Allelopathic Influence of Sunflower
II- Allelopathic Influence of Chopped Sunflower Stems on Wheat and Two Wheat Weeds

By

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ABSTRACT

Pot experiments were conducted during 1998/99 and 1999/2000 seasons, at greenhouse of Agriculture Faculty, Tanta University, at Kafr El-Sheikh, Egypt. Experiments were designed to determine the allelopathic influence of chopped-sunflower stems (mixed with clay soil at levels of 0, 2, 4, 6, 8 and 10% w/w) on germination, growth, grain yield and its attributes of wheat as well as germination and growth of two wheat-weeds [canary grass (*Phalaris minor*, Retz.) and wild oats (*Avena fatua*, L.)]. Experimental design was a completely randomized with 12 replicates. The important findings could be summarized as follows:

* Incorporating of chopped sunflower into pots soil above 8% (w/w) significantly affected the final germination percentage of wheat grains only in the 1st season, only as compared with control at 12 days from sowing. However, increasing the level of chopped-sunflower above 4% significantly decreased seed germination of the two weeds and delayed their initiation in both seasons.
* Germination speed and mean germination time indices of wheat were significantly affected by increasing sunflower debris level above 6%, while those of the two weed species were significantly affected by increasing the level above 2%.
* Dry weight (g/plant) of wheat wassignificantly decreased by increasing sunflower debris rate above 4%, while dry weight of canary grass and wild oats was gradually suppressed by increasing the debris rate above 2% as compared with control.
* Leaf area/plant of wheat plants and the two weed species was significantly reduced at the rate of 4% or greater from sunflower mass, except wild oats at 86 days after sowing in the first season.
* Increasing the level of incorporated sunflower debris into pots soil from 0 to 10% (w/v) suppressed plant height of wheat plants, number of tillers and spikes/plant, spike length, number of spikelets and grains/spike, 1000-grain weight and grain yield (g/plant) as compared with control. Incorporating sunflower debris into soil at 0-6% had no depressing impact on grain

yield/plant. Hoever the reduction was fact only at 8% and 6% rAtes in 1998/99 and 1999/2000 seasons, respectively.

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 an important mechanism of plant interference mediate by the addition of plant-produced phytotoxins to the plant environment. Irons and Burnside (1982) in greenhouse, found that incorporation of ground sunflower leaves into soil at the rate of 2% (w/w) or greater reduced emergence and growth of soybeans, sorghum and sunflower. Naseem (1997) in pot experiments, noticed that chopped sunflower plant materials suppressed the germination and growth of wheat, *Phalaris minor* and *Avena fatua.* He also stated that suppressive effects increased with each increment of chopped sunflower biomass as well as the germination and growth of weeds, were inhibited more than wheat. Kazinczi *et al.* (1998) in pot studies under glasshouse conditions, concluded that incorporation of root residues of milkweed into the soil significantly retarded the germination of *Brassica napus* but did not influence the germination of wheat, corn, sunflower, *Amaranthus retroflexus*, sugarbeet and *Chenopodium album.* He also reported that root residues significantly enhanced the fresh weight of corn, sunflower, *A. retrofexus* and *C. album* and it had no effect on fresh weight of sugarbeet, wheat and *B. napus.*

The main objectives of this study were to investigate the allelopathic influence of chopped-sunflower stems on germination, growth and grain yield of wheat as well as germination and growth of the two common wheat weeds (canary grass and wild oats).

