ALLELOPATHIC EFFECTS OF *EUCALYPTUS TERETICORNIS* ON *PHASEOLUS VULGARIS* SEEDLINGS

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ABSTRACT

The water extracts of leaves (green, brown and decayed stages) and bark of Eucalyptus tereticornis were tested for seed germination and primary root and shoot development of Phaseolus vulgaris seedlings. There was no significant difference in the germination percentage of Phaseolus vulgaris due to the treatments of water extracts of leaves and bark of Eucalyptus, also affected the development of the seedlings. Leachates from green and brown leaves of Eucalyptus were found to be most inhibitory in primary root development. Affected seedlings produced a curved blunt – ended extension of the root – shoot transition region which was devoid of a root cap and root hairs. Inhibition of root development in affected Phaseolus seedlings was attributed to an unknown water soluble substance(s) present in leachate.

Key words: Release of chemicals, Allelopathy, *Eucalyptus tereticornis*, seedling growth, inhibition.

INTRODUCTION

Large – scale plantation of *Eucalyptus tereticornis* are being raised in almost all the states of India to meet the increasing demand for fuel wood and pulp wood. *Eucalyptus* have been planted on farmlands in single and multiple rows along field boundaries as well as in blocks as a part of an agroforestry system. Kumar (2006) reported that a single row of *eucalyptus* growing along field boundaries gave yield increases of 24 percent for wheat and mustard in Gujarat, and 42, 43 and 64 percent increase for groundnut, pigeon pea and millet respectively in Andhara Pradesh. However, there have been a few reports that suggest that *eucalyptus* produces chemicals from its leaves or litter which inhibits the germination or growth of

other plants species (Del Moral and Muller, 1999; Al – Mousawi and Al – Naib, 2005; Suresh and Vinaya, 2007, Sale, 2009). Lack of herbaceous growth under multi-purpose trees is very often attributed to competition of natural resources like light, water and nutrients (Loomis and Whitman, 2003, Connors, 2003). Allelopathy, the direct or indirect deleterious effect of one plant upon another through production of chemical inhibitors as one of the environmental factors is seldom recognized in analyzing mechanism of plant interactions (Muller, 1999), despite such phytotoxic inhibition of *Eucalyptus spp.* This study was therefore conducted to see the effects of water extracts of *Eucalyptus* leaves and bark on seed germination of *Phaseolus vulgaris* and primary root and shoot development.

MATERIALS AND METHODS

Leaves of *Eucalyptus tereticornis* at different stages of degradation, i.e. decayed, brown, green and the fallen bark, were collected from the Research and Teaching farm of the Department of Forestry and Wood Technology, Federal University of Technology, Akure. The trees were six years old, planted at a spacing of 3 m x 3 m. The leachate was determined according to the procedure of Tukey and Mechlenburg (1994). Green, brown and decayed leaves and bark of *Eucalyptus tereticornis* were crushed using a leaf gridding machine. Four different concentrations of leachates, i.e. 100, 75, 50 and 25 percent, were prepared by decaying 200,150,100 and 50 g respectively of the crushed leaves and bark into 250 ml of distilled water for 24 hours. The suspension was filtered using No. 1 whatman filter paper. The filtrate was thereafter applied to test its effect on

seed germination and seed development of *phaseolus.*

Seeds of *Phaseolus vulgaris* (mung) were treated with 0.1 percent Mercuric chloride, washed thrice with distilled water and dried on an absorbent to eliminate fungal attack. The mung seeds were germinated on filter paper soaked in aqueous extracts of leaves and bark at different concentrations at 28± 1^0C; while distilled water was used in the controls. When *Phaseolus vulgaris* (mung bean) seed were sown under *Eucalyptus tereticornis* planted in a block with a spacing 3 m x 3 m, the germination and growth of the seedlings were poor. Percentage germination, root and shoot length and biomass production after seven days was studied.

The data collected from the experiment was subjected to one way analysis of variance (ANOVA) procedure for completely randomized design (CRD) using SPSS software.

RESULTS

Germination of *Phaseolus vulgaris* seeds following treatment of water extracts of leaves and bark of *Eucalyptus* was fairly uniform. The seeds germinated two days after planting (DAP) irrespective of the treatment.

There was a significant reduction in growth of treated Mung seedlings as compared to the control treatment (Table 1). The leachates from brown leaves showed maximum reduction in root growth. Roots were malformed with blackened tips. A large number of lateral roots were present at the base of the primary root. In a concentrated extract (100%) of brown leaves, the mung seedlings did not produce normal radicle growth beyond the point of the transition zone. Such seedlings were incapable of

producing a normal primary root with a root cap and root hairs.

