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ALLELOPATHIC EFFECTS OF *Artemisia monosperma* DEL. ON GERMINATION AND SEEDLING GROWTH OF SOME RANGE PLANT SPECIES

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ABSTRACT

Artemisia monosperma is observed to be as one of the first species to dominate disturbed sand dunes in Saudi Arabia. Despite its importance as a sand stabilizer, it has no forage value. It is feared that this species may arrest the natural succession of vegetation. A series of controlled environment experiments was conducted to study the potential allelopathic effects of *A. monosperma* on germination and seedling growth and survival of some species of sandy habitat (*Lasiurus scindicus, Pennisetum divisum, Scrophularia hypericifolia,* and *Plantago boissieri*). In one experiment, seeds were germinated in aqueous extracts prepared from leaves and inflorescence at a ratio of 1:10 weight to volume. Seeds were also germinated in a polyethylene glycol solution having an osmotic potential similar to that of extracts and in distilled water for comparison. In a second experiment, seeds were sown in 10-cm pots filled with sand and covered with a layer of 0, 1, 2 or 3g ground foliage (leaves and inflorescence) to simulate the effect of litter leachate on seedling growth and survival. In a third experiment, the effect of root exudates on seedling growth and survival was studied by irrigating recipient plants with either tap water (control) or leachates from intact one-year old *A. monosperma* plants grown in warm (30°C) or cool (20°C) temperatures. Results indicated that seed germination (except in *S. hypericifolia*) was partially controlled by the osmotic potential of extracts. The aqueous extracts were not significantly different in their effect on germination. The impact on germination ranged between 50-60% reduction in *L. scindicus* to a complete germination inhibition in *S. hypericifolia* and *P. boissieri*. Addition of *A. monosperma* litter to soil surface decreased seedling relative growth rate (RGR) and survival in proportion to the amount of litter added. *Artemisia monosperma* root exudates did not affect seedling biomass but reduced root to shoot ratio regardless of temperature, reduced RGR under warm temperature and decreased seedling survival especially in *S. hypericifolia* where complete seedling death occurred irrespective of temperature. These results have some practical importance when selecting for species in revegetation programs in *A. monosperma*- dominated sandy areas.

INTRODUCTION

Allelopathy is defined as the inhibitory or stimulatory reciprocal biochemical interactions among plants (Rice, 1984). Newman and Rovira, (1975) proposed two modes of action for allelopathy. First, the synergistic effect between competition and allelopathy may provide the producer of phytotoxins with an advantage over its competing species. The second mechanism is "self-balancing negative feed-back" whereby stressed plants produce more allelochemicals to suppress the growth of immediate vegetation, thereby providing enough reduction in competition to remain in the community. This assumes that allelochemicals are released from intact living plant materials such as roots.

Water extracts from herbage of several allelopathic species have been reported to adversely affect seed germination of recipient plants (Kalburtji and Mosjdis, 1993b; Assaeed and AI-Doss, 1997) and seedling growth (Roder *et al.*, 1988; Kalburtji and Mosjdis, 1992; Assaeed and AI-Doss, 1996). However, relatively few studies have addressed allelopathic effects of root exudates of intact plants. Kalburtji and Mosjdis, (1993a) reported that root exudates from *Lespedeza cuneata* did not affect germination of associate grasses but reduced their early seedling growth.

Early pioneering plants have been found to interfere with the normal succession pattern of natural vegetation through release of phytotoxins into the environment (Wali and Iverson, 1978; Lodhi, 1979). The genus *Artemisia* is known to include some allelopathic species that may arrest succession (Holechek *et al.,* 1998). *Artemisia monosperma* is an ascending aromatic green to silvery-green shrub. It may grow up to l00cm tall. It is characteristic of deep and unstable sand dunes in central and northern parts of Saudi Arabia (Mandaville, 1990; Al-Zoghet, 1997). *Artemisia monosperma* is observed as one of the first species to dominate disturbed sandy areas. Despite being very valuable in sand stabilization (Al-Zoghet, 1997), it has not been reported as a browse species. Al-Yahya *et al.*, (1990) have isolated alkaloids and flavonoides among other chemical compounds from *A. monosperma.* These compounds have been recognized as allelopathic agents (Rice, 1984). Further, these compounds have been classified as antiquality and unpalatibility components of forages (Martem, 1973). The objectives of this study were to: (1) investigate for the allelopathic potential of aqueous extracts from leaves and inflorescences of *A. monosperma* on seed germination of some range plant species of sandy habitat, (2) study the effect of *A. monosperma* herbage litter on seedling growth and survival of the same range plant species and (3) investigate the effect of root exudates of *A. monosperma* on growth and survival of seedlings at two different temperatures.

