

## ALLELOPATHIC EFFECTS OF FIVE SELECTED WEED SPECIES ON SEED GERMINATION AND SEEDLING GROWTH OF CORN

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Accepted for publication: May 21, 2008

### ABSTRACT

**Samad M. A., Rahman M. M., Hossain A. K. M. M., Rahman M. S. and Rahman S. M. 2008. Allelopathic Effects of Five Selected Weed Species on Seed Germination and Seedling Growth of Corn. J. Soil. Nature. 2(2): 13-18**

An investigation was carried out in typical maize growing sandy loam soil at the Agronomy Laboratory, Bangladesh Agricultural University, Mymensingh during March to August, 2000. The allelopathic effects of five weed species viz. *Polygonum hydropiper* L. (W<sub>1</sub>), *Amaranthus spinosus* L. (W<sub>2</sub>), *Chenopodium album* L. (W<sub>3</sub>), *Cyperus rotundus* L. (W<sub>4</sub>) and *Imperata cylindrica* L. (W<sub>5</sub>) on corn (cv. Barnali) seed germination, growth and development were studied. The trial included dried plant parts of five selected weeds (the whole plant, stem, leaf, root and five weed mixture) and weeds aqueous extract (whole plant, stem, leaf, root and five weed mixture) in Petridishes at laboratory condition. These five weed species exhibited inhibition of seedling height and radicle length. *Imperata cylindrica* affected the seedling height and seedling dry matter production severely than others. Radicle length is affected by *Amaranthus spinosus*. On the other hand, germination, seedling growth and dry matter production affected maximum by dried mass of stems of five weed species. The results demonstrated the allelopathic potential of five weed species and suggested that those weed species may affect corn seedling growth and development due to the inhibitory effect of allelochemicals, which are present in the dried parts and aqueous extracts of weed.

**Keywords:** Allelopathic effect, weed species, corn, seed germination, seedling growth

### INTRODUCTION

Weed is a serious pest that damages most of the crops and grain and is everlasting problem for our agriculture. Weeds present in crop field that compete with crop plants for light, moisture and other essential nutrients, resulting reduce quality and yield of crops and increase the cost of production. Plants can influence each other, by allelopathy which is usually harmful (Boonitee and Ritdhit, 1984); sometimes the effect is beneficial (Newman and Andrews, 1973). Rice (1974) defined allelopathy as any direct or indirect harmful effect by one plant to another through the production of chemical compounds, which escape into the environment. Allelopathic substances are most commonly found in plant extracts and in plant residues of soil, some were found in live plant exudates and as volatile gases liberated from leaves and rhizome (Keeley, 1987).

The use of herbicide is problem for health and environmental point of view which pollutes and affects at genetic level and induces on malformation. The principle of chemical weed control thus needs revision. Many plant products are known to inhibit germination and growth of plant, which is essential feature of all herbicides. Therefore, plant product can be a possible alternative for synthetic herbicides and these may be used as natural herbicides (Rizivi and Rizve, 1984). The idea of natural herbicide is the occurrence of allelopathic phenomenon, which refers to bio-chemical interactions between all types of plants. Although allelopathic studies received enormous attention during the past two decades, the idea of using allelopathy in weed control was conceived in the late seventies (Putnam and Duke, 1974) and several workers reported the possibility of using in weed control (Putnam and Frank, 1979; Putnam *et. al.*, 1983). Corn (*Zea mays* L.) is an important cereal crop and ranks third in acreage and production among the grain food crops of Bangladesh. The main objective of this study was to evaluate the allelopathic effect of five selected weed species viz. Katanatey (*Amaranthus spinosus*), Mutha (*Cyperus rotundus*), Bishkatali (*Polygonum hydropiper*), Bathua (*Chenopodiurn album*) and Ulu (*Imperata cylindrica*) on seed germination and growth of corn.

