ALLELOPATHIC EFFECTS OF SOME SELECTED WEEDS ON GERMINATION, GROWTH AND DEVELOPMENT OF BINA DHAN-7

A THESIS

BY

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Examination Roll No. 10 Ag. Agron. JD 25M
Registration No.: 32163
Session: 2005-2006
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MASTER OF SCIENCE (M.S.)
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ABSTRACT

An experiment was carried out at the Agronomy Seed Laboratory, Bangladesh Agricultural University, Mymensingh from 3rd to 19th May, 2011, to investigate the allelopathic effects of six weed species on rice (BINA dhan-7). Six weed species, viz. Pani marich (*Polygonum orientale*), Kalmilata (*Ipomoea aquatica*), Malancha (*Alternanthera philoxeroides*), Bishkatali (*Polygonum hydropiper*), Chapra (*Eleusine indica*), Bara Shama (*Echinochloa crusgalli*) were used in the experiment to observe their allelopathic effects on seed germination, median germination time, root length, shoot length and dry matter production of rice. The relative effect of different weed species and different concentrations (2.5% and 10%) were also investigated. All the selected weed species were more or less detrimental to rice seed germination. The ranking of the weed species on the basis of average per cent inhibition was- *Alternanathera phioxeroides* > *Eleusine indica*> *Echinochloa crusgalli*> *Polygonum orientale*> *Polygonum hydropiper*> *Ipomoea aquatica*. Lower concentration of weed extract was more detrimental to seed germination and seedling growth of rice. The extract of *Eleusine indica* and *Echinochloa crusgalli* with 2.5% concentration reduced 15.63% germination percentage and all the extract reduced 13.58% in dry matter weight of rice. But highest reduction in dry matter weight was done by *Echinochloa crusgalli* with 10% concentration (25.93%). 28.13% growth inhibition was noticed under the extract of *Alternanthera philoxenoides* at 10% concentration. About 36% increase in median germination time of rice seed was found due to the allelopathic effect of *Eleusine indica* and *Echinochloa crusgalli*

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CHAPTER 1
INTRODUCTION

Weed is an undesirable plant and a serious pest of our crops including rice. It competes with crop plants for space, light, moisture and other essential nutrients; as a result it reduces the quality and yield of crops. Its infestation increases the cost of production, which ultimately reduces the net return. Some of the weeds possess the harmful alellochemicals or that have allelopathic effect on the growth and development of field crops.

The term allelopathy denotes the toxic effect of chemicals which are produced by one plant to another. Rice (1984) defined allelopathy as any direct or indirect harmful or beneficial effect of one plant (including microorganism) on another through the production and secretion of chemical compounds that escape into the environment. Putnam and Weston (1986) noted that allelopathic substances are present in virtually all plant tissues, including stems, leaves, roots and seeds. These substances are released through processes such as volatilization, root exudation, leaching and decomposition of plant residues. It is also known that allelochemicals can affect mineral uptake by altering the cellular membrane function in plant roots. Phenolic acids depolarize the electrical field across membranes and thereby inhibit the active absorption of mineral ions (Balke, 1985). However, the more presence of allelopathic substances in the plant is not sufficient to prove allelopathy. Rather, allelopathic activity is believed to be the joint action of several secondary metabolites that may act synergistically (Oldfsdotter *et al.*, 1995; Chung *et al.*2001a, 2001b). Most allelochemicals are released during germination and early stages of growth (Dekker and Meggitt, 1983). Dilday *et al.* (1991) found allelopathic potential in rice accessions in the USA.

Allelopathy can be used in weed management in two ways. The first is by selecting an allelopathic crop variety or incorporating an allelopathic character into a desired crop variety. The second way is by applying residues and straw as mulches or growing an allelopathic variety in a rotational sequence that allows residues to remain in the field (Rice, 1995)

Some of the weeds exert chemical stress on some crops by their phytotoxic root exudates and other plant leaches which accumulated into the soil. As a result the growth of other plants in the proximity are adversely affected (Lall and Savongdy, 1981). Allelopathic substances are commonly found in plant extracts and in plant residues in soil, in live plant exudates and as volatile gases liberated from leaves and rhizome (Keeley, 1987). It has been known that plants can be influenced by each other, in the mechanism of allelopathy. Boonitee and Ritdhit (1984) stated that usually the effects are harmful, but there are occasional reports of beneficial effect (Newman and Andrews, 1973).

A number of weeds grow in rice field, which compete with crop and reduce the crop yield. When the weeds show allelopathic effect the qualitative and quantitative damage may be severe on the basis of allelochemicals present in the species. If the allelopathic effect of specific weeds species on specific crops can be known, weeds management becomes economically more effective for the crop grower. By knowing the potentiality of allelopathy in specific weed, we can remove those species from the crop field before they contribute allelopathy to crop suppression. All these information emphasize the study on allelopathy of different weed species on rice production.

With the above views in mind, the present study was undertaken to fulfil the following objectives:

i) To evaluate the allelopathic effects of six weed species on seed germination, median germination time, root length, shoot length and dry matter production of rice cv. BINA dhan-7.

ii) To identify the plant parts of the weeds and the concentration of weed extract at which they cause sufficient crop suppression.

CHAPTER 2

REVIEW OF LITERATURE

In our country very few works have been done on allelopathy but a good number of works on allelopathy have been done abroad. The reports and research findings of in country and foreign researches that are related to the present study are presented in this chapter.

2.1 Effect of aqueous extracts of different weeds

A laboratory experiment was conducted by Roy *et al. (2006)* to determine the influence of naturally occurring growth substances in aqueous extracts of some common weeds, i.e. Bathua *(Chenopodium album)*, Bhijli ghash *(Striga densiflora)*, Shetdrone *(Leucus aspera)*, Mutha *(Cyperus rotundus)*, Chapra *(Eleusine indica)* and Khude anguli *(Digitaria ischaemum)* on the germination and growth of wheat and jute seeds. Boiled and unboiled extracts of all weed species significantly reduced and delayed the germination of wheat and jute seeds. The effect of boiled and unboiled Bathua extracts showed the lowest germination in wheat seeds. The root and shoot length of wheat and jute were also decreased in the presence of the weed extracts.

Sharma *et al*. (2005) evaluated the allelopathic effects of some newly developed strains of Harar (*Terminalia chebula*) and Reetha (*Sapindus mukorossi*) on wheat (*Triticum aestivum*), maize (*Zea mays*), black gram (*Vigna* sp.), lentil (*Lens culinaris*), peas (*Pisum sativum*) and brinjal (*Solanum melongena*). Leaves of six strains of *Terminalia chebuld* and two strains of *Sapindus mukorossi* were collected and allowed to shade dry. The treated crops responded differently to aqueous leaf extracts of Harar and Reetha indicating the presence of different phytoactive compounds and growth promoters. Some strains had synergistic or no adverse effect on germination and growth of tested field crops, whereas other had antagonistic effects.

Kalita *et al.* (1999b) conducted an experiment and found that the aqueous extracts by *Cynodon dactylon* and *Cyperus rotundus* at concentrations of 1:5 and 1:10 (w/v) had significant allelopathic effects on seed germination of rice. Aqueous shoot extracts were more inhibitory than root extracts at the same concentration.

Castro *et al.* (1984) carried out an experiment and found that aqueous extracts of *Cynodon dactylon* roots reduced germination of rice seeds and inhibited the growth of aerial parts of the crops. Extracts of *Cyperus rotundus* tubers completely inhibited root development and reduced growth of aerial parts of the rice.

Oudhia and Tripathi (1999) conducted an experiment on allelopathic effect of *Lantana camera* on rice and reported that the extracts of root, stem, leaf and stem + leaf tissue of *Lantana camera* had significant promotive allelopathic effects, increasing rice germination rates and seedling vigour.

Meena (2001) conducted an experiment to determine the allelopathic effect of the aqueous extracts of shoots and tubers of purple nutsedge (*Cyperus retundus*) at 2.5, 5.0, 7.5 and 10% concentration on germination and seedling growth of pigeon pea and urdbean (*Vigna mungo*). The aqueous extract concentration of shoot reduced seed germination and seedling growth of pigeon pea and urdbean. The negative allelopathic effect was more pronounced with the tuber extract than shoot extract on all growth attributes i.e. germination, fresh weight, dry weight of radicle and plumule, radicle length, plumule length, leaves plant^{-1} and secondary roots plant^{-1} of both the pulses.

