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# Dried leaf litters: A nature's gift for germination and growth diversity in seeds

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## Abstract

Plants modify their biotic and abiotic soil environment, which in turn has a major influence on subsequent plant growth also referred to as plant-soil feedback. Allelopathy is a Biological interaction, by which an organism produces one or more biochemicals that Influence the germination, growth, survival, and reproduction of other organisms. The possible application of allelopathy in agriculture is the subject of much research. Depending on the plant, allelopathic substances can be released from a plant's flowers, leaves, leaf debris and leaf mulch, stems, bark, roots, or soil surrounding the roots. The pollution free environment is essential for sustaining life of all living being on the earth. Eco friendly farming has emerged as the only answer to bring sustainability to agriculture. The present investigation was carried out on the effect of easily available organic degradable leaf litters of *Mangifera Indica*, *Artocarpus heterophylla*, *Macaranga peltata* and *Heavea braziliensis* considered as treatment materials against the pulses *Vigna radiata*, *Vigna unguiculata*, *Macrotyloma uniflorum* and *Coriandrum sativum* as test materials.

**Keywords:** Allelopathy; Sustainability; Leaf litters; Pulses; Germination; Growth diversity

## 1. Introduction

Allelopathy is a biological interaction, by which an organism produces one or more Biochemicals that influence the germination, growth, survival, and reproduction of other Organisms. The biochemicals produced by plants are known as allelochemicals and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effect on the target organisms. The possible application of allelopathy in agriculture is the subject of much research. Current researchers are focused on the use of crop allelopathy to minimize serious problems in the agricultural production such as unsafe products, environmental pollution, reduction of crop productivity, loss of crop diversity. This work is focussed on the possibility of using allelochemicals to promote sustainable agriculture.

Sustainability involves the responsible use of natural resources to ensure they can sustain both current and future generations. As the global population continues to grow, there is an ongoing demand to boost food production and increase buffer stocks. As a result, home gardens are receiving significant focus as a way to improve household food security and nutrition. The major nutrition gardens are cultivating pulses, vegetables and fruits. Pulses are suitably grown in kitchen gardens as they are mostly short duration crops. Home gardens can help us in recycling of household waste especially when a compost pit is developed. Dead leaves can also become an ingredient in good compost which is better than chemical fertilizers.

Dry leaves have fallen from every day causing a large amount of leaf waste. Traditional methods for leaf waste disposal are burning and land filling. Burning of leaves leads to mainly air pollution, fire hazards and various health problems. In this study, we used dried leaf extract for seed germination. By using dried leaves cultivation, we can minimize air, soil, water pollution caused by increased use of chemical fertilizers that threatens the environment.

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Leaf litter is dead plant materials that have fallen to the ground. This dead organic material and its constituents are added to the top layer of soil, commonly known as litter layer. Plants may adversely or favourably affect other plants through allelochemicals, which may be released directly or indirectly from live or dead plants. The effects of one plant to another plant may be either both stimulatory and inhibitory that depends on the concentration of released compounds.

## 2. Material and methods

Two types of materials, treatment and test materials were considered for the present study. Materials used were four different types of selected leaf litters and four commonly growing vegetable plants. Easily available organic degradable leaf litters collected from the author's courtyard were *Mangifera indica*, *Artocarpus heterophylla*, *Macaranga peltata* and *Heavea braziliensis*. Litter falls were collected separately and dried under sunlight, sorted into different clean polythene bags and labelled. The present investigation was carried with the pulses *Vigna radiata*, *Vigna unguiculata*, *Macrotyloma uniflorum* and *Coriandrum Sativum*. The fresh seeds of *Vigna radiata* (M), *Vigna unguiculata* (B), *Macrotyloma uniflorum* (H) and *Coriandrum sativum* (C) were purchased from local market. Seeds with uniform size, colour and weight were selected and stored in room temperature.

A pilot study was conducted before the present investigation. In the initial stage the selection and collection of leaf litters considered as treatments and selected pulses as test materials were carried out. The collected leaf litters were washed and dried under shade, ground using a mortar and pestle. The leaf extract of 2 gm and 4 gm of ground sample was soaked with 100 ml of distilled water separately. Distilled water alone was considered as Control.

