Allelopathic Influence of Sunflower
I- Allelopathic Influence of Sunflower Stems Aqueous Extract on Seed Germination and Seedling Growth of Wheat and Some Associated Weeds

By

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ABSTRACT

Laboratory experiments were conducted during December, 1998 and 1999 seasons, at laboratories of the Faculty of Agriculture, Tanta University at Kafr El-Sheikh, Egypt to determine the allelopathic influence of sunflower stems extract (1:10 w/v) with different concentrations (0, 25, 50, 75 and 100% v/v) on wheat, ryegrass (*Lolium temulentum*, L.), canary grass (*Phalaris minor*, Retz.), wild oats (*Avena fatua*, L.) and common vetch (*Vicia sativa*, L.). Treatments were arranged in a completely randomized design with four replications. The important findings could be summarized as follows:

* The aqueous extract of sunflower stems with various concentrations had no significant effect on final germination percentage of wheat grains. However, it inhibited seed germination of all test weed species and delayed its initiation as the concentration of the extract increased.
* Variation in concentration of the extract caused a significant difference in germination speed and mean germination time indices of all test species. Dilution of the sunflower stems extract progressively increased germination speed index of all test species. The inverse was true in mean germination time index. Generally, increasing extract concentration delayed seed germination and increased the time required for complete seed germination.
* The 25% concentration of the extract had relatively no or little effect on shoot and root lengths of wheat and test wheat weed seedlings. However, increasing extract concentration greater than 25% caused a marked reduction in shoot and root lengths of seedlings for all test species in most cases.
* Seedlings fresh weight of all test species progressively decreased with successive increase in extract concentration from 50 to 100% in the two seasons.
* Unlike fresh weight, dry weight did not show significantly inhibition or stimulation at various concentration of the sunflower extract in all test

species in both seasons, except canary grass, whereas dry weight of its seedlings was reduced at the 100% concentration.

INTRODUCTION

One of the most serious problems of modern agriculture is crop losses caused by weeds. Worldwide 10% loss of agricultural production is caused by weeds alone (Altieri and Liebman, 1988). Controlling weeds through allelopathy is one focal point for researches working to sustain the world's food supply for future generations. The allelopathy is any direct or indirect harmful or beneficial effect by one plant (including microorganisms) on another through production of chemical compounds that escape into environment (Rizvi *et al.*, 1992). Allelopathy is important mechanisms of plant interference mediate by the addition of plant-produced phytotoxins to the plant environment.

Ben-Hammouda *et al.* (1995) found that bioassays of water extracts from different sorghum plant parts inhibited wheat seedlings growth and reducing wheat radical elongation. He also found that seedling elongation of wheat was inhibited more by sunflower stem extracts than the germination percentage. Chung and Miller (1995) indicated that dry weight of alfalfa cotyledons, hypocotyls and radicals were significantly reduced as the extract concentration increased. Naseem (1997) reported that allelopathic effects of aqueous extracts of whole sunflower plants on germination of wheat, canary grass and wild oats were concentration dependent and species specific, whears delay in initiation of germination and inhibitory effects increased with increasing concentration of extracts. In this connection, Sharma *et al.* (1997) found that germination of wheat seed was not affected significantly by allelopathic of eleven commonly farm-grown tree species under laboratory condition, whereas shoot and root lengths as well as fresh and dry weights of wheat seedlings showed a significant effect differences. Mehboob *et al.* (2000) concluded that sunflower water extract exhibited stimulatory effect on germination of linseed at lower concentration and inhibitory effect at higher concentrations.

The main objectives of this study were to investigate the allelopathic influence of sunflower stem aqueous extract on seed germination and seedlings growth of wheat and some associated weeds.

MATERIALS AND METHODS

Laboratory experiments were conducted during December, 1998 and 1999 seasons, at Faculty of Agriculture laboratories, Tanta University, at Kafr El-Sheikh, Egypt, to determine the allelopathic influence of aqueous

extract of sunflower stems on germination and growth of wheat cv. Sakha 69 and four wheat-weeds [ryegrass (*Lolium temulentum*, L.), canary grass (*Phalaris minor*, Retz.), wild oats (*Avena fatua*, L.) and common vetch (*Vicia sativa*, L.)].

