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RESEARCH ARTICLE

Phyto-toxicity of *Eucalyptus tereticornis* clones on *Leucaenaleucocephala* L.

V. D. Tripathi[1], A. Venkatesh[2], Rajendra Prasad[1] and S. K. Dhyani[1]

1.National Research Centre for Agroforestry, Jhansi – 284 003, (Uttar Pradesh) India.

2.ICAR Research Complex for NEH Region, Barapani – 793 103, (Meghalaya) India.

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An investigation was conducted to assess the phyto-toxicity of *Eucalyptus tereticornis* on *Leucaenaleucocephala*L. (Subabul). For these purpose four clones of *Eucalyptus tereticornis* (C3, C6, C7 and C10) were tested under laboratory bioassay experiments. In laboratory bioassay, three plant parts (leaves, twigs and roots) of four clones and three concentrations of extracts (5%, 10% and 15%) besides distilled water as control were used. The results revealed that the toxicity of the extract was in the order of leaves > twigs > roots and the concentration was in the order of 15% > 10% > 5% > 0%. Among the clones, the maximum toxicity was exhibited by C7 in subabul.

Introduction

Allelopathy is defined as the direct or indirect harmful or beneficial effects of one plant on another through the production of chemical compounds that escape into the environment. Allelopathy has been defined by Rice (1974) as any direct or indirect harmful and beneficial effect by one plant on another through production of chemical compounds that escape into the environment.

The germination and growth of plants from the undergrowth can be inhibited by compounds which are present in other species or in their residues, either directly or by microbiological activity in the soil. The allelopathic effect of soluble compounds in eucalyptus was reported by many authors (Del Moral and Mullar, 1969; Al-Naib and Al-Moussawi, 1976; Jayakumar*et al.,* 1990; Lisanework and michelsen, 1993). Plant residues often contain a variety of toxins that are known inhibitors of seed germination or seedling growth (Chov and Patrick, 1976; An *et al*.,1997). Recycling crop residue to the soil has been reported to be detrimental to future growth (Rice 1981). Leachates from plants have been shown to suppress seed germination and vegetative propagules, and early seedling growth (Babu and Kandasamy, 1997; Dhawan and Gupta, 1996); and decrease radicle growth (Casado, 1995). Aqueous extract of some plants inhibit seedling growth (Lydon *et al.,* 1997); root and shoot growth (Athanassova, 1996); germination (Pratley *et al.*, 1996); and induce mortality of plants (Eyini*et al*.,1996).

The release of phenolic compounds adversely affect the germination and growth of plants through their interference in energy metabolism, cell division, mineral uptake and biosynthetic process (Rice, 1984). The extract of fresh leaves, leaf litter and roots of *E. deglupta* and *E. alba* proved phytotoxic to *Shoreapalembanica* seedling and the extract of fresh leaves were found more toxic (Al- Naib and Al- Mousawi, 1976).

Reports on effect of *Eucalyptus* spp. on crops are available (May and Ash, 1990; Djanaguiraman*et al*., 2002; Sasikumar*et al*., 2001, 2002; Florentire and Fox, 2003, Tripathi*et al.,* 2012) while with reference to different clones of *E. tereticornis* is not available. At the same time, identification of suitable clone *Eucalyptus* plantation for intercropping with subabul will help to minimize the crops loss.

2. MATERIALS AND METHODS

The present study conducted during 2007 in National Research Centre for Agroforestry (NRCAF), Jhansi, Uttar Pradesh, India ($24^0$11' N latitude, 78^0 17' E longitude and 271 m above msl).

To examine the Allelopathic effect of *Eucalyptus tereticornis* clones (C3, C6, C7 and C10) on subabul (*Leucaenaleucocephala*L.). Fresh leaves, twigs and roots from different clones of *E. tereticornis*(3 years old)were collected during 2006 from the experimental farm of the NRCAF, Jhansi. These *Eucalyptus* clones were planted during August 2003. The material from each clones were air dried under shade for 3 days, then grained and passed through a mesh sieve to remove the visible plant residues. The ground material was kept in dark bottles.

The aqueous extract of each clone parts were prepared by soaking 150 g of powder in 1000 ml distilled water for 24 hours, at room temperature for the preparation of 15 per cent concentration. The solution was firstly passed through the cotton cloth and then further filtered through Whatman No.1 filter paper. The 15% solution was further diluted for the making of the 10% and 5% concentrations. In this way, the treatments consisted of 4 extract concentrations of leaves, twigs and roots (5%, 10% and 15%) and distilled water served as control (0%). Twenty seeds of subabul in five replicates (CRD design) were sown uniformly in the sterilized petri plates (9 cm diameter). The seeds were surface sterilized with the 0.2% (w/v) mercuric chloride before placing in the germination medium of double layered whatman No. 1. As per treatment, 2 ml of respective aqueous extract was added per petri plats to moist the filter papers. Seed germination was counted daily, while shoot and root growth was recorded at 15^{th} day after completion of experiment to assess the shoot and root length five seedlings from each replication were selected randomly.

