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ALLELOPATHIC POTENTIAL OF BUR PARSLEY [*Tungenia latifolia* (L.) Hoff.] SEED EXTRACTS

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ABSTRACT

Experiments were conducted to determine the effect of different concentrations of seed extracts of bur parsley on germination and growth of three dryland wheat (*Triticum aestivum* L.) cultivars (Sardari, Kalheidari and Tabasi) and bur parsley seeds. Polyethylene glycol (PEG) was used to determine the influence of osmotic potential on the bioassay materials. Bur parsley seed extract concentrations of 60, 80 and 100% of original strength significantly reduced the germination of three wheat cultivars after three days. After seven days, germination of Kalheidari wheat seeds was significantly reduced by using seed extract concentrations of 40, 60, 80 and 100% and germination of Sardari and Tabasi wheat seeds was significantly reduced by using seed extract concentrations of 80 and 100% Seed extract concentrations also reduced coleoptile and radicle lengths in the three wheat cultivars. Bur parsley seeds were not sensitive to the lower concentrations of their own extracts. The results of this study show the allelopathic potential of bur parsley seed extracts on the three dryland wheat cultivars.

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پتانسیل آللو پاتیک عصاره بذر علف هرز ماستونک

حسین غدیری و رضا حمیدی
به ترتیب استاد یار و دستیار فنی بخش زراعت و اصلاح نباتات دانشکده کشاورزی دانشگاه شیراز، شیراز، ایران.

چکیده

مطالعات آزمایشگاهی برای تعیین اثر غلظت‌های مختلف عصاره بذر علف هرزماستونک روی جوانه‌زدن و رشد بذر سه رقم گندم دیم (سرداری، کل‌حیدری و طبسی) و بذر ماستونک انجام گردید. از پولی‌اتیلن گلیکول برای تعیین اثر پتانسیل اسمزی روی قسمتهای گیاهی استفاده گردید. غلظتهای عصاره بذر ۶۰، ۸۰ و ۱۰۰ درصد پس از سه‌روز، جوانه زدن سه‌رقم گندم دیم را بطور معنی داری کاهش دادند. پس از هفت روز، جوانه‌زدن رقم کل‌حیدری در غلظتهای ۴۰، ۶۰، ۸۰ و ۱۰۰ درصد و جوانه‌زدن ارقام سرداری و طبسی در غلظتهای ۸۰ و ۱۰۰ درصد بطور معنی‌داری کاهش یافت. غلظتهای عصاره بذرماستونک همچنین، طول ساقه چه و ریشه چه سه رقم گندم دیم را کاهش دادند. بذور ماستونک در برابر غلظتهای پایین عصاره خود حساسیت نشان ندادند. این نتایج نشان‌دهنده پتانسیل آللوپاتیک عصاره بذر علف هرزماستونک روی سه رقم گندم دیم می‌باشد.

INTRODUCTION

Crop yield reductions may occur due to either competition between crop and weed for water, nutrients, light and CO_2 (9) or through the release of some toxins (19,20) from living or nonliving plant parts, a phenomenon known as allelopathy. Allelopathy occurs widely in natural plant communities (7) and is postulated to be a mechanism by which weeds interfere with crop growth (1, 2, 7, 14, 17, 21). This interference includes reduction in seed germination, shoot and root growth and crop yield. The effects of naturally occurring inhibitors in seeds in controlling germination have received considerable attention. Crocker and Barton (3), Evenari (4),

Mayer and Poljakoff-Mayber (12) and Toole *et al.* (23) have made extensive reviews on the germination inhibitors and their possible role in the germination processes in seeds.

Le Tourneau *et al.* (11) found that water extracts from 23 common weed and crop species inhibited germination and growth of wheat seedlings. Guenzi and McCalla (8) showed that the water extracts of a numher of crop residues inhibited the germination and growth of sorghum (*Sorghum bicolor*), corn (*Zea mays*) and wheat (Triticum aestivum) in a laboratory experiment. The phytotoxic effect of 14 aqueous root extracts upon germination and seedling length of 15 plant species was reported by Lawrence and Kilcher (10).

Bur parsley is a dominant troublesome weed in most dryland wheat fields in Fars province (5, 6, 15) and its natural population has been reported in rangelands and many other parts of Iran (13). It is a summer annual weed, from umbelliferae, reproducing by seed. Visual observations by authors in dryland wheat fields in Fars province indicated a reduction in wheat emergence or suppression of growth in those area of the fields where bur parsley plants were abundant.