Preparation of aqueous extract:

Stems of sunflower cv. Euroflore grown in field as recommended were uprooted after head harvest, then air dried for 10 days and chopped into small pieces (1-5 cm long) with an electric fodder cutter. Chopped stems of sunflower were dried in an oven at 70°C for 48 hours. Dried plant tissue was ground in a laboratory grinder and allowed to pass through a 20-mesh screen. An aqueous extract was obtained by mixing 100 g of dried sunflower stems powder with 1000 ml of distilled water and soaking for 24 hours at room temperature, which resulted in an extract (1:10 w/v) as discribed by (Hicks et al., 1989). The extract was filtered through filter paper (Whatman No. 42) and diluted with distilled water for making 25, 50, 75 and 100% concentrations (v/v), beside a distilled water as a control treatment. Four layers of filter paper in 1998 or 100 g sand in 1999 season were placed inside 9cm-diam. plastic petri dishes. Fifteen seeds of each wheat cv. Sakha 69, ryegrass, canary grass, wild oats and common vetch were separately placed into filter paper or into sand in mentioned petri dishes and treated with 10 ml of test solution and covered at room temperature. Distilled water was added to each treatment when even it was required. To facilitate germination, common vetch seeds were pre-treated with diluted sulfuric acid (50%) for 3 minutes followed by a 15 minutes running wash water. Treatments were arranged in a completely randomized design with four replications. The followings measurements were recorded:

1. Number of germinated seeds were counted daily till the completion of germination (12 and 14 days after sowing in the 1^{st} and 2^{nd} season, respectively) and expressed as germination percentage. Germination speed (Maguire, 1962) and mean germination time (Nichols and Heydecker, 1968) indices were computed as the following formula:

Germination speed index $= \Sigma (n / t)$

Mean germination time index $= \Sigma (nt) / \Sigma n$

Where : n = number of seeds newly germinating at time t.

t = days or hours from sowing.

2. Shoot and root lengths (cm) of seedlings were measured after completion of germination.

3. After shoot and root lengths measurement, the seedlings were immediately weighted for measuring fresh weight (mg/seedling). The

seedlings were oven dried to constant weight for 24 hours at 70°C to determine dry weight (mg/seedling).

The analysis of variance was carried out according to Gomez and Gomez (1984). Treatment means were compared by Duncan's multiple range test (Duncan, 1955). All statistical analysis was performed using analysis of variance technique by means of "IRRISTAT" computer software package.

RESULTES AND DISCUSSION

1. Germination percentage:

Seed germination percentage of wheat and some wheat-weeds as affected by different concentrations (0, 25, 75 and 100%) of sunflower stems aqueous extract (1:10 w/v) in 1998 and 1999 seasons is shown in (Table, 1 and Fig., 1). The aqueous extract of sunflower stems with various concentrations had no significant effect on germination percentage of wheat grains in the two seasons. Concentrations of sunflower stems extract showed inhibitory effects on seed germination of ryegrass, canary grass, wild oats and common vetch and delayed their initiation in the two seasons (Fig., 2, 3, 4 and 5). The degree of inhibition increased as the extract concentration increased. The highest two concentrations (75 and 100%) significantly reduced seed germination of the above mentioned wheat weeds compared with the distilled water as control (Table, 1 and Fig., 6). From the obtained data, it is clear that the influence of sunflower stems extract on germination of wheat grains was different from that of wheat weeds. This is possibly due to the selective effect of allelochemicals, which is species specific. These results are confirmed by the findings of Arshad (1995) and Naseem (1997), who reported that some species were more sensitive than others to the allelochemical materials. Mehboob *et al.* (2000) concluded that sunflower water extract exhibited stimulatory effect on germination of linseed at lower concentration and inhibitory effect at higher concentrations.

