ALLELOPATHIC EFFECTS OF ANACARDIUM OCCIDENTALE LINN OF TERENGGANU AND KELANTAN ON GROWTH OF MAIZE AND CUCUMBER


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Abstract: A study was conducted on Anacardium occidentale Linn. (Cashew) from Terengganu and Kelantan states of Malaysia, with the aim to determine the allelopathic effects of leaf and root extracts on the growth of bioassay plant species, Zea mays (maize) and Cucumis sativus (cucumber). On exposure to leaf and root aqueous extracts at 10 g/L, 50 g/L and 100 g/L concentrations, the growth of these bioassay plant species were found affected. With the increasing concentrations of leaf and root aqueous extracts, the percentage of germinations and radicle lengths of bioassay species were reduced. These findings showed that phytochemicals in the tissues of A. occidentale caused insignificant phytotoxic effects on growth of Zea mays and Cucumis sativus seeds. The leaf extract of A. occidentale showed similar phytotoxicity effects as that of its root extract, on the growth parameters of tested species. The different effects between leaf aqueous extracts and root aqueous extracts could be contributed by different allelochemical quantities or entities presence in plant tissues. This experiment showed similar trend of inhibition from both extracts, however some extracts obtained from Terengganu gave more inhibition effect compared to extracts obtained from Kelantan.

Key words: Anacardium occidentale Linn, cashew, allelopathic effects, aqueous extract, Zea mays, Cucumis sativus.

INTRODUCTION

There is an increasing interest in allelopathic studies and recently many researchers have focused on the exploration of plant allelopathy (Weston, 1996). The term allelopathy was coined by Molish in 1937. Presently, the term generally refers to the detrimental effects of higher plants of one species (the donor) on the germination, growth or development of plants of another species (the recipient). Allelopathy can be separated from other mechanisms of plant interference because detrimental effect is exerted through release of chemical inhibitors (allelochemicals) by the donor species.

Allelopathic potential is a natural and environmental friendly technique which may prove an effective strategy for weed and insect pest management and thereby increase crop yields and quality (Putnam, 1985). Allelopathic interaction can be evaluated through aqueous extract from donor plant (Jayakumar & Jaganathan, 2003). Quantities of allelochemicals vary between different plant tissues, under different ecological conditions. Chemicals with allelopathic potential are present in virtually all plant tissues, including leaves, stems, roots, rhizomes, flowers, fruits and seeds. Whether these
compounds are released from the plant to the environment in quantities sufficient to elicit a respond remains the critical question in field studies of allelopathy. Allelochemicals may be released from plant tissues in a variety of ways, including volatilization, root exudation, leaching, and decomposition of plant residues (Putnam, 1985).

Anacardium occidentale or well known as cashew plant, is a hardy drought-resistant tropical and subtropical tree. This species belongs to the genus Anacardium, a member of a family of Anacardiaceae, which comprises about 60 genera and 400 species. This tree may grow up to as much as 15 metres tall (Heywood, 2007). Anacardium occidentale is generally considered to be a native to northern part of Africa and now found in many tropical areas throughout Africa, Asia and Australia (Frankel, 1991). In 1973, cashew was planted on 1 200 hectares of land in Pahang, Malaysia by the Food Industry of Malaysia (FIMA). FIMA had also acquired a total of about 3 440 hectares in Terengganu for similar purpose. A survey had indicated that 120 000 hectares of land in Peninsular Malaysia are suitable for cashew planting (Heywood, 2007).

This species is a shrub with resinous bark and grows most abundantly in the tropics in both eastern and western hemispheres (Ohler, 1979). This tree is occasionally a shrub with resin canals. The leaves are glabrous, thick and leathery, 10 to 20 cm long, 5 to 10 cm wide, alternate, rarely opposite, often pinnate and sometimes simple. Cashew apples can be almost round, and sometimes elongated. The very young apple is green or purple, and later turn green. When ripe, the apple becomes red or yellow, or mixture of these. The cashew tree has an intensive lateral root system and a tap-root which penetrates deeply into the soil. After its emergence, the radicle rapidly developed into a tap-root which started producing lateral roots four days later (Prajapati et al., 2003).

