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The Impact of *Commolina benghalensis* Extract on Maize (*Zea mays* L.) Seed Germination and Early Seedling Growth

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Abstract
The laboratory experiment were conducted at Agricultural Technical Vocational Education and Training College at Wolaita Soddo, Ethiopia during 2013 with the objective of investigating the impact of root and whole plant extract of *Commolina benghalensis* on germination and early seedling growth of maize (*Zea mays* L.). Laboratory bioassay of different level water extract concentrations (0, 2.5, 5.0, 7.5 and 10.0%) of weed parts (root and whole plant) was arranged in Complete Randomized Design. It was found that the reduction in germination percentage was 6.7, 25.0, 36.7 and 43.3% with 2.5, 5.0, 7.5 and 10.0% water extracts, respectively, over the control. The shortest (9.06cm) root length was recorded with whole plant at 10.0% water extract which did not significantly vary from the interaction of root at 10% water extract concentration. The lowest shoot length was observed with the interaction of whole plant and 10.0% extract concentration which was statistically at par with10% root extract and 7.5% whole plant extract. The decrease in dry matter weight accumulation in maize seedling treated with 10.0% extract concentration was 37.2% over the control. The whole weed plant part was significantly reduced (11.1%) the dry matter weight than the root extract. The decrease in vigor index due to the increase in extract concentrations of *C. benghalensis* was 11.8, 30.2, 50.1 and 48.5% respectively, at the extract concentration of 2.5, 5, 7.5, and 10% over the control.
Keyword; Allelopathy, Commolina benghalensis, Water extract, Zea mays.

Introduction

The allelochemicals known to reduce uptake of nutrients (Kolesnichenko and Aleikina, 1976), suppress the activity of growth hormones such as IAA and Gibberellins (Kefeli and Turetskaya, 1976) and disturb the process of photosynthesis (Barkosky et al., 1999), which may result in declined shoot growth. Other basic plant process such as respiration, chlorophyll production, hormonal balance, protein synthesis, permeability and plant water relations alter by allelopathic compounds growth of Vigna radiata and Phaseolus vulgaris, both in length and biomass production, was significantly reduced by water shoot extract of Imperata cylindrica, at all the growth stages. The reduced root growth of test species may also be attributed to the reduced mitotic activity of root cells under allelopathic stress (Jensen and Welbourne, 1962; Bukolova, 1971).

The varied susceptibility of different species to extracts has previously been attributed to inherent differences in physiological and morphological characteristics of test species (Shaukat et al., 1983).
Toxicity is associated with the presence of strong electrophilic and nucleophilic system, which act on specific positions of proteins and enzymes, alter their configurations and affect their activity (Macias et al., 1992).

Benghal Dayflower (C. benghalensis) is native to tropical and subtropical regions in Africa, Asia, and the Pacific. It is one of the world's worst weeds affecting 25 crops in 29 countries (Webster et al., 2005). C. benghalensis can be annual or perennial widely distributed herbaceous weed that commonly invades agricultural sites, disturbed areas, road sides and home gardens. Once established, it has a high drought tolerance and grows well in all soils of variable pH and moisture levels (NAPPO, 2003; Webster et al., 2005). It has been found infesting many plantation, vegetable, fruit and field crops including maize (NAPPO, 2003).

The spread of C. benghalensis has posed a great threat to the production of the crops and has drawn the attention towards this problem. However, little is known about the allelopathic potential of the weed on maize seed germination, seedling growth and biomass production.

The response of maize to C. benghalensis water extracts, therefore, may be a solution in the development of natural weed control and management strategies. Therefore, an investigation was carried out under laboratory at Wolaita Soddo Agricultural College Plant Sciences Laboratory with the objective of

- Investigating the impact of root and whole plant extract of Commolina benghalensis on germination and seedling growth of maize.

Experimental Procedures

A laboratory experiment were conducted at Wolaita Soddo Agricultural College Plant Sciences during 2013 with the objective of investigating the impact of root and whole plant extract of Commolina benghalensis on germination and seedling growth of maize.

