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ALLELOPATHIC EFFECTS OF *EUCALYPTUS* LEAF EXTRACTS ON GERMINATION AND GROWTH OF MAIZE (*ZEA MAYS* L.)

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ABSTRACT

The allelopathic effect of Eucalyptus camaldulensis extracts; soaked, crushed and boiled in tape water, were evaluated on the seed germination and growth of maize variety 'Kissan' at the Department of Agronomy, Faculty of Agriculture, Gomal University, D. I. Khan, Pakistan during 2001. Analysis of variance revealed that all the extracts significantly reduced maize seed germination, root and shoot length, fresh and dry weight compared to control where no extract was used. The eucalyptus boiled extract decreased seed germination to 66% compared to 99% germination in the control. Soaked extract was more toxic to root growth and caused higher decrease of maize root length, fresh and dry weight compared to other extracts. The highest decrease in maize shoot length, shoot fresh and dry weight, was registered in the crushed extract. The suppression of maize seed germination and other growth parameters indicates allelopathic effec. It is suggested that maize should not be planted close to eucalyptus trees due to the adverse effects on its growth.

Keywords: *Eucalyptus*, *Zea mays* L, *Eucalyptus camaldulensis*, Allelopathy, Allelo-chemicals,

INTRODUCTION

Crops growing together compete for light, nutrients, soil moisture and space. The direct or indirect harmful effects of one plant on another by way of competition for light, soil moisture, nutrients and space have been much investigated in the past. The importance of forest trees to mankind cannot be denied. However, the harmful effects of forest trees on agricultural crops growing around them adversely affected through release of allelochemicals into the crop environment have acquired a great importance in the recent past with the recognition of agro-forestry as an independent discipline.

Forest trees produce allelo-chemicals that affect the growth of other crops and weeds growing near to it. Putnam (1984) reported that eucalyptus species released volatile compounds such as benzoic, cinnamic and phenolic acids, which inhibit growth of crops and weeds growing near it. Pawar and Chawan (1999) reported that some forest trees including *Eucalyptus globolus* reduced up-take of Ca, Zn and Mg in sorghum resulting in reduced growth. They further added that the *E. globolus* caused the greatest reduction in the absorption of Ca in sorghum. Schumann et al (1995) reported that *E. grandis* water extracts significantly reduced weed establishment. Allelopathy involves the release of chemicals into the echo-system and it is these chemicals, which have their beneficial or harmful effects on the crop. It is important that all allelo-chemicals once released are short lived in the environment and, therefore, do not disastrously upset the balance in the agro ecosystem.

E. camaldulensis has recently been introduced on experimental basis in Pakistan. Eucalyptus has been established to be an integral part of our agro-forestry system. Eucalyptus has been established in the irrigated area of D. I. Khan because of its fast growing nature. It is expanding in the command area of Chashma Right Bank Canal.

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There are however reports that Eucalyptus produces allelo-chemicals that affects the growth and yield of crops growing in its vicinity. Reports also depict that some crops are more tolerant than others. Soils from eucalyptus forests increased germination of wheat and cowpeas as compared to the germination in field soil but decreased germination of maize (Blaise et al. 1997). In other studies eucalyptus leaf extract reduced germination of sorghum, groundnut, maize, black gram, cowpeas and soybean. Sorghum was the most sensitive and groundnut and cowpeas the most tolerant (Devasagayam and Ebenezar (1996). Thakur and Bhardwaj (1992) reported that leachates from *E. globulus* leaves significantly reduced maize germination but were ineffective on wheat germination. Maize is an important cash crop and there is a great scope for increase in area of this crop in D.I. Khan division. Hence the instant study was initiated to determine the allelo-pathic effect of *E camaldulensis* on the growth parameters of *Zea mays* so that recommendations could be made for growing it close to the eucalyptus trees or not. The other objective of the study was to establish the allelopathic nature of the leaf extract so that its effectiveness as herbicide could be investigated in separate studies.

MATERIALS AND METHODS

Experiments were conducted to determine the allelo-pathic effect of aqueous leaf extracts of *E. camaldulensis* on some of the growth parameters of maize in the laboratory of Department of Agronomy, Faculty of Agriculture, Gomal University, D. I. Khan, Pakistan during the year 2000. The different leaf extracts to be evaluated for their allelopathic effect were made according to the following procedure.

1. 10 liter of tap water was kept in big bucket at room temperature for 72 hours. (Check)
2. One kg eucalyptus leaves were soaked in 10 liter tap water at room temperature for 72 hours.
3. One kg eucalyptus leaves crushed in 10 liter water.
4. One kg eucalyptus leaves boiled in 10 liter for one hour.

