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Allelopathic Effect of *Calotropis procera* Leaves Extract on Seed Germination of Some Plants

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Abstract. The effect of dry leaf water extraction (5, 10, 20, 40 and 60%) of *Calotropis procera* Decne. plants on the germination of Barley (*Hordeum vulgare* L.), Wheat (*Triticum aestivum* L.), Cucumber (*Cucumis satirus*) L., Fenugreek (*Trigonella foenum graecum* L.) and Alssana (*Senna occidentalis* L. Link) was investigated. The results showed that the germination delayed at the higher concentrations, and the final germination percentage was decreased by increasing leaf extract concentration. The most affected seeds of the tested plants were *Senna occidentalis* seeds, which were inhibited at the last two treatments (40 and 60%). Generally, the radicle and Plumule growth was sensitive to different levels of leaf extraction whereas, the radicle length was decreased by increasing the extract concentration; it died at the higher concentrations (40 and 60%) for Alssana seeds. Plumule emergence and growth stimulated by the lower concentration (5%) for Alssana Cucumber and Fenugreek more than control treatment, and then the plumule length decreased with increasing the concentration in leaf extracted of *C. procera* plants.

Introduction

Calotropis procera Decne. (*Asclepidaceae*) is an evergreen poisonous shrub. It is naturally and widely spread in different areas of Saudi Arabia [1]. It grows commonly around farms, agricultural areas, and in the sandy warm parts especially in the western coastal plain (Tehama plain) [2].

Association and disassociation patterns between certain plant species are widely known. Such phenomena may be governed by direct competition for necessary growth factors or through addition of allelopathic chemicals into the

soil environment [3]. It has been documented that allelopathy may play an important role in plant-plant interference by those chemical compounds [3-5]. If some of those compounds are released to the environment, from leaching, litter decomposition, root exudation, or direct volatilization, they could affect (either positively or negatively) germination and growth of other species. The allelopathic effects of some plants were studied including germination inhibition [6-8], plumule and radicle length [9-10], seedling growth retardation [11-13] and poor seedling survival [14-15].

The objective of this study is to evaluate the effect of *C. procera* leaves extract on the grain or seed germination of some crop plants *Hordeum vulgare*, *Triticum aestivum*, *Cucumis satirus*, *Trigonella foenumgraecum* and wild plant *Senna occidentalis.*

Materials and Methods

The leaves extract of *C. procera* plants was prepared by soaking the dry leaves in distilled water (1:10 weight to volume) for 24 hours at room temperature (23 ± 2ºC), and then filtered through Whatman filter paper No.1 [16]. The extract was diluted to obtain the concentrations of 5, 10, 20, 40, 60% while the distilled water was used as the control treatment and then kept under 4ºC in the refrigerator. Five plant species were chosen for this study, four of them are crop plants commonly planted in different agricultural areas in Saudi Arabia, and which are:

(Barley) *Hordeum vulgare* L. Family: *Poaceae* (*Graminaea*)
(Wheat) *Triticum aestivum* L. Family: *Poaceae* (*Graminaea*)
(Cucumber) *Cucumis satirus* L. Family: *Cucurbitaceae*
(Fenugreek) *Trigonella foenumgraecum* L. Family: *Fabaceae* (*Leguminosae*)

While the fifth plant species is a wild perennial medical plant, grow naturally in the low lands especially in the west of Saudi Arabia called (Alssana) *Senna occidentalis* (L.) Link (*Cassia*) Family: *Fabaceae* (*Leguminosae*).

Seeds of the four crop species were obtained from the agricultural shop, while the seeds of the wild species were collected from their habitats in Saudi Arabia. Twenty selected grains or seeds were placed on filter papers inside a Petri-dish 9cm in diameter for germination, and 15-20 ml of the leaves extract or distilled water for control treatment was added. The germinated seeds were recorded every day for a period of 15 days. In addition, growth of the radicle and the plumule was recorded for 5 days starting from the first day of emergence.

Results obtained were treated statistically by applying probability (P) using one way analysis of variance for each species with different concentrations where they were needed.

Results

Germination

The results showed that the effect of the water extract of the dried leaves of *C. procera* was inversely proportional to the percentages of daily germination. The seeds germination of Fenugreek at the first day at 60% concentration was 5% compared to the control (95%), while the germination percentages for cucumber, barley and wheat were 51.5, 76.5 and 91%, compared to the control with 86.5, 100 and 100% respectively (Fig. 1-5). On the other hand, there is clear effect of the dry leaf extraction of *C. procera* on the Alssana seeds. The germination was delayed for one, four, and six days in the last three treatments (20, 40 and 60% respectively), while the daily germination, also was affected in those treatments that gave a poor germination especially in the last two treatments (40 and 60%).

