Evaluation for performance of maize and rice on aqueous leaf extracts of *Flemingia semialata* Roxb. - underutilized legumes in Mizoram, India

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ABSTRACT

The allelopathic potential of aqueous leaf extracts of *Flemingia semialata* Roxb. a leguminous herbs was used to examined its effect on growth and yield of *Zea mays* L. and *Oryza sativa* L. at different concentrations in laboratory bioassays. The extracts show both inhibitory and stimulatory effect on the test crops. Significant stimulatory effects were observed in 50 and 75 per cent concentration for root length and 25 per cent for shoot length in maize. Stimulatory effect on the root length of rice were observed at lower concentrations, however inhibitory effect were observed on the shoot length whereby the inhibitory effect increases with increase in the concentration of extracts. The inhibitory effect on biomass yield was observed at lower concentration in maize but inhibitory effect was more pronounced in rice at higher concentrations. Aqueous leaf extract of *Flemingia semialata* Roxb. performed better in maize than in rice.

Key words: Agroforestry, Allelochemicals, Allelopathy, Inhibitory effect, Stimulatory effect.

INTRODUCTION

Mizoram, one of the states in NE India with a geographical area of 21,081 km² where primitive method of cultivation i.e., shifting cultivation is the major farming practices followed from time immemorial. The forest cover of the state have decreased from 90.68% in 2011, 90.38% in 2013 and 88.93% in 2015 (Anonymous, 2015) respectively due to this practice. The soil became less productive resulting in decline of crop yield. The main reasons for the decline of yield are soil fertility depletion, increased weed infestation, deterioration of soil physical properties, and increase insect and disease attacks (Sanchez, 1976). An alternative method needs to be developed to avoid loss caused by shifting cultivation. In regard to this, various approaches have been suggested as improvements and/or alternatives to shifting cultivation (Anonymous, 1986), and most of them emphasize the importance of retaining or incorporating the woody vegetation into the fallow phase, and even in the cultivation phase, as the key to the maintenance of soil productivity. Multipurpose trees intercropped with agricultural crops plays an important role in agroforestry programmes. However, a number of tree species are found to have a negative effect on the performance of crops through allelopathy when grown together (Singh et al., 2001). Leguminous tree species like *Leucaena leucocephala* and *Acacia* species are found to have allelopathic effects on agricultural crops when used as an intercrop in the field (Sahoo et al., 2007; Bora et al., 1999).

Allelopathy is the negative effect of chemicals released by one plant species on the growth and reproduction of another plant (Inderjit and Callaway, 2003). These allelochemicals are distributed in different parts of the plant (including leaf, flower, bark, root etc) at varying concentrations, however leaves are most potent source of these allelochemicals (Rice, 1984; 43 Inderjit, 1996) and have higher inhibitory effects on crops (Seigler, 1996). These allelochemicals are known to affect seed germination, growth, development (Inderjit and Malik, 2002), reduced dry weight accumulation and lowered reproductive capacity of many plant species (An et al., 1998). Due to limited information on the phytotoxic effect on agricultural crops, *F. semialata*, a nitrogen fixing herbs commonly used as hedge in improved fallow in Jhum and Alley cropping (Songachan and Kayang, 2012), was used to investigate the allelopathic compatibility of aqueous leaf extracts on the growth and yield of *Zea mays* L. and *Oryza sativa* L. when grown together in agroforestry systems.

MATERIALS AND METHODS

Freshly fallen leaves of *F. semialata* Roxb. were collected from Mizoram University, Tanhriil(23°44′ N, 92°39′ E, 755 m above sea level), Aizawl and air dried for one week at room temperature. Aqueous leaf extracts were prepared by adding 100g of grounded leaf in 1 litre of distilled water and soak it for 24 h. The solution was filtered out using Whatman filter paper No. 1 and different concentrations (25, 50, 75 and 100 per cent) were made from the stock solution whereas distilled water is taken as control.

