

ALLELOPATHIC POTENTIAL OF *ALBIZIA SAMANS* MERR.

MEHER NOOR AND M. AJMAL KHAN

*Department of Botany,
University of Karachi, Karachi-75270, Pakistan.*

Abstract

The effect of aqueous extracts obtained from various plant parts of *Albizia samans* and the under canopy soil was studied on germination and early seedling growth of different cultivars of *Zea mays*, *Triticum aestivum* and *Albizia lebbeck*. Stem and seed extracts delayed germination and inhibited seedling growth. Root and leaf extracts delayed germination and inhibited seedling growth in some test species. Flower and soil extracts had no effects on germination and growth.

Introduction

Allelopathy, one of the stress factors which operates in natural and managed ecosystem, is widely considered as a tool of self defense (Lovett, 1991). It can play an important role in regulating plant diversity (Chou & Lee, 1991). Competition alone could not explain the reduction of growth under favourable physical environment (Chou & Lee, 1991). Chemicals released from plants into the medium are therefore of major significance in adaptation of species and organization of communities as well as its possible role in shaping the evolution (Chou, 1989; Jeffrey *et al.*, 1989). Basic plant processes such as hormonal balance, protein synthesis, photosynthesis, respiration, chlorophyll production, plant-water relations and permeability may also be affected by allelochemicals (Yamane *et al.*, 1992). Only few plant species were found under or near the canopy of *Albizia samans* Merr., (Mimosaceae) a tree which is endemic to Central America and West Indies and has been naturalized in Pakistan. This lack of vegetation and the plants which were present showed poor growth, could be due to allelochemicals released from *A. samans*. Studies were therefore carried out to study the allelopathic potential of *A. samans*.

Materials and Methods

Fresh parts of leaf, flower, shoot, root, seed of *A. samans* growing at the University of Karachi campus and soil under the canopy at 0-15 cm depth were collected in April 1992. Five and 10 g samples of leaves, stems, flowers, seeds and roots were separately soaked in water for 24h and homogenized. Filtrate were used to see the affects on germination and growth of *Zea mays* (cv. R 796, Gohar, EV 1081), *Triticum aestivum* (cv. Inqalab, Chakwal, Pak 81, Rohtas) and *Albizia lebbeck* used as test plants.

Hard seeds of *A. lebbeck* were mechanically scarified by sand paper till the seed coat ruptured from at least one point. The seeds were sterilized with 0.5% sodium hypochlorite solution for 1 min., and then washed thoroughly with distilled water. Seeds of each test species were pre soaked in respective test solution and germinated in test tubes of 20 mm in diameter and 180 mm in length lined with 3.5 x 16 cm strip of Whatman # 1 filter paper folded to form a channel and saturated with the test solution. Distilled water was used as control. Three replicates of 5 seeds of each were

Table 1. Effect of aqueous extracts of *Albizia samans* on rate of germination of test species.

Species	Conc. (%)	Aqueous extracts					
		Soil	Root	Stem	Leaf	Flower	Seed
<i>Zea mays</i> cv.:							
Gohar	0	4.7	4.5	4.7	4.2	4.2	4.7
	5	4.3	3.5	2.8	3.3	3.8	2.8
	10	4.7	3.2	2.3	3.1	3.3	3.1
R 796	0	4.2	4.7	3.9	4.3	4.1	3.9
	5	4.2	3.4	2.5	3.7	3.9	2.3
	10	3.9	3.0	2.2	1.9	3.8	0.8
EV 1081	0	3.7	3.7	3.7	3.6	3.6	2.4
	5	3.9	2.4	1.6	3.6	3.4	1.5
	10	3.7	1.4	2.2	2.8	2.3	0.5
<i>Triticum aestivum</i> cv.:							
Pak 81	0	4.1	3.8	4.1	4.2	5.0	3.7
	5	4.1	4.0	3.7	2.7	4.6	3.8
	10	4.2	4.1	4.5	3.9	4.2	1.9
Inqalab	0	5.0	5.0	5.0	4.2	5.0	5.0
	5	4.2	4.3	5.0	2.9	5.0	4.6
	10	4.0	3.5	5.0	3.8	4.8	4.3
Chakwal	0	4.7	4.6	4.7	3.8	5.0	4.6
	5	4.0	4.7	3.0	2.3	4.1	4.3
	10	5.0	4.4	3.6	3.7	3.8	3.4
Rohtas	0	5.0	5.0	5.0	5.0	5.0	5.0
	5	4.6	4.6	2.8	3.9	5.0	5.0
	10	4.6	3.2	4.3	3.9	5.0	4.3
<i>Albizia lebbek</i>							
	0	5.0	5.0	5.0	5.0	5.0	5.0
	5	4.3	5.0	4.5	4.2	5.0	5.0
	10	4.7	5.0	3.9	4.6	5.0	5.0

