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Germination of Barley as Affected by the Allelopathy of *Sisymbrium irio* L. and *Descurainia sophia* (L.) Schur

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***Abstract*—**An experiment was conducted under controlled conditions to study the effect of water extract of leaves, shoots and roots of either *Sisymbrium irio* L. =SISIR and or *Descurainia sophia* (L.) Schur =DESSO on the germination and primary growth of barley. A split-split plot experiment in CRD with three replications was used. The main plots were the type of weed: i.e. SISIR and DESSO and the sub-plots were type of organ: i.e. leaf, stem and root and, the sub-sub plots were concentration of the water extract of each organ of the weeds: i.e. 0, 2, 4 and 8 % w/v. The results showed that the SISIR water extracts had a greater inhibitory effects on the germination and primary growth of barley than those of DESSO water extracts. The water extracts of the leaves of both weeds had the greatest inhibitory effects on the germination and primary growth of barley, compared to those of stems and roots. Increasing the concentration of water extracts of leaves, stems and roots of both weeds up to 8 % caused the greatest inhibitory effects to barley and reduced the germination rate and primary growth of it linearly.

***Keywords*—**Allelopathy, barley, DESSO, SISIR

I. Introduction

PLANTS live together in communities composed of one or more species, with the possibility for allelopathic communication between individuals. This means that the growth of plants and their organs may be affected by a variety of compounds released from other plants into the environment. The release of active substances can be the result of at least four different processes: volatilization, decomposition, leaching of plant residues in the soil, and root exudation. These released metabolites can inhibit or delay germination and also inhibit or stimulate the growth of roots and shoots of neighboring plants [1].

Generally, interactions between plants are called interference and include positive, negative, and neutral effects on each other [2]-[3]-[4]. Interference has two components: competition and allelopathy. Competition between weeds and crops occurs when some factors, such as water, nutrients, or sunlight is insufficient to meet the needs of both the weed and the desired plant [5]- [6]- [7]. Weeds can also affect a crop's growth by releasing allelochemicals into the growing environment. All plant parts of the weed including leaf, stem, root, and fruit have allelopathic potential. However, various parts of weeds show different behavior in exerting their allelopathic effects on crops. Weeds also exert allelopathic effects on crop seed germination and growth by releasing water-soluble compounds into the soil [8]-[9].

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Many phytotoxic chemical substances are known to be exuded by plants to suppress emergence or growth of the other plants. Some over ten thousand chemicals are estimated to be produced by the plants to protect themselves against, diseases, 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 [6].

Allelopathy is defined as the direct or indirect harmful or beneficial effects of one plant on another through the production of chemical compounds that escape into the environment. The term allelopathy was coined by Molisch (1937) to refer to biochemical interactions between all types of plants, including microorganisms [10]. Many of the phytotoxic substances, allelochemicals, that are suspected of causing germination and growth inhibition have been identified from plant tissues and soils [11]-[12]-[13]. These compounds usually are called secondary plant products or waste products of the main metabolic pathways in plants [14]-[15]-[16]. Allelopathy and autotoxicity are influenced by many environmental factors. Allelochemicals may be transported through the soil and can be transformed, metabolized, or become bound to organic matter during this process. Inconsistent allelopathic effects suggest that the severity and duration of field autotoxicity may vary with environment and geographic location [17] and can severely affect crop survival and productivity [18]. Allelochemicals produced by plants may be released into the surrounding environment in sufficient amounts with enough persistence to affect neighboring and succession species [19]-[20]. Two common winter weed species occurring in small grain production areas are SISIR and DESSO. These weeds are presumed to antagonize growth of crops, by their competitive and allelopathic effects. In the present study, we tried to compare the allelopathic effects of water extracts of different plant parts on the germination and primary growth of barley.

II. Materials and Methods

A pot experiment was conducted under laboratory conditions at the College of Agricultural Sciences, Islamic Azad University, Shiraz, Iran in 2009. A split-split plot experiment in CRD with three replications was used. The main plots were the type of weed: i.e. SISIR and DESSO, the sub-plots were type of organ: i.e. leaf, stem and root and the sub-sub plots were concentrations of the water extracts of each organ of the weeds: i.e. 0, 2, 4 and 8 % w/v. The

plant materials cut in 2-3cm pieces and dried then were ground in a blender. The crushed materials were weighed according to experimental protocol and the final volume was reached to 100 ml in distilled water in dark bottles. All bottles were put on a shaker for 24 hours. The solutions were filtered by muslin cloth. Whatman paper , 9 cm in diameter, were put in petri dishes and twenty seeds of barley were put on it and 5 ml distilled water or water extracts of weeds were added to each petri dish. All petri dishes were put in constant temperature of 15 ^{0}C in an incubator. On days 5, 7 and 10, germination percentages of each petri dish was determined. Plants were harvested after 10 days. Plumule and radicle lengths were measured and fresh and dry weights were determined. The data were subjected to analysis of variance by computer facilities, using SAS program.

