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Allelopathic Effects of *Eucalyptus camaldulensis* Leaf Leachate on the Growth of Wheat and Green Gram and its Control by Farm Yard Manure

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Abstract. Farm Yard Manure (FYM) significantly reduced the allelopathic effects of *Eucalyptus camaldulensis* leachate. This influence was studied on morphological and physiological aspect of two taxonomically different plants (wheat and green gram). *E. camaldulensis* aqueous leachate applied @ 1% and 5% alone and together with FYM and the results showed that *E. camaldulensis* leaf leachate had inhibitory effects on wheat growth, while promoted shoot and root growth in green gram when supplied in low concentration. The combined effects of litter and FYM reduced the inhibitory effects of leachate and supported the growth of both plants. These results suggested that, if both studied crops have to be cultivated in an agricultural land surrounded by *E. camaldulensis* tree, the possible growth rate could be supported by the application of FYM. But in the absence of this support, the plant growth was significantly arrested due to allelopathic effect of *E. camaldulensis* leaf leachate.

Keywords: farmyard manure, Allelopathy, *Eucalyptus camaldulensis*, litter, leachate, antagonistic effects

Introduction

Allelopathy has direct or indirect deleterious effect of one plant upon another through the release of chemical inhibitor (phototoxic) and it may be the main reason of failure or poor crop growth in different environmental systems. In Pakistan, Eucalyptus has been the choice tree species in most of the social forestry project in the Asia Pacific regions because of its fast growing nature. From the last few decades, it has registered pronounced deleterious effects on the environment. The Eucalyptus species are considered the most notorious of allelopathic trees causing understory suppression specially in dry climates and water is scarce (rainfall < 400 mm) (May and Ash, 1990). *Eucalyptus* sp. has a high potential of allelochemicals in the form of phenols and essential oils. Vaughan and Ord (1990) reported that most of the phenolic acids released from the eucalyptus plant parts were benzoic and cinnamic acid derivatives. Presence of coumaric, caffeic and gallic acids also identified from *E. globulu*. Similarly gentistic acid, phenolic glycosides and terpenoids were also reported from *E. baxteri.* Iqbal *et al*. (2003) found 16 components in the essential oil of *E. camaldulensis* out of which 5 compounds (alpha pinene, 3-carene, beta-phellandrene, 1-8 cineole and p-cymene) were identified. Ghafar *et al*. (2000) found that these allelochemicals and volatile compounds present in all parts of *E. camaldulensis* have harmful effect on the crops in the ecosystem resulting in the reduction and delaying of germination mortality of seedling and reduction in growth and yield, also reduce the soil pH (Putnum,1984). The release of phenolic compounds adversely affect plant growth through their interference with energy metabolism, cell division, mineral uptake and other biosynthesis processes (Rice, 1984). Different researchers found that the eucalyptus leachate had varying degree of inhibitory and stimulatory effects on germination percentage (Phlomina and Srivasuki, 1996) and plant growth considerably at higher concentration (Jayakumar *et al*., 1990). Therefore, *Eucalyptus*, though a potential industrial crop, is not being recommended as an inter crop in an agroforestry system (Bansal, 1988; Suresh and Rai, 1987), presumably due to the release of allelochemical and phytochemical compounds from the tree (Lisanework and Michelson, 1993). The research evidently pointed out that some crops showed the tolerance towards the inhibitory effects of these allelochemicals. Eucalyptus tree belt have more adverse effect on wheat than legume crop. Similar effects have been reported by Inouye *et al*. (2001), who studied the effects of leaf extracts of *Eucalyptus* spp. on wheat and mung bean in order to support this view.

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Farm yard manure is the potential source of nutrients which maintains soil fertility, improve crop yield and sustain productivity. This organic source of nutrient has potential to control plant growth growing under *E. camaldulensis* leaf litter that generally has inhibitory effects on crop growth due to allelochemicals release. Several studies reported the efficiency and effectiveness of farm yard manure as an organic nutrient source in maintaining soil fertility, improving crop yield and sustaining productivity. Thus, it is suggested that, in case of agroforestry, the allelopathic inhibitory effect of *E. camaldulensis* can be effectively suppressed by supplying the organic fertilizer (such as farm yard manure) to cure the yield drop. Hence, this study was initiated to determine the allelopathic effect of *E. camaldulensis* on the growth of wheat (*Triticum aestivum* L.) and green gram (*Vigna radiata* L.) and its suppression by the addition of farm yard manure.