The weeds C. benghalensis plants growing naturally in Wolaita Zone were uprooted and collected just

at flowering stage for the experiments and thoroughly washed with distilled water to remove soil and other inert particles. The plants were dried with blotting paper and root was immediately separated and whole plants were also taken simultaneously. Each part of the fresh plant was cut into smaller pieces and ground separately with a pestle and mortar and sieved with < 0.02mm sieves. 50g of each part of the ground plant material was taken and placed in a 250 ml volumetric flask. Then in each flask, 100 ml distilled water was added. After 24 hrs of soaking at room temperature (21–22 ^{o}C), it was filtered through muslin cloth, followed by cheese cloth and finally through Whatman No 1 filter paper and designated as stock solution containing 50% water extract, as described. The solution was kept in a refrigerator at 4^{o}C for further use. Out of the stock solution further diluted solution at 2.5, 5.0, 7.5 and 10.0% was made by taking 5, 10, 15 and 20 ml of stock solution and added distilled water to make 100 ml final volume.

The maize seeds were treated with 0.1% sodium hypochlorite in a Petridish for 3 minutes and then washed several times with distilled water for 2 minutes. Ten seeds of maize were placed in a petridish (9 cm diameter) lined with `Schleicher and Schuell No. 597' filter paper (F and J Specialty Products, Inc., FL, USA). Maize seeds and double layered filter papers were moistened with 10 ml each at 2.5%, 5.0%, 7.5% and 10.0% water extracts and distilled water (as control) in Complete Randomized Design with 3 replications. Petri-dishes were regularly checked for moisture and in case the moisture content reduced, equal amount of water was added to each Petridish.

Data on germinated seed (%) was recorded daily from the fourth to tenth day after sowing. On tenth day after sowing root (the sum of all roots) and shoot length (cm) as well as dry matter (mg) were recorded. The seedling vigour was determined by multiplying germination percentage with dry matter weight of seedlings at 10th day (vigour index II).

Result and Discussion

Impact on seed germination %

The germination of maize was reduced with increase in water extract concentration. It was found that the reduction in germination was 6.7, 25.0, 36.7 and 43.3% with 2.5, 5.0, 7.5 and 10.0% water extracts, respectively, over the control. However, the lowest germination percentage recorded with 10.0% water extract was statistically at par with 7.5% concentration. Both these concentrations significantly reduced the germination compared to other concentrations. However, there was no significant difference in germination percentage between 2.5% water extract and the control although; the germination decreased significantly at 5.0% concentration. In contrast with this result, Singh *et al.* (1989) observed that *C. benghalensis* caused stimulatory effect on germination of soybean and maize at 5%, whereas the result was in agreement with Singh *et al.* (1989) at 7.5% and 10% concentrations which show inhibitory effect. The whole plant extract was more inhibitory effect than the root extract, and the reduction amount was by 7.4% (Table 1).

The germination of both soybean and maize due to *C.benghalensis* extract was adversely effected (Singh *et al*., 1989; Turk and Tawaha, 2003). Researchers who have explained concentration effects and higher concentration contained more quantity of allelochemicals, which enhanced their ability to show better inhibition due to synergistic effect (Chen and Kim, 2004).

Impact on root length (cm/plant)

The root length of maize was significantly affected by the interaction of plant parts and the water extract concentrations of *C. benghalensis.* The shortest (9.1cm) root length was recorded with whole plant at 10 % water extract which did not significantly vary from the interaction of root at 10% water extract concentration (Table 2). It was also found that 7.5% whole plant extract concentration were as effective as 10% extract of root in reducing the root length. And also 2.5% of whole plant extract was as effective 2.5, 5.0 and 7.5% root part extract. This indicated more susceptibility of maize roots to weed whole plant than the root extract.

The root length was inhibited by all the concentrations of both root and whole plant over the control. Similarly, Singh *et al.* (1989) observed that *C. benghalensis* caused inhibitory effect on growth of soybean at all the concentrations. In general, the water extracts of this weed had deleterious effect on root length of maize seedling (Table 2).

Impact on shoot length (cm/plant)

The maize seedling shoot length under the influence of *C. benghalensis* water extracts showed that the root extracts up to 5.0% concentrations were statistically in parity with the control, and surprisingly both 2.5 and 5.0% shows that stimulatory effect on shoot length. While in case of whole plant no significant difference was observed between 2.5, 5.0 and 7.5% concentrations (Table 2). On the other hand, the lowest shoot length was observed with the interaction of whole plant and 10% extract concentration which was statistically at par with10% root extract and 7.5% whole plant extract. The shoot length was also significantly reduced with whole plant extract ranging from 2.5 to 7.5% concentration over root extract. More inhibition was obtained at higher concentration and less at low concentration.