MATERIALS AND METHODS

Allelopathic potential of *A. monosperma* was assayed in a series of experiments conducted at control environment. Experiments were run in growth chambers. Temperature was set constant at 25±2 °C unless otherwise stated. Light duration was 12 hours and light intensity was 1350 F.C. All experiments were laid out as split plot design. Treatments were the main plots and species were the sub-plots. Experiments were replicated four times. Data were statistically analyzed as factorial experiments (Gomez and Gomez, 1984; SAS, 1988). Species tested were two perennial grasses, *Lasiurus scindicus* Henr. and *Pennisetum divisum* (Gmel.) Henr., a shrublet *Scrophularia hypericifolia* Wydl. and an annual forb *Plantago boissieri* Hausskn. et Bomm. (used only in the germination trial due to seed shortage). All species are valuable grazing plants of sandy habitat although *L. scindicus* may be found in silty-sandy soils (Mandaville, 1990).

Germination Experiment

Shoots of *A. monosperma* were collected on early January 2000 from Al-Adhiriah sand dunes northeast of Riyadh. Plant materials were partitioned into leaves and inflorescence, air-dried, crushed and soaked in warm distilled water at a ratio of 1:10 weight to volume for 12 hours (Muller and Muller, 1965). Extracts from the two sources were filtered using Wattman No. 1 paper. Treatments included seed germination in distilled water (control) and germination in presence of leaf and inflorescence aqueous solutions. Many authors cautioned that allelopathic effects on germination could be overestimated because of possible interference from the osmotic potential of the aqueous solution with germination (Bell, 1974; Wardle *et a1*., 1992). Five samples of each extract were used to measure osmotic potential with a freezing point depression osmometer (μ Osmette, Model 5004, Precision System Inc.). Osmotic potential was found to be -l.l±O.02 and -1.09±O.03 MPa for leaves and inflorescence respectively. Therefore, another treatment involving seed germination in an osmotic potential equal to that imposed upon seeds by aqueous extracts was added. Ploy ethylene glycol (PEG, molecular weight = 8000) was used to create an osmotic potential of -1.1 MPa following the procedure of Michel, (1983). Seeds of each species (50 seeds per dish) were germinated in petri dishes lined with Wattrnan No. 1 filter paper. Ten ml of solutions were added to petri dishes and sealed to prevent water loss by evaporation. Germination was monitored daily for 10 days. Seeds were considered germinating when radicle length reached 2 mm or more.

Data of total germination percentage were arcsine transformed before performing statistical analysis but means were presented untransformed. Germination rate (GR) was calculated from: $\Sigma(N_i/T_i)/TG$, where N_i = number of seeds that germinated on day $_i$ after imbibition, T_i = day $_i$ after imbibition and TG = total germination (Evetts and Burnside, 1972).

The non-germinating seeds from the two aqueous extracts were rinsed thoroughly with distilled water and re-germinated using distilled water under similar experimental conditions to examine for the effect of extracts on seed viability. Total germination was expressed as percentages relative to the total non-germinating seeds.

Litter Leachate

A mixture of *A. monosperma* leaves and inflorescence was air-dried and ground to pass through 2-mm mesh screen. Two sets of 10-cm pots were filled with sterilized sand and saturated with water. Twenty-five seeds of *L. scindicus*, *P. divisum* and *S. hypericifolia* were sown in the pots. Effect of litter leaching on seedling growth and survival was simulated by placing an amount of 0, 1,2, 3 gm of ground material on top of sand contained in the pots. This procedure is commonly used for assaying litter leachate (del Moral and Muller, 1970).

Pots were carefully irrigated from top the first time and sub-irrigated thereafter to avoid seedling disturbance. Upon emergence, seedlings were thinned to 10 seedlings having similar appearance. One set of pots was harvested 10 days from sowing (30 days in the case of *S. hypericifolia*). The other set was harvested 45 later (65 days in the case of *S. hypericifolia*). In both harvests seedlings were partitioned into shoots and roots. Roots were washed from sand with tap water. Shoots and roots were dried separately at 65 °e for 72 hours to determine total biomass and root: shoot ratio (RS). Seedling survival was calculated as the percentage of surviving seedlings at the end of the experiment relative to the initial number of seedlings (10 seedlings) at the beginning of the experiment. Relative growth rate (RGR) was calculated from: $1/W \times dW/dT$ where W is total biomass, dW and dT are change in biomass with change in time respectively (Hunt, 1982).

