Global Journal of Agricultural Research

Vol. 1, No 1, pp.23-33

European Centre for Research Training and Development UK (www.ea-journals.org)

ALLELOTHIC EFFECTSOF SOME WEEDS ON THE GERMINATION OF SELECTED SEEDS OF CROPS GROWN IN AKWAIBOM STATE NIGERIA

P.E. Usuah[1], G. N. Udom[2] and I.D. Edem*[1]

1. Department of Soil Science and Land Resources Management, University of Uyo, Uyo, Akwa Ibom State, Nigeria.

2. Department of Crop Science, University of Uyo, Uyo, Akwa Ibom State, Nigeria.

Abstract: *In this work, a laboratory and polypot experiments were conducted to study the effects of water extracts of the tops and roots, and the decomposing mulches of the tops, of six (6) dominant weeds at the Teaching and Research Farms of the AkwaIbom State University, ObioAkpa Campus and adjoining areas, on the germination of seeds of six (6) most commonly grown seed crops. The weeds were Apiliaafricana, Emiliasonchifolia, Crotolariaretusa, Chromolaenaodorata, Panicum maximum, and Cyperusesculentus; the test crops were Zea mays, Citrullus vulgaris,Abelmoschusesculentus, Vignaunguiculata, Glycine soja, and Arachis hypogea. 500g of finely chopped tops and roots of each weed was extracted with 1litre of distilled water and applied to seeds in petri dishes after standing for 24hours. Finely chopped tops of each weed were also applied to 1.0kg of heat-sterilized soil in planting polybags as mulches at an equivalence of 0, 2.0, 4.0, 8.0 and 12.0 Mg ha_1.These were watered twice (2) daily and incubation for 48hours before planting of seeds. Germination counts (%) of seeds in petri dishes and seedlings emergence counts (%) from polybags were arranged for use with the randomized complete block design (RCBD) in 3 replications. Both the water extract and the decomposing mulches of tops of all the test weeds significantly (p<.05) inhibited the germination of all test seeds to varying degrees. Cyperusesculentus showed the highest inhibitory effect.*

Keywords: Allelopathy, predominant weeds, decomposing mulches, seed germination.

INTRODUCTION

The benefits of organic mulches in tropical agro ecosystems have been well documented (Lal, 1995; Ndaeyo et al, 2008; Rosolem, 2011). Awodun and Ojeniyi, (1999) stated that beside the effect of organic mulches on soil physical properties, they also improve biotic activity and add nutrients to soil thereby improving its fertility. Bruce et al. (1995) recommended that mulches be applied in the decomposing state instead of as completely decomposed material because of the added benefits of providing ingredients for persistent biological activity essential for creating a physically stable soil surface.

It is however known that plant residues, both of crops, weeds or natural vegetation produce assorted chemical compounds including phytogrowth-inhibitors, allelochemics or allelochemicals during decomposition(Narwal, 2006) which are a major factor in regulating the structure of plant communities in natural and agro ecosystems (Smith and Martin, 1994; Inderjit and Duke, 2003; Gawronska and Golisz,2006). They do this by means which include generating biotic stresses for germinating seeds, and although some products of decomposition of the residues are of nutritional value for the newly growing plants, others are phytotoxic and allelopathically interfere with the growth of both soil microbes and the newly growing plants (Gawronska and Golisz, 2006).

Allelopathy has been defined as any process involving secondary metabolites produced by plants, microorganisms, viruses or fungi that influence the growth and development of agricultural and biological systems (International Allelopathic Society, 1996). Allelopathic compounds may regulate plant growth and developmental processes involving photosynthesis, respiration, transpiration, biochemical metabolism and even in molecular basis of protein and nucleic acid synthesis (chou, 2006). Their action may, theoretically, be stimulatory, neutral, or inhibitory depending on their concentrations and sensitivity of the receiving target plant or plant organ (Rice, 1979). Seeds are an important plant organ and most sensitive to allelochemicals so seed germination has been the most widely used bioassay in allelopathic studies (Aliotta et al., 2006). Use of seed germination in bioassays in allelopathy is advantageous since the germination of seeds constitute a critical step in the propagation and cultivation of most crop species(Ishii-Iwamoto, et al., 2006).

The predominant weeds at the Teaching and Research Farms of the AkwaIbom State University, ObioAkpa and adjoining areas include wild Marigold(*Aspiliaafricana*),Shaving brush(*Emilia sonchifolia*), Rattle box (*Crotolariaretusa)* Siam weed(*chromolaenaodorata*), Guinea grass(*Panicum maximum*) and Tiger nut*(Cyperusesculentus)* and these are weeds most often used for mulching. The most commonly grown seed crops in the area include maize(*Zea mays*), melon(*Citrullus vulgaris*), okro(*Abelmoschusesculentus*), Cowpea (*Vignaunguiculata*), soya bean (*Glycine soja*) and groundnut(*Arachis hypogea*). This study was carried out to evaluate the allelopathic effects of the listed weeds on the germination of the selected seeds with a view to getting a better understanding of how best to manage the decomposing mulches of these weeds for crop production.

