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Assessment of allelopathic potential of different weeds on germination and early growth of aromatic rice

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Abstract

An experiment was carried out at the Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh during the period from July to November 2011 to investigate the allelopathic potential of different weeds on aromatic rice cv. BRRI dhan 50. Six weed species *viz.,* joina (*Fimbristylis miliacea*), mutha (*Cyperus rotundus*), khude shama (*Echinochloa colonum*), sobuj nakful (*Cyperus difformis*), foska begun (*Physalis heterophylla*) and chapra (*Eleusine indica*) were used in the experiment to observe their allelopathic effects on seed germination, root length, shoot length and dry matter production of aromatic rice. The result depicts that unboiled and boiled weed extracts have negative influence on germination and primary growth of aromatic rice. The ranking of weed species in respect of inhibitory effect on seed germination were *Echinochloa colonum* > *Cyperus difformis* > *Cyperus rotundus* > *Eleusine indica* > *Fimbristylis miliacea* > *Physalis heterophylla.* Khude shama (*Echinochloa colonum)* and sobuj nakful (*Cyperus difformis*) had strong detrimental effects on the early growth of aromatic rice. The experimental results proved that it was important to exclude two allelopathic weeds namely khude shama (*Echinochloa colomum*) and sobuj nakful (*Cyperus difformis*) in the aromatic rice field. So, it can be concluded that these two weeds should be avoided from the aromatic rice field during land preparation.

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Introduction

Rice (*Oryza sativa* L.) is the top most important cereal crop and staple food of about 135 million people of Bangladesh. It is grown on about 10.5 million hectares of land which has remained almost stable over the past three decades. Its average production is only 2.85 tons/ha which is very low compared to others rice producing countries like China, India, Indonesia, Vietnam, Brazil, Myanmar etc. (Anon., 2015). Low yield in Bangladesh is due to global warming results in climate change leading unwanted flood, prolonged drought, salinity intrusion, diseases and pest outbreak etc., as well as lacks of agricultural inputs on time, cultivation of local rice cultivar are also shared unsatisfactory production.

Weed is an undesirable plant and a serious pest of our crops including aromatic rice. It has been a persistent problem for farmers ever since beginning of agriculture because it causes enormous economic losses of farmers by reducing crop yields, increase costs of production and impair crop quality (Bhuler *et al.*, 1998). They often cause of total crop failure (Islam and Molla, 2001). Alarmingly greater loss in the yield of rice due to weed infestation has been reported by many investigators from the different parts of the world (Smith, 1993). In rice, the loss of yield due to weed infestation is greater than the combined yield losses caused by insect pest and diseases (Abbas *et al.*, 1995). Both transplanted and direct seeded rice, weeds are common and highly competitive to the crop. In addition, it causes a considerable reduction in yield by reducing soil fertility and productivity (Ahmad *et al.*, 1977).

Weed impairs crop productivity in many ways. It competes with crop plants for light, moisture, and other essential nutrients. Weeds are known to exhibit allelopathy by releasing water-soluble allelochemicals from leaves, stems, roots, rhizomes, flowers, fruits and seeds to the atmosphere or rhizosphere by means of volatilization, leaching, decomposition of residues, root exudation in ample quantities and long persistence to affect neighboring successional plants very badly (Ahn, 2000; Alam *et al.*, 1990; Batish *et al.*, 2007; Duke *et al.*, 2007; Rahimsouroush, 2007). Weeds which compete with main crops for nutrients and environmental variables besides appear to be toxic to the germination and seedling growth of the plants (Mojab and Mahmoodi, 2009). The harmful effect of weed allelopathy on the growth and development of field crops are well documented. The present study has been undertaken to examine the influence of some important weeds on germination and primary growth of aromatic rice. A number of weeds grow in aromatic rice field, which compete with crop and reduce crop yield. When the weed shows allelopathic effect, the qualitative and quantitative damage may be severed on the basis of allelochemicals present in the species. If the allelopathic effect of specific weed species on particular crop can be known, weed management becomes economically more effective for the crop grower. By knowing the potentiality of allelopathy in specific weed, growers can remove those species from the crop field before they contribute allelopathy to crop suppression. With the above views in mind, the present study was undertaken to observe the allelopathic effects of different weed species on seed germination and primary growth of aromatic rice cv. BRRI dhan 50.

