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ALLELOPATHY AS EXPRESSED BY *STACHYS PARVIFLORA* BTH.

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Allelopathic effects of *S. parviflora* Bth. on seed germination and seedling growth of *S. sudanense* Cv. Dale, *L. culinaris, P. radiatus, P. vulgaris, B. campestris, B. chinensis, R. sativus, T. alexandrum, S. italica* and *C. arietinum* were studied in the laboratory. Aqueous extracts, litter-bed of shoots and roots, and volatiles from entire plants of *S. parviflora* invariably arrested both germination and seedling growth under laboratory conditions. The inhibitory effects were species specific. The roots were generally more toxic than shoots. Soil leaching due to rains rectified the toxic effects of added toxins. The findings suggests that *S. parviflora* is potentially allelopathic.

Key words: Stachys parviflora; Allelopathy; Crops; Growth reduction.

INTRODUCTION

S. parviflora Bth. is a malodorous perennial herb growing as a waste-land species from 300 m to 2500 m in Pakistan. It also occurs as a weed of cultivation. However, only a few species can grow and associate with it in nature. One of the possible reasons for the negative association and preclusion of species is allelopathy. *S. leucophylla* [11-14], *Artemesia* [6], *Datura* [7], *Eucalyptus* [1, 4] and *Eragrostis* [8] exhibit allelopathy against susceptible species. Allelopathy is an ecologically important operative factor interfering with the yield, productivity, pattern and association of species in natural and agro ecosystems [9, 13]. The present investigation on the interference ecology of *S. parviflora* was undertaken to analyse its allelopathic potential in Pakistan.

MATERIALS AND METHODS

Mature plants of *S. parviflora*, collected from Peshawar University Campus during June and July, were separated into shoots (leaves, stems and inflorescences) and roots and air dried at room temperature (25-30°) and were tested for their allelopathic effects on seed germination of *S. sudanense* Cv. Dale, *L. culinaris, P. radiatus, P. vulgaris, B. campestris, B. chinensis, R. sativus, T. alexandrum, S. italica* and *C. arietinum* Cv. Kabuli as test species. Fifty seeds in five replicates of every tests species in each of the following 4 types of bioassays were incubated at 25°. Germination and radicle growth was recorded after 72 hr.

Aqueous extract bioassay. Five g finely powdered dry shoots and roots each were soaked in 100 ml distilled water for 24 hr at 25° and filtered. The aqueous extracts were tested against the test species following Ahmed *et al.* [1] The extracts were stored at 5-10° when not in use.

Litter-bed bioassay. Three g crushed shoots or roots were separately spread in a petri dish and topped with a single sheet of filter paper. Seeds of the test species were placed on the top and moistened with distilled water. Controls were similarly made by replacing plant material with fine pieces of filter papers. Seeds were incubated as described.

Soil residual toxicity. Soil for making test was sampled underneath *Stachys* up to a depth of 15 cm, air dried at room temperature and sieved through 2 mm mesh. Control soil was collected in the same vicinity without the influence of *Stachys.* Test and control soils were used in soil-bed bioassays by using 20 g soil in petri dish following Dirvi and Hussain [2] and Hussain *et al.* [8] against the test species.

Volatile inhibitor bioassay. Uncovered petri dishes containing seeds of test species on twice folded Whatman No. 1, moist filter paper seed-beds were placed on the second shelf in a Gallenkamp cooled incubator at 25°. Five mature *Stachys* plants were transferred to the lowermost shelf. The incubator was closed to simulate a micro-environmental condition where seeds/seedlings might come in contact with volatile inhibitors from *Stachys.* A parallel arrangement was simultaneously made for making control by replacing plants with moist filter paper pieces in another incubator of similar type and capacity. Germination and radicle growth was measured after 72 hr.

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RESULTS

Aqueous extract bioassay. Germination of *Lens* in shoot extract; of *B. chinensis* and *Phaseolus* in root extract and those of *B. campestris, Raphanus* and *Trifolium* in both the extracts significantly decreased (Table 1). Maximum inhibition in germination was shown by seeds of *B. chinensis* in root extracts followed by *B. campestris* in shoot extract.

The radicle growth of *Sorghum* in shoot extract, of *B. campestris* and *P. vulgaris* in root extract and of *Lens, Setaria, B. chinensis, Raphanus* and *Trifolium* in both extracts were severely arrested (Table 1). Among the various species the growth of non-susceptible species (*Raphanus* and *Trifolium*) decreased to 18 % in shoot extract and to 4.9 % (*B. chinensis*) in root extract, which generally exhibited more inhibition than the shoot extracts. The susceptibility to extracts was species-specific.

Litter-bed bioassay. Brassica, Cicer, Trifolium and *P. vulgaris* exhibited retarded germination in root litter; shoot litter reduced the germination of *P. vulgaris* only (Table 1). The radicle growth of all test species, except. *P. vulgaris* in shoot litter, significantly decreased (Table 1). *Cicer* and *P. vulgaris* were respectively the most and least susceptible to shoot litter; while *Brassica* and *P. radiatus* were the most and least susceptible to root litter respectively.

Soil residual toxicity. The germination of *Setaria* and radicle growth of *P. vulgaris* respectively decreased to 70 % and 84.22 %. The remaining species were either unaffected or stimulated in their growth (Table 1).