### MATERIALS AND METHODS

A field study was carried out in the Non Calcareous Dark Grey Floodplain soil at the Agronomy Laboratory, Bangladesh Agricultural University, Mymensingh during March to August in 2000. The soil used was sandy loam with p<sup>H</sup> 6.5 and 0.5% organic matter. The treatment included two sets of the experiment were: i) powdered five weed parts and ii) their aqueous extracts in petridishes soil at laboratory condition. The selected weeds were manually collected from the Agronomy field laboratory, Bangladesh Agricultural University, Mymensingh and were oven dried at 80°C for 48 hours. Two hundred and fifty gram of each of the five oven dried weeds- stem, leaf, root, whole plant and five weed mixed together and was ground separately. Five gram of each dried sample was taken in 100 ml distilled water. Then it was kept for 48 hours at 50°C and filtered with whatman No. 1. The filtrates obtained from these were taken as 5% stock aqueous extracts. The seeds of corn were treated with

vitavax-200 @ 10 g/kg seed. The growing media was sterilized sand. The experiment was laid out in randomized block design. The treated seeds were kept for germination in sterilized petridish (9cm diameter), which filled up with sand, and each petridish contains 25 ml of 5% aqueous extracts in four replications. Only distilled water was used for control. The germination tests were carried out under room temperature at  $28^{\circ}\pm 2^{\circ}\text{C}$ . Germination percentages, radicle length, and seedling height were measured after 7, 14 and 21 days of seed setting. Four seedlings from one side of each replicated petridish were collected randomly for each harvest to keep records on radicle length, seedling height and dry weights of radicle. The collected data on different characters were analyzed statistically and means were tested by Duncan's New Multiple Range Test (DMRT).

## RESULTS AND DISCUSSION

### Seed Germination

Maize seed germination was affected significantly by the allelopathic effect of the weeds. However, there was no significant difference between the weed species in respect of their allelopathic effects on seed germination of corn.

### Affected by Weed Whole Plant

The seed germination was inhibited dry weed parts and aqueous extracts of the five weed species (Table I). The effect of *Amaranthus spinosus* on germination percentage of corn was the highest (73.17%) and that of *Imperata cylindrica* was the lowest (83.9%). The effect of others was about to equal. When considered the mean effect of dried weed part and aqueous extracts of five weed species, there was no significant difference between the two means (Table 1). However, the effect of powdered weed parts was higher than the aqueous extracts. Overall, the germination percentage of corn seed was affected by whole of five weed species as compared to control.

Table 1. Effects of weed dry parts and aqueous extracts on germination (%) of Maize

Treatments	Whole weed part			Stem			Leaf			Root			Grand mean
	Dry part	Aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	
<i>Polygonum hydropiper</i> (W <sub>1</sub> )	82.5	75.0	78.75	83.75	80.0	81.88	76.25	72.5	74.37	88.75	70.00	79.37	78.55
<i>Amaranthus spinosus</i> (W <sub>2</sub> )	72.5	73.75	73.13	80.0	80.0	80.0	70.0	75.0	72.50	81.25	88.75	85.0	77.67
<i>Chenopodium album</i> (W <sub>3</sub> )	83.75	86.25	85.0	73.75	68.75	71.25	78.75	80.0	79.37	82.5	87.50	85.0	80.16
<i>Cyperus rotundus</i> (W <sub>4</sub> )	83.75	91.25	87.5	76.25	66.25	71.25	83.5	85.0	83.75	86.25	82.50	84.37	81.72
<i>Imperata cylindrica</i> (W <sub>5</sub> )	82.5	82.50	82.0	82.5	90.0	86.25	85.0	82.5	83.75	86.25	81.25	83.75	83.94
Mean	81.5	81.75	81.38	79.25	77.0	78.13	78.5	79.0	78.75	85.05	82.00	83.52	80.44
Five weed mixture	77.5	86.25	81.88	77.5	86.25	81.88	77.5	86.25	81.88	77.25	86.25	81.87	81.87
Control	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.50	97.5	97.5	97.5	97.5

All effects are insignificant

### Affected by Weed Stems

Dry weed stems and aqueous stem extract of the five weed species inhibited the maize seed germination. The lowest germination percent of 71.25% was recorded by *Chenopodium album* and the highest 86.25% due to *Imperata cylindrica* (Table 1). But there is no significance difference between powdered weed stems and aqueous stem extracts of five weed species.

