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ALLELOPATHIC EFFECT OF *GLOSSONEMA EDULE* (ASCLEPIADACEAE) ON ASSOCIATED FLOWERING PLANTS AND RHIZOSPHERE FUNGI IN QATAR

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تأثير الإبعاد التضادي الكيميائي لنبات الجراوة علي بعض النباتات الزهرية وفطريات المحيط الجذري

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تقوم العديد من النباتات الزهرية بإطلاق بعض السموم الكيميائية التي يكون لها دور مؤثر في إعاقة النباتات الأخرى أو الميكروبات التي تشاركها نفس الموقع . ويطلق على هذه الظاهرة الإبعاد التضادي الكيميائي أو الأليلوباثي . وقد أجريت هذه الدراسة المعملية لتوضيح هذه الظاهرة في نبات الجراوة وبيان مدى تأثيره على ستة أنواع من النباتات الزهرية المعمرة والحولية بالإضافة إلى ثلاثة أنواع من فطريات التربة . تم استخدام مستخلصات الماء والكحول والإثير وبيان مدى تأثيرها على إنبات بذور النباتات الزهرية ونمو الغزل الفطري . وأوضحت الدراسة أن مستخلصات نبات الجراوة المختلفة لها تأثير مثبط على إنبات البذور أو تكوين البادرات . وكان التأثير المثبط أكثر شدة على النباتات الحولية من الأنواع المعمرة ، وكذلك بينت الفطريات إنخفاضاً في معدل نمو الغزل الفطري تحت تأثير التركيزات المستخدمة من مستخلصات الماء والكحول والإثير وبذلك يمكن أن يؤثر الإبعاد التضادي الكيميائي في توزيع النباتات الزهرية أو فطريات التربة في عشائر نبات الجراوة الذي ينمو بريا في دولة قطر .

Key Words: *Glossonema edule*, Plant extract, Allelopathy, Seed germination, Soil fungi

ABSTRACT

Laboratory experiments were conducted to determine whether there were allelopathic effects of Glossonema edule (Asclepiadaceae) on six associated flowering plant species and three soil fungi. The tested species were the four perennial flowering plants *Farsetia hamiltonii*(Cruciferae), *Lycium shawii* (Solanaceae), *Salvia aegyptia* (Labiatae) and *Savygnia parviflora* (cruciferae), and the two annuals *Plantago ciliata* (Plantaginaceae) and *Spergula fallax* (Caryophyllaceae), and the two rhizosphere fungi *Aspergillus terreus* and *Aspergillus fumigatus* and the rhizosphere fungus *Chaetomium globosum.* The effect of water, ethyl alcohol and petroleum ether extracts on the flowering plant seed germination and the fungal mycelial growth was tested. Low concentration of *G. edule* extracts showed a stimulating effect on seed germination of *F. hamiltonii* and *S. parviflora*, at least during the early germination days. Germination of the other test species was inhibited by all tested extract concentrations. The annual flowering plant species were found to be more sensitive than perennial species to the allelopathic effect of *G. edule*. It is suggested that they have not developed resistance to toxins as they grow during the rainy season where allelopatthic effects may not operate in nature during winter due to soil washing by rain. The extracts were inhibiting to the mycelial growth of the three tested fungal species. If the sensitivity of the fungal growth to *G. edule* extracts is taken as a measure of sensitivity, the following sequence from highest to lowest of the fungal species was observed: *Chaetomium globosum, Aspergillus fumigatus* and *Aspergillus terrus.*

INTRODUCTION

The population structure of plant communities is influenced by the biological interactions among its component species. The existence of allelopathy, i.e. a process by which plants produce and release chemical compounds into the environment which may unfavourably affect other plants, animals and microorganisms has been proven to influence vegetation patterning in many terrestrial communities[1-7]. The influence of allelopathy affects plant distribution and abundance within natural communities[8-12]. *Glossonema edule* N.E. Br. (Asclepiadaceae) is a perennial herb with fleshy leaves. The branches are soft, erect and arising from the base of stem. The species undergoes repeated annual cycles of shoot growth and die-back. Shoot regrowth starts in winter and flowering occurs in March to April. During summer, all the aboveground shoots dry out except the buried base of the stem which is usually protected from desiccation.

During a study on a population of *Glossonema edule*, considerable distances were observed between individual plants in the population. It was also noted that none or very few seeds germinated in the immediate surroundings of the adult plants, and in most cases pure patches of the population grew within the community. It was hypothesized that these features could be caused by allelopathic activity of *Glossonema edule* which impedes the establishment of other plants, that favouring its annual regrowth from the perennating underground organs.

The present study was conducted to investigate the possible allelopathic effect of *Glossonema edule* on six associated flowering plants and on three soil fungi.

MATERIALS AND METHODS

Laboratory experiments were conducted to determine the allelopathic effects of *Glossonema edule* on six associated flowering plant species and three soil fungi. The flowering plants were the four perennials *Farsetia hamiltonii* Royle (Cruciferae), *Lycium shawii* Roem. et Schult. (Solanaceae), *Salvia aegyptia* L. (Labiatae) and *Savygnia parviflora* (Del.) Webb. (Cruciferae) and the two annuals *Plantago ciliata* Desf. (Plantaginaceae) and *Spergula fallax* (Lowe) Krause (Caryophyllaceae).

