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Influence of extracts from fresh samples of five tropical weeds on seed germination and early seedling development of selected crop species.

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Abstract

The inhibitory potentials of extracts from five of the major troublesome weeds in arable crop production in the humid tropics were investigated.

Extracts from fresh shoots of wild poinsettia (*Euphorbia heterophylla* L.) Siam weed (*Chromolaena odorate* (L) R.M. King and Robinson) and itchgrass (*Brottboellia cochinchinensis* (Lour) Clayton) generally produced greater inhibitory effects on the early seed germination of tomato (*Lycopersicon esculentum* Mill), pepper (*Capsicum frutescens* L.), and cowpea (*Vigna unguiculata* (L.) Walp) than their root extracts. Root extracts of nutsedge (*Syperus tuberosus* Rottb.) And speargrass (*Imperata cylindrica* (L.) Beauv) produced greater inhibitory effects on the development of the test crops than their shoot extracts. Both the root and shoot extracts from the various weed species produced no inhibitory effects on the germination of maize seeds. Siam weed and wild poinsettia shoot extracts delayed seed germination in millet (*Pennisetum maiwa* Stapf) and rice (*Oryza sativa* L. Var. ITA 22) and inhibited their seedling developments.

The effects of extracts from the different weed species on the test crops in order of potency were siam weed > wild poinsettia > nutsedge > itchgrass > speargrass.

Although the early germination stages of all the test crops except maize, were generally delayed by the weed extracts, their final germination was not significantly affected. The inhibitory effects tended to be more on the germination of smaller seeds (tomato, pepper, millet and rice) than on bigger seeds (maize and cowpea) and the development of young seedling root was more inhibited than that of young seeling shoot.

Introduction

Weeds interfere with crop growth and development primarily through competitive and/or allelopathic activities. While there is substantial information on the competitive properties of tropical weeds, little is known about their allelopathic potentials as information on the effects of plant residues on crops comes mainly from temperate countries (Mohamed-Saleem and Fawusi, 1983). Competition is a physical process which involves the depletion of one or more limiting resources such as light, nutrient and water required by other plants in the same community. Allelopathy, on the other hand, is a biochemical interaction among plants (Putnam, 1984). It occurs when chemical released by one plant, or its litterfall adversely affects growth and development of another plant species in the same habitat.

Evidence for allelopathy has been accumulating over many years (Rice, 1974; Bhowmik and Doll, 1983). The harmful effects of weed residues in soil on the growth of other plants have been reported (Bhowmik and Doll, 1983; Achhireddy and Singh, 1984). Awnless bromegrass (*Bromus inermis* Leysser) releases tomic materials from its roots (Benedict, 1941) and according to Grummer (1961) and Wellbank (1963), English couchgrass (*Agropyron repens* (L.) Beauv) inhibits the growth of cultivated plants.

Extracts from different parts of some weed species have been implicated in allelopathic activities. Leaf leachates of *Acanthospermum hispidum* DC reduces the percent germination in french beans and okra (Leela, 1985).

Although dry residues from some tropical weeds have been implicated in allelopathic activities (Mohamed-Saleem and Fawusi, 1983; Tijani-Eniola and Fawusi, 1989), there is need to examine the allelopathic potential of fresh samples of weeds that commonly interfere with crop development as their observed interference might result from the influence of external factors. Microbes in the rhizosphere could induce the production of toxic compounds by enzymatic degradation of conjugates or polymers in the plant tissue (Abdul-Wahab and Rice, 1967; Akobundu, 1987). The objective of this study was to investigate the allelopathic potentials of fresh samples of some wee species which are among the major troublesome weeds in arable crop production in the humid tropics.

Materials and Methods

Whole plants of wild poinsettia (*Euphorbia heterophylla* L.), speargrass (*Imperata cylindrica* (L.) Beauv), nutsedge (*Cyperus tuberosus* Rottb.), siam weed (*Chromolaena odorata* (L.) R.M. King and Robinson) and itchgrass (*Rottboellia cochinchinensis* (Lour.) (Clayton) were harvested, at their pre-flowering stages, and washed to remove foreign materials associated with them. The weeds were separated into their root and shoot parts. The different plant parts were chopped into length of about 2.00cm segments to facilitate easy milling. Two hundred and fifty grammes of roots or shoots were added to one litre of distilled water, then ground and homogenized in a blender for about ten minutes. The mixtures were allowed to stand for about 24 hours at room temperature before filtration.

