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Assessment of allelopathic potential of *Aphanamixis polystachya* on selected field crops

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ABSTRACT

Purpose: *Aphanamixis polystachya* (Wall.) R.N. Parker, belonging to Meliaceae family is very well known for its medicinal properties. But its allelopathic potentiality not yet has been reported. Hence, aqueous extracts of different parts of *Aphanamixis polystachya* were examined to investigate their allelopathic potentiality. **Research Method**: Different parts of *A. polystachya* extracts at four different concentrations (1:5, 1:10, 1:15 and 1:20 (*w/v*)) along with control (distilled water without extracts) were tested against jute, mungbean, mustard, radish, rice, wheat and tomato. The experiments were conducted following completely randomized design with three replicates. **Findings**: Among the test crop species, shoot growth of mustard was most sensitive (43% average inhibition (*a.i.*)) followed by radish (41% *a.i.*) to the extracts of different parts of *A. polystachya*., whereas shoot growth of tomato (14% *a.i.*) was less sensitive to the extracts followed by rice (25% *a.i.*) and mungbean (29% *a.i.*). Root growth of radish was most sensitive (41% *a.i.*) species followed by mustard (39% *a.i.*) and jute (36% *a.i.*) to the extract of different parts of *A. polystachya*. Root growth of mungbean (13% *a.i.*) was less sensitive to the extracts followed by tomato (18% *a.i.*) and rice (20% *a.i.*). Among the plant parts, leaf showed most phytotoxic activity on the shoot growth (41%) and twig on the root (40%) growth of the test plants. However, stem extract was less sensitive to both shoot and root growth of the test species. These results confirm that *A. polystachya* has allelopathic properties and may possess allelochemicals. **Research limitations**: There was no significant limitation to the report. **Originality/Value**: To the best of our knowledge this is the first report about the allelopathic potential of *Aphanamixis polystachya*.

INTRODUCTION

Allelopathy refers to the inhibitory or stimulatory effect of one plant to their neighboring plants and/or their associated micro and/or macrofauna by the production of allelochemicals (IAS, 2017). The substances that is released by allelopathic plants are commonly known as allelochemicals, which are released into the surrounding environment through volatilization from the leaves, , leaching from the above ground parts by precipitation, decomposition of leaf litter or sloughed root tissues, microbial transformation from the decayed leaf, stem, leaf litter or roots, through root exudates, from pollen of some crop plants or other processes in both natural and agricultural systems (Islam & Kato-Noguchi, 2013c). These substances upon release, may suppress the germination, growth and establishment of neighboring native plants, even the secreting plant itself either directly by affecting their physiological properties (Weir et al., 2004), or indirectly by modifying the rhizosphere soil properties through influencing the microbial biomass carbon and microbial community (Zhou et al., 2013).

In forest ecosystems, trees release allelopathic substances for long periods, which may accumulate in soil to toxic levels with passage of time. The accumulation may also occur due to reduction in microbial decomposition under certain conditions (Reigosa et al., 1996; 1998; Singh et al., 1999). Generally, one or few species dominate the forest system, which could lead to accumulation of allelochemicals of these particular species to the forest soil. The substances released from the allelopathic tree species affect the understory species with/without any effect on the secreting plants or their progeny (Kohli, 1999; Malik, 1999). Moreover, introduction of high yielding exotic tree species in forest plantation may also increase accumulation of allelochemicals in soil because of their very high demand for growth resources *viz.*, moisture and nutrients may cause their deficit in soil, leading to increased production of allelochemicals. In addition, the soil microflora also may not be adapted to such allelochemicals and therefore, the chemicals may accumulate in soil to toxic levels. Even though, the allelochemicals released from the dominated species may not cause any harm to the understory flora of that region where they co-evolved, may suppress the understory species in regions of its new introduction (Reigosa et al., 1998).

Aphanamixis polystachya (Wall.) R.N. Parker, belonging to Meliaceae family, a large evergreen tree found to grow in most of the hotter parts of India, as well as the lowlands and hill forests of Bangladesh, Malay and Ceylon (Chan et al., 2011; Rahman et al., 2017). It is an evergreen timber tree with bunches of rounded sub-globose fruits and glossy deep brown seeds, mainly grows in the tropical areas of Asia. The plant is commonly known as Roina or Pittraj in Bangladesh, and are very well known for its medicinal (Chan et al., 2011; Rahman et al., 2017), insecticidal (Talukder & Howse, 1993) and biodiesel properties (Palash et al., 2015).

