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Weed Science
ORIGINAL ARTICLE

Effects of weed extracts on germination and seedling growth of some vegetable crops

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A B S T R A C T

Chapra (*Eleusine indica*), Mutha (*Cyperus rotundus*)andDurba (*Cynodon dactylon*) are common weeds causing growth inhibition in crops. Therefore, their inhibitory effect on different crop species needs to be evaluated. A bioassay was carried out in the Plant Ecology Laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh to evaluate the allelopathic effects of the aqueous weed extracts on the germination and seedling growth of vegetable crops like red amaranth, radish and tomato during the period from July to November 2011. Hundred grams each of the weeds was chopped into small pieces and was made paste in mortar and pestles separately to extract them with distilled water having absolute weed extract volume of 100ml (100% conc.). Thus, the treatments were i) the absolute weed extract (100%) from each weed and its dilution with distilled water to ii) 12%, iii) 25% and iv) 50% along with control v) distilled water only. The experiment was laid out following completely randomized design (CRD) where each treatment was replicated five times. Germination percentage in all the test crops was significantly inhibited by the extracts in a concentration dependent manner. The germination of the seed and seedling growth were decreased with increase in concentration of the extracts and the highest inhibitory effect was observed in 100% concentration. Among the weed extract, mutha showed more inhibitory effect on seed germination and seedling growth of the test crops than other weed extracts and tomato seedlings were most sensitive to the extract.

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INTRODUCTION

Allelopathy is a biological phenomenon by which an organism produces one or more biomolecules that influence some other organisms affecting the growth, survival, reproduction and other processes. These biomolecules are known as allelochemicals and can have beneficial or detrimental effects on the target organisms. In field condition, crops and weeds germinate at about the same time and they grow simultaneously in the same land. Reduction in crop production due to weed infestation is not only caused for the competition between weeds and crops for natural resources (light, water, space and nutrients) but also for the exudation of toxic chemicals by weeds into the environment. The toxicity of weeds on crops through the phytotoxic exudates was first reported by De Candolle (1832). These effects are selective and concentration dependant and may have inhibitory or stimulatory effect on the growth of subsequent crops or weeds (Naseem et al. 2003; Cheema et al. 2004; Jalili et al. 2007). Rice (1984) reported allelopathic effects of purple nutsedge (*Cyperus rotundus*). Komai et al. (1977) isolated and identified some chemicals in purple nutsedge tubers *viz.* cyperone, ß-selinene, cyperenone, α-cyperone and they were found to inhibit the germination and root growth of crop plants. Hakim et al. (2011) reported that aqueous extracts of some common weeds strongly inhibit the growth and development of vegetable crops.

The use of herbicides causes many problems *viz.* development of resistance in organisms, environmental pollution, toxicity related health hazards in humans and livestock's. Hence, such practices are not sustainable and cannot remain in use forever. Before the widespread use of herbicides, weeds were controlled chiefly by cultivation and crop rotation. Moreover, use of allelopathy is one of the safe alternatives to overcome these

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problems and to achieve sustainability in agriculture and maintenance of clean environment for our future generations. Use of allelopathic strategies appears to reduce environmental pollution and maintaining ecological balance especially soil fauna and flora through reduced use of chemical herbicides or substituting them with natural products (Mahmood and Cheema 2004).

There are so many weeds found in crop fields of Bangladesh. Among them chapra (*Eleusine indica*), mutha (*Cyperus rotundus*) and durba (*Cynodon dactylon*) are common and treated as noxious weeds. These strongly inhibit the growth of crop plants in field condition. However, their levels of inhibition to the crop plants are not well documented. Therefore, the present study was undertaken to study allelopathic effect of the aqueous extracts of some selected noxious weeds on some test crops like red amaranth, radish and tomato, and to evaluate the level of susceptibility of those crops to the aqueous extracts of those weed species.

MATERIALS AND METHODS

Test Plant Materials

Seeds of three vegetable crops viz., red amaranth (*Amaranthus gangeticus var.* Altapetti), tomato (*Lycopersicon esculentum var.* Roma) and radish (*Raphanus sativus var.* Tasakishan), and three *w*eeds viz., chapra or crab grass (*Eleusine indica*), mutha (*Cyperus rotundus*)anddurba (*Cynodon dactylon*) were used in this experiments.