Porwal and Mundra (1992) carried out an experiment on allelopathic effects on aqueous extracts of *Cyperus rotundus* and *Echinochloa colonum* on germination and growth of blackgram and paddy. Result showed that aqueous extracts of fresh shoots and roots of *Cyperus rotundus* significantly reduced coleoptile and radicle lengths of *Vigna mungo* but not rice, while *Echinochloa colonum* extracts reduced coleptile and radicle length of both plants.

Agarwall *et al. (2002)* conducted an experiment and found that the weed extracts of *Avena fatua, Cyperus rotundus, Polygorum hydropiper* and *Solanum nigrum* inhibited the length of plumule in all the varieties of wheat.

Prasad *et al. (1999)* carried out an experiment to determine the allelopathic potential of aqueous and organic solvent extracts of *Phamnu virgatus* on the germination and growth of local strain of wheat. Both aqueous and organic solvent extracts of aerial part (leaves and stems) and roots were equally toxic to the growth and germination of test species. The most pronounced effect was observed at a concentration of 500 ppm.

The allelopathic effects of radish *(Raphanus sativus)* on different weeds *(Portulaca oleracea, Amaranthus retroflexus, Xanthium strumarium*, *Sorghum halepense* and *Cynodon dactylon)* and crops (wheat, maize, cotton and soybean) were studied by Dogan and Uygur (2006). Aqueous extracts of radish (33, 50, 60 and 100%) significantly reduced seed germination and rhizome development of the weeds but had no effect on the germination of wheat, maize and cotton seeds. Radish extract at 100% inhibited the seed germination of soybean.

A study was conducted by Batish *et al.* (2007) to determine the potential and nature of root-mediated allelopathic interference of *Chenopodium murale* on wheat. Early growth of wheat reduced significantly in agar medium where *C. murale* seedlings were previously growing as well as in rhizosphere soil of *C. murale.* The reduction in wheat growth was due to the presence of inhibitory metabolites released by roots of C. *murale* in the growth media. Even the soil incorporation of root residues also reduced the wheat growth in terms of seedling length and seedling dry weight. Root residues did not reduce the available nutrients in the soil, which was rather nutrient rich. These results indicated the definite role of allelopathy of *C. morale* roots in redarding wheat growth.

Laboratory based studies were undertaken by Shahid *et al.* (2006) to assess the allelopathic effect of different aqueous extracts of plants viz. Sorghum *(Sorgum bicolor)*, Sunflower *(Helianthus annuus)*, Johnson grass *(Sorghum halepense)*, *viz. (Azadirachta indica)*, eucalyptus *(Eucalyptus camaldulensis)* and acacia *(Acacia nilotica)* on wheat and its weeds. Analysis of data (taken twenty days after seeding) revealed that germination percentage, shoot length, root length and biomass plant^{-1} were significantly ($P < 0.001$) inhibited by plant extracts. Sunflower extract was the most inhibiting to germination, shoot and root length of wheat and to all species of weeds, while application of Johnson grass extract resulted in significantly minimum biomass plant^{-1}.

The allelopathic effect of hairy vetch *(Vicia villosa)* was studied by Fujihara and Yoshida (1999) using the filter method or a pot test in which dry shoots from hairy vetch were added to the soil surface. The growth of lettuce and spring wheat, and the plant *Sonchus oleraceus*, was suppressed on the glass filter which had been inserted between the soil surface and covering shoot of hairy vetch during four rainy days. Dry shoot (including leaf, stem and vein) of hairy vetch harvested in May exhibited the same allelopathic effect since germination or growth of summer weeds such as *Digitaria adscendens* and *Polygonum persicaria* was severely inhibited by the addition of the dry shoots into the pot. *Chenopodium album* was, however, not affected by these tests, indicating the selective inhibition of the allelochemicals from hairy vetch for weeds.

Gaffer *et al.* (1998) studied the allelopathic effect of four weed species *(Amaranthus spinosus*, *Cyperus rotundus*, *Echinochloa colonum* and *Imperata cylindrica)* incorporated in the soil of rice. Results showed that with the application of plant materials the infestation of weeds was reduced. Incorporation of *I. cylindrica* at a rate of 1.0 Kgm^{-2} resulted in a lower weed infestation and greater rice yield. The relative efficiency of weed species in controlling weeds was *I. cylindrica* > *C rotundus* > *E. colonum* > *A. spinosus.*

An investigation was done by Rahman *et al.* (1996) on germination and growth of rice and jute of aqueous extracts of some common weeds, viz. Katanotey *(Amaranthus spinosus L.),* Durba *(Cynodon dactylon L.),* Lazzabati *(Mimosa pudica L.),* Mutha *(Cyperus rotundus L.),* Shama *(Echinochloa crusgalli),* Baradudhia *(Euphorbia hirta* L.) and Haldemutha *(Cyperus esculentus* L.) and observed that boiled and unboiled extracts of Katanotey, Durba and Lazzabati reduced the germination and early growth of rice while all the 7 weed species inhibited germination and growth of jute. The extracts of all the weeds delayed the germination of rice and jute seeds.

Datta and Bandyopadhaya (1981) conducted an investigation on allelopathic influence of three weeds from two croplands. They observed that the vegetative and reproductive phases of mustard and wheat plants were seriously affected when they had been treated with leaf and inflorescence extracts of *Amaranthus spinosus*.

In laboratory experiments allelopathic effects of boiled and unboiled extracts of *Echinochloa crus-galli*, *Commelina benghalensis, Ageratum conizoides, Lantana camera* and *Cyperus rotundus* on groundnut were evaluated by Prassad and Srivastava (1991). The percentage of germination, time for complete germination and root and shoot length after 10 days were recorded. *A. conizoides* and *L. camera* had the most severe effects upon groundnuts, causing significant reductions in percentage of germination, root length and shoot length and delaying germination, respectively.

Gaffer *et al.* (1996) conducted an experiment at Bangladesh Agricultural University, Mymensingh with tossa jute to evaluate the effect of weed materials incorporated into soil on the intensity of weed infestation and their consequences on yield and yield contributing characters of jute. The fresh materials of four weed species viz. *Amaranthus spinosus, Cyperus rotundus, Echirochloa colonum* and *Imperata cylindrica* were incorporated into soil Oa 0.50, 0.75 and 1 Kgm^{-2}. Among the four weed species *I. cylindrica* was more effective in controlling the weeds and had positive influence on yield and yield components of jute. The relative efficiency of plant species in controlling weed population was *I. cylindrica* > *C. rotundus* > *E. colonum* > *A. spinosus.*

Madhu *et al.* (1995) studied allelopathic effect of weeds *(Parthenium, Acanthospermum, Euphorbia* and *Cyperus)* extracts (at 5 and 10%) applied to sunflower, maize, soybeans, french beans and cotton in laboratory trials. *Parthenium* and *Cyperus* extracts had the greatest inhibitory effect on the crop specially with 10% concentration.

Kalatha *et al.* (1996) carried out an experiment with aqueous leaf extracts of 14 weed species *(Cleome viscosa, Trichosanthes tricuspidata, Euphorbia hirta, Galusoga parviflora, Portulaca oleracea, Commelina benghalensis, Fumaria indica, Vicia faba, Vicia sp., Lathyras spaericus, Silene indica, Stellaria media, Cynoglossum glochidiatum* and *Chenopodium album)* and tested their allelopathic effects on germination and radicle elongation of finger millet, maize, barley, mustard, lentil, cowpeas and soybean. Among summer crops soybean, cowpeas, finger millet and maize were the most susceptible to phytotoxic responses to summer weeds. In aqueous extracts of weed, germination of crops varied from 63 to 81% with *Portulaca oleracea* being the most toxic weed. Among winter crops, *Hordeum himalayense* and *Brassica campestris* were susceptible crops and C. *album* was the most allelochemically active weed.

An investigation was carried out to study the allelopathic effects of 5 weed species namely, *Polygonum hydropiper, Amaranthus spinosus, Chenopodium* *album, Cyperus rotundus* and *Imperata cylindrica* by Roy (1995) on seed germination, growth and development of corn *(Zea mays L.)*. The weeds were used as whole dried plants at the rate of 1.25 g petridish-1 and aqueous extract of 25 ml petridish^{-1}. Seedling height was significantly affected by the dried weed mass. The weed, *I. cylindrica* affected the seedling height severely than others. Radical length was most affected by *A. spinosus*. Seedling dry matter (root and shoot) was also severely affected by *L cylindrica* than others. Among the plant parts, the dried mass of stem of these weeds were more detrimental than leaf and root.

