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INFLUENCE OF ALLELOCHEMICALS LIBERATED FROM SOIL DECAYED PLANTS ON THE GERMINATION AND SEEDLING DEVELOPMENT OF SOME CROPS

[28]

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ABSTRACT

The influence of allelochemicals liberated from purslane, oats, nutsedge, alfalfa, sunflower, onion, and garlic decayed plant parts residues on germination and seedling development of maize, alfalfa, wheat and onion crops was studied . Therefore, plant parts were mixed with soil and kept moist for two months after which seeds of each of the four tested crops were planted. Decayed residues have more negative effect on maize and alfalfa crops than winter crops seedling parameters. The maximum inhibitory effect was achieved from purslane decayed residues against summer crops. Maize seedling growth was stimulated with nutsedge decayed residues. Moreover, puslane decayed residues have a maximum inhibitory effect whereas sunflower, garlic and alfalfa caused a moderate inhibitory effect. Meanwhile, onion and oats decayed residues have slight effect on maize growth parameters. Alfalfa decayed residues have a maximum stimulatory effect on wheat seedling growth whereas others treatments had slightly effect on wheat growth. Meanwhile root length was more sensitive to allelochemical than others parameters. The maximum inhibition on alfalfa parameters caused by nutsedge and purslane decayed residues. Alfalfa fresh and dry weight, shoot and root lengths were more sensitive than others were parameters to onion, oats and purslane residues. Onion shoot and root length fresh and dry weight were more sensitive than others parameters to sunflower, onion and purslane decayed residues.

Keywords: Allelochemicals, Decayed plants, Allelopathy, Decomposition, Growth, Seedling

INTRODUCTION

Decayed plant tissue is another important way to allelochemical get out to the environment which had different effects on growth parameters of the following crops. Depending on the concentration of some residues caused great inhibition, others caused growth activation and the third had no significant effect (**Horowitz and Friedman 1971**). **Molish (1937)** stated that the term "allelopathy" originally described the biochemical interaction, both harmful and beneficial, which

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ccur between microorganisms and, its ommon usage now refers to detrimental effects of higher plants of one species (the donor) upon the germination, growth or development of another species (the receptor). **Zimdahl (1993)** defined allelopathy as a form of plant interference that occurs when one plant, through living or decaying tissue, interferes with the growth of another plant via a chemical inhibitor. **Patrick *et al* (1964)** reported that the decomposition of plant residues potentially provides the largest quantity of allochemicals that may added to rhizosphere as death of any plant part occurs, materials compartmentalized in cell are released and these in the cell wall complex will eventually be recycled. Important variables in this process with regard to allelopathy are the nature of the plant residue, the soil type, and conditions of decomposition.

Horowitz and Friedmen (1971) incubated dried subterranean organs of *Cynodon dactylon, Cyperus rotundus* and *Sorghum halepense* in light and heavy soils for 1,2,or3 months. After removal of the decayed plant material, the residual bioactivity of the soil was assayed by barley sown directly into the soil and by a barley radical length test on an ethanolic extract of the soil. The two assays gave similar results. In general, the inhibition of growth was proportional to the concentration of plant material in the soil, and was greater in light than in heavy soil. *C.rotundus* caused greater inhibition and *S. Halepense* than by *C. dactylon*. A few instances of growth stimulation were recorded. **Petrson and Harrison (1997)** reported that growth of alfalfa (*Medicago sativa L.*), cowpea (*Vigna unguiculata L.walp*) and yellow nutsedge (*Cyperus esculentus L.*) was inhibited by decaying tissue of sweet potato.

Abdul-Rahman and Habib (1989) showed that decomposed *Medicago sativa* roots and their associated soil produced a 51-56% reduction in *Imperata cylindrica* seed germination, and an average of 88% reduction in shoot and root length. Decayed and undecayed mixtures of *M. sativa* roots and soil at 0.15:1(w/ w) inhibited *I.cylindrica* seedling when both were grown together in nutrient culture. Caffeic, chlorogenic, iso chlorogenic, p-coumaric, p.OH benzoic, and ferulic acid were identified in root exudates and residues of alfalfa.

