Herbicidal Efficiency of *Aglaia odorata* Extracts Against *Mimosa pigra* L.

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Abstract

The application of botanical herbicides is one of alternative ways to reduce the use of harmful herbicides in agricultural pest management. Eighteen species of Thai local plant extracts i.e. *Murraya paniculata* (L.) Jack. leaf, *Hydrocotyle umbellata* L. leaf, *Mammea siamensis* T. Anders. seed, *Duranta erecta* L. leaf, *Pluchea indica* Less. leaf, *Aglaia Odorata* Lour. leaf, *Leucaena leucocephala* de wit. leaf, *Ipomoea aguatica* Forsk, *Eucalyptus camaldulensis* Dehnh leaf, *Leea macrophylla* Roxb.ex Hornem. leaf, *Metha cordifolia* Opiz. leaf, *Casuarina junghohniana* Mfg. leaf, *Stemona curtisii*. Hook.F. root, *Cassis fistula* Linn. pod, *Tinospora crispa* (L.) Miers ex Hook.f. & Thoms. stem, *Brachiaria mutica* (Forsk.) Stapf leaf, *Raphanus sativus* var. longipinnatus L. root and *Zollingeria dongnaiensis* Pierre leaf. were screened for the highest herbicidal activity in laboratory by the filter paper method. *Aglaia odorata* leaf extract demonstrated the highest germination inhibitory activity. It also had a highest significant efficiency to inhibit both root and shoot of Mimosa seedling. *Aglaia odorata* was selected for determination of its herbicidal efficiency under pot experiment. *Aglaia odorata* leaf extract at the concentration of 4 % w/v exhibited stronger toxicity on germination and growth of Mimosa seedling than control (solvent) treatment in pot experiment. Thus, the *Aglaia odorata* leaf extract should be one of the potentially natural resources for a botanical herbicide in reducing the use of harmful ones.

Keywords: botanical herbicide, plant extract, weeds, Allelopathy

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1. Introduction

Mimosa pigra, or giant sensitive plant, is a serious and increasing weed problem in wetlands of Thailand. Dense growth of *Mimosa* can eliminate most other species and alters the natural habitat in conservation areas. Chemical methods are most effective and currently the primary means of controlling mimosa populations. More than 21 herbicides have been investigated for their effectiveness (Lonsdale et al. 1995) However, during the past few decades, our environmental quality, biological resources and biodiversities have been in danger and some were damaged. FAO estimates that about three-quarters of the genetic diversity of agricultural crops have been lost over the last century (FAO, 2004). One of the many reasons is the use of chemical pesticides to improve agricultural productivity.

Thailand becomes the most important agricultural products exporter in the world during last decade. This had led the increasing of agricultural chemicals use for pest controlling; 10,000 tons of chemical herbicides were imported in 1998. However, this numbers had obviously increased to more than 80,000 tons in 2008. With the rising concern for human health and environmental safety there has been a renewed interest in the use of naturally occurring substances as pesticides, including plant bioactive compounds (Sanches and Ohsawa, 1994; Manasikarn, 1996).

Botanical herbicide might be considered as less toxic than synthetic herbicides for several reasons. One assumes that they generally pose less risk to environment and human health. Many of botanical herbicide are rapidly degraded and will not be accumulated in the environment. Some are very weed specific and damage to a little extend or not other organisms. The use botanical herbicides in the agriculture give the consumer more confidence on safe agricultural products. Farmers can reduce their costs of bioherbicides input. In general, there is a reduction of toxic chemical pollution in the whole ecosystem, plant products, farmers and consumers. Furthermore, the import of chemical pesticides can be reduced in the future. This research aims to investigate the herbicidal efficiency of local Thai plant extracts on the Mimosa under both laboratory and pot experiment.