Binita *et al*. (2001) conducted an experiment on allelopathic effect of eight important weeds commonly grown in northeast India, namely, *Amananthus* sp., *Argemone mexicana, Cynodon dactylon, Cyperus rotundus, Imperata cylindrica, Lantana camera, Parthenium hysterophorus* and *Chenopodium* sp. on different vegetable production. Of them C. *dactylon* and *P. hysterophorus* showed both stimulatory and inhibitory effects depending on concentration. While other weeds showed mainly inhibitory effect on germination and seedling growth of vegetables.

Ameena and George (2002) conducted an experiment to assess the allelopathic effect of aqueous extracts of purple nutsedge *(Cyperus rotundus)* on the germination and seedling growth of Okra *(Abelmoschus esculentus)* result showed that aqueous extracts of nutsedge dry plant parts inhibited the germination and seedling growth of Okra. Inhibition was concentration dependent.

In India, Lall and Savongdy (1981) conducted an experiment to find out the magnitude of plant growth inhibition by the leachates of purple nutsedge *(C.rotundus)* on pearl millet *(Pennisetum typhoideum)*. Pearl millet was grown in association with purple nutsedge and its plant residues. They observed no adverse effect of root exudates or leachates of purple nutsedge residues on the germination of pearl millet seeds but tillering, stem growth, plant height and dry matter production were affected. Root exudates of growing plants and leachates of plant residues of purple nutsedge caused significant reduction in plant height and dry matter production of pearl millet.

Olofsdotter (1999) reviewed the researches on rice allelopathy and utilization the mechanism in weed management programme. He noted that the potentially useful allelopathic effect of *Lantana camera* and *Sphenoclea zeylanica* on weed control and rice growth in the fields.

Hua *et al.* (2007) conducted a series of experiments to assess the phytotoxicity and to identify the allelochemicals of *Ambrosia ftifida* against wheat *(Triticum aestivum)*. The results showed that wheat growth could be significantly inhibited in *Ambrosia triflida* infested or residue emended soils in North-East China. Two carotane-type sesquiterpenes, 1 alpha(angeloyloxy)-carotol and 1 alpha-(2-methyl butyroyloxy)-carotol, were subsequently isolated and identified from the toxic soils. Both compounds had high inhibitory activity on wheat growth.

2.2 Effects of different concentrations of weed extract

Channappagoudar *et al.* (2005) studied the allelopathic effects of extracts of

Cyperus rotundus, Commelina benghalensis, Parthenium hysterophorus and *Prosopis juliflora* leaves (collected from Karnataka, India) at two concentrations (5 and 10% w/v) on sorghum, wheat, green gram, soybean, sunflower and groundnut in the laboratory. The results revealed that *Commelina* and *Cyperus* extracts had greater inhibitory effect on germination, seedling length and seedling vigour index, than the leaf extracts of the other crops.

Laboratory experiments were conducted by Yao *et al.* (2006) to study the potential role of allelopathy in plant interference and in the successful invasion of alien species *Salidago canadensis.* Aqueous and ethanolic extracts were used as treatment solutions to assess their effects on seed germination and seedling growth in four target species, mulberry *(Morns alba),* morning glory *(Pharbitis nil),* wheat *(Triticum aestivum)* and rape *(Brassica campestris) [Brassica napes* var. oleifera]. Reduction and/or growth in germination and growth of the target plant species in the presence of both aqueous and ethanolic extracts at different concentration indicated that the responses were species-specific and concentration-dependent. Generally, ethanolic extracts (especially from leaves) imposed stronger effects on both seed germination and seedling growth. Extracts with lower concentration at 0.001 g/ml dry weight could stimulate the seedling growth of rape and morning glory, whereas extracts at higher concentrations have inhibitory effects on wheat and mulberry.

Seeds of wheat (cv. Kiron) were treated with aqueous extracts of *Commelina benghalensis, Ocimum canum, Cyperus rotundus* and *Cynodon dactylon* to evaluate the germination percentage, root and shoot length and vigour index

(Uppar *et al., 1993).* The results indicated that C. *benghalensis* had the highest inhibitory effect on wheat seed germination followed by *O. canum* and C. *rotundus* compared to C. *dactylon.* Increasing the concentration of extract also increased the degree of inhibition for all species, although the lowest rates used had significant effects.

Kalita *et al.* (1999a) conducted an experiment to assess the allelopathic effect of four common upland rice weed species *(Ageratum conyzoides, Borreria hispida, Cynodon dactylon* and *Cyperus rotundus) on* leaf number, leaf area per plant, total leaf chlorophyll content and leaf nitrate reductase activity of potted rice plants at 25 to 50 days after sowing (DAS). The weeds were sun-dried, ground and mixed with rice potting soil at rate of 1:5, 1:10, 1:15 and 1:20 w/w. All rice parameters were affected by the effects of weed residues. The greater was the concentration of weed residue and the greater was the reduction of all tested parameters in rice plants both at 25 and 50 DAS.

In an experiment the aqueous extracts of rhizomes of *Scirpus acutus and* shoots of *Eleocharis smallii* were analysed for the presence of phytotoxic compounds using ethyl acetate extraction. The organic fraction of the extract of *Scirpus acutus* rhizome contained lactic, succinic, fumaric, 2- hydroxysuccinic, 2-phenyl lactic, m-hydroxybenzoic, P-hydroxybenzoic, protocatechuic, dehydroabietic and ferulic acids, and p-hydroxybenzyl alcohol, P-hydroxyphenyl ethanol and catechin. The extract of *Eleocharis smallii* shoots contained 4-methoxy phenol, benzofuran, benzene acetic acid, 1-hydroxy-5-methyl acetophenone and 1, 3, 4-dimethoxyphenol ethanone, identified by GC-

MS. The potential allelopathic effect of these compounds was noticed on wheat *(Triticum aestivum)* under field conditions (Quayyum *et al.*, 1999).

Effect of three weeds extracts, namely *Ageratum conyzoides*, *Melilotus indica* and *Parthenium hysterophorus* were examined by Saxena *et al.* (2003) on seed germination, seedling growth, uptake of both ^{32}P and 65Zn isotopes and their distribution in plant parts of wheat cultivars UP-2338, PBW-226 and RR-21. The weed extracts showed variable effects on germination and seedling growth of all test cultivars of wheat. The effect of weed extracts on seedling growth indicated that PBW-226 was resistant and RR-21 was susceptible. Among the weed species, *Ageratum conyzoides* caused maximum reduction in seedling growth of all wheat cultivars compared to *Parthenium hysterophorus* and *Melilotus indica.* The weed extracts also interfered in the uptake of both ^{32}P and ^{61} Zn and there was gradual decrease in their uptake in both root and shoot of all the cultivars, with increasing extract concentration.

It is obvious from the above reviews that a number of weed species possess allelopathic potential which suppress the growth of field crops including rice. The allelopathic effects are dependent on particular weed species. The per cent reduction also depends on the concentration of the aqueous extracts of the weed species. Few weeds also have the promotory effects on seed germination and seedling growth of rice. The inhibitory effects of allelopathic weeds are due to some chemicals, which are known as allelochemicals such as 2-hydroxysuccinic acid, 2-phenyl lactic acid, ferulic acids etc. Therefore, study on the allelopathic effects of common weed species of Bangladesh on rice seed germination are important.

CHAPTER 3
MATERIALS AND METHODS

An experiment was conducted at the Department of Agronomy, Agronomy Seed Laboratory, Bangladesh Agricultural University, Mymensingh from 3 to 19 May, 2011, to evaluate the allelopathic effect of six weed species on seed germination, median germination time, root length, shoot length and dry matter production of rice cv. BINA dhan-7. The growing media was germinating paper (Whatman No. 1 filter paper).