### 2.1. Trial experiment

Twenty five seeds of M, B, H and C in five replicates were placed in the cotton cloth and tied. Different colour codes were given to the seed bags for identifying them. Then these cotton bags were soaked in the leaf extracts and kept under room temperature for 24 hrs. After that, the cotton bags were removed and seeds were placed in sterilized paper plates. The number of seeds germinated in each treatment was counted daily starting from second day up to fifth day. After that, germination percentage and root and shoot length were calculated. The percentage of inhibitory effect on the germination and growth parameters to the control was calculated. Germination was confirmed by the initial appearance of radicle by visual observation. Germination percentage of seedlings was calculated by using the following formula:

$$\text{Germination percentage } = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sowed}} \text{x } 100$$

### 2.2. *In vivo* cultivation

Germinated seeds treated with leaf extracts of *Mangifera indica*, *Artocarpus heterophylla*, *Macaranga peltata* and *Heavea braziliensis* were sowed in different grow bags filled with soil for conducting *in vivo* cultivation. Untreated (soaked in distilled water) seeds were sowed in grow bags as Control.

### 2.3. Percentage of survival

Seedlings with cotyledons and leaves emerging in healthy conditions were considered as survived plants. Survival percentage in each growbag was calculated by the formula:

$$\text{Survival percentage } = \frac{\text{Number of seeds plants survived}}{\text{Total number of seedlings sowed}} \text{x } 100$$

### 2.4. Morphological parameters

Daily observations were conducted on the treated germinated seeds in different grow bags and the morphological parameters height of the plant, number of leaves, colour of the leaves and days taken for flowering and fruiting were observed and recorded.

## 3. Results and discussion

Preliminary experiment conducted with four selected seeds *Vigna radiata*, *Vigna unguiculata*, *Macrotyloma uniflorum* and *Coriandrum sativum*. From that no response was observed in the case of *Coriandrum sativum.* So, further experiments were conducted with other three pulses.

### 3.1. *In vitro* seed germination

Selected seeds were treated with treatments in the form of 'kizhis'. Allelopathic effect of the selected leaf litters in definite concentrations -2 % (2 gm in 100 ml water) of aqueous solution on green gram, cowpea, and horse gram seeds along with control exhibited great variation (Tables 1 – 3 and Figure 1). Seeds treated with *Artocarpus heterophylla* had shown (100%) good response than in other extracts. Seeds soaked in double amount (4 %) of extract had shown high degree of inhibitory growth. The germination percentage of pilot experiment is shown in Tables 4 – 6 and Figure 2.

**Table 1** Germination percentage of *Vigna radiata* in treatments - 2%

| Days | Control | *Mangifera indica* | *Artocarpus heterophylla* | *Macaranga peltata* | *Heavea braziliensis* |
|---|---|---|---|---|---|
| Day 1 | 90% | 40% | 50% | 30% | 20% |
| Day 2 | 90% | 50% | 60% | 40% | 30% |
| Day 3 | 95% | 90% | 95% | 80% | 60% |
| Day 4 | 95% | 90% | 95% | 85% | 60% |

**Table 2** Germination percentage of *Vigna unguiculata* in treatments - 2%

| Days | Control | *Mangifera indica* | *Artocarpus heterophylla* | *Macaranga peltata* | *Heavea braziliensis* |
|---|---|---|---|---|---|
| Day 1 | 40% | 30% | 60% | 20% | 10% |
| Day 2 | 70% | 50% | 90% | 40% | 20% |
| Day 3 | 80% | 70% | 100% | 60% | 40% |
| Day 4 | 90% | 80% | 100% | 75% | 60% |

**Table 3** Germination percentage of *Macrotyloma uniflorum* in treatments - 2%

| Days | Control | *Mangifera indica* | *Artocarpus heterophylla* | *Macaranga peltata* | *Heavea braziliensis* |
|---|---|---|---|---|---|
| Day 1 | - | - | - | - | - |
| Day 2 | 40% | - | 30% | 40% | 20% |
| Day 3 | 50% | 10% | 30% | 40% | 20% |
| Day 4 | 70% | 30% | 70% | 60% | 20% |

