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# Allelopathic Potential of *Eucalyptus microtheca* F.Muell.-I

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**Abstract:** The aqueous extracts from different plant parts showed variable results. Both the suppressing and the stimulatory effects of *E.microtheca* were noticed on radicle and plumule growth and seed germination of *Pennisetum glaucum* (L.) R.Br. cv. BARI-Hairy. The toxicity and stimulation varied from part to part. Exudates from fresh roots were highly toxic while whole plant exudates were highly exhilarating for the radicle growth. For plumule growth, whole plant extract was highly toxic and stem extracts were highly enhancing. No extract, irrespective of its origin, concentrations and incubation periods could produce a detrimental effect on seed germination of the test plant.

**Key words:** Allelopathy, allelopathic effect, phytotoxicity, inhibitory effect, stimulating effect, *Eucalyptus microtheca*, *Pennisetum glaucum*

## Introduction

Allelopathy is derived from two Greek words " Allelon" meaning mutual and " Pathos" meaning harm, i.e. the injurious effect of one plant upon another. Allelopathy is also regarded as a bio-chemical warfare. Plants inhibit the seed germination and growth of other plants by means of producing toxic chemicals, i.e. allelochemicals or allelopathins. The allelopathic behaviour of some plants has also been selective in some cases, i.e. retarding the growth of some species whereas enhancing the growth of others (Bisla *et al.*, 1992; Hasegawa, 1993; Patil, 1994; Macharia and Peffley, 1995; Ambika and Vidya, 1996). It means that some plants are highly specific in producing bio-chemicals, which are selectively toxic, in some cases, they have rather enhancing effect. Thus these recent reports about some toxic plants stimulating the growth is contradictory to the definition of allelopathy.

The weeds have been known as the more toxic to the growth of neighbouring plants (Chaghtai *et al.*, 1985; 1986; 1988 and Chaghtai, 1992). Crops have also been reportedly shown allelopathic effects (Yenish *et al.*, 1995). Besides weeds and crops, trees also exhibit allelopathic effects on other plants (Jayakumar *et al.*, 1989) but their stimulatory effects have also been observed (Bisla *et al.*, 1992; Baar *et al.*, 1994).

*Eucalyptus microtheca* has recently been introduced on experimental basis in Pakistan Forest Institute (PFI), Peshawer and also in D.I.Khan division. It is suspected of producing toxic substances. It is on this account that this research project was initiated to determine its allelopathic potential.

## Material and Methods

The plant material was collected from *Eucalyptus microtheca* trees grown in PFI, Peshawer. The allelopathic effect of cold water extracts from fresh leaves, roots, stem and whole plant was tested on the germination and growth of *Pennisetum glaucum* (L.) R.Br. cv.Bari-Hairy in the laboratory of the Department of Botany, Islamia College, Peshawer.

Plant material was collected and washed thoroughly with running water to remove dust and other undesired organic material. The material was crushed by an electric chopper, washed and soaked straight away for fresh material treatment. In whole plant treatment, equal weights of crushed leaves, roots, stem and fresh fruits were mixed thoroughly for homogeneity.

**Fresh Material Bioassay**: Fresh leaves, roots, stem and whole plant material weighing 5, 10 and 15g each were soaked in separate beakers each containing 100ml doubly distilled cold water for 24 hrs. Extracts were filtered using Whatman filter paper No.1. The filtrates were either used straight away or stored in a refrigerator at 8°C for further use. The effect of aqueous extracts was tested against *Pennisetum glaucum* using standard filter paper bioassay techniques following Khan (1982).

The germination and growth of *P. glaucum*, the test species, were studied in 9cm. diameter sterilized petri dishes each lined with two layers of Whatman filter paper No.1 The filter paper forming the seed bed was soaked with 3ml. of plant extracts and healthy seeds of *P. glaucum* which had been sterilized before by rinsing them with 2% $HgCl_2$ solution for a minute or so and then washing them with running water several times, were uniformly spread on the filter paper. The petri dishes were wrapped in tin foil and incubated for 24, 48 and 72 hours in an oven at 26°C (±2). Distilled water was used as a control. Each treatment was replicated five times.