2. Germination speed and mean germination time indices:

Dilution of sunflower stems extract progressively increased germination speed index of all tested species (Table, 2). The greatest germination speed index resulted from application of distilled water, while the lowest one resulted from application of the 100% concentration. The tested species exhibited different response to the aqueous extract of sunflower stems. Increasing extract concentration above 50% significantly

Table (1): Germination (%) of wheat and some associated weeds as affected by various concentrations of sunflower stems extract (1:10 w/v) in 1998 and 1999 seasons

Season	Concent-ration (%)	Wheat	Wheat weeds			
			Rye grass	Canary grass	Wild oats	Common vetch
1998		NS	*	*	*	*
	0	99.2	99.2 a	98.3 a	95.0 a	92.5 a
	25	99.0	100.0 a	81.7 b	85.1 a	90.0 a
	50	98.3	88.5 a	70.0 c	78.7 b	80.0 b
	75	95.0	76.7 b	26.7 d	76.7 b	70.0 c
	100	93.3	18.3 c	6.7 e	16.7 c	65.0 d
1999		NS	**	**	**	*
	0	92.5	92.5 a	90.0 a	95.0 a	90.0 a
	25	93.3	87.5 ab	80.0 ab	67.5 b	85.0 a
	50	90.5	82.5 bc	70.0 b	62.5 b	77.5 b
	75	88.2	75.0 c	62.5 b	57.5 b	70.0 c
	100	87.5	57.5 d	25.0 c	25.0 c	57.5 d

*, ** and NS indicate $p< 0.05$, $p<0.01$ and not significant, respectively. Means of each column designated by the same letters are not significantly different at 5% level, using Duncan's multiple range test.

increased the mean germination time index for all species compared with the control in both seasons (Table, 2). The required time for complete germination of wheat grains was less than those of the tested weed species, especially, common vetch at all concentrations in the two seasons. The different response of the tested species to the aqueous extract of sunflower stems suggests the selective effect of allelochemicals, which is species specific.

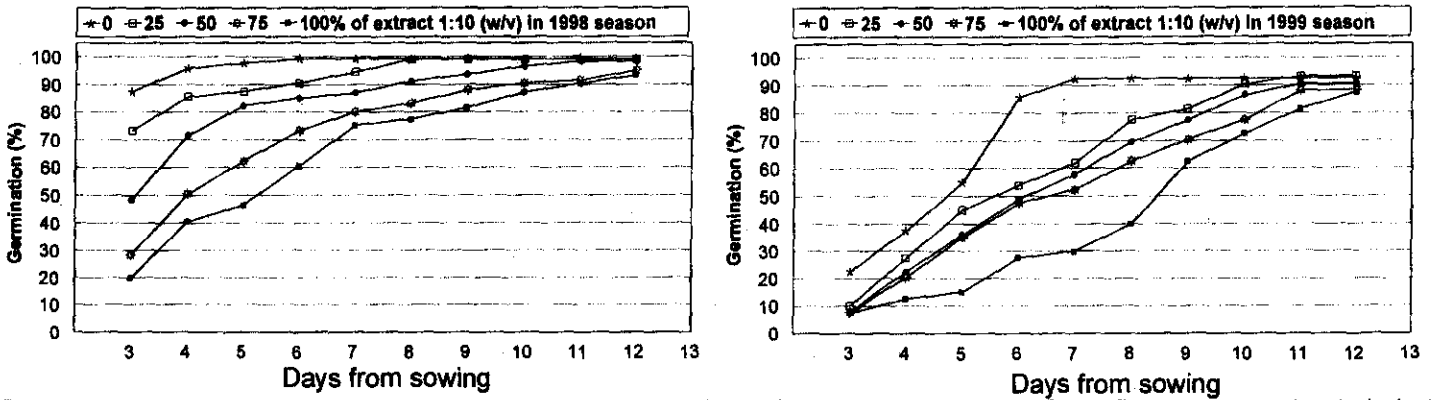

Fig. (1): Cumulative germination percentage of wheat as affected by concentrations of sunflower stem extract in both seasons