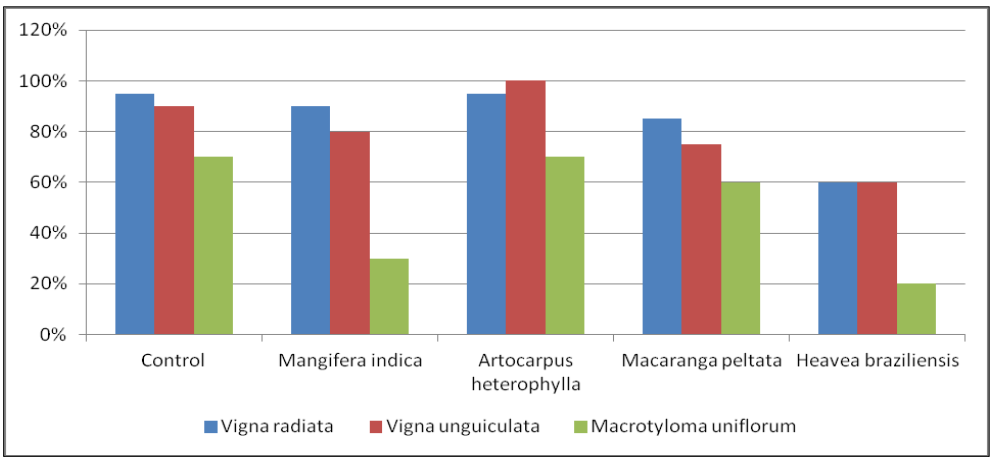


**Figure 1** Growth response of pulses vs treatments (2%)

**Table 4** Germination percentage of *Vigna radiata* in treatments - 4%

| Days | Control | *Mangifera indica* | *Artocarpus heterophylla* | *Macaranga peltata* | *Heavea braziliensis* |
|---|---|---|---|---|---|
| Day 1 | 90% | 40% | 30% | 50% | 40% |
| Day 2 | 90% | 40% | 40% | 50% | 60% |
| Day 3 | 90% | 40% | 40% | 50% | 60% |
| Day 4 | 90% | 70% | 80% | 70% | 70% |

**Table 5** Germination percentage of *Vigna unguiculata* in treatments - 4%

| Days | Control | *Mangifera indica* | *Artocarpus heterophylla* | *Macaranga peltata* | *Heavea braziliensis* |
|---|---|---|---|---|---|
| Day 1 | 90% | 20% | 50% | 60% | 40% |
| Day 2 | 90% | 60% | 70% | 60% | 50% |
| Day 3 | 90% | 60% | 70% | 60% | 50% |
| Day 4 | 90% | 90% | 100% | 90% | 90% |

**Table 6** Germination percentage of *Macrotyloma uniflorum* in treatments - 4%

| Days | Control | *Mangifera indica* | *Artocarpus heterophylla* | *Macaranga peltata* | *Heavea braziliensis* |
|---|---|---|---|---|---|
| Day 1 | - | - | - | 10% | - |
| Day 2 | 20% | 10% | 20% | 10% | - |
| Day 3 | 40% | 30% | 20% | 10% | - |
| Day 4 | 60% | 70% | 40% | 10% | - |

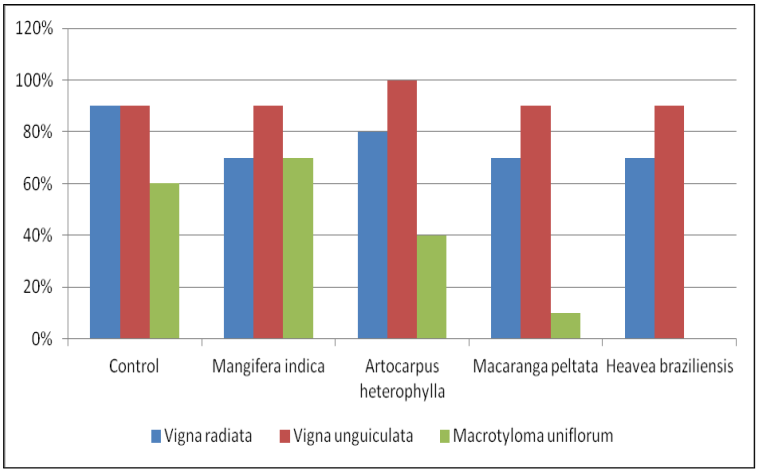


**Figure 1** Growth response of pulses vs treatments (4%)

### 3.2. *In vivo* cultivation

The treated seeds were sowed in different grow bags filled with soil for conducting *in vivo* cultivation. Untreated seeds (soaked in distilled water) were also sowed in grow bags for comparison. The germination percentage and shoot length of seeds were calculated for analysis (Tables 7 – 9). Flowering was observed on the 37$^{th}$ day in green gram and after 7 days, pods were ready to harvest.