For example, boiling of *A. polystachya* root bark in abdominal complaints like enlargement of glands, liver and spleen disorders and corpulence (Apu et al., 2013b). Seeds have refrigerant, laxative, anthelmintic activities; used against the diseases of the blood and scale back muscular pain (Apu et al., 2013b). Oil of the seeds is used to treat rheumatism and conjointly has pesticidal character. Bark and seeds of the plant are useful for ulcer (Hossain et al., 2009). Moreover, *A. polystachya* has been reported to possess analgesic (Hossain et al., 2009), antimicrobial (Chowdhury & Rashid, 2003; Yadav et al., 2010; Apu et al., 2013a), antioxidant (Krishnaraju et al., 2009; Sikder et al., 2010; Apu et al., 2013a), antitumor (Chan et al., 2011), CNS depressant (Hossain et al., 2009), cytotoxic (Sikder et al., 2010; Apu et al., 2013a), hepatoprotective (Gole & Dasgupta, 2002), insecticidal (Talukder & Howse, 1993), laxative (Chowdhury & Rashid, 2003), membrane stabilizing (Sikder et al., 2010), anticancer (Apu et al., 2013b) and thrombolytic (Apu et al., 2013a) properties. The plant has also antibacterial, mild antifungal (Rahman et al., 2017), antifeedant, repellant properties, and contact toxicity to beatles (Talukder & Howse, 1993). Besides, the pharmacological and/or toxicological properties, not a single research have so far been conducted to explore the phytotoxic properties of *A. polystachya*. Therefore, the current research was an attempt to investigate into the allelopathic potential of *A. polystachya* on the seedling growth of selected field crops.

MATERIALS AND METHODS

Location and site of the experiment

The experiment was conducted at the Agro Innovation Laboratory of the Department of Agronomy, Bangladesh Agricultural University, Bangladesh.

Collection of plant materials

Five different plant parts *viz.* bark, stem, leaf, root and twig of *Aphanamixis polystachya* were used for this study. The fresh plant parts were collected during March and April, 2018 from the nearby village of the experimental site.

Test plant

Jute (*Corchorus olitorius*), Mustard (*Brassica juncea*), Mungbean (*Vigna radiata*), Radish (*Raphanus sativus*), Rice (*Oryza sativa*), Tomato (*Solanum lycopersicum*) and wheat (*Triticum aestivum*) were used as test crop species. Radish was used in this experiment because it is highly sensitive to allelochemicals even at very low concentrations (Tsuzuki et al., 1995).

Extraction and bioassay procedure

The extraction and bioassay were done according to the procedure developed by Islam et al. (2018). The collected parts of *A. polystachya* plant were washed with tap water, then with distilled water. One hundred gram of each part was then chopped and crashed into paste by a mechanical grinder and soaked with 400 mL distilled water and homogenized in a warring blender for 5 minutes at room temperature (25 ºC). The extract was then filtered through one layer of filter paper (No. 2; Double Rings® Hangzhou Xinhla Paper Industry Co. Ltd., China). The filtrate was then put into 500 mL volumetric flask and filled with distilled water up to the mark, and homogenized by manual shaking. The prepared concentration was considered full strength concentration *i.e.* 1:5 (*w/v*), and was stored at 4ºC (normal freezing condition) in a refrigerator until further used. The extraction was done separately for each plant parts of *A. polystachya.*

The prepared full strength concentration of bark, stem, leaf, root or twig aqueous extracts were diluted into another three concentrations *viz.* 1:10, 1:15 and 1:20 (*w/v*), and a control (distilled water without extract) was also maintained. The bioassay experiment was replicated thrice. Twenty seeds of each jute, mustard, mungbean, radish, rice (sprouted seed), tomato and wheat were arranged on the filter paper in Petri dishes. After 48 h of incubation the shoot and root length of selected seven crop species were measured. The inhibitory potential of each extract was then examined against indicator plants following standard laboratory bioassay method. All the laboratory experiments were conducted following completely randomized design (CRD) with three replications.

Calculation of inhibition percentage

The percentage of inhibition was calculated according to the equation described (1) by Islam et al. (2018):

$$Inhibition\ (\%) = 1 - \frac{Length\ in\ aqueous\ extract}{Length\ in\ control} \times 100 \quad (1)$$

Statistical analysis

Data recorded on growth inhibition was compiled and tabulated for statistical analysis. The data were analyzed statistically by using R Statistics Software (Version 3.5.0).

RESULTS

Effect of aqueous extracts of *A. polystachya* plants parts on growth inhibition of jute

The aqueous extracts of different parts of *A. polystachya* plant significantly influenced the shoot and root growth of jute (Table 1). From the result it is clear that the inhibitory activity of the different extracts was concentration dependent. Except stem, all other plant parts of *A. polystachya* showed inhibition at all the concentration used in the study. At 1:5 *(w/v)* concentration, *A. polystachya* twig extracts showed more than 90% shoot growth inhibition of Jute, while at the same concentration both twig and leaf extract showed more than 90% root growth inhibition (Table 1). At 1:5 *(w/v)* concentration, extracts of all other parts showed more than 80% shoot and root growth inhibition. Stem extracts of *A. polystachya* at concentration lower than 1:5 *(w/v)* stimulated the shoot and root growth of jute (Table 1).

Effect of aqueous extracts of *A. polystachya* plants parts on growth inhibition of mungbean

Shoot and root growth inhibition of mungbean were also significantly affected by the aqueous extracts of different parts of *A. polystachya* plant (Table 2). Table 2 showed that the inhibitory activity of the different extracts was concentration dependent. Stem extracts of *A. polystachya* showed stimulatory activity on shoot and root growth of mungbean at concentration 1:10 (*w/v*) or below, whereas bark extract of *A. polystachya* showed stimulatory activity on the root growth of mungbean at the same concentration. In addition, leaf and root extracts of *A. polystachya* showed stimulation on the root growth of Mungbean at the lowest concentration used in this experiment i.e. 1:20 (*w/v*). At concentration 1:5 (*w/v*), leaf and root extracts showed more than 80% shoot and root growth inhibition of mungbean (Table 2).

