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Research Article

STUDY ON THE EFFECT OF TREE LEACHATES ON GROWTH AND PERFORMANCE OF OILSEED CROPS IN NORTHERN TRANSITIONAL TRACT OF KARNATAKA

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Abstract: The experiment was conducted to investigate the effect of tree leachates on the growth performance of commonly grown oilseed crops. The experiment was conducted for two years in green house in University of Agricultural Sciences, Dharwad. It was found that amongst the tested tree leachates, Eucalyptus tree leachates had more inhibitory effect on the emergence, dry matter, shoot and root length of the crops. Root + leaf leachate had significantly higher inhibitory effect than root leachate alone. The inhibitory effect of leachates was more during earlier stage of crop growth (15 DAS) than later stages (30 DAS).

Keywords: *Eucalyptus, Greengram, Inhibitory, Leachate, Teak*

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Introduction

India is the fourth largest producer of oilseeds in the World. India has 20.8 percent of the total area under worldwide cultivation and accounting for 10 percent of global production. Karnataka is one of the major states in the country with respect to area and production of important edible oilseed crops in India. According to 2014-15 the area under oilseed crop 13.73 lakh ha with production of 9.59 lakh and with productivity of 505.4 kg/ha. Major area under oilseed cultivation in Karnataka is under rainfed condition. Agroforestry, is the production of crops and forest/fruit trees simultaneously on the same piece of land and applies management practices compatible with the local cultural practices [1]. It gives supplementary returns per unit of land but it has dis-advantages like adverse effects of trees for dominating the understory field crops in utilizing the limited growth resources (nutrients, moisture, and light) [2]. Added to this, release of organic compounds with inhibitory effects on other organisms (allelopathy) is considered as an additional factor affecting growth conditions in any plant-plant environment [3]. Tree-crops interactions, which are quite complex in nature, are of paramount importance in any agroforestry system to understand clearly [4].

The research work carried out in the recent years has shown that it is not only the competition for physical growth resources but also interference of allelochemicals released by tree parts determines the performance of associated crops. This phenomenon of interference (phytotoxicity) was termed as "allelopathy" by Molisch in (1937) [5]. Allelopathy is the effect of one plant on other associated plants and/or micro-organisms through release of chemicals and their breakdown metabolites. With the increased recognition of agroforestry as an alternative land use system, several scientists have focused their attention on trees [6]. Like any living plant/organism, trees also release several phytotoxins or allelochemicals from leaves, stem, bark, roots, flowers, seeds, pollens and fruits which influence the growth of under vegetation [7].

Allelochemicals mostly refer to the secondary metabolites produced by plants and are by-products of primary metabolic processes which are produced by all kinds of trees and tree parts with leaf being the main source and they escape into environment (soil) through exudation, leaching, volatilisation and decaying/decomposition which again depends on climatic and soil factors.

Hence, the pot experiment was carried out to evaluate the effect of eucalyptus, teak and casuarina leachates on commonly grown oilseed crops like groundnut, safflower and soybean.

Material and Methods

The experiment was carried out in greenhouse at University of Agricultural Sciences Dharwad, Karnataka. The plastic pots were filled with sand and washed with distilled water. The seedlings of three years each tree species was planted in the pots individually and allowed to establish for two months. These pots were placed at higher elevation and were connected by nylon tubes to convey the leachate to the pots placed lower than these pots (which were also filled with sand washed with distilled water) in which oilseed crop seeds were sown to test the effect of tree species root and root + leaf leachates on germination and initial growth of crops. The crops were grown without supplying any external nutrient.

The pots with tree sp. when connected to the pots below with the test crops delivered the root leachate when they were watered. In order to deliver root + leaf leachate, a known quantity of leaf litter (powdered) was mixed in the pots having crop seedlings (the quantity was worked out based on the litter observed in 3-6 m distance from the tree grows in the field). In case of the control, the leachate came from pots having no tree species. Crop seeds (ten) were dibbled in pots, which were placed at lower elevation (placed on the ground). The crop germination was recorded after seven days of sowing and retained six seedlings out of ten. The crop observations recorded were plant dry weight (dg/pl), root length and shoot length at 15 and 30 days after sowing.