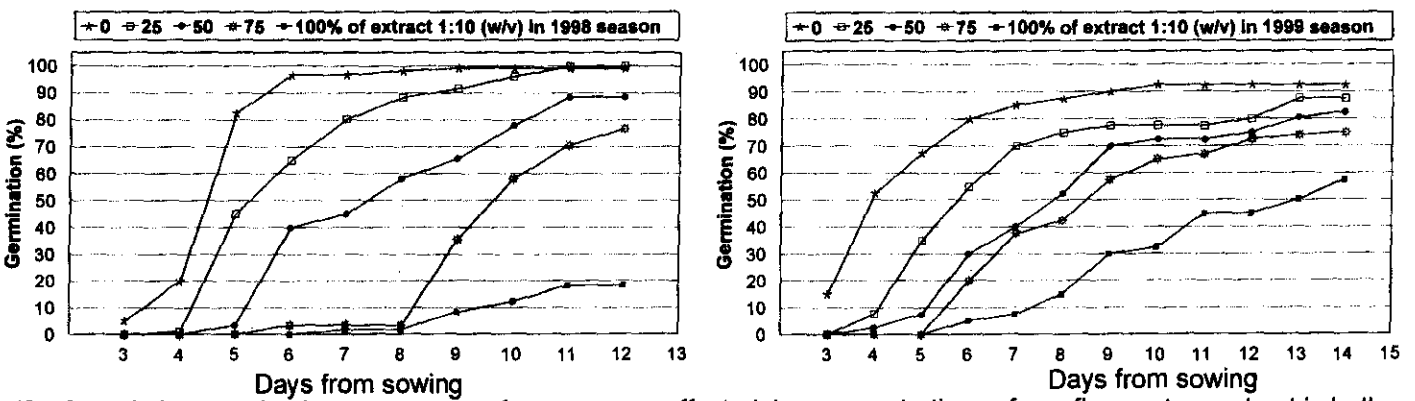

Fig. (2): Cumulative germination percentage of rye grass as affected by concentrations of sunflower stem extract in both seasons.

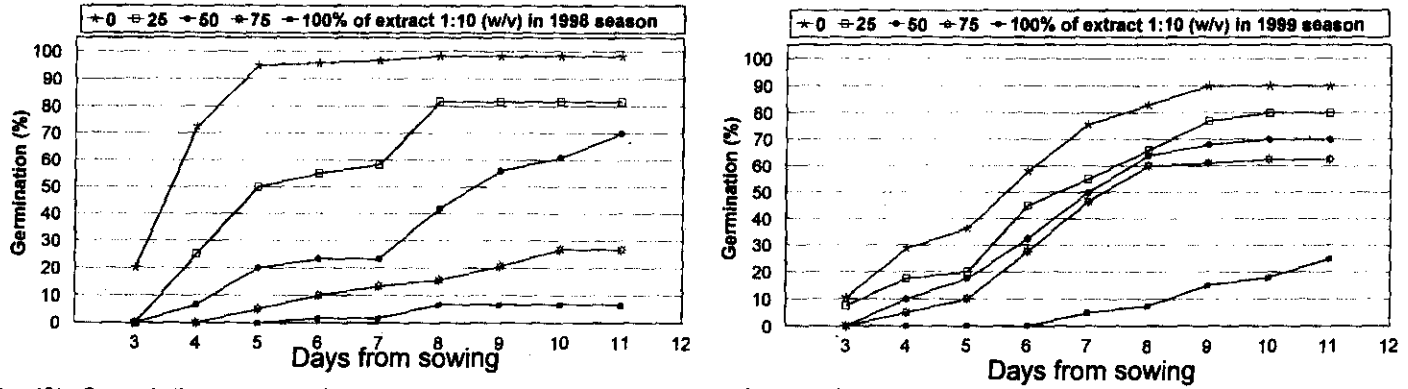

Fig. (3): Cumulative germination percentage of canary grass as affected by concentrations of sunflower stem extract in both seasons.