### Affected by Weeds Leaves

Powdered weed leaves and aqueous leaves extracts of five weed species inhibited the maize seed germination (Table 1). The effect of the *Amaranthus spinosus* was the highest (72.5%) and that of *Imperata cylindrica* was the lowest (83.75%). In the case of mean effect of the powdered weed leaves and aqueous leaves extracts of the five weed species, there was no significant difference between the two means. However, in the mean effect of powdered weed leaves and aqueous leaves extracts of the five-weed mixture, powdered weed leaves showed higher effect than aqueous leaves extracts. Similar result was observed by Martin *et al.* (1990) who stated that *Conyza canadensis* intact fresh leaves were inhibitory on maize seed germination.

**Affected by Weed Roots**

Seed germination percentage was more affected by the *Polygonum hydropiper* (79.37%) (Table 1) than others but there was no significant difference between powdered and aqueous root extracts of the five weed species. However, powdered weed roots had more inhibitory effect than aqueous extracts of weeds. The results indicate the inhibitory effect of the weeds under control environment. The germination percentage was affected by the allelopathic effect of five selected weed species.

**Seedling Height after Seven Days of Sowing**

The effect of the *Imperata cylindrica* was the highest (11.15 cm) and that of *Polygonum hydropiper* was the lowest (13.99 cm) (Table 2). However, it was observed that, aqueous extracts of weed whole, stem and leaves were statistically significant.

**Effect of Aqueous Extracts of the Weed Whole Plants on Seedling Height**

The allelopathic effects of *Chenopodium album* and *Imperata cylindrica* were the highest and that of others were about to equal. When aqueous extracts were mixed with soil, then it was found that plant height were 10.26 and 9.35 cm due to the effects of *Chenopodium album* and *Imperata cylindrica*, respectively. The effect of five-weed mixture was the lowest (seedling height was 18.37 cm). The effects of other weeds were statistically identical and their effects were medium as compared to control, where the seedling height was 19.85 cm. (Table 2).

Table 2. Effects of weed dry parts and aqueous extracts on seedling height of Maize after 7 days of sowing

Treatments	Whole weed part			Stem			Leaf			Root			Grand mean
	Dry part	aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	Dry part	aqueous extracts	Mean	Dry part	aqueous extracts	Mean	
<i>Polygonum hydropiper</i> (W <sub>1</sub> )	12.28	14.94ab	13.61	12.89	13.46b	13.17	13.36	12.74abc	13.05	15.64	16.65	16.14	13.99
<i>Amaranthus spinosus</i> (W <sub>2</sub> )	14.98	13.92ab	14.85	14.26	11.0 c	12.63	14.26	9.92bc	12.09	10.15	13.72	11.93	12.88
<i>Chenopodium album</i> (W <sub>3</sub> )	11.36	10.26b	10.81	13.22	12.0 c	12.61	13.22	14.27abc	13.74	11.3	15.64	13.47	12.66
<i>Cyperus rotundus</i> (W <sub>4</sub> )	15.97	13.82ab	14.89	9.73	12.54 bc	11.13	16.72	15.08ab	15.9	13.59	12.60	13.09	13.75
<i>Imperata cylindrica</i> (W <sub>5</sub> )	10.22	9.35b	9.78	11.85	11.07 c	11.46	13.82	7.68c	10.75	14.11	11.07	12.59	11.15
Mean	12.96	12.45	12.71	12.39	12.01	12.2	12.47	11.94	13.10	12.95	13.93	13.44	12.86
Five weed mixture	11.6	18.37a	14.99	11.60	18.37 a	14.99	11.6	18.37a	14.98	11.6	18.37	14.98	14.98
Control	19.85	19.85	19.85	19.85	19.85	19.85	19.85	19.85	19.85	19.85	19.85	19.85	19.85
SE	NS	1.8	NS	NS	0.56	NS	NS	2.26	NS	NS	NS	NS	NS
LSD (0.05)		3.84			1.19			4.82					

