<u>Original Research Article</u>

Allelopathic potential of Imperata cylindrica on the growth and germination of Zea Mays.

ABSTRACT

Allelopathy is regarded as any process whereby secondary metabolites produced by plants influence the growth and development of agricultural and biological systems including positive and negative effects. The species is one of the top ten worst weeds and is listed among the world's top 100 worst invasive alien species. To access the allelopathic potential of *Imperata cylindrica* on the germination and growth of *Zea mays, Zea mays* was treated with different concentrations of aqueous extract *of Imperata cylindrica*. The treatment was laid out in completely randomized designs with five treatments and 3 replications. Results indicated that the highest germination percentage was recorded from control whereas the lowest was at 20% concentration level. There was no significant difference in seed germination, root length, shoot length, seedling length, and vigor index between the treatments ($P>0.05$) when compared to the control. Crop residues of Imperata cylindrica could be spread on wastelands, resulting in the leaching of allelochemicals that would reduce the seed germination and consequently the population of weeds.

INTRODUCTION

1.1 Background of study

Weeds are associated with many crops and are a major threat to crop production in many cropping systems. It has been observed that weeds may cause a reduction up to 25-30% in the yield of wheat (Chaudhary et al., 2008; Marwat et al., 2008), 35-40% reduction in rice yield (Oreke and Dehne, 2004), 35-80% reduction in maize (Dangwal et al., 2010) and 20-40% reduction in sugarcane yield (Khan et al.,2004), depending upon weed density, types of weeds, duration of competition, management practices and weather conditions.

Weeds cause a reduction in the growth and yield of crops by interfering with different metabolic processes (Hajizadeh and Mirshekari, 2011). The interference of weeds with crops may be the consequence of competition and/or allelopathy.

Allelopathy is regarded as any process whereby secondary metabolites produced by plants, microorganisms, viruses and fungi influence the growth and development of agricultural and biological systems including positive and negative effects (Torres et al., 1996). The ability of various plant species to induce allelopathic impacts on plants in their surroundings has been documented since ancient times. The most primitive writings on allelopathy are accredited to the Theophrastus (300 BC) who detected the detrimental effect of cabbage over the growth of a vine and proposed that such effects were occurred by odors from cabbage plants (Willis, 1985).

Allelochemicals are secondary metabolites which are liberated from plants and affect the germination and growth of recipient plants (Kruse *et al*., 2000; Asaduzzaman et al., 2010). Allelochemicals are released through volatilization, root exudation, residues decomposition and leaching from leaf litter, and they act upon by various modes of action. Allelochemicals are very diverse and therefore its difficult to establish a general action model; since it depends on the compound type, the receiving plants and how it acts. Allelochemicals can act at internal level and external level. Talking about the internal level, there is a large number of physiological parameters that can be affected. They have action on the cellular membrane, disrupt the activity of different enzymes or structural proteins or alter hormonal balance. They can also inhibit or reduce cellular respiration and chlorophyll synthesis, leading to a reduction in vitality, growth and overall development of the plant. These substances can also reduce seed germination or seedling development, or affect cell division, pollen germination, etc. (Ferguson *et al.,* 2013).

On the other hand, at external level, the allelochemicals may be related to the release or limitation of nutrients that are found in the soil. Others act on microorganisms leading to a perturbation on the symbiotic relationships they establish (Aguilela and Puch, 2004).

Seed germination and plant growth is interrupted by the disturbance of a variety of physiological functions occurring within plant bodies. The plant functions of prime importance which are affected by allelochemicals include respiration, photosynthesis, cell division and enlargement, metabolic activities, protein synthesis and enzyme actions (Lin *et al.,* 2004)

One dominant weed in Ebonyi state is *Impereta cylindrica*. Decomposing residues of this weed are commonly left on the soil surface as mulches. However, it is known that plant residues of crops, weeds or natural vegetations left on, and in the soil, release assorted chemical compounds into the soil during decomposition. The chemical compound interferes with the growth of other plants and often adversely affect the yields of crop plants through the process of allelopathy. Release of such chemical compounds, or allelochemicals is held as a major factor in regulating the structure of plant communities in both natural and agroecosystem (Gawronska and Golisz, 2006). The regulation is accomplished in part by generating biotic stresses for germinating seeds in form of allelopathic interferences. The allelochemicals are released on the environment by plant but, they are not directly aimed to the action site, thus it is a private mechanism. To be effective, allelopathic interaction needs that these substances are distributed along the ground or the air and that they reach the other plant. Use of seed germination results is of advantage since the process constitutes a critical step in the propagation and cultivation of most crop species (Ishii-Iwamoto et al. 2006). One of the most commonly grown edible seeds in this area are Zea mays L (maize). This study was carried out to evaluate the allelopathic potential of imperata cylindrica on the germination of maize.