**Statistical Analysis:** The data were statistically analyzed by applying 't' test to determine the significance of the results obtained.

## Results and Discussion

### Roots

**Radicle growth**: All the incubation periods exhibited inhibitory effects on the radicle growth at all concentrations which is in conformity with the findings of others (Table 1) ( Choi, 1993; Tsuchiya *et al.*, 1994). Toxicity decreased with increasing concentration at 24hrs and 48 hrs incubation period while the trend was disarrayed in 72-hrs incubation period. Though inhibitory effect was observed in all the cases but it was statistically significant only in one case i.e., in 5g concentration at 24 hrs incubation period while in rest of the cases, the effect was insignificant (Table 1) showing that the toxic chemicals were in a dilute form and thus failed to produce detrimental effect. Chaghtai

Table 1: Effect of aqueous fresh extracts having soaking period 24 hours from various parts of *Eucalyptus microtheca* on germination, radicle and plumule growth of *Pennisetum glaucum*. Data is expressed as % of control, figures in parenthesis represent % germination

| | | Incubation periods | | | | | |
|---|---|---|---|---|---|---|---|
| | | Radicle length | | | Plumule length | | |
| Plant Parts | Concentration (%) | 24hrs | 48hrs | 72hrs | 24hrs | 48hrs | 72hrs |
| | 5 | 56.6* (100) | 71.12 (90) | 80.02 (95) | 62.5 (100) | 117.78 (90) | 34.92* (95) |
| Roots | 10 | 64.4 (100) | 72.62 (95) | 68.24 (100) | 90.9 (100) | 117.3 (95) | 33.88* (100) |
| | 15 | 72.7 (100) | 91.37 (95) | 62.83 (95) | 65.68 (100) | 135.57 (95) | 38.43* (95) |
| | 5 | 90.98 (100) | 90.05 (95) | 101.66 (95) | 94.31 (100) | 77.84 (95) | 137.63 (95) |
| Stem | 10 | 97.13 (100) | 84.01 (100) | 92.28(90) | 109.09 (100) | 84.75 (100) | 107.81 (90) |
| | 15 | 105.73 (100) | 88.95 (95) | 107.08 (100) | 118.18 (100) | 79.67 (95) | 138.54 (100) |
| | 5 | 120.0 (95) | 135.0*(95) | 111.79 (100) | 54.16*(95) | 135.11 (95) | 95.07 (100) |
| Leaves | 10 | 56.39* (95) | 123.6 (100) | 89.2 (100) | 43.75* (95) | 95.50 (100) | 97.75(100) |
| | 15 | 51.63*(100) | 75.61 (125) | 86.06 (100) | 57.81* (100) | 122.36 (125) | 124.65 (100) |
| | 5 | 94.35 (85) | 116.04 (85) | 106.07 (100) | 44.44* (85) | 65.42 (85) | 132.76 (100) |
| Whole Plant | 10 | 111.29 (95) | 120.7 (100) | 90.84 (95) | 77.77 (95) | 52.67* (100) | 99.75 (95) |
| | 15 | 72.58 (95) | 129.00 (100) | 94.76(100) | 47.22*(95) | 47.87* (100) | 85.67 (100) |

* significant at 5% level.

Table 2: General view of stimulatory and inhibitory( statistically significant and non-significant) effect of exudates from fresh parts of *Eucalyptus microtheca* on the growth of radicle and plumule of *Pennisetum glaucum*

| Plant parts | Stimulatory effects(%) | | Inhibitory effects(%) | | | |
|---|---|---|---|---|---|---|
| | | | Significant | | Non-significant | |
| | Radicle growth | Plumule growth | Radicle | Plumule | Radicle | Plumule |
| Roots | 0 | 33 | 11 | 33 | 89 | 34 |
| Stem | 33 | 56 | 0 | 0 | 67 | 44 |
| Leaves | 44 | 33 | 22 | 33 | 34 | 34 |
| Whole Plant | 56 | 11 | 0 | 44 | 44 | 45 |