2. Method

2.1 Plant extraction

Eighteen plant species showing herbicidal activities were selected from secondary data. There were *Murraya paniculata* (L.) Jack. leaf, *Hydrocotyle umbellata* L. leaf, *Mammea siamensis* T. Anders. seed, *Duranta erecta* L. leaf, *Pluchea indica* Less. leaf, *Aglaia Odorata* Lour. leaf, *Leucaena leucocephala* de wit. leaf, *Ipomoea aguatica* Forsk, *Eucalyptus camaldulensis* Dehnh leaf, *Leea macrophylla* Roxb.ex Hornem. leaf, *Metha cordifolia* Opiz. leaf, *Casuarina junghohniana* Mfg. leaf**,** *Stemona curtisii*. Hook.F. root, *Cassis fistula* Linn. pod, *Tinospora crispa* (L.) Miers ex Hook.f. & Thoms. stem, *Brachiaria mutica* (Forsk.) Stapf leaf, *Raphanus sativus* var. longipinnatus L. root and *Zollingeria dongnaiensis* Pierre leaf. All selected plants were washed and dried by circulating dry air in an oven at 50°C and then chopped into small pieces. The materials were then soaked in 95% ethanol and placed in an ultrasonic bath for 45 minute, filtered by filter paper No.1, 90 mm diameter and concentrated by evaporation under reduced pressure with a rotary evaporator at 50 °C. All crude extracts were kept in 4 °C until use.

2.2 Dormancy breaking of *Mimosa pigra* seed

Mimosa pigra seeds were collected from Chiang Mai Province in northern Thailand. Seeds were washed and then air dried. Seeds were soaked in sulfuric acid (conc.) for 5 minutes and then washed with distilled water for its dormancy breaking.

2.3 Effect of plant crude extracts on Mimosa seed germination and seedling development in laboratory

Herbicidal bioassay was studied according to the method described by Deba et al. (2007). Mimosa seeds germination and seedling development were tested by filter paper method. All plant crude extracts were dissolved in acetone to reach the final concentration of 1, 2 and 4 % w/v. Five milliliters of each tested solution was then added to 9 cm diameter Petri Dish that contain paper filter. Ten uniform seed size was put on the filter paper and covered with a lid. The tested Petri dishes were kept under room temperature (25 ± 5 °C). The experiment was done with 3 replications. A parallel series of tests with control solvent and control water were also conducted. One week after application, germination percentage, shoot length, root length, fresh and dry weights were investigated.

2.4 Effect of plant crude extracts on Mimosa seed germination and seedling development in greenhouse

A pot experiment was carried out with Completely Randomized Design (CRD) with 10 seeds per pot. Three pots were conducted for each treatment. Selected plant extract was dissolved in 20% ethanol to reach the final concentration of 1, 2 and 4 % w/v. After sowing, 50 ml of tested solution was poured into each pot. Twenty percent of ethanol was used as negative control. The experiment was conducted with a daily watering system. Two weeks after application, Germination percentage, shoot length, root length, fresh and dry weights were investigated.

2.5 Data analysis

All statistical analysis was performed using SPSS software for Windows with analysis of variance (ANOVA) at the significant level of 0.05 and the Duncan's multiple range test (DMRT) was also used.

3. Results and Discussion

3.1 Effect of plant crude extracts on Mimosa seed germination and seedling development in laboratory

The herbicidal activity of 18 plant extracts was investigated by filter paper test. The results from seed germination indicated that *Hydrocotyle umbellata* at the concentration of 1 and 2% had the highest inhibitory efficiency on Mimosa seed germination with the germination percentage of 80.0 and 83.3, respectively. Whereas,

4% of *Aglaia odorata* leaf extract demonstrated the highest germination inhibitory activity with 73.3 % germination. However, no statistically significant differences found in germination percentage compared with the control treatment (Table 1, 2 and 3).

The result from shoot and root length of Mimosa seedling showed that *Aglaia odorata* leaf extract at 1 and 2% w/v had a highest significant efficiency to inhibit both root and shoot of Mimosa seedling (Table 1 and 2). While, it gave significant shortest of seedling shoot and root with the length of 0.63 and 0.47 cm , respectively at the concentration of 4% w/v (Table 3; Figure 1). In addition to Mimosa seedling weight, seedling treated with all concentrations of *Aglaia odorata* leaf extract were significantly lower in both fresh and dry weight than that treated with control (Table 1, 2 and 3). According to its herbicidal effects, the chemical constituents of *Aglaia odorata* should be considered. Globe in Med (2012) reported the 22 chemical compounds from *Aglaia odorata*. Among these compounds, pyrimidinone was most interesting compound which suggested as herbicidal and plant growth regulators by Kofies et. al. (1997).

From those results, it could be indicated that *Aglaia odorata* had the highest herbicidal activity against Mimosa. Due to its high efficiency in laboratory test, *Aglaia odorata* leaf extract was selected for investigating of its herbicidal efficiency in pot experiment.

Figure 1 Morphological characteristic under stereomicroscope of Mimosa seedling treated with 4% *Aglaia odorata* leaf extract.