used. Tubes were temporarily sealed by polythene sheets. Germination were recorded every 24h and root and shoot length were measured at the end of 3 day experimental period.

Relative germination and elongation ratios were determined using indexes proposed by Rho & Kil (1986).

$$\text{Relative germination ratio (RGR)} = \frac{\text{Germination ratio of test plant}}{\text{Germination ratio of control}} \times 100$$

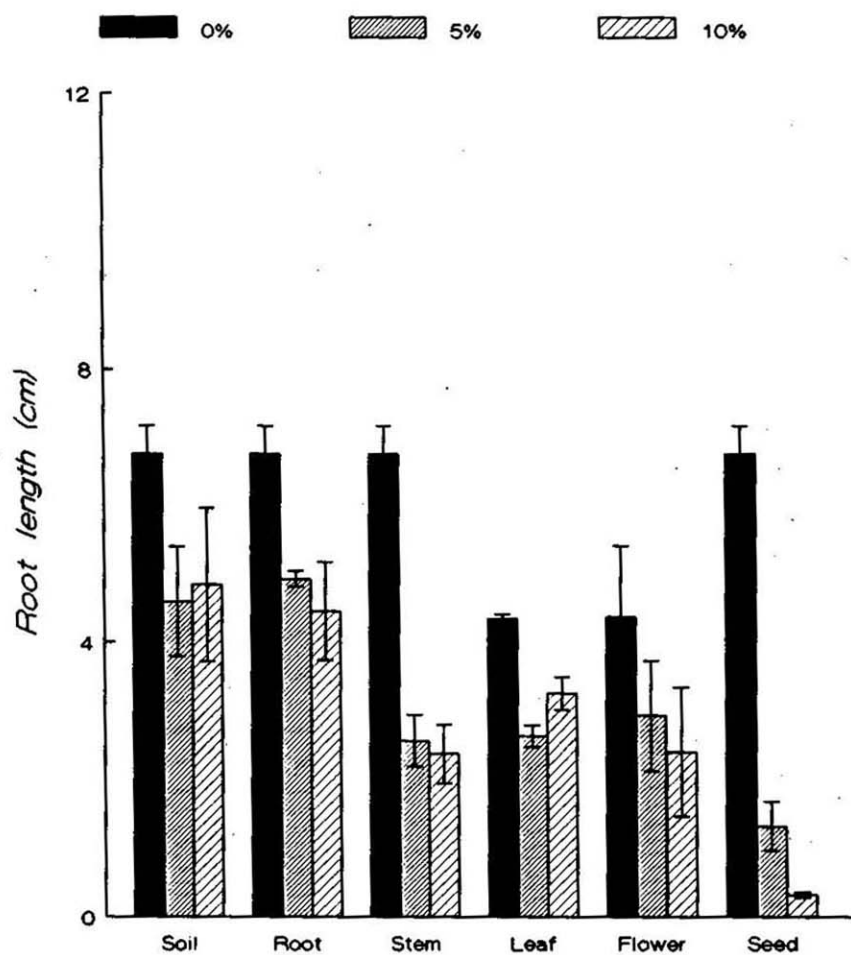


Fig 1. Effect of various concentrations of aqueous extract of *A. samans* on root length of *T. aestivum* var. Inqalab.

