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Allelopathic Effects of Plant Extracts Against Seed Germination of Some Weeds

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Abstract: In this study, mostly weeds, the effect of 22 plant's extracts on germination of seeds from nine different weeds was investigated. Plants used were sampled with their leaves and flowers, in 2002, then plant extracts were obtained after they were ground and processed with methanol. The experiments were conducted in 9 cm diameter sterile petri dishes inside covered with sterile filter paper. Fifty seeds were placed in each of petri dishes. Acetone (10%) was used as the control. The seeds germinated were taken out from the petri dishes and counted in every three day during 21 days. *Lepidium sativum* L. was very slightly affected by the extracts. All the weeds extracts except *Lolium temulentum* L. were stimulated the seed germination of *Descurania sophia* L. Webb. Ex. Prant. at a different levels. Germination of *Lolium perenne* L. were inhibited most strongly by *Salvia officinalis* L., *Laurus nobilus* L. and *Artemisia vulgaris* L. The extracts of all the plants studied inhibited the germination of *Abutilon theophrastii* Medik, *Amaranthus retroflexus* L., *Avena sterilis* L., *Rumex crispus* L. and *Trifolium repens* L. It was concluded that some of these extracts may be used as herbicide to control the germination and growth of some other weeds.

Key words: Plant extract, allelopathy, weed, seed germination

INTRODUCTION

Weeds harm crops, competing them for water, nutrients and light. Unless protected, while the diseases cause 16.4% and pests 11.2% of the yield to be loss, the losses caused by weeds can be as high as 24%[1]. Many different sort of chemicals are being used to decrease these losses. However, these application of chemicals bring about some undesired side effects. Today, many researches have been conducted to develop environmentally sound plant protection methods.

Weed can affect the crops by allelopathic effect as well as they compete them for water, nutrients and light. When these two effects occur concomitantly, the harm caused becomes even greater.

Allelopathy is one plant's directly affecting another plant's growth either positively or negatively, exuding chemical substances[2]. Many phytotoxic chemical substances are known to be exuded by plants to suppress emergence or growth of the other plants. Some over 10 thousand chemicals are estimated to be produced by the plants to protect themselves against, deceases, pests and other plants, especially weeds. As the knowledge on these substances advances, these substances may be used as herbicide, which will be very beneficial for environment. The weeds have allelopathic superiority over crops besides their competition superiority. In allelopathy, relations between weeds and crops, between weeds and weeds and between crops and crops are been examined and the means to benefit from these relations have been studied[2-4]. Chon *et al.*[5] found that extracts of *Lactuca sativa* L., *Xanthium occidentale* L. and *Cirsium japonicum* DC inhibited root growth of *Medicago sativa* L. In another study[6], water extracts of *Eucalyptus cameldulensis* Dehn., *Juglandis regio*, L., *Melia azederanch* L., *Nerium oleander* L., *Raphanus sativus* L. and *Thymus* sp. showed no adverse effect on corn growth under field conditions. Especially, residue of *N. oleander* and *M. azederach* increased corn yield and decreased weed courage area.

Amaranthus retroflexus L., *Abutilion theophrastii* Medik. are weeds abundant in Turkey, especially in the areas where summer crops are grown[7]. *A. retroflexus* is characterized among allelopathic effective-weeds[8]. The plant extracts of *M. sativa* inhibit emergence of weeds such as *Chenopodium album* L., *A. retroflexus*, *A. theophrastii* and *Setaria faberi* L.[9]. However, Turk *et al.*[10] found that plant extracts of *Brassica nigra* L. affected the germination and growth of *M. sativa*, indicating that some plants known allelopathic-effective can be affected negatively by other plants.

Just as in the World, *Lolium multiflorium* L., *Descurania sophia* L., Webb. Ex. Prant, *Avena sterilis* L.

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and *Trifolium repens* L. are predominant weed species in Turkey occurring in winter time in small grain production areas[11-13]. These weeds are presumed to antagonize growth of crops, by their competitive and allelopathic effects. To know their natural enemies may help decrease their harm and better control these weeds.

In this study, the effect of the extracts of 22 plants, mostly weeds, on emergence of seeds of nine weeds was studied under in vitro conditions and potential use of allelopathy to decrease the harmful effects of these weeds was investigated.