The experimental layout was a randomized complete block design with four replications repeated in time to provide eight replications. Results of the first set of replications demonstrated that with the controls, tomato reached 50% and final germination levels at 48 and 132 hours after culturation (HAC); pepper at 168 and 216 HAC; maize at 48 and 172 HAC and cowpea at 24 and 60 HAC respectively. Data on seed germination for each crop species were therefore taken at the various times for the different crop species to reach 50% and final germination levels as indicated above. Root and shoot lengths were measured for cowpea, maize, tomato and pepper at 7, 10, 14 and 21 days after culturation (DAC) respectively. Analysis of variance was carried out using percent germinated seeds and the root and shoot lengths (cm). The means were compared using the Least Significant Difference at the 5% level.

The earlier experiment was concentrated primarily on the effects of the weed species on dicotyledonous plants; the weed extracts did not sinificantly inhibit the germination of maize, the only monocotyledonous crop among the test species. Further study was therefore conducted to investigate the effects of the azueous extracts of wild poinsettia and siam weed (the two weed species that produced the greatest inhibitory effects in the earlier experiment) on the germination and early seedling development of African millet (*Pennisetum Maiwa* Stapf) and rice (*Oryza sativa* L var. ITA 222).

The weed extracts were prepared as in the earlier experiment and the prepared extracts were bioassayed against millet and rice in petridish cultures. Ten seed each of millet and rice were cultured per petri-dish and the experimental layout was a completely randomized design with four replications. The experiment was repeated in time providing eight replications. Data on millet seed germination were recorded up to 36 HAC when there was a total germination of all the seeds; while those on the germination or rice were recorded at 24-hour intervals up to 132 HAC when there was no further seed germination. Data on root and shoot lengths were also recorded at 7 DAC for millet and 10 DAC for rice. The collected data were subjected to analysis of variance and the means were separated with LSD at the 5% level.

Results

Effects of root and shoot extracts on tomato

Table 1 shows the effects of root and shoot extracts of the different weed species on the seed germination and seedling development of tomato. Root and shoot extracts of wild poinsettia significantly inhibited the early germination of tomato seed while the final seed germination was not significantly affected by the extracts. Shoot extract was more inhibitory than the root. Both the root and shoot extracts showed similar inhibitory effects on tomato root development.

Root and shoot extracts of speargrass also significantly delayed early seed germination stage of tomato. Root extract was more inhibitory than the shoot. Both the root and shoot developments of tomato were significantly reduced by the root extract while the shoot extract showed no inhibitory effects.

Both the root and shoot extracts of nutsedge significantly inhibited the early seed germination and also the seedling development of tomato. The root was generally more inhibitory than the shoot. Siam weed shoot extract produced significant inhibitory effect on the seed germination of tomato while the root extract delayed the early stage of seed germination. Both the root and shoot extracts showed similar inhibitory effects on the shoot development of tomato seedling.

The root and shoot extracts of itchgrass significantly inhibited the early but not final seed germination of tomato as compared to the control. The seedling development was also significantly affected with the shoot extract having greater effects than the root.

Effect of root and shoot extracts on pepper

Table 2 shows the effects of fresh root and shoot extracts of the various weed species on the seed germination and development of pepper seedling. Shoot extract of wild poinsettia showed significant inhibitory effects on the seed germination of pepper. The root and shoot extracts produced similar inhibitory effects on the seedling development of pepper.

TABLE 1: EFFECTS OF ROOT AND SHOOT EXTRACTS FROM VARIOUS WEED SPECIES ON TOMATO SEED GERMINATION AND EARLY SEEDLING DEVELOPMENT 14 DAYS AFTER CULTURATION.