Root Exudates

Two sets of one-year old *A. monosperma* plants grown in 30-cm pots filled with sand were used as donor plants. Pots were leached and leachates were used to irrigate recipient plants. Care was taken to remove senescing leaves before falling on pot surface to avoid leachates from leaves. This procedure has been used in assaying root exudates (Leather, 1983; Kil and Lee, 1987). Seeds of *L. scindicus, P. divisum* and *S. hypericifolia* were sown in 10-cm pots filled with sand. When emergence ceased, seedlings were thinned to 10 seedlings having similar appearance. One set of the donor plants was grown along with the recipient plants at 30 °C and the other set with similar recipient plants was grown at 20 °C. Thereafter, these will be referred to as warm and cool temperatures, respectively. The idea was that exposing plants to warm temperature may create stressed conditions to the donor plants thereby if allelochemicals are released in the root environment, they could be collected with water leached from pots containing the donor plants. Each plant set was divided into two groups, the first group was harvested ten days from sowing (30 days in the case of *S. hypericifolia*) and the second group was harvested 45 days later (65 days in the case of *S. hypericifolia*). Plant measurements were performed as in the previous experiment.

RESULTS AND DISCUSSION

Seed Germination

Significant variation ($P<0.001$) occurred among germination treatments (Table 1). Germination decreased by 22% due to the effect of osmotic potential compared to the control. The two aqueous extracts of *A. monosperma* were not significantly different from each other, but were significantly less than the PEG solution having the same osmotic potential. This indicates that the effect of phytotoxins released from litter is not simply an osmotic inhibition. In general, these results are in agreement with findings of other workers on germination response to some allelopathic species (Kakburtji and Mosjidis, 1993b; Assaeed and AI-Doss, 1997). They also suggest similar phytotoxic influence of different *A. monosperma* aerial parts on germination. However, Roder et al., (1988) found differential allelopathic effect of *Cenchrus longispinus* on phenological stages of germination of *Panicum virgatum*. Osmotic potential (-1.1 MPa) created by the PEG solution delayed germination as inferred from germination rate. Aqueous solutions of leaves and inflorescence substantiated the delay further by about 3 and 4 folds compared to the control treatment respectively (Table 1). These results are in agreement with findings by other workers on germination rate of different species (Modgil and Kapil, 1990; AI-Humaid and Warrag, 1999).

Species also varied significantly (P<0.001) when averaged over treatments. *Pennisetum divisum* had the highest germination percentage (63%) while *P. boissieri* was the lowest in germination (16%). Similarly. *P. divisum* had the highest germination rate while *S. hypericifolia* had the lowest germination rate (Table 1).

Table (1): Germination percentage and germination rate (Means ± SE) as affected by source of leachate and plant species.

	Total germination (%)	Germination rate (Seeds . day $^{-1}$)
Treatments		
Control	71.13 ± 5.332	0.40 ± 0.029
PEG (-1.1 MPa)	55.75 ± 6.755	0.24 ± 0.024
A. monosperma extracts		
Leaf	16.25 ± 4.274	0.14 ± 0.037
Inflorescence	20.38 ± 5.314	0.11 ± 0.030
$LSD_{0.05}$	4.28	0.0075
Species		
Lasiurus scindicus	56.13 ± 5.296	0.25 ± 0.019
Pennisetum divisum	63.13 ± 7.292	0.37 ± 0.022
Scrophularia hypericifolia	28.13 ± 7.354	0.09 ± 0.025
Plantago boissieri	16.13 ± 5.411	0.37 ± 0.022
$LSD_{0.05}$	4.28	0.0075