3.1 Test weed species

The scientific name and bengali name of the selected weed species are given below:

Scientific name	Bengali name
Polygonum orientale	*Pani marich*
Ipomoea aquatica	*Kalmilata*
Alternanthera philoxeroides	*Malancha*
Polygonum hydropiper	*Bishkatali*
Eleusine indica	*Chapra*
Echinochloa crusgalli	*Boro Shama*

3.2 Experimental treatments

The experimental treatments were as follows-

A. Weeds species -6

i. *Polygonum orientale* (W_1)

ii. *Ipomoea aquatica* (W_2)

iii. *Alternanthera philoxeroides* (W_3)

iv. *Polygonum hydropiper* (W_4)

v. *Eleusine indica* (W_5)

vi. *Echinochloa crusgalli* (W_6)

B. Concentration of weed extracts-3

1. 2.5% (C_1)
2. 10% (C_2)
3. Control, water only (C_0)

Treatment combination (For Four replication)

$W_1C_1R_1$	$W_1C_1R_2$	$W_1C_1R_3$	$W_1C_1R_4$
$W_1C_2R_1$	$W_1C_2R_2$	$W_1C_2R_3$	$W_1C_2R_4$
$W_2C_1R_1$	$W_2C_1R_2$	$W_2C_1R_3$	$W_2C_1R_4$
$W_2C_2R_1$	$W_2C_2R_2$	$W_2C_2R_3$	$W_2C_2R_4$
$W_3C_1R_1$	$W_3C_1R_2$	$W_3C_1R_3$	$W_3C_1R_4$
$W_3C_2R_1$	$W_3C_2R_2$	$W_3C_2R_3$	$W_3C_2R_4$
$W_4C_1R_1$	$W_4C_1R_2$	$W_4C_1R_3$	$W_4C_1R_4$
$W_4C_2R_1$	$W_4C_2R_2$	$W_4C_2R_3$	$W_4C_2R_4$
$W_5C_1R_1$	$W_5C_1R_2$	$W_5C_1R_3$	$W_5C_1R_4$
$W_5C_2R_1$	$W_5C_2R_2$	$W_5C_2R_3$	$W_5C_2R_4$
$W_6C_1R_1$	$W_6C_1R_2$	$W_6C_1R_3$	$W_6C_1R_4$
$W_6C_2R_1$	$W_6C_2R_2$	$W_6C_2R_3$	$W_6C_2R_4$

W_0 (Control, water only)

Treatment combination = $6 \times 2 \times 4 = 48$

3.3 Collection of weeds and rice seed, and preparation of weed extracts

The six weed species *namely Polygonum orientale, Ipomoea aquatica, Alternanthera philoxeroides, Polygonum hydropiper, Eleusine indica and Echinochloa crusgalli* were collected from the Agronomy Field Laboratory and its surrounding area in May, 2011. The collected weed species were washed and air-dried slightly and put them in conical flask. Then 20 g of each of the species were cut separately into 1 cm pieces, and put 100 ml of distilled water was added to them. The flask were shaken for 30 minutes and kept at 4°C for 48 hours and filtered through Whatman No. 1 filter paper. The filtrates were considered as 20% stock of aqueous weed extracts (w/v). The 2.5% and 10% aqueous extracts were made by mixing of appropriate amount of distilled water with the stock aqueous extracts.

The seeds of rice cv. BINA dhan-7 were collected from Bangladesh Institute of Nuclear Agriculture (BINA) and treated with Vitavax -200, at the rate of 4 g/kg of seed. The germination percentage of the collected seeds were 96.

3.4 Setting up the experiment

The effect of weed extracts on the germination of rice cv. BINA dhan-7 seeds were tested in Petridishes in the laboratory. The treated seeds at the rate of 25 seeds Petridish^{-1} were placed on the Petridishes lined with 9 cm Whatman No. 1 filter paper. Ten milliliter aqueous extracts of different concentrations were put in each Petridish. Only distilled water (10 ml) was used as control. The treatments were replicated four times. The experiment was carried out in the

Seed Laboratory, Department of Agronomy under room temperature at 28 ± 2°C.

3.5 Data collection

Data collecting procedure are described below:

3.5.1 Seed germination

The number of germinated seeds was counted from the 2nd day of seed placement and was continued up to completing of the seed germination at 17 days after sowing.

3.5.2 Median germination time of rice seeds

Median germination time was calculated after counting germination as per the following formula:

Median germination time (MdGT) i.e. time to reach half of the final germination (Karim and Naylor, 1999).

3.5.3 Shoot length of rice seedlings

After 17 days of seed setting, 5 seedlings were taken out of petridish and the shoot length of the seedling was measured with the help of measuring scale.

3.5.4 Root length of rice seedlings

At the same time of shoot length measurement, after 17 days of seed setting, the root length of the seedling was measured.

3.5.5 Dry matter of rice seedlings

The sample seedlings (5 seedlings) were placed in paper bags and then put in an electric oven at 80°C for 72 hours. The weights of oven-dried specimens were recorded.

3.5.6 Determination of average per cent inhibition of rice

Overall effects on the rice growth was determined on the basis of average per cent inhibition as below-

$$\text{Average Per cent Inhibition (API)} = \frac{\text{G (\%)} + \text{RL (\%)} + \text{SL (\%)} + \text{DM (\%)}}{4}$$

where,

G = Germination, RL = Root length, SL = Shoot length,
DM = Dry matter

4 = Parameters

3.6 Layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Petridish with water only was considered as control. The total number of treatments were 48, and one treatments for control only water (Treatment combination = 6 × 2 × 4 = 48).

3.7 Analysis of data

The collected data on different parameters of the crop were statistically analyzed and the mean differences were adjudged using DMRT (Gomez and Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

The results obtained from the experiment have been presented and discussed in this chapter. The whole discussion has been categorized as the effects on seed germination, median germination time, root length, shoot length and dry matter accumulation of rice cv. BINA dhan-7. Interaction effects have also been discussed.

4.1 Effect on seed germination of rice

4.1.1 Effect of weed species

Rice seed germination was affected significantly by the allelopathic effect of different species of weeds. The highest germination (96%) was observed under no weed extracts (control) and the lowest germination (83%) was found in *Eleusine indica* (Table 1). The per cent reduction in seed germination was 13% in *Eleusine indica* and 9% in *Echinochloa crusgalli* (Table 2). Other weeds contributed to reduction less than the above mentioned two. There was small significant variation between *Polygonum orientale* and *Allternanthera philoxeroides* and the per cent reduction in seed germination of those weeds were 8 and 7.5% respectively. From Table 1 and 2 it was observed that the percentage of germination was comparatively higher due to less allelopathic effect of *Polygonum hydropiper* and *Ipomoea aquatica*. On the other hand, percentage of germination was less due to higher allelopathic effect of *Eleusine indica*. Therefore, the weed *Eleusine indica* and *Echinochloa crusgalli* had strong inhibitory effect on seed germination of rice. The ranking of the selected weed species in respect of inhibitory effect on seed germination was *E. indica* > *E. Crusgalli* > *P. orientale* > *A. philoxeroides* > *P. hydropiper* > *I. aquatica.* Similar inhibitory effect of *Eleusine indica* on seed germination of wheat was noted by Roy *et. al.* (2006). Similar inhibitory effect of *Echinochloa crusgalli* on seed germination of rice was found by Castro *et al.* (1984); Rahman *et al.* (1996), Prassad and Srivastava (1991). Binita *et al.* (2001) found inhibitory effect on germination and seedling growth of vegetables. Prassad and Srivastava (1991) noted that the aqueous extract of different weed species reduced the germination of groundnut by 54%. Agarwal *et al.* (2002) found inhibitory effect on germination and seedling growth of all varieties of wheat used in their experiment. The inhibitory effect of *Polygonum hydropiper* on seed germination, growth and development of corn *(Zea mays* L.) was noted by Roy (1995). Results of the study suggest that the germination of rice seed cv.BINA dhan-7 in the field might be reduced by the presence of weed species, especially *Eleusine indica* and *Echinochloa crusgalli* due to their allelopathic influence.