The main objective of this investigation was to investigate the influence of allelochemicals liberated from decayed plant parts of seven plant species on the germination and seedling development of four selected crops.

MATERIALS AND METHOD

Experiments were performed at the Plant Protection Department of Desert Research Center, Mataria, Cairo, Egypt. The purpose was to investigate the allelopathic effects of substances released from some plants by residue decomposition on germination and growth of associated plants.The tested plants were: purple nutsedge (*Cyprus rotundus ,L.*) as a perennial weed, purslane (*Portulaca oleracea*, L.) as a summer annual weeds, sunflower (*Helianthus annuus, L.*) as a summer crop, alfalfa (*Medicago sativa ,L.*) as a perrenial forage crop, oats (*Avena sativa ,L.*) as a winter crop, garlic (*Allium sativum,* L.) and onion (*Allium cepa, L.*) as a vegetable crops.

The allelopathic effect of these plants were tested against wheat (*Triticum aestivum*, L), onion (*Allium cepa, L*).as a winter crops, maize (*Zea mays*,L.) as a summer crop and Alfalfa (*Medicago sativa L.*) as a perennial forage crop.

Four experiments were conducted, one for each of the previous crops. The tested plants were collected at the flowering stage, separated to roots and vegetative parts, air dried, cut into about 1cm segments and thoroughly mixed with soil in pots at the rate of 1% (w/w). Untreated soil was served as control. Plastic pots 15cm in diameter and 14cm in height were filled with mixed soils (1kg), watered and kept moist for two months. At the end of the incubation period, five seeds of each tested plant except for alfalfa (10 seeds) were planted in each pot. Pots were placed in greenhouse and arranged in a completely randomized design in four replications. Pots were gently and regularly irrigated at 3 day intervals with suitable amounts of water. Germination percentage was recorded. Whereas shoot and root lengths (cm), fresh and dry weight (g/plant) and number and area of leaves (cm^2/plant) were estimated after 4 weeks from sowing.

Statistical analysis was performed according to **Snedecor and Cochran** (1990). Treatment means were compared by L.S.D test at 5%level of probability.

RESULTS AND DISCUSSION

1- Effect of decayed plant residues on maize germination and seedling growth

As shown in **Table (1)**, results indicate that decayed plant residues had different influences on maize germination and seedling growth. Some plant residues caused grades of inhibition, others caused growth activation and the third had no significant effect. All the tested decayed plant residues inhibited maize seed germination differently. Purslane residues showed the most inhibitory as it reduced germination percentage by 30%, while sunflower, garlic and onion had moderate effects by 20, 20 and 20%. On the other hand, alfalfa, oats and nutsedge had the lowest effect on maize germination percentage by 5, 5 and 5%, respectively, as compared with control treatment.

Purslane residues caused, also the greatest inhibition in maize shoot length followed by sunflower residues, showing 39.4 and 19.5%, reduction, respectively. On the contrary, nutsedge and garlic residues had significant activation effect on maize seedling shoot growth, revealing 49.5 and 16.2 %, increase, respectively. Other treatments had no significant effect on maize shoot length. The same trend was observed on maize root elongation. Purslane and sunflower residues showed inhibition effect by 47.3 and 26.1%, respectively.

Data in the same Table indicate that purslane and sunflower had inhibitory effect on maize shoot fresh weight by 32.5 and 21.7%, respectively. On the other hand nutsedge and alfalfa residues showed significant activation effect by 27.2 and 12.5%, respectively. As for maize root fresh weight, data indicate that nutsedge residue was the only plant, which had an activation effects by 14.4%. However purslane caused a great inhibitory effect on root fresh weight, followed by sunflower and garlic. Alfalfa and onion had a moderate inhibitory effect. Above mentioned treatments reduced maize root fresh weights by 57.8, 40.5, 35.9, 19.8 and 16.3%, respectively.

Table 1. Effect of decayed plant residues on maize germination and seedling growth.