Effect of aqueous extracts of *A. polystachya* plants parts on growth inhibition of mustard

The aqueous extracts of *A. polystachya* plant parts had also significant influence on shoot and root growth inhibition of mustard where growth inhibition increased significantly with the increase of the aqueous extract concentrations (Table 3). Bark extracts of *A. polystachya* showed stimulatory activity on root growth of mustard at concentration 1:10 (*w/v*) or below. Whereas, root and stem extracts of *A. polystachya* showed stimulation on the root and stem growth of mustard, respectively at the lowest concentration used in this experiment *i.e.* 1:20 (*w/v*). At 1:5 *(w/v)* concentration, *A. polystachya* bark, leaf, root, stem and twig extracts showed 55, 90, 85, 89, 94% shoot growth, and 59, 98, 89, 96 and 99% root growth inhibition of mustard, respectively (Table 3).

Table 1. Effect of different plant parts of *A. polystachya* on the shoot and root growth of Jute

Plant parts	% inhibition							
	Shoot growth				Root growth			
	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*
Bark	13.56 b	18.63 c	21.17 c	87.30 b	7.83 c	27.067 c	23.06 d	87.40 b
Leaf	21.73 a	17.40 c	36.97 b	87.70 b	3.33 d	7.63 d	60.36 b	95.70 a
Root	6.67 c	40.00 a	53.33 a	74.73 d	32.47 a	61.13 a	64.66 a	89.86 b
Stem	-10.97 d	-39.37d	-8.40 d	84.53 c	-41.33 e	-78.70 e	-26.66 e	81.26 c
Twig	19.43 a	28.43 b	36.97 b	91.00 a	22.80 b	45.60 b	55.63 c	94.06 a
Level of sig.	***	***	***	***	***	***	***	***
C.V (%)	2.30	1.22	5.33	1.60	2.20	3.57	2.68	1.93
LSD	4.80	3.48	4.92	2.57	2.48	3.20	1.78	3.26

In column, means followed by different letters are significantly different. *** means at 0.1% level of probability. The positive value indicates inhibition, whereas the negative value indicates stimulation by the extract.

Table 2. Effect of different plant parts of *A. polystachya* on the shoot and root growth of Mungbean

Plant parts	% inhibition							
	Shoot growth				Root growth			
	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*
Bark	32.63 a	21.20 b	23.36 b	64.13 b	-33.23 e	-24.63 e	-41.16 e	50.86 c
Leaf	7.36 c	48.03 a	39.00 a	83.07 a	-11.57 c	31.40 a	20.53 b	89.33 a
Root	23.30 b	22.90 b	23.26 b	82.43 a	-2.83 b	1.86 c	8.60 c	83.96 b
Stem	-5.86 d	-2.30 d	-8.83 c	40.53 d	-20.00 d	-16.43 d	-15.83 d	41.03 d
Twig	7.83 c	12.33 c	17.63 b	48.73 c	2.20 a	17.87 b	25.70 a	54.00 c
Level of sig.	***	***	***	***	***	***	***	***
C.V (%)	1.43	1.85	1.03	1.40	5.68	4.85	3.43	2.68
LSD	4.53	6.86	6.76	1.68	3.18	3.67	2.69	3.22

Other details are same as Table 1.

Table 3. Effect of different plant parts of *A. polystachya* on the shoot and root growth of Mustard

Plant parts	% inhibition							
	Shoot growth				Root growth			
	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*
Bark	23.00 c	14.93 d	17.23 d	55.17 d	-34.27 e	-24.80 d	-41.83 e	58.53 d
Leaf	33.93 b	23.86 b	34.87 b	89.93 b	24.83 b	7.33 c	5.87 d	97.67 ab
Root	18.16 d	40.00 a	18.17 d	84.87 c	-6.63 d	14.90 b	23.50 c	89.43 c
Stem	-1.90 e	19.23 c	26.43 c	88.73 b	6.300 c	15.70 b	39.067 b	95.83 b
Twig	41.96 a	37.83 a	49.43 a	93.63 a	67.27 a	70.133 a	80.53 a	99.00 a
Level of sig.	***	***	***	***	***	***	***	***
C.V (%)	3.90	6.75	3.17	1.91	1.82	6.84	4.66	1.46
LSD	1.69	3.45	1.74	2.97	4.29	2.14	1.88	2.42

Other details are same as Table 1.