The experiment was conducted for two years and the data was pooled and analyzed. Details of the experiments are as below

Tree species (Factor A): Three
1.Eucalyptus (*Eucalyptus tereticornis*)
2.Teak (Tectona)
3.Casuarina (Casuarina).

Table-1 Allelopathic effect of tree seedlings on emergence of oilseeds at 6 days after sowing

Treatment	Groundnut			Sunflower			Safflower			Soybean		
Tree	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
Eucalyptus	8(-4)*	7.67(-8)	7.83(-6)	8.67(-7)	8(-14)	8.33(-11)	9.33(100)	8.67(-7)	9(-4)	9(-7)	8.67(-10)	8.84(-9)
Teak	9.33(+12)	9(+8)	9.17(+10)	9.33(100)	8.33(-11)	8.83(-5)	9.33(100)	8.67(-7)	9(-4)	9.33(-3)	8(-17)	8.67(-10)
Casuarina	9.67(+16)	9.33(+12)	9.5(+14)	9.67(+4)	9(-4)	9.33(100)	9.67(+4)	9.33(100)	9.5(+2)	9.67(100)	8.67(-10)	9.17(-5)
Mean	9(+8)	8.67(+4)	8.83(+6)	9.22(-1)	8.44(-10)	8.83(-5)	9.44(+1)	8.89(-5)	9.17(-2)	9.33(-3)	8.44(-13)	8.89(-8)
Control			8.33(100)			9.33(100)			9.33(100)			9.67(100)
	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)
Tree	0.3		0.91	0.28		0.86	0.22		NS	0.35		NS
Treatment	0.24		NS	0.23		0.7	0.18		0.55	0.29		0.88
Interaction	0.42		1.29	0.39		NS	0.31		NS	0.49		NS
	SEd±			SEd±			SEd±			SEd±		
Control V/S Rest	0.42		NS	0.39		NS	0.3		NS	0.49		NS

Table-2 Allelopathic effect of tree seedlings on shoot and root length (cm) of groundnut at 15 and 30 DAS

Treatment	15 DAS						30 DAS					
Tree	SL			RL			SL			RL		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
Eucalyptus	14.6(-1)*	12.59(-14)	13.6(-7)	2(-13)	1.93(-16)	1.97(-14)	26.8(+2)	26.6(+1)	26.7(+1)	6.2(-3)	6.2(-3)	6.2(-3)
Teak	14.54(-1)	14.5(-1)	14.52(-1)	2.4(+4)	2.13(-7)	2.27(-1)	29(+10)	28.7(+9)	28.85(+9)	7.6(+19)	7.2(+13)	7.4(+16)
Casuarina	14.63(100)	13.6(-7)	14.11(-4)	2.8(+22)	2.6(+13)	2.7(+17)	30.1(+14)	29(+10)	29.55(+12)	7.7(+20)	7.2(+13)	7.45(+16)
Mean	14.59(-1)	13.56(-8)	14.12(-4)	2.4(+4)	2.22(-3)	2.31(100)	28.63(+9)	28.1(+6)	28.37(+8)	7.17(+12)	6.87(+7)	7.02(+10)
Control			14.7(100)			2.3(100)			26.4(100)			6.4(100)
	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)
Tree	0.23		0.72	0.08		0.24	0.25		0.78	0.14		0.42
Treatment	0.19		0.58	0.07		NS	0.21		NS	0.11		NS
Interaction	0.33		1.01	0.11		0.34	0.36		1.11	0.19		0.58
	SEd±			SEd±			SEd±			SEd±		
Control V/S Rest	0.32		NS	0.11		NS	0.36		0.78	0.18		0.4

Table-3 Allelopathic effect of tree seedlings on shoot and root length (cm) of sunflower at 15 and 30 DAS