MATERIAL AND METHODS

a. Weed Collection and Preparation

Weeds for the study were collected from the Teaching and Research Farms of the AkwaIbom State University, ObioAkpa campus(situated between latitude 40^{o}30’ and 50^{o}30’N and longitude 7^{o}30’ and 8^{o}20’E. Whole plants were carefully dug up using a digging fork to loosen the soil around them. Plant tops were detached from the root with a knife and both sections were spread out on polythene cover under shed for 48hours to wither slightly.

b. Laboratory Study

The tops and roots of each weed species were separately chopped with a knife into very tiny bits and 500g of the materials added to 1litre of water in plastic buckets, vigorously stirred and allowed to stand for 24hours. These were then vigorously re-stirred and filtered into wash bottles for use.

Two hundred and fifty two (252) petri dishes were double layered with Whatman No. 1 filter paper and divided into two (2) sets of 126 petri dishes – one set for water extracts of tops and the other set for extracts of roots. Each set was further divided into six (6) subsets of 21 petri dishes each, with a subset allocated to a crop.

Ten (10) seeds were sown in each petri dish and moistened with an appropriate water extract of the weed. There were three (3) replicates of each treatment (an aqueous extract plus a type of seed). Distilled water was applied to the control.

Filter paper linings of each petri dish were moistened daily with appropriate extracts until final germination counts were taken seven (7) days after sowing. The petri dishes were kept in a growth chamber at room temperature until final germination count.

Germination data obtained were subjected to analysis of variance (ANOVA) and means were separated using the Duncans Multiple Range Test (DMRT).

c. Polybag Study

One (1) kilogram of heat sterilized loamy soil was packed into each of 540 large perforated polybags with enough space at the top to hold mulch materials. Freshly cut and finely chopped tops of each of the weeds were applied as mulch to the soil in each polybag at five (5) levels equivalent to 0, 2.0, 4.0 and 12.0Mgha^{-1} and designated A,B,C,D and E, giving five (5) treatment per weed. Distilled water was applied to each polybag to wash the mulch into the soil twice (2 times) daily for two (2) days after which twenty (20) certified seeds of each test crop were sown through the mulch according to treatment. Every treatment was applied to each of the six (6) test seeds and replicated three (3) times. The polybags were subsequently watered every 24hours till final emergence count were taken ten (10) days after sowing.

Seedlings emergence data obtained were subjected to ANOVA and means were separated by DMRT.

RESULTS AND DISCUSSION

Table 1 and 2 show the effect of water extracts of the tops and roots of the test weeds respectively on the germination of the seeds. Table 3 – 8 show data on the effects of the decomposing mulches of tops of the test weeds on the germination of the seeds and emergence of the seedlings. Comparing data in Tables 1 and 2, with those in Tables 3 – 8, it can be observed that the effect of metabolites in the water extracts were more potent than the same metabolites from the decomposing mulches through the soil to the seeds. Germination counts were generally higher for the potted seeds than for seeds in the petri dishes. This may be attributed to the much higher concentrations of allelochemicals in the water extract and the more intimate contact of the seeds with the allelochemicals in the petri dishes. Mohler (2001) observed that when plant residue is used as mulch, the allelopathic toxins are released into the soil surface and may not diffuse deeply into the soil profile. Data in Tables 1 – 8 also indicate that germination of the larger-sized seeds was less adversely affected by the allelochemicals. This agree with the findings of Mohler (2001) and Aliotta*et al* (2006).

Aspiliaafrican

Water extracts of Aspilia tops and roots significantly ($p<.05$) lowered the germination of all the seeds, but with less inhibitory effect on maize seeds(Tables 1 and 2). Its decomposing mulches also significantly ($p<.05$) inhibited the germination of melon and soya bean. However its inhibitory effect on the germination of maize, okro, cowpea and groundnut, irrespective of mulch level in the study, was not significant (Table 3). The insignificant inhibitory effect on maize, okro, cowpea and groundnut may be attributed to the relatively larger sizes of these seeds and their deeper planting depths compared to the sizes and planting depths of melon and soya bean.Aliota et al.(2006) pointed out that the surface - to – volume ratios of small seeded species are usually greater, and therefore their exposure per unit mass to allelochemicals in both the petri dishes and the soil are greater. Barnes and Putnam (1986) showed that percent germination and root elongation of several species decreased as the layer of soil separating seeds from rye residues decreased from 15 to 0mm. Kiran et al.(1995) and Appleton and Kathy (1999) also reported inhibition of the germination of seeds of many crop plants by *Aspiliaafricana*.