Weed extract	Seed germination		Seedling length	
	48 HAC	132 HAC	Root	Shoot
	% germinated seeds		------------cm---------	
Wild poinsettia				
Root	40.0	85.0	3.8	6.8
Shoot	2.5	80.0	2.8	7.2
Control	60.0	95.0	6.3	6.0
LSD	15.8	NS	0.5	0.7
Speargrass				
Root	15.0	72.5	1.3	2.7
Shoot	22.5	80.0	6.0	6.5
Control	65.2	87.5	6.8	5.6
LSD	25.2	NS	0.6	0.9
Nutsedge				
Root	0.0	82.5	3.3	2.9
shoot	5.0	80.0	3.8	6.3
Control	60.0	85.0	6.2	6.1
LSD	22.0	NS	0.7	0.5
Siam weed				
Root	0.0	67.5	2.1	4.4
Shoot	0.0	10.0	1.2	4.1
Control	57.5	80.0	6.2	6.2
LSD	17.5	15.8	0.5	0.6
Itchgrass				
Root	30.0	77.5	5.4	6.5
Shoot	0.0	72.5	3.5	4.3
Control	52.5	90.0	6.6	6.0
LSD (0.05)	20.5	NS	0.8	0.7

HAC = Hours after culturation.
NS = No significant difference.

TABLE 2: EFFECT OF ROOT AND SHOOT EXTRACTS FROM VARIOUS WEED SPECIES ON PEPPER SEED GERMINATION AND EARLY SEEDLING DEVELOPMENT 21 DAYS AFTER CULTURATION.

Weed extract	Seed germination		Seedling length	
	168 HAC	216 HAC	Root	Shoot
	% germinated seeds		---------cm---------	
Wild poinsettia				
Root	50.0	57.5	2.4	2.9
Shoot	10.0	45.0	2.4	2.7
Control	62.5	82.5	5.7	3.4
LSD	21.8	20.3	0.5	0.5
Speargrass				
Root	45.0	62.5	2.2	3.5
Shoot	50.0	80.5	3.9	3.5
Control	52.5	87.5	5.7	3.7
LSD	NS	NS	0.4	NS
Nutsedge				
Root	37.5	50.0	2.9	2.4
Shoot	52.5	76.5	2.5	2.7
Control	62.5	85.0	5.7	3.7
LSD	15.3	12.2	0.3	0.4
Siam weed				
Root	52.5	65.0	2.8	3.1
Shoot	10.0	35.0	2.4	2.4
Control	62.5	85.0	5.6	3.7
LSD	18.1	20.7	0.9	0.5
Itchgrass				
Root	45.0	75.0	3.1	3.5
Shoot	50.0	72.5	2.9	2.8
Control	75.0	82.5	5.4	3.6
LSD (0.05)	19.9	NS	0.8	0.3

HAC = Hours after cultivitation
NS = No significant difference

Root and shoot extracts of speargrass showed no significant inhibitory effects on the seedling germination of pepper. Both the root and shoot extracts significantly retarded root development in pepper. The root extract produced greater inhibitory effect than the shoot. The shoot and root extracts of nutsedge were inhibitory to germination and seedling development of pepper although root extract was more inhibitory to both seed germination and seedling development as compared to the control.

Shoot extract of siam weed was significantly inhibitory to both the early and final germination of pepper seeds. Both the root and shoot developments of pepper seedling were also significantly retarded. The shoot had greater inhibitory effect than the root.

Itchgrass root and shoot extracts significantly inhibited the early seed germination and development of pepper seedling. Shoot extract in general showed greater inhibitory effects than the root extract.

Effects of root and shoot extracts on maize

The effects of fresh root and shoot extracts of the various weed species on maize seed germination and early seedling development are shown in Table 3. Root and shoot extracts of wild poinsettia showed no significant inhibitory effects on both the seed germination and seedling development of maize. Root and shoot extracts of speargrass also showed no significant inhibitory effects on the germination of maize. However, the root extract was inhibitory to the development of maize root as compared to the control.

Nutsedge extracts showed no significant inhibitory effects on the germination of maize. Root and shoot lengths of maize seedling were significantly inhibited by both the root and shoot extracts. The root showed higher inhibitory effects than the shoot.

Although the germination of maize was not effected by siam weed extracts, seedling development was significantly affected. The shoot extract had greater effects than the root extract. Itchgrass root and shoot extracts generally showed no inhibitory effects on the germination and seedling development of maize.

