EFFECT OF *ACACIA XANTHOPHLOEA* LEACHATES ON SEED GERMINATION OF SOME AGRICULTURAL AND MULTI-PURPOSE TREE CROPS

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NSOLOMO, V. R., MRECHA, M. S. & MAGHEMBE, J. A. 1995. Effect of *Acacia xanthophloea* leachates on seed germination of some agricultural and multipurpose tree crops. Laboratory and nursery studies were carried out to determine the effect of water leachates of *Acacia xanthophloea* on the germination of some agricultural and leguminous tree crops to determine compatibility for intercropping in agroforestry systems. Leachates from leaves, bark and litter were applied on seeds of *Zea mays* (maize), *Eleusine coracana* (finger millet), *Vigna radiata* (green gram), *Albizia lebbeck*, *Leucaena leucocephala* and *Acacia xanthophloea*. The germination of the agricultural crops and of two tree species, *Albizia lebbeck* and *Acacia xanthophloea*, was not inhibited by the leachates both in the laboratory and nursery. However, the germination of *L. leucocephala* was significantly inhibited by the bark and litter leachates in the laboratory, but not in sand culture in the nursery. The inhibition effect of the leachates on root and shoot elongation for all the test species was also not significant. From this study it appears unlikely that *Acacia xanthophloea* produces potentially allelopathic substances and hence it is suggested that *A. xanthophloea* could be successfully intercropped in agroforestry systems with a diverse range of agricultural and tree species in well drained and aerated soils.

Keywords: *Acacia xanthophloea* - allelopathy - tree and agricultural crops - agroforestry

NSOLOMO, V.R., MRECHA, M.S. MAGHEMBE, J.A. 1995. Kesan pelarutresap *Acacia xanthophloea* kepada percambahan biji benih tanaman pertanian dan tanaman pelbagai guna. Kajian makmal dan tapak semaian dijalankan untuk menentukan kesan pelarutresap *Acacia xanthoploea* pada percambahan beberapa tanaman pertanian dan kekacang untuk menentukan kesesuaian bagi penanaman selingan dalam sistem hutan tani. Pelarutresap dari daun, kulit dan sarap telah di bubuh pada biji benih *Zea mays* (jagung), *Eleusine coracana* (finger millet), *Vigna radiata* (green gram), *Albizia lebbeck*, *Leucaena leucocephala* dan *Acacia xanthophloea*. Percambahan tanaman pertanian dan dua spesies pokok iaitu *Albizia lebbeck* dan *Acacia xanthophloea* tidak terencat oleh pelarutresap dalam makmal atau di tapak semaian. Bagaimanapun, percambahan *L. leucocephala* terencat dengan ketara oleh pelarutresap kulit dan sarap di makmal, tetapi tidak pula di dalam kultur pasir di tapak semaian. Kesan rencatan pelarutresap pada akar dan pemanjangan pucuk bagi kesemua spesies yang diuji juga tidak ketara. Kajian ini menunjukkan bahawa *Acacia xanthophloea* tidak berpotensi untuk mengeluarkan bahan-bahan alelopati. Oleh sebab itu, dicadangkan bahawa *Acacia xanthophloea* boleh dijadikan tanaman selingan yang berjaya di sistem agrotani yang mempunyai pelbagai spesies pertanian dan pokok di tanih yang berudara dan mempunyai saliran yang baik.

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Introduction

In agroforestry systems trees interact among themselves and with adjacent crops through competition for light, temperature, moisture and nutrients resources and as well as through allelopathy (Del Moral & Muller 1970, Hollis *et al.* 1982, Huxley 1983). To reduce competition due to trees on crops, wide tree spacing and manipulation of tree crowns are often applied in agroforestry systems (Kang *et al.* 1981, Chingaipe 1985, Lulandala 1985). However, in order to determine chemical compatibility between agricultural crops and trees, laboratory and nursery tests including field trials (e.g. Bhatt & Todaria 1990) may be necessary to investigate possible allelopathic interactions in these systems.

Plants exhibiting allelopathy produce secondary chemicals which inhibit the germination and healthy growth of adjacent plants (Kraft & Robins 1962, Whitaker 1970, Harbone 1977, Rice 1984). Although literature has reported the release of allelochemicals by some trees in their environment, many multipurpose tree species with potential for agroforestry including *Acacia xanthophloea* have, however, not been tested for allelopathy.

A. xanthophloea is a leguminous tree which is distributed in Africa and India (Brewbaker 1987). In Africa it is a pioneer species in cleared savannah woodlands in a variety of soils including vertisols, and is found in most lowlands in semi-arid areas (Palmer & Pitman 1972, Lind & Morison, 1974). Being a legume, it has the potential of improving depleted soils through biological nitrogen fixation (Brewbaker 1987) and therefore merits consideration for integration in agroforestry systems.