Effect of aqueous extracts of *A. polystachya* plants parts on growth inhibition of radish

The aqueous extracts of *A. polystachya* plant parts significantly influenced the growth inhibition of radish (Table 4). This result indicated that the inhibitory activity of the different extracts of *A. polystachya* was concentration dependent. In the present study, root extract stimulated the shoot and root growth of radish at concentration of 1:20 *(w/v)* while leaf extract stimulated the root growth at concentration of 1:20 *(w/v)*. Except these, all other extracts showed inhibitory activity on the shoot and root growth of radish at any concentration used in this study (Table 4). At 1:5 *(w/v)* concentration, *A. polystachya* bark, leaf, root, stem and twig extracts showed 78, 97, 86, 93 and 93% shoot growth inhibition, and 86, 97, 91, 95 and 97% root growth inhibition of radish, respectively (Table 4).

Effect of aqueous extracts of *A. polystachya* plants parts on growth inhibition of tomato

The growth inhibition of tomato was also statistically significant among the aqueous extract of different plant parts of *A. polystachya* at different concentrations (Table 5). Table 5 showed that the inhibitory activity of the different extracts was concentration dependent. All the extracts of *A. polystachya* plant parts except twig for shoot growth, and bark and leaf for root growth stimulated the shoot and root growth at lowest concentrations. At 1:5 *(w/v)* concentration, both leaf and twig extracts showed more than 90% shoot growth of tomato, while at the same concentration leaf, stem and twig extract showed more than 90% root growth inhibition (Table 5).

Effect of aqueous extracts of *A. polystachya* plants parts on growth inhibition of rice

Different parts of *A. polystachya* significantly inhibited the percent shoot and root growth inhibition of rice at different concentrations (Table 6). The growth inhibition of rice increased with the increasing concentrations of the aqueous extracts of any parts of *A. polystachya*. Root and stem extracts of *A. polystachya* stimulated the shoot growth of rice at concentration 1:15 (*w/v*) or below, while this parts stimulated the root growth of rice at concentrations 1:10 (*w/v*) or below. The twig extracts of *A. polystachya* showed the opposite trend i.e. concentration 1:10 (*w/v*) or below stimulated the shoot and 1:15 (*w/v*) or below stimulated the root growth of rice. At 1:5 *(w/v)* concentration, only bark extract of *A. polystachya* showed more than 90% shoot and root growth inhibition of rice, while at the same concentration twig extract showed more than 85% root growth inhibition (Table 6). At 1:5 *(w/v)* concentrations, all other parts extracts of *A. polystachya* showed less than 80% shoot and root growth inhibition.

Effect of aqueous extracts of *A. polystachya* plants parts on growth inhibition of wheat

The growth inhibition of wheat was also significantly influenced by the aqueous extract of *A. polystachya* plant parts at different concentrations (Table 7). Table 7 shows that inhibitory activity of the different extracts was concentration dependent. Except root extract of *A. polystachya* for shoot growth, and stem and twig extracts for root growth, all other plant parts of *A. polystachya* showed inhibition at all the concentrations used in the study. At 1:5 *(w/v)* concentration, *A. polystachya* bark, leaf, root, stem and twig extracts showed 46, 88, 87, 60 and 76% shoot growth inhibition, and 74, 97, 91, 73 and 84% root growth inhibition of wheat, respectively (Table 7).

Table 4. Effect of different plant parts of *A. polystachya* on the shoot and root growth of Radish

Plant parts	% inhibition							
	Shoot growth				Root growth			
	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*
Bark	16.93 c	17.16 d	15.43 d	77.76 d	17.93 b	16.30 c	32.40 d	85.63 d
Leaf	56.77 a	43.90 a	81.76 a	97.30 a	-2.40 d	17.43 b	76.10 a	96.60 a
Root	-19.20 e	23.16 c	28.13 c	85.76 c	-1.33 e	27.90 a	35.76 c	91.10 c
Stem	21.10 b	9.03 e	17.53 d	92.76 b	11.66 c	1.23 d	16.26 e	94.90 b
Twig	4.00 d	26.26 b	35.86 b	92.66 b	20.46 a	29.10 a	57.90 b	96.50 a
Level of sig.	***	***	***	***	***	***	***	***
C.V (%)	4.73	4.11	1.68	1.53	3.71	2.57	5.30	1.62
LSD	3.21	1.85	7.26	2.58	2.99	3.41	6.35	1.10

Other details are same as Table 1.

Table 5. Effect of different plant parts of *A. polystachya* on the shoot and root growth of tomato

Plant parts	% inhibition							
	Shoot growth				Root growth			
	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*
Bark	-7.67 c	3.56 c	13.26 b	58.17 b	27.30 b	7.30 c	50.60 a	77.00 b
Leaf	-9.40 d	-5.66 d	33.50 a	91.20 a	43.53 a	19.76 b	18.80 c	91.13 a
Root	-9.17 d	-8.43 d	12.70 b	62.67 b	-85.60 e	-25.37 d	-5.70 d	43.17 c
Stem	-6.20 b	12.43 b	12.43 b	82.60 a	-9.70 d	25.73 a	33.03 b	91.40 a
Twig	15.60 a	22.63 a	35.60 a	91.70 a	-3.13 c	25.43 a	35.23 b	94.73 a
Level of sig.	**	***	***	***	***	***	***	***
C.V (%)	4.73	1.40	306	7.23	3.94	3.9	-11.93	5.59
LSD	13.16	8.26	9.37	10.52	1.56	2.76	3.42	7.80

Other details are same as Table 1.

