Pak. J. Bot., 46(6): 2057-2061, 2014.

ALLELOPATHIC POTENTIAL OF *MALLOTUS PHILIPPINENSIS* MUELL. EUPHOBIACEAE

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Abstract

Mallotus philippinensis Muell. is a small to medium-sized monoecious tree, having widespread natural distribution, sometimes gregarious but more usually mixed with other species, both in forests and in open scrubland. It is frost-hardy and resistant to drought. The wood is often used as fuel wood. The fruits and bark have been reported to be used medicinally to treat stomach ulcers and tapeworm. A relatively reduced density of grasses and forbs is often observed below/near it. Therefore the present study was conducted to assess the allelopathic potential of *Mallotus philippinensis* against some test species. Plant material of *Mallotus philippinensis* were collected from Gadoon Hills, District Swabi in 2009 and were dried at room temperature (25˚C-30˚C). Aqueous extracts obtained from various parts including leaves, fruits, bark, litter and mulches in various experiments invariably inhibited the germination, plumule, radicle growth, fresh and dry weight of *Lactuca sativa*, *Pennisetum americanum,* and *Setaria italica* under laboratory conditions. The aqueous extracts obtained after 48 h were more inhibitory than 24 h. Leaves and fruits were more toxic than bark. Litter and mulches also proved to be inhibitory. It is suggested that the various assayed parts of *Mallotus philippinensis* have strong allelopathic potential at least against the tested species. Further inquiry is needed to see its allelopathic performance under field condition against its associated grasses and forbs and to identify the toxic principles.

Keywords: Allelopathy, Aqueous, Extracts, Bioassay, Litter, Mulching, *Mallotus philippinensis*.

Introduction

Mallotus philippinensis Muell. (Euphobiaceae) is a small to medium-sized monoecious tree, up to 25 m tall having a widespread natural distribution, from the western Himalayas, through India, Sri Lanka, to southern China, and throughout Malaysia to Australia and Melanesia (Floyd, 2008). *Mallotus philippinensis* commonly known as sometimes gregarious but more usually mixed with other species, both in forests and in open scrubland. Kamala tree is common in evergreen forest, especially in secondary forest, and sometimes even dominant in the undergrowth. Kamala tree withstands considerable shade; it is frost-hardy and resistant to drought. The wood is often used as fuel wood. The fruits and bark have been reported to be used medicinally to treat stomach ulcers and tapeworm.

Allelopathy is a complex process that operates along with competition in nature to restrain and finally preclude the susceptible associated species from the common habitat. It has been frequently observed that allelopathically potential chemicals are present almost in all plant parts which are released into the habitat under specific environmental conditions (Hussain *et al*., 2004, 2005, 2010; Machado, 2007). Callaway & Aschehoug (2000) and Vivanco *et al*., (2004) reported that allelopathy can boost up the competitive success of the strange species, since the release of allelochemicals in the environment may affect the growth and life processes of other associated species. Community dynamics, pattern and productivity in natural and agro-ecosystem is governed by allelopathy (Rice, 1984; Willis, 2000; Duke *et al.*, 2001; Irshad & Cheema, 2004). Many plant species such as *Melia azedarch* (Hussain *et al.,* 1987), *Eucalyptus Sp*. (Malik & Shah, 1995; Gilani *et al.,* 2002; Shah, 1991), *Juglan regia* (Hussain *et al.,* 1991), *Ginkgo biloba* (Lin *et al.*, 2003), *Broussonetia papyrifera* (Hussain *et al.*, 2004), *Helianthus annuus* (Tehmina & Bajwa, 2005; Kamal & Bano, 2008), *Prosopis juliflora, Eucalyptus camaldulensis* and *Acacia nilotica* (Marwat & Khan 2006) *Calotropis procera* (Samreen *et al.,* 2009), *Dodonaea viscosa* (Barkatullah *et al.*, 2010), *Lantana camara* (Hussain *et al.,* 2011), *Popolus euphratica* (Sher *et al.*, 2011), are known to exhibit allelopathy, reducing the regeneration, growth and yield of the allied species. The review of literature shows that no such study is conducted on *Mallotus philippinensis*, suspected as allelopathic, owing to its secondary compounds and relatively reduced under storey observed below it. The present study was therefore conducted to explore its allelopathic potential.

Materials and Methods

Leaves, fruits and bark of *Mallotus philippinensis* were collected from Gadoon Hills, District Swabi and were dried at room temperature (25˚C-30˚C) in Phytoecology laboratory, Department of Botany, University of Peshawar. They were powdered and stored in paper bags. Glassware, thoroughly washed with tap water, sterilized at 170˚C for at least 4 hours. All the results were statistically analyzed through LSD in one way ANOVA.