3.2 Effect of *Aglaia odorata* leaf extract on Mimosa seed germination and seedling development in pot experiment

Herbicidal efficiency of *Aglaia Odorata* leaf extract in the pot experiment was studied compared with control treatment (solvent). The results of some physical properties of Mimosa are shown in Table 4.

Aglaia odorata leaf extract seems to be more effective in controlling of mimosa seed germination than control treatment. It tends to gave slightly lower germination percentage than control treatment with 89.6, 83.3 and 73.3% for the concentration of 1, 2 and 4% w/v, respectively. Nevertheless, non statistically significant difference was found.

The Mimosa treated with *Aglaia odorata* leaf extract showed a lower yield in terms of shoot length, root length, fresh weight and dry weight than that treated with control treatment. Four percent (w/v) of *Aglaia odorata* leaf extract demonstrated no marked significant shorter shoot length than control treatment.

Interestingly, with this concentration, *Aglaia odorata* leaf extract exhibited an herbicidal activity to reduce seedling fresh weight (0.395 g) and dry weight (0.041 g) compared with that control treatment (0.594 and 0.051 g) (Table 4). This result was supported by Phuwiwat et al., (2001) who reported that the crude chloroform extract of *Aglaia odorata* leaf significantly inhibited the *Mimosa pigra* L. seed germination with 62.80 percent of germination at the concentration of 1000 ppm. Chatiyanon and Phuwiwat (2001) also stated for the herbicidal efficiency of *Aglaia odorata* extract on *Pennisetum setosum* and *Chloris barbata*. Moreover, *Aglaia odorata* dry leaf extract at the concentration of 125 mg/Petri dish also demonstrated high inhibitory efficiency on *Phaseolus lathyroides* L. and *Echinochloa crusgalli* L. with 75 and 30%, respectively (Chimnoi et al., 2008).

Table 1 Effect of 1% w/v plant crude extracts on Mimosa seed germination and some seedling developmental parameters in laboratory

Plant extracts	Part used	Germination (%)	Shoot length (cm)	Root length (cm)	Fresh weight (g)	Dry weight (g)
Murraya paniculata	leaf	90.0± 10.0 abc	1.82±0.74 a	2.02±0.19 cde	0.370±0.03 bc	0.047±0.006 bc
Hydrocotyle umbellata	leaf	80.0±10.0 a	5.40±0.29 cde	2.41±0.26 defg	0.387±0.07 bc	0.040±0.000 ab
Mammea siamensis	seed	86.7±5.8 abc	4.37±0.09 b	1.26±0.05 ab	0.443±0.01 c	0.040±0.000 ab
Duranta erecta	leaf	100.0±0.0 c	6.27±0.45 gh	1.49±0.20 abc	0.497±0.17 c	0.047±0.006 bc
Pluchea indica	leaf	86.7 ±5.8 abc	6.28±0.27 gh	3.48±0.31 ij	0.460±0.04 c	0.043±0.006 bc
Aglaia odorata	leaf	83.3±5.8 ab	1.62±0.26 a	0.98±0.10 a	0.177±0.07 a	0.030±0.000 a
Leucaena leucocephala	leaf	8.67±5.8 abc	5.89±0.44 defg	1.72±0.29 bcd	0.290±0.08 ab	0.047±0.006 bc
Ipomoea aguatica	leaf	96.7±5.8 bc	5.91±0.28 defg	2.81±0.47 fghi	0.470±0.12 c	0.053±0.006 c
Eucalyptus camaldulensis	leaf	96.7±5.8 bc	5.87±0.53 defg	3.33±0.52 hij	0.463±0.06 c	0.047±0.006 bc
Leea macrophylla	leaf	83.3±5.8 ab	5.93±0.42 defg	2.92±0.59 fghi	0.377±0.12 bc	0.040±0.010 ab
Metha cordifolia	leaf	86.7±5.8 abc	6.04±0.29 defg	3.55±0.23 ij	0.530±0.05 c	0.047±0.006 bc
Casuarina junghohniana	leaf	93.3 ±5.8 abc	6.16±0.39 efg	3.10±0.23 ghij	0.527±0.05 c	0.047±0.006 bc
Stemona curtisii	root	83.3±15.3 ab	4.93±0.59 bc	2.27±0.06 def	0.490±0.08 c	0.043±0.006 bc
Cassis fistula	pod	96.7±5.8 bc	6.06±0.53 defg	3.67±0.37 j	0.475±0.02 c	0.050±0.000 bc
Tinospora crispa	Stem	96.7±5.8 bc	5.43±0.44 cdef	1.97±0.56 bcde	0.490±0.10 c	0.053±0.006 c
Brachiaria mutica	Leaf	86.7±5.8 abc	5.34±0.41 cd	1.67±0.24 abcd	0.487±0.08 c	0.043±0.006c
Raphanus sativus	root	90.0±10.0 abc	6.23±0.51 gh	2.66±0.97 efgh	0.490±0.08 c	0.050±0.010 bc
Zollingeria dongnaiensis	leaf	100.0±0.0 c	6.20±0.04 fg	2.89±0.57 fhi	0.530±0.05 c	0.043±0.012 bc
Control (solvent)	acetone	93.0± 10.0 abc	6.96 ±0.19 h	2.85±0.11 fghi	0.480±0.05 c	0.047±0.006 bc