**Table 7** Response of *Vigna radiata* in different leaf litters

| Treatments | Day 1 | | Day 2 | | Day 3 | | Day 4 | |
|---|---|---|---|---|---|---|---|---|
| | Germination % | Shoot Length (cm) | Germination % | Shoot Length (cm) | Germination % | Shoot Length (cm) | Germination % | Shoot Length (cm) |
| Control | 60 | 4.5 | 70 | 5.2 | 90 | 8 | 90 | 10.5 |
| *Mangifera indica* | 70 | 3.5 | 70 | 6 | 90 | 9.3 | 90 | 12.4 |
| *Artocarpus heterophylla* | 60 | 3.6 | 80 | 6.8 | 95 | 9.5 | 95 | 12.6 |
| *Macaranga peltata* | 50 | 3 | 60 | 6.5 | 90 | 8.8 | 90 | 10.8 |
| *Heavea braziliensis* | 10 | 2.5 | 20 | 5.2 | 20 | 8 | 20 | 10.5 |

**Table 8** Response of *Vigna unguiculata* in different leaf litters

| Treatments | Day 1 | | Day 2 | | Day 3 | | Day 4 | |
|---|---|---|---|---|---|---|---|---|
| | Germination % | Shoot Length (cm) | Germination % | Shoot Length (cm) | Germination % | Shoot Length (cm) | Germination % | Shoot Length (cm) |
| Control | 30 | 2.8 | 70 | 4.3 | 70 | 9 | 90 | 11.6 |
| *Mangifera indica* | 20 | 4 | 60 | 7.5 | 90 | 10.5 | 80 | 12.3 |
| *Artocarpus heterophylla* | 90 | 5 | 90 | 8.1 | 100 | 11.3 | 100 | 14 |
| *Macaranga peltata* | 20 | 3 | 80 | 5 | 80 | 8.5 | 80 | 11.6 |
| *Heavea braziliensis* | 30 | 1.5 | 50 | 4.5 | 80 | 8.3 | 50 | 10.3 |

**Table 9** Response of *Macrotyloma uniflorum* in different leaf litters

| Treatments | Day 1 | | Day 2 | | Day 3 | | Day 4 | |
|---|---|---|---|---|---|---|---|---|
| | Germination % | Shoot Length (cm) | Germination % | Shoot Length (cm) | Germination % | Shoot Length (cm) | Germination % | Shoot Length (cm) |
| Control | 20 | 3.4 | 40 | 3.5 | 50 | 4.7 | 50 | 5.3 |
| *Mangifera indica* | 15 | 1.2 | 40 | 3.5 | 50 | 5 | 50 | 5.9 |
| *Artocarpus heterophylla* | 30 | 3 | 80 | 3.6 | 80 | 5.9 | 80 | 6.5 |
| *Macaranga peltata* | 15 | 1.5 | 60 | 2.5 | 70 | 4.3 | 70 | 6 |
| *Heavea braziliensis* | 10 | 1.4 | 20 | 3 | 30 | 3.5 | 30 | 5 |

Litter fall is the major pathway for nutrient cycle, especially for nitrogen and phosphorus. The accumulation of these nutrients in the top layer of soil is known as soil immobilisation. Once the litter fall has settled, decomposition occurs through the leaching of nutrients by rainfall and through fall. By the efforts of detritivores, releases the break down products into the soil [1].

The present investigation was carried out on the effects of different dried leaf extraction on selected seeds germination and seedling growth. The selected study reveals that there were significant differences in the parameters studied including *in vitro* and *in vivo* germination, shoot length, morphology of seedlings, plants flowering and fruiting.

In the present study, the germination percentage was observed more in the leaf extract of Artocarpus which has some fast promoting effect in seed germination. The extract was made in two concentrations. In second stage, doubled concentration of the extract of the initial was considered. The aqueous leaf extract of Artocarpus adversely increased the germination percentage of the seeds M, B and H in the present investigation. It showed 90 %, 95 %, and 80 % for each seeds. But in the second stage experiment, it is 80 % and 100% for M and B seeds and there was a change in the case of H. When the doubled concentration of extract was taken for the treatment, *Mangifera indica* extract showed more germination percentage (70%) than *Artocarpus heterophylla* extract (40%).