Table 6. Effect of different plant parts of *A. polystachya* on the shoot and root growth of Rice

Plant parts	% inhibition							
	Shoot growth				Root growth			
	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*
Bark	9.17 a	21.43 a	26.00 a	90.53 a	3.50 b	22.30 a	37.86 a	92.13 a
Leaf	7.90 a	-1.90 b	2.70 d	63.40 b	26.67 a	22.43 a	10.40 c	58.93 e
Root	-18.77 b	-12.77 d	10.17 b	50.57 d	-30.10 c	-12.70 b	-16.70 d	67.67 d
Stem	-20.86 c	-8.07 c	5.63 c	54.63 cd	-21.33 d	-21.46 c	-23.67 e	76.37 c
Twig	-28.90 d	-14.56 de	-6.73 e	58.73 c	-21.50 d	-20.80 c	12.87 b	88.77 b
Level of sig.	***	***	***	***	***	***	***	***
CV (%)	3.45	-5.06	-7.36	3.62	-3.37	-2.93	3.48	2.18
LSD	5.26	7.77	7.14	4.33	3.47	2.76	3008	3.16

Other details are same as Table 1.

Table 7. Effect of different plant parts of *A. polystachya* on the shoot and root growth of Wheat

Plant parts	% inhibition							
	Shoot growth				Root growth			
	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*	1:20 *(w/v)*	1:15 *(w/v)*	1:10 *(w/v)*	1:5 *(w/v)*
Bark	18.63 b	34.93 a	39.30 a	46.00 d	27.46 a	29.80 a	34.76 a	73.56 d
Leaf	32.37 a	17.33 c	34.96 ab	87.70 a	15.70 c	6.33 d	29.33 b	97.13 a
Root	-10.46 d	17.80 c	20.40 c	87.43 a	23.93 b	23.50 b	4.23 e	91.16 b
Stem	17.30 b	18.96 bc	11.80 d	59.46 c	-0.63 d	18.36 c	14.53 c	73.06 d
Twig	7.06 c	19.70 bc	30.96 b	75.90 b	-11.56 e	-3.66 e	9.53 d	83.50 c
Level of sig.	***	***	***	***	***	***	***	***
CV (%)	5.59	6.94	1.72	4.06	3.97	4.36	2.65	1.49
LSD	5.47	3.91	6.70	5.46	2.21	2.21	3.67	2.35

Other details are same as Table 1.

DISCUSSION

The allelopathic potential of *A. polystachya* plant parts were evaluated at different concentrations for selecting the most influencing part(s) and concentration(s) which will substantiate the elevated inhibition of studied seven field crops by containing higher allelopathic potentiality.

The aqueous extracts of *A. polystachya* plant parts had inhibitory and stimulatory effects on both shoot and root growth of fall the field crops studied (jute, mungbean, mustard, radish, tomato, rice and wheat), which confirm the presence of allelochemicals in all the extracts. In this study, shoot and root growth of test crops showed stimulatory effect with the extract(s) of *A. polystachya* plant parts at concentration lower than 1:5 *(w/v)*. Both inhibitory and stimulatory effects were reported by Islam and Kato-Noguchi (2013a) where they found stimulatory activity on the hypocotyls /coleoptiles growth of lettuce, alfalfa, rapeseed, timothy, crabgrass, barnyard grass and Italian ryegrass, and the root growth of rapeseed, timothy and crabgrass was caused by the *Mentha sylvestris* plant extract at concentrations ≤ 30 mg Dry weight equivalent extract mL^{-1} while inhibitory activity was recorded with higher concentrations of *M. sylvestris* aqueous methanol extract on studied field crops. The growth inhibition at higher concentration and tendency of growth stimulation at lower concentration could be explained by the recent findings of Islam and Kato-Noguchi (2012), Amini et al. (2016), Sutradhar et al. (2018), M'barek et al. (2018); Islam et al. (2018) and Islam et al. (2019a; b). This type of inhibitory activity is known as concentration dependent activity and are very common in allelopathic research *viz.*, Ghnaya et al. (2016), Islam et al. (2018), Suwitchayanon et al. (2017) and Appiah et al. (2017) where they reported that the inhibitory effect was dosage dependent and higher concentration showed strongest inhibitory activity on crops.

In this study the leaf extracts at higher concentration showed elevated growth inhibitory activity (more than 85%) among the most test crop species followed by twig and bark extracts. This might be due to the presence of more amounts of allelochemicals in leaf extract than that of other extracts which ultimately enhanced the inhibitory activity on different test crop species. These results are in agreement with the earlier findings of many researchers working with other plant materials. Amini et al. (2016) evaluated the allelopathic potential of 68 medicinal plants where the leaf of *Atriplex canescens* and the flower of *Achillea millefolium* had the strongest inhibitory effect on growth of lettuce than that of flower and fruits extracts of other medicinal plant. Tanveer et al. (2010), Raoof and Siddiqui (2012), Ravlić et al. (2012) and Abu–

Romman (2016) also confirmed that the leaf extract inhibited more strongly the seedling growth than any other extracts. The results differ from those of BaličEvić and Ravlić (2015) who reported that root extract had the highest inhibitory effect on root and shoot length and fresh weight of test species.