Table 1. Effect of aqueous extracts of different weed species on germination, median germination time, root length, shoot length and dry matter production of rice under laboratory conditions

Weed species	Germination (%)	Median germinations time (day)	Root length (cm)	Shoot length (cm)	Dry matter (g/5 seedling)
W_0	96	1.00	7.3	7.25	0.081
W_1	88	1.09	6.75	6.27	0.077
W_2	91	1.08	6.77	6.96	0.073
W_3	88.5	1.09	4.28	5.92	0.068
W_4	90.5	1.08	6.83	7.10	0.067
W_5	83	1.11	5.63	6.01	0.070
W_6	87	1.11	6.14	6.33	0.063
Level of significance	**	NS	**	**	**
SE	2.75	0.011	0.37	0.42	0.002
CV (%)	3.13	7.43	3.13	3.13	3.13

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).
W_0 = No weed extract
CV = Coefficient of variance
SE = Standard error
** = Significant at 1% level of probability
NS = Not significant

W_0 = No weed extract
W_1 = *Polygonum orientale*
W_2 =*Ipomoea aquatica*
W_3 =*Alternanthera philoxeroides*
W_4 =*Polygonum hydropiper*
W_5 =*Eleusine indica*
W_6 =*Echinochloa crusgalli*

Table 2. Per cent reduction due to effects of aqueous extracts of different weed species on germination, root length, shoot length and dry matter production of rice under laboratory conditions

Weed species	Germination (%)	Root length (%)	Shoot length (%)	Dry matter (%)	Average per cent inhibition (%)
Polygonum orientale	8	7.53	13.52	4.94	8.50
Ipomoea aquatica	5	7.26	4	9.876	6.54
Alternanthera philoxeroides	7.5	41.37	18.34	16.05	20.82
Polygonum hydropiper	5.5	6.43	2.07	17.28	7.82
Eleusine indica	13	23.01	17.10	13.58	16.67
Echinochloa crusgalli	9	15.89	12.69	22.22	14.95

4.1.2 Effect of weed extract concentrations

The concentration of different weed extracts significantly affected the seed germination of rice. Germination percentage was the highest (96%) when no weed extract (only water) was placed in Petridish and the lowest germination percentage (87%) was found when concentration of the weed extract was 2.5%. A concentration of 2.5% was found to be more inhibitory to seed germination than of 10% (Table 3). This might be due to higher number and amount of allelochemicals 9.38% germination was reduced due to 2.5% concentration of weed extract. On an average, the average per cent inhibition (API) was the highest (13.60%) due to the highest (10%) concentration of weed extract (Table 4). Bora *et al.* (1999), Kalita *et al.* (1999b), and Ameena and George (2002) noted more or less similar findings. In contrast Channappagoudar *et al.* (2005), Upper *et al.* (1993) and Yao *et al.* (2006) found that increasing the concentration of extracts increased degree of inhibition for many plant species, although the lowest rates used had significant effects.

Table 3. Effect of different concentration of aqueous extract of weeds on germination, median germination time, root length, shoot length and dry matter production of rice under laboratory conditions

Concentrations (%)	Germination (%)	Median germination time (day)	Root length (cm)	Shoot length (cm)	Dry matter (g/5 seedlings)
Control (W_0)	96	1.00c	7.30	7.25	0.081
C_1 (2.5%)	87	1.30a	6.14	6.64	0.068
C_2 (10%)	89	1.08b	5.98	6.22	0.069
SE	1.59	0.009	0.21	0.24	0.001
CV (%)	3.13	7.43	3.13	3.13	3.13
Level of significance	**	**	*	**	**

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).
W_0 = No weed extract
CV = Coefficient of variance
SE = Standard error
** = Significant at 1% level of probability
* = Significant at 5% level of probability

C_1 = Concentration 1 (2.5%)
C_2 = Concentration 2 (10%)

Table 4. Per cent reduction due to effects of aqueous extracts of different concentration on germination, root length, shoot length and dry matter production of rice under laboratory conditions

Weed concentration (%)	Germination (%)	Root length (%)	Shoot length (%)	Dry matter (%)	Average per cent inhibition
2.5	9.38	15.89	8.41	16.04	12.43
10	7.29	18.08	14.21	14.81	13.60

4.1.3 Effect of interaction between weed species and weed extract concentrations

A significant ($p < 0.05$) effect of interaction between weed species and extract concentration on rice seed germination was observed in the study (appendix I). The highest germination (93%) was found in the interaction of *Echinochloa crusgalli* with the concentration of 10% which was statistically identical with the interaction at 10% and 5% concentration of *P. orientale*, *A. philoxeroides*, *P. hydropiper* and in *I. aquatica*. The lowest germination (81%) was found in the interaction of *Echinochloa crusgalli* with concentration of 2.5%, which was statistically identical with the interaction of 2.5% concentration and *Eleusine indica* (Table 5). The highest reduction (15.63%) in seed germination was, therefore, occurred when the extract of *Eleusine indica* was used at 2.5% concentration which was statistically identical with the interaction of concentration of 2.5% and *Echinochloa crusgalli* (Table 6).

Table 5. Effect of interaction between weeds species and different concentrations of aqueous extract of weeds on germination, median germination time, root length, shoot length and dry matter production of rice under laboratory conditions

Interaction of weed species and concentration	Germination (%)	Median germination time (day)	Root length (cm)	Shoot length (cm)	Dry matter (g/5 seedlings)
Control (W_0)	96.00a	1.00e	7.3ab	7.25	0.081
W_1C_1	88.00ab	1.25c	6.47a-d	6.49ab	0.07
W_1C_2	88.00ab	1.25c	7.01abc	6.01ab	0.07
W_2C_1	91.00ab	1.15e	6.15a-d	6.36ab	0.07
W_2C_2	91.00ab	1.15e	7.39ab	7.55a	0.07
W_3C_1	89.00ab	1.20d	5.67bcd	6.79ab	0.07
W_3C_2	88.00ab	1.25c	2.89e	5.06b	0.07
W_4C_1	92.00ab	1.08e	5.92bdc	6.62ab	0.07
W_4C_2	89.00ab	1.20d	7.74a	7.58a	0.07
W_5C_1	81.00b	1.36a	6.42a-d	7.20a	0.07
W_5C_2	85.00ab	1.31b	5.25d	4.98b	0.07
W_6C_1	81.00b	1.36a	6.22a-d	6.37ab	0.07
W_6C_2	93.00ab	1.06e	6.05a-d	6.29ab	0.06
Level of significance	*	*	*	**	NS
SE	0.98	0.021	0.18	0.016	0.01
CV (%)	3.13	7.43	3.13	3.13	3.13

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).
CV = Coefficient of variance
SE = Standard error
** = Significant at 1% level of probability
* = Significant at 5% level of probability
NS = Non-significant

W_0 = No weed extract
W_1 = *Polygonum orientale*
W_2 =*Ipomoea aquatica*
W_3 =*Alternanthera philoxeroides*
W_4 =*Polygonum hydropiper*
W_5 =*Eleusine indica*
W_6 =*Echinochloa crusgalli*

Aqueous extract of weeds
C_1 = Concentration 1 (2.5%)
C_2 = Concentration 2 (10%)

Table 6. Per cent reduction due to effects of interaction of aqueous extracts of different weed species and concentrations on germination, root length, shoot length and dry matter production of rice under laboratory conditions

Interaction of weed species and concentration	Germination (%)	Root length (%)	Shoot length (%)	Dry matter (%)	Average per cent inhibition
W_1C_1	8.33	11.37	10.48	13.58	10.94
W_1C_2	8.33	3.97	17.10	13.58	10.75
W_2C_1	5.21	15.75	12.28	13.58	11.71
W_2C_2	5.21	-1.23	-4.14	13.58	3.36
W_3C_1	7.29	22.33	6.34	13.58	12.39
W_3C_2	8.33	60.41	30.21	13.58	28.13
W_4C_1	4.17	18.90	9.38	13.58	11.51
W_4C_2	7.29	-5.48	-4.55	13.58	2.71
W_5C_1	15.63	12.05	0.69	13.58	10.49
W_5C_2	11.46	28.08	31.31	13.58	21.11
W_6C_1	15.63	14.79	12.14	13.58	14.04
W_6C_2	3.13	17.12	13.24	25.93	14.86

W_1 = *Polygonum orientale*
W_2 =*Ipomoea aquatica*
W_3 =*Alternanthera philoxeroides*
W_4 =*Polygonum hydropiper*
W_5 =*Eleusine indica*
W_6 =*Echinochloa crusgalli*

C_1 = Concentration 1 (2.5%)
C_2 = Concentration 2 (10%)

4.2 Effect on median germination time

4.2.1 Effect of weed species

Median germination time of rice seed was non significant by the allelopathic effect of different species of weed (Appendix I). The highest Median germination time (1.11 days) was observed in *Eleusine indica* and *Echinochloa crusgalli* .The lowest Median germination time (1.00 days) was found in control (no weed extract). Median germination time of *I. aquatica and P. hydropiper* was medium (Table 1). The percent increase in median germination time was 11% in *Eleusine indica* and *Echinochloa crusgalli* (Fig. 1, Appendix II). It was observed that *Eleusine indica* and *Echinochloa crusgalli* showed the higher inhibitory performance on median germination time.