Effect of aqueous extracts: Five and 10 gm of each part was separately soaked in 100 ml distilled water at 25˚C for 24 and 48 hours and filtered to get aqueous extracts. These extracts were tested against *Lactuca sativa, Pennisetum americanum,* and *Setaria italica* on 2-folds of filter paper in petri dishes. The filter papers were moistened with the respective extracts, while distilled water was used as a control. For each treatment, five replicates, each with 10 seeds were made. The petri dishes were incubated at 25˚C. After 72 hours, germination % , growth of plumule and radicle were noted. Twenty seedlings were randomly taken out for fresh and dry weight determination. Seedlings were dried at 65˚C for 72 hours.

Effect of litter: Five gm litter from leaves, fruits and bark were crushed and spread on one fold of filter paper in a petri dish. The filter papers were moistened with 5ml distilled water. In control treatment fine pieces of filter paper were used. For each treatment, five replicates, each with 10 seeds were made. The petri dishes were incubated at 25˚C. After 72 hours, germination %, growth of plumule and radicle were recorded. Twenty seedlings were randomly taken out for fresh and dry weight determination as earlier.

Effect of hot water extracts: Five gm dried plant parts were separately boiled in 100 ml of water for 5 minutes and filtered. The room cooled extracts were applied against the same test species as before.

Effect of mulching: Five gm crushed dried leaves, fruits and bark were placed in plastic bags containing sterilized moist sand for test. Control consisted of sand only. For each treatment five replicates, each with 10 seeds was made. The plastic glasses were incubated at 25˚C and daily observed for germination. After germination the glasses were transferred to light at room temperature (25-30˚C). Plumule and radicle growth were measured after 15 days. Twenty seedlings were randomly taken out for determining fresh and dry weight and moisture contents.

Results and Discussion

In nature many ecological routes are involved for releasing and transporting allelochemicals from allelopathic plant species. Soaking in rain water, irrigation or even moist soil releases water soluble substances from living and/or dead plant parts that might have allelopathic substances causing the poor growth or complete exclusion of the associated species from common habitat (Samreen *et al.,* 2009; Barkatullah *et al.,* 2010; Hussain *et al.,* 2011; Sher *et al.,* 2011). The present study suggested the presence of various phytotoxins in aqueous extract from leaves, fruits and bark of *Mallotus philippinensis* which exhibited inhibitory stress against the germination, seedling growth, fresh and dry weight of tested species. Aqueous extracts from all parts significantly reduced the germination, plumule and radicle growth of all test species. The extracts from fruits were inhibitorier followed by leaves and bark (Table 1). Similar results were found in many studies for various plant species (Tehmina & Bajwa, 2005; Kamal & Bano, 2008; Samreen *et al.,* 2009; Barkatullah *et al.,* 2010; Hussain *et al.,* 2011; Sher *et al.,* 2011). The germination, plumule and radicle growth of *Lactuca sativa,* was more sensitive followed by *Pennisetum americanum* and *Setaria italica* respectively (Table 1). Aqueous extracts from leaves and fruits obtained after 48 hours were inhibitorier than 24 hour extracts (Table 1). Our results in this regards agree with other studies (Hussain *et al.,* 2004, 2011; Barkatullah *et al.,* 2010; Sher *et al.,* 2011) who recorded that various parts of same plant have differential phytotoxicity. Increase in soaking duration and concentration generally enhanced inhibition (Sher *et al.,* 2011). Our findings agree with them because similar trend was also observed in the present case. The results suggest that toxicity of various parts depended upon the part assayed, concentration, soaking time and sensitivity of test species.

Allelopathy declines the absorption of water of susceptible species from the growth medium (Lodhi & Nickell, 1973; Marwat & Khan 2006). Low moisture contents of shoots and roots might be due to the inability of roots to absorb enough water from the growth medium or due to high transpiration rate due to allelopathic tension. Reduced root or shoot moisture contents create physiological drought like condition that imbalance the various metabolic activities to ultimately dwindle the overall growth routine. (Lodhi & Nickell, 1973; Marwat & Khan 2006; Barkatullah *et al.,* 2010; Hussain *et al.,* 2011). Fresh weight, dry weight and moisture contents of all the test species affected by aqueous extracts obtained from the leaves, fruits and bark of *Mallotus philippinensis* is given in Table 1. Similar findings were also observed for *Juglan regia* (Hussain *et al.,* 1991), *Broussonetia papyrifera* (Hussain *et al.,* 2004), *Melia azedarch* (Hussain *et al.,* 1987), *Helianthus annuus* (Tehmina & Bajwa, 2005; Kamal & Bano, 2008), *Ginkgo biloba* (Lin *et al.,* 2003), *Prosopis juliflora, Eucalyptus camaldulensis* and *Acacia nilotica* (Marwat & Khan 2006). Therefore our findings are in line with them.