The tested fungi were two rhizosphere fungi, namely *Aspergillus fumigatus* and *Aspergillus terreus* and the non-rhizosphere fungus *Chaetomium globosum*.

Vegetative shoot and root systems of *Glossonema edule* were collected from the Doha-Abu Samrah road, Qatar in April 1993. The material was air dried, ground and extracted in water, ethyl alcohol and petroleum ether[6,13,14]. The stock extracts were diluted into concentrations of 10, 8, 6, 4, 2 percent (V/V) for further use in allelopathic tests.

At the same time of plant material collection, roots were sampled for rhizosphere fungi determination. Root-free soil samples from an adjacent area were collected as control (non-rhizosphere) to evaluate the changes in the fungal population due to plant growth.

The effect of different plant extracts on seed germination was assessed in Petri dishes on Whatman filter paper. Germination tests were carried out in the dark at a temperature of 25° C. Germination tests indicated that the dark is not inhibitory to germination of tested species seeds. Experiments were terminated after 10 days. To test the effect of plant extract on fungal mycelial growth, potato dextrose agar medium containing the tested extract was inoculated in the centre of the Petri dish with the mycelium obtained from 10 day old cultures of every test fungus[15]. Plates were incubated at 25° C for 6 days. Radial growth of the mycelium was measured daily. Three replicates were used in every seed germination and fungal growth test.

Mechanical and chemical properties of rhizosphere and non-rhizosphere soil at a depth of 5-20 cm were analyzed[16]. Mechanical analysis was carried out by the sieve method, organic matter by the wet oxidation titration method, pH by the pH meter and electric conductivity by the conductivity meter.

RESULTS

Soil factors

The physical and chemical properties of soil are shown in Table 1. The silt and clay contents were the only tested factors that differed significantly between rhizosphere and non-rhizosphere soils. The non-significant differences between the other tested factors may suggest, the soil qualities may be disregarded as factors affecting fungal flora and presence in both rhizosphere and non-rhizosphere soils.

Table 1

Soil properties in the rhizosphere and non-rhizosphere of *Glossonema edule*. n = 3, mean ± S. D.

Soil factor	Rhizosphere	Non-rhizosphere
Mechanical analysis (%)		
Coarse sand	16 ± 3.5	13 ± 2.1
Fine sand	67 ± 5.1	78 ± 8.3
Silt	11 ± 0.9	6 ± 1.2*
Clay	6 ± 1.4	3 ± 0.6*
Water holding capacity (%)	38 ± 3.9	33.7 ± 3.1
Organic matter (%)	0.21 ± 0.03	0.16 ± 0.02
pH	7.3 ±0.4	7.9 ± 0.4
Electric conductivity (m.mohs/cm)	0.35 ± 0.07	0.28 ± 0.05

*Significant difference at 0.01 probability level.

Biological Activities of Plant Extract

Bioassay against flowering plants

The bioassay tests of water, ethyl alcohol and petroleum ether extracts were inhibitory to the seed germination of the tested flowering plants (Figure 1). The six species showed different responses to the three plant extracts of *G. edule*. Low concentrations of water and alcohol extracts were more inhibitory to the seed germination of *S. aegyptia*, while the opposite was true in case of *S. parviflora* and *S. fallax* (Figure 1c, d & f). In response to the different plant extracts, the seed germination of *P. ciliata* (Figure 1e) suffered the highest inhibition among the tested species. In general, the annual flowering plant species seem to be more sensitive than the perennial species to allelopathic effect of *G. edule*.