Sixteen plastic pots (15.6 cm^{-2}) were filled with sand. The experiment was carried out in randomized complete block design with four replications in completely randomized design (CRD). Four pots each were soaked with tape water, soaked extract, crushed extract and boiled extract. Ten seed of commercial maize variety Kissan were sown in each pot. The pots were kept moistened with their respective extracts throughout the study. The experiment was terminated at the end of third week.

Data were recorded on % seed germination; shoot length (cm), root length (cm), shoot fresh weight (g) and root fresh weight (g) shoot dry weight (g) and root dry weight (g) according to the standard procedures. All the data were analyzed using statistical procedures appropriate to the design. The treatment means were compared using Fishers protected least significant difference test laid down in Steel and Torrie (1980).

RESULTS AND DISCUSSIONS

Maize seed germination (%)

The percent seed germination means in Table-1 delineated that all the Eucalyptus extracts significantly ($P \leq 0.05$) differed in reducing the maize seed germination compared to the control.

The maximum seed percent germination was shown in the control where no extract was used whereas the lowest seed germination of 66% was obtained in the boiled extract. The boiled extract induced 33% reduction in the maize seed germination. The decrease in maize seed germination in the eucalyptus extracts ranged between 15% and 33% (66-84 5% plants/plot) compared to 99% seed germination in the control. The least reduction in the seed germination was recorded in the soaked extract. The highest reduction in the maize seed germination by the boiled extract may be the result of allelo-chemicals released by the process of boiling that affected seed germination process. Similar results were reported by Swaminathan et al. (1993) and Thakur and Bhardwaj (1992), who reported that trees

extracts. including *Eucalyptus sp.*, decreased maize germination and growth. Blaise et al. (1997) discovered that soil from eucalyptus tree decreased maize seed germination and seedling growth. Devasagayam and Ebenezar (1996) and Khan et al. (1999) reported that water extract of eucalyptus (100g/liter distilled water) decreased maize seed germination by 8%.

Maize root length (cm)

The study of Table -1 revealed that all the eucalyptus extracts significantly ($P \leq 0.05$) decreased the maize root length as compared to the control. The smallest root length of 1.65 cm was registered in the soaked extract, which significantly differed from the other extracts in reducing the maize root length. The highest root length of 9.53 cm was obtained in the control. The decrease in maize root length in the eucalyptus extracts ranged between 36% and 83% (6.03-1.65 cm root length) compared to 9.53 cm root length in the control. The highest reduction in maize root length exhibited in the soaked extract revealed that the allelochemicals in the soaked extract were different from the boiled extract, which caused the maximum reduction in seed germination. These results confirm the findings of Lisanework and Michelsen (1993), who discovered that leaf extracts of *E. camaldulensis* decreased root growth of the majority of the crops in these studies.

Maize root fresh weight (g)

A study of the means (Table- 1) indicated that all the eucalyptus extracts significantly ($P \leq 0.05$) decreased the root fresh weight as compared to the control. The lowest maize root fresh weight of 0.21g was obtained in the soaked treatment which was at par with crushed extract in affecting the maize root fresh weight but significantly different from the boiled extract. The boiled extract was the least effective in affecting the fresh weight. The highest fresh root weight of 2.61 g was harvested in the control. It was noted that the soaked extract had more potency than the other extracts but its action either started some what slow or its allelochemicals differed from the ones in the other extracts, as it was less effective on germination. Similar results were reported by Sangina and Swift (1992), Lisanework and Michelsen (1993) and Khan *et al* (1999).

Maize root dry weight (g)

An investigation into the means (Table-1) displayed that all the eucalyptus extracts significantly ($P \leq 0.05$) decreased the root dry weight as compared to the control. The lowest maize root dry weight of 0.06 g was gained in the soaked treatment which was significantly lower than the root dry weight secured in either the crushed or boiled extract in affecting the maize root fresh weight. The boiled extract was the least effective in affecting the fresh weight. The highest fresh root weight of 0.43 g was reaped in the control. It was noticed that the soaked extract was more toxic to root and shoot growth than the other extracts. But , its adverse effects on germination were minimum, which may be due to the change in chemical in this extract . The allelochemicals in the soaked extract may be different from the ones in the other extracts where it produced the highest reduction in the maize root length, root fresh weight and root dry weight. The crushing and boiling may have altered the allelochemicals. The presumption seems to be reliable because the boiled extract caused the maximum reduction in seed germination but was the least effective on the other parameters specially when compared to soaked extract. The decrease in root dry weight in the eucalyptus extracts ranged between 34% and 55% (0.19-0.28 g) compared to 0.43 g dry weight in the check (Table –1).

Table 1. Maize percent germination, root length, fresh weight and dry weight response to leaf extracts of eucalyptus.