The essential amino acids in cashew apple are arginine, histidine, lysine, phenylalanine, threonine, tryptophan, leusine, isoleusine, and valine. Other amino acids present include alanine, aspartic acid, cystine, glutamic acid, glycine, serine and tyrosine. The testa is a good source of condensate of tannins. The polyphenols identified in the testa are catechin, epicatechin, ethylgallate, leucocyanidin, proanthocyanidin, leucodelphinidin and epiafzelchin. Gallic acid and an acrid resin are also found in cashew nut. In addition, tannin, an extractive substance is present in gum-resin. Viscid liquid contained between the two shells of the nut is named anacardic acid. Another compound presence is cardol (Prajapati et al., 2003).

**MATERIALS AND METHODS**

**Materials**
Approximately five kg of plant materials of leaves and roots of Anacardium occidentale were collected separately from Kampung Saujana, Setiu, Terengganu which is located at (N 5°37.768’, E 102°44.726’) and 8 meters from sea level; and Kampung Cherang Ruku, Pasir Puteh, Kelantan which is located at (N 5°51.184’, E 102°29.674’) and 16 meters from sea level. The plant materials and soils were collected in October and November 2010. For allelopathic properties experiment, Zea mays (corn) and Cucumis sativus (cucumber) seeds from the Koperasi Peladang Terengganu were used as bioassay test species.

**METHODS**
Approximately 100 g of fresh leaves and roots of Anacardium occidentale were cut into smaller pieces before extraction. Plant materials were blended with 300 mL distilled water by using the laboratory blender. The previous steps were also followed similarly for root extraction. Immediately, they were kept in several flasks and agitated for an hour on an orbital shaker (120 r.p.m) at room temperature (28 + 3 °C). The extract were then centrifuged (3 000 r.p.m.). The supernatant was collected and the remaining pellet was removed. Three concentrations of extract were used in this experiment, which were 100 g/L, 50 g/L and 10 g/L. Ten seeds of each test species of Zea mays and Cucumis sativus were placed in separate petri dishes, which had been lined with 9 cm Whatman filter paper. Exactly 10 mL of aqueous extract, or distilled water as control, were used to wet the filter paper. The petri dishes were then placed on laboratory bench at room temperature. The percentages of germination, radicle length and fresh weight of each bioassay test species were observed and recorded after seven days.

**RESULTS AND DISCUSSIONS**
Both leaf and root aqueous extracts of Anacardium occidentale of Terengganu and Kelantan reduced the percentage of germinations and radicle lengths of Zea mays and Cucumis sativus, however none of them showed significant effect compared to control.
Cucumis sativus indicated the highest sensitivity compared to Zea mays (Figure 1). The highest inhibition of percentage of germination was recorded on Zea mays by the treatment with 100 g/L of Kelantan leaf extract which was 84.5% lower than control. The highest inhibition of fresh weight was recorded on Zea mays by the treatment with 10 g/L of Terengganu leaf extract which was 0.612 g lower than control. The highest inhibition of radicle length was recorded on Zea mays by the treatment with 100 g/L of Kelantan leaf extract which was 16.53 cm lower than control (Table 1).

Previous research revealed that various concentrations of Parthenium hysterophorus L. root extracts decreased the germination and growth of maize and barley (Rashid et al., 2008). The inhibitory effects also have been reported in P. hysterophorus extract on germination of many crops (Narwal, 1994). Various concentrations of P. hysterophorus had significant effects on seedling weight of Avena fatua and Lepidium (Batish et al., 1997). The leaf extract of Metapium brownie (Family: Anacardiaceae) inhibits radicle growth of Amaranthus hypochondriacus (Anaya et al., 1999).

The findings from this study showed that there were some phytochemical compounds in the tissues of Anacardium occidentale which showed insignificant phytotoxic effects on agricultural crop seeds of Zea mays and Cucumis sativus. Anacardium occidentale retarded the crops’ growth, which could happened due to inhibition of cell division because allelopathic chemicals have been found to inhibit gibberellins and indoleacetic acid function (Tomaszewski & Thimann, 1966). The different effects between leaf aqueous extracts and root extracts were perhaps contributed by different allelochemical quantities and entities presence in plant tissues. In addition, the allelopathic interaction depended on the chemical stability of bioactive compounds and the concentrations of extract used in the experiment (Ismail and Kumar, 1996).