OBJECTIVES

- To determine the effect of aqueous extract of *Imperata cylindrica* on the germination of Zea mays
- To determine the effect aqueous extract of *Imperata cylindrica* on the plumule growth of Zea mays
- To determine the effect of aqueous extract of *imperata cylindrica* on the radicle growth of Zea mays

MATERIALS AND METHODS

2.1 Study Area

The experiment was conducted at the laboratory of Applied Biology Department, Ebonyi state university abakaliki located on latitude 6° 22'26''N and longitude 8° 6'6''E of the Greenwich meridian.

2.2 Experimental design and layout

A completely randomized design was used with 5 treatment and 3 replications as follows:

Treatment	Variety	Replicates
Distilled water	1	3
20% (w/v-1) plant extract	1	3
15% (w/v-1) plant extract	1	3
10% (w/v-1) plant extract	1	3
5% (w/v-1) plant extract	1	3

2.3 Experimental Procedure

Imperata cylindrica was collected from crop fields and brought to laboratory. It was authenticated at the herbarium of the department of applied biology. The plant material was rinsed in clean water. The fresh leaves were cut into small pieces and pounded it using mortar and pestle. A 200g of the ground sample was measured and soaked in 2000ml distill water in a plastic bucket, and shaken regularly for 7 days, producing a 20% (w v-1)aqueous extract. The aqueous extract of the weed sample was filtered and the concentrated aqueous extract collected in a beaker and stored. Some quantity of the 20% (w-v-1) extract were diluted to 15, 10 and 5% with distilled water.

The seeds of test crop (zea mays var Oba Super 4.) were treated with different concentrations of the aqueous extract. Ten seeds were placed equidistantly in 8cm diameter Petri plates fitted with two layers of filter paper. 5ml of 5, 10,15 and 20% aqueous extract of *imperata cylindrica* were added into the petri plates as per treatment using syringe and needle daily. Sterilized water was used as control. The treatments were replicated three times in complete randomized design. The criterion for measuring germination is embryo protrusion, and this was evaluated every 12 hours during the first seven days of the experiment (that is seeds were considered as germinated upon emergence of radical).

2.4 DATA COLLECTION

The number of seeds germinated was counted on 1,2,3,4,5,6 and 7 days after sowing (DAS) and seedling growth was measured at 7 DAS. The various growth parameters were evaluated as follows:

i. **Germination percentage**: The formular given by Rehman et al. (1998) was used to estimate germination percentage. Germination % $=\frac{no\ of\ seeds\ germinated}{total\ no\ of\ seeds} x\ 100$
ii. **Root and shoot length**: length of root and shoot of seedlings was calculated using the standard centimeter scale. Kabir et al. (2008)

iii. **Vigor index**: the formula suggested by Abdul-Baki and Anderson (1973) was used to calculate vigor index. Vigor index = Germination % x (root length + shoot length) on % x (root length + shoot length) in cm).

iv. **Mean germination time (MGT)**: mean germination time was calculated by the formula given by Ellis and Roberts (1981). MGT = $\frac{n1\ xd1+n2\ xd2+n3\ xd3+-----}{totalnumberofdays}$

Where, n= number of germinated seed

d= numbers of days

v. **Mean daily germination (MDG):** Mean daily germination was calculated by the following formula given by Czabator (1962). MDG= $\frac{totalnumberofgerminatedseeds}{totalnumberofdays}$

vi. **The phytotoxicity (%)**: The phytotoxicity was calculated using the formular given by Choe *et al.* (1978).

Phytotoxicity (%) = $\frac{length\ of\ control-length\ of\ treated}{length\ of\ control} x$ 100

vii. **The extract tolerance index (ETI)**: This was calculated using the formular determined by Turner & Marshal (1972). $\frac{mean\ length\ of\ the\ longest\ root\ and\ shoot\ in\ acqueous\ extract}{mean\ length\ of\ the\ longest\ root\ and\ shoot\ in\ the\ control}$

2.5 Statistical Analysis

Data on seed germination, shoot length, root length were analyzed using one- way analysis of variance (ANOVA)

RESULTS

3.1 effect of different concentration of *imperata cylindrica* on seed germination

The mean seed germination percentage of *zea mays* under different concentrations of aqueous extract of *imperata cylindrica* are given in table 1. There was no significant difference among the treatments *P>0.05*. 15% and 20% concentrations of the aqueous extract had similar germination percentage while the lower percentage germination was observed in the control

3.2 Effect of different concentration of *imperata cylindrica* on shoot length of *zea mays*

The mean shoot length of *zea mays* seedlings under different concentrations of aqueous extract of *imperata cylindrica* are given in Table 1. There was no significant difference in shoot length between treatments *(P>0.05)* when compared to the control.

3.3 effect of different concentration of *imperata cylindrica* on root length

The mean root length of *zea mays* seedlings under different concentration of aqueous extract of *imperata cylindrica* are given in Table 1. There was no significant difference in root length between the treatments *(P>0.05)* when compares to the control. Root length was lowest at 20% concentration whilst the highest root length was recorded in the control.