Significant interaction between treatments and species (P<0.001) was observed on their effect on germination parameters (Table 2). Within species. the two aqueous extracts had greater impact on germination than osmotic solution relative to the control. Across species and within treatments, germination response was not consistent. While *P. divisum* was the least affected by osmotic potential, *L. scindicus* was less affected than P. divisum in the presence of extracts although means of the two species were not different. Osmotic potential (-1.1 MPa) reduced germination of all species except *S. hypericifolia*. The reduction ranged between 1- 68%. The effect of leaf extract on germination ranged between 50% reduction in *L. scindicus* and complete inhibition in *S. hypericifolia* and *P. boissieri*, while reductions due to inflorescence varied from 60% in *L. scindicus* to complete inhibition of *S hypericifolia* and *P. boissieri*. Comparing germination response to aqueous extracts to that of osmotic solution and control, suggests that the effect of *A. monosperma* extracts on germination of *L. scindicus*, *P. divisum* and *P. boissieri* was partially controlled through the osmotic interference, while that of *S. hypericifolia* was mainly due to direct phytotoxic effect. Within species and across treatments, wherever germination occurred, germination rate was always lower in the presence of extracts than when germinated in the presence of osmotic solution relative to the control with inflorescence having greater effect than leaf extract. Also, GR was partially delayed by the -1.1 MPa osmotic potential. Across species and within treatments, *P. divisum* had higher GR than *L. scindicus*.

Table (2): Interaction effects between species and source of *Artemisia monosperma* leachate on seed germination (%) and rate (GR).

	L. scindicus		*P. divisum*		*S. hypericifolia*		*P. boissieri*	
	%	GR	%	GR	%	GR	%	GR
Control	83.0	0.36	96.5	0.50	56.5	0.23	49.0	0.50
PEG (-1.1MPa)	66.5	0.26	84.5	0.38	56.0	0.15	15.5	0.17
Extracts								
Leaf	41.5	0.20	40.0	0.34	0	0	0	0
Infloresce.	33.5	0.18	31.5	0.27	0	0	0	0
***LSD* 0.05**	**for % germination = 8.54, for GR= 0.015**							

When non-germinating seeds were washed from extracts and regerminated in distilled water, species varied significantly in germination and GR ($P< 0.001$). Seeds from the two sources were not, however, different from each other (data not presented). Table (3) shows the interaction effect of seed source and species on germination of washed seeds. No consistent trend was observed within species and across seed sources. However, only *L. scindicus* had significantly higher germination in seeds previously treated with leaf extract than ones previously treated with inflorescence extract. This supports the previous finding that extract from inflorescence had greater impact than leaf extract on germination of the same species. Also, *P. boissieri* had higher GR under the same treatment. Within seed sources and across species. *L. scindicus* also had significantly higher germination and GR than any other species. These results support the conclusion that the influence of *A. monosperma* herbage aqueous extracts on germination is partially controlled by their osmotic potential and also agree with findings of Assaeed and AI-Doss, (1997) on the effect of *Rhazya stricta* foliage extract on germination of some range plant species.

Table (3). Germination percentage and germination rate of non-germinating seeds after being washed from aqueous extracts of *Artemisia monosperma*.

	Seed source			
	Leaves leachate		**Inflorescence leachate**	
	Germination %	**Germination rate Seeds. Day^{-1}**	**Germination %**	**Germination rate Seeds. Day^{-1}**
L. scindicus	**35.0**	**0.29**	**20.00**	**0.28**
P. divisum	**9.17**	**0.09**	**13.33**	**0.08**
S. hypericifolia	**7.50**	**0.08**	**6.67**	**0.07**
P. boissieri	**12.5**	**0.12**	**12.50**	**0.08**
***LSD* 0.05**	**for % germination = 6.397, for GR = 0.017**			

Effect of Litter Leachate on Seedling Growth and Survival

Artemisia monosperma litter decreased species RGR and survival significantly ($P< 0.001$). The decrease in RGR and seedling % survival was proportional to the amount of litter added (Table 4). However, no significant effect ($P>0.05$) was found on seedling biomass or RS ratio. This suggests that within the experimental range, leachate release from litter was not probably great enough to cause adverse effects on plant biomass or growth pattern.

Averaged over treatments, species differed significantly ($P<0.001$) in all measured parameters except the RS ratio (Table 4). *Lasiurus scindicus* had the highest seedling biomass while *S. hypericifolia* was the lowest. The species followed the same pattern in RGR and % survival. Earlier, Smith, (1990) found that mixing leaf tissue from weeds reduced lucerne and Italian ryegrass development and foliage production.