The following study was carried out to determine the inhibitory effect of water extracts of bur parsley seeds on germination, coleoptile and radicle growth of three dryland wheat cultivars and bur parsley.

MATERIALS AND METHODS

Mature bur parsley seeds were harvested in early July, 1990 from the experiment station farm, College of Agriculture, Shiraz University, located in Bajgah valley, 18 km north of Shiraz, Iran. Bur parsley seeds were combined and stored at room temperature until experiments were conducted in fall 1990. Seeds of three dryland wheat cultivars (Sardari, Kalheidari and Tabasi) were used in this study.

Seeds of bur parsley were soaked in distilled water in the ratio of 1:4.

The container was shaken at intervals and after 24 hr, the extract was collected and filtered twice using Whatman No. 2 filter paper and considered as full strength (100%). Aliquots of the extract were taken and diluted to 80, 60, 40 and 20% strength with distilled water. Electrical conductivity of each extract concentration was measured by using an electrical conductivity measuring set, and the osmotic potential was calculated by the equation (osmotic potential=0.36 electrical conductivity of the extract) (24). Although this equation is strickly used for inorganic materials, it was used in our study to determine the concentration of PEG to create equivalent osmotic potential.

Twenty five wheat seeds (or bur parsley seeds) were germinated in 9-cm petri dishes at 15±1 C°. Each petri dish contained two Whatman No. 2 filter papers moistened with 5 ml of the appropriate extract or with distilled water (control treatment). Three ml of each appropriate extract or distilled water (control treatment) were added to each petri dish after 3 days to prevent drying. Lettuce seeds of a local cultivar were used (fifty seeds in each petri dish) as a bioassay material, since the responses of lettuce to germination variables and growth inhibitors are well documented in the literature (3, 4, 12, 23). After 3 and 7 d, germinated wheat and lettuce seeds were counted and the lengths of coleoptiles and radicles of five randomly chosen seedlings were measured and averaged for each replicate within each treatment. The same measurement was performed for bur parsley seeds after 7 and 14 d. A completely randomized design with four replications was used.

Polyethylene glycol, PEG [an inert, nonionic, long-chain polymer : $HOCH_2$ -$(CH_2$-O-CH2) $\times CH_2OH$] (carbowax 6000) has been widely used to maintain experimental media at predetermined water potential values (22). Under the same conditions and concurrent with the bur parsley seed extract expriments, PEG was used in order to distinguish between the inhibitory effect of possible inhibitory substances and that of osmotic concentrations of seed extracts. The same measurements were performed using PEG instead of bur parsley seed extracts.

Data were analyzed by analysis of variance procedure and differences between means were subjected to Duncan's new multiple range test. Data consisted of germination percentage, coleoptile and radicle lengths of wheat and bur parsley seeds and germination percentage and seedling length of lettuce seeds.

RESULTS AND DISCUSSION

Lettuce seed germination and seedling length, known to be readily affected by inhibitory substances, were significantly reduced by all extract concentrations after 3 and 7 d (Table 1). However, germination of lettuce seeds was unaffected by PEG concentrations of 20 and 40% after 3 and 7 d, indicating the effect of allelochemicals in the extracts. The inhibitory effects of extract concentrations of 60, 80, and 100% on lettuce could be the result of either the osmotic potential of the extracts or allelochemicals in the extracts. Maintenance of inhibitory effects of extracts on lettuce seedling length after 7 d could be due to the effects of allelochemicals or osmosis.

Bur parsley seed extract concentrations of 60, 80 and 100% significantly reduced the germination of three wheat cultivars after 3 days (Table 2). During this period, all extract concentrations significantly reduced Kalheidari seed germination. After 7 d, germination of Kalheidari wheat seeds was significantly reduced by using seed extract concentrations of 40, 60, 80 and 100%; and germination of Sardari and Tabasi wheat seeds was significantly reduced by using seed extract concentrations of 80 and 100%. Table 2 also shows the effect of different concentrations of PEG on germination of the three wheat cultivars. Germination of the three wheat cultivars was unaffected by PEG concentrations of 20 and 40% after 3 and 7 d. This indicates that any reduction in wheat seed germination using bur parsley seed extract concentrations of 20 and 40% (e.g. Kalheidari after 3 and 7 d) must have been the result of allelochemicals in the extracts. Germination of three wheat cultivars was affected differently by PEG

concentrations of 60, 80 and 100% after 3 and 7 d. This suggests that any reduction in wheat seed germination using bur parsley seed extract concentrations of 60, 80 and 100% may have been the result of either the osmotic potential of the extracts or allelochemicals in the extracts.