MATERIALS AND METHODS

Pot experiments were conducted during 1998/99 and 1999/2000 seasons, at greenhouse of Agriculture Faculty, Tanta University, at Kafr El-Sheikh, Egypt, to determine the allelopathic influence of chopped-sunflower stems on germination, growth and grain yield of wheat as well as germination and growth of two wheat-weeds [canary grass (*Phalaris minor*,

Retz.) and wild oats (*Avena fatua*, L.)]. After the harvest of sunflower (cv. Eurflore) heads and stems were air dried and then chopped into 1-5 cm small pieces with an electric fodder cutter. This material was mixed with clay soil at levels of [0, 2, 4, 6, 8 and 10% (w/w)]. Plastic pots measuring 20 cm diameter and 15 cm depth were filled with this mixture, while the control pots were filled with clay soil only. Ten of seeds each of wheat, canary grass and wild oats were sown per pot on December 20th 1998 and December 4th 1999. Water was added when even it is required to avoid water stress. Experimental design was a completely randomized with 12 replicates. Soon after complete emergence, pots of each treatment were divided into three sections. One section of 6 pots was used to determine grain yield and its components, other section was used for two plant growth samplings (3 pots each). The followings data were recorded:

1. Number of seedlings emerged in each pot was counted daily till the completion of germination and the following characters were determined: germination percentage as well as germination speed index (Maguire, 1962) and mean germination time index (Nichols and Heydecker, 1968) of all tested species 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. Plants of three pots were taken from each treatment at 70 and 86 days after sowing (DAS). Plants of wheat, canary grass and wild oats per each pot were cut off at the soil surface and separated into leaves (leaf blades), stems (stems + sheaths) and spikes. The different plant parts were oven dried to a constant weight for 48 hours at 70°C. The sum of dried plant parts was used to calculate the total dry matter accumulation/plant. Leaf area (blade area) was measured by Portable Area Meter (Model LI-3000A).

3. At harvest, plant height of wheat plants and number of tillers and fertile tillers (spikes) were counted per pot and expressed as a number/plant. Wheat plants of 6 pots were harvested and the following data were recorded: [spike length, number of spikelets and grains/spike, 1000-grain weight and grain yield (g/plant).

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.

RESULTS AND DISCUSSION

1. Germination percentage :

Incorporation of chopped-sunflower had a significant effect on seed germination of the three tested species, except on wheat in the second season (Table, 1 and Fig., 4). Incorporating of chopped sunflower into pots soil up to 8% (w/w) did not affect the final germination percent of wheat seed as compared with control at 12 days from sowing in the two seasons (Fi., 1). The degree of inhibition increased as the incorporation of chopped sunflower increased above 4% in the two weed species (Fig., 2 and 3). Generally, the allelopathic effect of chopped-sunflower was slight on germination of wheat seed, while it's deletrious on germination of two tested weeds. These results are supported by the finding of Nassem (1997), who found suppressive effect of chopped-sunflower on the germination of *Phalaris minor*, *Avena fatua* and wheat. The inhibition or promotion of germination may be arise from the species specific allelopathic effects of sunflower plants.

Table (1): Germination (%) of wheat and two wheat-weeds as affected by different rates of chopped-sunflower stems in 1998/99 and 1999/2000 seasons.

Season	Chopped sunflower %	Wheat	Canary grass	Wild oats
1998/99		*	*	*
	0	96.3 a	88.9 a	91.3 a
	2	97.5 a	89.6 a	92.5 a
	4	95.0 a	73.2 a	75.0 b
	6	93.8 a	38.1 b	73.8 b
	8	87.5 a	31.7 b	72.5 b
	10	76.3 b	28.7 b	51.3 c
1999/2000		NS	**	*
	0	93.2	90.8 a	96.2 a
	2	93.3	90.8 a	97.5 a
	4	92.5	79.2 ab	95.0 a
	6	92.5	65.0 bc	84.1 b
	8	88.5	62.5 c	74.2 c
	10	88.3	40.0 d	51.7 d

*, ** and N.S. indicate $p<0.05$, $p<0.01$ and not significant, respectively. Means designated by the same letters are not significantly different at 5% level, using DMR test.