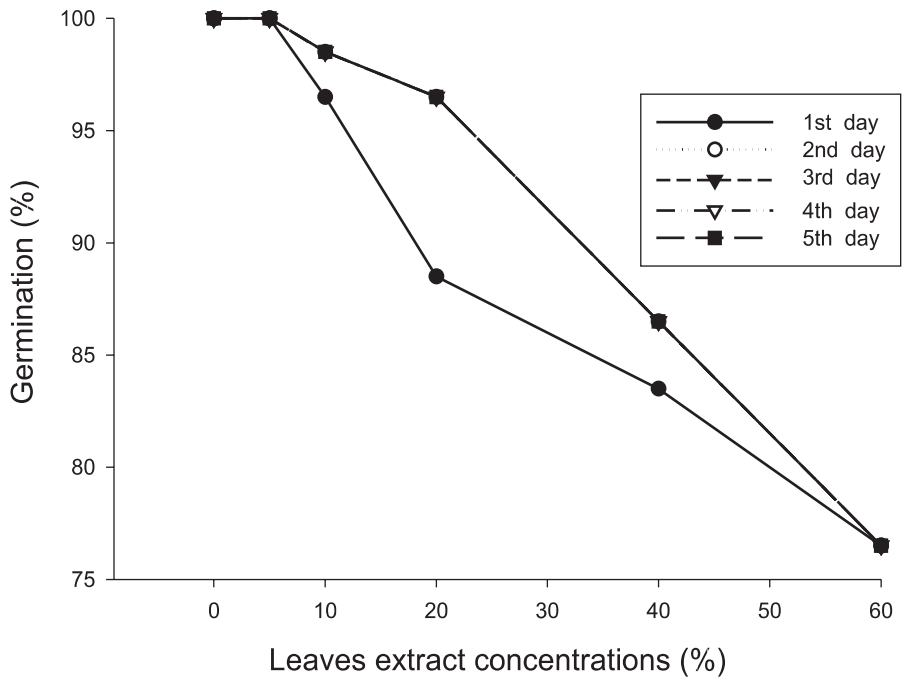

Fig. 1. Effect of dry leaves extract of *C. procera* on the germination of barley grains.

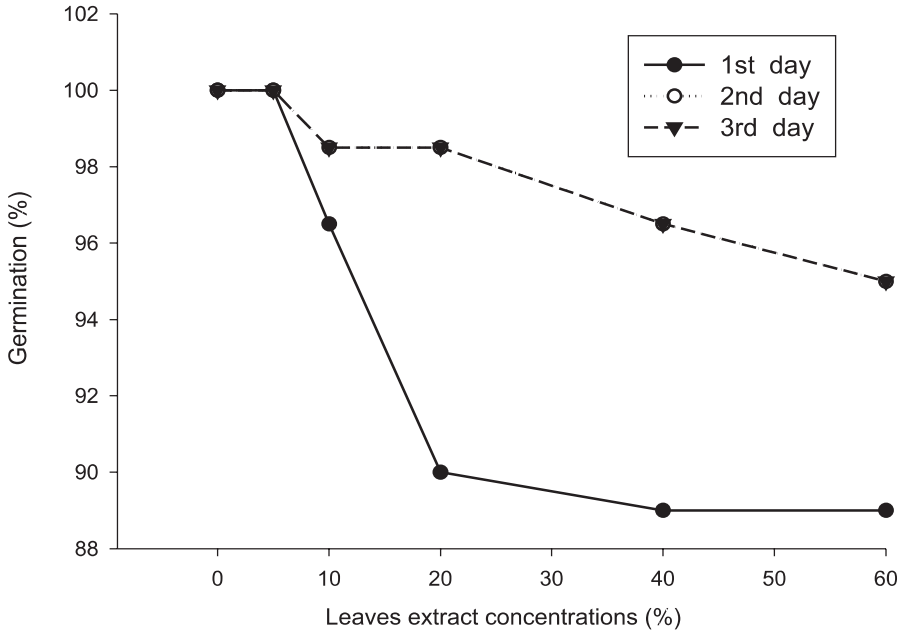

Fig. 2. Effect of dry leaves extract of *C. procera* on germination of wheat grains.