Preparation of Weed Extracts

Hundred gram each of fresh weeds (whole plants including nuts) was chopped into small pieces and ground to paste with distilled water in a mortar and pestle separately. The mixture was filtered through filter paper (Whatmann no.1) and the filtrates were collected in volumetric fluxes. The extract volume was adjusted to 100 mL with distilled water for the bioassay and this was considered as stock solution for absolute concentration. Same procedure of extraction was followed for all the selected weeds taking whole plants.

Experimental Treatments

The final extracts of 100 mL each from the weeds (chapra, mutha and durba) were used as stock solution (100%) which was diluted with distilled water to a series of concentrations. The dilutions were 50%, 25% and 12% of the stock solution (100%) for each weed species and were considered as test solutions including distilled water as control. Each extract along with the control (distilled water) for the weeds were treated as experimental treatments.

Bioassay Procedure

Glass petri dishes of 15 cm diameter were used in this experiment. Double layer of tissue papers (Bashundhara company ltd.) were used as the medium of germination in each Petri dish. Ten milliliters extracts of each test solution (extract) as per treatments was added to moisten the substratum. Thirty seeds of red amaranth were placed uniformly by a pair of forceps in each treated petri dish with five replications and were kept in racks in dark at room temperature. Germination was recorded daily. A seed was said to be germinated when the emerged root length was about 2 mm. After six days, length of root and shoot of some selected seedlings from each perti dish were recorded to evaluate inhibition potential of the extract. The same bioassay procedure was followed for tomato and radish with all extracts.

Experimental Design

The experiment was laid out in a completely randomized design (CRD) where each treatment was replicated five times. All the treatments were distributed in the Petri dishes according to the principle of randomization.

Seed Germination Calculation

Data on the germination were recorded daily at 24 h intervals after sowing and continued up to completion of germination in six days. Germination percentage was calculated using the following formula.

$$\%\ \text{Germination} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

Sampling for Seedling Growth

The petri dishes were carefully taken out from the racks at dark place after six days of sowing. Ten seedlings were selected randomly from each petri dish and were uprooted carefully by a forceps in order to ensure intact root to be available. The root and shoot length of the uprooted seedlings were recorded by a graduated meter scale.

Evaluation of Inhibition

After recording the data on germination and seedling growth, the potential effect of each test solution on the test crops was calculated as percent inhibition in germination and growth over control treatment (distilled water) using following formula:

$$\text{Inhibition (\%)} = \frac{\text{Germination or growth in in test solution} - \text{Germination or growth in control}}{\text{Germination or growth in control}} \times 100$$

Statistical Analysis

Data recorded on germination and growth parameters were complied and tabulated for statistical analysis. Analysis of variance was done with statistical package MSTAT-C software. The mean differences among the treatments were tested by Duncans Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effect of Weed Extracts on Seed Germination

The aqueous extracts of the weeds (chapra, durba and mutha) at different concentrations were prepared and their allelopathic effects were evaluated through petri dish seed germination test using the vegetable crops *viz.* red amaranth, radish and tomato as test materials. Maximum germination was recorded in distilled water (control) followed by 12% weed extracts irrespective of their sources. On the other hand, the most concentrated extract (100%) showed strongest inhibition on the germination of these crops. Among the weed extract, mutha exerted significantly highest inhibition on seed germination of different crops and chapra inhibited the lowest (Table 1). The similar results were found by Challa and Ravindra (1998). They applied root extracts of mutha (*Cyperus rotundus*) on onion and radish and observed reduced germination of the test crops. The results from the germination test reveal that germination percentage of vegetable seeds decreased with increasing the concentration of the weed extracts irrespective of weed species (Table 2). The allelopathic potential *Cynodon dactylon* was also tested against wheat, barley and maize varieties and the results showed that seed germination was significantly reduced by the weed extract (Hussain and Khan 1988). However, the germination responses to the weed extracts varied with the crop species. Among them tomato seeds were more responsive followed by red amaranth to the weed extracts.