Table 1. Effect of different concentrations of bur parsley seed extracts and PEG on germination and seedling length of lettuce.

Extract % of original strength	Germination after		Seedling length after	
	3 d	7 d	3 d	7 d
----- % -----	---------- % ----------		---------- mm ----------	
0	90a†	95a	14a	36a
20	80b	82b	9b	40b
40	58c	78b	3c	15c
60	20d	50c	2c	14c
80	0e	13d	0c	10d
100	0e	0e	0c	0e
PEG¶ (%)				
0	90a	92a	14a	36a
20	89a	91a	10ab	20b
40	88a	87a	9b	20b
60	76b	78b	7bc	16bc
80	45c	48c	4cd	13c
100	16d	26d	3d	8d

† Means followed by the same letter are not significantly different at the P=0.05 level according to Duncan's multiple range test.

¶ PEG= Polyethylene glycol.

Table 2. Effect of different concentrations of bur parsley seed extracts and PEG on the germination of three wheat cultivars.

Extract % of original strength	Cultivar					
	Sardari		Kalheidari		Tabasi	
	Percent germination after		Percent germination after		Percent germination after	
	3 d	7 d	3 d	7 d	3 d	7 d
----- % -----	---------- % ----------					
0	96a†	97a	81a	93a	89a	91a
20	86a	89a	63b	85a	89a	91a
40	85a	86ab	52b	70b	81a	88a
60	67b	83ab	27c	47c	62b	82ab
80	48c	73bc	24c	43c	55bc	71b
100	21d	62c	17c	37c	42c	69b
PEG¶ (%)						
0	92a	95a	81a	87a	87a	90a
20	86a	94a	80a	85ab	86a	88ab
40	86a	94a	74ab	85ab	85a	85ab
60	84a	92a	64b	84ab	79a	79bc
80	67b	89a	64b	75bc	65b	72c
100	56b	87a	44c	70b	62b	70c

† Means followed by the same letter are not significantly different at the P=0.05 level according to Duncan's multiple range test.

¶ PEG= Polyethylene glycol.

All bur parsley seed extracts and PEG concentrations reduced coleoptile length of three wheat cultivars as compared to control (Table 3). This similar influence of extracts and PEG concentrations suggests that the reduction in coleoptile length may have been the result of either the osmotic potential of the extracts or the presence of allelochemicals in the extracts.

Table 4 shows that all bur parsley seed extract concentrations reduced radicle length of three wheat cultivars as compared with control. Lowest concentration of the extract caused 26, 30 and 38% reduction in radicle length of Sardari, Kalheidari and Tabasi, respectively, after 3 d. The reductions in radicle length by this concentration after 7 days were 20, 32 and 39% for the three cultivars, respectively. The equivalent PEG concentration did not reduce radicle length of the three wheat cultivars as compared to control. Therefore, allelochemicals in the extract must have been responsible for radicle length reduction. Radicle length decreased progressively with increasing extract concentration to full strength. The two highest concentrations of PEG also reduced radicle length of the three wheat culltivars, indicating that the inhibition may be partially an osmotic effect.

Bur parsley seeds were not sensitive to the lower concentrations of their own extracts (Table 5). Only the two highest concentrations of extracts reduced their germination significantly after 7 and 14 d. Considering the effect of the equivalent PEG concentrations on bur parsley seed germination, the inhibition by the two highest concentrations of extracts could by an osmotic effect. Bur parsley radicles were quite sensitive to their own seed extracts and even the lowest concentration

Tabel 3. Effect of different concentrations of bur parsley seed extracts and PEG on coleoptile length of three wheat cultivars.

