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Allelopathic Effect of Different Concentration of Water Extracts of *Acacia auriculiformis* Leaf on Some Initial Growth Parameters of Five Common Agricultural Crops

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Abstract: Allelopathic effect of leaf extracts (different concentration) of *Acacia auriculiformis* and its possible phytotoxicity was tested in a laboratory experiment by using some agricultural crops e.g. ***Brassica juncea*** (L.) Czern & Coss; ***Phaseolus mungo*** L.; ***Raphanus sativus*** L. and ***Vigna unguiculata*** (L.) Walp. and ***Cicer arietinum*** L. as a bioassay material. The experiment was conducted in sterilized petri dishes with a photoperiod of 24 hours on an average of 29°C. The effects of the different concentrations of aqueous extracts were compared to distill water (control.). The aqueous extracts caused significant inhibitory effect on germination, root and shoot elongation and development of lateral roots of receptor plants. Bioassays indicated that the inhibitory effect was proportional to the concentrations of the extracts and higher concentration (50-100%) had the stronger inhibitory effect whereas in some cases the lower concentration (10-25%) showed stimulatory effect. The study also revealed that inhibitory effect was much pronounced in root and lateral root development rather than germination and shoot growth.

Key words: Allelopathic effect, ***Acacia auriculiformis***, germination, root length and shoot length

Introduction

Acacia auriculiformis, a leguminous species (Mimosoideae), naturally distributed in Australia, Papua New Guinea and Indonesia (Pinoyopusarerk, 1990), introduced in Bangladesh for afforestation and reforestation of degraded and wasteland areas (Rahman, 1984 and Das, 1985). Although the species is fast growing and can grow in wide ranges of soils (Davidson, 1985) the ground vegetation under its canopy indicated that it has some allelopathic potentials which might have been caused either by fallen leaves (through decomposition of litter) or plant leachates or root exudates. Consequently, the release of allelochemicals (organic substances) into the soil inhibits seed germination and establishment of agricultural crops and vegetation (Rice, 1979). Such inhibitory effects on the under storey vegetation have been exhibited in Pines (Rice, 1974). Joyakumar ***et al.*** (1978a, 1978b), Swami Rao and Reddy (1984), Melkania (1987), Eyini ***et al.*** (1989), Koul ***et al.*** (1991) and Bansal ***et al.*** (1992) studied the inhibitory effect of ***Eucalyptus***, Bamboo, Teak, ***Acacia nilotica***, ***Dalbergia sissoo***, ***Bauhinia variegota***, ***Ficus bengalensis***, ***Morus alba***,

Populus deltoides*, *Salix babylonica and ***Leucaena leucocephala*** on the germination and seedling growth of certain food crops. Petmark and Williams (1991) recommended ***Acacia auriculiformis*** as agroforestry species. King (1979) pointed out the need for investigations of allelopathy in various tree species used in agroforestry where there is a good chance of allelochemicals release by the intercrop trees affecting food and fodder crops. Therefore, it seems essential that the allelopathic compatibility of crops with trees should be checked before introducing in agroforestry system (Gaba, 1987; Khan and Alam, 1996). Very few researches were done on this aspect in case of ***Acacia auriculiformis*** (Jadhav and Gaynar, 1992; Rao ***et al.***, 1994; Bora ***et al.***, 1999) in this sub-continent. So the purpose of the present study was to elucidate the allelopathic potential of different concentration of ***Acacia auriculiformis*** leaf extracts on some common agricultural crops used in Bangladesh.

Materials and Methods

Acacia auriculiformis was considered as the donor plant and the receptor agricultural crops selected were Indian mustard (***Brassica juncea*** (L.) Czern & Coss), Chickpea (***Cicer arietinum*** L.), Black gram (***Phaseolus mungo*** L.), Radish (***Raphanus sativus*** L.) and Falen (***Vigna unguiculata*** (L.) Walp).