Effects of root and shoot extracts on cowpea

Table 4 shows the effects of fresh root and shoot extracts of the various weed species on the seed germination and early seedling development of cowpea. Root and shoot extracts of wild poinsettia showed no significant inhibitory effects on the seed germination of cowpea. Cowpea seedling development was however, significantly inhibited.

Root and shoot extracts of speargrass showed no significant inhibitory effects on the seed germination of cowpea; cowpea seedling development was, however significantly inhibited by speargrass root extract. Both the root and shoot extracts of nutsedge significantly reduced the early germination and seedling root and shoot development of cowpea. The root tended to be more inhibitory than the shoot.

The early seed germination, seedling shoot and root of cowpea were significantly reduced by the extracts from siam weed. The effects of the root and shoot extracts gave similar inhibition on seedling development.

The root and shoot extracts of itchgrass significantly reduced the early seed germination and seedling shoot length of cowpea. The shoot extract tended to be more inhibitory than the root extract as compared to the control.

TABLE 3: EFFECT OF ROOT AND SHOOT EXTRACTS FROM VARIOUS WEED SPECIES ON MAIZE SEED GERMINATION AND EARLY SEEDLING DEVELOPMENT 10 DAYS AFTER CULTURATION.

Weed extract	Seed germination		Seedling length	
	48 HAC	132 HAC	Root	Shoot
	% germinated seeds		------------cm--------	
Wild poinsettia				
Root	80.0	100.0	22.5	17.3
Shoot	70.0	100.0	19.0	16.2
Control	80.0	100.0	22.1	16.5
LSD	NS	NS	NS	NS
Speargrass				
Root	80.0	100.0	9.5	15.5
Shoot	80.0	97.5	23.0	16.8
Control	80.0	100.0	22.0	16.8
LSD	NS	NS	1.6	NS
Nutsedge				
Root	80.0	100.0	12.4	10.6
Shoot	65.0	100.0	18.7	13.9
Control	80.0	100.0	21.8	16.5
LSD	NS	NS	3.1	1.3
Siam weed				
Root	57.5	100.0	10.7	15.6
Shoot	67.5	100.0	11.3	12.3
Control	87.5	100.0	21.9	16.5
LSD	NS	NS	2.5	1.8
Itchgrass				
Root	77.5	100.0	21.0	17.2
Shoot	55.0	97.5	22.3	16.2
Control	90.0	100.0	21.6	16.1
LSD (0.05)	NS	NS	NS	NS

HAC = Hours after culturation
NS = No significant difference

TABLE 4: EFFECT OF ROOT AND SHOOT EXTRACTS FROM VARIOUS WEED SPECIES ON COWPEA SEED GERMINATION AND EARLY SEEDLING DEVELOPMENT 7 DAYS AFTER CULTURATION.

Weed extract	Seed germination		Seedling length	
	48 HAC	132 HAC	Root	Shoot
	% germinated seeds		------------cm---------	
Wild poinsettia				
Root	40.0	100.0	13.2	16.0
Shoot	27.5	100.0	10.7	12.4
Control	55.0	100.0	12.3	18.1
LSD	NS	NS	1.2	1.4
Speargrass				
Root	57.5	100.0	7.0	8.7
Shoot	55.0	100.0	16.8	17.8
Control	65.0	100.0	12.0	17.5
LSD	NS	NS	2.4	2.9
Nutsedge				
Root	25.0	100.0	6.7	8.8
Shoot	20.0	100.0	14.1	14.0
Control	62.5	100.0	13.2	18.1
LSD	18.2	NS	1.1	1.9
Siam weed				
Root	30.0	100.0	7.3	10.4
Shoot	65.0	100.0	7.8	11.0
Control	75.0	100.0	13.4	17.7
LSD (0.05)	16.9	NS	1.5	2.3
Itchgrass				
Root	25.0	100.0	14.1	18.1
Shoot	25.0	100.0	12.8	13.4
Control	65.0	100.0	13.6	17.4
LSD	16.0	NS	NS	1.7

HAC = Hours after culturation
NS = No significant difference.

TABLE 5: EFFECT OF AQUEOUS SHOOT EXTRACT OF WILD POINSETTIA AND SIAM WEED ON THE SEED GERMINATION, ROOT AND SHOOT LENGTH OF MILLET.