Table 3: Overall view of the effect of aqueous extracts from various fresh parts of *Eucalyptus microtheca* in all concentrations and incubation periods on the germination of the seeds of *Pennisetum glaucam*

| Plant Parts | No Effect (%) | Inhibitory Effect (%) | Rate of inhibition (%) | Stimulatory Effect(%) | Rate of Stimulation (%) |
|---|---|---|---|---|---|
| Roots | 4 | 56 | 0-10 | 0 | 0 |
| Stem | 56 | 44 | 0-10 | 0 | 0 |
| Leaves | 56 | 33 | 0-5 | 11 | 25 |
| Whole Plant | 44 | 56 | 0-15 | 0 | 0 |

*et al.* (1988) has also come across such a situation. Less inhibitory effect was observed in 15g concentration at 48hrs incubation period. As a whole, the toxic effect does not follow a uniform pattern and the trend was disarrayed which confirms the findings of others. (Hussain *et al.*, 1984; Chaghtai *et al.*, 1986; 1988).

**Plumule growth:** Besides inhibitory effect on plumule growth, enhancing effect was also observed at 48 hrs incubation periods in almost all the concentration (Table 1). Significant inhibitory effect was observed in 72hrs incubation period while insignificant inhibitory effect was observed at 24 hrs incubation period. These results show that those allelochemicals, which are volatile in nature therefore in 72hrs incubation period, these chemicals are unable to show their action and also indicate the slow diffusion of toxic allelochemicals.

**Seed germination:** In 44% cases, seed germination was not affected while in 56% cases, inhibitory effect on seed germination was observed (Table 1 and 3). A relatively low rate of germination, i.e., 0-10% has been observed.

**Stem**

**Radicle growth:** In fresh material treatments, the exudates did not produce statistically significant toxic effect in all incubation periods and all the three concentrations. However statistically insignificant toxic effect was observed in 67% and enhancement of growth was noticed in 33% treatments. The toxic allelochemicals seemed to be dilute in form and thus failed to produce serious detrimental effects. The intensity of toxicity did not seem to affect the radicle growth.

**Plumule growth:** In 56% treatments stimulatory effect was noticed (Velu *et al.*, 1990) while rest of the treatments caused insignificant inhibitory effect (Table 1 and 2).Velu *et al.* (1990) had also observed while working on *Amaranthus*. The stimulatory and inhibitory effects on plumule growth were selective and not uniform. Stem extracts were found to be relatively less toxic to the plumule growth.

**Seed germination:** No serious inhibitory effect on the germination of seeds was observed, the rate of seed germination was 0-10% (Table 3). In 56% cases, no inhibition of seed germination occurred.

**Leaves**

**Radicle growth:** Both stimulatory and inhibitory effects of fresh leaves extracts on radicle growth of test plant were

observed (Table 1). Statistically both significant and insignificant inhibitory effects were noticed. Strongest inhibitory effect was observed only at 24 hrs incubation period while at 48 hrs and 72 hrs incubation periods, the toxic effect was not detrimental, it was rather stimulatory (Table 1). These results hint at the volatile nature of toxins however toxicity in all the incubation periods increased with increasing concentration. The stimulatory effect was also noticed in 45% cases (Table 2). All these effects were selective and in agreement with others too ( Hussain *et al.*, 1984; Chaghtai *et al.*, 1986; 1988). Both the stimulatory and inhibitory effects coincide with each other indicating the presence of both types of allelochemicals having the ability of enhancing and suppressing at the same time but the toxic allelochemicals are more volatile in nature than the stimulatory allelochemicals.

**Plumule growth:** Both inhibitory effects as reported by others (Jayakumar *et al.*, 1990) and enhancing effects agreeing with Bisla *et al.* (1992) were observed. However, both the effects were statistically significant and insignificant. Toxicity increased with increasing concentration. No enhancing effect was observed in higher concentrations i.e. 15g showing higher concentration of toxic and lower amount of stimulative allelochemicals.