From the present study, it was found that the shoot growth of different field crops showed less inhibition than their roots. The greater sensitivity of root compared to shoot is usual in allelopathic study and this is because roots are the first organs to absorb phytotoxic substances from the extract and the permeability of phytotoxic substances into root tissue is higher than the shoot tissue (Islam & Kato-Noguchi 2013a; b), and according to Franco et al. (2015) allelochemicals can affect genes responsible for the cellular characterization of ground tissues and endoderm, reducing root development. Whereas, Levizou et al. (2002) observed low mitotic division in root apex resulted in higher root inhibition of *Lactuca sativa* when treated with *Dittrichia viscose* leaf extracts.

The study also revealed that all the studied field crops were highly sensitive (more than 90%) except mungbean, where mustard showed the strongest sensitivity with the aqueous extract of *A. polystachya* plant parts which confirms that the *A. polystachya* plant contain potential allelochemicals to inhibit the test species. These findings indicated that the inhibitory activities of *A. polystachya* plant parts on different field crop species are not identical. This imbalanced susceptibility to different extracts of *A. polystachya* plant parts could be due to inherent differences in allelochemicals content in different parts of this plant. So, it is clear that the leaves extract followed by twig and bark extracts of *A. polystachya* plant had strong inhibitory effect on the growth of different field crops at higher concentration. This finding was strongly supported by M'barek et al. (2018) who reported that the seedling growth of radish was more sensitive than lettuce, barley and tomato to the different extracts of *Tetraclinis articulate*.

CONCLUSION

Present study showed that the shoot and root growth inhibition of rice, wheat, jute, tomato, radish, mungbean and mustard by leaf, bark, stem, twig and root extracts of *Aphanamixis polystachya* varies significantly. Compared to the shoot growth, root growth of the test species were inhibited more. The leaf and twig have higher allelopathic potential than any other parts of *A. polystachya*. Since leaf and twig of *A. polystachya* extracts had greater inhibitory activities than other parts, these plant parts could be used for isolation and identification of allelochemicals. The findings of this experiment would be helpful for the researchers to know the inter-specific interactions of these plant species with their neighbor plant species under natural settings.

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Disclosure Statement
All the authors declare that there is no conflict of interest in publishing this manuscript.

REFRENCES

Abu-Romman, S. (2016). Differential allelopathic expression of different plant parts of *Achillea biebersteinii*. *Acta Biologica Hungarica*, *67*(2), 159-168. https://doi.org/10.1556/018.67.2016.2.4

Amini, S., Azizi, M., Joharchi, M. R., & Moradinezhad, F. (2016). Evaluation of allelopathic activity of 68 medicinal and wild plant species of Iran by Sandwich method. *International Journal of Horticultural Science and Technology*, *3*(2), 243-253.

Appiah, K. S., Mardani, H. K., Osivand, A., Kpabitey, S., Amoatey, C. A., Oikawa, Y., & Fujii, Y. (2017). Exploring alternative use of medicinal plants for sustainable weed management. *Sustainability*, *9*, 1-23. https://doi.org/10.3390/su9081468

Apu, A. S., Chowdhury, F. A., Khatun, F., Jamaluddin, A. T. M., Pathan, A.H., & Pal, A. (2013a). Phytochemical screening and in vitro evaluation of pharmacological activities of *Aphanamixis polystachya* (Wall) Parker fruit extracts. *Tropical Journal of Pharmaceutical Research*, *12*, 111-116. https://doi.org/10.4314/tjpr.v12i1.18

Apu, A. S., Pathan, A. H., Jamaluddin, A. T. M., Ara, F., Bhuyan, S. H., & Islam, M. R. (2013b). Phytochemical analysis and bioactivities of *Aphanamixis polystachya* (Wall.) R. Parker leaves from Bangladesh. *Journal of Biological Sciences*, *13*, 393-399. https://doi.org/10.3923/jbs.2013.393.399

BaličEvić, R., & Ravlić, M. (2015). Allelopathic effect of scentless mayweed extracts on carrot. *Herbologia*, *15*, 11-18. https://doi.org/10.5644/Herb.15.1.02

Chan, L. L., George, S., Ahmad, A., Gosangari, S. L., Abbasi, A., Cunningham, B. T., & Watkin, K. L. (2011). Cytotoxicity effects of *Amoora rohituka* and chittagonga on breast and pancreatic cancer cells. *Evidance Based Complementary and Alternative Medicine*, *860605*, 1-8. https://doi.org/10.1155/2011/860605

Chowdhury, R., & Rashid, R. B. (2003). Effect of the crude extracts of *Amoora rohituka* stem bark on gastrointestinal transit in mice. *Indian Journal of Pharmacology*, *35*, 304-307