Extract % of original strength	Cultivar					
	Sardari		Kalheidari		Tabasi	
	Percent germination after		Percent germination after		Percent germination after	
	3 d	7 d	3 d	7 d	3 d	7 d
---- % ----	mm					
0	14a†	94a	19a	101a	23a	106a
20	13a	79b	9b	73b	16b	99a
40	10b	71b	8b	51c	12c	74b
60	8bc	57c	7bc	30d	7d	45c
80	7cd	42d	6c	22de	6d	36de
100	5d	25e	5c	16e	5d	24e
PEG¶ (%)						
0	26a	118a	16a	97a	22a	106a
20	16b	81b	11b	63b	9b	60b
40	15b	71bc	9bc	55b	8b	45c
60	12c	62c	8c	41c	6bc	31d
80	9d	40d	6cd	32cd	5cd	16e
100	4e	32d	4d	25d	3d	8e

† Means followed by the same letter are not significantly different at the P=0.05 level according to Duncan's multiple range test.

¶ PEG= Polyethylene glycol.

Table 4. Effect of different concentrations of bur parsley seed extracts and PEG on radicle length of three wheat cultivars.

Extract % of original strength	Cultivar					
	Sardari		Kalheidari		Tabasi	
	Percent germination after		Percent germination after		Percent germination after	
	3 d	7 d	3 d	7 d	3 d	7 d
---- % ----	mm					
0	35a†	96a	23a	85a	37a	125a
20	26b	77b	16b	58b	23b	76b
40	26b	61c	16b	37c	22b	63c
60	25b	55c	15b	25d	22b	42d
80	24b	38d	15b	21de	21b	32de
100	15c	24e	12b	13e	16c	27e
PEG¶ (%)						
0	34a	117a	22a	95a	26a	108a
20	32a	108a	21a	94a	25ab	105ab
40	32a	107a	20a	94a	24ab	88bc
60	31ab	104a	20a	74b	21b	63d
100	23c	72b	16b	64b	17c	45e

† Means followed by the same letter are not significantly different at the P=0.05 level according to Duncan's multiple range test.

¶ PEG = Polyethylene glycol.

Table 5. Effect of different concentrations of bur parsley seed extracts and PEG on the germination of bur parsley.

Extract % of original strength	Germination after	
	7 d	14 d
---- % ----	---------- % ----------	
0	44a†	68a
20	42a	60a
40	41a	59a
60	33a	50a
80	25b	41b
100	23b	37b
PEG¶ (%)		
0	44a	68a
20	44a	64a
40	43a	55b
60	21b	17bc
80	2c	2cd
100	0c	0d

† Means followed by the same letter are not significantly different at the P=0.05 level according to Duncan's multiple range test.

¶ PEG= Polyethylene glycol.

of the extract caused 47% reduction in their radicle length after 7 d (Table 6). Bur parsley radicle and epicotyl lengths were reduced 76 and 73%, respectively, after 14 days when extract concentration of 40% was used.

Quantities of allelochemicals within plants vary with plant tissue, phenology and environmental conditions (18, 20). The magnitude of allelopathic interactions is dependent upon the concentration and chemical stability of the active compounds and plant tolerance to such compounds and their microbial metabolites (16). Thus, accurately characterizing

Table 6. Effect of different concentrations of bur parsley seed extracts on epicotyl and radicle length of bur parsley.

Extract % of original strength	Germination after 7 d		Germination after 14 d	
	Radicle length	Epicotyl length	Radicle length	coleoptile length
---- % ----	---------- mm ----------			
0	17a†	0	17a	15a
20	9b	0	13a	10a
40	8b	0	4b	4b
60	6c	0	1b	2b
80	2b	0	1b	2b
100	2d	0	0b	1b
PEG¶ (%)				
0	17a	0	17a	15a
20	13ab	0	8a	3b
40	12b	0	7a	3b
60	2c	0	0b	0b
80	0d	0	0b	0b
100	0d	0	0b	0b

† Means followed by the same letter are not significantly different at the P=0.05 level according to Duncan's multiple range test.

¶ PEG= Polyethylene glycol.

allelopathic effects of bur parsley seed extracts can be difficult unless such aspects are taken into account. Identification of the compound (s) responsible for the effects observed in this study would further define these probable allelopathic interactions. The results of this study show the allelopathic potential of bur parsley seed extracts on Sardari, Kalheidari and Tabasi wheat cultivars and that at least some of the phytotoxins are water soluble. These results would infer that allelopathy from bur parsley in dryland wheat fields of Fars province could occur from compounds that are released from bur parsley seeds. Therefore, special attention should be given to the efficient control of this weed in dryland wheat fields.

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