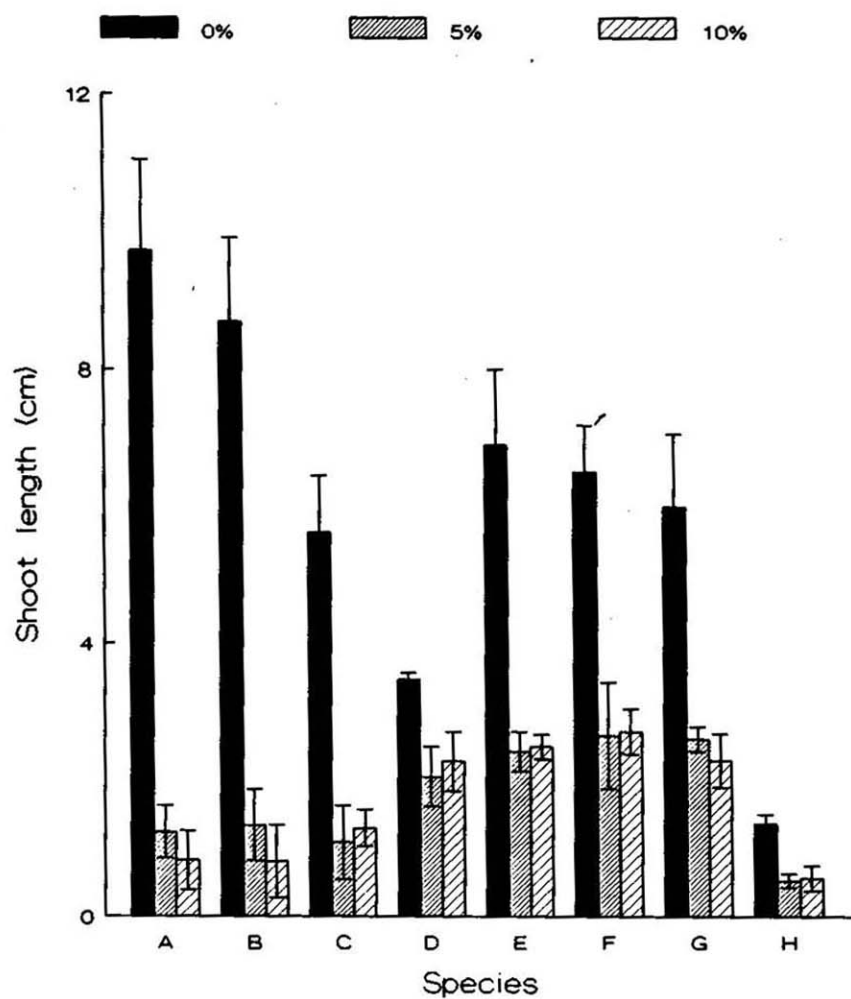


Fig. 2. Effect of stem extract of *A. samans* on the shoot growth of *Z. mays* var. Gohar (A), R 796 (B), EV 1081 (C); *T. aestivum* var. Pak 81 (D), Inqalab (E), Chakwal (F), Rohtas (G) and *A. lebeck* (H).

$$\text{Relative elongation ratio (RER)} = \frac{\text{Mean length of tested plant}}{\text{Mean length of control}} \times 100$$

The data was subjected to statistical analysis using SPSS package on IBM-PC, 486/66m hz computer.

Results

Extracts obtained from stem, leaf and seeds of *A. samans* delayed germination in most of the test species (Table 1). Root extract delayed germination in *Z. mays* cv. EV 1081 while others remained unaffected. Water extracts obtained from soil and flower did not influence the rate of germination of test species.

Leaf, flower and soil extracts showed no effect on final germination percentages (Table 2). Root, stem and seed extracts significantly ($p < 0.01$) reduced the germination. Seed extract showed highest inhibitory potential reducing 70% germination of seeds of *Z. mays* cv. EV 1081 as compared to 50 and 40% inhibition respectively by root and stem extracts (Table 3).