The study of allelopathic effect of leaf extracts of *Artocarpus heterophyllus* on the growth of jhum crops in, Mizoram, North-East India shown that, in case of maize, alternate allelopathic effects i.e. both stimulatory and inhibitory observed [2]. However in some cases inhibitory effects occurs usually at higher concentration. The highest stimulatory effects of *Artocarpus heterophyllus* extract were observed on B (*Vigna unguiculata*).

The inhibitory effect was observed on the *Heavea braziliensis* extract in the first stage experiment, seeds of M, B, H showed 20 %, 50 %, and 30 % of germination. Then in the second stage, it was increased to 60 %, 90% for M and B. But H seeds were not even germinated. When compared to other extracts, rubber showed highest inhibitory effect.

A study conducted on 'Allelopathic interactions between rubber tree and *Chromolaena odorata* as measured by seed germination and seedling growth of the two species' discovered that extracts of rubber tree leaves inhibited seed germination of *Chromolaena odorata* but mostly promoted seedling growth *Chromolaena odorata* under field conditions [3].

In the first stage experiment, Horse gram seeds germinated in the rubber extract. But in the second stage, it doesn't germinate. It may be due to the constituents in the leaf extract may have high inhibitory effect for it in doubled concentration. The degree of inhibition Increased with the extract concentration. This indicates that some factor functioning to suppress germination.

When analysed the effect of mango leaf extract, it showed some degree of inhibitory effect, when compared to the control. The study showed mango leaf extract have stimulatory effect when it was taken doubled concentration. It stimulated H seeds with 70% germination more than that of control (60%). It may be due the factors present in the leaf extract. Mango leaf extract contain phenolic acids, benzophenoids and other antioxidants such as flavonoids, carotenoids, quercetin, isoquercetin, ascorbic acid and tocopherols. Mangiferin is the main contributor of most of the biological activities of mango leaf extract [4].

The seeds in the Macaranga leaf extract also showed reduced germination percentage and lowest shoot length in second stage. It was moderate in first stage experiment. These inhibitory effects were of great important in allelopathic control of invasive species. There is urgent need to understand the integrative role of allelopathy in plant invasion, resistance of native community and management or invasive plants. It's potential to control exotic plant invasion by regulating the native species allelopathic effect on invasive species [5].

Based on the results*, Artocarpus heterophylla* was the only leaf extract which showed highest germination and growth rate over the control. The *Vigna radiata* soaked in jack fruit leaf extract was the first one flowered and completed the life cycle. And shoot length of plants was also increased in this extract.

Allelochemicals in dried leaves extract is used to promote sustainable agriculture development, it is important in cultivation systems that take advantage of the stimulatory or inhibitory effects of allelopathic plants. Sustainable crop production under changing climate is crucial to feed the increasing population of the world. Efforts are underway to discover novel strategies to ensure global food security. Allelopathy is one such phenomenon that can help in this regard. It is a direct or indirect and positive or negative effect of plant species and Microorganisms, through the release of secondary metabolites known as allelochemicals [6]. Biofertilizers are a key component in integrated nutrient

management as well as for increased economic benefits from reduced expenditure on chemical fertilizers, holistically leading to sustainable agriculture [7].

## 4. Conclusion

Trees shed huge piles of leaves throughout the year. It is highly inconvenient to burn these leaves, and it also releases different types of chemicals. Litters derived from the standing vegetation can act as a seed trap and thus prevent seed germination. Using dried leaves for cultivation, can reduce the impact of pollution caused by increased use of chemical fertilizers in agriculture that destroys the environment. This process decreases the disposal cost of leaf waste, the mitigation of pollutants emission and the recycling of organic waste. The investigation reveals that the leaf litters – a season's activity – can ensure the environment cleaning and reduce pollution by using dried leaves in cultivation, an eco-friendly environment for future generations. From the investigation the authors suggest collect, separate and store the fallen leaf litters. Use them as bio-fertilizers for cultivars or as weedicides.

## Compliance with ethical standards

*Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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