Treatment	15 DAS						30 DAS					
Tree	SL			RL			SL			RL		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
Eucalyptus	10.08(-1)*	9.64(-4)	9.86(-2)	3.1(-9)	2.67(-22)	2.88(-15)	19.5(+10)	18.5(+5)	19(+8)	6.27(-2)	6.03(-6)	6.15(-4)
Teak	10.05(100)	9.72(-4)	9.89(-2)	3.4(100)	3.2(-6)	3.3(-3)	21.5(+22)	18.83(+7)	20.17(+14)	7.1(+11)	6.2(-3)	6.65(+4)
Casuarina	9.9(-2)	9.6(-5)	9.75(-3)	3.6(+6)	3.3(-3)	3.45(+2)	20.9(+18)	18.53(+5)	19.72(+12)	7.5(+17)	6.8(+6)	7.15(+12)
Mean	10.01(-1)	9.65(-4)	9.83(-3)	3.37(-1)	3.06(-10)	3.21(-6)	20.63(+17)	18.62(+5)	19.63(+11)	6.96(+9)	6.34(-1)	6.65(+4)
Control			10.1(100)			3.4(100)			17.67(100)			6.4(100)
	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)
Tree	0.18		NS	0.09		0.28	0.31		0.95	0.12		0.36
Treatment	0.15		NS	0.08		0.23	0.25		0.78	0.09		0.29
Interaction	0.26		NS	0.13		0.4	0.44		1.35	0.16		0.49
	SEd±			SEd±			SEd±			SEd±		
Control V/S Rest	0.27		NS	0.13		NS	0.43		0.94	0.15		NS

Table-4 Allelopathic effect of tree seedlings on shoot and root length (cm) of safflower at 15 and 30 DAS

Treatment	15 DAS						30 DAS					
Tree	SL			RL			SL			RL		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
Eucalyptus	6.42(-3)*	5.02(-24)	5.72(-13)	5.3(+2)	5(-4)	5.15(-1)	14.25(-7)	14(-8)	14.13(-7)	5.6(+4)	5.4(100)	5.5(+2)
Teak	6.51(-1)	6.34(-4)	6.43(-3)	5.77(+11)	5.6(+8)	5.68(+9)	14.77(-3)	14.6(-4)	14.68(-4)	5.97(+11)	5.4(100)	5.68(+5)
Casuarina	6.3(-4)	6.22(-6)	6.26(-5)	6.7(+29)	6.1(+17)	6.4(+23)	15.6(+2)	15.4(+1)	15.5(+2)	6.47(+20)	5.6(+4)	6.03(+12)
Mean	6.41(-3)	5.86(-11)	6.14(-7)	5.92(+14)	5.57(+7)	5.74(+11)	14.87(-2)	14.67(-4)	14.77(-3)	6.01(+11)	5.47(+1)	5.74(+6)
Control			6.6(100)			5.2(100)			15.25(100)			5.4(100)
	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)
Tree	0.2		0.62	0.16		0.49	0.24		0.73	0.08		0.25
Treatment	0.16		0.5	0.13		NS	0.19		NS	0.07		0.2
Interaction	0.28		0.87	0.22		0.68	0.34		1.04	0.11		0.35
	SEd±			SEd±			SEd±			SEd±		
Control V/S Rest	0.29		NS	0.22		0.47	0.32		NS	0.11		0.24

Table-5 Allelopathic effect of tree seedlings on shoot and root length (cm) of soybean at 15 and 30 DAS