In this study a preliminary investigation was made to test for possible allelopathic effects of *A.xanthophloea* on some crop and tree species. Leachates from parts of *A.xanthophloea* trees were used on seed of crop species [(*Zea mays* (maize), *Eleusine coracana* (finger millet) and *Vigna radiata* (green gram)] and on seed of tree species (*Albizia lebbeck, Leucaena leucocephala* and *Acacia xanthophloea*).

Materials and methods

Leachates were prepared by separately soaking 200 g of unground foliage, bark or litter of *A.xanthophloea* in one liter of distilled water for 24 h. Seed of each tree species was collected from individual trees on the University farm, Morogoro and bulked before germination. Seed of maize, finger millet and green gram was obtained from the Tanzania Seed Certification Laboratory (Morogoro). All the seedlots were reduced to working samples of uniform size and washed several times to reduce fungal contamination. Tree seeds were soaked in hot water (70 °C) and allowed to cool overnight to break dormancy (Msanga & Maghembe 1986). The effect of the leachates on seed germination was assessed both in the laboratory and nursery, while the effect on root and shoot elongation was determined in the nursery.

Laboratory experiment

A randomized block design replicated five times was used for the study. Petri dishes of 9 cm diameter containing three layers of Whatman No. 41 filter paper were used to germinate the seed. One petri dish containing 25 seeds constituted a plot. Tap water (as control) and leachates from either bark, leaves or litter were then applied to the designated plots. Each petri dish was given 6 ml of one of the treatments initially and later 3 ml daily to maintain the filter paper in a moist condition.

Nursery experiment

The laboratory experimental design was repeated in sand culture in plastic pots in nursery and also replicated five times. The pots (11 × 11 cm open top, and tapering to 8 × 8 cm perforated bottom) each contained 25 seeds and constituted a plot. Seeds were sown at a depth of 10 mm (ISTA 1976) and the pots were put under shade. Each pot was given 150 ml of one of the treatments initially and thereafter 75 ml once daily to maintain the sand in a moist condition.

Data collection and analysis

In the laboratory germinated seeds were counted in each plot, then removed and discarded to avoid fungal contamination. The criteria of ISTA (1976 for a germinated seed was used in this assessment. Termination of the germination counts was done after three consecutive recordings had shown no further germination. In the nursery germinated seeds (ISTA 1976) were allowed to grow to the formation of the first true leaves, then harvested and assessed for root and shoot lengths.

The daily germination counts were converted into cumulative germination percentages which were then subjected to arcsine transformation and analysis of variance. Differences between treatment means were compared for significance using the Duncan's New Multiple Range Test.

Results

Germination of agricultural crops

Germination of *Z.mays* for all the treatments in both the laboratory and nursery experiments was above 90% and maximum germination in both experiments was attained 8 days after sowing. At $p < 0.05$, there were no significant differences between the treatments on maize germination (Table 1). The germination of *E.coracana* and *V.radiata* was also not significantly affected by the leachates ($p < 0.05$). Germination percentages were high both in the laboratory and nursery (Table 1), and for both species, maximum germination in the laboratory and nursery was respectively attained 5 and 7 days after sowing. Application of the leachates did not affect the time of maximum germination of the three crop species.

Table 1. Mean germination percentages of agricultural and tree species treated with tap water and leachates from parts of *Acacia xanthophloea*

Medium	Species	Germination percentage by treatment			
		Tap water	Leaves	Bark	Litter
Filter paper	*Zea mays*	94.4	99.2	95.2	98.4
	Eleusine coracana	94.4	95.2	89.6	93.6
	Vigna radiata	85.6	86.4	77.6	84.0
	Albizia lebbeck	56.0	51.2	42.4	42.4
	Leucaena leucocephala	84.8 a	82.4 ab	68.0 c	70.4 bc
	Acacia xanthophloea	33.6 bc	36.8 bc	26.4 b	44.0 c
Sand	*Z.mays*	90.4	96.8	90.4	95.2
	E.coracana	79.2	88.4	91.2	84.8
	V.radiata	88.8	86.4	92.8	95.2
	A.lebbeck	50.4	42.4	44.0	46.4
	L.leucocephala	40.8	31.2	34.5	39.6
	A.xanthophloea	36.8	36.0	27.2	29.6

Figures in the same row having the same letter or without letters do not differ significantly at $p < 0.05$ based on Duncan's New Multiple Range Test.