Table 1. Effect of aqueous weed extracts of different concentrations on the seed germination (%) of some vegetable crops

Weeds	Red amaranth		Radish		Tomato	
	24hrs	72hrs	24hrs	72hrs	48hrs	96hrs
Chapra	16.2a	49.8a	33.4a	48.9a	15.8a	43.1a
Durba	14.2b	45.7b	29.6b	42.2b	14.0b	39.1b
Mutha	13.0b	40.7c	24.4c	35.8c	12.0c	34.0c
Conc. (%)	24hrs	72hrs	24hrs	72hrs	48hrs	96hrs
Control	25.4a	77.3a	50.7a	70.7a	26.7a	71.5a
12	17.8b	51.8b	38.7b	52.2b	16.7b	47.8b
25	13.7c	41.5c	29.6c	42.2c	11.5c	35.9c
50	10.7d	33.0d	17.8d	31.1d	9.3d	25.2d
100	4.8e	23.3e	8.9e	15.2e	5.6e	13.3e

Table 2. Effect of aqueous extracts from different weeds on the seed germination of some vegetable crops assayed through petri dish germination method

Treatments		Seed germination (%)					
		Red amaranth		Radish		Tomato	
Weeds	Conc. of the extracts (%)	24 hrs	72 hrs	24 hrs	72 hrs	48 hrs	96 hrs
Chapra	Control	24.3ab	77.8a	53.3a	70.0a	25.6a	73.3a
	12	18.9bc	58.9b	46.1b	62.2b	18.9b	51.1b
	25	17.8c	46.7cd	34.4cd	51.1c	14.4cd	41.1d
	50	13.3cde	37.8de	21.1e	41.1cd	12.2d	31.1e
	100	6.7f	27.8g	12.2f	20.0f	7.8e	18.9g
Durba	Control	25.6a	75.3 a	50.0a	68.9a	26.7a	71.1a
	12	17.8c	54.4bc	40.0bc	52.2bc	16.7c	48.9bc
	25	13.3cde	42.2d	30.0cd	43.3c	11.1d	36.7de
	50	10.0d	33.3ef	18.9ef	31.1e	8.9e	25.6f
	100	4.4f	23.3 h	8.9g	15.6g	6.7f	13.3h
Mutha	Control	26.3a	78.9a	48.9a	73.3a	27.8a	70.0a
	12	16.7 cd	42.2d	30.0cd	42.2cd	14.4cd	43.3cd
	25	10.0d	35.6e	24.4d	32.2 d	8.9e	30.0e
	50	8.9e	27.8g	13.3f	21.1f	6.7f	18.9g
	100	3.3f	18.9i	5.6h	10.0g	2.2g	7.8h

The figures in a column having the same letter(s) do not differ significantly as per DMRT at 5% level of significance

Effect of Weed Extracts on Root Length

Suppressive allelopathic effects of the aqueous extracts of different weeds on the root growth of the vegetables crops were assessed through bioassay. Irrespective of source of the extracts, the root growth of the test crops was significantly affected by the weed extracts. The root length of red amaranth seedlings in control (distilled water) was about 72 mm which was significantly reduced by absolute concentrated extract (100%) to 41, 32,18 mm for the extracts from chapra, durba and mutha, respectively(Table 4), indicating that the weed extracts had a strong inhibitory effect of root growth. Considering the inhibitory view point, strongest inhibitory effects (43, 55 and 76% over control) were observed in 100% concentration of the extracts from chapra, durba and mutha, respectively, followed by 50% concentration of these weed extracts. The lowest inhibitions in root length (12, 18 and 26% over control) were found in red amaranth at 12% weed extract from chapra, durba and mutha, respectively, at the same condition (Figure 1). Root length of radish seedling was also significantly different for weed extracts. Results revealed that root length in radish significantly decreased with increased in the concentration of the different weed extracts (Figure1). Hundred percent concentrated extract showed the strongest inhibitory effect on the root growth (46, 58 and 74% over control) of radish seedlings and resulted in 43, 34 and 21 mm root length for the chapra, durba and mutha extracts, respectively, followed by 50% extract (Table 4). Unlike radish seedlings, the lowest inhibition 15, 21 and 26% over control was found for the extract from chapra, durba and mutha, respectively at 12% concentration of the absolute extract (100%) (Figure1). Similar results were found in case of tomato where 100% concentration of the weed extracts exhibited the strongest root growth inhibition followed by 50% concentration and the lowest inhibition was found for 12% extract of the different weeds (Figure1).