Treatment	15 DAS						30 DAS					
Tree	SL			RL			SL			RL		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
Eucalyptus	21.20(-10)*	18.72(-20)	19.96(-15)	2.30(-18)	2.10(-25)	2.20(-21)	42.75(-6)	42.13(-7)	42.44(-7)	5.83(+2)	5.40(-6)	5.62(-2)
Teak	20.24(-14)	19.76(-16)	20.00(-15)	2.87(+2)	2.63(-6)	2.75(-2)	46.00(+1)	45.73(+1)	45.87(+1)	6.30(+10)	5.83(+2)	6.07(+6)
Casuarina	20.76(-12)	17.74(-24)	19.25(-18)	2.97(+6)	2.73(-2)	2.85(+2)	48.33(+6)	47.30(+4)	47.82(+5)	6.63(+15)	6.10(+6)	6.37(+11)
Mean	20.73(-12)	18.74(-20)	19.74(-16)	2.71(-3)	2.49(-11)	2.60(-7)	45.69(100)	45.06(-1)	45.38(100)	6.26(+9)	5.78(+1)	6.02(+5)
Control			23.50(100)			2.80(100)			45.50(100)			5.75(100)
	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)
Tree	0.28		NS	0.07		0.22	0.26		0.81	0.15		0.45
Treatment	0.23		0.71	0.06		0.18	0.21		0.66	0.12		0.37
Interaction	0.4		1.23	0.1		0.31	0.37		1.14	0.21		NS
	SEd±			SEd±			SEd±			SEd±		
Control V/S Rest	0.39		0.85	0.11		NS	0.38		NS	0.22		NS

Table-6 Allelopathic effect of tree seedlings on dry weight (dg/pl) of groundnut and sunflower at 15 and 30 DAS

Treatment	Groundnut						Sunflower					
Tree	15 DAS			30 DAS			15 DAS			30 DAS		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
Eucalyptus	19.47(-2)*	18.70(-6)	19.08(-4)	41.33(-2)	40.57(-4)	40.95(-3)	17.60(-8)	17.27(-10)	17.43(-9)	37.67(+3)	36.60(100)	37.13(+2)
Teak	19.60(-1)	18.90(-4)	19.25(-3)	42.37(100)	41.60(-2)	41.98(-1)	18.40(-4)	18.07(-6)	18.23(-5)	38.33(+5)	37.60(+3)	37.97(+4)
Casuarina	19.72(100)	19.05(-4)	19.39(-2)	44.47(+5)	43.70(+3)	44.08(+4)	21.50(+12)	19.73(+3)	20.61(+7)	39.20(+7)	38.27(+5)	38.73(+6)
Mean	19.60(-1)	18.88(-5)	19.24(-3)	42.72(+1)	41.96(-1)	42.34(100)	19.17(100)	18.36(-4)	18.76(-2)	38.40(+5)	37.49(+2)	37.94(+4)
Control			19.8(100)			42.3(100)			19.2(100)			36.60(100)
	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)
Tree	0.22		NS	0.31		0.95	0.21		0.65	0.16		0.5
Treatment	0.18		0.56	0.25		0.77	0.17		0.53	0.13		0.41
Interaction	0.31		NS	0.43		NS	0.3		0.92	0.23		0.71
	SEd±			SEd±			SEd±			SEd±		
Control V/S Rest	0.31		NS	0.43		NS	0.29		NS	0.22		0.47

Table-7 Allelopathic effect of tree seedlings on dryweight (dg/pl) of safflower and soybean at 15 and 30 DAS

Treatment	Safflower						Soybean					
Tree	15 DAS			30 DAS			15 DAS			30 DAS		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
Eucalyptus	10.80(-4)*	10.53(-6)	10.67(-5)	23.17(-5)	22.00(-10)	22.58(-8)	19.47(-8)	18.20(-14)	18.83(-11)	37.33(-3)	36.60(-5)	36.97(-4)
Teak	11.67(+4)	9.90(-12)	10.78(-4)	23.77(-3)	23.00(-6)	23.38(-5)	21.40(+1)	20.77(-2)	21.08(-1)	38.13(-1)	37.40(-3)	37.77(-2)
Casuarina	12.67(+13)	9.90(-12)	11.28(+1)	26.37(+8)	26.17(+7)	26.27(+7)	22.63(+7)	21.63(+2)	22.13(+4)	39.50(+3)	38.53(100)	39.02(+1)
Mean	11.71(+5)	10.11(-10)	10.91(-3)	24.43(100)	23.72(-3)	24.08(-2)	21.17(100)	20.20(-5)	20.68(-2)	38.32(100)	37.51(-3)	37.92(-1)
Control			11.20(100)			24.50(100)			21.20(100)			38.50(100)
	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)	SEm±		C.D.(5%)
Tree	0.15		0.47	0.23		0.71	0.17		0.51	0.19		0.59
Treatment	0.13		0.38	0.19		0.58	0.14		0.42	0.16		0.48
Interaction	0.22		0.67	0.32		0.98	0.23		0.71	0.27		0.83
	SEd±			SEd±			SEd±			SEd±		
Control V/S Rest	0.22		NS	0.32		NS	0.24		0.52	0.27		0.59

