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Research Article
Evaluation of Allelopathic Potential of *Ricinus communis* on the Growth of Seven Field Crops

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Abstract

Background and Objectives: Although, the pharmacological and/or pharmaceutical properties of *R. communis* have been found in literature, research articles about its allelopathy on different field crops species is rarely reported. Therefore, aqueous extracts of different plant parts of *R. communis* were examined to investigate their allelopathic potentiality. **Materials and Methods:** Different plant parts of *R. communis* (leaf, twig, bark, stem, root, pericarp and seed) extracts at four different concentrations viz. 1:5, 1:10, 1:15 and 1:20 (w/v) along with control were tested against jute, mungbean, mustard, radish, rice, wheat and tomato. The experiments were conducted under Completely Randomized Design (CRD) with three replicates. **Results:** The inhibitory activity of *R. communis* on different field crops were concentrations and plant parts dependent. Most of the plant parts at lower concentration stimulated the shoot and root growth of all test crop species. The root growth of the test crop species was more sensitive than their shoot growth. Among the test crop species, the shoot and root growth of mustard were most sensitive followed by radish to the different plant parts extract of *R. communis*. Whereas, the shoot and root growth of rice was less sensitive followed by tomato and mungbean. Among the plant parts, twig showed most phytotoxic activity on the test plants. **Conclusion:** The *R. communis* has allelopathic properties and may possess allelochemicals. Since, twig of *R. communis* extracts had greater inhibitory activity than other parts, this plant parts could be used for isolation and identification of allelochemicals for sustainable agriculture.

Key words: Euphorbiaceae, phytotoxicity, allelopathy, bio-diesel plant, allelochemicals, *R. communis*

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Molisch[1] introduce the term 'allelopathy' to refer both inhibitory and stimulatory biochemical interactions between all plants, including micro-organisms. Later, it was defined as any direct or indirect, beneficial or destructive effect by one plant on another through production of allelochemicals that escape into environment from plant parts[2]. Allelochemicals are escaped into the surrounding environment either from their above or below ground parts in the form of root exudation, leaching by precipitation, pollination through insect and volatilization or decaying plant tissue[3]. When the neighboring plants come in contact and received the allelochemicals, if susceptible to this allelochemicals the growth of receiver plants become stunted. Even sometimes the chemicals inhibit the growth of the progeny of donor plants. In such way, this allelopathic interaction gives an extra benefit to the donor plants to dominate in their vicinity.

Among oilseeds, castor (*Ricinus communis* L.) is the most primitive non-edible crop belonging to the family Euphorbiaceae grown under tropical, sub-tropical and temperate regions[4-6]. India ranks first with respect to area and production of castor in the world and contribute 68 and 85%, respectively[7]. *Ricinus communis* is a small wooden tree which can grow up to 12 m height in the wild, but when cultivated, the height is usually 1-4 or even[8] 10 m. The plant is well known for many of its pharmacological and/or pharmaceuticals properties[9-12]. The leaf, root and seed oil of this plant have been used for the treatment of inflammation and liver disorders. Those parts also have hypoglycemic and laxative properties. Oil is extensively used in Ayurveda, Unani, Homeopathic and Allopathic system of medicines as cathartic. The plant is reported to possess antioxidant, anti-implantation, anti-inflammatory, antidiabetic, central analgesic, antitumour, larvicidal, antinociceptive and antiasthmatic activity[13,14]. The major phyto-constituent reported in this plant are rutin, gentisic acid, quercetin, gallic acid, kaempferol-3-O-beta-d-rutinoside, kaempferol-3-O-beta-d-xylopyranoid, tannins, Ricin A, B and C, ricinus agglutinin, Indole-3-acetic acid and an alkaloid ricin[15-17].

Although, a number of evidences are found in the literature about the pharmacological and pharmaceutical properties of *R. communis*, research articles about its allelopathic potentiality on different crop and weed species have rarely been reported by Islam and Kato-Noguchi[18], Saadaoui *et al.*[19], Da Silva *et al.*[20] and Islam *et al.*[21]. Even though few reports have been documented, those are very preliminary work rather than details phytotoxic studies of their specific organs[18,22-24]. Therefore, more research work with different parts of *R. communis* to investigate their allelopathic potentiality warrant need attention. The current research was, therefore, undertaken to evaluate allelopathic potential of different plant parts of *R. communis* on the seedling growth of major field crops commonly cultivated in Bangladesh and to identify the strongest allelopathic parts of *R. communis*.

