Allelopathic Effects of Some Crop Residues on the Germination and Growth of Maize (*Zea mays* L).

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ABSTRACT

The allelopathic effects of aqueous extracts from sorghum stem and rice husks were examined on the germination and growth of maize. The extracts brought about considerable inhibitions in the germination of maize seeds and in the growth of radical and plumule. In both extracts, the degree of inhibition increased with the increase in the concentrations of the extracts thus suggesting that the effects of the extracts were concentration dependent. However, the results obtained also tend to suggest that the degree of retardation might be more pronounced in the extracts derived from the sorghum stem than those from the rice husks. In the sorghum extract-treated seeds, no growth of the plumule was obtained until the 72-hour period of the experiments whereas plumule growths were recorded at the lower extract concentrations of the rice-husk derived extracts.

(Keywords: sorghum stem extract, rice husk extract, germination, corn, plant development, allelopathy, allelochemicals)

INTRODUCTION

The relevance of allelopathy in crop management is now widely established. It is a phenomenon whereby some plants release allelopathic chemical compounds, often referred to as allelochemicals, into the soil via various processes such as volatilization, root exudation, leaching and decomposition of plant residues (Rice 1984). Allelochemicals inhibit seed germination by blocking hydrolysis of nutrients reserve and cell division (Irshad and Cheema 2004), and cause significant reductions in the growth of plumule and radical of various crops (Ogbe *et al.,* 1994).

Previous studies conducted in Asia had revealed that some crop residues exhibited allelopathic potentials. For example, Chou and Lin (1976) asserted that aqueous extracts of decomposing rice residues in soil inhibited root growth of lettuce and rice seedlings. Similarly Cheema (2000) and Cheema and Kaliq (2000) asserted that aqueous extracts from sorghum suppressed weed populations in wheat, mungbean, and maize. In Nigeria, allelopathic studies so far reported had concentrated on the allelopathic potentials of weeds on agricultural crops. These include the studies of Tijani-Eniola and Fawusi (1989), Gill *et al.* (1993) and Ogbe *et al.* (1994) on *Chromoleana odorata* and Kayode (1998, 2004a, 2004b, 2006), respectively, on *Euphorbia heterophylla, Calotropis procera, Aspilia Africana, Chromoileana odorata,* and *Euphorbia heterophylla.* No study has yet reported on allelopathic potentials of crop residues in the country.

Consequent to the above, the study being reported here aims at examining the allelopathic effects of aqueous extracts from residues of sorghum stem and rice husks on maize which constitutes an important cereal crop that is widely cultivated in the Nigeria.

MATERIALS AND METHODS

Freshly removed rice husks were obtained from a rice mill in Iworoko-Ekiti, a town situated about 3 kilometers from the University of Ado-Ekiti, Ado-Ekiti, Nigeria, while mature sorghum plants were harvested from a farm within the University campus and chopped into pieces with knife. The rice husks and sorghum pieces were air-dried for two weeks after which they were pounded using a mortar and pestle.

Portions of 5, 10, 15, 20, and 25g, each of the crop residues were measured out and each was soaked in 200ml of distilled water for 24 hours. The extracts were filtered and the filtrates used afresh either as such or stored in a freezer for further use. Petri dishes were double-layered with Whatman No. 1 filter papers and five maize seeds, obtained from the Department of Plant Science, University of Ado-Ekiti, Ado-Ekiti, Nigeria, were placed in each Petri dish. The filter papers were moistened daily with the five different concentrations of the extracts. Extracts from each concentration were replicated ten times. Control experiments whose filter papers were moistened with distilled water were set up and replicated ten times.

All of the Petri dishes were kept in a growth chamber at room temperature. The germination, radicle and plumule growth elongation measurements were recorded at 24 hour intervals. The results obtained from the extract-treated seeds were compared statistically to those obtained from the control experiments.

RESULTS AND DISCUSSION

The effects of the aqueous extracts from sorghum stem and rice husks on the germination of maize are shown in Tables 1 and 2, respectively. The extracts brought about considerable inhibition in the germination of maize seeds. In both extracts, the degree of inhibition increased with the increase in the concentrations of the extracts. This tends to suggest that the effects of the extracts are concentration dependent.

The results of the tests conducted on the effects of the different aqueous extracts from the sorghum stem and rice husks on the radical lengths of maize are shown in Tables 3 and 4, respectively. The results revealed that the growths of the radicle in the extract-treated seeds were retarded when compared to the control. The degree of retardation increased with the increase in the concentrations of the extracts. However the degrees of retardation were not significantly different at 5% level. Similarly, the degree of inhibition between the varying concentrations were not significantly different in both extracts at the 5% level.

The results of the effects of the two different aqueous extracts on the plumule lengths of maize were similar to those of the radicle. The plumule lengths were retarded (shown in Tables 5 and 6), and the retardation increased with the increase in the concentrations of the extracts thus suggesting that the effect of the extracts on both radicle and plumule are also concentration-dependent. However, the results tend to suggest that the degree of retardation might be more pronounced in the extracts derived from the sorghum stem than those from the rice husks. In the sorghum extract-treated seeds, no growth of the plumule was obtained until the 72-hour point of the experiments (Table 5) whereas plumule growths were recorded at the lower extract concentrations (5 and 10g/200ml) of the rice-husk derived extracts (Table 6).