MATERIALS AND METHODS

Sampling of plant materials and preparation of extracts: Weed species were sampled from different parts of Tokat during flowering or fruit development stages between May and August, 2002 (Table 1). All the weed materials were dried, ground and stored in dark condition at room temperature in the glass jars until use. To obtain extracts, 100 g ground materials from each weed species were placed in a 1000 mL flask containing 600 mL absolute methanol and shacked for 24 h on an orbital shaker (120 rpm) at room temperature. The extract was filtered through a four-layer cheesecloth to separate solid materials.

The methanol was evaporated at 32°C by use of ratory evaporator and then solid phase was dissolved in 10% acetone to obtain 10% concentration of each extract. Single concentration (10%) of each extract was used for the germination tests.

Germination tests: Germinations tests were carried out with each of the weed extracts. Seeds of 9 weeds (Table 2) were surface sterilized with 10:1 water/bleach solution for 2 min before soaking into 10% extracts and then seeds were dried on laboratory benches before being evenly placed on steril watman No:10 filter papers in 9 cm petri dishes. Acetone (10%) was used as the control. Based on seed size, 50 seeds were placed per petri dishes.

Treatments were arranged in a completely randomized design with four replications. The experiments were repeated twice. Wild out, poison hemlock, fixweed, curly dock, garden cress, white clover seeds were incubated at 15°C and other seeds were incubated at 24°C in the growth chamber for 21 days.

Germination was determined by counting and removing germinated seeds at 3 day intervals over a 21 day period and expressed as total percent germinated. Seeds were considered to be germinated when the radicle and hypocotyl length was over 2 mm.

Table 1: Plant species used for extraction

Latin name	Family	Common name
Artemisia vulgaris L.	Asteraceae	Mugwort
Avena sterilis L.	Poaceae	Wild oat
Bifora radians Bieb.	Apiaceae	Bifora
Chenopodium album L.	Chenopodiaceae	Common lamb's quarters
Conium maculatum L.	Apiaceae	Poison hemlock
Consolida regalis SF. Gray.	Ranunculaceae	Forking larkspur
Datura stramonium L.	Solanaceae	Jimson weed
Ecbalium elatorium (L.) A. Rich	Cucurbitaceae	Squirting cucumber
Galium aparine L.	Rubiaceae	Catchweed bedstraw
Glycyrrhiza glabra L	Fabaceae	Liquorice plant
Humulus lupunus L.	Cannabaceae	Hops
Hypericum perforatum L.	Guttiferae	St. john'swort
Laurus nobilus L.	Lauraceae	Bay laurel
Lolium temulentum L.	Poaceae	Italian rye grass
Matricaria chamomilla L.	Asteraceae	Common chamomille
Nerium oleander L.	Apocynaceae	Common oleander
Reseda lutea L.	Resedaceae	Yellow mignonette
Rubia tinctoria L.	Rubiaceae	Dyer's madder
Salvia officinalis L.	Labiatea	Broadleaf sage
Solanum nigrum L.	Solanaceae	Black night shade
Sorghum halepense (L.) Pers.	Poaceae	Johnson grass
Urtica urens L.	Urticaceae	Burning nettle

Table 2: List of the plants used in germination tests

Latin name	Family	Common name
Abutilon theophrastii Medik.	Malvaceae	Velvetleaf
Amaranthus retroflexus L.	Amaranthaceae	Redroot pigweed
Avena sterilis L.	Poaceae	Wild oat
Conium maculatum L.	Apiaceae	Poison hemlock
Descurania sophia (L.) Webb. Ex Prant	Brassicaceae	Fixweed
Lepidium sativum L.	Brassicaceae	Garden cress
Lolium perenne L.	Poaceae	English rye grass
Rumex crispus L.	Polygonaceae	Curly dock
Trifolium repens L.	Fabaceae	White clover

Statistical analysis: The data were analysed using Analysis of Variance (ANOVA) test. The means of treatments were grouped on the basis of least significant difference (LSD) at the 0.05 probability level. The software SAS was used to conduct all the statistical analysis.

RESULTS AND DISCUSSION

The effects of plant extracts on germination of some weeds after 6 and 21 days are given in Table 3 and 4, respectively.