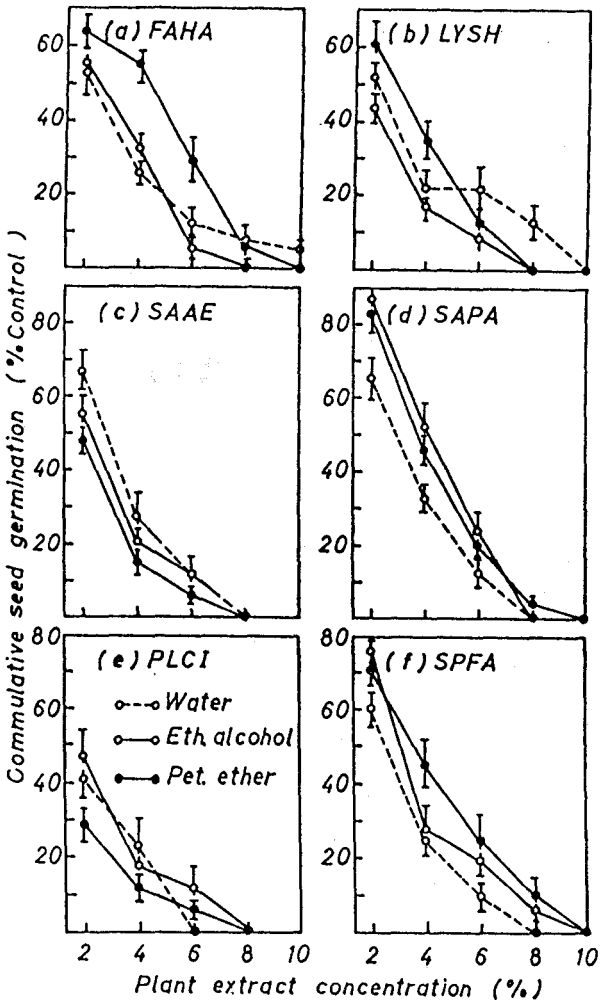

Fig 1. Effect of water extract, ethyl alcohol extract and petroleum ether extract of *Glossonema edule* on seed germination of: (a) *Farsetia hamiltonii* (FAHA), (b) *Lycium shawii* (LYSH), (c) *Salvia aegyptia* (SAAE), (d) *Savygnia parviflora* (SAPA), (e) *Plantago ciliata* (PLCI), and (f) *Spergula fallax* (SPFA). n = 3, mean ± S.D.

Bioassay against soil fungi

As shown in Figure 2, the effect of the water extract bioassay on mycelial radial growth of the three tested soil fungi was more inhibitory than the alcohol and ether extracts. The water extract progressively reduced the mycelial growth of the three tested fungi with the increase of extract concentration. The growth of *A. fumigatus* was less resistant to the water extract than were the other two fungi (Figure 2a, b & c). At the same time, mycelial growth of *A. terreus* was completely inhibited at water extract concentration of 10%.

The alcohol and ether extracts showed no strong inhibition for the mycelial growth of *A. terreus*. They were most inhibitory for *C. globosum* (Figure 2b & c). The inhibitory effect of the ether extract on *A. fumigatus* occupied an intermediate position between the effect of water and alcohol extracts (Figure 1a). Generally the non-rhizosphere fungus *C. globosum* was more sensitive to *G. edule* extracts than the two rhizosphere fungi, *A. fumigatus* and A. *terreus*.

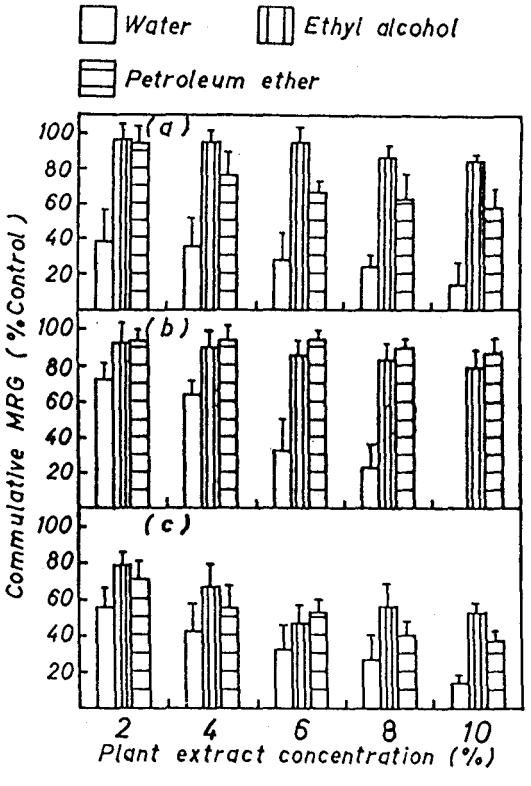

Fig 2 Effect of water extract, ethyl alcohol extract and petroleum ether extract of *Glossonema edule* on mycelial growth of: (a) *Aspergillus fumigatus* (b) *Aspergillus terreus* and (c) *Chaetomium globosum*. n = 3, mean ± S.D.

DISCUSSION

The strong inhibitory effect of *Glossonema edule* extract on flowering plant seed germination and fungal mycelial growth in vitro suggests this species may have the potential for causing allelopathy in nature. The perennial flowering plant species seem to be more resistant to the allelopathic effect of *G. edule* than the annual species. The most likely explanation for this is that annuals have not developed resistance as they grow during the rainy season, because allelopathy may not be effective during the rainy season due to dilution or leaching of allelo-chemicals by the winter rain[6].

Water extract was much more inhibitory for seed germination and fungal mycelial growth of the test species than were ethyl alcohol and petroleum ether extracts. This suggests that allelopathic potential of *G. edule* is operating in nature as a result of water-soluble allelochemicals. Phytochemical screening of *G. edule*[17,13,14] revealed the presence of sterols, terpenes, coumarins, flavonoids, saponins and tannins. Most of these substances are known to have an allelopathic effect[4-18] and may have an important role in plant community structure and function[6, 8, 19-23].

The inhibitory effect of *G. edule* on test species was apparently not due to any factors other than allelopathy because there were no significant differences in soil properties measured under *G. edule* and its surroundings.

This was confirmed in other studies[15,24]. In conclusion, the allelopathic effects of *Glossonema edule* suggested by this study may operate in its natural habitats, thus explaining the failure of other flowering plants establishment within its patches and the decrease of fungal diversity in the rhizosphere. The role of allelopathy in reducing plant density and the depletion of soil moisture will be tested in a subsequent publication.

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