Germination of tree seeds

Generally, the germination percentages of tree seeds were lower than those of the agricultural crops in all treatments (Table 1). *Albizia lebbeck* and *Acacia xanthophloea* were well below the germination percentages achieved by the crop species. The germination of *L.leucocephala* in the laboratory was significantly lower ($p < 0.05$) with the bark and litter leachates compared to the control. However, in the nursery there were no significant differences in the germination percentages between the leachates and the control although the leaf leachate had the lowest values. Despite the inhibitory effect observed in the laboratory, *L.leucocephala* was the only tree species with high germination values (Table 1). This suggests that *L.leucocephala* could still be a potential tree species for intermixing with *A.xanthophloea* due to its high germination capacity.

The germination of *A.xanthophloea* seed was not significantly affected by its own leachates either in the laboratory or the nursery. Proportionately though, the litter leachate gave the highest cumulative germination and this was significantly higher ($p < 0.05$) than germination in the bark leachate. None of the leachates, however, were significantly different from the control (Table 1). These differences (between germination in the bark and litter leachates) were not significant in sand culture in the nursery. It was interesting, however, that the lowest germination values in the nursery were also associated with the bark leachate.

Root and shoot length

The effect of the leachates on shoot and root length was not significant ($p < 0.05$). For each of the seedlots studied, the leachates applied did not affect the growth of shoots and roots of the seedlings (Table 2).

Table 2. Mean shoot and root elongation of some agricultural and tree species in sand culture, treated with tap water and leachates from parts of *Acacia xanthophloea*

	Species	Mean length by treatment (cm)			
		Tap water	Leaves	Bark	Litter
Shoot	*Zea mays*	7.7	7.6	7.9	7.3
	Eleusine coracana	4.2	4.4	3.9	4.5
	Vigna radiata	8.4	8.5	7.9	8.1
	Albizia lebbeck	5.0	5.5	5.1	5.1
	Leucaena leucocephala	3.1	2.6	2.9	3.3
	Acacia xanthophloea	5.2	6.1	5.6	5.7
Root	*Z. mays*	19.1	19.5	20.7	20.1
	E. coracana	15.3	15.2	16.6	14.8
	V. radiata	14.4	13.2	14.1	14.0
	A. lebbeck	5.6	4.9	5.0	4.6
	L. leucocephala	5.4	4.3	4.6	6.5
	A. xanthophloea	8.3	8.6	7.4	9.8

Discussion

Species sensitivity to allelo chemicals during the establishment phase may depend on whether they were grown from seed or planted (Rietveld 1983). The effect of leachate from *A. xanthophloea* on seed germination and root and shoot elongation shown in this study gives an indication on how some herbaceous and woody plants would perform when intercropped with this species. Two tree species and all the agricultural crops studied showed no response to possible allelochemicals in *A.xanthophloea* while *L.leucocephala* showed sensitivity to the chemicals in the laboratory. Although Harbone' (1977) has reported that allelochemicals can inhibit the growth of the producer plant itself, *A.xanthophloea* did not inhibit the germination or early growth of its seed.

The bark and litter inhibition of *L.leucocephala* in the laboratory was not repeated in the nursery and the poor germination values for the species (as compared to those obtained in the laboratory - see Table 1) could be due to the effect of the germination medium. These results resemble those found on various *Eucalyptus* spp. which inhibited plant growth in the laboratory but failed to do so in a sand culture (see Del Moral & Muller 1970, Rao & Reddy 1984). Del Moral and Muller (1970) and Rietveld (1983) agree that for substantial expression of allelopathic influence to occur, the soil must be either poorly aerated and drained or shallow with high colloidal content. These properties are not exemplified by sand. Although the concentration of allelochemicals of *A.xanthophloea* in the field has not been measured, it is evident that soil characteristics should allow for proper aeration and drainage so that possible allelopathic substances do not build up to toxic proportions.

Conclusion

Since the leachates did not show significant inhibition of germination of any of the agricultural crops (*Zea mays, Eleusine coracana* and *Vigna radiata*) both in laboratory and in the nursery tests, *Acacia xanthophloea* has potential to be intercropped in agroforestry systems with the agricultural crops studied. *A. xanthophloea* may also be used in multi-species agroforestry technologies using *Acacia lebbeck.* And judging by its high germination capacity in the laboratory (despite being inhibited significantly by the bark and litter leachates) and the absence of its inhibition in the sand culture, *L.leucocephala* is also a potential tree species for intermixing with *A.xanthophloea* in agroforestry systems. However, more tests on compatibility of *A.xanthophloea* with *L.leucocephala* may be warranted including testing the effect of various concentrations of the leachates on germination. Considering the wide geographical distribution, ability to increase soil fertility through nitrogen fixation, production of various forest-based products and its positive compatibility with various agricultural and tree species, *A.xanthophloea* is a tree which can benefit various agricultural communities in Africa and the Indian sub-continent.

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