Franco, D. M., Silva, E. M., Saldanha, L. L., Adachi, S. A., Schley, T. R., Rodrigues, T. M., Dokkedal, A. L., Nogueira, F. T. S., & Rolim de Almeida, L. F. (2015). Flavonoids modify root growth and modulate expression of short-root and HD-ZIP III. *Journal of Plant Physiology*. *188*, 89-95. https://doi.org/10.1016/j.jplph.2015.09.009

Ghnaya, A. B., Hamrouni, L., Amri, I., Ahoues, H., Hanana, M., & Romane, A. (2016). Study of allelopathic effects of *Eucalyptus erythrocorys* L. crude extracts against germination and seedling growth of weeds and wheat. *Natural Product Research* *30*(18), 2058-2064. https://doi.org/10.1080/14786419.2015.1108973

Gole, M. K., & Dasgupta, S. (2002). Role of plant metabolites in toxic liver injury. Asia Pacific *Journal of Clinical Nutrition*, *11*, 48-50. https://doi.org/10.1046/j.1440-6047.2002.00265.x

Hossain, M. M., Biva, I. J., Jahangir, R., & Vhuiyan, M. M. I. (2009). Central nervous system depressant and analgesic activity of *Aphanamixis polystachya* (Wall.) parker leaf extract in mice. *African Journal of Pharmacy and Pharmacology*, *3*, 282-286.

IAS. (2017). International allelopathy society. Online available at http://allelopathy-society.osupytheas.fr/about/

Islam, A. K. M. M., Haque, M. M., Bhowmik, O., Yeasmin, S., & Anwar, M. P. (2019a). Allelopathic potential of three oil enriched plants against seedling growth of common field crops. *Journal of Botanical Research*, *1*(3), 8-15. https://doi.org/10.30564/jrb.v1i3.1438

Islam, A. K. M. M., Hasan, M., Musha, M. M. H., Uddin, M. K., Juraimi. A. S., & Anwar, M. P. (2018). Exploring 55 tropical medicinal plant species available in Bangladesh for their possible allelopathic potentiality. *Annals of Agricultural Sciences*, *63*, 99-107. https://doi.org/10.1016/j.aoas.2018.05.005

Islam, A. K. M. M., Hasan, M. M., Yeasmin, S., Abedin, M. A., Kader, M. A., Rashid, M. H., & Anwar, M. P. (2019b). Bioassay screening of tropical tree sawdust for allelopathic properties and their field performance against paddy weeds. *Fundamental and Applied Agriculture*, *4*(3), 906-915. https://doi.org/10.5455/faa.54326

Islam, A. K. M. M., & Kato-Noguchi, H. (2012). Allelopathic potentiality of medicinal plant *Leucas aspera*. *International Journal of Sustainable Agriculture*, *4*(1), 01-07.

Islam, A. K. M. M., & Kato-Noguchi, H. (2013a). Plant growth inhibitory activity of medicinal plant *Hyptis suaveolens*: could allelopathy be a cause?. *Emirates Journal of Food and Agriculture*, *25*(9), 692-701. https://doi.org/10.9755/ejfa.v25i9.16073

Islam, A. K. M. M., & Kato-Noguchi, H. (2013b). *Mentha sylvestris*: A potential allelopathic medicinal plant. *International Journal of Agriculture and Biology*, *15*, 1313-1318.

Islam, A. K. M. M., & Kato-Noguchi, H. (2013c). Allelopathic prospective of *Ricinus communis* and *Jatropha curcas* for bio-control of weeds. *Acta Agriculturae Scandinavica, Section B - Soil and Plant Science*, *63* (8), 731-739, https://doi.org/10.1080/09064710.2013.865073

Kohli, R .K. (1999). Allelopathic interactions in forestry system. In: *Environmental forest science*. Kluwer Academic Publishers, Dordrecht, Netherlands. pp. 269-283. https://doi.org/10.1007/978-94-011-5324-9_29

Krishnaraju, A. V., Rao, C. V., Rao, T. V. N., Reddy, K. N., & Trimurtulu, G. (2009). In vitro and in vivo antioxidant activity of *Aphanamixis polystachya* bark. *American Journal of Infectious Diseases*, *5*, 60-67. https://doi.org/10.3844/ajidsp.2009.60.67

Levizou, E. F. I., Karageorgou, P., Psaras, G. K., & Manetas, Y. (2002). Inhibitory effects of water soluble leaf leachates from *Dittrichia viscosa* on lettuce root growth, statocyte development and graviperception. *Flora - Morphology, Distribution Functional Ecology of Plants*, *197*, 152-157. https://doi.org/10.1078/0367-2530-00025

Malik, A. U. 1999. Allelopathy and competition in coniferous forests. In: *Environmental forest science Dordrecht Netherlands*. Kluwer Academic Publishers. pp. 309-315. https://doi.org/10.1007/978-94-011-5324-9_33

M'barek, K., Zribi, I., & Haouala, R. (2018). Allelopathic effects of *Tetraclinis articulata* on barley, lettuce, radish and tomato. *Allelopathy Journal*, *43*(2), 187-202. https://doi.org/10.26651/allelo.j./2018-43-2-1140