Table 4. Inhibition potentials of the aqueous extracts from different weeds on the root growth of some vegetables grown in petri dishes for six days in dark at ambient condition

Treatments		Root length of the crop seedlings (mm)		
Weeds	Conc. of the extracts (%)	Red amaranth	Radish	Tomato
Chapra	Control	72.4 a	80.4 a	77.0 a
	12	63.5 b	68.1 b	66.5 b
	25	56.5 d	63.7 c	59.1 d
	50	50.4 g	55.5 e	48.5 f
	100	41.3 i	43.4 g	38.1 h
Durba	Control	72.4 a	80.4 a	77.0 a
	12	59.3 c	63.7 c	62.0 c
	25	52.4 f	56.3 e	53.7 e
	50	44.3 h	49.1 f	42.1 g
	100	32.7 k	33.5h	30.2 i
Mutha	Control	72.4 a	80.4 a	77.0 a
	12	54.3 e	59.6 d	52.7 e
	25	44.3 h	48.3 f	42.3 g
	50	36.9 j	35.3 h	30.3 i
	100	17.7 l	21.0 i	7.5 j

The figures in a column having the same letter (s) do not differ significantly as per DMRT at 5% level of significance

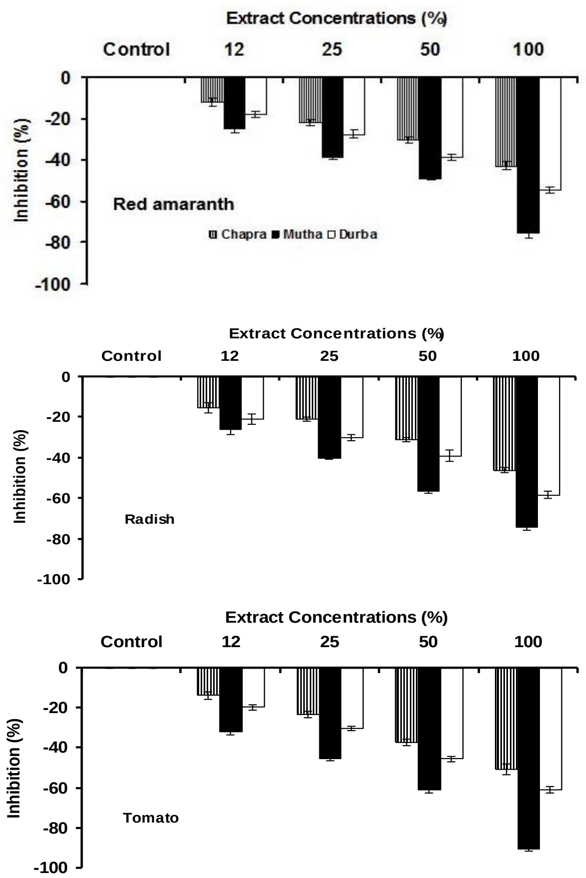

Figure 1. Effect of aqueous extracts of different weeds on the root growth inhibition over control of red amaranth, radish and tomato after six days of germination

Among the weed extracts, the extract from mutha exerted the strongest inhibition than other two weed extracts. It seems that the extract from mutha might have some toxic chemicals (Komai et al. 1977) and those might induce stronger inhibition than those from the other weed extracts. Chapra showed lowest inhibition and highest germination of those vegetables, as a result highest root length was observed in case of chapra and lowest root length was observed in case of mutha. It was also observed that root length was gradually decreased with the increasing concentration of the extracts (Table 3). Among the crops, the highest inhibition was recorded in tomato (90% over control) followed by red amaranth (76%) and radish (74%) from mutha extract at 100% concentration. Similar results were also observed by Zeng and Luo (1996). They applied root extract of *Cymbopogon citrons* on radish, rice and cucumber root growth and observed the adverse effect of the extract on those crops. Sanget al. (2003) reported that leaf extracts of alfalfa is autotoxic to seed germination and root growth of alfalfa seedlings.