Materials and Methods

Preparation of extract. Naturally decomposed *E. camaldulensis* leaf litters were collected from a Karachi city garden surrounded by rows of *E. camaldulensis* tree as a sources of leaf litter fallen on the ground. Farm yard cattle manure used in the experiment was well decomposed under shade. The aqueous extract of leaf litter and farm yard manure was prepared by soaking materials separately to obtain 1% and 5% (w/v) extract of leaf litter and farm yard manure in order to make six treatments i.e. 1% leachate, 5% leachate, 1% FYM extract, 5% FYM extract along with two mixtures, 1% leachate +FYM extract and 5% leachate +FYM extract.

In this experiment petri dish method was used to study the allelopathic effects of aqueous litter extract on wheat and green gram (growing singly or together) along with farm yard manure (FYM) extract. Ten healthy chemically sterilized seeds of green gram and wheat were placed in petri dishes with one disc of filter paper under normal laboratory condition with temperature ranging from 21-25 °C. Five mL of each treatment was added to 3 replicates of each treatment plate. Distilled water was applied to the control level. The growth variables including germination rate, shoot length, root length, shoot fresh and dry weight and root fresh and dry weight were recorded after 5th day of germination.

Inhibitory percentage (I). The percentage of inhibitory effect on shoot and root growth (length, fresh weight and dry weight) in comparison to control was calculated by Surendra and Pota (1978) formula:

$$I = 100- T / C \times 100$$

Where, I is the percentage of inhibition, T is treatment reading and C is control plant reading.

Data analysis. The data obtained was statistically analyzed and presented as Standard Deviation calculated through Duncan's Multiple Range Test method (Steel and Torrie, 1980) to examine the differences between each treatment. The level of statistical significance was set at $P \geq 0.05$.

Results and Discussion

Table 1 shows that Eucalyptus leaf leachate had inhibitory effect on wheat growth but supported green gram (*Vigna radiata*) growth at low concentration (Table 2) while at high concentration, only gram shoot and root dry weight showed positive response while all other growth variables were inhibited. These inhibitions were significantly controlled by farm yard manure application as L+FYM treatment.

Shoot length. Wheat shoot length more significantly affected by leachate application than gram (Tables 1-2). With increasing leachate concentration, wheat shoot length was significantly inhibited i.e. 60%. The parallel application of farm yard manure extract reduced the inhibitory effect from 60% to 28%. Table 2 shows a positive effect of leachate on shoot length at low concentration i.e. 21.3% over control, while at high concentration 11.66% inhibition was calculated over control. The inhibitory effect of Eucalyptus leaf leachate on both crops, shoot length was significantly controlled by farm yard manure application. This result is in agreement with those reported by Smith (1989). Mukhopadhyay *et al*. (1995) also reported that extracts of Eucalyptus decreased the plant growth of rabi crops and concluded that the inhibitory effect of Eucalyptus leaf extracts on germination and growth was attributed to the essential oil content.

Root length. Table 2 shows that leachate had positive effect on gram root length i.e. 82% to 34% at low and high concentrations, respectively. Wheat plant showed a positive response of 5.36% over control only at low concentration. While the high dose had inhibitory effect but it was significantly overcomed by FYM application that reduced 54% inhibition to 19.16% over control.

Shoot fresh weight. Leachate application significantly reduced shoot weight in wheat at both strengths. Same result was found with gram, more pronouncing at low leachate concentration (16.8% over control). Similar findings have been reported by Khan *et al*. (2004); Blaise *et al*. (1997) and Thaukar and Bhardwaj (1992).

Shoot dry weight. *E. camaldulensis* leachate had high inhibitory effect on wheat shoot dry weight at both concentrations (Table 1). This reduction was significantly supported by farm yard manure extract supply which reduced the inhibitory percentage from 56.52% to 34.78% at high leachate dose. Whereas, gram showed a positive response at high concentration of leachate

Table 1. Effect of aqueous extract of *E. camaldulensis* leaf litter and farm yard manure extract on wheat (*Triticum aestivum* L.)