Table 1: Effect of the Aqueous Extract from Sorghum Stem on the Germination of Maize Seeds.

Extracts (g/200ml)	Maize seed germination (%) / Experimental Time (Hrs.)				
	24	48	72	96	120
5	0 -	30 (0.44)	60 (0.08)	6 (0.04)	- -
10	0 -	16 (0.70)	68 (0.14)	14 (0.12)	- -
15	0 -	10 (0.81)	68 (0.20)	18 (0.04)	- -
20	0 -	8 (0.85)	66 (0.24)	16 (0.10)	10 -
25	0 -	6 (0.89)	56 (0.37)	16 (0.22)	22 -
Control	0	54	44	2	-

Table 2: Effect of the Aqueous Extract from Rice Husk on the Germination of Maize Seeds.

Extracts (g/200ml)	Maize seed germination (%) / Experimental Time (Hrs.)				
	24	48	72	96	120
5	0 -	42 (0.19)	50 (0.04)	8 (0.00)	- -
10	0 -	32 (0.38)	60 (0.04)	8 (0.00)	- -
15	0 -	24 (0.54)	58 (0.15)	18 (0.00)	- -
20	0 -	18 (0.65)	62 (0.17)	20 (0.00)	- -
25	0 -	16 (0.69)	60 (0.21)	24 (0.00)	- -
Control	0	52	44	4	-

Table 3: Effect of the Aqueous Extract from Sorghum Stem on the Radicle Length (cm.) of Maize.

Extracts (g/200ml)	Maize germination (%) / Experimental Time (Hrs.)				
	24	48	72	96	120
5	0	0.66	33.2	114.36	150.66
10	0	0.50	13.75	75.10	118.61
15	0	0.34	20.02	32.60	95.50
20	0	0.16	11.26	27.23	45.10
25	0	0.20	10.06	25.04	34.04
Control	0	4.54	76.70	120.61	157.38

Table 4: Effect of the Aqueous Extract from Rice Husk on the Radicle Length (cm.) of Maize.

Extracts (g/200ml)	Maize germination (%) / Experimental Time (Hrs.)				
	24	48	72	96	120
5	0	2.54	33.74	116.10	193.7
10	0	1.40	30.76	104.32	175.98
15	0	1.16	23.68	97.18	159.90
20	0	0.34	16.68	84.14	177.86
25	0	0.52	26.48	74.17	107.70
Control	0	2.96	53.32	151.50	242.46

Table 5: Effect of the Aqueous Extract from Sorghum Stem on the Plumule Length (cm.) of Maize.

Extracts (g/200ml)	Maize germination (%) / Experimental Time (Hrs.)				
	24	48	72	96	120
5	0	0	3.50	12.00	18.84
10	0	0	1.14	6.06	13.94
15	0	0	1.05	6.01	12.76
20	0	0	0.48	5.20	9.48
25	0	0	0.22	4.20	6.54
Control	0	0.40	7.78	15.48	24.98

Table 6. Effect of the Aqueous Extract from Rice Husk on the Plumule Length (cm.) of Maize.

Extracts (g/200ml)	Maize germination (%) / Experimental Time (Hrs.)				
	24	48	72	96	120
5	0	0.10	2.24	7.02	12.12
10	0	0.04	2.14	6.94	11.82
15	0	0	1.86	6.62	10.44
20	0	0	1.80	6.44	10.20
25	0	0	1.68	6.38	10.16
Control	0	0.14	5.56	15.90	26.52

Statistical analysis at 5% level also revealed that there were no significant differences in the plumule lengths of the extract-treated seeds and those of the control in the two different aqueous extracts. Also there were no significant differences in the plumule lengths in the varying concentrations of the two extracts used in this experiment.

CONCLUSION

The allopathic effects of the plant residues were similar to those exhibited by some weeds and trees that inhibited the germination of agricultural crops. This study suggests that some plant residues also contained allelochemicals which are released into the soil during decomposition.

Previous assertions by Cheema (1988) revealed that mature sorghum contained benzoic acid, p-hydroxybenzoic acid, vanillic acid, m-comadic acid, p-coumaric acid,gallic acid, caffeic acid, ferulic acid, and chlorogenic acid while Chou and Lin (1976) asserted that rice husks contained phenolic compounds such as p-hydroxybenzoic, vanillic, ferrulic, p-coumaric, and o-hydrophenylacetic acid. All of these compounds constitute allelochemicals to maize. Most of the studies had, however, revealed that the inhibition obtained in the laboratory experiments might differ from the situations in the fields (Hauser 1993, Lisanework and Michelsen 1993, Tian and Kang 1994, Mehar *et al.* 1995, Hansen-Quartey *et al.*1998).

Studies have also revealed that situations abound where allelochemicals inhibit seed germination, but seedling growth, and perhaps other growth parameters, were unaffected. Thus intensive studies on allelochemicals are still desirable to provide detail information on their effects, particularly to farmers in Nigeria who often leave crop residues uncared for in their fields.

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