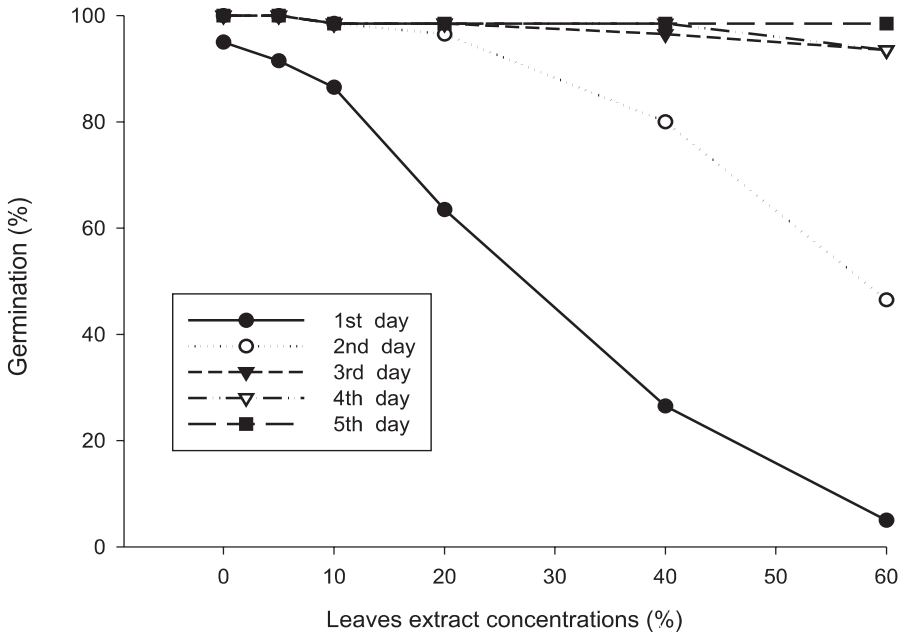

Fig. 3. Effect of dry leaves extract of *C. procera* on germination of fenugreek seeds.

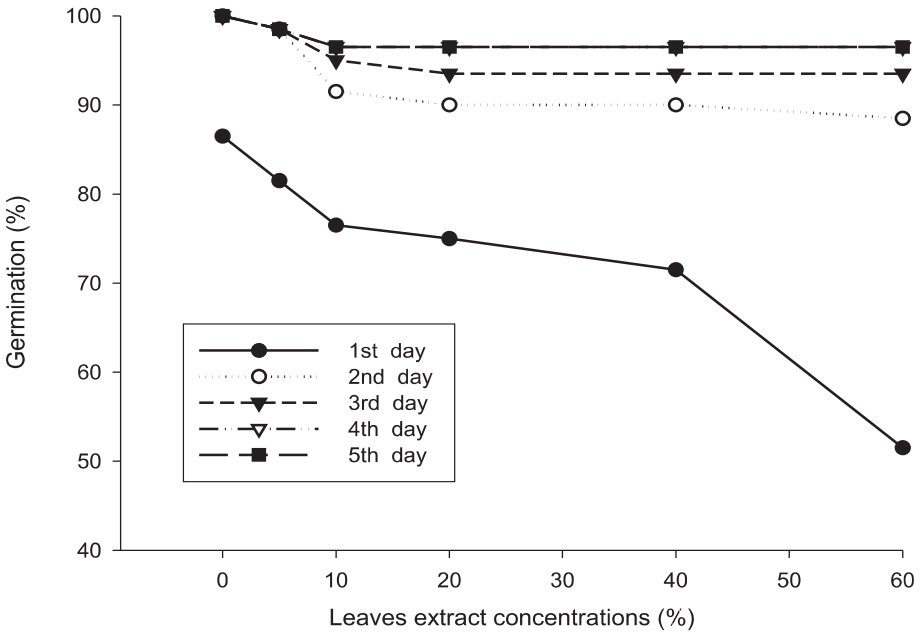

Fig. 4. Effect of dry leaves extract of *C. procera* on germination of cucumber seeds.

