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Allelopathic Effect of Eucalyptus on Soil Characteristics and Growth of Maize

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Abstract:

The allelopathic effect of eucalyptus extract on maize grown in different soil series of D.I.Khan was evaluated at Goma University, Dera Ismail Khan, during 1996. The results showed that aqueous extract of *Eucalyptus camaldulensis* reduce germination seedlings height, fresh shoot weight and fresh root weight of maize seed. More dry matter was produced i extract applied seedlings. Application of aqueous extract of *Eucalyptus camaldulensis* reduced pH and increased in all so series phosphorus level.

Introduction

Despite of the fact that about 80 per cent of total population of Pakistan is dependant on agriculture, the country is not self sufficient in wood need and basic food commodities because the total area under forest in Pakistan is 5.2 percent (Jan, 1993). Population pressure (Tree cutting and over grazing of forest areas), arid climate, water constraints, financial limitations, salinity, water logging and erosion has led to continuous dwindling of forest in Pakistan (Keerio, 1991). The only solution to overcome that problem is to maximize tree plantation on farm lands. Since crop husbandry is vital and equally is the wood need, it is therefore, imperative to have such a balance integration of the 'two' to overcome the gap, the only is the "Agroforestry". However, the major constraint in this regard is that the farmers are reluctant to grow trees on their croplands because of certain illusions in their minds that trees have adverse effects on the crops (Sulemani, 1994). Competition for moisture, space, light, and nutrients is often well understood, where as phytotoxic effect of tree plantation is beyond from the comprehension of the farmers. Molisch (1937) coined the term allelopathy (Allelo of each other pathos- to suffer or harm) for the determental, beneficial and reciprocal biochemical interaction of plants in an ecosystem. Allelopathy is separated from competition as its effect depends upon a chemical compound added to the environment (Rice, 1974). Allelopathic effect also depends upon environmental factors including temperature, light, soil, precipitation and nutrients level of a habitat. It has been presumed that many a tree species grown on the farm land decrease the crops yield due to their allelopathic effect on crop plants. In Pakistan, especially in Dera Ismail Khan one of such notorious trees is *Eucalyptus* spp. Due to its fast growing nature and well adaptability in semi arid climatic conditions, it has got much popularity among the farmers.

To test this hypothesis, a pot experiment was conducted at Faculty of Agriculture, D.I.Khan to estimate the allelopathic effect of *Eucalyptus camaldulensis* on germination and growth of maize (*Zea mays*) in four soil series with known physio-chemical characteristic under controlled conditions. The main objective of this study was to elucidate th farmers of this region about the allelopathic effect o *Eucalyptus camaldulensis* on maize crop.

Materials and Methods

The pot experiment was conducted at Faculty o Agriculture, Gomal University, Dera Ismail Khan, durin 1996. The leaves of *Eucalyptus camaldulensis* we collected and mixed. Ten kg of this mixture was taken i the plastic-tub. Fifty liters of tap-water was added to th tub. The material was stirred after every 12 hours. Th process was continued up to 72 hours. The soil samples f each soil series were thoroughly mixed. The mixed so sample was then divided into 5 parts. The four parts of so were moistened separately with Eucalyptus extract. On part was moistened with tap-water. Five pots (15 x 10 cm were taken. Four pots were filled with extract treated so and one with tap-water treated soil. The same procedu was repeated for each soil series and also with sand Selected seeds of maize of "Kisan" variety were take Some of them were soaked in Eucalyptus extract an remaining in the tap-water for 12 hours. The Extract soake seeds were sown in Eucalyptus extract treated pots an water soaked seeds were sown in water treated pots. S seeds were sown in each pot, the same procedure w adopted for all soil series and sand. The pots were ke moist throughout the course of experiment by applying th respective solutions. The physio-chemical properties of th Nivela, Gishkori, Zindani and Buzdar soil series we determined in the Research Laboratory of Soil Chemist Section at Agriculture Research Institute, Ratta-Kulac Dera Ismail Khan.

The electrical conductivity, soil pH, Ca + Mg, CO_3 and in the soil were determined by the procedure as outlined Richard (1954). The available phosphorus and sand in s samples were determined by the method of Black (196 and Moddie *et al.* (1954) respectively. The data w statistically analysed by applying Paired T-test.