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, from July, 2017-2018.

Collection of plant materials: Fresh leaves, bark, stem, root, seed, twig and pericarp of castor (*Ricinus communis* L.) plant were collected during the full growing stage from different locations of Mymensingh including BAU campus. The plant samples were collected during July-December, 2017 from the nearby village of Bangladesh Agricultural University, Mymensingh, Bangladesh.

Test plant: The allelopathic potentiality of the aqueous extracts of different parts of castor (*R. communis*) on the seedling growth of seven field crops commonly cultivated in Bangladesh were examined in this study. The test crop seeds included in this study were listed in Table 1.

Table 1: List of test species used in the experiment

Common	Scientific Name	Family	Variety	Source
Jute	*Corchorus capsularis* L.	Malvaceae	BJRI Deshi Pat Sak-1	Bangladesh Jute Research Institute
Mustard	*Brassica juncea* (L.) Czern.	Cruciferae	Binasarisha-9	Bangladesh Institute of Nuclear Agriculture
Mungbean	*Vigna radiate* (L.) R. Wilczek	Leguminosae	Binamoog-8	Bangladesh Institute of Nuclear Agriculture
Radish	*Raphanus sativus* L.	Cruciferae	PAIRA 40	Winall Hi-Tech Seed Co. Ltd., China
Rice	*Oryza sativa* L.	Poaceae	BRRI dhan34	Bangladesh Rice Research Institute
Tomato	*Solanum lycopersicum* L.	Solanaceae	Binatomato-9	Bangladesh Institute of Nuclear Agriculture
Wheat	*Triticum aestivum* L.	Poaceae	BARI Gom-32	Bangladesh Wheat and Maize Research Institute

Extraction and bioassay procedure: The collected parts of castor (*Ricinus communis*) plant were washed with tap water, then with distilled water. One hundred gram of each part was then chopped and crushed into paste by a mechanical grinder and soaked with 400 mL distilled water and homogenized in a warring blender for 5 min at room temperature (25°C). 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 4°C (normal freezing condition) in a refrigerator until further used. The extraction was done separately for each plant parts of *R. communis*.

The prepared each (bark, stem, leaf, root twig, seed or pericarp) aqueous extract was then diluted into another three concentrations from the previously prepared stock solution 1:5 (w/v) viz., 1:10, 1:15 and 1:20 (w/v). A control distilled water without extract was also maintained. The bioassay experiments were conducted with Completely Randomized Design (CRD) and each experiment was replicated thrice. Twenty seeds of each jute, mustard, mungbean, radish, rice, tomato or wheat were arranged on the filter paper in Petri dishes. After 48 h of incubation the shoot and root length of the corresponding crop species were measured. The inhibitory potential of each extract was then examined against indicator plants following standard laboratory bioassay.

Calculation of inhibition (%): The inhibition (%) was calculated according to the equation described by Islam *et al.*[25] as stated below:

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

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 3.0). The mean differences among the treatments were adjudged following by Duncan's multiple range test.

RESULTS

Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of jute: The aqueous extracts of different plant parts of *R. communis* plant extracts significantly inhibited the shoot and root growth of jute (Table 2). The effect of aqueous extract of *R. communis* varies according to the plant parts and the concentrations of the extracts. All the plant parts of *R. communis* inhibited the seedling growth of jute at all concentrations used in the study except stem extracts. Stem extract inhibited only at 1:5 (w/v). Among the plant parts, bark, leaf, pericarp, seed and twig showed more than 90% shoot and root growth inhibition of jute at concentration 1:5 (w/v). On the other hand, the inhibition values for shoot and root growth of jute by root and stem extracts of *R. communis* were 82 and 78%, 88 and 81%, respectively (Table 2). Stimulatory activity on the shoot and root growth was observed at lower concentration.

Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of mungbean: The aqueous extracts of different plant parts of *R. communis* plant significantly influenced the shoot and root growth of mungbean (Table 3). For shoot growth of mungbean, only leaf aqueous extracts showed more than 80% inhibition, whereas, more than 90% inhibitory effect was observed by leaf and seed aqueous extracts for root growth of mungbean seedlings at 1:5 (w/v) concentration. Stimulatory activity on the shoot and root growth of mungbean were also observed at lower concentration.