Leaf, root, seed and stem extract significantly ($p < 0.001$) inhibited the root growth in all the test species with pronounced effect observed in seed extract (Table 4, Fig. 1).

Water extracts obtained from flower and soil had no effect on shoot growth while leaf extract caused 70% reduction in shoot growth of *Z. mays* cv. EV-1081, with no effects on other species (Table 5, Figs. 2, 3, and 4). Seed, stem and root extracts significantly ($p < 0.001$) inhibited the shoot growth of all test species (Figs. 2-4). Stem and seed extracts were more inhibitory as compared to root extract.

Stem, leaf and seed extracts significantly ($p < 0.001$) reduced seedling elongation (Fig. 5) with substantial inhibition in stem and seed extract as compared to leaf. Root, flower and soil extracts had no effect on seedling elongation.

Table 2. Two-way analysis of variance of germination of individual plants x species x concentration.

Dependent Variable	Independent variable		
	Species	Concentration	S x C
Leaf	1.56 ^{n.s.}	2.07 ^{n.s.}	1.33 ^{n.s.}
Flower	6.77 ^{***}	4.19 [*]	1.47 ^{n.s.}
Root	5.89 ^{***}	6.30 ^{**}	1.32 ^{n.s.}
Seed	17.05 ^{***}	18.27 ^{***}	2.21 [*]
Soil	1.49 ^{n.s.}	1.22 ^{n.s.}	0.61 ^{n.s.}
Stem	4.85 ^{***}	5.65 ^{**}	2.06 [*]

Note: Numbers represent F values; * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$, n.s. = not significant.