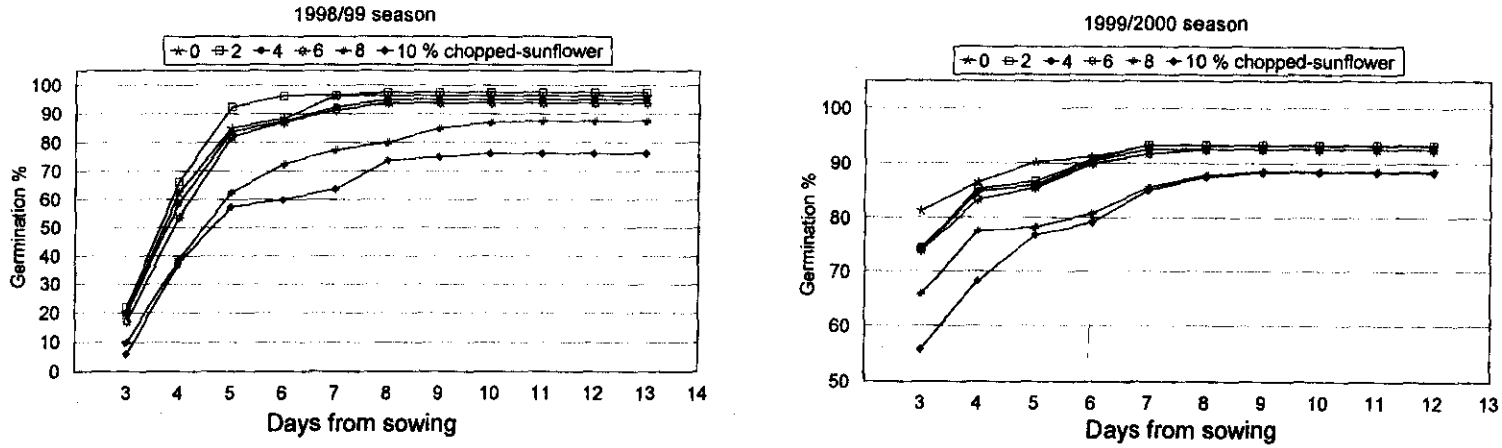

Fig. (1): Cumulative germination percentage of wheat as affected by chopped-sunflower stems in both seasons.

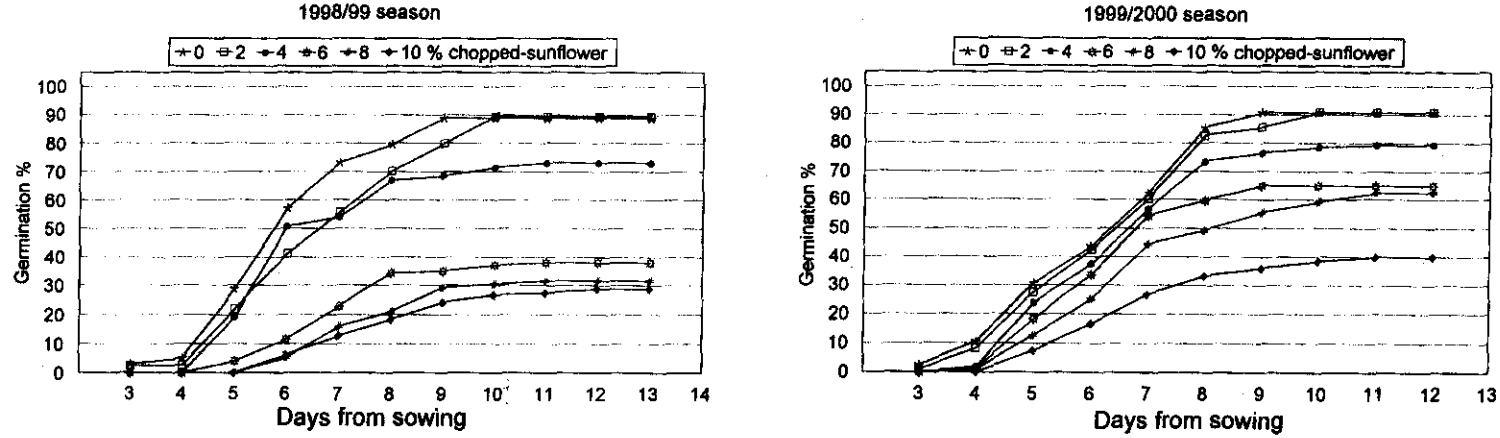

Fig.(2): Cumulative germination percentage of canary grass as affected by chopped-sunflower stems in both seasons.