The aqueous extracts of were prepared from fresh leaf of the donor plant. 100 gram of fresh senescent leaves of each species were soaked in 500 ml of distill water and kept at room temperature. After 24 hours the aqueous extract was filtered through the sieve. Some extracts were diluted to make the concentration of 10%, 25%, 50% and 75% and stored for seed treatment experiments. The following treatments were used in the experiment:

T_0 = Seeds of receptor plants grown in distill water only (Control),
T_1 = Seeds of receptor plants grown in leaf extracts of 10% concentration
T_2 = Seeds of receptor plants grown in leaf extracts of 25% concentration
T_3 = Seeds of receptor plants grown in leaf extracts of 50% concentration
T_4 = Seeds of receptor plants grown in leaf extracts of 75% concentration
T_5 = Seeds of receptor plants grown in leaf extracts of 100% concentration

Germination and growth records

The germination test was carried out in sterile petri dishes of 12 cm in size placing a Whatman no.3 filter paper on petri dishes. The extract of each concentration was added to each Petridish of respective treatment daily in such an amount just to wet the seed. The control was treated with distill water only. 20 seeds of an agricultural crop were placed in each Petridish replicating five times. The petri dishes were set in the analytical laboratory of the Institute of Forestry and Environmental Sciences, Chittagong University, Bangladesh at an average room temperature of 29°C. The experiment extended over a period of ten days to allow the last seed germination and the measurement of the shoot and root length. The seed was considered as germinated when the radicle emerged and the germination was recorded daily. The results were determined by counting the number of germinated seeds, number of lateral roots and measuring the length of primary root and main shoot on 10th day of the experiment. The data were subjected to Analysis of Variance and Duncan's Multiple Range Test (DMRT).

Ratio of germination and elongation were calculated as suggested by Rho and Kil (1986):

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

$$\text{Relative Elongation Ratio (RER) of shoot} = \frac{\text{Mean shoot length of tested plant}}{\text{Mean shoot length of control}} \times 100$$

$$\text{Relative Elongation Ratio (RER) of root} = \frac{\text{Mean root length of tested plant}}{\text{Mean root length of control}} \times 100$$

For the calculation of percentage of inhibitory effect on the germination and growth parameter to the control was calculated as per formula evolved by Surendra and Pota, (1978):

$$I = 100 - \frac{E_2 \times 100}{E_1}$$

Where: I = % inhibition, E_1= Response of control plant, E_2 = Response of treatment plant

Results

Germination

Table 1 shows the germination percentage of the five receptor plants. The study revealed that the inhibitory effect increases with the increase of extract concentration. In all cases the most inhibitory effect was found at T_5 treatment (100% conc.). The highest inhibitory effect (-90.39%) was found in *C. arietinum* at T_5 treatment while the lowest was (-1.76%) found in *B. juncea* and *P. mungo* at T_3 treatment. The stimulatory effects were mostly observed at T_1 (10% conc.) treatment. This result supports the findings of Rice (1984) who inferred that chemicals that inhibit the growth of some species at certain concentrations could stimulate the growth of the same or different species at lower concentrations. Significant inhibition of seed germination was not observed in *P. mungo* and *B. juncea* upto 50% concentration. Maximum relative germination (RGR) ratio (105.26%) was observed in *P. mungo* at T_4 treatment while the minimum (9.61%) was found in *C. arietinum* at T_5 treatment (Fig.1).