In all the plant extracts, the inhibition rate of seed germination was time dependent but relatively parallel. However, compared with control, the 6th day germination rate was lower than that of 21 day, that is those extracts inhibiting the germination, delayed the start of germination, too. No extracts occurred to have an effect on germination of *Lepidium sativum* L. a crop that sometimes considered as a weed. *Salvia officinalis* L., *Laurus nobilus* L. and *Artemisia vulgaris* L. most strongly inhibited the germination of *Lolium prenne* L. Malkani *et al.*[14] reported that the plant extracts of

Table 3: Effects of plants extracts on seed germination on experimental weeds at the end of 6 day incubation period (%)

Weed species	*A. theophrastii*	*A. retroflexus*	*A. sterilis*	*C. maculatum*	*D. sophia*	*L. sativum*	*L. perenne*	*R. crispus*	*T. repens*
Control	24.5	30.5	19.5	0.0	37.0	99.5	96.0	1.5	0.0
A. vulgaris	68.5	45.0	22.0	0.0	95.5	95.5	68.5	0.0	0.0
A. sterilis	7.5	21.0	0.0	0.0	80.5	97.5	61.0	0.0	0.0
B. radians	7.5	37.5	0.0	0.0	92.0	95.0	17.0	0.0	0.0
C. album	52.5	53.5	6.0	0.0	98.5	99.0	80.5	0.0	0.0
C. maculatum	4.5	7.5	0.0	0.0	85.0	85.5	8.0	0.0	0.0
C. regalis	6.0	27.0	0.0	0.0	48.5	85.5	45.0	0.0	0.0
D. stramonium	41.0	80.0	1.0	0.0	87.5	99.0	77.0	11.5	0.0
E. elatorium	0.5	45.0	59.0	0.0	99.0	99.5	54.5	0.0	0.0
G. aparine	9.5	11.5	0.0	0.0	59.5	74.0	51.0	0.0	0.0
G. glabra	2.0	50.0	0.0	0.0	54.5	90.0	61.5	0.0	0.0
H.lupulus	1.5	80.0	6.0	0.0	70.0	77.5	68.0	0.0	0.0
H. perforatum	2.0	71.5	22.0	0.0	53.0	98.5	87.0	0.0	0.0
L. nobilus	23.0	47.0	0.0	0.0	75.0	100.0	35.0	14.5	0.0
L. temulentum	11.0	10.5	0.0	0.0	34.5	96.5	59.0	0.0	0.0
M. chamomilla	35.0	37.0	0.0	0.0	48.0	97.5	71.5	0.0	0.0
N.oleander	24.5	68.0	40.0	0.0	48.5	100.0	72.5	0.0	0.0
R. lutea	35.0	55.5	2.0	0.0	69.0	98.5	59.0	7.5	0.0
R. tinctoria	29.0	73.0	0.5	0.0	69.0	100.0	72.5	10.0	0.0
S. officinalis	0.5	45.5	44.0	0.0	88.5	97.0	57.5	0.0	0.0
S. nigrum	7.0	35.0	0.0	0.0	92.5	99.0	40.5	0.0	0.0
S. halepense	6.0	62.0	51.0	0.0	72.5	91.5	66.0	0.0	0.0
U. urens	10.0	10.5	0.0	0.0	73.5	75.5	59.0	0.0	0.0
LSD (0.05)	9.0487	14.694	11.359	0.0	14.797	11.09	14.466	2.8605	0.0

Table 4: Effects of plants extracts on seed germination on experimental weeds at the end of 21 day incubation period (%)

