

# Evaluation of the Allelopathic Influence of Selected Multi-purpose Tree Species on Maize (*Zea mays*) under a Simulated Field Condition

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## Summary

*Germination and growth response of maize (Zea mays) that was periodically watered with 200 ml of leaf leachates of three selected multipurpose tree species (MPTs) - Inga edulis, Anthonatha macrophylla and Dactyladenia barterii were evaluated under a simulated field condition to determine their allelopathic characteristics and suitability for alley cropping. There was a significant ( $P \leq 0.05$ ) difference in the germination percentage of the maize seeds among the MPTs studied. Maximum germination percentage (76.7%) of the seeds and seedling growth as indicated by radicle length, shoot length, fresh weight and plant height at tasselling were obtained from seeds watered/treated with rainwater as the control treatment. Reduction in germination percentage (33%) was observed in Anthonatha macrophylla leachates while moderate germination percentage of 50% was observed in Dactyladenia barterii leachate. Anthonatha macrophylla leachate inhibited both radicle and shoot length. Similarly, Inga edulis leachate had inhibiting effects on radicle and shoot of germinating maize seeds. This result suggests that Inga edulis, Anthonatha macrophylla and Dactyladenia barterii produce allelochemicals which inhibit seed germination and growth of maize under the conditions of the experiment. Investigations on allelopathic characteristics of potential MPTs could be integrated in farm planning strategies in a tropical agroecology especially where alley cropping is contemplated.*

## Résumé

**Evaluation de l'influence allélopatique des essences forestières sur la culture du maïs (*Zea mays*) en conditions contrôlées**

*Cette étude évalue la germination et la croissance du maïs (Zea mays) en conditions contrôlées.*

*L'objectif de cet essai était d'identifier et de caractériser des allochèmes produits par des essences forestières avant d'envisager leur éventuelle utilisation comme alley cropping. Les plantes ont été arrosées régulièrement avec une solution (200 ml) de filtrats de culture produits par des feuilles d'essences forestières aux propriétés allélopatiques (Inga edulis, Anthonatha macrophylla et Dactyladenia barterii).*

*Différents paramètres (taux de germination, longueur des racelles et des pousses, hauteur de la plante à la floraison, poids de la matière fraîche) ont été comparés à ceux des plantes témoins arrosées avec de l'eau de pluie.*

*Les résultats obtenus montrent des différences significatives ( $P \leq 0,05$ ) entre traitements. Ces essences produiraient des allochèmes qui inhibent la germination et la croissance du maïs. Le taux de germination le plus élevé (76,7%) a été obtenu avec les plantes témoins. Les plantes arrosées avec les filtrats produits par Dactyladenia barterii ont montré un taux de germination moyen (50%) tandis que les plantes arrosées avec les filtrats produits par Anthonatha macrophylla étaient caractérisées par un taux de germination le plus bas (33%). Cette étude montre également que la solution des filtrats de culture de Inga edulis a inhibé la croissance des racelles et des pousses.*

*D'autres études relatives à la caractérisation chimique de ces filtrats s'avèrent nécessaires avant de proposer l'intégration de ces essences dans les systèmes agro-écologiques des régions tropicales.*

## Introduction

Maize (*Zea mays*) is a cereal crop belonging to the poaceae family and is believed to have originated from Central America, probably Mexico (10). It is a major cereal for numerous people in developing countries. It is grown under a wide range of agroecological conditions. It is also one of the major fodder crops in the humid tropics. As such it is also one an integral component of

most farming systems in Rivers State, South-eastern Nigeria (15).