Materials and methods

Six common weed species *viz.* joina (Lesser fimbristylis/*Fimbristylis miliacea*), mutha (Purple nutsedge/*Cyperus rotundus*), khude shama (small burnyardgrass /*Ehinochloa colonum*), sobuj nakful (Smallflower umbrellagrass /*Cyperus difformis*), foska begun (Clammy ground cherry/*Physalis herophylla*) and chapra (Indian goosegrass /*Eleusine indica*) collected from the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh; were used as treatment. Aromatic rice cv. BRRIdhan 50 (Banglamoti) was used as test crop in the experiment.

Preparation of weed extracts

Collected weed species were washed, chopped and macerated separately. In a set, fresh weed mass (250 g) of each weed species was boiled in 1 L water and kept for 3 days with intermittent stirring. The extracts were filtered through filter paper (Whatman No. 1). The filtrates were used as boiled extracts of weeds. In another set, 250 g fresh weed mass were decomposed in 1 L water for 7 days at normal room temperature. The extracts were filtered and used as unboiled extract. Thus boiled and unboiled extracts of each weed species were prepared and used in this experiment following the technique as stated by Prasad and Srivastava (1991).

Experimental procedure

Twenty five seeds of aromatic rice were placed in each petridish lined with double layer of filter paper and treated with weed extracts. Fifteen milliliter aqeous extracts of different weeds were put in each petridish and a control set with distilled water was run simultaneously every time. The filter papers were kept constantly moist with distilled water. The experiment was arranged in a completely randomized design with 3 replications at room temperature (28 ± 1°C).

Methods of data collection

Data on the following parameters were recorded:

a) Germination (%)

b) Days to complete germination

c) Seedling growth and weight

i) Root and shoot lengths

ii) Root and shoot weights

The number of germinated seeds was counted from the beginning to completion of the seed germination and expressed in per cent. Mean time required for germination was calculated after counting the germinated seeds. The root and shoot lengths, fresh and dry weights of aromatic rice seedlings were measured 14 days after plating the seeds for germination. 10 plants were selected to each parameter and the average results were calculated from the test plants. The means for all treatments were calculated and analysis of variance for all characters was performed by F-test. The significance of difference between the pairs of means was calculated by LSD.

Results

Effect of unboiled and boiled weed extracts on seed germination

The experimental findings revealed that seed germination varied significantly due to the effect of unboiled and boiled weed extracts on aromatic rice seeds cv. BRRIdhan 50 (Table 1 & Table 2). In case of unboiled extract (Table 1), maximum germination rate (96.2%) was observed in control and minimum rate (80.8 %) was found in khude shama (*Echinochloa colonum)* extract treated seeds. It was observed that germination rate was comparatively higher due to less allelopathic effect of *Physalis heterophylla* (93.0%), *Fimbristylis miliacea* (91.6%), *Eleusine indica* (91.0%), *Cyperus rotundus* (89.3%) and *Cyperus difformis* (82.5%) extract treated seeds. The ranking of weed species in respect of inhibitory effect on seed germination of aromatic rice seed was *Echinochloa colonum* > *Cyperus difformis* > *Cyperus rotundus* > *Eleusine indica* > *Fimbristylis miliacea* > *Physalis heterophylla*. Again, days required to complete the germination of seeds was also affected significantly by weed extracts. Minimum days (3.00 days) required to complete the germination was recorded in control treatment where as maximum days (7.00 days) were recorded in *Echinochloa colonum* extract treated seeds. Therefore, the effect of unboiled extracts of different weed species induced statistically significant variation in germination rate and number of days required to complete the germination of aromatic rice seeds.

In case of boiled extract (Table 2), maximum germination rate (95.5%) was observed in control and minimum rate (75.5%) was found in khude shama (*Echinochloa colonum*) extract treated seeds.

The rate of germination was comparatively higher due to less allelopathic effect of *Physalis heterophylla* (92.8%), *Fmbristyis miliacea* (91.2%), *Eleusine indica* (90.3%), *Cyperus rotundus* (90.3%) and *Cyperus difformis* (83.3%). The ranking of selected weed species in respect of inhibitory effect on seed germination of aromatic rice was *Echinochloa colonum* > *Cyperus difformis* > *Cyperus rotandus* > *Eleusine indica* > *Fimbristyis miliacea* > *Physalis heterophylla.* Again, days required to complete the germination of seeds was also affected significantly by weed extracts. In case of boiled extract, the lowest number of days (4.10 days) required to complete the germination was recorded from control treatment whereas maximum days (6.23 days) were recorded from khude shama (*Echinochloa colonum*) extract treated seeds.