Table 2: Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of jute

	Shoot growth inhibition (w/v %)				Root growth inhibition (w/v %)			
Plant parts	1:20	1:15	1:10	1:5	1:20	1:15	1:10	1:5
Bark	11.49^{a}	14.94^{b}	18.39^{c}	91.95^{a}	15.50^{b}	32.21^{c}	34.04^{d}	92.40^{b}
Root	2.79^{c}	26.81^{a}	58.10^{a}	81.56^{b}	25.03^{a}	49.80^{a}	68.36^{a}	87.67^{c}
Leaf	5.60^{bc}	17.60^{b}	40.00^{b}	93.60^{a}	15.50^{b}	17.97^{d}	62.92^{b}	97.07^{a}
Pericarp	12.40^{a}	27.00^{a}	37.95^{b}	91.97^{a}	11.79^{c}	44.99^{b}	55.41^{c}	94.92^{a}
Seed	6.55^{b}	14.75^{b}	36.88^{b}	94.26^{a}	16.62^{b}	17.55^{d}	62.81^{b}	96.76^{a}
Stem	-61.66^{d}	-25.00^{c}	-20.00^{d}	77.50^{c}	-51.60^{d}	-21.60^{e}	-13.92^{e}	81.42^{d}
Twig	9.15^{ab}	29.57^{a}	39.43^{b}	91.54^{a}	17.28^{b}	46.96^{b}	57.12^{c}	94.85^{a}
Level of significance	***	***	***	***	***	***	***	***
CV (%)	-2.75	2.82	3.72	2.25	2.17	5.01	3.29	1.44
LSD	3.56	3.44	3.60	3.56	2.74	2.39	2.73	2.36

In a column, means followed by different letters are significantly different, ***means at 0.1% level of probability

Table 3: Aqueous extracts of *R. communis* plants parts on growth inhibition mungbean

	Shoot growth inhibition (w/v %)				Root growth inhibition (w/v %)			
Plant parts	1:20	1:15	1:10	1:5	1:20	1:15	1:10	1:5
Bark	4.02^{c}	6.04^{d}	16.77^{c}	44.96^{c}	-8.28^{a}	6.35^{c}	10.98^{d}	56.26^{c}
Root	-18.25^{e}	-6.22^{e}	5.80^{d}	58.92^{b}	-41.49^{c}	-24.84^{d}	-5.63^{e}	66.95^{b}
Leaf	16.56^{a}	23.56^{a}	24.84^{a}	82.80^{a}	-7.59^{a}	34.27^{a}	44.16^{a}	90.10^{a}
Pericarp	-5.37^{d}	3.48^{d}	18.98^{c}	46.83^{c}	-5.78^{a}	5.87^{c}	26.71^{c}	52.68^{d}
Seed	11.68^{b}	16.88^{b}	26.62^{a}	79.22^{a}	-7.91^{a}	35.43^{a}	37.05^{b}	91.00^{a}
Stem	-36.94^{f}	-24.89^{f}	-23.69^{e}	6.42^{d}	-38.34^{b}	-30.92^{e}	-28.94^{f}	9.92^{e}
Twig	-3.25^{d}	10.65^{c}	22.18^{b}	47.63^{c}	-7.35^{a}	9.88^{b}	24.90^{c}	52.79^{d}
Level of significance	***	***	***	***	***	***	***	***
CV (%)	-3.64	2.91	1.45	5.08	-9.77	2.11	1.64	2.96
LSD	2.45	3.21	2.43	4.74	2.90	2.48	2.95	3.16

In a column, means followed by different letters are significantly different, ***means at 0.1% level of probability