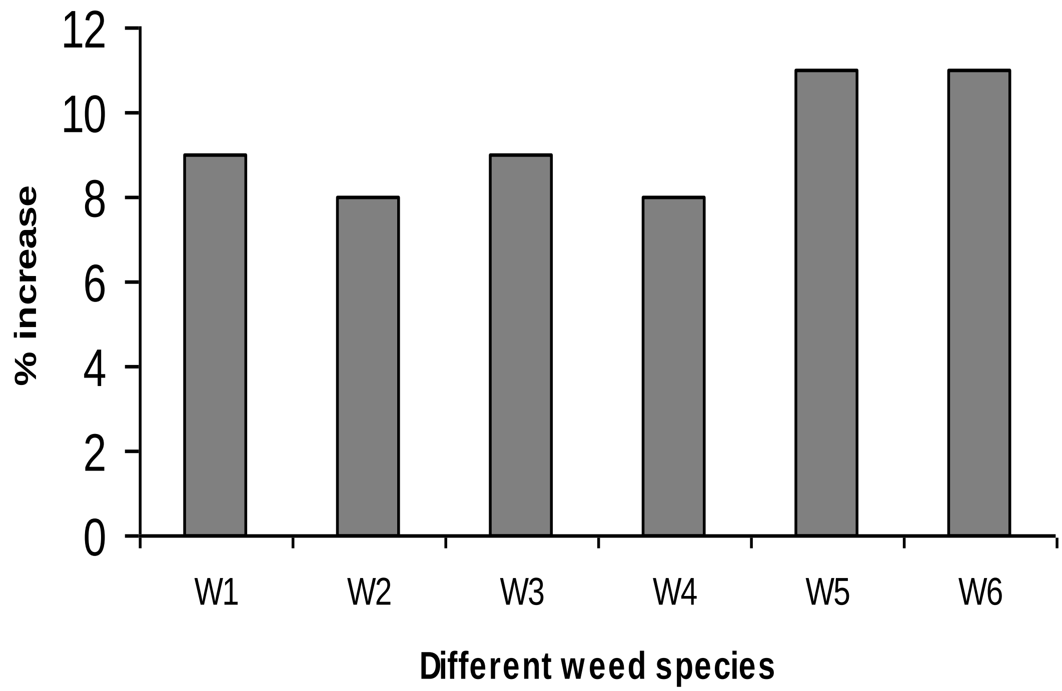
4.2.2 Effect of weed extract concentrations

The concentration of different weed extracts significantly affected the

median germination time of rice (Appendix I). The highest median germination time (1.30 days) was found in concentration of 2.5% and the lowest median germination time (1.00 day) was found in control (no weed extract) (Table 3). The percent increase in median germination time was 30% under 2.5% concentration (Fig. 2, Appendix IV). A concentration of 2.5% was found to be more inhibitory to rice and has increased the median germination time than other concentrations of different weed extracts.

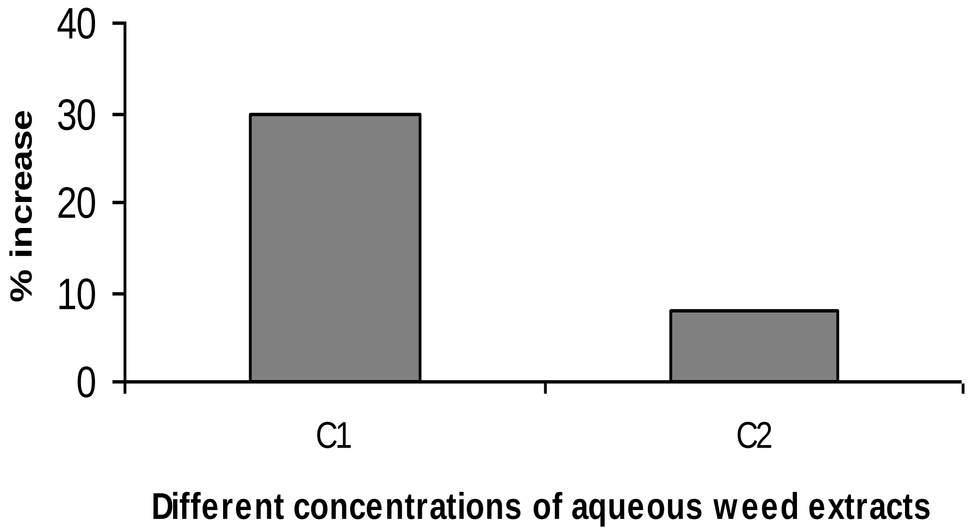
4.2.3 Effect of interaction between weed species and weed extract concentrations

The interaction between weed species and weed extract concentrations on median germination time of rice seed was significant at 5% level of probability (Appendix I). The highest median germination time (1.36 days) was found in *Eleusine indica* and *Echinochloa crusgalli* with concentration of 2.5% . The lowest Median germination time (1.00 day) was found in control (no weed extract), which was statistically similar to the interaction of 2.5% concentration of *P. hydropiper and* 10% concentration of *Echinochloa crusgalli* (Table 5). The highest increase (36%) in median germination time was, therefore, occurred when the extract of *Eleusine indica* and *Echinochloa crusgalli* were used with the concentration of 2.5% (Fig. 3, Appendix VI).



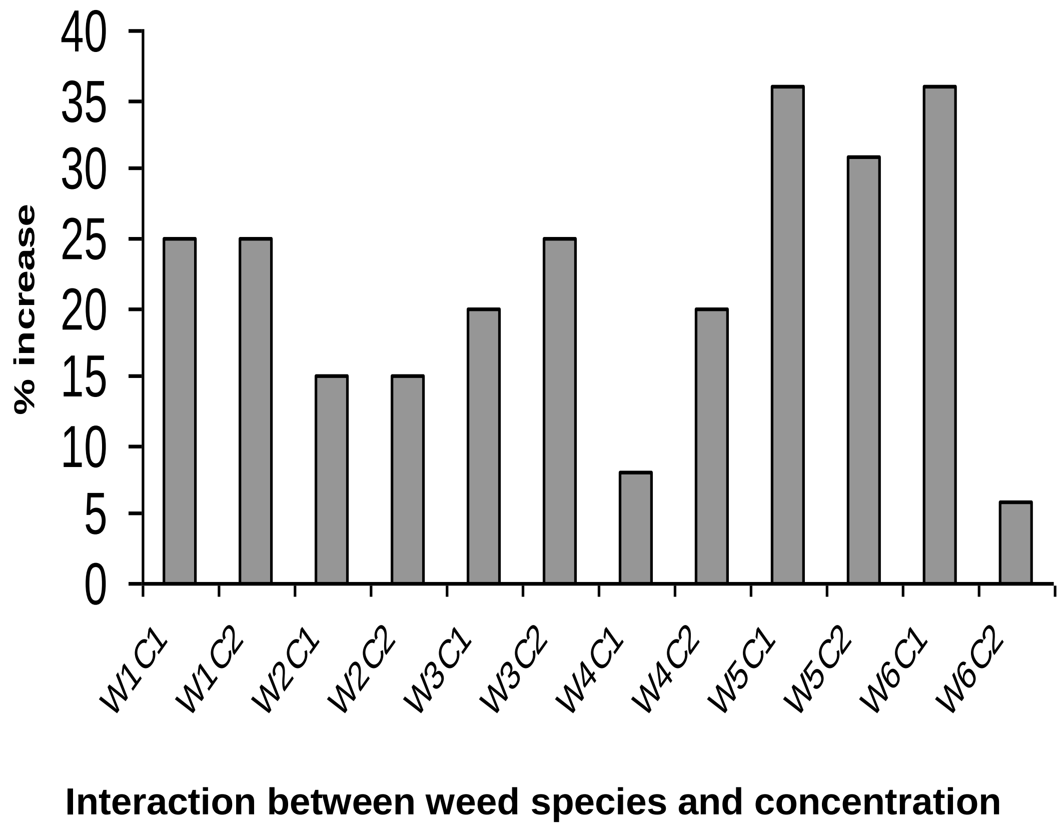
W_1 = *Polygonum orientale*
W_2 =*Ipomoea aquatica*
W_3 =*Alternanthera philoxeroides*
W_4 =*Polygonum hydropiper*
W_5 =*Eleusine indica*
W_6 =*Echinochloa crusgalli*