Volatile inhibitor bioassay. The germination of *Setaria, P. vulgaris* and *Cicer* respectively decreased to 57.14 %,

Table 1. Allelopathic effects of different plant parts of *S. parviflora* on seed germination and radicale growth of some test plants. (The results are percent of control calculated from the means of 5 replicates, each with 10 seeds).

S. No.	Test plants	Shoot Extract	Shoot Litter	Soil-bed	Shoot Volatile	Root Extract	Root Litter
				Seed germination			
1.	*Sorghum sudanense*	91.89	—	—	—	91.89	—
2.	*Lens culinaris*	68.41	91.48	100.00	94.00	97.36	55.75
3.	*Phaseolus radiatus*	90.00	94.00	100.00	100.00	110.00	51.88
4.	*Phaseolus vulgaris*	100.54	88.00	96.00	86.00	65.78	116.15
5.	*Setaria italica*	126.08	100.00	70.00	57.14	104.34	27.32
6.	*Brassica campestris*	150.00	95.13	100.00	102.04	27.77	20.68
7.	*Brassica chinensis*	108.00	—	—	—	22.22	—
8.	*Raphanis sativus*	76.92	97.95	100.00	96.00	82.05	59.76
9.	*Trifolium alexandrum*	52.63	100.00	100.30	96.00	65.78	30.11
10.	*Cicer aurietinum*	—	97.91	90.00	87.75	—	25.67
				Radicle Length			
1.	*Sorghum sudanense*	66.35	—	—	—	94.83	—
2.	*Lens culinaris*	50.06	90.00	100.51	72.01	61.18	36.65
3.	*Phaseolus radiatus*	131.55	100.00	163.51	51.33	149.84	67.11
4.	*Phaseolus vulgaris*	110.51	86.00	84.32	45.78	55.28	45.35
5.	*Setaria italica*	65.83	94.00	147.43	41.02	42.70	24.59
6.	*Brassica campestris*	109.97	32.65	120.39	50.36	14.05	15.41
7.	*Brassica chinensis*	28.67	—	—	—	4.91	—
8.	*Raphanis sativus*	18.72	92.00	128.75	94.89	8.55	31.93
9.	*Trifolium alexandrum*	18.61	75.51	90.81	50.36	21.18	48.78
10.	*Cicer aurietinum*	—	55.10	122.18	64.63	—	64.51

– Not tested

86 % and 87.75 % in the *Stachys* environment. The radicle growth of all the test species, except *Raphanus*, significantly declined (Table 1). The inhibited germination and growth suggest the effectivity of some toxins volatilizing from *Stachys*.

DISCUSSION

Metabolic wastes from plants and/or litter might prove harmful against the associated species to exclude them from the common habitat. The litter deposited by *Stachys* under suitable condition releases phytotoxins prior to complete decay. This was observed by the inhibited germination and growth of test species in the aqueous extracts of shoots and roots. The aqueous extracts might have had some kind of water soluble toxins. *Salvia* [11-14] expresses similar allelopathy against test species. Aqueous extracts from *Datura* [7], *Eucalyptus* [1, 4], *Eragrostis* [8] and *Artemesia* [6] retard the germination and growth of test species. The growth medium containing *Stachys* litter adversely reduced the germination and growth of test species. This suggests the release of some toxins from the litter. The laboratory extraction of toxins simulates the natural conditions [7]. Rain, fog, dew or any other source of waters release phytotoxins from *Stachys* litter to create undesirable habitat for the susceptible species which might get eliminated from the common habitat. *Stachys* inhibits the species tested in the present investigation. Dirvi and Hussain [2], Ahmed *et al.* [1], Hussain *et al.* [7, 8], Naqvi and Muller [15] and Muller [10-12] reported similar findings for other plants. Volatilization from aromatic plants is an effective means of transporting toxins. *Stachys* harbours a micro-environment of volatile inhibitors that significantly suppresses the germination and growth of associated species. Volatile inhibitors might be absorbed and/or adsorbed on the moist growth medium [7], or they might directly come in contact with the seeds/seedlings of the susceptible species to cause inhibition. Inhibitory volatiles from *Datura* [7] reduce the germination and growth of species under laboratory and field condition. *Salvia* creates a bare zone extending upto one meter through volatile inhibitors [11, 12]. Similarly *Eucalyptus* [1, 4] effectively exhibits allelopathy. We report the same for *S. parviflora*. The toxins ultimately reach to the soil to accumulate in significant quantities. The effectivity of added toxins is ecologically important. It was however, observed that *Stachys* soil, with few exception, did not prove toxic against most of the species. This might be attributed to the leaching of the soil during heavy rains at the time of soil sampling in late July. Rains reduce the soil toxicity [5]. Slight inhibition in some susceptible cases hint upon the presence of phytotoxins in small quantities. *Encelia* and *Franseria* failed to express allelopathy due to lack of accumulated litter and release of toxins [10]. The toxicity was related to species sensitivity and this fact agrees with some workers [2, 6-8] and disagree with others [6, 7] who reported the shoots to be more toxic than roots. The present findings suggest that *Stachys* releases toxins through volatilization and during the decay of the litter. Allelopathy might be one of the factors responsible for the poor association of other plants with *Stachys*. However, allelopathic effects are modified by other factors of the environment in natural ecosystems as rains modified the phytotoxicity of soil in the present investigation.

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