3.4 seedling length

There was no significant difference in seedling length between treatments *(P>0.05)* when compared to the control. Seedling length was lowest at 20% concentration whilst the highest seedling length was recorded in control as shown on table 1.

3.5 seedling vigor index

Seedling vigor index was lowest at 20% concentration while the highest was recorded in control as shown in table 1. There was no significant difference in root length between the treatments *(P>0.05)* when compared to control.

Table 1: Effect of different concentrations of *Imperata cylindrica* on seed germination, root length, shoot length, seedling length, and seedling vigor index of *Zea mays*

Mean in the same column with the same letters are not significant while the ones with different letters are significant

Treatment	Seed germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling vigor index

	(%)				
Control	100.00±0.00	9.54±0.82a	8.66±0.38a	18.04±1.67a	17.6667±158.74b
5%	90.00±5.77	9.38±0.88a	7.99±0.82a	17.55±1.58a	1623.60±150.90b
10%	80.00±5.77	9.23±1.00a	7.07±0.80a	16.31±1.73a	1305.06±138.84b
15%	76.66±3.33	8.75±1.12a	6.68±0.87a	15.77±1.97a	1209.81±151.53b
20%	76.66±8.81	8.26±0.91a	6.11±0.90a	13.51±1.74a	1036.21±133.77b

3.6 germination time

The mean germination time of zea mays under different concentration of aqueous extract of imperatacylindica are given in table 2. 5% and 10% concentrations had similar mean germination times. The highest mean germination time was recorded in 15%

3.7 germination index

The highest germination index was recorded in the control (Table 2). 15% and 20% concentration had similar germination index

3.8 effects of different concentrations of imperata cylindrica on mean daily germination

The highest mean daily germination was recorded in 20% concentration (table 2). 5% and 10% concentrations had similar mean daily germination.

3.9 relative elongation rate of shoot

The highest relative elongation rate of shoot and root was recorded in control whilst 20% concentration recorded the lowest relative elongation rate of shoot and root (table 2).

3.9 phytotoxicity

Phytotoxicity in maize seedlings at different concentration of aqueous extracts was found to be significantly different. The highest phytotoxicity was recorded in 20% concentration whilst 5% concentration recorded the lowest phytotoxicity (table 2)

3.10 percentage inhibition for shoot and root

The highest inhibition percentage for shoot and root was recorded at 20% and the lowest inhibition in seed germination was recorded at 5% concentration (table 2) it reveals that as the dose increased the inhibition also increased.

Table 2: Effect of different concentrations of Imperata cylindrical on Germination index, Mean germination time, Mean daily germination, Relative Elongation Rate of Shoot, Relative Elongation Rate of Root, phytotoxicity, Extract tolerance index, and Percentage inhibition

Treatment	Germination	Mean germination time	Mean daily germination	Relative Elongation Rate of Shoot	Relative Elongation Rate of Root	Phytotoxicity	Extract Tolerance index	Percentage Inhibition for shoot	Percentage inhibition for root	Percent age inhibition for Germination

Control	1.00	10.71	3.42	100	100	0	30.9	0	0	0
5	0.9	10.42	3.28	92.2	98.3	1.67	1.12	7.67	1.71	10
10	0.8	10.42	3.28	81.6	96.7	3.24	0.98	18.3	3.22	20
15	0.0007	14.4	4.28	77.1	91.7	8.28	1.15	22.87	8.24	23.33
20	0.0007	12.71	3.85	70.5	86.5	13.4	1.04	29.45	13.45	23.33

DISCUSSION CONCLUSION AND RECOMMENDATION

5.1 DISCUSSION

Aqueous extract of plant parts of imperata cylindrica exhibited allelopathic effect on germination, shoot and root lengths of zea mays. There was no significant difference in seed germination, root length, shoot length, seedling length and vigor index between the treatments (P>0.5) when compared to control (table 1).

The phytotoxic effects of imperata cylindrica on seed germination and seedling growth has been widely reported. It has been revealed by koger and Bryson (2004), Samad et al, (2011), Devi and Dutta (2012) and Sahid and yusoff (2014). This indicates that the plant contained allelopathic substances that affected the seeds of zea mays. Imperata cylindrica extracts showed inhibitory effect on shoot and root length but exerted more inhibitory effects on the shoot than on the root tested (table 2).

CONCLUSION

I.cylindrica have significant allelopathic effects on the germination and growth of zea mays. Imperata cylindrica could be spread on wastelands, resulting in the leaching of allelochemicals such as fatty acids, terpenoids, simple phenolics, benzoic acids etc which would reduce seed germination and consequently the population of weeds.

RECOMMENDATION

Further studies are required to identify and isolate the most effective allelochemicals from *imperatacylindrica* and develop natural-product based herbicides to curb weeds.

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