**Effect of Aqueous Extracts of the Weed Stems on Seedling Height after Seven Days of Sowing**

The effects of aqueous extracts of *Amaranthus spinosus* and *Imperata cylindrica* were the highest and that of five weed mixture was the lowest. The effects of others were moderately significant and they were identical (Table 2).

**Effect of Aqueous Extracts of the Weed Leaves on Corn Seedling Height after Seven Days of Sowing**

The inhibitory effect of *Imperata cylindrica* was the highest (7.68cm) and that of *Cyperus rotundus* was the lowest (15.08cm) The inhibitory effects of other weeds were low and statistically identical (Table 2).. It was obvious that allelopathic effects were in all the five weeds and *Amaranthus spinosus* and *Imperata cylindrica* showed more than other three weeds. These two weeds significantly affected the corn seedling height. Hossain (1992) observed that the allelopathic effect of *Imperata cylindrica* on maize seedling growth was the highest. Aqueous extracts of *Imperata cylindrica* significantly reduced the early growth of maize seedling. The aqueous extracts of leaves and roots were more inhibitory than other parts of weed. Qasem (1993) found that some weed like *Amaranthus spinosus* and *Chenopodium album* had allelopathic effect on maize and barley growth. They found when the aqueous extracts of these two weeds were applied in petridishes in laboratory condition, the coleoptiles length reduced in the case of barley and maize. The results demonstrated that the five selected weed species reduced the seedling height. Aqueous extracts were more inhibitory than dried weed mass and the aqueous extracts of leaves were more harmful than that of other parts.

### Effect of Five Selected weeds Dry Parts and Aqueous Extracts on Seedling Dry Matter after Seven Days of Sowing

The allelopathic effect of dried weed parts and aqueous extracts of weeds whole plant was statistically significant. The effect of *Imperata cylindrica* was the highest and that of the *Cyperus rotundus* was the lowest among the five weed species. When considered the mean effect of dried and aqueous extracts on corn seedling dry weight, there was no significant difference between these two (Table 3). However, the effect of dried weed parts of the five weed mixed was higher than aqueous extracts. This agreed to the findings of Qasern (1993) who observed that the aqueous extracts of *Chenopodium album* and *Amaranthus spinosus* reduced the root and shoot dry weight of maize and barley. The allelopathic effects of *Imperata cylindrica* were higher than the others. The allelopathy affected higher in seedling dry weight as compared to seedling height.

Table 3. Effects of weed dry parts and aqueous extracts on dry matter production of Maize after 7 days of sowing

Treatments	Whole weed part			Stem			Leaf			Root			Grand mean
	Dry part	aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	Dry part	aqueous extracts	Mean	Dry part	aqueous extracts	Mean	
<i>Polygonum hydropiper</i> (W <sub>1</sub> )	0.17ab	0.22a	0.195	0.19	0.20	0.195	0.17	0.14	0.155	0.21	0.21	0.21	0.185
<i>Amaranthus spinosus</i> (W <sub>2</sub> )	0.20a	0.20abc	0.20	0.21	0.14	0.175	0.17	0.14	0.155	0.20	0.16	0.18	0.175
<i>Chenopodium album</i> (W <sub>3</sub> )	0.19a	0.13bc	0.16	0.21	0.17	0.19	0.19	0.20	0.195	0.19	0.17	0.18	0.18
<i>Cyperus rotundus</i> (W <sub>4</sub> )	0.22a	0.21ab	0.215	0.14	0.15	0.145	0.25	0.22	0.235	0.15	0.14	0.145	0.18
<i>Imperata cylindrica</i> (W <sub>5</sub> )	0.12b	0.12c	0.12	0.14	0.14	0.14	0.18	0.09	0.135	0.17	0.14	0.155	0.135
Mean	0.18	0.176	0.178	0.17	0.16	0.167	0.192	0.158	0.175	0.184	0.164	0.174	0.17
Five weed mixture	0.18a	0.22a	0.20	0.18	0.22	0.20	0.18	0.22	0.20	0.18	0.22	0.20	0.20
Control	0.263	0.263	0.263	0.263	0.263	0.262	0.263	0.263	0.263	0.263	0.263	0.263	0.263
SE	0.03	0.04		NS	NS		NS	NS		NS	NS		
LSD (0.05)	0.06	0.09											