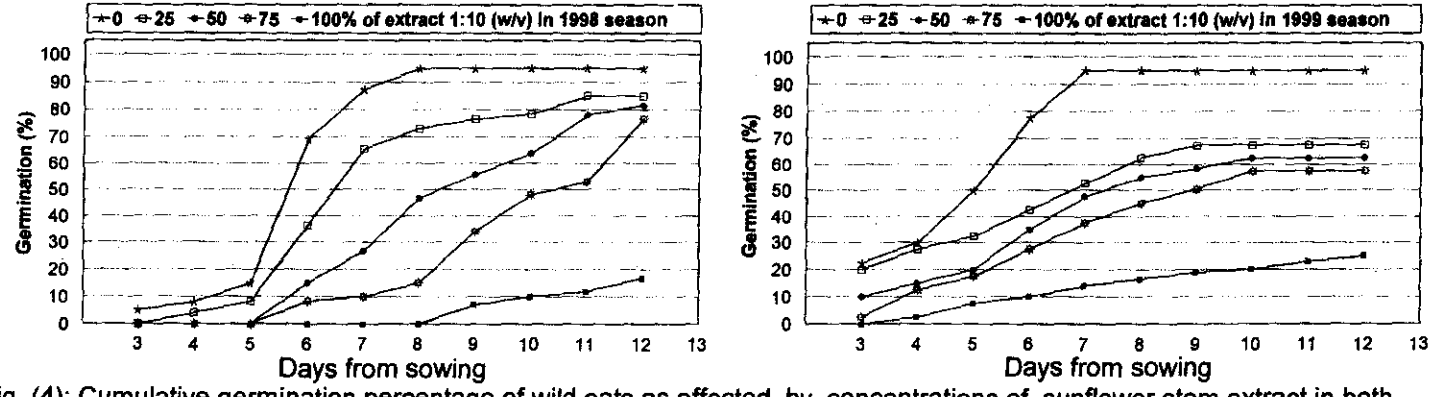

Fig. (4): Cumulative germination percentage of wild oats as affected by concentrations of sunflower stem extract in both seasons.

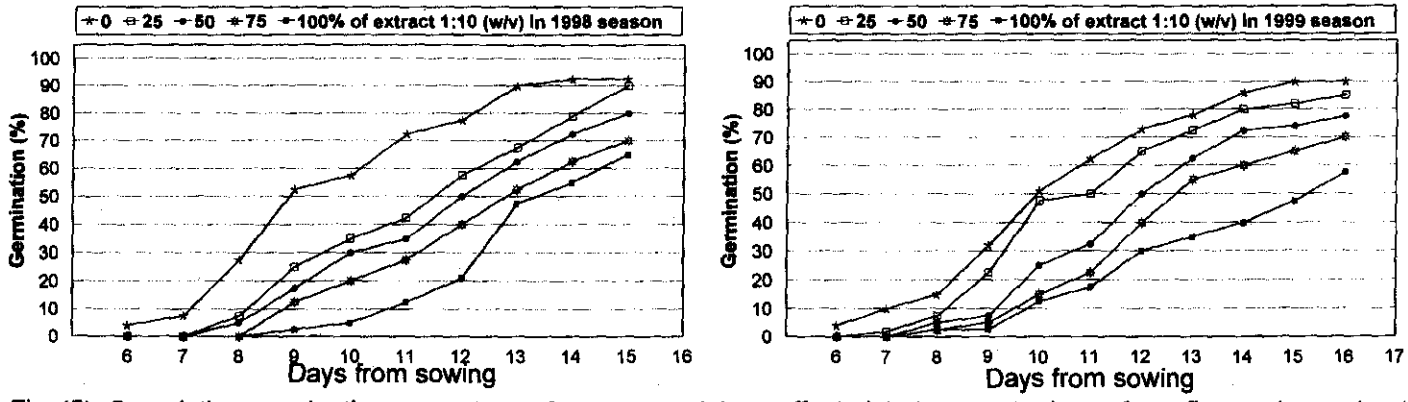

Fig. (5): Cumulative germination percentage of common vetch as affected by concentrations of sunflower stem extract in both seasons