Table 1. Effect of unboiled weed extracts on germination and early growth of aromatic rice cv. BRRI dhan 50 (Banglamoti).

Experimental treatments	Germi-nation (%)	Days to complete germination	Root length (cm)	Shoot length (cm)	Fresh weight of root (mg)	Dry weight of root (mg)	Fresh weight of shoot (mg)	Dry weight of shoot (mg)
Control	96.2	3.00	8.25	9.87	5.81	4.25	8.28	5.15
Joina (*Fimbristylis miliacea*)	91.6	4.75	4.13	4.00	2.90	2.10	5.33	4.35
Mutha (*Cyperus rotundus*)	89.3	4.33	4.85	5.35	3.85	2.18	4.91	3.10
Khude shama (*Echinochloa colonum*)	80.8	7.00	3.50	4.00	2.17	1.53	3.19	2.56
Sobuj nakful (*Cyperus difformis*)	82.5	6.00	3.89	4.40	2.50	2.00	3.50	2.90
Foskabegun(*Physalis heterophylla*)	93.0	4.28	7.80	8.00	5.40	3.39	8.12	5.12
Chapra(*Eleusine indica*)	91.0	5.10	6.80	7.48	4.80	3.00	7.12	4.95
LSD	0.8	0.15	0.24	0.23	0.27	0.15	0.22	0.16
Level of significance	**	**	**	**	**	**	**	**
CV (%)	6.3	6.2	5.3	6.2	7.1	6.1	6.3	8.2

** Significant at 1% level of probability.

Table 2. Effect of boiled weed extracts on germination and early growth of aromatic rice cv. BRRI dhan 50 (Banglamoti).

Experimental treatments	Germin-ation (%)	Days to complete germination	Root length (cm)	Shoot length (cm)	Fresh weight of root (mg)	Dry weight of root (mg)	Fresh weight of shoot (mg)	Dry weight of shoot (mg)
Control	95.5	4.10	8.00	9.50	6.25	4.15	8.71	5.29
Joina (*Fimbristylis miliacea*)	91.2	4.00	4.10	3.80	2.80	2.00	5.10	4.00
Mutha (*Cyperus rotundus*)	90.3	4.25	4.00	4.10	2.50	1.98	4.05	3.33
Khuda shama (*Echinochloa colonum*)	75.5	6.23	3.25	4.00	2.16	1.20	2.75	1.50
Sobuj nakful (*Cyperus difformis*)	83.3	5.80	3.60	4.25	2.79	1.56	2.89	1.73
Foskabegun (*Physalis heterophylla*)	92.8	4.00	7.40	7.80	5.33	3.20	8.00	5.00
Chapra (*Eleusine indica*)	90.3	4.75	6.40	7.25	4.50	2.90	7.11	4.73
LSD	0.3	0.41	0.43	0.24	0.23	0.11	0.10	0.57
Level of significance	**	**	**	**	**	**	**	**
CV (%)	7.7	17.7	7.4	9.9	2.4	4.7	4.3	4.1

** Significant at 1% level of probability.

Effects on root and shoots lengths

The result revealed that unboiled and boiled weed extracts reduced root and shoot lengths of aromatic rice cv. BRRIdhan 50 significantly (Tables 1 & Table 2). In case of unboiled extract (Table 1), the highest root length (8.25 cm) of aromatic rice seeding was observed in control treatment and the lowest root length (3.50 cm) was obtained in khude shama (*Echinochloa colonum*) extract treated aromatic rice seedling.