Decayed plant	Germin.	Length (cm)		Fresh weight (g)		Dry weight (g)		Leaves/plant	
		Shoot	Root	Shoot	Root	Shoot	Root	Number	Area $(cm)^2$
Control	100.0	24.18	28.50	11.40	7.23	1.16	1.33	6.23	173.91
Alfalfa	95.0	25.30	29.99	12.83	5.80	1.15	1.38	6.63	189.53
Sunflower	80.0	19.45	21.05	8.93	4.30	0.70	0.66	6.08	165.88
Garlic	80.0	28.08	34.31	10.20	4.63	0.71	0.91	7.29	157.78
Onion	80.0	24.75	25.85	11.33	6.05	0.99	1.18	6.15	176.77
Oats	95.0	23.28	28.15	11.70	6.85	1.02	0.98	6.50	167.67
Purslane	70.0	14.65	15.01	7.70	3.05	0.53	0.70	6.45	84.27
Nutsedge	95.0	36.14	31.03	14.50	8.27	2.17	1.33	7.25	206.35
LSD(0.05)	3.19	3.49	2.439	1.167	0.643	0.423	0.456	0.89	5.261

*Each figure in the table represents the average of 3 samples

Purslane, sunflower and garlic decayed residues caused significant reduction on maize seedling shoot dry weight, relative to the untreated control treatment by 54.3, 39.6 and 38.8%, respectively. Nutsedge residues was the only treatment which increased maize seedling shoot dry weight by 87.1 %. Also, purslane and sunflower reduced maize root dry weight by 47.4 and 50.4 %, respectively. As for leaf numbers, decayed residues of nutsedge and garlic caused significant activation amounted to 16.1 and 17.1%, respectively.

Nutsedge and alfalfa decayed residues increased maize leaf area by 18.6% and 9.0 %, respectively. On the contrary, purslane, garlic, sunflower and oats residues had inhibitory effects on maize leaf area. Purslane residues was the most inhibitory. It decreased leaf area by 51.5%. Garlic had a moderate effect while sunflower and oats had slight causing inhibitory effect, showing 9.31, 4.6 and 3.6% reduction, respectively.

In general, the aforementioned results indicate that nutsedge decayed residues activated maize seedling growth parameters, while purslane was the most inhibitory effect residues. Sunflower, garlic and alfalfa had moderate effect and only affected some growth parameter. Onion and oats had slight or moderate effects on maize seedling growth. These results are in agreement with those obtained by **Hoffman *et al* (1996).** In this respect **Fayed *et al* (1997b)** reported that allelochemicals liberated from decayed underground parts of weeds affect division and elongation of meristematic cells of the germinated seeds. Thus inhibited was height and decreased number of leaves per crop plant (sugerbeet) and consequently reduced areas of total leaves per plant.

2- Effect of decayed plant residues on wheat germination and seedling growth.

Data in **Table (2)** indicate that decayed plant residues inhibited wheat seed germination in different degrees. Sunflower, garlic and oats residues had moderate effects. Alfalfa, onion and nutsedge gave highest reduction on germination percentage (80% compared with 90% for the control).

Sunflower and alfalfa residues had significant activation effect on wheat seedling shoot growth reached 17.2 and 22.7 %, respectively. The contrary was obtained with onion residues, which caused significant decrease in shoot length by 12.6%. On the other hand nutsedge, oat, garlic and sunflower decayed residue had significant activation on root growth, by 60.1, 31.3, 28.4 and 18.5%, respectively.

Data in the same Table indicate that alfalfa decayed residues showed activation on both shoots and roots fresh weight of wheat seedling by 50% and 14.5%, respectively. Also, nutsedge and alfalfa decayed residues increased shoot dry weight by 49.9 and 61.2 %, respectively. Nutsedge, purslane and alfalfa activated wheat root dry weight by 45.5, 45.5 and 31.7 %, respectively.

Decayed plant residues had no significant effect on wheat leaves number as compared with untreated control. Purslane, sunflower, garlic, oats and alfalfa decayed residues increased wheat leaf area by 34.4, 54.9, 47.7, 37.2 and 25.5%, respectively. The contrary was recorded with nutsedge residues showing 32.61% inhibition.