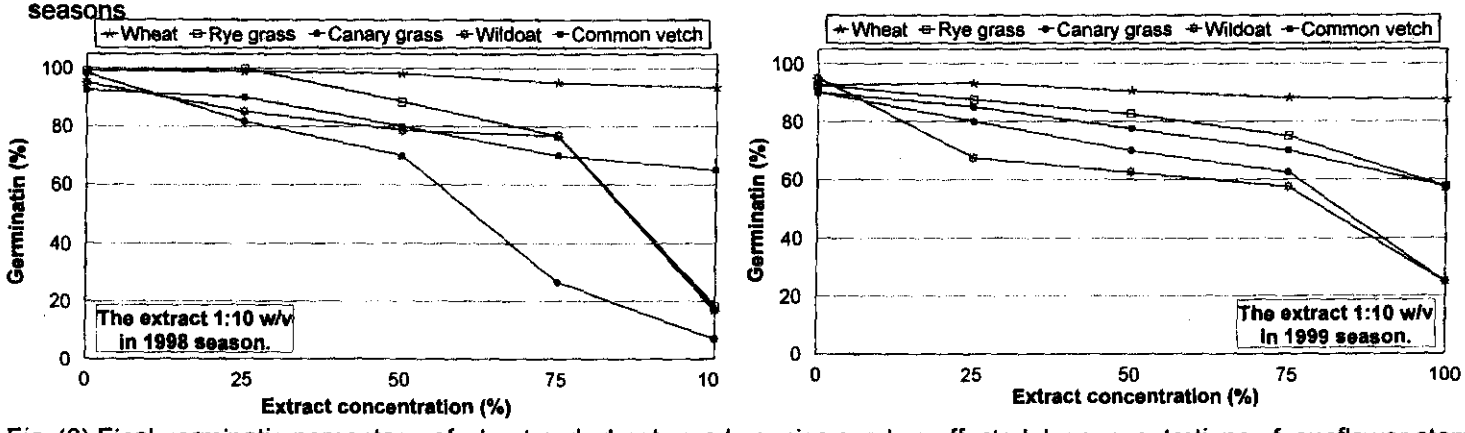

Fig. (6) Final germinatin percentage of wheat and wheet-weed species seed as affected by concentrations of sunflower stem extract in both seasons

Table (2): Germination speed index and mean germination time index of wheat and some associated weeds as affected by various concentrations of sunflower stems extract (1:10 w/v) in 1998 and 1999 seasons

Season	Concent-ration (%)	Wheat	Wheat-weeds			
			Rye grass	Canary grass	Wild oats	Common vetch
Germination speed index						
1998		**	**	**	**	*
	0	4.781 a	3.088 a	3.713 a	2.460 a	1.480 a
	25	4.428 ab	2.511 b	2.322 b	1.925 b	1.221 ab
	50	3.906 bc	1.824 c	1.514 c	1.512 bc	1.072 bc
	75	3.255 cd	1.205 d	0.564 d	1.229 c	0.906 cd
	100	2.889 d	0.288 e	0.136 d	0.248 d	0.774 d
1999		*	**	**	*	*
	0	3.125 a	3.152 a	2.611 a	3.069 a	1.362 a
	25	2.608 ab	2.094 b	2.099 b	2.166 b	1.207 ab
	50	2.405 bc	1.615 c	1.709 bc	1.739 b	1.018 bc
	75	2.289 bc	1.427 c	1.475 c	1.452 b	0.883 cd
	100	1.914 c	0.777 d	0.419 d	0.562 c	0.701 d
Mean germination time index						
1998		**	**	**	**	**
	0	3.167 c	4.976 d	4.134 c	6.056 d	9.795 b
	25	3.643 bc	6.326 c	5.695 b	6.978 c	11.511 a
	50	4.333 b	7.722 b	7.681 a	8.502 b	11.594 a
	75	5.182 a	9.726 a	7.584 a	9.806 a	11.929 a
	100	5.792 a	9.689 a	7.493 a	10.263 a	12.792 a
1999		**	**	**	**	*
	0	4.831 c	4.838 d	5.753 c	5.105 c	10.430 c
	25	6.199 bc	6.543 c	6.400 b	6.481 b	11.555 b
	50	6.503 ab	6.697 b	6.543 b	6.644 b	11.755 ab
	75	6.765 ab	7.740 a	6.938 b	6.843 b	12.214 ab
	100	8.011 a	8.043 ab	9.180 a	8.492 a	12.739 a

* and ** indicate $p< 0.05$ and $p<0.01$, respectively. Means of each column designated by the same letters are not significantly different at 5% level, using Duncan's multiple range test.

3. Shoot and root length:

The sunflower stems aqueos extract with different concentrations significantly affected shoot and root growth similarly in all test species (Table, 3). The 25% concentration had relatively no or little effect on shoot and root lengths of wheat, as well as on seedlings of the different tested wheat weeds. In contrast, increasing concentration of the extract greater than 25% caused a marked reduction in shoot and root length of seedlings of all test species. Similar results were obtained by Ben-Hammouda *et al.* (1995), who reported that bioassays of water extracts from sorghum plant parts inhibited wheat seedlings growth and reduced wheat radical elongation. The obtained results show also that seedlings elongation of wheat was inhibited more by sunflower stem extract than the germination percentage. Chung and Miller (1995) came to the same conclusion on alfalfa.