According to Tomaszewski and Thimann (1966), plants also appear to vary in their production of allelopathic chemicals depending upon the environment in which they are grown due to their response to various stresses that they encountered. Based on data obtained from the Malaysian Meteorology Department, Kelantan recorded higher average amount of rainfall (16.6 mm per day) compared to Terengganu (14.4 mm per day) from October to December 2010. Terengganu and Kelantan however, showed similar mean data of temperature (26.5 °C; 26.4 °C) and relative humidity (86.5%; 86.9%) for the whole three months study durations, respectively. It is possible that the phytotoxicity observed with A. occidentale aqueous extracts was related to a synergistic combination of phenolic and some water-soluble chemical constituents, which occurred in substantial quantities but not yet identified. The higher amount of rainfall caused phenolic compound and some water-soluble compounds in the leaf surface to leach through the rainwater. This will cause total phenolic compounds to reduce to smaller amount. This experiment showed many trends of inhibition from plant extracts obtained from Terengganu and Kelantan. Leaf extract from Kelantan, with high amount of rainfall, duly will cause lower effect on the growth of bioassay test plant due to the lower amount of allelochemical remaining in the surface of leaf and root.

The trend showed that with the increasing concentration of leaf and root aqueous extract, the percentage of germinations, fresh weights and radicle lengths of each bioassay test plant species decreased respectively (Figures 1-3), except for fresh weights of Cucumis sativus treated with leaf extract from Kelantan (Figure 2). This experiment showed similar trend of inhibition of both extracts, however some extracts from Terengganu gave more inhibition effects compared to extracts obtained from Kelantan.

CONCLUSIONS

Keeping view of the results of this study that provided evidence of insignificant allelopathic effects of A. occidentale but showed the decreasing growth trends of Zea mays and Cucumis sativus, indicated that A. occidentale leaf and root extracts may not be suitable to be used as potential biofertilizer. Nevertheless, its leaves could be more suitable as traditional vegetable or ‘ulam’ as it is rich in tannins that are reportedly useful due to their biological activities that include anti-inflammatory and astringent effects.

ACKNOWLEDGEMENTS

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## Table 1: Allelopathic effects of *Anacardium occidentale* aqueous extracts obtained from Terengganu and Kelantan on percentages of germination, fresh weights and radicle lengths of *Zea mays* and *Cucumis sativus* (mean differences by control)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Concentration of aqueous extract (g/L)</th>
<th>Cashew</th>
<th>Percentage of Germination (%)</th>
<th>Fresh weight (g)</th>
<th>Radicle length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leaf Extract</td>
<td>Root Extract</td>
<td>Leaf Extract</td>
</tr>
<tr>
<td><em>Zea mays</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Terengganu</td>
<td>7.83</td>
<td>14.50b</td>
<td>0.612b</td>
<td>0.114b</td>
</tr>
<tr>
<td></td>
<td>Kelantan</td>
<td>41.17</td>
<td>11.17b</td>
<td>0.210b</td>
<td>0.302b</td>
</tr>
<tr>
<td>50</td>
<td>Terengganu</td>
<td>45.56</td>
<td>24.50b</td>
<td>0.319b</td>
<td>0.236b</td>
</tr>
<tr>
<td></td>
<td>Kelantan</td>
<td>71.17</td>
<td>64.50b</td>
<td>0.335b</td>
<td>0.386b</td>
</tr>
<tr>
<td>100</td>
<td>Terengganu</td>
<td>57.83</td>
<td>67.33b</td>
<td>0.442b</td>
<td>0.390b</td>
</tr>
<tr>
<td></td>
<td>Kelantan</td>
<td>84.50</td>
<td>77.83b</td>
<td>0.467b</td>
<td>0.467b</td>
</tr>
<tr>
<td><em>Cucumis sativus</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Terengganu</td>
<td>10.00</td>
<td>20.00b</td>
<td>0.068b</td>
<td>0.098b</td>
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<td>3.33b</td>
<td>0.068b</td>
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<td>50</td>
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<td>33.33</td>
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<td>0.247b</td>
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<tr>
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<td>0.206b</td>
<td>0.185b</td>
</tr>
<tr>
<td></td>
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<td>50.00</td>
<td>73.33b</td>
<td>0.113b</td>
<td>0.115b</td>
</tr>
</tbody>
</table>

Note: b indicates inhibitory effect of *Anacardium occidentale*.

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**Fig. 1:** The effects of *Anacardium occidentale* aqueous extracts from Terengganu and Kelantan on percentages of germination of *Zea mays* and *Cucumis sativus*. 

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Fig. 2: The effects of *Anacardium occidentale* aqueous extracts from Terengganu and Kelantan on fresh weights of *Zea mays* and *Cucumis sativus*

Fig. 3: The effects of *Anacardium occidentale* aqueous extracts from Terengganu and Kelantan on radicle lengths of *Zea mays* and *Cucumis sativus*

**REFERENCES**