Bioassays: Seeds were surface sterilized with sodium hypochlorite (1%) and then washed again in running tap
Table 1: Effects of different aqueous leaf extract of F. semialata on root and shoot length (cm) of Zea mays and Oryza sativa.

| Extract concentrations | Zea mays | Oryza sativa |
|------------------------|----------|--------------|
|                        | Root length | Shoot length | Root:Shoot ratio | Root length | Shoot length | Root:Shoot ratio |
| Control                | 9.65±0.40    | 4.50±0.28    | 2.14±0.10       | 6.94±0.38    | 6.92±0.35    | 1.01±0.09       |
| 25%                    | 8.37±2.34   | 11.96±2.84  | (-13.26)        | 2.53±0.12    | 7.22±0.78    | (55.11)         |
| 50%                    | 17.67±1.44  | 7.91±0.51    | (83.11)         | 2.27±0.04    | 6.44±0.39    | (4.03)          |
| 75%                    | 17.92±0.49  | 7.36±0.45    | (85.69)         | 2.22±0.04    | 6.44±0.39    | (4.03)          |
| 100%                   | 13.22±0.94  | 7.36±0.45    | (36.99)         | 1.79±0.25    | 5.02±0.37    | (75.78)         |

Values presented are means ± SE (Standard Error). Superscripts (a, b, c, ab, bc) indicate significant difference between the extract concentrations within same crop growth parameter. Values in the parenthesis indicate percentage inhibition (-) or stimulation (+) relative to control.

Percentage of inhibition/stimulation effect on germination over control was calculated using the formula given by Surendra and Pota (1978), \( I = 100 - \left( \frac{E_2}{E_1} \times 100 \right) \), where I is the percentage inhibition/stimulation, E, the response of control and E, the response of treatment. Elongation ratio of roots and shoots were also calculated using the formula given by Rho and Kil (1986), \( R = \left( \frac{T}{T_r} \right) \times 100 \), where R is the relative elongation ratio, T is the ratio of treatment crop and T, is the test ratio of control.

RESULTS AND DISCUSSION

The root and shoot length of maize show a stimulatory effect on the concentration of extracts. Highest stimulatory effect on the root (+85.69) and shoot (+75.78) length was observed in 75% concentration. Significant (p<0.05) stimulatory effect on the root length was found in 50% and 75% extract concentrations and for shoot length at 25% extract concentration when compared to control (Table 1). This finding confirm the findings by Musyimi et al. (2015) where the shoot heights of cowpea increases with an increase in the concentration of aqueous shoot extracts of T. diversifolia. Mubeen et al. (2012) also found a stimulatory effect on germination and seedling growth of rice by allelochemicals of sunflower and jowar.

However, inhibitory effect was observed on the root and shoot length of rice. The inhibitory effect was concentration dependent, the inhibitory effect increased with an increase in the concentration of the leaf extracts. Highest inhibitory effect on the root (-27.67) and shoot (-51.73) was observed in 100% extract concentration (Table 1). The findings also conform to the findings by Sahoo et al. (2015), where aqueous leaf extract of Citrus reticulate inhibit the root and shoot length of soybean, maize, paddy, chilli and lady’s finger. Desai and Gaikwad (2015) also found that the litter leachate of Excoecaria agallocha cause inhibitory effect on the germination, root length, shoot length, seedling dry matter and vigour index of rice as the concentration of leachates increased. The result was also at par with the findings by Ahmed et al. (2008) where leaf litter of...
**Eucalyptus camaldulensis** inhibit the root and shoot length of *Vigna anguiculata*, *Cicer arietinum*, *Cajanus cajan*, *Albizia procera* and *Leucaena leucocephala* seedlings, whereby the inhibitory effect increased with increase in the concentration of *E. camaldulensis* leaf litter when mixed with soil. The result also confirmed to the findings by Mukherjee et al. (2014) where aqueous extracts of leaf, stem, root and whole plant of *Polygonum orientale* inhibit the root and shoot length of jute.