### Effect of powdered and aqueous Weeds Extracts on Seedling Height after Fourteen Days of Sowing

Only powdered mass of weed root affected the seedling height significantly (Table 4). The adverse effect of the *Amaranthus spinosus* on seedling height was the highest (27.46) and that of *Cyperus rotundus* was the lowest (39.87). This investigation agreed to the finding of Meissner *et. al.*, (1970) who observed that appreciable reduction in root and shoot growth of barley where previously grown with *Cyperus rotundus* and attributed reduction due to the biologically active substances contained in the under ground weed parts.

Table 4. Effects of weed dry parts and aqueous extracts on seedling height of Maize after 14 days of sowing

Treatments	Whole weed part			Stem			Leaf			Root			Grand mean
	Dry part	aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	Dry part	aqueous extracts	Mean	Dry part	aqueous extracts	Mean	
<i>Polygonum hydropiper</i> (W <sub>1</sub> )	37.41	34.61	36.01	36.93	34.8	35.865	35.94	34.78	35.36	37.41a	33.20	35.31	35.63
<i>Amaranthus spinosus</i> (W <sub>2</sub> )	35.89	27.46	31.67	35.71	28.31	32.01	31.02	32.68	31.85	28.14b	35.34	31.74	31.82
<i>Chenopodium album</i> (W <sub>3</sub> )	28.47	33.60	31.03	31.01	35.13	33.07	30.21	27.37	28.79	32.14ab	39.31	35.73	32.15
<i>Cyperus rotundus</i> (W <sub>4</sub> )	34.27	39.87	37.07	32.45	36.90	34.675	38.93	29.84	34.39	38.68a	36.81	37.75	35.97
<i>Imperata cylindrica</i> (W <sub>5</sub> )	33.48	29.10	31.29	29.25	26.76	28.005	33.01	31.93	32.47	32.21ab	35.44	33.83	31.40
Mean	33.904	32.92	33.41	33.07	32.38	32.725	33.82	31.32	32.57	33.716	36.02	34.87	33.39
Five weed mixture	38.90	32.40	35.65	38.90	32.40	35.65	38.90	32.40	35.65	38.90a	32.40	35.65	35.65
Control	41.76	41.76	41.76	41.76	41.76	41.76	41.76	41.76	41.76	41.76	41.76	41.76	41.76
SE	NS	NS		NS	NS		NS	NS		2.87	NS		
LSD (0.05)										6.12			

**Effect of powdered and Aqueous Extracts of Weed on Seedling Dry Matter Production after Fourteen Days of Sowing**

The effect of *Chenopodium album* was the highest and that of five-weed mixture was the lowest on seedling dry matter production (Table 5). It was observed that powdered weed parts (whole plant and stem) had allelochemicals which affected the seedling dry matter production.