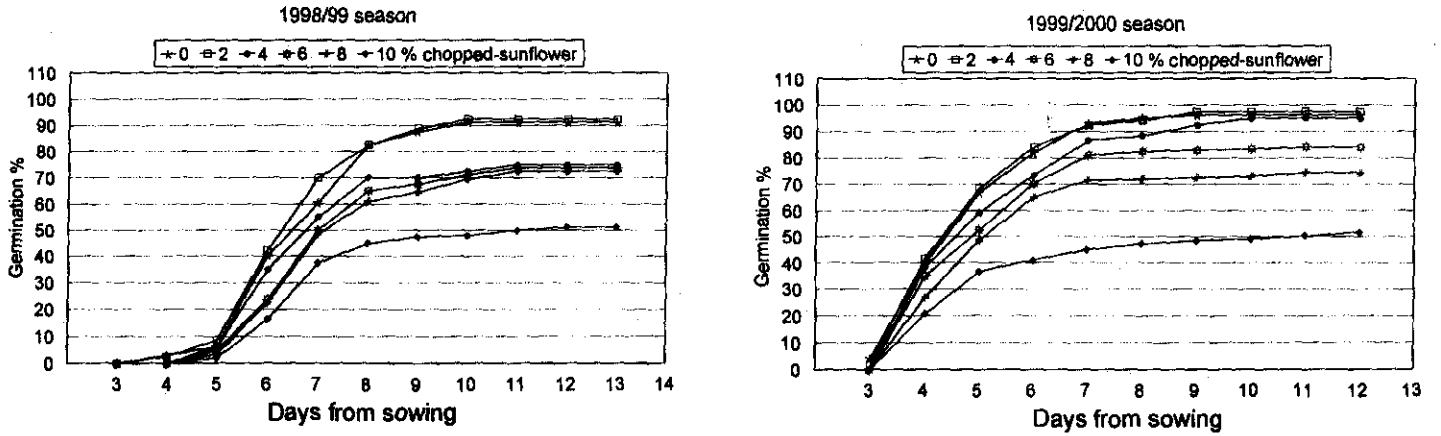

Fig.(3): Cumulative germination percentage of wildoats as affected by chopped-sunflower stems in both seasons.