Growth of seedlings

Shoot elongation (cm)

The shoot lengths of five bioassay species are shown in Table 2. It was observed that in most cases the stimulatory effect was found at T_1 and T_2 treatment. The inhibitory effect was much more pronounced at T_5 treatment followed by T_4, T_3 and T_2 treatment respectively. The highest inhibitory effect (-41.56%) was found on *B. juncea* at T_5 treatment while the lowest (-1.20%) was

Table 1: Germination percent of receptor agricultural crops to distill water (T_0) and different concentrations of *Acacia auriculiformis* extracts (T_1-T_5)

Treatment	Agricultural crops *C. arietinum*	*R. sativus*	*V. unguiculata*	*B. juncea*	*P. mungo*
T_0	86.67a*	83.33 a	95.00a	95.00a	95.00a
T_1	90.00a	91.67 a	91.67a	95.00a	98.00a
	(+3.84)	(+10.00)	(-3.51)	(0.00)	(+3.16)
T_2	81.67a	80.00 a	95.00a	98.33a	98.33a
	(-5.77)	(-3.99)	(0.00)	(+3.50)	(+3.51)
T_3	35.00c	71.67ab	85.00ab	93.33a	93.33a
	(-59.62)	(-13.99)	(-10.52)	(-1.76)	(-1.76)
T_4	50.00b	73.33ab	83.33ab	85.00a	100.00a
	(-42.31)	(-12.00)	(-12.28)	(-10.52)	(+5.26)
T_5	8.33d	50.00b	76.67b	56.67b	85.00b
	(-90.39)	(-39.99)	(-19.29)	(-40.35)	(-10.52)

Table 2: Shoot elongation (cm) of receptor agricultural crops to distill water (T_0) and different concentrations of *Acacia auriculiformis* extracts (T_1-T_5)

Treatment	Agricultural crops *C. arietinum*	*R. sativus*	*V. unguiculata*	*B. juncea*	*P. mungo*
T_0	4.98ab*	7.51b	13.94a	3.97ab	18.28a
T_1	6.13a	9.29a	13.22ab	5.1 a	17.63ab
	(+23.09)	(+23.70)	(-5.16)	(+28.46)	(-3.56)
T_2	5.25ab	9.82b	12.65ab	4.24ab	15.86bc
	(+5.42)	(+30.76)	(-9.25)	(+6.80)	(-13.24)
T_3	4.92ab	9.41a	12.67ab	3.97ab	16.45ab
	(-1.20)	(+25.30)	(-9.11)	(0.00)	(-10.01)
T_4	4.57bc	9.09ab	11.35b	3.56bc	14.91c
	(-8.23)	(+21.04)	(-18.58)	(-10.33)	(-18.43)
T_5	3.33c	4.43c	8.19c	2.32c	12.20d
	(-33.13)	(-41.01)	(-41.25)	(-41.56)	(-33.26)

Values in the parenthesis indicates the inhibitory (-) or stimulatory (+) effects in comparison to control (T_0)

* Values in the columns followed by the same letter(s) are not significantly different ($P \leq 0.05$) according to Duncan's Multiple Range Test (DMRT)

in ***C. arietinum*** at T_3 treatment. Maximum elongation of shoot (18.28 cm) was observed in ***P. mungo*** followed by (13.94 cm) in ***V. unguiculata*** both at control. Maximum Relative Elongation Ratio (RER) of shoot (130.76%) was observed in ***R. sativus*** at T_2 treatment while among the survivors the minimum (58.43%) was in ***B. juncea*** at T_5 treatment (Fig. 2).

Root elongation (cm)

The mean root lengths (cm) as well as the percentage of inhibition of root elongation of all the receptor agricultural crops are shown in Table 3. The study revealed that in all cases the root length of the crops were greatly inhibited with the increasing extract concentration except ***P. mungo*** T_1 and T_2 treatment. Statistically pronounced significant inhibitory effect

Table 3: Root elongation (cm) of receptor agricultural crops to distill water (T_0) and different concentrations of *Acacia auriculiformis* extracts (T_1-T_5)