Effect of Weed Extracts on Shoot Length

The effect of extracts from chapra, durba and mutha on shoot length of red amaranth was found statistically significant. The shoot length had shown decreasing trend with increasing the concentration of weed extracts (Table 5). The longest shoot of 65 mm was observed in control followed by treatment at 12% concentration in red amaranth. Absolute concentrated extracts (100%) had shown the shortest length of shoot (42, 39 and 28 mm for the extracts of chapra, durba and mutha, respectively), indicating that weed extracts exerted inhibitory effect on the shoot growth too. The highest percent of adverse effect (36, 41 and 57% over control) were found for hundred percent concentration of the extract from chapra, durba and mutha, respectively, and the lowest (9, 13 and 18% over control) from 12% concentration (Figure 2). On the other hand, the shoot length of radish was reduced to 49, 43 and 35 mm when treated with 100% extract from chapra, durba and mutha, respectively, which indicated the adverse effect of these weed extract on shoot growth (Figure 2). Similar result was found in case of tomato where 100% concentration of weed extracts caused maximum shoot length inhibition followed by 50% concentration of weed extract and the lowest was found in 12% extracts of different weeds (Table 6) and (Figure 2). Among the weed extract, mutha extract had strongest inhibitory action than other two weed extract. Among the crops, tomato experienced the highest inhibition (67%) from mutha extract (100%) followed by red amaranth (57%) and radish (50%). The result is in agreement with the findings of Rao and Kumar (1996) who applied root extract of *Dutura metel* on groundnut and observed the toxic effect of extract on the test crops. Zeng and Shiming (1996) studied the allelopathic effects of aqueous extracts of *Binderns pilosa* on seedling growth of radish, rice and cucumber. Result showed that the inhibitory effects of the extracts were strong. Kim et al. (1993) evaluated the allelopathic nature of chapra (*Eleusine indica*) extract from whole plant on radish.The stem extract was the most inhibitory and 5% (w/v) concentration inhibited completely the seedling growth of radish. Among the crop species, radish was the most susceptible followed by wheat and rice. In contrast, Lall and Savongdy (1981) observed no adverse effect of root exudates or leachates of purple nutsedge residues on the germination of vegetable seeds but root growth and plant height were affected.

Table 5. Effects of aqueous weed extracts and concentration on shoot length (mm)

Weeds	Redamaranth	Radish	Tomato
Chapra	54.2a	60.9a	53.8a
Durba	51.1b	57.3b	50.7b
Mutha	45.6c	51.3c	44.1c
Conc(%)	Red amaranth	Radish	Tomato
Control	64.8a	70.2a	67.0a
12	56.3b	61.7b	55.6b
25	50.3c	57.5c	48.9c
50	43.9d	50.8d	42.4d
100	36.0e	42.3e	33.7e

Table 6. Inhibition potentials of the aqueous extracts from different weeds on the shootgrowth of some vegetables grown in petri dishes for six days in dark at ambient condition

Treatments		Shoot length (mm)		
Weeds	Conc. of the extracts (%)	Red amaranth	Radish	Tomato
	Control	64.8 a	70.2a	67.0 a
	12	59.1 b	65.1b	61.7 b
Chapra	25	54.7 cd	63.1b	56.1 d
	50	50.4 f	56.9c	49.2 f
	100	41.8 h	49.1d	42.9 h
	Control	64.8a	70.2a	67.0 a
	12	56.3 c	63.2b	59.5 c
Durba	25	51.4 ef	57.8c	53.5 e
	50	44.3 g	52.3c	46.2 g
	100	38.5 i	43.1e	38.5 i
Mutha	Control	64.8 a	70.2 a	67.0 a
	12	53.5 de	56.9 d	53.8 e
	25	44.9 g	51.5 e	46.9 g
	50	36.9 i	43.2 g	39.3 i
	100	27.7 j	34.7 h	22.5 j

The figures in a column having the same letter (s) do not differ significantly as per DMRT at 5% level of significance