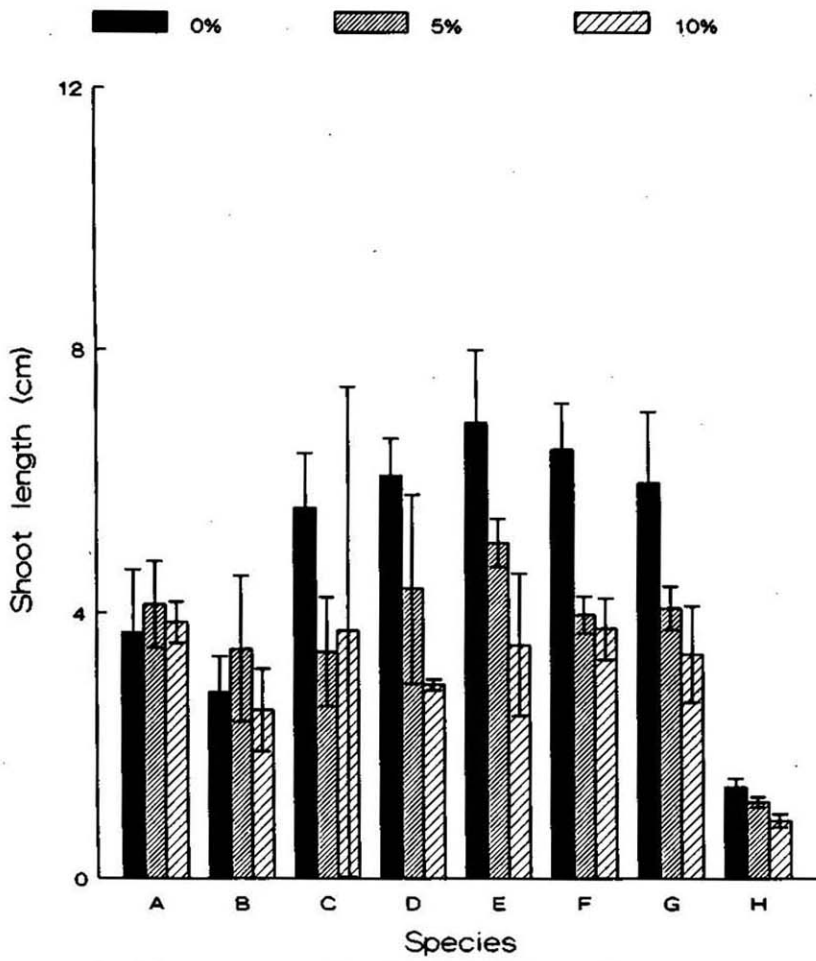


Fig. 3. Effect of root extract of *A. samans* on the shoot growth of *Z. mays* var Gohar (A), R 796 (B), EV 1081 (C); *T. aestivum* var. Pak 81 (D), Inqalab (E), Chakwal (F), Rohtas (G) and *A. lebeck* (H).

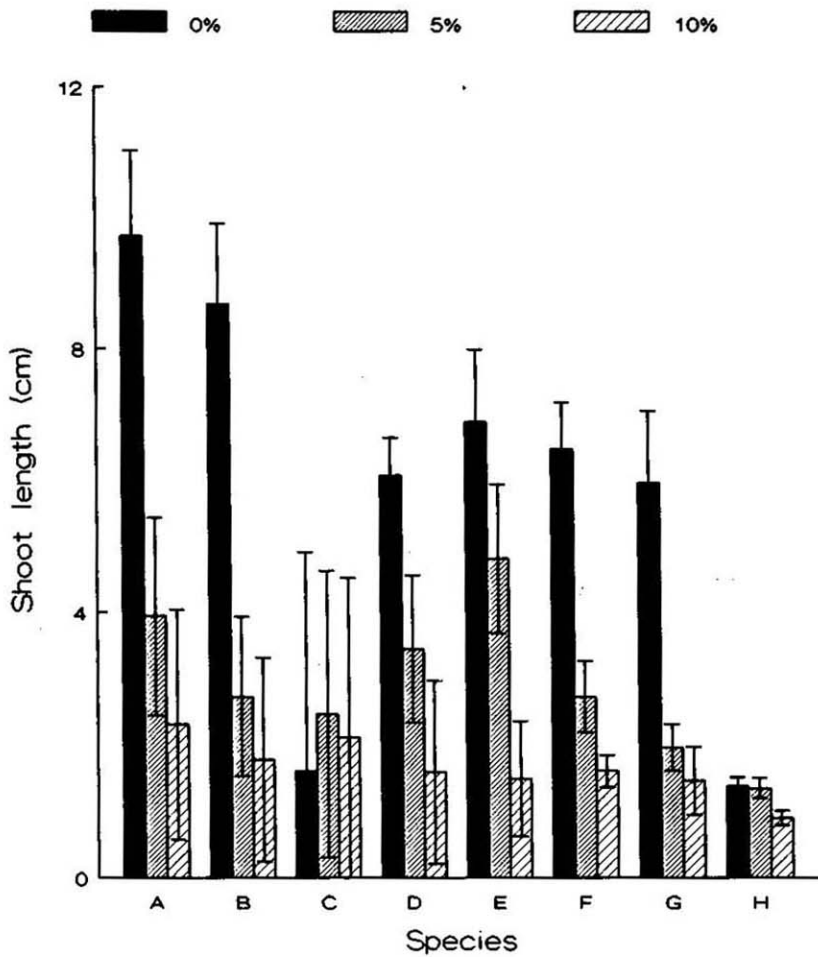


Fig. 4. Effect of seed extract of *A. samans* on the shoot growth of *Z. mays* var Gohar (A), R 796 (B), EV 1081 (C); *T. aestivum* var. Pak 81 (D), Inqalab (E), Chakwal (F), Rohtas (G) and *A. lebeck* (H).

Table 3. Relative germination ratio (RGR) of tested plants at different concentrations of water extracts of *Albizia samans*.