	Agricultural crops				
Treatment	*C. arietinum*	*R. sativus*	*V. unguiculata*	*B. juncea*	*P. mungo*
T_0	18.29a*	17.41a	14.09a	9.93a	8.23ab
T_1	13.49 b	16.86ab	11.05a	8.39b	9.43a
	(-26.24)	(-3.46)	(-21.58)	(-15.51)	(+14.58)
T_2	13.63b	16.63ab	8.28ab	7.69 b	8.62 ab
	(-25.48)	(-4.48)	(-41.23)	(-22.56)	(+4.74)
T_3	9.86bc	11.57bc	6.61bc	3.41c	6.49ab
	(-46.09)	(-33.54)	(-53.08)	(-65.66)	(-21.14)
T_4	8.21c	9.79c	4.11c	2.76c	6.03bc
	(-55.11)	(-43.77)	(-70.83)	(-72.21)	(-26.73)
T_5	6.42c	3.96b	2.47c	0.8d	4.70c
	(-64.90)	(-77.25)	(-82.47)	(-91.94)	(-42.89)

Table 4: Number of lateral roots developed in receptor agricultural crops to distill water (T_0) and different concentrations of *Acacia auriculiformis* extracts (T_1-T_5)

	Agricultural crops				
Treatment	*C. arietinum*	*R. sativus*	*V. unguiculata*	*B. juncea*	*P. mungo*
T_0	24.00a*	42.73a	29.13a	5.27a	11.13a
T_1	21.53ab	41.93a	17.93b	4.41ab	10.80ab
	(-10.29)	(-1.87)	(-38.45)	(-16.32)	(-2.96)
T_2	16.73bc	30.87b	16.60b	4.33ab	10.47ab
	(-30.29)	(-27.76)	(-43.01)	(-17.83)	(-5.93)
T_3	7.33d	18.60c	11.47bc	4.27ab	7.13c
	(-69.46)	(-56.47)	(-60.62)	(-18.98)	(-35.94)
T_4	8.87d	16.73c	10.23bc	3.47b	8.20bc
	(-63.04)	(-60.85)	(-64.88)	(-34.15)	(-26.33)
T_5	10.00cd	6.13d	5.27c	2.00c	6.87c
	(-58.33)	(-85.65)	(-81.91)	(-62.05)	(-38.27)

Values in the parenthesis indicates the inhibitory (-) or stimulatory (+) effects in comparison to control (T_0)

*- values in the columns followed by the same letter(s) are not significantly different ($P \leq 0.05$) according to Duncan's Multiple Range Test (DMRT)

was found at T_5 treatment followed by T_3 and T_4 treatment. The highest inhibitory effect (-91.94 %) was observed in *B. Juncea* at T_5 treatment while the lowest (-3.45%) was found on *R. sativus* at T_1 treatment. Maximum Relative Elongation Ratio (RER) of shoot (114.58%) was observed in *P. mungo* at T_1 treatment while the minimum (8.05%) was found in *B. juncea* at T_5 treatment (Fig.3).

Number of lateral roots developed

Table 4 presents the number of lateral root developed in different treatments. It was found that in all cases, higher concentration of water extracts had pronounced inhibitory effect on lateral root development. The highest number of lateral root developed at control

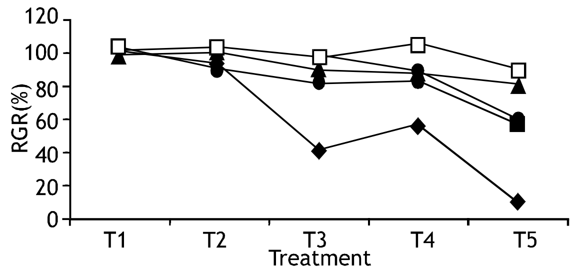

Fig. 1: Relative Germination Ratio (RGR) of bioassay species grown in petri dishes at different concentrations of *Acacia auriculiformis* extracts