Physio-chemical properties of different soil series

	Nivela	Gishkori	Zindani	Buzdar	Sand
Moisture (%)	4.4	9.2	13.0	8.3	--
Soil pH	8.2	8.0	8.2	8.2	8.1
EC (μ.mohs)	200.0	1570.0	300.0	540.0	--
Ca + Mg m.eq/l	2.0	12.5	2.4	4.2	--
CO_3 m.eq/l	--	--	--	--	--
HCO_3 m.eq/l	4.3	3.0	3.2	3.3	--
Cl^- m.eq/l	3.6	12.2	3.9	4.8	--
P ppm	8.0	6.8	5.6	8.2	7.6

Results and Discussion

Germination (%): Results indicated that eucalyptus aqueous extract had adverse effect on germination (Table 1). The reduction in germination is evident due to the allelopathic effect of aqueous extract of *Eucalyptus camaldulensis* as compared to water applied soil. Sanginga and Swift (1992) observed that *E. grandis and E. camaldulensis* extracts inhibited germination of maize seeds. The difference in inhibitory effect on germination among the different soil series where extract was applied might be due to the differences in physio-chemical properties of different soils. The aqueous extract of Eucalyptus showed severe inhibiting effect on germination in Nivela soil series. This increased reduction in the germination seems to be more because of deficiency in P-level and due to its textural class. The effect of aqueous extract on germination in sand was low as compared to other fine-textured soil series.

Days required for seed germination: The results presented in the Table 1 indicated that Eucalyptus aqueous extract caused delay in seed germination. There was a significant difference between extract treated and water treated seeds to complete their germination. There was also a significant difference among the soil series treated with aqueous extract of Eucalyptus. The variation in the days taken to germination completion might be due to interaction between physio-chemical properties of soil series and allelo-chemicals of Eucalyptus aqueous extract.

Fresh Shoot Weight (g): The results regarding fresh shoot weight showed that there was a significant decrease in shoot fresh weight of maize seedlings grown in extract treated soils (Table 1). This might be due to adverse effect of allelo-chemicals on water and minerals uptake by the plants. This is in an agreement with the findings of Bell and Koeppe (1972) who reported 35 percent reduction due to allelopathic effect of giant foxtail on maize growth.

Fresh Root Weight (g): It is clear from the data presented in Table 1 that fresh root weight was slightly greater in water treated plants as compared to aqueous extract treated plants. The radical growth was reduced in extract treated soils. Lisanework and Michelson (1993) reported that aqueous leaf extracts of four trees significantly reduced radical growth. But in Zindani series and Sand, the fresh root weight was more in extract treated soils as compared to water treated. It was due to low P-level in Zindani series and coarse texture of Sand. The differences were also found in plants root weight among all soil series both in water treated and extract treated. The probable reason for these differences might be the interaction of allelo-chemicals and physio-chemical composition of these soils.

Dry Shoot Weight (g): It is evident from the Table 1 that dry shoot weight was slightly more in water treated plants as compared to extract treated plants in all soil series. Igboanugo (1980) reported incompatibility of field crops grown with eucalyptus resulted in low yield. There was no significant difference in shoot dry weight of plants treated with water in all soil series. But dry shoot weight was more in fine textured soil treated with aqueous extract of *Eucalyptus camaldulensis*. The difference of dry shoot weight among various soil series might be due to their different physio-chemical compositions.

Dry Root Weight (g): The data pertaining to dry root weight showed that extract treated plants produced more dry root weight in all soil series (Table 1). In Zindani series the root weight was much reduced in water treated plants. Its probable reason might be the low phosphorus concentration i.e only 5.6 ppm. Lisanework and Michelsen (1993) observed the allelopathic effect of four trees including eucalyptus and reported that aqueous of all tree species reduced germination and dry root weight of maize crop. In Sand, also the dry root weight was much reduced in water treated plants because of its coarse texture and low mineral concentration, whereas extract contains phosphorous itself and this phosphorous was also supplied by applying this extract to plants.

Shoot Dry Matter Production (%): The results of Table 1 indicated that shoot dry matter production was greater in extract treated. This is in consistent with the work of Sangunga and Swift (1992) who reported decrease in shoot dry weight of maize by the application of leaf and litter extracts of eucalyptus. There was no significant difference in shoot dry matter production by maize plant treated with tape water in all soil series. But a significant difference was observed in shoot dry matter production of maize plants among extract treated soils. This difference might be due to

interrelationship of allelo-chemicals present in extract and soil physio-chemical composition.

Root Dry Matter Production (%): There was a significant increase in root dry matter production by maize plant treated with extract in all soil series as compared to water treated plants (Table 1). Dry matter production in Zindani and Sand series was much greater as compared to other soil series in both cases i.e extract treated and water treated. The variation in root dry matter production by maize plants among different soil series might be due to different physio-chemical characteristics of these soils.