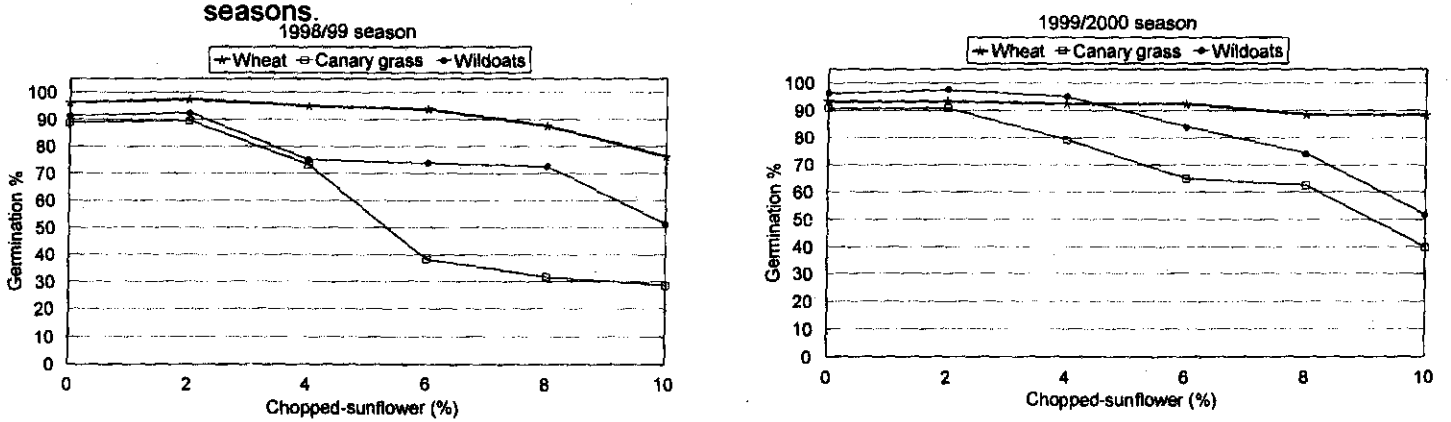

Fig. (4): Final germination percentage of wheat, canary grass and wildoats as affected by chopped-sunflower stems in both seasons.

2. Germination speed and mean germination time indices :

Sunflower chopped material had a significant effect on the two germination indices of seed for the three tested species in both season (Table, 2). Increasing the rate of chopped-sunflower stems into pot soils reduced germination speed index, while it increased mean germination time index of wheat, canary grass and wild oats in the two seasons. The greatest reduction germination speed index, while it increased mean germination time index of wheat, canary grass and wild oats in the two seasons. The greatest reduction in germination speed index for seed of all tested speices occurred at the high level (10%) of chopped-sunflower in the two seasons. In wheat, the two indices of germination were not affected by increasing sunflower matter level up to 6 % as compared with control in both seasons. In the two weed species, soil incorporation of sunflower mass above 2%

Table (2): Germination speed index and mean germination time index of wheat and two wheat-weeds as affected by different rates of chopped-sunflower stems in 1998/99 and 1999/2000 seasons.

Season	Chopped sunflower %	Germination speed index			Mean germination time index		
		Wheat	Canary grass	Wild oats	Wheat	Canary grass	Wild oats
1998/99		*	**	*	**	*	*
	0	2.35 a	1.51 a	1.37 a	4.04 b	6.23 bc	6.73 b
	2	2.44 a	1.39 ab	1.41 a	4.17 b	6.94 bc	6.81 b
	4	2.30 a	1.18 b	1.13 b	4.39 b	6.48 bc	6.88 b
	6	2.23 a	0.55 c	1.06 b	4.47 b	7.19 ab	7.17 a
	8	1.88 b	0.42 c	1.03 b	5.13 a	7.78 a	7.28 a
	10	1.64 b	0.37 c	0.74 c	5.10 a	7.97 a	7.20 a
1999/2000		*	**	*	*	**	*
	0	2.96 a	1.52 a	2.02 a	3.25 c	6.11 b	5.04 c
	2	2.88 a	1.47 a	2.03 a	3.39 c	6.61 a	5.07 c
	4	2.87 a	1.26 b	1.90 a	3.37 c	6.61 a	5.17 bc
	6	2.85 a	1.05 c	1.71 b	3.41 bc	6.63 a	5.30 ab
	8	2.65 ab	0.94 c	1.50 c	3.62 b	7.04 a	5.31 ab
	10	2.51 b	0.60 d	1.04 c	3.88 a	7.03 a	5.45 a

* and ** indicate $p<0.05$ and $p<0.01$, respectively. Means designated by the same letters are not significantly different at 5% level, using DMR test.

significantly reduced germination speed index and above 4% significantly delayed germination time compared with the control in the two seasons. At any level of sunflower mass, germination speed of wheat was faster than that of the two weed species. The differential response of species may be due to the selective effect of allelochemicals that is species specific.