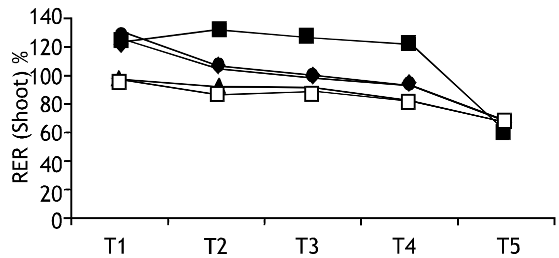

Fig. 2: Relative Elongation Ratio (RER) of shoot of bioassay species grown in petri dishes at different concentrations of *Acacia auriculiformis* extracts

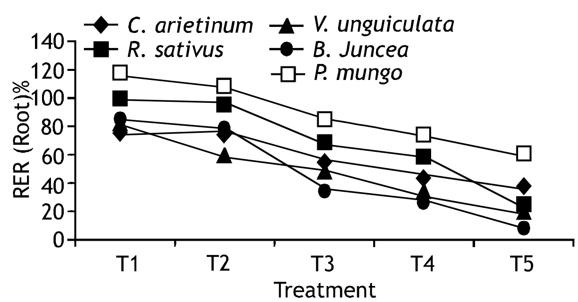

Fig. 3: Relative Elongation Ratio (RER) of root of bioassay species grown in petri dishes at different concentrations of *Acacia auriculiformis* extracts

(T_0). Maximum (42.73 nos.) root developed in *R. sativus* at control while the minimum (2.00 nos.) was recorded in *B. juncea* at T_5 treatment. The most inhibitory effect (-85.38%) was found in *R. sativus* at T_5 treatment followed by (-81.91%) in *V. unguiculata* at the same treatment while the lowest inhibitory effect (-1.87%) was in *R. sativus* at T_1 treatment followed by (-2.96%) *P. mungo* at the same treatment.

Discussion

Considering the foregoing results, it seemed that there is phytotoxic effect of *Acacia auriculiformis* leaf extract on the bioassay species germination, shoot elongation, root elongation and development of lateral root. These results correlated with the findings of Bora *et al.* (1999) who found the allelopathic effect of leaf extracts of *Acacia auriculiformis* on seed germination of some agricultural crops. This observation also confirmed the findings of Mousawi and Al Naib (1975) who reported inhibition of seed germination and seedling growth of some herbaceous plants by leaf extracts of *Eucalypts*. It was also observed that the leaf extracts of *Acacia auriculiformis* delayed as well as hindered the germination significantly in all the receptor plants compared to the control. The result also revealed that root elongation was much more inhibited than shoot elongation and germination. This confirmed the findings of Meissner *et al.*(1982) who also found that the undiluted tuber extract of *Cyperus rotundus* impeded the radicle elongation of cucumber, radish, onion and tomato. Antonio *et al.* (1999) reported the effects of aqueous extracts of *Leucaena* on germination and radicle elongation of three forage grasses in which radicle elongation was a more sensitive indicator for extracts effects rather than seed germination. The results are also in conformity with the earlier findings of Chou and Waller (1980a, 1980b); Swami Rao and Reddy (1984), Chou and Kuo (1986), Alam (1990), Chaturvedi and Jha (1992), Zackrisson and Nilsson (1992) and Uddin *et al.* (2000). All those studies supported that root growth and lateral root development was more sensitive and responds more strongly to the increasing concentration of the aqueous extract in comparison to shoot. Many bioassay species loss their ability to develop normally as a result of reduced radicle elongation and root necrosis. Based on the overall findings it can be concluded that allelopathy is a concentration-dependent phenomenon. This confirmed the report of Ballester *et al.* (1982), Rai and Tripathi (1984), Rizvi and Rizvi (1987) and Daniel (1999).

The studies provide the evidence of *Acacia auriculiformis* has allelopathic potential. Again its inhibitory effect on agricultural crops in absence of fungi and bacteria is an added evidence for allelopathy. The allelochemicals present in the *Acacia auriculiformis* can have an allelopathic inhibitory effect on different agricrops including trees and weeds species associated with *Acacia* plantations and also different agroforestry systems in field conditions. However, long-term field based studies must be carried out.

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