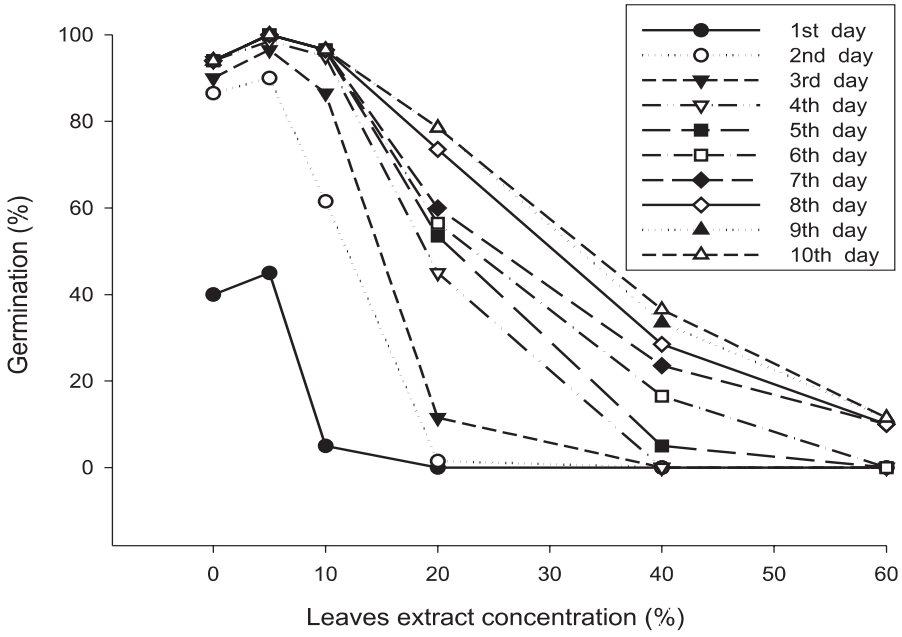

Fig. 5. Effect of dry leaves extract of *C. procera* on germination of alssana seeds.

The results also indicated that the extract was affected on the total germination percentage of the seeds (Table 1). Barley grains were the most affected of crop plants by the higher extract leaf concentrations (40 and 60%), as the germination percentage reached 88.5 and 76.5 respectively, while the most affected germination between all tested plants was Alssana seeds. The data showed that the seeds were stimulated by the leaf extract and gave the highest percentage of germination (100%) in the lowest leaf concentration (5%) higher than that in the control treatment (94% only). The germination percentage decreased dramatically by increasing the leaf extracts concentration for the last four treatments.

Table 1. Effect of dry leaf extract of *C. procera* on the final germination (percentage of the sowed seed).

Plant name	Concentration of leaf extraction %					
	0	5	10	20	40	60
Barley	100	100	98.5 ± 1.5	96.5 ± 1.5	88.5 ± 1.3	76.5 ± 4.1
Wheat	100	100	98.5 ± 1.5	98.5 ± 1.2	96.5 ± 1.5	95.0 ± 0.9
Fenugreek	100	100	98.5 ± 0.3	98.5 ± 0.6	98.5 ± 1.5	98.5 ± 1.9
Cucumber	100	98.5 ± 0.3	96.5 ± 0.6	96.5 ± 1.5	96.5 ± 1.5	96.5 ± 1.5
Alssana	94.0 ± 1.1	100	96.5 ± 1.3	78.5 ± 1.0	36.5 ± 2.2	16.5 ± 1.9

Radicle Elongation

There are clear differences in the results obtained from the effect of different concentration of water extract for *C. procera* leaves on the radicle elongation of various selected plants. The radicle growth of barley and wheat was continued in the low and high concentrations, but growth substantially was reduced. The highest radicle length was recorded in the control treatment and then decreased by increasing leaf extract concentration (Table 2). In the case of the other three plants (cucumber, fenugreek and Alssana), the lower concentration of the leaves extract (5%) stimulated radicle growth to give the highest length for all treatments. It reached 13.4, 4.7 and 2.4 cm, compared to 11.9, 3.6 and 2.2 cm respectively in the control treatments, and then the radicle length decreased by increasing leaf extract (Table 2). However, the radicle of Alssana species was dying in the last two treatments (40 and 60%) immediately after emergence.

Plumule Length and Emergence

The results showed that a remarkable differences in plumule emergence and length among the different plant species and in the different concentrations of *C. procera* leaves extract (Table 3). In wheat, the plumule emerged earlier at the

Table 2. Effect of dry leaf extract of *C. procera* on the radicle length of the tested plants.