In case of boiled extract (Table 2), the highest root length (8.00 cm) of aromatic rice was observed in control treatment and the lowest root length (3.25 cm) was found in khude shama (*Echinochloa colonum*) extract treated aromatic rice seedlings. Again, maximum shoot length (9.87 cm) of aromatic rice seedling was noted in control treatment and minimum shoot length (4.00 cm) was recorded in unboiled extract of khude shama (*Echinochloa colonum*) and joina (*Fimbristylis miliacea*). Again, maximum shoot length (9.50 cm) of aromatic rice seedling was noted in control and minimum shoot length (3.80 cm) was recorded in boiled extract of khude shama (*Echinochloa colonum*) as presented in Tables 2. Reduced shoot and root lengths were observed in this experiment was possibly due to the effect of allelochemicals of weed species under investigation.

Effects on fresh and dry weights of roots

The effect of unboiled and boiled extracts of weeds on aromatic rice seedlings indicated significant reduction on fresh and dry weights of root. In case of unboiled weed extract (Table 1), maximum fresh (5.81 mg) and dry (4.25 mg) weights of root were recorded in control treatment. On the other hand, minimum fresh (2.17 mg) and dry (1.53 mg) weights were recorded in unboiled extract of khude shama (*Echinochloa colonum*). In case of boiled weed extract (Table 2), maximum fresh (6.25 mg) and dry weights (4.15 mg) were observed in control treatment. Minimum fresh (2.16 mg) and dry (1.20 mg) weights of root were found in boiled extract of *Echinochloa colonum*. Fresh and dry weights of root of aromatic rice seedlings were inhibited significantly by allelopathic effect of different weed species.

Effects on fresh and dry weights of shoot

Fresh and dry weights of shoot of aromatic rice seedlings were affected significantly by the allelopathic effect of unboiled and boiled extracts of different weed species. In case of unboiled extract (Table 1), Maximum fresh (8.28 mg) and dry (5.15 mg) weights of shoot were found in control (no weed extract) whereas minimum fresh (3.19 mg) and dry (2.56 mg) weights were recorded in the seedlings treated with *Echinochloa colonum* extract. On the other hand, In case of boiled extract (Table 2), maximum fresh (8.71 mg) and dry (5.29 mg) weights of shoot were recorded in control and minimum fresh (2.75 mg) and dry (1.50 mg) weights of shoot were recorded in extract of *Echinochloa colonum*.

Discussion

The effects of unboiled and boiled weed extracts of six weed species viz. joina (*Fimbristylis miliacea*), mutha (*Cyperus rotundus*), khude shama (*Echinochloa colonum*), sobuj nakful (*Cyperus difformis*), foska begun (*Physalis heterophylla*) and chapra (*Eleusine indica*) were studied on germination and early growth of aromatic rice cv. BRRI dhan 50. The results revealed that all the weed species have inhibitory effects on seed germination, root and shoot length, and biomass production of aromatic rice. The results also ascertained that decreased and delayed seed germination, shortened root and shoot length as well as reduced fresh and dry mass production of BRRI dhan 50 might be due to allelopathic influences by releasing allelochemicals or inhibitory metabolites of existing weed species, especially *Echinochloa colonum* and *Cyperus difformis* in the rice field ecosystem.

Earlier investigations have found similar impacts of weed allelopathy on various crop species. Hua *et al.* (2007) found that allelochemicals present in *Ambrosia trifida* have higher inhibitory action on growth of wheat in north-east China. Batish *et al.* (2007) recorded that *Chenopodium murale* reduced seedling length and dry weight by releasing growth inhibitory metabolites in the rhizosphere of wheat plant. Khatun (2008) shown that unboiled and boiled extract of foska begun *(Physalis heterophylla)* has strong detrimental effect on germination and early growth of mungbean. Poly (2009) found that weed extracts of nunia (*Portulaca oleracea)* and biskataly *(Polygonum hydropiper)* reduced the germination and primary growth of wheat. Nasrin (2009) also studied the effect of weeds on seed germination and early growth of jute and soybean. She reported that durba (*Cynodon dactylon*) and katanotey (*Amaranthus spinosus*) had strong detrimental effect on primary growth of jute.

Conclusion

From the above findings it could be suggested that khude shama (*Echinochloa colonum*) and sobuj nakful (*Cyperus difformis*) had strong detrimental effect on aromatic rice.

Therefore, the cited weeds must be taken into well care and it should be avoided from the aromatic rice field during land preparation. The experimental results proved that it was important to exclude these allelopathic weeds especially khude shama (*Echinochloa colonum*) and sobuj nakful (*Cyperus difformis*).

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