The traditional agrotechnic of shifting cultivation and related bush-fallow systems have for generations provided resource-poor farmers with an efficient and stable food production system in the absence of purchased inputs (12). When land becomes limiting and fallow peri-

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ods are shortened so that adequate nutrient levels are no longer restored, the system deteriorates (1). In recognition of this and knowing the importance of deep-rooted trees and shrubs in nutrient recycling; scientists at the International Institution of Tropical Agriculture (IITA) have developed alley cropping which involves growing annual food crops in alleys between hedgerows of trees/shrubs (5). Hedgerows are periodically pruned to prevent excessive shading of food crops and to supply green manure and mulch. The practice is increasingly becoming accepted as a cropping system with the potential to provide stable and sustainable food production (3, 14). If alley cropping (6) is to be considered as an alternative to shifting cultivation, then it becomes imperative to evaluate the compatibility of pruned hedgerow species with major food crops such as maize. A constraint to alley cropping is the competition of hedgerow tree or shrub roots with those of companion food crops for available water and nutrients in the top soil (11) and reduce significantly the yields (7). Again, the superficial large roots of hedgerow trees or shrubs may cause some cultivation difficulties. In addition to competing for light, water and minerals, plants can inhibit seed germination and growth of neighbouring plants by releasing a variety of toxic chemicals, called allelochems (9). The phenomenon of one plant (donor) having a direct or indirect detrimental chemical effect on another (receptor) plant through the production of allelochems is called allelopathy (9). Allelopathic compounds are known to inhibit seed germination or reduce plant seedling growth by inhibiting cell division, reducing mineral uptake, increasing or decreasing respiration and inhibiting protein and haemoglobin synthesis (9). Other effects may include decline in number and dry weight of seedlings and decline in productivity and eventual death. In the present investigation seed germination and growth response of maize, periodically watered with leaf leachates of three selected multipurpose tree species - *Inga edulis*, *Anthonatha macrophylla* and *Dactyladenia barterii* were conducted under a simulated field condition to determine their allelopathic characteristics and their suitability for alley cropping.

*Anthonatha macrophylla* belongs to the family leguminosae. It is a small tree (8-12 m high) which is common throughout the rain forest of Nigeria. It has 2-4 pairs of leaflets on a common stalk of 6-20 cm long and minutely hairy.

*Dactyladenia barterii* belongs to the family chrysobalanaceae. It is a genus of 27 african species, previously included in the american genus *Acioa*. In Nigeria it is the most common species. It is a glabrous shrub with cordate leaves.

*Inga edulis* is an exotic germplasm probably of the american origin. Not much is known about the allelopathic potentials of these MPTs on maize germination and seedling growth.

## Material and methods

Dry leaves of three multipurpose tree species (MPTs) viz: *Inda edulis*, *Anthonatha macrophylla* and *Dactyladenia barterii* were obtained from the International Centre for Research in Agroforestry (ICRAF)/International Institute of Tropical Agriculture (IITA) High Rainfall Station, Onne South-eastern Nigeria. Leaf leachates were prepared following a modified method as

described by Bhandwaj (4). Dry leaves of the three MPTs weighing 93 g/each were immersed in 20 liters of rainwater separately and allowed to stand for 7 days. The rainwater was collected during a rainy day from corrugated roofing sheets over an office block of the University. Rainwater was preferred over other sources of water supply to simulate natural field condition since all farming systems in this agroecology are rainfed dependent. The solutions were then filtered and filtrates obtained constituted experimental treatments with the rainwater as control. Twenty healthy seeds of a local maize variety (local white) obtained from a peasant farmer in the locality during the planting season (April, 1999) were used. Prior to sowing, germination test was carried out and found to be 98.6%. The seeds were planted in 40 x 40 x 40 cm polythene bags in a completely randomised design (CRD) and replicated 3 times and a total of 1440 seeds were planted in all. Polybags were filled with non-fumigated top soil obtained from the Research and Experimental Farm of the Rivers State University of Science and Technology, Port Harcourt, South-eastern Nigeria. Polybags were lightly mulched with dry leaves of the selected MPTs according to the treatments to supply leachates continuously during the rains. This method simulated natural field conditions. Prepared leachates of the selected MPTs were watered periodically when necessary and at an even level of 200 ml per polybag. Germination records were obtained daily for 7 days and thereafter seedlings were thinned to 2 plants per polybag for plant height and fresh weight observations. Data were analysed by the analysis of variance (ANOVA) method.