Plant name	Concentration of leaf extraction	Radicle length (cm)	% stimulation (+) or inhibition (–) over control
Barley	0	13.4 ± 1.6	–
	5	8.1 ± 0.5	–39.6
	10	7.2 ± 0.3	–46.3
	20	5.3 ± 0.3	–60.4
	40	4.2 ± 0.5	–68.7
	60	1.3 ± 1.3	–90.3
	P	< 0.001	
Wheat	0	9.8 ± 0.8	–
	5	7.9 ± 0.2	–19.4
	10	7.8 ± 0.2	–20.4
	20	5.1 ± 0.2	–48.0
	40	1.7 ± 0.1	–82.7
	60	0.9 ± 0.1	–90.8
	P	< 0.001	
Fenugreek	0	3.6± 0.1	–
	5	4.7 ± 1.7	+ 30.6
	10	4.3 ± 0.6	± 19.4
	20	3.6 ± 0.5	–
	40	2.8 ± 0.6	–22.2
	60	1.7 ± 0.3	–52.8
	P	0.007	
Cucumber	0	11.9 ± 0.3	–
	5	13.4 ± 2.0	± 12.6
	10	12.7 ± 1.3	± 6.7
	20	10.9 ± 0.5	– 8.4
	40	6.1 ± 1.3	–48.7
	60	3.3 ± 0.2	– 72.3
	P	< 0.001	
Alssana	0	2.2 ± 0.2	–
	5	2.4 ± 0.7	+ 9.1
	10	1.5 ± 0.6	–31.8
	20	0.6 ± 0.3	–72.7
	40	–	–
	60	–	–
	P	< 0001	

Table 3. Effect of dry leaf extraction of *C. procera* on the plumule emergence and length of the tested plants.

Plant name	Concentration of leaf extraction	Plumule length (cm)	% stimulation (+) or inhibition (–) over control	Days of plumule emergence
Barley	0	17.7 ± 0.8	–	3
	5	17.5 ± 0.1	–1.1	3
	10	15.7 ± 0.7	–11.3	3
	20	14.1 ± 0.8	–20.3	4
	40	9.4 ± 0.9	–46.9	4
	60	2.6 ± 0.1	–85.3	4
	P	< 0.001		
Wheat	0	8.9 ± 0.3	–	2
	5	8.7 ± 0.2	–2.2	2
	10	8.5 ± 0.0	–4.5	2
	20	6.1 ± 0.1	–31.5	2
	40	1.9 ± 0.2	–78.7	2
	60	1.0 + 0.0	–88.8	3
	P	< 0.001		
Fenugreek	0	5.9 ± 0.1	–	4
	5	6.7 ± 0.0	±13.6	5
	10	6.5 ± 0.2	+10.2	5
	20	5.1 ± 0.1	–13.6	5
	40	3.6 ± 0.6	–39.0	6
	60	1.1 ± 0.2	–81.4	7
	P	< 0.001		
Cucumber	0	6.9 ± 0.4	–	4
	5	12.2 ± 1.5	+ 76.8	4
	10	11.7 ± 0.2	+69.6	4
	20	7.7 ± 0.4	+11.6	5
	40	3.8 ± 0.6	–44.9	5
	60	2.2 ± 0.3	–68.1	5
	P	< 0.001		
Alssana	0	5.3 ± 0.1	–	4
	5	5.6 ± 0.7	+5.7	6
	10	3.9 ± 0.6	–26.4	6
	20	1.5 ± 0.8	–71.7	7
	40	–	–	–
	60	–	–	–
	P	< 0.001		

second day after sowing, the highest growth appeared at the control treatment and then the plumule growth decreased with increasing concentrations of the leaf extract (Table 3). In barley grains, however, the plumule appeared at the third day after germination except at the last two treatments (40 and 60%) the plumule grew in the fourth day. The plumule growth of barley followed the same pattern of wheat. It was very slow in growth and never emerged out of the sheath. The lowest plumule length reaching 1 and 2.6 cm in length compared to the control with 8.9 and 17.7 cm in both wheat and barley respectively. In cucumber and fenugreek, the plumule emerged in the 4^{th} and 5^{th} day respectively in the low extract concentration. It continued to grow reaching 12.2 and 6.7 cm in length exceeding that of the control treatment, which gave only 6.9 cm and 5.9 cm respectively. Nevertheless, in the high concentrations the plumule emerged in the 5^{th} and 7^{th} day, respectively, and continued to grow very slowly and reached at the end of the experiment only 2.2 and 1.1 cm in the two species.

For Alssana seeds, the plumule appeared at the sixth day after sowing at the low and medium concentrations of the leaf extraction (5, 10 and 20%) while the plumule did not appear at the high leaf extract concentration (40 and 60%, Table 3).