Significant interaction ($P< 0.001$) occurred between treatments and species in RGR and % survival (Table 5). Within species and across treatments, the order of species from high to low RGR was always as follows: *L. scindicus* > *P. divisum* > *S. hypericifolia*. Addition of litter created significant differences among species at all three levels. However, within a species, it appears that there is no specific trend for the effect of litter treatment. Moreover, no significant difference among treatment levels was detected for any species where it survived. Theoretically, the lower density, the more absorption of leachates per seedling and hence, the lower plant performance. However, the inverse magnitude of RGR of *L. scindicus* with increase in the amount of litter could have been partially mitigated by less competition between the fewer surviving seedlings (Weidenhamer *et al*., 1989). Most studies on allelopathic effects on seedling growth dealt with early development of seedlings (Karachi and Pieper, 1987; Kalburtji and Mosjidis, 1992; 1993b). These studies reported decrease in coleoptile and radicle growth. Our results are in agreement with findings of Assaeed and AI-Doss, (1996) on *Rhazya stricta* foliage leachate on growth and survival of some range plant species.

Table (4): Effect of *Artemisia monosperma* foliage litter on seedling growth and survival of *Lasiurus scindicus, Pennisetum divisum* and *Scrophularia hypericifolia*.

	Seedling biomass (mg)	RS ratio	RGR (mg . gm $^{-1}$. week $^{-1}$)	Percentage seedling survival
Treatments				
Control	24.9	0.97	142.2	78.3
1 g	24.5	0.69	139.9	53.3
2 g	18.7	0.83	111.5	40.0
3 g	15.5	0.56	108.7	35.0
LSD $_{0.05}$	**NS**	**NS**	**16.41**	**11.57**
Species				
L.scindicus	41.3	0.63	183.4	68.1
P. divisum	18.1	1.04	138.3	51.9
S. hypericifolia	3.2	0.62	55.0	35.0
LSD $_{0.05}$	**11.27**	**NS**	**14.21**	**10.02**

Table (5): Effect of *Artemisia monosperma* foliage litter on seedling relative growth rate (RGR, mg . gm $^{-1}$. week $^{-1}$) and percentage survival of *Lasiurus scindicus*, *Pennisetum divisum* and *Scrophularia hypericifolia*.

	Lasiurus scindicus		*Pennisetum divisum*		*Scrophularia hypericifolia*	
	RGR	**Survival (%)**	**RGR**	**Survival (%)**	**RGR**	**Survival (%)**
Control	167.8	90.0	139.1	47.5	119.8	97.5
1g litter	183.3	55.0	136.0	62.5	100.4	42.5
2g litter	186.0	55.0	140.1	50.0	0	0
3g litter	196.3	72.5	138.0	47.5	0	0
***LSD* 0.05**	NS	NS	NS	NS	26.38	71.71
***LSD* 0.05**	for RGR = 28.47, for % survival = 20.06					

Effect of Root Exudates on Seedling Growth and Survival

Significant differences ($P< 0.001$) occurred between treatments in all measured parameters. Highest seedling biomass was attained when seedlings were grown at the warm-temperature control treatment followed by its respective root exudates treatment. Although, the two treatments were not significantly different (Table 6). It appears that seedling performance in terms of biomass is better under the warmer temperatures. Similarly, seedling biomass under the cool-temperature control was not significantly different from its respective treatment. Under both control treatments, seedlings were investing more assimilates into root growth compared to the root exudates-treated seedlings as it appears from the higher RS ratio values. Earlier, Bhatt and Todaria, (1990) have reported similar results. Despite the higher seedling biomass under warm temperature, RGR's were lower than those of cool temperature irrespective of treatment imposed. No significant change in RGR was observed in presence of root exudates at cool temperature relative to its control. However, the warm-temperature treatments were significantly different suggesting that stressed *A. monosperma* plants may release phytotoxic chemicals to interfere with growth of other species. Kalburtji *et al*., (1989) and Kalburtji and Mosjidis, (1993a) reported similar effects of root exudates on different plant species. Also. seedling RGR of the control treatment at warm temperature was significantly less than the cool temperature control. No significant difference occurred between the control treatments in seedling survival. However, survival of seedlings irrigated with root exudates was different from their respective control but not different from each other.

Averaged over treatments, species differed significantly ($P< 0.001$) in all measured traits except RS ratio. Table (6) indicates that *L. scindicus* was the highest in biomass followed by *P. divisum*. Relative growth rates of *L. scindicus* and *P. divisum* were not significantly different from each other while *S. hypericifolia* was significantly lower than the two grass species. Similarly, seedling survival was not different between the two grasses, while the *S. hypericifolia* had lower survival.