Palash, S. M., Masjuki H. H., Kalam, M. A., Atabani, A. E., Fattah, I. M. R., & Sanjid, A. (2015). Biodiesel production, characterization, diesel engine performance, and emission characteristics of methyl esters from *Aphanamixis polystachya* oil of Bangladesh. *Energy Conversion and Management*, *91*, 149-157. https://doi.org/10.1016/j.enconman.2014.12.009

Rahman, M. S., Ahad, A., Saha, S. K., Hong, J., & Kim, K. (2017). Antibacterial and phytochemical properties of *Aphanamixis polystachya* essential oil. *Analytical Science and Technology*, *30*(3), 113-121. https://doi.org/ 10.5806/AST.2017.30.3.113

Raoof, K. M. A., & Siddiqui, M.B. (2012). Allelopathic effect of aqueous extracts of different parts of *Tinospora cordifolia* (Willd.) Miers on some weed plants. *Journal of Agricultural Extension and Rural Development*, *4*(6), 115-119. https://doi.org/ 10.5897/JAERD11.069

Ravlić, M., BaličEvić, R., Knežević, M., & Ravlić, I. (2012). Allelopathic effect of scentless mayweed and field poppy on seed germination and initial growth of winter wheat and winter barley. *Herbologia*, *13*(2), 1-7.

Reigosa, M. J., Souto, X. C., & Gonzalez, L. (1996). Allelopathic research: methodological, ecological and evolutionary aspects. In: Narwal SS, Tauro P (eds.), *Allelopathy: Field Observations and Methodology*. Scientific Publishers, India. pp. 213-231.

Reigosa, M. S., Gonzalezy, L., Sout, X. C., & Pastoriza, J. E. (1998). Allelopathy in forest ecosystems. In: Narwal, S. S., Hoagland RE, Dilday, R. H., Reigosa Roger, M. J. (Eds.), *Allelopathy in ecological agriculture and forestry*. Kluwer Academic Publishers. 183-193. https://doi.org/10.1007/978-94-011-4173-4_12

Sikder, M. A. A., Kuddus, M. R., Kaisar, M. A., Karna, S., & Rashid, M. A. (2010). In vitro membrane stabilizing activity, total phenolic content, free radical scavenging and cytotoxic properties of Aphanamixis polystachya (Wall.). *Bangladesh Pharmaceutical Journal*, *13*, 55-59.

Singh, H. P., Kohli, R. K., Batish, D. R., & Kaushal, P. S. 1999. Allelopathy of gymnospermous trees. *Journal of Forest Research*, *4*, 245. https://doi.org/10.1007/BF02762256

Sutradhar, T., Lokho, A., & Das, A. P. (2018). Effects of extracts and leachates of *Trianthema portulacastrum* L. (Aizoaceae) on the seed germination and performance of young jute seedlings (*Corchorus olitorius* L. of Malvaceae) in Bardhaman district of West Bengal, India. *International Journal of Current Agricultural Sciences*, *8*(3), 279-282.

Suwitchayanon, P., Kunasakdakul, K., & Kato-Noguchi, H. (2017). Screening the allelopathic activity of 14 medicinal plants from northern Thailand. *Environment and Control Biology*, *55*(3), 143-145. http://doi.org/10.2525/ecb.55.143

Talukder, F. A., & Howse, P. (1993). Deterrent and insecticidal effects of extracts of pithraj, *Aphanamixis polystachya* (Meliaceae), against *Tribolium castaneum* in storage. *Journal of Chemical Ecology*, *19*(11), 2463-2471. https://doi.org/10.1007/BF00980683

Tanveer, A., Rehman, A., Javaid, M. M., Abbas, R. N., Sibtain, M., Ahmad, A. U. H., Ibin-I-Zamir, M. S., Chaudhary, K. M., & Aziz, A. (2010). Allelopathic potential of *Euphorbia helioscopia* L. against wheat (*Triticum aestivum* L.), chickpea (*Cicer arietinum* L.) and lentil (*Lens culinaris* Medic.). *Turkish Journal of Agriculture and Forestry*, *34*, 75-81.

Tsuzuki, E., Shimazaki, A., Naivaluevu, L. U., & Tomiyama, K. (1995). Injury by continuous cropping to taro and its related factors. *Japanese Journal of Crop Science*, *64*, 195-200. https://doi.org/10.1626/jcs.64.195

Weir, T. L., Park, S. W., & Vivanco, J. M. 2004. Biochemical and physiological mechanisms mediated by allelochemicals. *Current Opinion in Plant Biology*, *7*, 472-479. https://doi.org/10.1016/j.pbi.2004.05.007

Yadav, R., Chauhan, N. S., Chouhan, A. S., Soni, V. K., & Omray, L. 2010. Antimicrobial screening of various extracts of *Aphanamixis polystachya* stems bark. *International Journal of Advanced Pharmceutical Science*, *1*, 147-150.

Zhou, B., Kong, C .H., Li, Y. H., Wang, P., & Xu, X. H. (2013). Crabgrass (*Digitaria sanguinalis*) allelochemicals that interfere with crop growth and the soil microbial community. *Journal of Agricultural and Food Chemistry*, *61*(22), 5310-5317. https://doi.org/10.1021/jf401605g