4. Seedling fresh weight:

There was a substantial difference in seedlings fresh weight (mg/seedling) of all test species among different concentrations of sunflower extract in the two seasons (Table, 4). Seedlings fresh weight of all test species showed a progressive reduction with successive increase in extract concentration from 50 to 100% in both seasons. The obtained reduction in fresh weight may be due to specific allelochemicals present in sunflower extract, which at high concentration had inhibitory effects and promoting or less effect at low concentration. Sharma *et al.* (1997) reported that allelopathic of eleven commonly farm grown tree species had a significant effect on fresh weight of wheat.

5. Seedling dry weight :

Unlike fresh weight, dry weight (mg/seedling) did not show any significant inhibition or stimulation at various concentrations of the sunflower extract in all test species in both seasons, except that of canary grass in both seasons (Table, 4). Whereas the 100% concentration significantly reduced dry weight of canary grass seedlings compared with the distilled water as control. Chung and Miller (1995) indicated that dry weight of alfalfa cotyledons, hypocotyls and radicals were significantly reduced as the extract concentration increased.

Table (3): Shoot and root lengths (cm) of wheat and some associated weeds seedlings as affected by various concentrations of sunflower stems extract (1:10 w/v) in 1998 and 1999 seasons.

Season	Concent-ration (%)	Wheat	Wheat-weeds			
			Rye grass	Canary grass	Wild oats	Common vetch
Shoot length (cm)						
1998		*	*	*	*	*
	0	9.92a	17.69 a	8.34 a	16.70 b	27.21 a
	25	9.98a	14.91 b	6.51 b	18.37 a	19.32 b
	50	3.00b	7.42 c	4.28 c	9.84 c	13.63 c
	75	1.63bc	2.03 d	2.71 d	4.08 d	12.62 c
	100	0.97c	1.34 d	0.97 e	1.68 e	11.17 c
1999		*	**	**	**	*
	0	9.95 a	16.61 a	9.33 a	14.08 a	22.31 a
	25	11.30 a	15.48 ab	6.15 b	13.33 ab	21.71 a
	50	5.88 b	13.35 ab	5.85 b	9.08 bc	16.29 b
	75	3.56 bc	12.44 b	5.41 b	8.01 c	11.87 c
	100	1.31 c	4.81 c	1.11 c	7.06 c	6.99 d
Root length (cm)						
1998		*	*	*	*	*
	0	9.09 a	14.24 a	4.76 a	15.09 a	9.51 a
	25	7.22 b	11.63 b	3.59 b	13.83 a	7.75 b
	50	2.31 c	3.56 c	0.89 c	4.15 b	6.07 bc
	75	1.64 c	1.23 d	0.31 c	1.41 c	5.09 cd
	100	1.37 c	1.11 d	0.11 c	0.66 c	3.49 d
1999		*	*	*	*	*
	0	7.45 a	10.41 a	2.61 a	8.66 a	10.37 a
	25	7.27 a	7.89 b	2.40 ab	8.99 a	8.98 a
	50	4.96 b	8.30 b	1.88 b	5.25 b	6.60 b
	75	3.82 b	6.65 b	1.21 c	4.05 b	4.45 bc
	100	2.35 c	3.43 c	0.67 d	2.74 b	3.29 c

* and ** indicate $p< 0.05$ and $p<0.01$, respectively.Means of each column designated by the same letters are not significantly different at 5% level, using Duncan's multiple range test.

Table (4): Fresh and dry weights (mg/seedling) of wheat and some associated weed seedlings as affected by different concentrations of sunflower stems extract (1:10 w/v) in 1998 and 1999 seasons.