Table (6): Effect of root exudates of *Artemisia monosperma* on seedling growth and survival of *Lasiurus scindicus, Pennisetum divisum* and *Scrophularia hypericifolia*.

	Seedling biomass (mg)	RS ratio	RGR (mg . gm $^{-1}$. week $^{-1}$)	Seedling survival (%)
Cool temperature				
Control	22.5	0.97	80.7	93.3
Root exudates	17.4	0.45	67.4	58.3
Warm temperature				
Control	34.5	1.13	55.5	89.2
Root exudates	29.7	0.40	36.2	50.0
LSD $_{0.05}$	7.22	0.21	16.59	9.6
L. scindicus	48.2	0.77	79.7	80.0
P. divisum	25.4	0.81	71.2	90.0
S. hypericifolia	4.5	0.63	28.9	48.1
LSD $_{0.05}$	6.25	NS	14.37	8.3

Significant interaction (*P*<0.001) occurred between treatments and species in all measured parameters (Table 7). Within species, *S. hypericifolia* had the lowest biomass where it survived while *L. scindicus* had the highest biomass although it was not significantly different from *P. divisum* when exposed to root exudates at cool temperature. Apart from *S. hypericifolia* having higher RS than the two other species when irrigated with tap water at warm temperature, species were not different in their RS ratio. Species RGR did not have a specific trend in response to different treatments. The only significant difference in species RGR was that between *S. hypericifolia* and *L. scindicus*. Seedling survival in response to different treatments varied significantly. While S. *hypericifolia* had high seedling survival in absence of root exudates, complete death occurred in presence of root exudates at both temperatures. On the other hand, survival of the two grasses was greatly affected in presence of root exudates at warm temperature (Table 7).

Across species and within treatments, seedling biomass of *L. scindicus* and *P. divisum* was more related to temperature than to the presence of root exudates although differences in the later species were not significant between warm and cool treatments. Where it survived. *S. hypericifolia* was also favored by warm temperature although differences between the treatments were not significant. Root: shoot ratios of *L. scindicus* and *P. divisum* were higher in the absence of root exudates in warm temperature than in its presence. Where it survived. *S. hypericifolia* RS did not change in response to different treatments. Relative growth rate of *L. scindicus* was higher under cool than warm temperature regardless of treatment imposed. Mean differences of *P. divisum* RGR were not statistically different among treatments. Relative growth rate of *S. hypericifolia* was similar to *P. divisum* where it survived. Seedling survival of *L. scindicus* decreased significantly in presence of root exudates at cool temperature. Survival of *P. divisum* decreased significantly in presence of root exudates at warm temperature while complete death of *S. hypericifolia* seedlings occurred in presence of root exudates regardless of temperature.

Table (7): Effect of *Artemisia monosperma* root exudates on seedling growth traits and survival of *Lasiurus scindicus, Pennisetum divisum,* and *Scrophularia hypericifolia* under warm and cool temperatures

	Lasiurus scindicus			
	Biomass (mg)	**RS ratio**	**RGR ($mg \cdot gm^{-1} \cdot week^{-1}$)**	**Seedling survival (%)**
Cool temperature				
Control	39.8	0.92	100.1	80.0
Root exudates	32.0	0.71	113.8	75.0
Warm temperature				
Control	60.2	0.93	50.1	80.0
Root exudates	60.7	0.52	55.0	85.0
	Pennisetum divisum			
Cool temperature				
Control	21.9	0.87	80.6	100.0
Root exudates	20.0	0.64	88.4	100.0
Warm temperature				
Control	31.2	1.05	62.1	95.0
Root exudates	28.4	0.68	53.5	65.0
	Scrophularia hypericifolia			
Cool temperature				
Control	5.9	1.11	61.2	100
Root exudates	0	0	0	0
Warm temperature				
Control	12.1	1.41	54.4	92.5
Root exudates	0	0	0	0
LSD 0.05	RGR = 42.47 , RS = 0.357 , Survival = 8.48 , Dry weight = 12.518			

In a summary, aqueous extracts from leaves and inflorescence of *A. monosperma* decreased seed germination of *L. scindicus*, *P. divisum*. .*S. hypericifolia* and *P. boissieri*. The decrease in germination was partially controlled by the osmotic potential of the extracts except in *S. hypericifolia* where germination was least affected by osmotic potential but complete inhibition occurred in presence of extracts. Seedling growth and survival were proportional to the amount of litter added. Within the range of the imposed treatments, only *S. hypericifolia* was greatly affected when the amount of litter added was 1g per pot. Complete seedling death of the species occurred when the amount of the litter exceeded 1g. Root exudates from *A. monosperma* did not affect seedling biomass but reduced RS ratio regardless of temperature, reduced RGR under high temperature and decreased seedling survival especially in *S. hyperieifolia* where complete seedling death occurred irrespective of temperature.