The vigour index was calculated by using**formula,** given by Abdul Baki and Anderson, 1973.

Vigour index = Germination % X (Root length + Shoot length)

The data collected were subjected to an analysis of variance according to Panse and Sukhtame (1978).

3. RESULTS

The results of the present investigation showed the inhibitory effect of leaf extract of different clones of *E. tereticornis* on subabul. However, the level of inhibition varies with *E. tereticornis* clones and concentration of the extract. In general, as the increase in the level of concentration of the extract showed decreasing trend for all the recorded parameters of the *Leucaenaleucocephala*L.. The seed germination of *Leucaenaleucocephala*L. found non-significant among the clones. Among the *E. tereticornis* clones, C7 was recorded lowest germination when comparing the percent reduction of germination over the control (irrespective of concentrations). The effect of plant parts, significant reduction was observed by leaf extract followed by twig and root extract. Twig and root extract was at par with each other. However, 15 % concentration of plant parts extract reduced maximum significant inhibition effect on *L. leucocephala*L. (subabul) followed by 10% and 5%. The reduction in germination by *E. tereticornis* clones (irrespective of concentrations and plant parts) was in the order of C6<C3<C10<C7 were found (Table 1, Fig. 2).

Minimum root and shoot length was exhibited by C7. The shortest shoot length was (6.2 cm) and shortest root length was (6.1 cm). Among the clones the shoot length and root length were found significantly higher in C6 while compression other clones. Leaf was showed most inhibitory effect in both of the parameters followed by twig and root. The reduction in shoot and root length by plant parts (irrespective of clones and concentrations) was in the order of root< twig< leaf were observed (Table 1).

Total dry weight of seedling, higher weight was found in C6 while other clones were significantly inhibited the total dry weight of *L. leucocephala*L. (Table 1).

Among the clones, C7 (69%) was recorded minimum vigour index when compared Per cent reduction by various extracts and concentration of *E. tereticornis* clones. In the plant part extract maximum reduction was found by leaf extract. 15% concentration was showed most inhibitory effect of *L. leucocephala*L. vigour index. In the vigour index the plant part was in the order of leaf<twig<root, and the concentration was 15 %< 10 %< 5% were recorded (Table 1, Fig.1).

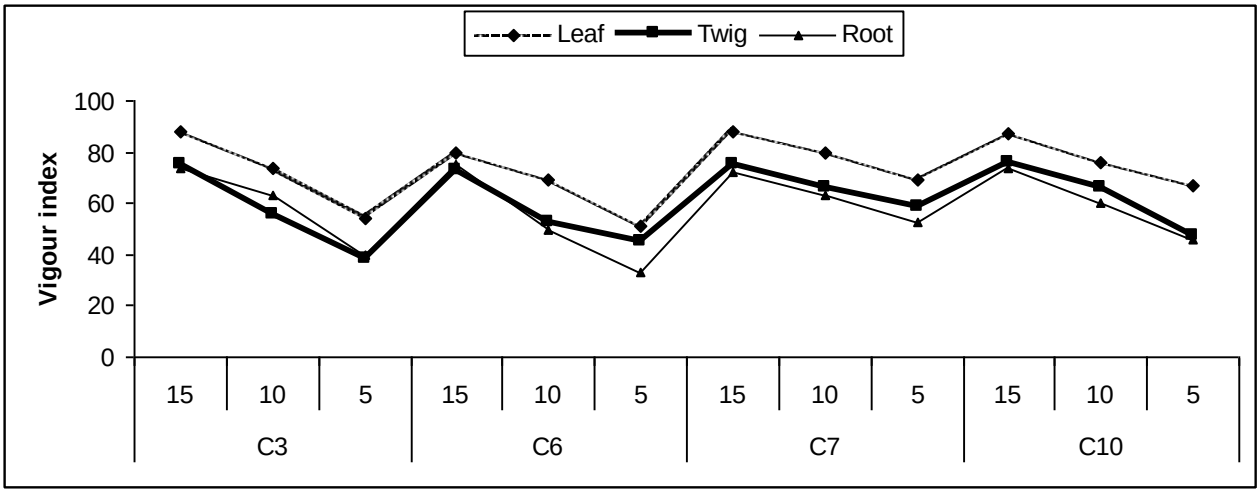

Figure 1. Per cent reduction by various extracts and concentration of *E. tereticornis* clones in vigour index of *Leucaenaleucocephala* over control.