Fig. 1. Per cent increase in median germination time of rice cv. BINA dhan-7 due to effects of aqueous extracts of different weed species under laboratory conditions



C_1 = Concentration 1 (2.5%)
C_2 = Concentration 2 (10%)

Fig. 2. Per cent increase in median germination time of rice cv. BINA dhan-7 due to effects of aqueous weed extracts of different concentrations under laboratory conditions



W_1 = ***Polygonum orientale***
W_2 =*Ipomoea aquatica*
W_3 =*Alternanthera philoxeroides*
W_4 =*Polygonum hydropiper*
W_5 =*Eleusine indica*
W_6 =*Echinochloa crusgalli*

C_1 = Concentration 1 (2.5%)
C_2 = Concentration 2 (10%)

Fig. 3. Per cent increase in median germination time of rice cv. BINA dhan-7 due to effects of interaction between weeds species and concentrations under laboratory conditions

4.3 Effect on root length of rice

4.3.1 Effect of weed species

The effect of different weed species on the root length of rice was found statistically significant (Appendix I). The highest root length (7.30 cm) was found in control (no weed extract). The lowest root length (4.28 cm) was found under *A. philoxeroides* (Table 1). On an average 41.37% root length was reduced due to allelopathic effect of *A. philoxeroides* as compared to control (Table 2). The lower root length of rice seedling might be due to the effect of allelopathic agent on the growth of rice. Al the selected weed species in this experiment were able to reduce root length of rice. From the (Table 2) it was observed that the ranking of weed species in reducing root length of rice was *A. philoxeroides*. > *E. indica* > *Ec. Crusgalli* > *P. orientale* > *I. aquatica* > *P. hydropiper*, respectively. More or less findings were also noted by Channappagoudar *et al.* (2005).

4.3.2 Effect of weed extract concentrations

A significant effect of concentration of weed extracts on root length of rice seedling was found in the study (Appendix-I).Root length of rice was the highest (7.3 cm) under control and the lowest root length (5.98 cm) was found when the concentration of weed extract was 10% (Table 3). It was found that higher concentration was more inhibitory than that of lower concentration (Table 4). Bora *et al.* (1999), Kalitha *et al.* (1999a) and Ameena and George (2002) was noted more or less similar findings.

4.3.3 Effect of interaction between weed species and weed extracts concentrations

The effect of interaction between weed species and weed extract concentration on the root length of rice seedling was significant at 5% level of probability (Appendix I). The highest root length (7.74 cm) was found in concentration of 10% in *P. hydropiper* and *I. aquatica* .The lowest root length (2.89 cm) was noted in the treatment combination of 10% in *A. philoxeroides* (Table 5). The highest reduction (28.08%) was found when the rice seed was treated with *E. indica* at concentration 10% (Table 6).

4.4 Effect on shoot length of rice

4.4.1 Effect of weed species

The shoot length of rice seedling was also affected significantly by the allelopathic effect of different species of weed (Appendix I). The highest shoot length (7.25 cm) of rice was found in control (no weed extract), which was ststistically similar to the mean effects of *P. hydropiper* and *I. aquatica* (Table 1). The lowest shoot length (5.92 cm) was found under the effects of *A. philoxeroides* (Table 1). Therefore, the highest per cent reduction of shoot length (18.34%) was found iunder *A. philoxeroides* and the lowest per cent reduction (2.07%) was in *P. hydropiper* (Table 2). It was said that the presence of plant parts of *E. indica* and *Ec. Crusgalli* in rice field might lead to reduction of rice growth. All the selected weeds caused the reduction of shoot length and the ranking of the weeds in respect of shoot length reduction was *A. philoxeroides*> *E. indica* > *P. orientale* > *Ec. Crusgalli* > *I. aquatica*> *P. hydropiper*. Agarwal *et al.* (2002) observed that weed extracts of *C. rotundus* and *P. hydropiper* inhibited the length of plumule in all varieties of wheat. Similar inhibitory effect of the weed on vegetables was also noted by Binita *et al*. (2001).

4.4.2 Effect of weed extract concentrations

The concentration effects of weed plant extracts on shoot length of rice was found statistically significant (Appendix I). The highest shoot length (7.25 cm) of rice was found in control (no weed extract) and the lowest shoot length (6.22 cm) of rice was found at 10% concentration(Table 3). The concentration of 10% was found most inhibitory to shoot length than those of 2.5%. This might be due to the fact of increasing the concentration of allelochemicals. Bora *et al.* (1999), Kalita *et al*. (1999a), and Ameena and George (2002) noted more or less similar findings. Channappagoudaret *et al.*, (2005), Uppar *et al*. (1993), and Yao *et al.* (2006) found that increasing the concentration of weed extracts increased degree of inhibition for many plant species.

4.4.3 Effect of interaction between weed species and weed extracts concentrations

The effect of interaction between weed species and weed extract concentration on the rice shoot length was significantly at 5% level of probability(Appendix I).The highest shoot length (7.58 cm) of rice was observed in *P. hydropiper* and *I. aquatica* with 10% concentration which was statistically similar with control (no weed extract). The lowest shoot length (4.98 cm) of rice was found in the interaction of *E. indica* with 10% concentration which was statistically similar with 10% concentration of *A. philoxeroides* (Table 5). The highest reduction (31.31%) of rice shoot length was occured when the weed extract of *E. indica* was used at 10% concentration (Table 6).

4.5 Effect on dry matter production of rice

4.5.1 Effect of weed species

The effect of weed extracts on the root and shoot length of rice have been reflected on the dry matter formation by the rice seedlings. A significant effect was found in the study (Appendix I). The highest dry weight (0.081 g/5 seedlings.) was found in control (no weed extract). Among the weed species, the highest dry matter weight (0.077 g/ 5seedlings) was found in *P. orientale* and the lowest dry matter weight (0.063 g/ 5 seedlings) was found in *E. Crusgalli* (Table 1). Therefore, the weed extract of *E. Crusgalli* had great inhibitory effect (about 22.22% reduction) on dry matter production of rice. From the Table 2, it was found that the ranking of weed species in respect of reduction of rice dry matter was *E. Crusgalli* > *P. hydropiper* > *A. philoxeroides* > *E. indica* > *I. aquatica* >*P. orientale*. On the basis of reduction percentage of dry matter, *E. Crusgalli* was most allelopathic where *P. orientale* was the least one.

4.5.2 Effect of weed extract concentrations

A significant effect of concentration of weed extract on dry matter weight of rice seedling was found in the discussion (appendix I). Among the treatment the highest dry matter weight (0.081 g/5 seedlings) of weed seedling was found in control (no weed extract) and the lowest dry matter (0.068 g/5 seedling) of weed was found when the concentration of weed extract was 10% (Table -3).

The higher concentration of weed extracts produced strong inhibitory effect on dry matter formation by rice seedling than lower concentration. The highest reduction of dry matter production of rice seedling was found in both concentration of 2.5% and 10% (16.04% and 14.81%, respectively) (Table -4). Casini *et al.* (1998), Bora *et al.* (1999) and Kalita *et al.* (1999a) also found similar effects of weed extracts on the dry matter formation by rice.

4.5.3 Effect of interaction between weed species and weed extract concentrations

A significant effects of interaction between weed species and concentration of weed extract was found on dry matter weight of rice seedling (Appendix I). The highest dry matter weight (0.081 g/5 seedlings) of rice seedling was found in control. Among the weed species the dry matter weight (0.07 g/5 seedling) was found due to interaction of all weed species with concentration of 2.5% and 10% (except *E. crusgalli* with 10% concentration). The lowest dry matter weight (0.06 g/5 seedling) of rice seedling was found in the interaction of *E. crusgalli* with 10% concentration (Table 5). The highest reduction (25.93%) of dry matter production of rice seedling was found from the interaction of *E. crusgalli* with 10% concentration (Table 6).

