agricultural Research Center, Giza, Egypt. Ten seeds from the investigated species were sown in plastic pots (diameter 20cm x height 22cm) with sandy loam soil completely mixed with electrically crushed crude powder of alfalfa plant (w/w) make available the alfalfa crude powder (MSCP) concentrations of 1, 2, 4 and 8%. The experiment was performed under normal laboratory conditions with day temperature ranging from 19 -22°C, light duration was 12 hours and light intensity was 1350 foot-candle

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