Treatments (Factor B): Two
1.Root leachate (RL), 2.Root + Leaf leachate (RL + LL).

Control : One control in each crop was maintained for all three-tree species.
Crops:
1.Groundnut (variety: JL-24)
2.Sunflower (variety: Morden)
3.Safflower (variety: A-2)
4.Soybean (variety: JS-335)

Replication : Three
Design : Two factor single control (RBD).

Results and Discussion

All the arable crops tested for trees leachates were significantly varied with respect to the treatments. Leachates recorded lower emergence [Table-1] in soybean (8.89) followed by sunflower (8.83) and safflower (9.17) compared to their respective control (9.67, 9.33 and 9.33 respectively).

Whereas, in groundnut crop stimulatory effect was seen. Root + leaf leachate (RL+LL) recorded lower emergence in soybean (8.44) followed by sunflower (8.44) and safflower (8.89) compared to their respective root leachate (RL) (9.33, 9.22 and 9.44). It is observed that significantly higher inhibitory effect on crop emergence in soybean (13.0 per cent) and significantly lower inhibitory effect was in safflower (5.0 per cent). Among trees, significantly higher inhibitory effect to emergence was observed with eucalyptus leachates in sunflower (11.0 per cent), soybean (9.0 per cent) and safflower (4.0 per cent), whereas teak leachates recorded significantly lower emergence in soybean (10 .0 per cent). Studies of Sreedevi *et al.* (1996) [8] depicts that *Eucalyptus tereticornis* leaf extracts had significant adverse effect on the germination of pigeonpea, groundnut, sunflower, sorghum and castor. Similarly, Sajjan *et al.* (1997) [9] reported that the aqueous extracts of eucalyptus stem and leaves on seed germination and seedling growth of sunflower and soybean, wherein leaf extracts were more effective than stem extracts in reducing the germination and seedling growth. The sunflower crop was most susceptible to eucalyptus extracts. Monocarp extract of teak inhibited significantly the germination of soybean and cowpea as reported by Masilamani *et al.* (1998) [10].

In groundnut crop [Table-2& 6], shoot length (SL) and root length (RL) were not varied significantly in earlier stage of crop growth (15 DAS) but later stages (30 DAS) they varied significantly. The stimulatory effect was seen during later stages. There was 8% and 10% higher shoot length was seen with leachates effect compared to control. During earlier stages root + leaf leachates (RL + LL) recorded significantly lower shoot length (13.56 cm) compared to control (14.70 cm). Dry matter production of groundnut crop was significantly lower in RL+LL (18.88 dg/pl) compared to control (19.80 dg/pl) whereas later stages the inhibitory effect was reduced to 1.0%. Nadagouda (1990) [11] reported that four-year-old trees of teak and eucalyptus reduced grain yield of groundnut by 20.4 and 41.6 per cent, respectively under irrigated condition.

In sunflower oilseed crop, at 15 DAS the root length was significantly lower in RL + LL (3.06 cm) compared to RL (3.37 cm). The inhibitory effect was reduced during later stages as the stimulatory effect was observed. Similar trend was observed with respect to dry weight. In the earlier studies, dry leaf mulching or application of aqueous leaf extracts of *E. tereticornis* has been found to affect germination, root length and drymatter production of sunflower due to allelopathic effect. Singh (1993) [12] concluded that the leaf leachate of casuarina inhibited and reduced radicle length and plumule length of sunflower. Sunflower radicle length was affected more by leaf -leachates of casuarina than plumule length.