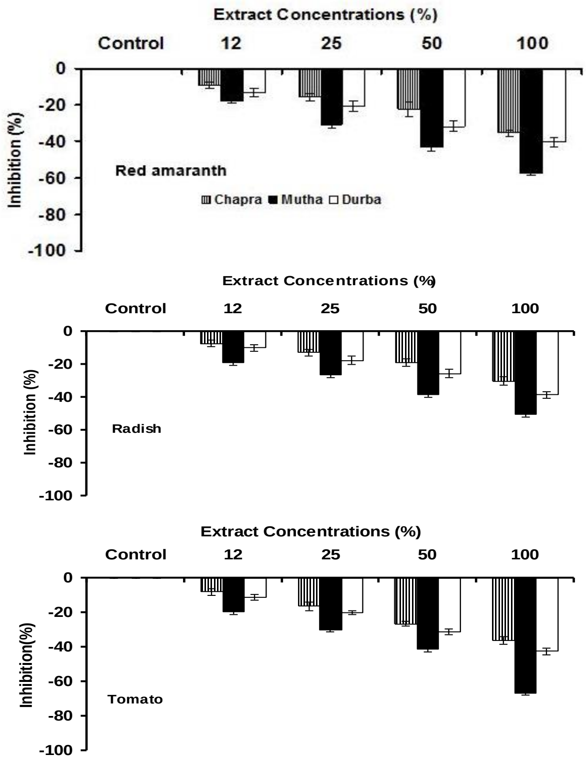

Figure 2. Effect of aqueous extracts of different weeds on the shoot growth inhibition over control of red amaranth, radish and tomato after six days of germination

CONCLUSION

The results led to the conclusion that the mutha weed extracts showed more adverse effect on root length as well as shoot length of tomato, radish and red amaranth. Irrespective of concentration of the weed extracts, root length of these crops were more inhibited than the shoot because the root was in direct contact with the extract than that of shoot. More specifically, mutha extract showed the strongest inhibition to germination, root length and shoot length of tomato followed by radish and red amaranth compared to other weed extracts.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

REFERENCES

Cheema ZA, Khaliq A, Saeed S. 2004. Weed control in maize (*Zea mays* L.) through sorghum allelopathy. J Sust Agric, 23: 73-86.

Challa, Ravindra PV. 1998. Allelopathic effects of major weeds on vegetable crops. Allelopathy J, 5: 89-92.

De Candolle, MAP. 1832. Physiologic Vegetaic lll Bchet, Jeune. Lib-Fac. Med. P. 1474.

Hakim MA, Begum S, Asaduzzaman M, Pramanik MHR. 2011. Inhibitory effect of weed exudates on germination and seedling growth of different crops. Bangladesh J Agriculturist, 4: 41-47.

Hussain F, Khan TW. 1988. Allelopathic effects of Pakisthan weed *Cynodon dactylon* (L) Pers. Weed Sci, 35: 9-17.

Jalili A, Abbassi F, Bazoobandi M. 2007. Allelopathic influence of canola on germination of five weeds of canola fields. Absts. International Workshop on Allelopathy-Current trends and future application. University of Agriculture, Faisalabad, Pakistan.

Komai K, Iwamura, J, Ueki K. 1977. Isolation, identification and physiological activities of sesquiterpenes in purple nutsedge tubers. Weed Res (Japan), 22:14-18.

Mahmood A, Cheema ZA. 2004. Influence of sorghum mulch on purple nutsedge (*Cyperus rotundus* L.).Int J Agric Biol, 6 (1): 86–88.

Naseem M, Cheema ZA, Bazmi SA. 2003. Allelopathic effects of sunflower aqueous extracts on germination of wheat and some important wheat weeds. Pak J Sci Res, 5:71-75.

Rice EL. 1984. Allelopathy 2nd, Academic press, New York.

Sang RM, Sheriff PK, Perumal P, Seetha RM, Chandra BR, Mossa SM, Pallikonda PRK. 2003. Allelopathic potential of shoot and root leachates of certain weed species. J Agron Crop Sci, 164:81-84.

Zeng RS, Lou SM. 1996. The allelopathic effects of root exudates of *Cymbopogon citratus*, *Aratiim conyzoi* and *Bidens pilosa.* J South China Agril Univ, 17:119-120.