Season	Concent-ration (%)	Wheat	Wheat-weeds			
			Rye grass	Canary grass	Wild oats	Common vetch
Fresh weight (mg/seedling)						
1998		*	*	*	*	*
	0	207.4 a	84.4 a	14.4 a	151.0 b	270.5 a
	25	193.9 a	83.3 a	11.1 b	185.3 a	253.3 b
	50	106.4 b	49.3 b	9.0 b	121.6 c	218.9 c
	75	90.7 b	36.5 bc	5.2 c	83.7 d	185.4 d
	100	93.9 b	25.5 c	2.8 c	56.9 e	174.8 d
1999		*	*	*	*	*
	0	210.7 a	139.8 a	15.5 a	190.8 a	284.21 a
	25	210.4 a	144.3 a	11.1 b	192.7 a	274.18 a
	50	143.7 b	108.8 b	11.8 b	140.3 ab	200.52 b
	75	118.7 b	108.1 b	11.2 b	127.5 b	190.13 b
	100	78.4 c	65.2 c	4.3 c	95.6 b	168.42 c
Dry weight (mg/seedling)						
1998		NS	NS	**	NS	NS
	0	31.43	8.55	1.08 ab	19.05	34.4
	25	31.63	9.57	1.32 a	22.59	35.11
	50	37.30	9.42	0.95 ab	24.14	37.36
	75	33.82	11.50	1.04 ab	23.85	32.13
	100	38.65	8.45	0.51 b	24.25	33.37
1999		NS	NS	**	NS	NS
	0	34.17	15.72	1.53 a	24.89	32.10
	25	35.65	16.96	1.31 a	26.12	32.78
	50	36.36	12.20	1.33 a	27.91	30.97
	75	37.80	15.26	1.26 a	24.50	35.55
	100	38.39	14.39	0.45 b	25.02	38.87

*, ** and NS indicate $p < 0.05$, $p < 0.01$ and not significant, respectively. Means of each column designated by the same letters are not significantly different at 5% level, using Duncan's multiple range test.

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الملخص العربى
التأثير الأليلوباثى لعباد الشمس
أولا: التأثير الأليلوباثى للمستخلص المائى لسيقان عباد الشمس على إنبات ونمو القمح وبعض الحشائش المصاحبة

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أجريت تجارب معملية خلال شهر ديسمبر عامى ١٩٩٨ ، ١٩٩٩لتقييم التأثير الأليلوباثى لمستخلص من سيقان عباد الشمس (١ : ١٠ وزن/حجم) وذلك بإضافة (١٠٠ جم مسحوق سيقان عباد الشمس الجافه للتر ماء مقطر) على إنبات ونمو القمح وبعض حشائش القمح وهى الصامه والزمير والفلارس والدحريج. وتم تخفيف المستخلص بماء مقطر الى تركيزات (صفر، ٢٥، ٥٠، ٧٥، ١٠٠%). وقد تم استخدام المستخلص بتركيزاته المختلفة على كل نوع من الأنواع النباتية تحت الدراسة فى أطباق بترى، وتم استخدام التصميم تام العشوائية فى أربع مكررات فى تنفيذ التجارب. **وتتلخص أهم النتائج المتحصل عليها فيما يلى :**

* لم يؤثر المستخلص بتركيزاته المختلفة معنويا على نسبة إنبات حبوب القمح، ولكنها أعاقت إنبات بذور الحشائش المختبرة وأخرت بداية إنباتها كلما زاد تركيز المستخلص.
* أدت التركيزات المختلفة من المستخلص الى اختلافات معنوية فى كل من دليل سرعة الانبات، ودليل متوسط وقت الانبات للأنواع النباتية المختبرة. وأظهرت النتائج أن زيادة تركيز المستخلص الى ٢٥% لم تؤثر معنوياً على كلا الدليلين فى القمح، بينما أدت زيادة تركيز المستخلص الى ٢٥% فأكثر الى نقص دليل سرعة الإنبات لأنواع الحشائش المختبرة وعلى العكس أدى الى زيادة معدل متوسط وقت الإنبات لهذه الأنواع. وبوجه عام فإن زيادة تركيز المستخلص قد أدى الى تأخير إنبات البذور واطالة الوقت اللازم لاكتمال إنباتها.
* كان تأثير التركيز ٢٥% من المستخلص قليلاً أو معدوماً على طول ساق أو جذر بادرات القمح أو الحشائش المختبرة بينما أدت زيادة التركيز الى أعلى من ٢٥% الى نقص واضح فى طول ساق وجذر بادرات كل الأنواع النباتية المختبرة فى معظم الحالات.
* أدت زيادة تركيز المستخلص من ٥٠ الى ١٠٠% الى نقص تدريجى فى الوزن الغض لبادرات جميع الأنواع النباتية المختبرة فى كلا الموسمين.
* بخلاف الوزن الغض، فلم يؤدى استخدام المستخلص بالتركيزات المختلفة له الى تأثير مثبط أو منشط للوزن الجاف للبادرة فى الأنواع المختلفة، فيما عدا الفلارس، حيث انخفض الوزن الجاف لبادراته معنويا باستخدام المستخلص بتركيز ١٠٠%.