Table 2 Effect of 2% w/v plant crude extracts on Mimosa seed germination and some seedling developmental parameters in laboratory

Plant extracts	Part used	Germination (%)	Shoot length (cm)	Root length (cm)	Fresh weight (g)	Dry weight (g)
Murraya paniculata	leaf	93.3±5.8 a	1.13±0.15 a	0.83±0.12 ab	0.33±0.02 b	0.041±0.002 b
Hydrocotyle umbellata	leaf	83.3±5.8 a	2.03±0.29 b	5.37±0.42 ij	0.41±0.04 bcd	0.041±0.003 b
Mammea siamensis	seed	9.33±11.5 a	1.30±0.10 a	4.87±0.35 fi	0.47±0.09 bcde	0.042±0.004 bc
Duranta erecta	leaf	90.0±10.0 a	1.47±0.25 ab	6.47±0.31 ik	0.42±0.11 bcd	0.045±0.005 bc
Pluchea indica	leaf	93.3±5.8 a	3.20±0.26 c	5.97±0.21 ijk	0.49±0.05 cde	0.049±0.003 bc
Aglaia odorata	leaf	90.0±10.0 a	1.23±0.06 a	0.67±0.06 a	0.16±0.05 a	0.027±0.010 a
Leucaena leucocephala	leaf	86.7±5.8 a	6.33±0.67 f	1.87±0.23 abc	0.45±0.03 bcde	0.045±0.004 bc
Ipomoea aguatica	leaf	90.0±10.0 a	5.13±1.02 d	2.27±0.40 de	0.42±0.10 bcd	0.045±0.006 bc
Eucalyptus camaldulensis	leaf	90.0±10.0 a	5.23±0.49 d	3.63±0.40 ef	0.46±0.03 bcde	0.045±0.004 bc
Leea macrophylla	leaf	93.3±11.5 a	6.13±0.40 ef	2.87±0.29 de	0.47±0.10 bcde	0.048±0.010 bc
Metha cordifolia	leaf	90.0±10.0 a	5.47±0.40 de	3.30±0.20 e	0.50±0.06 cde	0.046±0.004 bc
Casuarina junghohniana	leaf	90.0±0.0 a	6.20±0.52 f	2.47±0.35 de	0.51±0.06 cde	0.047±0.003 bc
Stemona curtisii	root	86.7±11.5 a	4.90±0.36 d	2.10±0.10 bcd	0.38±0.04 bc	0.046±0.006 bc
Cassis fistula	pod	90.0±14.1 a	6.15±0.21 ef	2.90±0.42 de	0.44±0.04 bcde	0.049±0.002 bc
Tinospora crispa	Stem	93.3±5.8 a	5.37±0.15 d	1.67±0.21 abc	0.46±0.08 bcde	0.049±0.004 bc
Brachiaria mutica	Leaf	90.0±17.3 a	5.17±0.32 d	1.90±0.26 abc	0.46±0.12 bcde	0.049±0.010 bc
Raphanus sativus	root	90.0±10.0 a	6.43±0.21 f	2.70±0.46 de	0.55±0.14 de	0.046±0.005 bc
Zollingeria dongnaiensis	leaf	96.7±5.8 a	6.37±0.29 f	2.57±0.15 de	0.58±0.10 e	0.052±0.004 c
Control (solvent)	acetone	93.0± 10.0 a	6.96 ±0.19 f	2.85±0.11 de	0.48±0.05 cde	0.047±0.006 bc

Table 3 Effect of 4% w/v plant crude extracts on Mimosa seed germination and some seedling developmental parameters in laboratory