Sher *et al.,* (2011) and Barkatullah *et al.,* (2010) recorded that the germination, plumule and radicle growth of all test species significantly declined when grown on litter beds. Our results support them because similar findings are assessed in the present investigation. The fresh and dry weight of all the test species retarded except the fresh weight of *Pennisetum americanum* (Table 2). The radicle growth of *Lactuca sativa* and *Setaria italica* was severely affected compared with *Pennisetum americanum* (Table 2). Hot water extracts from various parts of the different allelopathic plant species inhibit the germination and seedling growth of the investigated test species (Hussain *et al.,* 2004; Barkatullah *et al.,* 2010; Sher *et al.,* 2011). In the present endeavor, it appeared that hot water extracts had more inhibitory effect than cold water extracts. Furthermore, hot water extracts from fruits were more toxic than leaves and bark (Table 3). The added mulch significantly reduced the germination in all the test species (Table 3). Plumule and radicle growth significantly declined. Biomass and moisture contents of all the test species decreased in all the treatments (Table 3).

Table 1. Effect of aqueous extract on germination, plumule & radicle growth, fresh and dry weight and moisture contents of the test species. Each value is a mean of 10 replicates each with 10 seedlings.

Test species	*Lactuca sativa*			*Pennisetum americanum*			*Setaria italica*		
Concentration (g) & soaking duration	Leaves	Fruits	Bark	Leaves	Fruits	Bark	Leaves	Fruits	Bark
	Germination %								
Control	82	82	74	90	90	92	88	88	88
5g/24h	44**	46**	64*	82*	76*	88	80*	82	86
5g/48h	44**	34**	48**	86	80*	76*	64*	70*	74
10g/24h	38**	0	42**	88	90	80	86	56**	86
10g/48h	12**	0	28**	88	68*	76*	74*	58**	80
LSD value	3.637	4.696	8.133	4.932	6.368	11.03	5.485	7.082	12.27
	Plumule growth (mm)								
Control	12.76	12.76	7.8	49.4	49.4	37.08	30.84	30.84	83.6
5g/24h	4.68*	2.6**	7.28	21.44**	27.22*	37.96	20.56**	18.5**	54.98**
5g/48h	1.24**	1.14**	2.36**	14.02**	12.16**	30.94	25.8*	15.82**	58.64**
10g/24h	2.3**	0	1.5**	10.78**	7.26**	17.4**	26.08*	12.28**	36.52**
10g/48h	0.12**	0	0.62**	8.38**	1.58**	17.66**	16.24**	6.06**	27.28**
LSD value	0.5512	0.7115	1.23	3.214	4.149	7.186	3.494	4.511	7.814
	Radicle growth (mm)								
Control	8.02	8.02	4.82	73.6	73.6	57.32	21.6	21.6	35.38
5g/24h	3.06**	1.02**	4.62	22.68**	31.7**	55.72	6.72**	8.3**	28.06*
5g/48h	0.92**	0.6**	3.76*	12.44**	28.46**	61.72	9.62**	11.74**	26.7*
10g/24h	1.56**	0	1.2**	37.94**	11.2**	32.42**	9.7**	9.38**	28.44*
10g/48h	0.98**	0	0.82**	37.74**	3.88**	39.1**	14.6**	1.86**	20**
LSD value	0.4419	0.5705	0.9881	3.662	4.727	8.188	2.211	2.854	4.943
	Fresh weight (% of control)								
5g/24h	83.33	88.23	94.11	95.23	105	95.23	88.88	88.23	88.88
5g/48h	88.88	82.35	88.23	90.47	90	80.95	83.33	88.23	83.33
10g/24h	66.66	0	76.47	85.71	85	71.42	72.22	76.47	77.77
10g/48h	66.66	0	82.35	76.19	70	66.66	66.66	70.58	72.22
	Dry weight (% of control)								
5g/24h	85.71	78.57	100	106.25	94.11	80	85.71	92.85	86.66
5g/48h	92.85	78.57	84.61	81.25	82.35	8125	85.71	85.71	86.66
10g/24h	71.42	0	76.92	81.2	74.47	75	71.42	78.57	73.33
10g/48h	71.42	0	84.61	75	64.70	62.5	71.42	71.42	66.66
	Moisture contents (% of control)								
5g/24h	87.50	169.74	75	56.45	177.05	80	116.66	71.76	115.35
5g/48h	80.74	127.31	157.60	147.68	161.87	98.46	87.50	116.65	76.9
10g/24h	70	0	97.52	123.07	174.33	80	105.01	84.83	136.35
10g/48h	70	0	88.65	106.65	154.50	128	70	93.32	150

Table 2. Effect of litter on germination, plumule and radicle growth, fresh and dry weight and moisture contents of test seedlings. Each value is a mean of five replicates each with 10 seedlings.