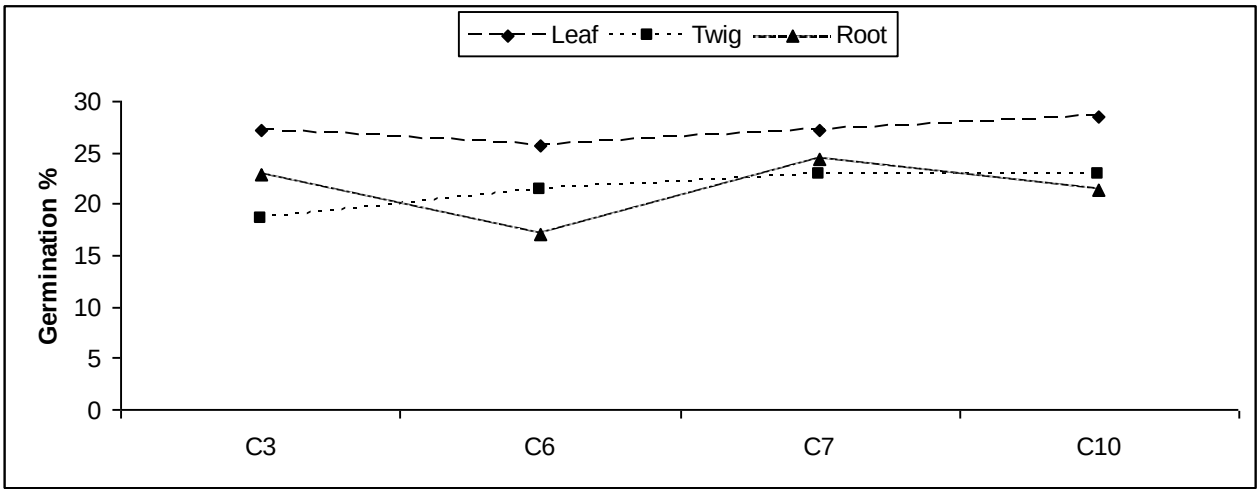

Figure 2. Per cent reduction by various extracts of *E. tereticornis* clones in germination of *Leucaenaleucocephala* over control.

Table 1. Effect of various extracts and concentrations of different clones of *E. tereticornis* on *Leucaenaleucocephala*in bioassay

Clones	Plant part of *E. tereticornis*															Grand mean
	Leaf					Twig					Root					
	Concentrations (%)															
	15	10	5	0	Mean	15	10	5	0	Mean	15	10	5	0	Mean	
***Germination %*(G)**																
C3	36	45	55	70	51	45	52	60	70	57	42	46	56	70	54	54
C6	41	45	54	70	52	42	54	55	70	55	42	59	60	70	58	55
C7	42	45	48	70	51	47	48	53	70	54	44	48	52	70	53	53
C10	38	46	46	70	50	42	49	55	70	54	44	52	54	70	55	53
Mean	39	45	51	70	51	44	51	56	70	55	43	51	56	70	55	
Pooled mean	42	49	54	70												
***Shoot length* (cm) (SL)**																
C3	3.6	5.6	6.1	9.8	6.3	4.3	6.5	7.2	9.8	6.9	4.4	6.4	8.1	9.8	7.3	6.8
C6	4.4	5.5	7.4	9.8	6.8	5.2	6.5	7.6	9.8	7.2	4.9	6.2	8.1	9.8	7.2	7.1
C7	3.1	3.8	5.2	9.8	5.4	4.0	5.7	5.9	9.8	6.3	5.2	5.8	6.8	9.8	6.9	6.2
C10	3.7	4.6	5.6	9.8	5.9	5.0	5.5	7.5	9.8	6.9	5.4	6.0	7.5	9.8	7.2	6.7
Mean	3.7	4.9	6.1	9.8	6.1	4.6	6.0	7.0	9.8	6.9	5.1	6.1	7.6	9.8	7.1	
Pooled mean	4.5	5.7	6.9	9.8												
***Root length* (cm) (RL)**																
C3	2.9	3.5	5.8	10.4	5.6	4.5	6.1	7.4	10.4	7.1	5.2	6.2	7.6	10.4	7.3	6.7
C6	3.9	5.3	5.8	10.4	6.3	5.4	6.3	7.4	10.4	7.4	4.7	5.9	7.7	10.4	7.2	7.0
C7	1.7	3.2	4.7	10.4	5.0	4.4	5.0	5.7	10.4	6.4	5.3	6.1	6.4	10.4	7.0	6.1
C10	2.5	3.6	5.5	10.4	5.5	4.3	4.9	6.4	10.4	6.5	4.3	5.1	7.2	10.4	6.7	6.2
Mean	2.7	3.9	5.5	10.4	5.6	4.6	5.6	6.7	10.4	6.8	4.9	5.8	7.2	10.4	7.1	
Pooled mean	4.1	5.1	6.5	10.4												
***Total dry weight* (mg/5 seedlings) (TDW)**																
C3	71.8	168.2	286.9	995.2	380.5	168.0	243.6	397.9	995.2	451.1	189.8	271.6	459.7	995.2	479.0	436.9
C6	171.8	222.7	252.8	995.2	410.6	246.4	269.8	327.9	995.2	459.8	264.3	282.0	499.4	995.2	510.2	460.2
C7	30.9	81.9	130.9	995.2	309.7	78.3	155.8	212.1	995.2	360.3	134.9	129.5	172.6	995.2	376.1	348.7
C10	83.9	129.5	172.6	995.2	345.3	161.1	212.9	282.1	995.2	412.8	182.6	225.3	273.7	995.2	419.2	392.4
Mean	89.6	227.8	381.5	995.2	361.5	227.5	258.1	360.0	995.2	421.0	81.2	138.3	180.3	995.2	446.1	
Pooled mean	148.6	203.3	291.1	995.2												
***Vigour index*(VI)**																
C3	217	450	806	1763	809	443	783	1092	1763	1020	454	661	1062	1763	985	938
C6	357	543	858	1763	880	477	828	976	1763	1011	433	882	1184	1763	1065	985
C7	214	350	540	1763	717	445	596	723	1763	881	493	651	825	1763	933	844
C10	230	426	585	1763	751	420	592	932	1763	927	461	702	957	1763	971	883
Mean	255	422	697	1763	789	446	699	931	1763	960	751	927	971	1763	988	
Pooled mean	387	622	878	1763												
				$LSD_{0.05}$												
	G%	SL	RL	TDW	VI											
C	ns	0.21	0.22	28.84	58.27											
P	2.34	0.18	0.19	24.98	50.47											
N	2.70	0.21	0.22	28.84	58.27											