Plant extracts	Part used	Germination (%)	Shoot length (cm)	Root length (cm)	Fresh weight (g)	Dry weight (g)
Murraya paniculata	leaf	90.0±0.0 a	0.63±0.31 a	0.47±0.12 a	0.22±0.06 a	0.039±0.008 b
Hydrocotyle umbellata	leaf	93.3±5.8 a	1.53±0.31 b	4.63±0.76 i	0.44±0.09 bc	0.046±0.005 bc
Mammea siamensis	seed	93.3±5.8 a	1.27±0.21 b	4.50±0.36 i	0.45±0.10 bc	0.041±0.002 b
Duranta erecta	leaf	83.3±5.8 a	0.63±0.15 a	5.70±0.53 j	0.40±0.05 bc	0.040±0.012 b
Pluchea indica	leaf	93.3±5.8 a	2.40±0.20 c	5.33±0.35 j	0.42±0.04 bc	0.046±0.003 bc
Aglaia odorata	leaf	73.3±28.9 a	1.13±0.06 ab	0.50±0.00 a	0.15±0.06 a	0.025±0.011 a
Leucaena leucocephala	leaf	83.3±5.8 a	6.00±0.44 hi	2.07±0.55 def	0.39±0.14 b	0.040±0.003 b
Ipomoea aguatica	leaf	90.0±17.3 a	4.53±0.15 de	1.27±0.15 bc	0.47±0.14 bc	0.048±0.005 bc
Eucalyptus camaldulensis	leaf	96.7±5.8 a	4.77±0.45 ef	3.03±0.21 h	0.51±0.05 bc	0.046±0.004 bc
Leea macrophylla	leaf	93.3±11.5 a	5.57±0.32 fgh	2.83±0.47 gh	0.41±0.07 bc	0.050±0.007 bc
Metha cordifolia	leaf	96.7±5.8 a	4.10±0.30 d	2.63±0.32 fgh	0.57±0.06 c	0.051±0.003 bc
Casuarina junghohniana	leaf	86.7±5.8 a	5.73±0.06 hi	1.87±0.29 cde	0.43±0.11 bc	0.046±0.006 bc
Stemona curtisii	root	86.7±11.5 a	4.33±0.51 de	1.60±0.60 bcd	0.45±0.10 bc	0.040±0.007 b
Cassis fistula	pod	93.3±11.5 a	6.30±0.26 i	3.03±0.29 h	0.53±0.13 bc	0.050±0.006 bc
Tinospora crispa	Stem	90.0±10.0 a	5.13±0.71 fg	0.97±0.67 ab	0.47±0.07 bc	0.048±0.007 bc
Brachiaria mutica	Leaf	86.7±11.5 a	4.80±0.10 ef	1.23±0.06 bc	0.45±0.10 bc	0.045±0.007 bc
Raphanus sativus	root	93.3±5.8 a	5.97±0.32 hi	2.37±0.35 efgh	0.55±0.04 bc	0.051±0.002 bc
Zollingeria dongnaiensis	leaf	96.7±5.8 a	6.00±0.53 hi	2.13±0.21 defg	0.51±0.08 bc	0.054±0.002 c
Control (solvent)	acetone	93.0± 10.0 a	6.96 ±0.19 i	2.85±0.11 gh	0.480±0.05 bc	0.047±0.006 bc

Table 4 Effect of different concentration of *Aglaia odorata* leaf extract on Mimosa seed germination and some seedling developmental parameters in pot experiment

Concentration (% w/v)	Germination (%)	Shoot length (cm)	Root length (cm)	Fresh weight (g)	Dry weight (g)
1	86.6± 5.7 a	5.75±0.27 a	3.80±0.56 ab	0.527±0.01 b	0.048±0.004 ab
2	83.3±11.5 a	5.86±0.46 a	3.89±0.96 ab	0.412±0.04 a	0.040±0.005 a
4	76.6±9.1 a	5.19±0.64 a	2.98±0.38 a	0.395±0.09 a	0.041±0.004 a
Control (solvent)	93.3±5.8 a	5.69±0.31 a	4.78±0.37 b	0.594±0.02 c	0.051±0.003 b

4. Conclusion

Aglaia odorata leaf extract showed a clear effect in controlling the germination and seedling development of Mimosa both in laboratory and under pot experiments. This plant extract exhibited a lower germination percentage than that control treatment. All of the physical property parameters i.e. shoot length, root length, fresh weight and dry weight of Mimosa were statistically significant lower than that in the control treatment.

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