Table 4: Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of mustard

	Shoot growth inhibition (w/v %)				Root growth inhibition (w/v %)			
Plant parts	1:20	1:15	1:10	1:5	1:20	1:15	1:10	1:5
Bark	4.71^{c}	21.69^{c}	32.07^{d}	83.01^{c}	11.19^{d}	32.85^{c}	46.20^{b}	85.20^{c}
Root	7.04^{c}	19.71^{c}	24.64^{e}	81.69^{c}	-7.57^{f}	1.14^{e}	24.62^{d}	78.78^{d}
Leaf	16.19^{b}	18.57^{c}	41.42^{c}	93.33^{b}	12.50^{d}	32.18^{c}	41.75^{c}	98.40^{a}
Pericarp	31.19^{a}	33.48^{b}	50.91^{b}	95.87^{a}	58.20^{b}	69.93^{a}	79.60^{a}	98.08^{a}
Seed	17.30^{b}	19.23^{c}	41.34^{c}	92.78^{b}	5.40^{e}	14.86^{d}	43.24^{c}	98.38^{a}
Stem	7.95^{c}	21.59^{c}	42.61^{c}	91.47^{b}	15.62^{c}	40.65^{b}	42.12^{c}	95.48^{b}
Twig	32.27^{a}	38.63^{a}	54.54^{a}	96.36^{a}	62.78^{a}	69.66^{a}	81.67^{a}	98.03^{a}
Level of significance	***	***	***	***	***	***	***	***
CV (%)	1.86	3.07	4.12	1.36	6.46	3.85	2.70	0.95
LSD	3.52	3.98	3.017	2.20	2.59	2.55	2.47	1.58

In a column, means followed by different letters are significantly different, ***means at 0.1% level of probability

Table 5: Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of radish

	Shoot growth inhibition (w/v %)				Root growth inhibition (w/v %)			
Plant parts	1:20	1:15	1:10	1:5	1:20	1:15	1:10	1:5
Bark	6.23^{e}	22.58^{bc}	28.38^{d}	75.69^{d}	17.12^{b}	22.92^{b}	39.61^{c}	82.69^{d}
Root	-41.77^{g}	5.33^{d}	8.00^{f}	77.33^{d}	-11.20^{e}	18.40^{c}	23.08^{e}	85.48^{c}
Leaf	27.13^{a}	30.23^{a}	82.16^{a}	98.43^{a}	16.79^{b}	24.42^{b}	82.06^{a}	98.09^{a}
Pericarp	13.29^{d}	19.43^{c}	35.54^{c}	97.18^{ab}	18.10^{b}	30.86^{a}	55.45^{b}	97.88^{a}
Seed	23.25^{b}	27.90^{a}	82.94^{a}	96.89^{ab}	12.89^{c}	16.015^{c}	82.03^{a}	97.26^{ab}
Stem	-4.77^{f}	6.68^{d}	17.19^{e}	93.63^{c}	-3.22^{d}	7.67^{d}	27.89^{d}	95.37^{b}
Twig	17.07^{c}	26.34^{ab}	40.00^{b}	94.39^{bc}	25.06^{a}	32.44^{a}	58.49^{b}	97.20^{ab}
Level of significance	***	***	***	***	***	***	***	***
CV (%)	3.20	1.48	4.35	1.88	4.53	3.70	3.84	1.29
LSD	3.41	4.04	3.25	3.03	2.79	2.98	3.60	2.15

In a column, means followed by different letters are significantly different, ***means at 0.1% level of probability

Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of mustard: The aqueous extracts of different plant parts of *R. communis* plant also significantly inhibited the shoot and root growth of mustard at 0.1% level of probability (Table 4). Compared to jute and mungbean, the aqueous extracts of different parts of *R. communis* showed higher inhibitory effect on shoot and root growth of mustard at concentration 1:5 (w/v). Among the plant parts, leaf, pericarp, seed, stem and twig showed more than 90% shoot and root growth inhibition of mustard at concentration 1:5 (w/v). On the other hand, the inhibition values for shoot and root growth of mustard by bark and root extracts of *R. communis* were 83 and 82%, 85 and 79%, respectively (Table 4). Only the root extract of *R. communis* at 1:20 (w/v) concentration stimulated the root growth of mustard.

Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of radish: The aqueous extracts of different plant parts of *R. communis* plant significantly influenced the shoot and root growth of radish at 0.1% level of probability (Table 5). The leaf, pericarp, seed, stem and twig extracts of

Table 6: Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of rice

	Shoot growth inhibition (w/v %)				Root growth inhibition (w/v %)			
Plant parts	1:20	1:15	1:10	1:5	1:20	1:15	1:10	1:5
Bark	14.86^{a}	22.63^{a}	34.12^{b}	90.20^{a}	15.30^{a}	17.19^{a}	22.01^{b}	69.18^{ab}
Root	-34.05^{d}	-14.01^{c}	6.68^{d}	33.83^{d}	-30.15^{d}	-21.75^{d}	-3.53^{d}	63.74^{b}
Leaf	-2.46^{b}	13.14^{ab}	49.48^{a}	67.35^{c}	-63.45^{f}	-49.24^{e}	-28.93^{f}	94.16^{a}
Pericarp	-35.1^{d}	-34.74^{d}	-32.83^{g}	21.18^{e}	-29.48^{d}	-17.11^{c}	13.86^{c}	91.25^{a}
Seed	-2.71^{b}	6.88^{b}	20.45^{c}	76.20^{b}	-48.24^{e}	-25.41^{d}	60.70^{a}	94.35^{a}
Stem	-25.74^{c}	-13.77^{c}	2.39^{e}	36.72^{d}	-21.53^{c}	-15.57^{c}	-13.32^{e}	68.42^{ab}
Twig	-28.01^{c}	-18.93^{c}	-10.25^{f}	65.68^{c}	-12.52^{b}	-11.24^{b}	22.23^{b}	92.07^{a}
Level of significance	***	***	***	***	***	***	***	***
CV (%)	-7.96	-10. 61	1.53	5.25	-3.75	-12.91	2.45	1.48
LSD	2.29	10.46	3.29	5.22	1.81	4.04	4.72	26.92

In a column, means followed by different letters are significantly different, ***means at 0.1% level of probability

Table 7: Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of tomato

	Shoot growth inhibition (w/v %)				Root growth inhibition (w/v %)			
Plant parts	1:20	1:15	1:10	1:5	1:20	1:15	1:10	1:5
Bark	-12.93^{b}	-3.48^{b}	6.96^{d}	51.74^{d}	16.19^{a}	17.32^{b}	26.70^{c}	39.20^{d}
Root	-27.40^{c}	-10.37^{c}	2.96^{e}	47.40^{e}	-83.01^{e}	-17.76^{c}	2.70^{e}	19.30^{e}
Leaf	-45.94^{d}	-45.27^{d}	-27.70^{f}	87.83^{b}	-55.51^{d}	-37.95^{d}	10.20^{d}	83.67^{c}
Pericarp	17.14^{a}	26.42^{a}	32.14^{b}	92.14^{a}	-2.04^{c}	23.97^{a}	33.27^{b}	94.05^{a}
Seed	-49.29^{d}	-46.47^{d}	-33.80^{g}	88.02^{b}	-57.85^{d}	-38.84^{d}	10.33^{d}	86.36^{b}
Stem	-25.37^{c}	-8.95^{c}	18.65^{c}	84.32^{c}	3.81^{b}	18.72^{b}	38.90^{a}	87.45^{b}
Twig	18.79^{a}	22.81^{a}	40.26^{a}	92.61^{a}	2.925^{b}	24.78^{a}	39.75^{a}	93.45^{a}
Level of significance	***	***	***	***	***	***	***	***
CV (%)	-11.33	-29.25	3.44	2.36	-7.56	-134.21	4.68	1.66
LSD	3.60	4.85	3.05	3.27	3.37	3.32	3.57	2.13

In a column, means followed by different letters are significantly different, ***means at 0.1% level of probability

R. communis showed more than 90% shoot and root growth of radish at 1:5 (w/v) concentration. Whereas, at the same concentration bark and root extracts of *R. communis* showed more than 75 and 80% shoot and root growth inhibition of radish, respectively (Table 5).

Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of rice: The shoot and root growth of rice were significantly influenced by the aqueous extracts of different plant parts of *R. communis* (Table 6). For shoot growth of rice seedlings, only bark aqueous extract showed 90% at 1:5 (w/v) concentrations. Growth stimulation was also observed at lower concentrations. In case of root growth of rice seedlings, leaf, pericarp, seed and twig showed more than 90% growth inhibition at 1:5 (w/v) concentration. The inhibition values of bark root and stem extract were found 69, 64 and 68%, respectively at 1:5 (w/v) concentration. But root, leaf and stem aqueous extracts stimulated rice root growth at below 1:5 (w/v) concentration and pericarp, seed and twig stimulated below 1:10 (w/v) concentration (Table 6). Bark aqueous extract inhibited both shoot and root growth of rice seedlings at all concentrations.

Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of tomato: The shoot and root growth of tomato were significantly influenced by the aqueous extracts of different plant parts of *R. communis*. Pericarp and twig extracts showed more than 90% inhibition and leaf, seed and stem extracts showed more than 80% inhibition at 1:5 (w/v) concentration in the shoot and root growth of tomato (Table 7). For shoot growth, bark and root extracts showed 52 and 47% inhibition. Stimulation on the shoot and root growth of tomato were also found here at lower concentrations.

Effect of aqueous extracts of *R. communis* plants parts on growth inhibition of wheat: The aqueous extracts of different plant parts of *R. communis* plant significantly influenced the shoot and root growth of wheat 0.1% level of probability. Leaf, pericarp, seed and twig extracts showed more than 70% root growth inhibition at the concentration of 1:5 (w/v) and the highest root growth inhibition was observed by leaf extract (93%). Whereas, leaf and seed aqueous extracts showed more than 70% shoot growth inhibition and the highest growth inhibition was 76% by seed

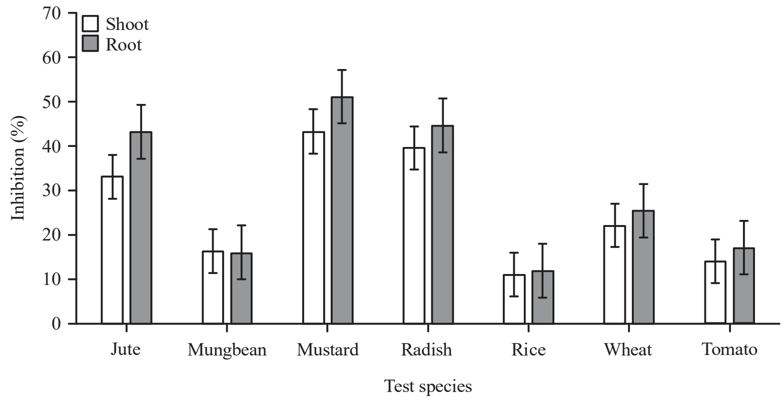

Fig. 1: Sensitivity of the shoot and root growth of different test species to *R. communis* extracts

Table 8: Effect of different plant parts of *R. communis* on the shoot and root growth of wheat

	Shoot growth inhibition (w/v %)				Root growth inhibition (w/v %)			
Plant parts	1:20	1:15	1:10	1:5	1:20	1:15	1:10	1:5
Bark	7.56^{a}	17.64^{b}	22.68^{bc}	26.47^{d}	11.72^{a}	13.89^{b}	21.49^{b}	59.39^{e}
Root	1.25^{b}	2.18^{d}	5.93^{e}	24.37^{d}	3.95^{b}	6.07^{c}	13.24^{c}	57.03^{e}
Leaf	-13.10^{c}	26.64^{a}	27.48^{a}	73.86^{a}	-6.53^{de}	19.71^{a}	28.19^{a}	92.67^{a}
Pericarp	-12.27^{c}	16.84^{b}	19.23^{c}	66.66^{b}	-8.54^{e}	2.25^{d}	9.35^{d}	78.74^{c}
Seed	5.67^{a}	22.89^{a}	24.26^{ab}	75.55^{a}	-7.23^{de}	20.54^{a}	28.52^{a}	85.43^{b}
Stem	8.09^{a}	9.96^{c}	11.83^{d}	53.42^{c}	-2.32^{c}	8.47^{c}	13.66^{c}	69.21^{d}
Twig	-11.93^{c}	15.63^{b}	21.84^{bc}	68.57^{b}	-5.17^{d}	5.33^{cd}	13.47^{c}	79.82^{c}
Level of significance	***	***	***	***	***	***	***	***
CV (%)	-88.95	5.04	2.34	4.09	-60.15	1.83	1.22	2.11
LSD	3.33	4.27	4.18	4.04	2.15	3.45	3.65	2.81

In a column, means followed by different letters are significantly different, ***means at 0.1% level of probability

aqueous extract at the same concentration which was the lowest among the other crops. Similar to other crop species stimulatory activity was also observed here at lower concentration (Table 8).