Species	Conc. (%)	Aqueous extracts					
		Soil	Root	Stem	Leaf	Flower	Seed
<i>Zea mays</i> cv.:							
Gohar	0	100	100	100	100	100	100
	5	100	100	86.6	80	100	66.6
	10	100	85.7	66.6	80	80	86.6
R 796	0	100	100	100	100	100	100
	5	93.3	93.3	92.3	93.3	100	69.2
	10	86.6	80	76.2	80	100	30.7
EV 1081	0	100	100	100	100	100	100
	5	86.6	91.6	60	116.6	116.6	69.9
	10	86.6	50	66.6	100	75	30.0
<i>Triticum aestivum</i> cv.:							
Pak 81	0	100	100	100	100	100	100
	5	100	100	107.1	64.3	93.3	100
	10	100	100	107.1	92.8	86.6	58.2
Inqalab	0	100	100	100	100	100	100
	5	86.6	86.6	86.6	92.3	100	93.3
	10	80	80	86.6	92.3	100	86.6
Chakwal	0	100	100	100	100	100	100
	5	80	107.2	60	84.6	100	92.8
	10	100	107.2	100	100	100	78.5
Rohtas	0	100	100	100	100	100	100
	5	93.3	93.3	80	93.3	100	86.6
	10	93.3	73.3	100	93.3	100	86.6
<i>Albizia lebbeck</i>							
	0	100	100	100	100	100	100
	5	100	100	100	93.3	100	100
	10	100	100	86.6	93.3	100	100

Discussion

Water extract of *A. samans* exhibited phytotoxic activity in reducing rate of germination and early seedling growth of the cultivars of *Z. mays*, *T. aestivum* and *A. lebbeck*. Phytotoxic effects of plant species like *Ademostoma fasciculatum* (Kaminsky, 1981); *Washingtonia filifera* (Khan, 1982); *Pinus densiflora* (Kil, 1989); *Ipomea tricolor* (Anaya et al., 1990); *Eucalyptus* (May & Ash, 1990); *Parthenium* (Singh & Sangeeta, 1991); *Brassica napus* (Choesin & Boerner, 1991); *Rorippa sylvestris* (Mizutani, 1989) has been reported. Germination and growth was significantly reduced which could be due to presence of water soluble inhibitors (Inderjit & Dakshini, 1992; Kil & Yun,

Table 4. Two-way analysis of variance of root length of individual plants x species x concentration.

Dependent Variable	Independent variable		
	Species	Concentration	S x C
Leaf	01.8 ^{n.s.}	25.6 ^{***}	0.6 ^{n.s.}
Flower	00.3 ^{n.s.}	00.9 ^{n.s.}	00.1 ^{n.s.}
Root	01.9 ^{n.s.}	23.6 ^{***}	01.9 ^{**}
Seed	00.8 ^{n.s.}	16.5 ^{***}	00.3 ^{n.s.}
Soil	00.4 ^{n.s.}	00.2 ^{n.s.}	00.2 ^{n.s.}
Stem	05.9 ^{***}	112.4 ^{***}	02.1 ^{**}

Note: Numbers represent F values; * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$, n.s. = not significant.

1992; Singh & Sangeeta, 1991) and inhibitory potential increased with increasing concentration of the extract (Hsu *et al.*, 1989; Lawrence, 1991). This suggests that phytotoxicity may be proportional to the concentration of the toxin in the environment. The effect of aerial parts on germination and growth was greater than the effects of sub aerial parts (Shaukat *et al.*, 1983; Singh & Sangeeta, 1991; Kil & Yun, 1992).

Root length was observed to be more sensitive to seed extract than seed germination or shoot length (Aliotta *et al.*, 1989; Smith, 1989). Since roots are the first to absorb allelochemical compounds from the environment and thus may show their abnormal growth in response to allelochemicals resulting in increased length as compared to control.

Table 5. Two-way analysis of variance of shoot length of individual plants x species x concentration.