Plant succession in areas dominated by *A. monosperma* could be enhanced by revegetation using *L. scindicus* and *P. divisum*. However, more work is needed to determine ecological requirements of seedling survival and establishment of those two grasses as well as investigating the sensitivity of more palatable range plant species of sandy habitat to *A. monosperma* phytotoxicity in order to increase species diversity of sandy areas.

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التأثير المثبط لنبات العاذر على إنبات بذور بعض نباتات المراعي ونمو بادراتها

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الرياض ١١٤٥١ المملكة العربية السعودية

يعد نبات العاذر *Artemisia monosperma* من أوائل النباتات التي تتمكن من سيادة الكثبان الرملية المتحركة أو تلك التي تعرضت لعامل اضطرابي في المملكة العربية السعودية. ورغم أهميته البالغة في تثبيت الكثبان الرملية، إلا أنه ليس له أهمية رعوية. ولهذا يخشى أن تكون سيادته عائقاً دون التقدم الطبيعي للتعاقب النباتي من خلال تأثيره المثبط على الأنواع النباتية الأخرى. أجريت سلسلة من التجارب المعملية لاستجلاء التأثير المثبط لنبات العاذر على إنبات بذور نبات الضعة *Lasiurus scindicus* والثيموم *Pennisetum divisum* والعلقا *Scrophularia hypericifolia* والربلة *Plantago boissieri* ونمو بادراتها وبقائها. في إحدى التجارب، نبتت البذور في المستخلص المائي لأوراق العاذر ونوراته بنسبة جزء واحد من الوزن الجاف من المادة النباتية إلى عشرة أجزاء من الماء. كما نبتت البذور في ماء مقطر وفي محلول مادة البولي إثيلين جليكول له جهد أزموزي مساو لمثيله في مستخلصي العاذر للمقارنة. وفي تجربة أخرى، زرعت بذور النباتات الثلاثة الأولى في مراكن قطر الواحد منها ١٠سم ومملوءة بالرمل وغطي سطح التربة بطبقة من مسحوق المجموع الخضري (أوراق ونورات) لنبات العاذر بمقدار صفر، ١جم، ٢جم، أو ٣جم لمحاكاة تأثير الراشح المائي لمخلفات النبات في نمو البادرات وبقائها. وفي تجربة ثالثة، اختبر تأثير إفرازات الجذور في نمو البادرات وبقائها بري البادرات المستقبلة بالماء (معاملة الشاهد) أو بالماء الراشح من نباتات العاذر المزروعة في مراكن قطر الواحد منها ٢٠سم وعمرها سنة واحدة وزرعت النباتات المانحة (العاذر) والمستقبلة في درجات حرارة ٣٠°م (دافئة) أو ٢٠°م (باردة). أظهرت النتائج أن الإنبات يتحدد جزئياً بالجهد الأزموزي لمستخلصي العاذر (في ما عدا نبات العلقا) وقد تراوح التأثير المثبط لأوراق العاذر ونوراته ما بين انخفاض للإنبات قدره ٥٠–٦٠% في نبات الضعة إلى منع تام لإنبات بذور نباتي العلقا والربلة. وأدت إضافة مخلفات المجموع الخضري لنبات العاذر إلى خفض معدل النمو النسبي للبادرات وبقائها بمقدار يتناسب مع كمية المخلفات المضافة. لم تؤثر إفرازات جذور العاذر في كمية الكتلة الحية للبادرات إلا أنها قللت من نسبة الجذور إلى السوق بصرف النظر عن درجة حرارة الوسط الذي نمت فيه كما عملت على خفض معدل النمو النسبي في درجة الحرارة الدافئة وعلى خفض النسبة المئوية لبقاء البادرات وبخاصة نبات العلقا حيث ماتت جميع بادراته بصرف النظر عن درجة الحرارة التي نمت فيها. ولهذه النتائج بعض الدلالات التطبيقية عند اختيار الأنواع النباتية في برامج إعادة زراعة المناطق الرملية التي يسودها العاذر.