As conclusion, the aforementioned results indicate that alfalfa decayed residue was mostly achieved activation in wheat seedling growth. Growth traits of wheat seedling seems to be positively accelerated by residues of all the tested plants except the inhibitory impacts of residues of onion on shoot length and nutsedge on leaf area of wheat plant. These results are in agreement with these obtained by **Horowitz and Friedman (1971)** and **Oleszek and Jurzysta (1987).**

3- Effect of decayed plant residues on alfalfa germination and seedling growth

Data in **Table (3)** indicate that decayed plant residue had no significant effect on alfalfa seed germination except purslane residues, which caused significant inhibition. Meanwhile, onion residue significantly activated alfalfa shoot growth by 25.9%. Whereas, purslane and nutsedge decayed residues decreased root length by 14.2 and 7.8 %, respectively. Garlic and onion residues had significant activation effects on alfalfa root growth by 6.6 and 9.4%, respectively. On the other hand, alfalfa, sunflower, oats, purslane and nutsedge residues decreased root length by 9.7, 6.8, 10.1, 23.6 and 19.3%, respectively.

As for shoot fresh weight, results in **Table (3)** indicate that garlic, onion, purslane and nutsedge residues showed activation effect amounted to 23.3, 52.9, 33 and 29.6%, respectively on alfalfa root fresh weight. Data, also showed that alfalfa, sunflower, onion and purslane decayed residues activated alfalfa root fresh weight by 31.2, 21.8, 24.6and 11.6%, respectively. Meanwhile, all the applied decayed plant residues had no significant effect on alfalfa seedling shoot dry weight compared with the control.

Table 2. Effect of decayed plant residues on wheat germination and seedling growth.

Decayed plant	Germin.	Length (cm)		Fresh weight (g)		Dry weight (g)		Leaves/plant	
		Shoot	Root	Shoot	Root	Shoot	Root	Number	Area $(cm)^2$
Control	90.0	21.70	22.63	1.40	2.82	0.647	0.44	4.00	34.62
Alfalfa	80.0	26.62	26.10	2.10	3.23	1.043	0.58	4.10	43.44
Sunflower	85.0	25.43	26.82	1.60	2.55	0.60	0.43	4.25	53.65
Garlic	85.0	22.46	29.05	1.60	2.80	0.392	0.44	4.00	51.14
Onion	80.0	18.95	20.10	1.45	2.63	0.64	0.38	4.00	39.00
Oats	85.0	21.45	29.70	1.65	2.75	0.67	0.52	4.00	47.47
Purslane	90.0	23.20	25.25	1.10	2.60	0.94	0.64	4.00	46.53
Nutsedge	80.0	23.62	36.23	1.75	2.83	0.97	0.64	4.00	23.31
LSD (0.05)	3.451	2.10	3.8	0.43	0.38	0.315	0.115	NS	9.60

*Each figure in the table represent the average of 3 samples

Table 3. Effect of decayed plant residues on alfalfa germination and seedling growth.

Decayed Plant	Germin. %	Length (cm)		Fresh weight (g)		Dry weight (g)		Leaves/ plant	
		Shoot	Root	Shoot	Root	Shoot	Root	Number	Area $(cm)^2$
Control	96.67	7.13	7.97	2.57	1.46	0.29	0.17	6.27	33.28
Alfalfa	93.33	7.20	7.20	2.79	1.92	0.28	0.13	6.83	30.62
Sunflower	93.33	6.73	7.43	2.70	1.78	0.26	0.19	6.67	33.98
Garlic	100.0	7.53	8.50	3.17	1.48	0.33	0.12	6.33	34.37
Onion	100.0	8.98	8.72	3.93	1.82	0.35	0.18	8.10	39.73
Oats	100.0	6.90	7.17	2.64	1.51	0.25	0.12	6.27	33.84
Purslane	90.0	6.12	6.08	3.42	1.63	0.36	0.16	5.33	28.24
Nutsedge	100.0	6.57	6.43	3.33	1.57	0.36	0.15	4.82	33.30
LSD(0.05)	4.99	0.50	0.52	0.40	0.12	0.09	0.05	0.51	2.59

*Each figure in the table represents the average of 3 samples

Also, garlic and oats residues decreased alfalfa seedling root dry weight by 29.4 and 29.4%, respectively.