Discussion

Certain plant species or their residues selectively inhibit the development of particular species. This differential sensitivity observed in field, green house and laboratory experiments with residues, extracts and purified allelochemicals [8, 17]. In this study, the water extract of the dry leaves of *C. procera* has resulted in retardation of the daily and total seed germination percentages of the seeds and grains of all selected species. The maximum reduction in germination was at the highest concentration coming from *C. procera* extract. Alssana had the most reduction (83.5%) followed by barley (23.5%), wheat (5%), cucumber (3.5%) and lastly Fenugreek (1.5%). The results agree with most of the previous results obtained by many other researchers, which emphasized that extracts of many plants inhibit germination of many other plants [18-19]. Also results from different parts and different allopathic plants proved the inhibition effect on seed germination of some pasture plants [4, 20-21]. Oudhia [22] found that extracts of some weeds as *Calotropis gigantea* has caused allelopathic effects inhibited germination and growth of *Lathyrus sativus*. The difference between the species in the responses of their seeds for Allelopathic coming from *C. procera* leaves agree with the findings of other works like Patil [7] who proved differences in seeds germination as a response to the leaf extract of *Glyricidia maculate.*

The results also indicated that most of the leaf extract treatments have resulted in retardation in radicle and plumule elongation. Plumule reduction in the highest concentration reached 88.8, 85.3, 81.4 and 68.1% in wheat, barley, Fenugreek, and cucumber respectively when compared to the control, while that for radicle reached 90.8, 90.3, 52.8 and 72.3% respectively. For Alssana, plumule reduction in 20% concentration reached 71.7% and for radicle 72.7% compared to the control while the radicle growth stopped immediately after emergence and plumule did not appear at the last two treatments (40 and 60%). These findings agree with what was found by Oudhia [22] where he found inhibition at growth in radicle and plumule of *Lathyrus sativus* by extracts from *C. gigantea*. El-Darier and Yousef [23] found a negative relationship among the different concentrations of alfalfa on plumule and radicle elongations of *Lepidium sativum*. The results in this study also showed that the low concentration of the water leaf extract (5%) has caused stimulation in plumule and radicle growth in cucumber, Fenugreek and Alssana seeds. This agree with the finding of Oudhia and Tripathy [16] who found a stimulation in radicle and plumule growth of rice due to the influence of the water extract of the leaf, root and stem of *C. gigantea* at the 10% concentration compared to the control. Finally, radicle length was relatively more sensitive to allelochemicals of *C. procera* than was plumule length. These results agree with other studies reporting that water extracts of allelopathic plants had more pronounced effects on radicle growth than on plumule growth [9, 24,25]. This is likely because those roots are the first to absorb the allelochemicals from the environment [24]. An especially high degree of inhibition occurred with leaf extracts at the highest concentrations in all tested crop plants.

Generally, it can be concluded that *C. procera* plays an important role in the formation of its natural habitats as it contains the allelochemical compounds that enable the plant to compete with other species. This plant may change communities when recycled as a green manure in the soil for increasing organic materials in agro-ecosystems, where it inhibits crop growth and production.

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التأثير الأليلوباثي لمستخلص أوراق العشر على إنبات بذور بعض النباتات

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المستخلص. تم في هذا البحث دراسة تأثير المستخلص المائي (٥، و١٠، و٢٠، و٤٠، و٦٠٪) للأوراق الجافة لنبات العشر على إنبات كل من القمح، والشعير، والخيار، والحلبة، والسنا. وأوضحت النتائج تأخر الإنبات في التركيزات العالية، وانخفضت نسبة الإنبات النهائي كلما زاد تركيز المستخلص الورقي. وقد كانت أكثر البذور تأثرا بذور نبات السنا وذلك مقارنة بالنباتات الأخرى المختارة، والتي تضرر فيها الإنبات في المعاملتين الأخيرتين (٤٠ و٦٠٪). وقد تأثر نمو كل من الجذير والريشة. حيث انخفض طول الجذير كلما زاد تركيز المستخلص، وقد مات الجذير في التركيزات المرتفعة (٤٠ و ٦٠٪) في بذور نبات السنا. كما استحث مستخلص الورقة المنخفض التركيز (٥٪) ظهور ونمو الريشة في كل من نباتات السنا والخيار والحلبة أكثر من نباتات المعاملة الضابطة لكل منهم، بعد ذلك انخفض طول الريشة مع زيادة تركيز مستخلص ورقة نبات العشر.