Impact on Dry Matter Weight (mg/seedling)

The dry matter weight accumulation of maize seedling was also decreased with increase in water extract concentration. However, up to 5.0% concentration, it was statistically at par with the control. Treatment of maize grains with 10% water extract concentration significantly decreased the dry matter weight compared to other concentrations. The decrease in dry matter weight accumulation in maize seedling treated with 10.0% extract concentration was 37.2% over the control. The whole weed plant part was significantly reduced (11.1%) the dry matter weight than the root extract (Table1). This might be above ground plant part contain more allelochemical than root part.

Impact on Seedling Vigour Index

The seedling vigour index was decrease with increasing weed extract concentration. Decrease in vigour due to increase in extract concentrations of *C. benghalensis* was 11.8, 30.2, 50.1 and 48.5% respectively, at the extract concentration of 2.5, 5, 7.5, and 10% over the control (Table 3). The lower vigour in the seedling might be due to the allelopathic potential of the weeds on the germination and dry matter accumulation.

Similarly, the inhibitory effect of *C. benghalensis* water extract in all concentrations resulted in deleterious effect on germination and seedling vigour index on soybean was studied by Singh *et al*. (1989)

Conclusion

The water extract of *C. benghalensis* might contain allelochemicals with detrimental effect on the germination and growth of the maize seedling. The germination and dry matter accumulation was affected by main factors whereas the root and shoot length of maize seedling were significantly influenced by the interaction of plant part and water extract concentrations level. The whole plant part extract was more inhibitory effect on dry matter weight accumulation than the root part extract.

Therefore, it can be recommended that it was important to dilute the soil with enough amount of water to remove toxic chemical of the extract released from the weed, which were introduced in to the soil during land preparation or it was better if the farmer sow the crop after well aeration of the toxic chemical from his/her field or after leaching process were completed.

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Tables

Table 1: Impact of extract concentration and used part interaction on root and shoot length (cm/plant)

Water Extracts Concentration (%)	**Seed Germination (%)**	Dry matter weight (mg/plant)
Control	100.0[a]	56.7[ab]
2.5	93.3 [a]	53.6 [ab]
5.0	75.0[b]	52.8[bc]
7.5	63.3[c]	44.7[c]
10.0	56.7[c]	35.6[d]
LSD(0.05)	**7.9**	**7.4**
Weed Part Used		
Root	80.7[a]	51.5[a]
Whole plant	74.7[b]	45.8[b]
LSD(0.05)	**5.0**	**4.6**
CV (%)	**8.5**	**12.6**

Means followed by the same letter are not significantly different at 5% level of significance. LSD = least significant difference at 5 % level of significance.

Table 2: Impact of extract concentration and used part interaction on root and shoot length (cm/plant)

Extracts concentration (%)	Weed parts used			
	Root length		Shoot length	
	Root extract	Whole plant extract	Root extract	Whole plant extract
Control	23.0[ab]	23.0[ab]	5.5[b]	5.5[b]
2.5	18.7[c]	19.6[c]	6.1[a]	3.7[cd]
5.0	20.0[bc]	14.8[d]	6.2[a]	2.9[de]
7.5	19.8[c]	13.4[de]	4.5[c]	2.9[de]
10.0	11.3[ef]	9.1[f]	2.9[de]	2.1[e]
LSD(0.05)	**3.05**		**0.86**	
CV (%)	**10.4**		**11.9**	

Means followed by the same letter are not significantly different at 5% level of significance. LSD = least significant difference at 5 % level of significance.

Table 3: Impact of water extracts concentrations of *C. benghalensis* on vigor index after 10 days of maize planting.

Water Extracts Concentration (%)	Vigour index
Control	5670.0[a]
2.5	5001.0[b]
5.0	3960.0[c]
7.5	2829.5[d]
10.0	2918.5 [d]
LSD (0.05)	**107.7**
CV (%)	**1.5**

Means followed by the same letter are not significantly different at 5% level of significance. LSD = least significant difference at 5 % level of significance.

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