Average inhibition of *R. communis* plants parts on different test species: Among the test crop species, the shoot growth of mustard was most sensitive species followed by radish to the different parts extract of *R. communis*. Whereas, the shoot growth of rice was less sensitive to the extracts followed by tomato and mungbean (Fig. 1). The root growth of mustard was most sensitive species followed by radish and jute to the different parts extract of *R. communis*. The root growth of rice was less sensitive to the extracts followed by mungbean and tomato (Fig. 1). Among the plant parts, twig showed most phytotoxic activity on the test plants e.g., 33 and 42% on shoot and root growth, respectively (Fig. 2).

DISCUSSION

The inhibitory activity of the aqueous extracts of different parts of *R. communis* on the shoot and root growth of seven field crops increased with increasing the concentration with few exceptions. The concentration 1:5 (w/v) showed significant inhibitory effects on shoot and root growth of all test crops. Stimulatory activity was also observed in some cases especially at lower concentrations. In comparison to the shoot growth of all crops the root growth was more sensitive to the aqueous extracts of different parts of *R. communis*. A number of abnormalities mainly in the root system have been observed where the primary roots were shriveled, defective and in some cases practically or fully absent. The inhibition in shoot and root growth of test plant species in response to allelochemicals is a good indicator of phytotoxicity. This type of growth inhibition by the allelopathic plants extracts were also reported by Khan *et al.*[26], Islam *et al.*[27], Islam and Kato-Noguchi[28], Oliveira *et al.*[29], Masum *et al.*[30] and Islam *et al.*[31].

Ricinus communis is a non-edible biodiesel plants normally found in homestead areas, along roadsides, river-banks, close to gardens and work sites, dumps and other disturbed areas of Bangladesh. Some parts of the world, the plant is considered as weed even though the plant has huge medicinal importance[32]. In natural setting *R. communis* is a colonizer plant and grows vigorously[33-35]. Their colonize areas are reported to inhospitable for other plants, but the reason

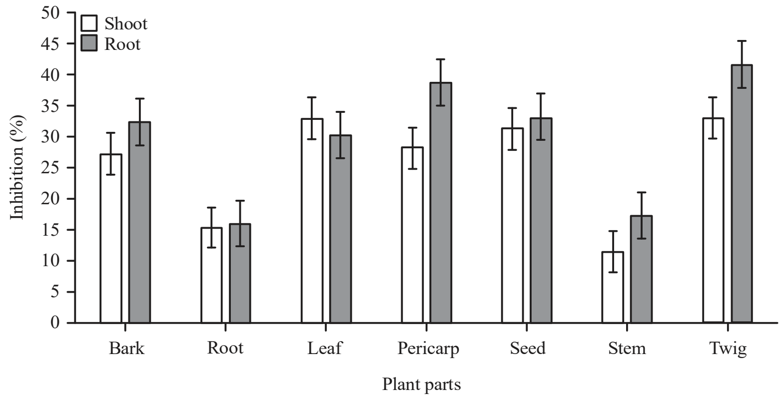

Fig. 2: Average inhibition (%) of aqueous extracts of different plant parts of *R. communis* on the shoot and root growth of test plant species

behind that is quite unclear. Based on the results, one of the major reasons might be due to their allelopathic potentiality. The findings of the study could be helpful for the researchers to isolate and identify the allelochemicals responsible for its growth inhibitory activity. This will explore the plant-plant interaction of *R. communis* to its neighboring plant species. On the other hand, identified allelochemicals can be used as a tool for new natural herbicide development. However, the present study was conducted under control laboratory condition. It is well known that a plant may show strong allelopathic activity on target plants in laboratory experiments, but the magnitude of its activity might differ in the field conditions due to the in uence of several soil-environmental factors[36]. Hence, it is recommended to perform several field experiments before concluding the allelopathy of *R. communis*.

CONCLUSION

These results suggest that *R. communis* has allelopathic properties and may possess allelochemicals. Since, twig of *R. communis* extracts had greater inhibitory activity than other parts, this plant parts could be used for isolation and identification of allelochemicals. Moreover, the results of this experiment will be helpful for the researchers to know the plant-plant interaction of *R. communis* to its neighboring plant species.

SIGNIFICANCE STATEMENT

This study discover the allelopathic potential of different parts of *R. communis* on the seedling growth of seven major field crop species that can be beneficial for isolation and identification of the allelopathic substances responsible for their growth inhibitory activity. This study will help the researcher to uncover the plant-plant interaction of *R. communis* to its neighboring plant species.

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