3. Dry weight (g/ plant):

Allelopathic effect of soil incorporated chopped-sunflower stems was substantial on dry weight (g/plant) of wheat, canary grass and wild oats in the two seasons (Table, 3). Incorporation of chopped-sunflower stems into pots soil up to 4% (w/w) did not affect dry weight, (g/plant) of wheat as compared with the control at all sampling dates in both seasons. However, dry weight of canary grass and wild oats was gradually suppressed by increasing the rate of chopped-sunflower above 2% (w/w) at all sampling dates (Table, 3) and at harvest in the two seasons (Table, 4). Stimulatory effects at low residue level and inhibitory effects at high residue level have also been reported by Ahmad *et al.* (1995), Naseem (1997) and Kazinczi *et al.* (1998).

4. Leaf area (cm^2/ plant) :

Soil incorporation of chopped sunflower stem significantly affected leaf area per plant of all test species, except wild oats at 86 days after sowing in the first season (Table, 3). Leaf area of wheat was not significantly affected by increasing the rate of sunflower mass up to 4% compared with control at the two sampling dates, while it was significantly reduced at the high residue level of 10% in both seasons. The 2% residue level did not affect leaf area per plant of canary grass and wild oats at all sampling dates in both seasons. However, increasing chopped-sunflower level greater than 2% reduced gradually leaf area of the two weed species. These results concur with the findings of Arshad (1995), Nassem (1997) and Zouza *et al.* (1997), who reported suppressive effect of several crop residues on leaf area of weeds and crops.

Table (3): Dry weight (g/plant) and leaf area (cm^2/ plant) of wheat, canary grass and wild oats at two sampling dates as affected by different rates of chopped-sunflower stems in 1998/99 and 1999/2000 seasons.

Season	Chopped sunflower %	DAS	Dry weight (g/plant)			Leaf area (cm^2/plant)		
			Wheat	Canary grass	Wild oats	Wheat	Canary grass	Wild oats
1998/99			*	*	*	**	**	**
	0	70	2.82 a	0.091 a	0.741 a	211.8 a	23.92 a	125.6 a
	2		2.71 ab	0.114 a	0.781 a	227.4 a	26.43 a	123.6 a
	4		1.98 abc	0.049 b	0.627 b	188.8 ab	20.86 b	100.2 b
	6		1.90 bc	0.040 b	0.636 b	157.4 bc	15.69 c	84.4 bc
	8		1.63 cd	0.029 b	0.559 b	108.9 cd	12.64 d	76.3 cd
	10		1.01 d	0.027 b	0.396 c	78.8 d	11.42 d	59.4 d
			**	**	**	**	**	N.S
	0	86	3.94 a	0.215 a	1.071 a	115.9 a	23.17 a	128.3
	2		3.25 a	0.224 a	1.005 ab	100.6 a	22.67 ab	123.7
	4		3.43 a	0.156 b	0.766 b	99.2 a	19.76 bc	118.0
	6		2.15 b	0.150 b	0.990 b	97.3 a	18.62 c	114.0
	8		1.99 b	0.116 bc	0.983 b	96.5 a	17.17 c	103.6
	10		1.44 b	0.093 c	0.871 c	69.7 b	8.80 d	108.7
1999/2000			**	*	**	*	*	*
	0	70	3.49 a	0.177 a	1.132 a	207.6 a	34.44 a	132.1 a
	2		3.20 ab	0.197 a	1.061 ab	175.3 ab	36.10 a	128.2 ab
	4		2.76 ab	0.131 b	1.036 b	152.4 ab	31.86 b	120.9 b
	6		2.50 b	0.121 bc	1.003 b	157.6 ab	30.60 b	123.0 b
	8		1.54 c	0.092 c	0.814 c	145.9 b	29.76 b	125.5 b
	10		1.48 c	0.060 d	0.806 c	129.7 b	20.29 c	123.5 b
			**	**	**	**	**	**
	0	86	4.35 a	0.256 a	1.790 a	190.4 a	29.97 a	174.4 a
	2		3.84 ab	0.269 a	1.828 a	159.7 ab	28.61 a	149.5 ab
	4		3.96 ab	0.232 b	1.603.b	133.2 abc	21.93 b	132.5 bc
	6		3.37 b	0.211 b	1.608 b	125.6 bc	18.05 b	121.9 c
	8		2.15 c	0.132 c	1.186 c	123.0 bc	17.49 b	110.0 c
	10		1.75 c	0.090 d	0.967 d	83.3 c	6.75 c	75.8 d

*, ** and N.S. indicate $p<0.05$, $p<0.01$ and not significant, respectively. Means designated by the same letters are not significantly different at 5% level, using DMR test.