Mutanal (1998) [13] reported grain/pod yield of sorghum/groundnut was higher in sole crop as compared to sorghum/groundnut with teak, teak plus grass or teak plus subabul. Grain/pod yield was higher on western side as compared to eastern side of teak alley. Grain/pod yield was increased with increase in distance from teak alley.

In safflower, at 15 DAS RL + LL recorded significantly lower shoot length (5.86 cm) compared to root leachate alone (6.41). Dry weight was significantly lower in RL + LL (10.11) compared to RL alone (11.71). At Bellary, Karnataka state. *Acacia nilotica* caused greater yield reduction in *rabi* sorghum and safflower than eucalyptus and the reduction was attributed to the competition for moisture, which increased with age [14].

In soybean crop, at 15 DAS, leachates recorded significantly lower shoot length (19.74 cm) compared to control (23.50 cm). RL + LL recorded significantly lower shoot and root length (18.74 & 2.49 cm respectively) compared to RL alone (20.73 cm & 2.71 cm respectively). The leachates had inhibitory effect on dry weight of plant at 15 DAS (20.68 dg/pl) and 30 DAS (37.92 dg/pl) compared to control (21.20 dg/pl & 38.50 dg/pl respectively). Tripathi *et al.* (1998) reported that the leaf extracts of *Tectona grandis, Albizzia lebbek* and *Acacia* species showed stimulatory affects on germination, growth, chlorophyll, carbohydrates and protein content of soybean. The stimulatory activity was in the order of soil > leaf > root extracts. Srinivasan *et al.* (1990) [15] studies reveals that the effect of leachates of eucalyptus on soybean and it found that soybean was the most sensitive crop.

Mandal *et al*., 1998 [16], studies reveals that aqueous extracts of dry teak leaves inhibited the root and shoot growth of rice seedlings developing from seeds germinated on filter paper soaked in extracts. Panneerselvam *et al.* (1998) [17] showed that aqueous extracts of root and fully mature leaf leachate of *Tectona grandis* reduced the shoot length, root length, leaf area and chlorophyll content of peanut and maize seedlings. Baziramakenga *et al*., (1997) [18], concluded that the BEN and CIN induced decrease in soybean nutrient absorption may be a consequence of damage to cell membrane integrity caused by decrease in sulfhydryl - groups followed by lipid peroxidation. Tripathi *et al.* (1999) [19] reported that polyphenols and glycosides were present in root, leaf and soil extracts of teak and their concentration was in the order of root and leaves and soil. HPLC revealed the presence of four phenolic acids in leaves, six in roots and six in soil extracts. Channal *et al*. (2000) [20] opined that the leaf extract of teak at 5 to 10 per cent promoted germination in sorghum (15-32% over the control), but decreased seedling length of sorghum and drymatter in sorghum and rice at both concentrations. Tree leachates inhibitory effect was reduced gradually after 15 DAS and had least adverse effect or stimulatory effect at 30 DAS in tested oilseed crops.

Conclusion

The leachates study clearly indicates that the inhibitory effect was more during initial stages of crop growth than later stage (30 DAS) may be due to dilution effects. Still the inhibitory effect during earlier stages may have detrimentally effect on yield of the crops due to restricted vegetative growth.

Application of research: Study on the effect of tree leachates on growth and performance of oilseed crops

Research Category: Oilseed Crops

Abbreviations: T_1-Root Leachate ; T_2-Root +Leaf Leachate ;
*-Values in paranthesis per cent (+ for stimulation effect ; - for inhibition effect ; 0 for no effect)
SL-Shoot length : RL-oot length

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Study area / Sample Collection: University of Agricultural Sciences, Dharwad, 580005

Cultivar / Variety / Breed name: Eucalyptus, Greengram

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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