Test species	*Lactuca sativa*	*Pennisetum americanum*	*Setaria italica*
	Germination %		
Control	86	84	82
Test	40**	76*	80
LSD value	8.082	6.599	11.43
	Plumule growth (mm)		
Control	12.54	40.1	47.78
Test	2.16**	7.84**	15.68**
LSD value	4.807	3.925	6.799
	Radicle growth (mm)		
Control	8.22	55.78	19.64
Test	1.8**	24.86**	6.98**
LSD value	5.010	4.091	7.085
	Fresh weight (% of control)		
Test	86.67	78.95	70.59
	Dry weight (% of control)		
Test	83.33	68.75	76.92
	Moisture contents (% of control)		
Test	120	193.94	65

Table 3. Effect of hot water extract and soil intoxication on germination, plumule and radicle growth, fresh and dry weight and moisture contents of test seedlings. Each value is a mean of five replicates each with 10 seedlings.

Parameters	Hot water extract			Soil intoxication		
Test species	***Lactuca sativa***	***Pennisetum americanum***	***Setaria italica***	***Lactuca sativa***	***Pennisetum americanum***	***Setaria italica***
	Germination %					
Control	74	88	88	54	62	58
Leaves	54**	70*	72*	50	56	54
Fruits	0	68*	72*	0	42*	0
Bark	60*	82*	80	46*	46*	68
LSD value	4.786	5.527	9.573	5.746	6.653	11.49
	Plumule growth (mm)					
Control	9.2	46.72	34.04	6.9	18.36	39.74
Leaves	2.46**	14.66**	12.3**	5.24	6.68**	6.02**
Fruits	0	6.92**	6.46**	0	1.12**	0
Bark	1.88**	31.66**	14.52**	2.66*	3.7**	12.68**
LSD value	2.089	2.413	4.179	2.704	3.122	5.408
	Radicle growth (mm)					
Control	5.8	64.62	25.78	4.26	22.28	20.9
Leaves	1.84**	13.6**	5.9**	3.06	12.98**	11.74**
Fruits	0	9.72**	3.76**	0	3.7**	0
Bark	1.54**	56.98*	12.52**	2.12*	5.26**	16.92*
LSD value	2.984	3.445	5.967	1.335	1.542	2.671
	Fresh weight (% of control)					
Leaves	93.33	85	88.24	86.67	80.95	82.35
Fruits	0	75	76.47	0	61.90	70.59
Bark	86.67	80	82.35	80	71.43	76.47
	Dry weight (% of control)					
Leaves	100	93.33	92.86	91.67	81.25	85.71
Fruits	0	73.33	78.57	0	68.75	71.43
Bark	91.67	80	85.71	83.33	75	78.47
	Moisture contents (% of control)					
Leaves	66.67	64	71.79	72.73	98.46	77.78
Fruits	0	109.09	84.85	0	58.18	93.33
Bark	72.73	100	77.78	80	80	84.85

Allelochemicals may inhibit plant growth by affecting the division, elongation and ultra-structure of cells or by altering the normal physiological processes such as photosynthesis, respiration, mineral uptake and enzyme activity (Tseng *et al.,* 2003). Toxins might affect chlorophyll contents of susceptible plants that also lead to reduction of growth. The poor moisture contents of seedlings might be due to some disorders in the water absorption mechanism by roots or the toxins might have created physiological drought for the affected seedlings and this could be true for *Mallotus philippinensis* that has reduced the moisture contents of susceptible species. Low moisture contents imbalance physiological functions leading to adverse effects on growth of plants. These findings suggested that *Mallotus philippinensis* exhibits strong allelopathy through the release of some water soluble allelochemicals from the live parts and litter into the immediate soil. It is suggested that the various assayed parts of *Mallotus philippinensis* have strong allelopathic potential at least against the test species. Further investigation is required to see its allelopathic behavior under field cultivation against its associated species and to identify the toxic principle.

Acknowledgements

We are very thankful to Higher Education Commission of Pakistan to sponsor this study under indigenous Ph.D. program, awarded to the principal author.

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(Received for publication 17 April 2013)