Decayed residues of nutsedge and purslane reduced significantly alfalfa leaf number by 23.2 and 14.9%, respectively. The contrary was obtained with alfalfa and onion, showing 8.9and 29.3%, increase than the check, respectively. Meanwhile onion decayed residues increased leaf area by 19.3%, but, alfalfa and purslane residues caused 7.9 and 15.2%reduction, respectively,

In general, the aforementioned results indicate that onion residue activated alfalfa growth parameters, whereas purslane and nutsedge seems with inhibitory effect on seedling elongation and leaves formation. The other plant residues showed various activation or inhibitory actions according to the tested traits. Moreover, it is worth noting that alfalfa residues manifested a deleterious autopathy impact on their newly germinated seedlings, and decreased significantly root length and leaves area of alfalfa seedling. Those results are in agreement with these obtained by **Mishustin & Naumova (1955); Patrick *et al* (1964); Abdul-Rahman & Habib(1989) and Chung & Miller (1995 a & b).**

4- Effect of decayed plant residues on onion germination and seedling growth

Data in Table (4), indicate that decayed plant residue activated significantly onion seed germination in different degrees. Comparing with the control all the applied plants residues activated to different extent germination percentage of onion seeds. Alfalfa, sunflower and onion residues were the potent treatment in this respect with germination percentage values of 100% comparing with 85%for the control. Garlic, oats, purslane and nutsedge residues, stimulated germination % of onion seeds to be 95% compare3d with 85% for the control.

Table 4. Effect of decayed plant residues on onion germination and seedling growth.

Decayed Plant	Germin. %	Length (cm)		Fresh weight (g)		Dry weight (g)		Leaves/ plant	
		Shoot	Root	Shoot	Root	Shoot	Root	Number	Area $(cm)^2$
Control	85.00	21.53	17.18	10.10	3.63	2.40	0.34	3.50	95.25
Alfalfa	100.0	26.45	16.38	11.75	5.30	2.30	0.66	4.00	87.32
Sunflower	100.0	24.58	11.78	14.40	4.33	2.38	0.39	4.25	131.06
Garlic	95.0	25.60	13.33	14.33	4.20	2.60	0.42	4.00	126.11
Onion	100.0	25.10	15.45	11.72	4.30	1.69	0.46	3.50	139.00
Oats	95.0	25.90	16.33	12.85	4.70	2.30	0.43	4.00	100.43
Purslane	95.0	23.58	14.93	12.73	3.80	2.17	0.24	3.25	82.50
Nutsedge	95.00	24.73	15.33	12.10	3.9	2.035	0.38	3.75	123.57
LSD (0.05)	6.10	4.38	4.31	1.310	0.43	0.43	0.11	NS	10.50

*Each figure in the table represent the average of 3 samples.

Alfalfa residue had significant activation effect on onion seedling shoot growth by 22.8%. The different trend was observed on onion root length. Sunflower residue had significant inhibition effect on onion root length by 31.4%. For shoot fresh weight, results in Table (4) indicate that alfalfa, sunflower, garlic, onion, oats, purslane and nutsedge residues caused 16.4, 42.6, 41.8, 16.4, 27.2, 26.0 and 19.8% increase, respectively.

As for the effects on onion root fresh weight, alfalfa, sunflower, garlic, onion and oats decayed residues caused activation by 46, 19.5, 15.7, 18.5 and 29.5%, respectively. Data in the same table showed that onion residues caused inhibition effect on onion shoot dry weight, by 29.6 %. Also, alfalfa and onion residues increased onion root dry weight by 94.1 and 35.3%, respectively.

Meanwhile decayed plant residues had no significant effects on onion leaf number as compared with untreated control. Whereas sunflower, garlic, onion and nutsedge decayed residues increased onion leaves area by 37.6, 32.4, 45.9 and 29.7%, respectively. On the contrary, purslane residues decreased leaf area by 13.4%.