The fresh and dry weight of root and shoot show a stimulatory effect on maize, the stimulatory effect increased with an increase in the concentration of extracts (Table 2). Significant stimulatory effect (p<0.05) on the fresh weight of root was observed in 75% extract concentration and fresh weight of shoot in 50%, 75% and 100% respectively. However, inhibitory effect on the fresh and dry biomass was observed in rice, where the inhibitory effect is concentration dependent. Greater concentration of allelochemicals might inhibit the seed germination by suppressing the synthesis of gibberellins and indole acetic acid (Moradshahi et al., 2003). Highest inhibitory effect on the fresh and dry biomass was found in 100% extract concentration. This finding is also in par with the findings by Mukherjee and Barik (2013) where the fresh and dry weight of rice decreases with an increase in the concentration of *Ludwigia adenosemendens* L. leaf and stem extracts. Joshi et al., 2009 also found that the dry weight of radicle and plumule of different wheat varieties shows inhibitory effect on aqueous weed extracts of *Ageratum conyzoides*, *Chenopodium album* and *Parthenium hysterophorus* when compared to control. The stimulatory effect on the biomass of maize is in agreement with the findings by Bano et al. (2012), where neem leaf extracts significantly stimulates the root growth of wild oats. Lalremmsang et al. (2017) also found a stimulatory effect on the biomass of maize when treated with *F. semialata* leaf extracts. The result also was at par with the findings by Musyimi et al. (2015) in which *T. diversifolia* leaf extracts stimulate the root and shoot dry weight of the test crop.

Inhibitory effect on the fresh and dry weight biomass is more pronounced in rice (Table 2), this may be due to the sensitivity of allelochemicals by smaller seeds (Weidenhamer et al., 1987). The reduction in biomass may be due to the effect of leaf extract causing stunted and reduced seedlings growth (Tripathi et al., 2000). Elisante et al. (2013) found that the shoot length, root length, fresh weight and dry weight of *Cenchrus ciliaris* and *Neonotonia wightii* decreased with an increase in the concentration of aqueous seed and leaf extracts of *Datura stramonium*. The result also confirmed the findings by (Djanaguiraman et al., 2003; Karthiyayini et al., 2003; Sasikumar et al., 2002) where the concentration of leaf leachate inhibit dry matter production in pulses, rice and sorghum. Chouhan et al. (1992) also reported suppressive effect of leaf litters of *L.

### Table 2: Effects of different aqueous leaf extract of *F. semialata* on fresh and dry weight (g) of *Zea mays* and *Oryza sativa*.  

| Extract concentrations | *Zea mays* Root | *Zea mays* Shoot | *Oryza sativa* Root | *Oryza sativa* Shoot |
|-------------------------|----------------|-----------------|--------------------|--------------------|
| 25%                     | 5.69±0.45       | 6.26±0.42       | 0.30±0.03          | 0.84±0.03          |
| 50%                     | 0.34±0.15       | 0.23±0.08       | 0.05±0.00          | 0.08±0.01          |
| 75%                     | 8.88±0.59       | 10.08±0.80      | 0.92±0.06          | 1.12±0.12          |
| 100%                    | 3.43±0.51       | 4.38±0.77       | 0.56±0.02          | 0.67±0.03          |

Values presented are means ± SE (Standard Error). Superscripts (a, b, c, ab, bc, abc) indicate significant difference between the extract concentrations within same crop biomass parameters. Values in the parenthesis indicate percentage inhibition (-) or stimulation (+) relative to control.
leucocephala on dry matter production of grasses under fuelwood plantation.

The varying degree of inhibition/stimulation highlights the difference in their response to allelochemicals on the test crops. The stimulatory effect on maize suggests that F. semialata is a better tree species to be used as an intercrop with maize than rice in agroforestry systems.

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CONFLICT OF INTEREST
The authors would hereby like to declare that there is no conflict of interests that could possibly arise.
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