Table 1: Effect of eucalyptus extract on soil characteristics and growth of maize.

Soil series	Water	Eu. Aq. Extract	t-value
	Germination percentage		
Nivela	100.00	79.15	7.06*
Giskori	100.00	83.15	
Zindani	100.00	87.50	
Buzdar	100.00	83.35	
Sand	83.35	74.95	
Mean	96.66	81.65	
Variance	55.78	22.75	
	Days required for germination		
Nivela	4	4.25	3.98*
Giskori	3	6.00	
Zindani	3	4.75	
Buzdar	3	4.75	
Sand	3	5.50	
Mean	3.2	0.40	
Variance	0.02	0.48	
	Fresh shoot weight (g)		
Nivela	1.37	0.52	3.75*
Giskori	1.68	0.57	
Zindani	1.15	0.78	
Buzdar	1.39	1.16	
Sand	1.20	0.16	
Mean	1.26	0.67	
Variance	0.013	0.14	
	Fresh root weight (g)		
Nivela	0.47	0.35	0.13NS
Giskori	0.57	0.42	
Zindani	0.18	0.30	
Buzdar	0.34	0.32	
Sand	0.23	0.36	
Mean	0.36	0.35	
Variance	0.03	0.002	
	Dry shoot weight (g)		
Nivela	0.17	0.08	2.32NS
Giskori	0.13	0.12	
Zindani	0.13	0.11	
Buzdar	0.16	0.15	
Sand	0.16	0.05	
Mean	0.15	0.103	
Variance	0.0003	0.0015	
	Dry root weight (g)		
Nivela	0.12	0.11	2.55NS
Giskori	0.10	0.14	
Zindani	0.05	0.11	
Buzdar	0.08	0.10	
Sand	0.07	0.14	
Mean	0.08	0.119	
Variance	0.0006	0.0003	
	Shoot dry matter production (%)		
Nivela	12.5	16.6	3.69*
Giskori	10.9	17.4	
Zindani	11.7	13.4	
Buzdar	11.7	13.1	
Sand	13.3	16.6	
Mean	12.0	15.42	
Variance	0.83	4.42	
	Root dry matter production (%)		
Nivela	26.6	30.4	6.84*
Giskori	17.4	32.8	
Zindani	29.3	40.0	
Buzdar	23.0	33.1	
Sand	29.9	40.0	
Mean	24.84	35.26	
Variance	26.07	19.82	
	Soil pH		
Nivela	8.2	7.5	9.89*
Giskori	8.0	7.3	
Zindani	8.2	7.3	
Buzdar	8.2	7.3	
Sand	8.1	7.6	
Mean	8.14	7.4	
Variance	0.01	0.02	
	Soil phosphorus (ppm)		
Nivela	8.0	4.0	2.78*
Giskori	6.8	4.8	
Zindani	5.6	3.6	
Buzdar	8.2	7.2	
Sand	7.6	4.4	
Mean	7.24	4.8	
Variance	1.13	2.0	
	Soil phosphorus (ppm)		
Nivela	8.0	7.2	0.49*
Giskori	6.8	7.2	
Zindani	5.6	4.4	
Buzdar	8.2	9.2	
Sand	7.6	6.4	
Mean	7.24	6.88	
Variance	1.13	2.89	

*Significant at 5% probability level.

Soil pH: The data regarding the effect of *Eucalyp camaldulensis* aqueous extract on the soil pH in differ soil series are shown in Table 2. The mean values revea that aqueous extract of *Eucalyptus camaldulensis* cau significant reduction in soil pH. The pH of aqueous extr was acidic in reaction. Tomar *et al.* (1992) reported t

mulch materials, comprising chapped leaves, reduced the soil pH from 5.6 to 5.0. The pH of Sand was minimum as compared to other soil series, probably due to its coarse texture. The coarse textured soils can not hold the allelo-chemicals as much as fine textured soils.

Soil phosphorus: The phosphorus level in soils which were treated with water was reduced up to significant level (Table 1). The phosphorous level in extract treated soils was 10 ppm. It means that phosphorous was also supplied through extract to the soils. There was also difference in P-level among the soil series when treated with aqueous extract and tap water. The soil having a higher content of clay have good water holding capacity so, these soils held up aqueous extract more and their P-level remained high even after harvest of crop (Table 1).

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