## Results and discussion

Germination which is the emergence and development of embryonic radicle through the seed coat was found to be significantly different with leaf leachates of *Inga edulis*, *Anthonatha macrophylla* and *Dactyladenia barterii*. Maximum germination percentage (76.7%) was observed in maize seeds watered with rain water (Table 1). However, reduction in germination percentage (33%) calculated against germination test results of approximately 100% was observed in *Anthonatha macrophylla* leachates while moderate germination per-

**Table 1**  
Effect of *Inga edulis*, *Dactyladenia barterii* and *Anthonatha macrophylla* leachates on germination and seedling growth of maize cv. local white\*

Character attribute	<i>Inga</i> leachate	<i>Dactyladenia</i> leachate	<i>Anthonatha</i> leachate	Rain water
Germination %	44.3 <sup>c</sup>	50.0 <sup>b</sup>	33.0 <sup>d</sup>	76.7 <sup>a</sup>
Radicle length (cm)	1.7 <sup>a</sup>	1.5 <sup>b</sup>	0.9 <sup>b</sup>	3.3 <sup>a</sup>
Shoot length (cm)	7.0 <sup>b</sup>	9.2 <sup>b</sup>	5.1 <sup>c</sup>	11.6 <sup>a</sup>
Fresh weight (g)	13.2 <sup>b</sup>	15.0 <sup>b</sup>	8.9 <sup>c</sup>	21.5 <sup>a</sup>
Plant height at tasselling (m)	1.9 <sup>a</sup>	1.8 <sup>a</sup>	1.6 <sup>a</sup>	2.4 <sup>a</sup>

\* Mean values with identical letters within a row are not statistically different at P < 0.05

a. Radicle length at the end of germination (7 days)

b. Shoot length at the end of germination (7 days)

c. Fresh weight at 21 days after sowing

centage (50%) was observed in *Dactyladenia barterii* leachates. The present investigation indicates that *Inga eduli*, *Anthonatha macrophylla* and *Dactyladenia barterii* leaves probably produce allelochemicals which inhibit germination of maize. Studies on allelopathy have been conducted on other plant species but such reports on *Inga eduli*, *Anthonatha macrophylla* and *Dactyladenia barterii* are scarce. For instance, Anwar (2) indicated that *Eucalyptus* spp. had allelopathic effect on the growth of maize seedlings. Similarly, Malkania (8) reported the decrease in germination of certain crop plants from leachates of *Celtis australis* and *Juglans regia*.

The growth of the radicle as indicated by its length and shoot of maize seedlings indicated that *Anthonatha macrophylla* leachate is inhibitory to probably cell elongation. The control treatment (rain water) promoted the growth of the radicle as well as the maize seedling. Following Wareing and Phillips (16), plant development involves both growth and differentiation. Tian and Kang (13) reported phytotoxic effects of *Gliricidia sepium* leachates on maize and cowpea seedlings in both laboratory and field conditions. In that report, growth of maize was significantly reduced by addition of *G. sepium* prunings. Leaf leachates of *Robinia pseudoacacia* were found to reduce germination percentage and growth of shoots and roots of *Zea luxurians* (4).

As evident from table 1, fresh weight and plant height

values were higher in control than in the leachates obtained from the evaluated multipurpose tree species. This further suggests that these MPTs are allelopathic on maize crop, although their degree of influence may appear naturally variable.

## Conclusion

The three MPTs investigated appear to inhibit germination and growth of maize. This suggests their allelopathic potential probably due to the existence of allelochemicals in the MPTs. However, *Anthonatha macrophylla* exhibited a stronger allelopathy than the others. Of these species, *Dactyladenia barterii* and *Inga edulis* are moderately allelopathic on maize seed germination and seedling growth.

Further studies on the allelopathic characteristics of root exudates and aqueous extracts obtained from soils under these MPTs are currently in progress to correlate the results obtained from the pot experiments.

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