TABLE 1: Effect of different concentrations of leachates of Eucalyptus on the growth of *Phaseolus vulgaris* seedlings

Treatment	**Germination** (%)	**Root length** (cm)	**Shoot length** (cm)	**Root – Shoot ratio**
Control	98.3	7.87	9.0	0.87
Green leaves				
100	77.7	5.56	4.70	1.18
75	88.8	6.74	5.81	1.16
50	91.1	6.68	6.93	0.96
25	95.5	7.77	8.58	0.90
Brown leaves				
100	62.2	1.79	3.27	0.54
75	60.0	3.72	6.19	0.60
50	80.0	4.98	6.85	0.72
25	82.2	5.37	7.68	0.69
Decayed leaves				
100	88.8	7.67	7.59	1.01
75	93.3	7.80	8.15	0.95
50	93.3	8.79	8.71	1.00
25	95.5	9.63	10.29	0.93
Bark				
100	95.0	4.42	5.75	0.76
75	96.3	3.73	8.02	0.46
50	97.7	5.11	8.58	0.59
25	97.9	6.59	8.79	0.74
SEM ±	2.98	0.22	0.21	0.02
CD at 5%	5.84	0.41	0.43	0.04

The root - shoot transition region was extended and curved, and had a blunt tip. Interestingly, the extract from decayed leaves had a stimulatory effect on root elongation (root length) (Table I).The aqueous extracts from the green leaves, brown leaves and bark showed an inhibitory effect on the shoot length of

the seedlings. The differences in the shoot length of seedlings also followed the same patterns as in root length (Table 1). The degree of toxicity of leachates on shoot growth was in the order of brown leaves > green leaves > bark. The lower concentration (25%) of decayed leaves stimulated shoot growth.

There was a significant variation in the root shoot ratio between the treatments and the control (Table 1). The extracts of green and decayed leaves showed a higher ratio while in brown leaves and bark the ratio was low as compared to seeds grown in distilled water (control).

The percentage moisture of the roots and shoots was higher in seedlings grown in the leachates (Table 2) the dry weight of roots decreased significantly when grown in leachates prepared from green leaves, brown leaves and bark (table 2). It did not vary significantly in seedlings grown in leachate of decayed leaves as compared to Control.

TABLE 2: Effect of different concentrations of leachates of *Eucalyptus* on the biomas and moisture content in *Phaseolus vulgaris* seedlings

Treatment	Dry wt. (mg/seedlings)		Total Biomass	Moisture content (%)	
	Root	Shoot	mg/seedlings	Root	Shoot
Control	4.38	17.62	22.00	10.0	3.56
Green leaves					
100	2.57	10.35	12.90	15.20	7.88
75	2.35	11.50	13.80	18.80	7.25
50	3.63	12.17	15.80	17.92	6.65
25	3.32	12.78	16.10	15.18	6.19
Brown leaves					
100	2.62	11.34	13.90	22.50	9.94
75	2.14	13.68	15.80	17.16	11.40
50	3.16	13.73	16.90	17.19	9.00
25	2.87	13.28	16.10	15.63	8.30
Decayed leaves					
100	4.13	15.64	19.70	20.80	9.02
75	5.55	15.90	21.40	17.28	9.18
50	4.75	15.30	20.01	16.60	9.60
25	3.90	16.48	20.40	15.13	9.65
Bark					
100	1.63	13.75	15.40	12.09	10.23
75	2.62	17.21	19.80	18.30	12.38
50	2.85	15.50	18.30	15.27	10.45
25	1.43	15.60	17.00	14.40	8.50
SEM ±	0.29	0.10	0.12	2.26	0.30
CD at 5%	0.56	0.19	0.23	4.42	0.58

The dry weight of the shoot system was higher and varied significantly in the concentration of the leachates decreased. It was observed to be greater in seedlings growth in the leachates of decayed leaves.

DISCUSSION

It is an established fact that one plant may influence the germination, growth and metabolism of another through the release of chemicals which may be beneficial or

harmful. The reduced growth of *Phaseolus vulgaris* (a test species) under *Eucalyptus* was apparently not due primarily to physical factors. It was found that leachates from green and brown leaves inhibited germination and growth of radicle in selected test species. The biomass production reduced significantly in seedlings grown in leachates of brown or green leaves as compared to those growing under normal conditions. The low productivity rates under *eucalyptus* were therefore apparently primarily due to allelopathic effects.

Result presented in this paper indicate the presence of some phytotoxic substance in the leaf and bark of *eucalyptus*. The allelochemicals responsible are commonly the secondary plant products, such as phenolics, terpenoids, organic cynides and many organic acids, which are or can be transformed into compounds inhibiting the germination or growth of the plants (Tukey and Morgan, 1994; June, 2006; Rice, 1984 and Del Moral and Muller 1998, 1999) reported the production by *eucalyptus* leaves of phenols like ellagic, chlorogenic, P – coumarylquinic, gentisic and gallic acids or volatile terpenes like ά pinene, β pinene, δ – phellandrene and cineole. The mechanism of growth inhibition by the allelopathic compound(s) is complex and may take place through effects on division, elongation and ultra – structure of cells, hormone – induced growth, membrane permeability, mineral uptake, respiration, protein synthesis, inhibition or stimulation of specific enzymes, or other processes (Rice, 1984).

It is hypothesized that the allelopathic substance(s) present in the litter of *eucalyptus* interfere(s) with the growth of the mycorrhizal fungi present in the root system and this in turn affects

the nutrient uptake and growth of seedlings.

CONCLUSION

Both positive and negative effects of *eucalyptus* leaf leachates were observed in the present studies. The leachates from the decayed leaves had a stimulatory effect on the growth of seedlings. Moreover, the lower concentration of leachates promoted biomass production.

The allelopathic substance(s) may be synthesized in the leave of *eucalyptus* and then transported to the litter or soil through rain or irrigation. Experimental studies are under way to test this hypothesis.

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