4.6 Effect of average growth inhibition of rice

4.6.1 Effect of weed spices

It was found that the effect of weed species on seed germination, root length, shoot length and dry matter production except median germination time of rice were significant (Table 1). The highest average per cent inhibition (API)

(20.82%) in rice was found due to *Alternanthera philoxeroides* and the lowest average per cent inhibition (6.54%) was found in *Ipomoea aquatica.* The ranking of weed species in respect of average per cent inhibition on rice growth and development was -*Alternanthera philoxeroides*> *Eleusine indica*> *Echinochloa crusgalli* >*Polygonum orientale*> *Polygonum hydropiper* > *Ipomoea aquatica* (Table 2.). Result of the study suggests that the growth and development of rice (BINA dhan-07) must be reduced when the weed species *Alternanthera philoxeroides*, *Eleusine indica* and *Echinochloa crusgalli* will be present excessively in the fields due to its allelopathic influence.

4.6.2 Effect of weed extract concentrations

The effects of concentration of weed extracts on seed germination, median germination time, root length, shoot length and dry matter production of rice were also remarkable (Table 3). The greatest average per cent inhibition (13.60%) was found when concentration of weed extract was 10% and the lowest average per cent inhibition (12.43%) was found when concentration of weed extract was 2.5% (Table 4). Therefore, higher concentration (10%) exhibited greater inhibitory effect on the growth and development of rice than lower concentration (2.5%) of weeds aqueous extract.

4.6.3 Effect of interaction between seed species and weed extract concentrations

Interaction effect of weed species and concentration on seed germination median germination time, root length, shoot length and dry matter production of rice was statistically significant (Table 5). The greatest average per cent inhibition (28.13%) was found in the interaction of *Alternanthera philoxeroides* with concentration of 10% and the lowest average per cent inhibition (2.71%) was found in the interaction of *Polygonum hydropiper* with concentration of 10% (Table 6).

CHAPTER 5

SUMMARY AND CONCLUSION

A laboratory experiment was conducted at the Seed Laboratory, Department of Agronomy, Bangladesh Agricultural University, Mymensingh from 3 to 19 May 2011 to evaluate allelopathic effects of six selected weed species viz. Pani marich (*Polygonum orientale*), Kalmilata (*Ipomoea aquatica*), Malancha (*Alternanthera philoxeroides*), Bishkatali (*Polygonum hydropiper*), Chapra (*Eleusine indica*), Bara Shama (*Echinochloa crusgalli*) on seed germination, median germination time, root length, shoot length and dry matter production of rice (BINA dhan-7). The effect of different weed plants with two concentrations viz. 2.5% and 10% of the extracts were evaluated.

The weed species were collected from the Agronomy Field Laboratory and its surrounding area of Bangladesh Agricultural University, Mymensingh. The rice seeds were collected from BINA office in BAU Campus, Mymensingh. The weed species were washed and air-dried. 20 grams of each plant of each of the six weeds were cut into 1 cm. pieces. The cut pieces of weed were kept in different conical flasks and 100 ml of distilled water was added to each flask and shaken them for 30 minutes. Then it was kept at 4°C for 48 hours and then filtered with Whatman No.1 filter paper. The filtrates obtained from these extracts were considered as 20% stock of aqueous extracts. A dilution of 2.5% and 10% aqueous weed extract were made by mixing appropriate amount of distilled water from the stock aqueous extracts.

Twenty five rice seeds were placed in Petridish lined with 9 cm Whatman No.1 filter paper and then moistened with 10 ml of aqueous extracts of weed plant parts as per treatment specification. Petridish with distilled water only was considered as control. The counting of seed germination was started, from one day after seed placement and continued for 17 days. After that the root length and shoot length of the seedlings were measured. Six weed seedlings were randomly taken out and put in an oven at 80°C for 72 hours to record dry weights. The aqueous extracts of weed species reduced the seed germination, root length, shoot length and dry matter production, and increased the median germination time of rice. The highest reduction in rice seed germination was caused by *Eleusine indica* (13%) and the lowest by *Ipomoea aquatica* (5%). Rice seed germination decreased more with lower concentration (2.5%) of weed extract than that of higher concentration (10%). In case of median germination time, the harmful effects of *Eleusine indica* and *Echinochloa crusgalli* were greater than all the other selected weed species. The maximum harmful effect on median germination time of rice was found in plant extract of *Eleusine indica* (11% increase than control) which was statistically identical with extract of *Echinochloa crusgalli*. In case of root length, the harmful effects of *Alternanthera philoxeroides* was greater than all other selected weeds. The greatest inhibition (41.37%) on root length was found due to extract of *Alternanthera philoxeroides*. The highest reduction of root length was noticed from the lower concentration (2.5%) of the extract.

The shoot length was highly affected (18.34% reduction) by the weed *Alternnanthera philoxerodies* and less affected (2.07% reduction) by the weed

Polygonum hydropiper. Similarly the higher concentration of weed extracts led to greater reduction of shoot length.

The dry matter production of rice was also adversely affected by the extracts of the weed species due to their differential allelopathic effects. The highest reduction in dry matter weight was due to *Echinochloa crusgalli* (22.22%) and the lowest reduction of dry matter weight was found in *Polygonum orientale* (4.94%). The higher and lower both concentrations of extracts led to similar reduction in dry matter weight.

The effects of weed species on seed germination, median germination time, root length, shoot length and dry matter production of rice were different, when the average of all the effects were considered it was noticed that the highest average per cent inhibition (20.82%) was found due to *Alternanthera philoxeroides* and the lowest average per cent inhibition (6.54%) was found in *Ipomoea aquatica*. The ranking of weed species in respect of average per cent inhibition in rice was- *Alternanthera phioxeroides* > *Eleusine indica*> *Echinochloa crusgalli*> *Polygonum orientale*> *Polygonum hydropiper*> *Ipomoea aquatica*. Higher concentration (10%) exhibited greater inhibitory effect than lower concentration in aqueous extract. From the above results of the present experiment it could be concluded that the *Alternanthera philoxeoides*, *Eleusine indica and Echinochloa crusgalli* had strong detrimental effect on rice (BINA dhan-7) seed germination and seedling growth. Therefore, the effects of *Alternanthera philoxeoides*, *Eleusine indica and Echinochloa crusgalli* must be taken into consideration and the weed should be excluded from the field during land preparation for rice cultivation.

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Appendix I. Analysis of variance of the data on seed germination, median germination time, root length, shoot length and dry matter production of rice (BINA dhan-7) as affected by aqueous extracts of weed species under laboratory conditions

Sources of variation	Degrees of freedom	Mean square value				
		% Germination	Median germination time (day)	Root length (cm)	Shoot length (cm)	Dry matter wt (g)
Replication	3	79.111	0.031	1.166	0.405	0.002
Weed species (A)	5	66.4	0.06 NS	7.619	1.82	0.0002
Concentration of extracts (B)	1	48	1.61**	0.089	1.845	0.001
A×B	5	58.4	0.014*	5.691	3.818	0.002
Error	33	60.687	0.007	1.077	1.395	0.0001

* = Significant at 5% level of probability
** = Significant at 1% level of probability
NS = Not significant

Appendix II. Per cent increase in median germination time of rice cv. BINA dhan-7 due to effects of aqueous extracts of different weed species under laboratory conditions

Weed species	Median germination time (%)
Polygonum orientale	9
Ipomoea aquatica	8
Alternanthera philoxeroides	9
Polygonum hydropiper	8
Eleusine indica	11
Echinochloa crusgalli	11

Appendix III. Per cent increase in median germination time of rice cv. BINA dhan-7 due to effects of aqueous weed extracts of different concentrations under laboratory conditions

Concentrations of weed extract	Median germination time (%)
Conc. 2.5%	30
Conc. 10%	8

Appendix IV. Per cent increase in median germination time of rice cv. BINA dhan-7 due to effects of interaction between weed species and concentrations under laboratory conditions

Weed Species Concentrations	Median germination time (%)
W_1C_1	25
W_1C_2	25
W_2C_1	15
W_2C_2	15
W_3C_1	20
W_3C_2	25
W_4C_1	8
W_4C_2	20
W_5C_1	36
W_5C_2	31
W_6C_1	36
W_6C_2	6