Weed species	*A. theophrastii*	*A. retroflexus*	*A. sterilis*	*C. maculatum*	*D. sophia*	*L. sativum*	*L. perenne*	*R. crispus*	*T. repens*
Control	24.5	100.0	90.0	34.0	54.0	100.0	96.0	45.0	19.5
A. vulgaris	2.5	59.5	76.0	29.5	100.0	100.0	75.5	5.5	6.0
A. sterilis	8.5	26.0	51.0	41.5	90.5	100.0	88.0	3.0	9.5
B. radians	15.0	36.5	47.0	41.0	96.5	100.0	79.0	3.0	0.0
C. album	58.0	96.0	74.0	25.5	97.5	100.0	86.0	16.5	17.5
C. maculatum	17.0	19.5	76.0	36.0	88.5	98.5	79.0	7.5	10.5
C. regalis	15.0	31.0	20.0	12.5	56.5	94.5	81.5	4.0	8.5
D. stramonium	42.5	80.5	69.0	26.0	87.5	100.0	88.0	48.5	14.5
E. elatorium	1.0	64.5	73.0	24.5	100.0	100.0	78.0	6.0	1.0
G. aparine	13.0	13.0	54.0	18.0	58.5	100.0	81.0	10.5	9.0
G. glabra	2.5	62.5	88.0	18.5	70.0	98.5	79.5	3.5	7.5
H.lupulus	3.0	89.5	44.0	22.5	73.0	93.5	82.5	5.5	9.0
H. perforatum	2.0	92.5	80.0	8.5	73.0	98.5	92.0	11.5	6.0
L. nobilus	22.5	57.5	55.0	20.0	86.0	100.0	73.0	16.0	10.5
L. temulentum	14.0	12.5	34.0	20.5	43.0	98.5	84.0	7.0	18.0
M. chamomilla	32.5	97.5	62.5	32.5	51.0	100.0	76.0	4.7	17.0
N.oleander	36.0	96.5	67.0	28.0	57.0	100.0	81.5	15.0	17.0
R. lutea	46.0	74.5	80.0	14.5	66.0	98.5.	69.5	17.5	3.5
R. tinctoria	30.0	75.0	80.0	16.0	85.0	98.0	84.5	16.5	7.5
S. officinalis	2.0	58.5	75.0	24.0	90.5	100.0	60.0	4.5	6.5
S. nigrum	12.5	40.5	63.0	48.5	95.5	100.0	81.5	4.0	3.0
S. halepense	7.5	81.5	89.0	33.0	74.0	98.0	77.5	7.5	3.0
U. urens	14.0	14.5	65.0	42.0	74.5	100.0	89.0	12.5	11.5
LSD (0.05)	6.6927	10.163	11.814	9.5868	11.888	7.5556	9.6553	9.322	6.0068

Artemisia vulgaris and its soil where it was grown inhibited the growth of *Lolium prenne* L. In the present study, extracts of *Chenopodium album* L. and *Reseda lutea* L. promoted the germination of *Abutilon theophrastii* Medik. The other extracts inhibited germination of *A. theophrastii* and then the lowest germination rate (1%) occurred in the plates treated with extract of *Ecbalium elatorium* L. A. Rich. In previous studies, it was reported that the growth of *Amaranthus refroflexus* L. was inhibited by the rhizom of *Sorghum halepense* L. Pers. extracts[15] and plant of *Cyperus esculentus* L. extracts[16]. In this study, germination *A. retroflexus* was strongly inhibited by the extracts of *Galium aparine* L. (13%), *Lolium temulentum* L. (12.5%), *Conium maculatum* L. (19.5%) and *Avena sterilis* L. (26%).

Allelopathy is some plant's affecting the others, either positively or negatively, by exuding chemicals[2]. Compared with the control, all the extracts used in this study, except *Lolium temulentum* L., promoted emergence of *Descurania sophia* L. Webb. Ex. Prant. Uygur and Iskenderoglu[6] reported that the residues of *Nerium oleander* L. and *Melia azederach* L. encouraged growth of corn although they decreased the area covered by the weeds. Some plants can exhibit both positive and negative allelopathy. For example, while *S. halepense*

inhibits growth of corn, okra, tomato and carrot[17,18]; extracts of *Raphanus sativus* inhibits seed germination and rhizom growth of *S. halepense*[19], suggesting that plants may not affect each other's growth negatively, but sometimes positively. In some other studies, it was reported that extracts of *A. retroflexus* and *C. album* stimulated growth of *Lepinus albus* and *Zea mays*[6, 20]. In this study, compared to control, some decreases occurred in germination of *Avena sterilis*, *Rumex crispus* and *Trifolium repens*.

A. sterilis is a predominant weed with economical damage threshold of 4-5 plant m^2 in wheat, barley and onion production areas in Turkey[7,12]. Compared with control, germination of *A. sterilis* seeds was significantly decreased by the *Consolida regalis* S.F Gray (20%), L. *tumelentum* (34%) and *Humulus lupulus* L. (44%) extracts.

Results of present study and previous works show that use of plant extracts as herbicides to control the weeds will bring a great success in this area. Moreover, the positive allelopathic effects should also be investigated to exploit its benefit in crop production.

This study examined the effects of extracts of plants, mostly weeds, on germination of weeds in laboratory conditions. Other studies should be conducted with the same plants, used in this study, in pot and field conditions. Also, chemical compounds in extracts, having significant positive or negative allopathic effects on other plants, should be studied in detail for their specific effects on plant growth.

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