Treatment		Wheat					
		Length (cm)		Fresh weight (g)		Dry weight (g)	
		Shoot	Root	Shoot	Root	Shoot	Root
T0	(Control)	3.48a	6.16f	0.42a	0.346b	0.046a	0.04a
T1	(1% Leachate)	2.76e (-20.69)	6.49b (+5.36)	0.378c (-10.0)	0.3e (-13.29)	0.042b (-8.70)	0.03f (-25.0)
T2	(1% FYM Extract)	3.34b (-4.02)	6.61a (+7.31)	0.35e (-16.67)	0.343c (-0.86)	0.04e (-13.04)	0.04a (0)
T3	(1% L+FYM)	3.25c (-6.61)	6.52c (+5.84)	0.378b (-10.0)	0.35a (+1.16)	0.03d (-34.78)	0.036c (-10.0)
T4	(5% Leachate)	1.38g (-60.34)	2.83g (-54.06)	0.145g (-65.48)	0.19g (-45.09)	0.02g (-56.52)	0.031e (-22.5)
T5	(5% FYM Extract)	3.19d (-8.33)	6.47d (+5.03)	0.37d (-11.90)	0.33d (-4.62)	0.041c (-10.87)	0.037b (-7.50)
T6	(5% L+FYM)	2.49f (-28.45)	4.98e (-19.16)	0.26f (-38.10)	0.2f (-42.2)	0.03f (-34.78)	0.035d (-12.5)

Value in parenthesis indicates percent increase (+) or decrease (-) over control. Means followed by different letters show significant result at the level of standard deviation.

Table 2. Effect of aqueous extract of *E. camaldulensis* leaf litter and farm yard manure extract on green gram (*Vigna radiata* L.)

Treatment		Green gram					
		Length (cm)		Fresh weight (g)		Dry weight (g)	
		Shoot	Root	Shoot	Root	Shoot	Root
T0	(Control)	7.03c	3.65f	1.72c	0.37b	0.19e	0.03a
T1	(1% Leachate)	8.53a (+21.33)	6.65a (+82.19)	2.01a (+16.86)	0.38a (+2.70)	0.15g (-21.05)	0.024d (-20)
T2	(1% FYM Extract)	5.15f (-26.74)	4.34e (+18.90)	1.46g (-15.11)	0.25e (-17.14)	0.22b (+15.79)	0.025c (-16.67)
T3	(1% L+FYM)	l7.95b (+13.08)	6.13b (+67.94)	1.94b (+12.79)	0.34c (-8.11)	0.18f (-5.26)	0.029b (-3.33)
T4	(5% Leachate)	6.21e (-11.66)	4.89d (+34.25)	1.64d (-4.65)	0.26d (-37.0)	0.2d (+5.26)	0.03a (0)
T5	(5% FYM Extract)	4.62g (-34.28)	3.14g (-13.97)	1.57e (-8.72)	0.21f (-43.24)	0.21c (+10.53)	0.021e (-30)
T6	(5% L+FYM)	6.82d (-2.98)	5.48c (+50.13)	1.55f (-9.88)	0.13g (-64.86)	0.24a (+26.32)	0.019f (-36.66)

Value in parenthesis indicates percent increase (+) or decrease (-) over control. Means followed by different letters show significant result at the level of standard deviation.

and increased shoot dry weight 5.26% over control. Amendment of FYM raised this positive effect up to 26.32% over control (Table 2).

Root fresh weight. Leachate had inhibitory effect on root fresh weight in both crops significantly at high concentration i.e. 45% in wheat and 25.82% and 45% in gram at both concentrations, respectively. Low concentration inhibition markedly reduced by supplying farm yard manure extract i.e. 13.29% of wheat root fresh weight reduction at 1% leachate converted to 1.16% increase over control.

Root dry weight. Inhibitory effect of leachate on root dry weight of both crops was significantly controlled by FYM application. In gram, 20% reduction in root dry weight reduced to 3.3% at low concentration. In wheat, inhibitory percentage was decreased by FYM application from 25% to 10% at low concentration and 22.5% to 12.5% at high concen-tration.

Conclusion

In the present study, shoot length, root length, shoot fresh and dry weight and root fresh and dry weight of wheat were more affected by the application of *E. camaldulensis* leaf litter extract than green gram. The phenolic compounds released from *E. camaldulensis* leaf litter due to its allelopathic interference caused an inhibition of a number of interacting physiological processes as respiration, net photosynthesis and enzymatic activities which was the main factor which suppressed growth rate and dry matter production. The interference of nutrient accumulation is one of the most effective mechanisms of phenolic compound action. The study indicated that the phytotoxicity of phenolic compounds present in *E. camaldulensis* leaf litter as allelochemical is highly significant but could be overcomed by the application of farm yard manure as bio-control agent.

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