Treatments	Germination (%)	R L (cm)	RFW (9)	RDW (9)
Control (simple water)	99 00a	9.53a	2.61a	0.43b
Eucalyptus bark soaked in water	84.50b	1.65d	0.21c	0.63a
Eucalyptus bark crushed in water	78.00c	3 93c	0.93bc	0.19d
Eucalyptus bark boiled in water	66.00d	6.03b	1.43b	0.28c
$LSD_{0.05}$ = 5 07	5.07	0.69	0.73	0.08

Values sharing a common letter are not significantly different at probability of (P≤0.05)

Maize shoot length (cm)

An examination of the maize shoot means (Table-2) revealed that all the Eucalyptus extracts significantly reduced the maize shoot length as compared to the shoot length in the control. The smallest shoot of 7.07cm was harvested in the crushed extract which produced significantly smaller shoots as compared to the shoots produced in the boiled extract but was statistically (P≤0.05) at par to the soaked extract in decreasing the maize shoot length. The decrease in shoot length of maize in the Eucalyptus extracts treatment ranged between 61% and 68% (8.37-7.07cm shoot length) compared to 22 43 cm maize shoot length in the untreated control. The highest decrease in the shoot length of maize observed in the soaked and crushed extract was presumably due to the concentrated amount of allelochemicals in these treatment that affected the essential growth processes,resulting in decreased shoot lengths.

Maize shoot fresh weight (g)

A probe into the means (Table-2) demonstrated that all the eucalyptus extracts significantly (P≤0 05) decreased the maize shoot fresh weight as compared to the control. The lowest maize shoot fresh weight of 2.05 g was achieved in the crushed extract which, was significantly lower than the root dry weight received either in the crushed or in the boiled extract in affecting the maize shoot fresh weight. The boiled extract was the least effective in affecting the maize shoot fresh weight. The highest fresh root weight of 8.76g was acquired in the control. It was noticed that the crushed extract had more intensity than the other extracts in affecting the maize shoot parameter. The decrease in maize shoot fresh weight in the eucalyptus extracts ranged between 45% and 77% (4.83-2.05 g) compared to 8.75 g shoot fresh weight in the control. Our findings are in corroboration to Sanginga and Swift (1992) who reported that eucalyptus litter incorporated into the soil reduced maize shoot dry weight. It was observed that crushed extract was the most potent in affecting the shoot parameters while soaked extract the root parameters. This variability could not be ascertained with any precision. However, the different extraction methodology may have induced variability in the allelo-chemicals in the extract.

Maize shoot dry weight (g)

A perusal into the means Table 2 illustrates that all the eucalyptus extracts significantly (P≤0 05) decreased the maize shoot dry weight as compared to control. The lowest maize shoot dry weight of 0.29 g was obtained in the crushed extract which was significantly lower than the root dry weight received either in the crushed or in the boiled extract in affecting the maize shoot dry weight. The soaked extract was the least effective in affecting the maize shoot dry weight. The highest dry root weight of 0.82 g was procured in the control. It was noticed that the crushed extract had more intensity than the other extracts in affecting the maize shoot parameters. The decrease in maize shoot dry weight in the eucalyptus extracts ranged between 34%% and 65% (0.56-0.29 g) compared to 0.82 g shoot dry weight in the control. It was observed that crushed extract was the most potent in affecting

the shoot parameters while soaked extract was more effective in affecting the root parameters. This variability in the effect of eucalyptus could not be ascertained with any precision. However the different extraction methodology may have caused variability of the allelochemicals in the extract. Alam and Azmi (1991) who observed that *Cyperus rotundus* leaf extracts had no significant effect on wheat germination but significantly decreased root and shoot growth proclaimed similar results. Similarly Porwal and Mundra (1992) reported that boiled and un-boiled extracts of fresh shoots of *Cyperus rotundus* and *Echinochloa* did not influence germination of *Vinga mungo* and rice but significantly reduced shoot and radicle growth of *V. mungo* but not rice.

Table 2. Maize shoot length, fresh weight and dry weight response to leaf extracts of Eucalyptus.

Treatments	SL (%)	SFW (cm)	SDW (g)
Control (simple water)	22.43a	8.76a	0.37c
Eucalyptus bark soaked in water	8.37bc	3.83b	0.56a
Eucalyptus bark crushed in water	7.07c	2.05c	0.29d
Eucalyptus bark boiled in water	8.61b	4.83d	0.46b
$LSD_{0.05}$	1.034	0.93	0.04

Values sharing a common letter are not significantly different at probability of ($P \leq 0.05$)

RL = root length, RFW = root fresh weight, RDW = root dry weight
SL = Shoot length, SFW = shoot fresh weight, SDW = shoot dry weight

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