Dependent Variable	Independent variable		
	Species	Concentration	S x C
Leaf	9.1 ^{***}	11.1 ^{***}	1.9 ^{**}
Flower	0.8 ^{n.s.}	0.2 ^{n.s.}	0.1 ^{n.s.}
Root	13.6 ^{***}	18.2 ^{***}	01.8 ^{**}
Seed	0.8 ^{n.s.}	9.9 ^{***}	0.3 ^{n.s.}
Soil	1.2 ^{n.s.}	2.1 ^{n.s.}	0.2 ^{n.s.}
Stem	26.6 ^{***}	374.8 ^{***}	18.7 ^{***}

Note: Numbers represent F values; * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$, n.s. = not significant.

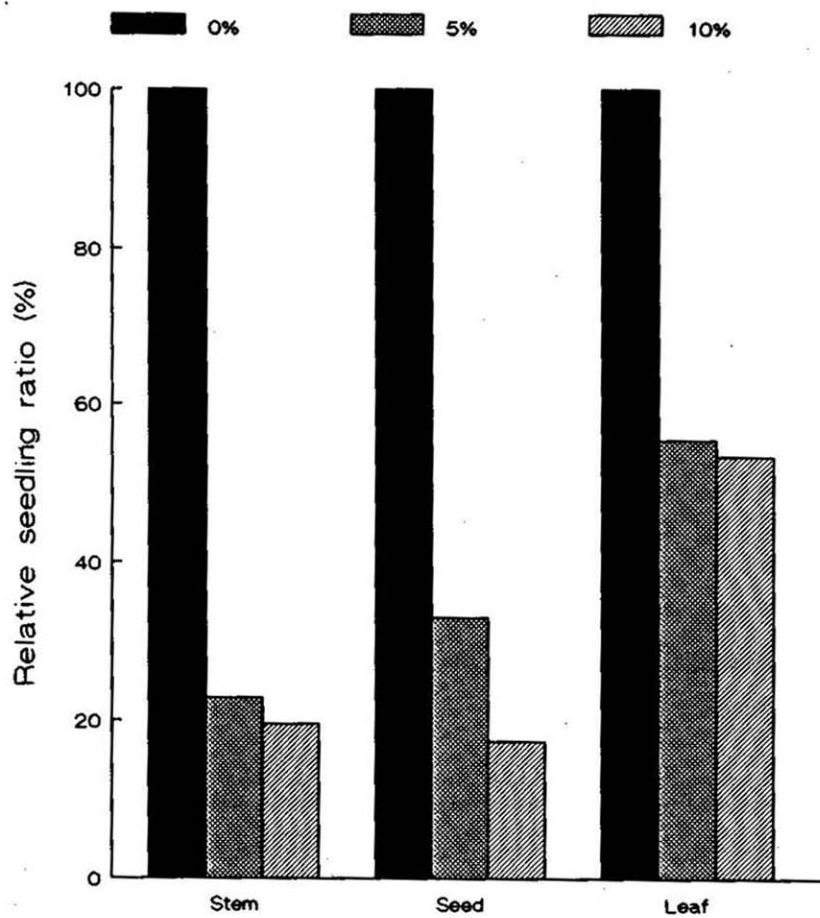


Fig. 5. Effect of stem, leaf and seed extracts of *A. samans* on the relative elongation ratio of *Z. mays* var. Gohar.

The response of various test species to the same extract treatment was different as has also been observed by (Hussain *et al.*, 1985) or inhibitors may be selective in their effects (Chou, 1989). This unequal susceptibility to the extract could be due to inherent differences in physiological and morphological characteristics of various species involved (Shaukat *et al.*, 1983). Toxicity is assumed to be associated with the presence of strong electrophilic or nucleophilic system. Action by such systems on specific positions of proteins or enzymes would alter their configurations and affect their activity (Macias *et al.*, 1992).

The present study shows that water extracts of seed, stem and leaf are more inhibitory as compared to soil, root and flower. This indicate the presence of allelopathic potential in *A. samans* and could perhaps explain the absence of other plant species or stunted growth of individuals present there. There is need to examine the chemical nature of inhibitors and carry out field experiments to ascertain the ecological role of allelopathic potential of *A. samans*.

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