In general, the aforementioned results indicate that all plant decayed residues activated germination percentage and fresh weight of shoot and roots of onion seedling. Alfalfa decayed residue had activation effect on most of onion seedling growth parameters. Inhibitory impact of plant residues was limited only in root length, shoot dry weight and leaves area / seedling with residues of sunflower, onion and purslane, respectively. These results are in agreement with that obtained by **Moore & Waid (1971) and Macharia & Peffley (1995).**

Stimulation and activation lumped together in crops growth parameters, response to decayed residues depending on the amount and type of allelochemicals include biomass accumulations. Some growth pramaters seems to be more sensitive to allelochemicals and others seems to be low responsive to decayed allelochemicals. It may be due to differences in allelochemical distributions and partitioning responsible for diference in interference. **Fayed *et al* (1997b)** suggested that weed residues may be phytotoxic and greatly reduced germination and establishment of the following crop seedling. This may be important in reducing the stand of the following crop plant and its ability to exploit resources earlier and could reduce their competitive abilities and consequently decline their development and productivity. Our results are in harmony with **Fayed *et al* (1997 a & b).**

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تأثير الاليلوكيميائيات المتحررة من النباتات المتحللة فى التربة على ا نبات وتكشف بادرات بعض المحاصيل

[٢٨]

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٢- مركز بحوث الصحراء- المطرية- القاهرة- مصر

أجريت ٤ تجارب أصص في مركز بحوث الصحراء بهدف دراسة تأثير النواتج الاليلوباثية المتحررة من تحلل أجزاء سبعة أنواع نباتية هى الرجلة والشوفان والسعد والبرسيم الحجازي وعباد الشمس والبصل والثوم، حيث تم تقطيع نباتات كل نوع الى قطع صغيرة و دفنها فى تربة اصص الزراعة لمدة شهرين مع توفير الرطوبة للمساعدة على تحللها وبعدها تمت زراعة تقاوي المحاصيل الأربعة التي سيتم دراسة تأثير هذه المتبقيات المتحللة على إنباتها ونمو بادراتها مع كل محصول فى تجربة مستقلة فى تصميم تام العشوائية فى ٤ مكررات.

أظهرت النتائج أن المتبقيات المتحللة في التربة كانت اكثر أضرارا بإنبات و نمو بادرات الذرة الشامية والبرسيم الحجازي مقارنة بالقمح والبصل وكانت متبقيات حشيشة الرجلة هي اكثر المتبقيات أضرارا بإنبات ونمو بادرات الذرة الشامية والبرسيم الحجازي وكانت متبقيات عباد الشمس والثوم والبرسيم الحجازي متوسطة في تأثيرها التثبيطي على نمو بادرات الذرة الشامية على حين كانت بقايا البصل والشوفان ضعيفة التأثير على نمو هذه البادرات وعلى العكس كان لمتبقيات حشيشة السعد تأثيرا منشطا على نمو بادرات نفس المحصول.

تأثر إنبات القمح سلبيا بمتبقيات البرسيم الحجازي والبصل والسعد في التربة على حين لم يثبط نمو بادراتة سوى بقايا البصل بتثبيطها لنمو الريشة وبقايا السعد لتثبيطها لمساحة الأوراق وعلى العكس أحدثت البقايا المتحللة للبرسيم الحجازي وأحيانا عباد الشمس زيادة في طول الريشة والوزن الغض والجاف للريشة والجزير لبادرات القمح. كانت البقايا المتحللة للسعد والرجلة هي أكثر المتبقيات أضرارا لإنبات ونمو

بادرات البرسيم الحجازي على حين كانت لبقايا البصل والثوم تأثيراً منشطاً على بعض صفات نمو بادرات البرسيم- أما البصل كمحصول تحت الدراسة فلم يتأثر إنباتة بنواتج تحلل أي من هذه الأنواع السبعة إلا أن بعض صفات نمو بادراته تأثرت سلبيا بنواتج تحلل متبقيات عباد الشمس والبصل والرجلة على حين كان لبقايا البرسيم الحجازي المتحللة في التربة تأثيراً منشطاً على معظم قياسات نمو بادرات هذا المحصول.

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