C= clone; P= plant part and N= concentration

4.DISCUSSION

Eucalyptus monoculture plantations are reported to support either very little or almost negligible under-storey vegetation (Del Moral and Muller, 1969; del Moral *et al*., 1978; Bhaskar and Dasappa, 1986; Singh *et al*., 1993). The species diversity index is also highly reduced under eucalypt monoculture plantations when compared with the other native plantations. Allelopathy has often been considered as a possible reason for the species depletion (Suresh and VinayaRai, 1987; Kohli*et al*., 1992). Kohli and his associates have reported significant reduction in the density, root and shoot length, biomass, and economic yield of crops. Eucalypts are reported to release a number of volatile and non-volatile allelochemicals that affect growth of the associated vegetation (Kohli, 1990). Various volatile terpenes like limonene, cineole, citronellal, citronellol, a-pinene, and grandinol, etc. identified from the crude oil are highly toxic and affect the germination and growth of native vegetation (Baker, 1966; del Moral and Muller, 1970; Al-Mousawi and Al-Naib 1975, 1976; Bolte*et al*., 1984; Kohli*et al*., 1992). Under natural conditions, volatile oils are released from the leaves through diffusion and being heavier than air, travel downward, get adsorbed to the surface of soil particles, and thus affect the vegetation supported by this soil. The content of the oil in leaves varies with species, climatic conditions, and because of seasonal changes. The volatile allelochemicals have also been found to inhibit respiration (Vicherkova and Polova, 1986), reduce the chlorophyll content, and cause wilting (Kohli and Singh, 1991). In addition, the leachates and extracts from the eucalypt leaves, litter, bark, flowers, and leaf mulch have been reported to reduce the germination and initial growth of a number of plant species (Singh and Bawa, 1982; Ahmed *et al*., 1984; Igboanugo, 1986; Sidhu and Hans, 1988; Kohli, 1990; May and Ash, 1990; Lisanework and Michelson, 1993).

5. CONCLUSION

This preliminary study was carried out to investigate the Phyto-toxicity of *Eucalyptus tereticornis* clones (C3, C6, C7 and C10) on germination and growth of *Leucaenaleucocephala*(subabul). Germination of *L. leucocephala* was reduced significantly under 15% leaf aqueous extract of all the clones of *Eucalyptus tereticornis*. Among the clones, the maximum toxicity was exhibited by C7. Toxicity of the extract was in the order of leaves > twigs > roots and the concentration was in the order of 15% > 10% > 5% > 0%.

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