**Seed germination:** Slight inhibitory effect was observed in 33% cases (Table 3). In 56% cases, seed germination of test species remained unaffected by the leaf extracts of *E. microtheca* (Table 3). Stimulatory effect occurred in 11% treatments. Velu *et al.* (1990) and Mahapatra and Tewari (1994) have also reported such stimulatory effects produced by different plants.

**Whole plant**

**Radicle growth:** The whole plant extracts, irrespective of their origin and concentrations produced provoking effects in all incubation periods (Table 1) in 56% treatments and insignificant inhibitory effects in 44% treatments ( Table 2). No significant inhibitory effect was observed in any treatment. However, order of stimulation and inhibition does not follow a uniform pattern and the effects are selective.

**Plumule growth:** Both inhibitory and stimulatory effects as reported by Alam and Azmi(1990) and Velu *et al.* (1990)were observed in all the concentrations ( Table 1). Statistically significant inhibitory effect was observed in 45% treatments and in 45% cases, it was insignificant (Table 2). Both the effects were selective and did not follow a uniform pattern. The highest statistically significant inhibition occurred in 5g concentration with 24 hrs incubation periods. The inhibitory effect seemed to diminish gradually with increasing the incubation periods.

**Seed germination:** The germination of seeds inhibited slightly in 56% treatments while in 44% cases, no adverse effect on seed germination was observed ( Table 3).

By comparing the effect of fresh roots, stem, leaves and whole plant extracts in all the concentrations and incubation periods, roots were found to be more toxic to radicle growth than any other part which is contradictory to the findings of Bisla *et al.* ( 1992) and Nandal *et al.* (1992) who found leaves producing the highest detrimental effects.

Order of toxicity observed in radicle growth was roots (100%) > stem (67%) > leaves (56%) > whole plant (44%). For the stimulatory effect, whole plant extracts were found to be more exhilarating than any other plant part which is in agreement with the findings of Alam and Azmi (1990) and Velu *et al.* (1990).The order of stimulation for the radicle growth was: whole plant (56%) > leaves (44%) >stem (33%) > roots (0%).

For the growth of plumule, the whole plant extracts were more toxic than any other plant part which is contrary to the findings of others who found that the leaves were more toxic to the plumule length (Table 1 and 2) ( Bisla *et al.*, 1992; Jayakumar *et al.*,1990). Order of toxicity for plumule growth was whole plant (89%)> roots (67%)> leaves (67%)> stem (44%) (Table 2).

For the stimulatory effect on the growth of plumule, the stem extracts were found to be more selective than any other plant part which is in agreement with the findings of Velu *et al.* (1990).The order of stimulation for plumule was: stem (56%) > leaves (33%) > roots (33%) > whole plant (11%).

In most of the treatments statistically insignificant effect of plant extracts on radicle and plumule growth of test plant is dominated which may be due to relatively low concentrations of the toxic chemicals (Chaghtai *et al.*, 1988).The significant toxic effects of exudates from fresh stem on radicle and plumule growth were not found i.e. 0% (Table 2).

The exudate from any plant part failed to produce statistically significant toxic effect on the germination of seeds, however the extracts from whole plant produced relatively more insignificant toxic effect than the other plant parts (Table 3). The order of toxicity for seed germination was: whole plant and roots (56%) > stem ( 44%) > leaves (33%) (Table 3). The stimulatory effect i.e., 11% was only produced by the leachates from leaves (Table 3). By and large the rate of germination was not adversely affected in more than 22% treatments in exudates from various fresh plant parts hinting at the inability of *Eucalyptus microtheca* to interfere with the germination of the grass species *Pennisetum glaucum* growing in its vicinity. Indeed, grasses are usually strong competitors, flexible and have wide distribution in various diverse habitats. It has been observed that under the *Eucalyptus* trees, grass cover is more than any other plants (M.A. Khan, pers.comm.). Hence the allelopathic effect of *Eucalyptus microtheca* could have been more injurious to other groups of angiosperms.

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