Shoot extract	Seed germination		Seedling length	
	48 HAC	132 HAC	Root	Shoot
	% germinated seeds		------------cm---------	
Wild poinsettia				
Root	47.5	100.0	2.9	2.6
Siam weed	55.0	100.0	1.7	0.6
Control	87.5	100.0	26.4	9.2
LSD (0.05)	13.6	NS	2.8	0.6

HAC = Hours after culturation
NS = No significant difference.

Table 6: Effects of aqueous shoot extracts of wild poinsettia and siam weed on the seed germination, root and shoot developments of rice seedling.

	Seed germination				Seedling length	
Shoot extract	60	84	108	132(HAC)	Root	Shoot
	-------------- %germinated seeds				----------- cm--------	
Wild poinsettia	45.0	62.5	70.0	75.5	2.2	3.5
Siam weed	17.5	55.0	75.0	80.0	3.0	3.7
Control	62.5	80.0	80.0	80.0	11.2	8.3
LSD (0.05)	28.5	19.8	NS	NS	2.0	1.7

HAC = Hours after culturation
NS = No significant difference.

Effects of Aqueous shoot Extracts of Wild poinsettia and Siam Weed on Millet and Rice.

Table 5 shows that extracts from the shoots of wild poinsettia and siam weed significantly reduced the number of germinated seeds in millet only within 24 HAC; both the root and shoot lengths of millet were significantly reduced by the extracts from the two weed species as compared to the control.

Table 6 shows that the inhibitory effects of the two weed species on the germination of rice seeds were limited to within 84 HAC after which normal germination, comparable to the control, was obtained. Shoot extracts from the two weed species exhibited significant inhibitory effects on the root and shoot development of rice seedlings.

Discussion

Result of this study suggest that residues of the different weed species have allelopathic potentials. The early germination stage of virtually all the test crops was more adversely affected than the final germination stage. This observation may result from two possible reasons either the secondary plant metabolites from the various weeds are with low stability and therefore become easily degraded into non-phytotoxic chemicals or the persistence of the secondary plant metabolites is low. The results of the study indicate that young seedling roots are more sensitive to allelochemicals than young shoots. This might be as a result of direct contact of the tender roots with the allelochemicals in the growing medium. This observation is in agreement with the findings of Luu et al (1982) who found that the growth of tresoil roots was reduced more by allelopathic substances than either germination or hypocotyl growth. Stachon and Zimdahl (1980) also found the ethanolic extracts of Canada thistle *(Cirsium arvense* L.) More inhibitory to cucumber *(Cucumis sativus* L.) Radicles than to hypocotyls. Allelochemicals, like some pesticides, may need to be translocated to the shoot before they could effect their inhibitory activities on it.

The use of extracts removed the competitive aspect of weed interference, thus the delay in seed germination and the retardation in seedling development resulting from the application of the extracts from the different weed species are postulated to be the resultant effects of allelopathic activities of the different weed species on the test crops. Delayed germination, growth inhibition and root tissue damage are some of the characteristic symptoms of allelopathic activities (Patrick, 1971).

Extracts from fresh shoots of wild poinsettia, siam weed and itchgrass produced greater detrimental effects on the seed germination and early seedling development of the test crops than their fresh root extracts, indicating the likely presence of either the same phytotoxic secondary plant metabolites at higher concentration or the presence of different but more potent allelochemicals in the shoot than in the roots of the different weed species. The more inhibitory activities of the root extracts from nutsedge and speargrass might also result from the same reasons. The underground and above ground portions of many weeds are known to affect crop growth differently. While leafy spurge *(Euphorbia esula* L.) roots were found to be inhibitory to tomato *(Lycopersicon esculentum* Mill.) Development than stems (Stenhagen and Zimdahl, 1979), the shoot of wild poinsettia *(Euphorbia heterophylla* L.) Was found to be more inhibitory to the seed germination and seedling development of Tomato (Tijani-Eniola and Fawusi 1989).

The observed inhibitory effects of the extracts of wild poinsettia and siam weed shoots on the development of rice and millet (monocotyledonous plants) seedlings indicate that the allelochemicals contained in the weed species are with a wide spectrum of activities as the weed extracts also produced inhibitory effects on the development of tomato, pepper and cowpea which are dicotyledonous plants.

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