Table (4): Dry weight (g/plant) of canary grass and wild oats at harvest as affected by different levels of chopped-sunflower stems in 1998/99 and 1999/2000 seasons.

Chopped sunflower (%)	Canary grass		Wild oats	
	1998/99	1999/2000	1998/99	1999/2000
	*	**	*	*
0	0.272 a	0.381 a	2.902 a	4.522 a
2	0.196 ab	0.395 a	2.729 ab	4.817 a
4	0.133 b	0.258 b	2.512 bc	4.014 b
6	0.158 b	0.203 bc	2.464 bc	3.992 b
8	0.175 b	0.181 bc	2.315 cd	3.885 b
10	0.122 b	0.106 c	2.041 d	3.028 c

* and **, indicate $p<0.05$ and $p<0.01$, respectively. Means designated by the same letters are not significantly different at 5% level, using DMR test.

5. Grain yield and its attributes of wheat :

Plant height of wheat plants at harvest, grain yield/plant and its attributes as affected by chopped-sunflower stems in pots soil during 1998/99 and 1999/2000 seasons are shown in Table (5).

Data revealed that chopped-sunflower stems in pots soil significantly reduced plant height, number of tillers and spikes/plant, spike length, number of spikelets and grains/spike, 1000- grain weight (in the 2nd season, only) and grain yield/plant. The degree of reduction increased as the amount of sunflower stems debris into pots soil progressively increased from 2% to 10% (w/w). Increasing sunflower debris level above 6% (w/w) substantially reduced grain yield of wheat/plant and the most yield attributes characterestices. Such reduction in grain yield/plant might be attributed to decrease in number of grains/spike in both seasons. The contribution of spike length in the reduction was recognized at the highest level. These variable effects were presumably due to the production and release of different concentrations of allelochemicals from sunflower stem debris. Allelochemicals at low concentration enhanced the growth and yield of wheat, while at high concentration depressed it (Ahmed *et al.*, 1994 and Naseem, 1997).

Table (5): Grain yield and its attributes as affected by different levels of chopped-sunflower stems in pots in 1998/99 and 1999/2000 seasons.

Season	Chopped Sunflower % (w/w)	Plant height (cm)	No. of tillers/plant	No. of spikes/plant	Spike length (cm)	No. of spikelets/ spike	No. of grains/ spike	1000-grain weight (g)	Grain yield (g/plant)
1998/99		**	*	*	*	*	*	N.S	*
	0	75.9 a	2.22 a	1.54 a	8.56 a	17.79 a	25.2 a	47.8	1.855 a
	2	76.9 a	1.88 ab	1.26 b	8.45 a	17.26 ab	27.1 a	47.6	1.617 a
	4	76.8 a	1.60 bc	1.10 bc	7.85 a	16.86 ab	28.9 a	47.8	1.525 a
	6	76.8 a	1.59 bc	1.03 bc	8.33 a	16.03 b	30.0 a	48.3	1.493 a
	8	73.3 a	1.18 cd	1.03 bc	8.08 a	15.98 b	21.7 b	48.8	1.087 b
	10	60.5 b	1.03 d	1.00 c	6.71 b	13.32 c	15.6 c	47.9	0.750 b
1999/2000		**	*	**	*	*	**	*	**
	0	81.6 a	2.86 a	1.93 a	8.90 a	18.82 a	38.1 a	48.8 a	3.294 a
	2	85.8 a	2.34 a	1.52 b	9.29 a	19.46 a	40.0 a	44.8 a	2.714 a
	4	82.7 a	1.76 b	1.44 b	9.05 a	18.70 a	41.8 a	45.0 a	2.711 a
	6	82.3 a	1.64 bc	1.07 c	8.99 a	18.12 a	41.5 a	43.7 b	1.943 b
	8	79.0 a	1.18 cd	1.05 c	8.67 a	17.96 a	23.7 b	43.7 b	1.138 c
	10	64.9 b	1.05 d	1.01 c	7.61 b	15.58 b	17.3 c	43.0 b	0.752 c