III. Results and Discussion

The effects of water extracts of different parts of SISIR and DESSO on the growth parameters of barley seedlings after 10 days are shown in Tables I, II and III.

Increasing the concentrations of water extracts of leaves, stems and roots of both weeds up to 8 % caused more inhibition and reduced the germination rate of barley linearly. As a whole, the root water extracts of both weeds caused the least reductions in the emergence and seedling growth of barley as compared to those of leaves and stems. with the other extract. The results indicated that the water extracts of leaves of both leaves had the greatest inhibitory effect on the growth of barley as compared to those of stems and roots. More delay in seed germination and lower germination index with other plant part extracts could of attributed to a more inhibitory effect of allelochemicals present in leaves [6]. SISIR water extracts had a greater inhibitory effect on germination and primary growth of barley than that of DESSO water extracts.

It is difficult to apply our results to a production situation directly, because the concentration of inhibitory substances in aqueous extracts is probably greater than what would be observed under natural condition. However, the results of the present study and previous work [5]-[18]-[21] show the potential of allelopathic plant extracts should be investigated to exploit its benefit in crop production.

Table I
Effect Of Water Extracts Of The Leaves, Stems And Roots Of Sisir And Desso On The Plumule And Radicle Fresh Weights Of Barley After 10 Days (Mean Of 3 Repls.)

Conc.		Plumule fresh Weight (mg)	Radicle fresh Weight (mg)
DESSO			
Leaf	0	1100abcdef	580a
	2	890bcdefg	420ab
	4	570efgh	220ab
	8	590defgh	170ab
Stem	0	1210abc	520ab
	2	1170abcdef	527ab
	4	1200abcde	500ab
	8	1170abcdef	407ab
Root	0	1530a	500ab
	2	1500abcdef	480ab
	4	1470abcdef	460ab
	8	1450abcdef	440ab
SISIR			
Leaf	0	1320a	410ab
	2	1160abcde	330ab
	4	380gh	100b
	8	190h	90b
Stem	0	1440ab	160ab
	2	1410ab	120b
	4	1320abc	100b
	8	550fgh	90b
Root	0	1330abc	330ab
	2	1390abcd	380ab
	4	1370abcdef	370ab
	8	1300cdefgh	290ab

In each column, the numbers with similar letter have no significant difference by Duncan Multiple Range Test (DMRT) at 5 % level.

Table II
Effect Of Water Extracts Of The Leaves, Stems And Roots Of Sisir And Desso On Plumule And Radicle Dry Weights Of Barley After 10 Days (Mean Of 3 Repls.)

Conc.		Plumule dry Weight (mg)	Radicle dry Weight (mg)
DESSO			
Leaf	0	140a	120a
	2	120ab	80abcde
	4	80abc	40ef
	8	50abc	20f
Stem	0	140a	120a
	2	150a	122abc
	4	142ab	96cde
	8	131abc	85def
Root	0	140a	120a
	2	110ab	100ab
	4	90ab	77abcd
	8	70a	58abcdef
SISIR			
Leaf	0	150a	110ab
	2	80abc	80abcde
	4	20bc	10f
	8	10c	1f
Stem	0	140a	90abcd
	2	130a	90abcd
	4	120ab	70abcde
	8	20bc	10f
Root	0	110ab	90abcd
	2	117ab	97abcde
	4	115ab	93abcde
	8	94abc	85bcde

In each column, the numbers with similar letter have no significant difference by Duncan Multiple Range Test (DMRT) at 5 % level.

TABLE III
EFFECT OF WATER EXTRACT OF LEAVES, STEM AND ROOTS OF DESSO AND SISIR ON PLUMULE AND RADICAL LENGTH OF BARLEY AFTER 10 DAYS (MEAN OF 3 REPLS.)

	Conc.	Plumule length (mm)	Radicle length (mm)
DESSO			
Leaf	0	97abc	109abc
	2	70efgh	76efgh
	4	53ghij	64hi
	8	38ij	45ij
Stem	0	96abcd	104abcd
	2	81bcdef	89bcde
	4	78efgh	84efg
	8	65fghi	66efgh
Root	0	107a	113abc
	2	77cdef	84cdef
	4	74defg	80efg
	8	70efgh	73efg
SISIR			
Leaf	0	102a	99a
	2	63efgh	66efgh
	4	19j	27k
	8	17j	24k
Stem	0	99abc	99ab
	2	95abcd	94cdefg
	4	84abcde	89fghi
	8	13hij	19jk
Root	0	106a	109abc
	2	111abcde	115bcde
	4	110abcde	114defg
	8	102efgh	104ghi

In each column, the numbers with similar letter have no significant difference by Duncan Multiple Range Test (DMRT) at 5 % level.

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