Table 5. Effects of weed dry parts and aqueous extracts on dry matter production Maize after 14 days of sowing

Treatment	Whole weed part			Stem			Leaf			Root			Grand mean
	Dry part	Aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	
<i>Polygonum hydropiper</i> (W <sub>1</sub> )	0.28a	0.21	0.245	0.28a	0.24	0.26	0.22	0.20	0.21	0.26	0.24	0.25	0.24
<i>Amaranthus spinosus</i> (W <sub>2</sub> )	0.25a	0.19	0.22	0.25ab	0.22	0.235	0.27	0.25	0.26	0.25	0.24	0.245	0.237
<i>Chenopodium album</i> (W <sub>3</sub> )	0.19a	0.19	0.19	0.17b	0.25	0.21	0.25	0.27	0.26	0.22	0.28	0.23	0.22
<i>Cyperus rotundus</i> (W <sub>4</sub> )	0.23a	0.26	0.245	0.20ab	0.28	0.24	0.22	0.21	0.215	0.24	0.26	0.25	0.23
<i>Imperata cylindrical</i> (W <sub>5</sub> )	0.25a	0.20	0.225	0.21ab	0.23	0.22	0.24	0.24	0.24	0.18	0.25	0.215	0.22
Mean	0.24	0.21	0.225	0.222	0.244	0.233	0.24	0.234	0.2375	0.23	0.254	0.242	0.23
Five weed mixture	0.29a	0.20	0.245	0.29a	0.20	0.245	0.29	0.20	0.245	0.29	0.20	0.245	0.24
Control	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
SE	0.02	NS		0.03	NS		NS	NS		NS	NS		
LSD (0.05)	0.04			0.07									

**Effect of powdered Weed Parts and Aqueous Extracts of five Selected Weed Species on Dry Matter Production of Maize Seedling after 21 Days of Sowing**

The effect of the *Polygonum hydropiper* was the highest and that of five weeds mixture was the lowest. The effect of aqueous extracts of *Polygonum hydropiper* was the highest (0.207 g) and that of *Amaranthus spinosus* was the lowest among the five selected weed species (Table 6). The effect of others was about equal. The results indicated that the different weed species had different allelopathic effect on corn seedling dry matter production and they affected at different harvest time.

Table 6. Effects of weed dry parts and aqueous extracts on dry matter production of Maize seedling after 21 days of sowing

Treatment	Whole weed part			Stem			Leaf			Root			Grand mean
	Dry part	Aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	Dry part	Aqueous extracts	Mean	
<i>Polygonum hydropiper</i> (W <sub>1</sub> )	0.195b	0.207b	0.201	0.225	0.29	0.2575	0.33	0.255	0.2925	0.29	0.30	0.295	0.2575
<i>Amaranthus spinosus</i> (W <sub>2</sub> )	0.257ab	0.38a	0.3185	0.23	0.21	0.22	0.255	0.235	0.29	0.245	0.30	0.2725	0.27
<i>Chenopodium album</i> (W <sub>3</sub> )	0.30a	0.26b	0.28	0.29	0.26	0.275	0.23	0.265	0.2475	0.22	0.295	0.2575	0.26
<i>Cyperus rotundus</i> (W <sub>4</sub> )	0.31a	0.24b	0.275	0.24	0.235	0.2375	0.305	0.360	0.3325	0.245	0.315	0.28	0.27
<i>Imperata cylindrical</i> (W <sub>5</sub> )	0.27ab	0.295ab	0.2825	0.22	0.27	0.245	0.325	0.26	0.2925	0.235	0.235	0.235	0.26
Mean	0.2664	0.2764	0.2714	0.241	0.253	0.247	0.289	0.275	0.282	0.247	0.289	0.268	0.26
Five weed mixture	0.325a	0.31ab	0.3125	0.325	0.31	0.3175	0.325	0.31	0.3175	0.325	0.310	0.3175	0.31
Control	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
SE	0.03	0.05		NS	NS		NS	NS		NS	NS		
LSD (0.05)	0.07	0.10											

## CONCLUSION

Weed parts (the whole plant, stem, leaf, root and five weed mixtures) of selected weed species exhibited inhibition of seed germination, seedling height, radicle growth and dry matter production of corn crops. But among the five weed species *Imperata cylindrical* and *Amaranthus spinosus* had a more inhibitory effect on corn seed germination, growth and development in comparison to *Chenopodium album*, *Cyperus rotundus* and *Polygonum hydropiper*. In the case of weed parts, stem was more harmful than other parts.

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