*, ** and N.S. indicate $p<0.05$, $p<0.01$ and not significant, respectively. Means designated by the same letters are not significantly different at 5% level, using DMR test.

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الملخص العربى

التأثير الأليلوباثى لعباد الشمس

ثانيا: التأثير الأليلوباثى لتبن سيقان عباد الشمس على القمح والفلارس والزمير

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أجريت تجارب فى الأصص بالصوبة الخاصة بكلية الزراعة بكفرالشيخ- جامعة طنطا لتحديد تأثير خلط تبن عباد الشمس بالتربه الطينية بنسب (صفر، ٢، ٦، ٨، ١٠%) وزن من تبن عباد الشمس الى وزن تربة الاصيص على الانبات والنمو وكذا محصول الحبوب فى القمح وكذلك على انبات ونموحشيشتى الفلارس والزمير خلال موسمى ١٩٩٩/٩٨ ؛ ٢٠٠٠/٩٩. وقد تم استخدام التصميم تام العشوائية فى اثنى عشر مكررة فى تنفيذ التجارب. **وتتلخص أهم النتائج المتحصل عليها فيما يلى:**

* أدى خلط عباد الشمس بالتربة أعلى من ٨% الى انخفاض معنوى فى نسبة إنبات حبوب القمح النهائية فى الموسم الأول فقط مقارنة بعدم إضافة تبن العباد (المقارنه). بينما أدت زيادة كمية تبن عباد الشمس المضاف للتربه أكثر من ٤% الى انخفاض معنوى فى نسبة إنبات بذور الفلارس والزمير وأخرت بداية إنباتها بكلا الموسمين.
* تأثر دليل سرعة الإنبات، دليل متوسط وقت الإنبات معنويا بزيادة تبن سيقان عباد الشمس المضاف الى التربة بمعدل أعلى من ٦% بالنسبة للقمح و بزيادة المعدل عن ٢% فى كلا من الفلارس والزمير.
* نقص الوزن الجاف لنبات القمح معنويا بزيادة معدل خلط تبن سيقان عباد الشمس أعلى من ٤% بينما نقص الوزن الوزن الجاف لنباتات الفلارس والزمير تدريجيا بزيادة معدل خلط تبن سيقان عباد الشمس المضاف لتربه الأصص لأعلى من ٢% مقارنة بمعاملة المقارنة.
* نقصت مساحة أوراق القمح وكل من الحشيشتين تحت الدراسة لكل نبات معنويا عند معدل سيقان عباد ٤% فأكثر ، فيما عدا الزمير عند ٨٦ يوم بعد الزراعة فى الموسم الأول حيث لم يكن التأثير معنوياً.
* أدت زيادة معدل اضافة تبن سيقان عباد الشمس بتربة الأصص من (صفر الى ١٠% وزن/وزن) الى انخفاض فى ارتفاع نباتات القمح عند الحصاد، عدد الأشطاء والسنابل/نبات، طول السنبلة، عدد السنيبلات والحبوب لكل سنبلة، وزن الـ١٠٠٠ حبة (فى الموسم الثانى فقط) ولم يتأثر محصول حبوب النبات بتركيزات تبن عباد الشمس حتى المعدل ٦% وبالتالى لم يظهر الانخفاض المعنوى للمحصول الا عند المعدلات ٨%، ٦% فقط للعامين الأول و الثانى على التوالى.