Emilia sonchifolia

Germination of all the test seeds were significantly ($p<.05$) inhibited be the water extracts of both the tops and the roots of Emilia sonchifolia (Tables 1 and 2). Its decomposing mulches also significantly ($p<.05$) lowered the percent germination count of all the test seeds especially with increasing mulch levels (Table 4). The smaller sized seeds were inhibited most, apparently due to their high surface- to – volume ratios which make the seed more exposed to the allelochemicals.Slylesh et al.(2005) also found that Emilia had some inhibitory effect on the germination of some seeds.

Wild crotolaria

Water extracts of Crotoloria tops and roots lowered the germination counts of all the test seeds significantly (p<.05). with the greatest inhibitory effect showing on the smaller-sized seeds (Tables 1 and 2). Similarly, its decomposing mulches significantly (p<.05) inhibited the germination of all the test seeds with the inhibitory effect increasing with increasing levels of the mulch (Table 5). The result agrees with those of Carlson (2000).

Siam weed

Water extracts of both Siam weed tops and roots significantly (p<.05) inhibited the germination of all the test seeds (Tables 1 and 2). The inhibitory effects were also highest on the smaller-sized seeds. The decomposing mulches of the weed also significantly (p<.05) lowered the germination counts of the test seeds with the effect also increasing with increased mulch level. The greatest inhibitory effect was on the germination of soya bean seeds while the least was on cowpea seeds (Table 6). Okon and Amadu (2003) aslo reported the inhibition of seed germination by the decomposing mulches of Siam weed.

Guinea grass

Water extracts of both the tops and roots of Guinea grass significantly (p<.05) lowered the germination counts of all the test seeds, with extracts from the tops exhibiting a higher inhibitory effect (Tables 1 and 2). Its decomposing mulches equally significantly (p<.05) lowered the germination counts of the test seeds, with effect also increasing as mulch levels increased (Table 7) apparently due to increases in levels of allelochemicals released into the soil. The results agree with those of Alam et al.(2001) and Carlson (2000).

Cyperusesculentus

Cyperussp was the most phytotoxic of the test weeds.While water extract of its tops allowed only 10 and 20 percent germination of cowpea and groundnut seeds respectively, its root extract allowed the germination of only 10 percent of maize seeds. Germination of all other seeds were prevented (Table 1 and 2).The decomposing mulches of its tops equally significantly (p<.05) inhibited the germination of all test seeds (Table 8). Alam et al.(2001) also found that water extract of Cyperus sp. at different levels significantly reduced the percent germination of wheat. Limore (1995) also reported that Cyperusspallelopathically caused the crop losses of cotton, maize, soya bean, groundnut and tobacco.

CONCLUSION

From the findings of this study it can be concluded that a large number of weeds in the agro ecosystems of the study area areallelopathic and could play some role in yield reductions while

Vol. 1, No 1, pp.23-33

growing as weeds or used as green or decomposing mulches. There is need to be familiar with the type of plants most likely to produce toxic effects, as well as the site conditions likely to contribute to adverse plant interactions if problems with allelopathic competition are to be avoided (Chick and Kielbaso, 1998). This calls for more laboratory as well as more site specific field studies.

Table 1: Germination of seeds (%) as affected by aqueous extracts of tops of test weeds.

Type of weed	Type of seed					
	Maize	melon	okro	cowpea	soybean	Groundnut
Aspilia africana	90b	50b	40c	30d	0e	20c
Emilia sonchifolia	90b	40c	50b	20e	20c	90b
Crotolaria retusa	70c	30d	10d	90b	60b	90b
Chromolaena odorata	40d	10e	10d	40c	10d	90b
Panicum maximum	30e	10e	10d	10f	10d	10d
Cyprus esculentus	0f	0f	0e	10f	0e	20c
Distilled water	100a	100a	100a	100a	100a	100a

Figure followed by same letter along the columns are not significantly different at

5% level of probability.

Table 2: Germination of seeds (%) as affected by aqueous extracts of roots of test weeds.

Type of weed	Type of seed					
	Maize	Melon	okro	cowpea	soybean	Groundnut
Aspilia Africana	80c	30d	20c	10d	0d	30d
Emilia sonchifolia	90b	30c	30c	40b	10c	80b
Crotolaria retusa	90b	10e	30c	40b	40b	50c

Chromolaena odorata	90b	30c	60b	50b	20c	90b
Panicum maximum	80c	40b	30c	20c	40b	20e
Cyprus esculentus	10d	0f	0d	0d	0d	0f
Distilled water (control)	100a	100a	100a	100a	100a	100a

Figures following by same letters along the column are not significantly different at 5% level of probability.

Table 3: Mean germination counts (%) as affected by decomposing mulches ofAspiliaafricana

Mulch Type	Mulch	Percent seed Germination					
	Level	Maize	Melon	Okro	Cowpea	Soyabean	Groundnut
Aspilia	A	100a	90a	95a	90a	100a	100a
africana	B	95a	40b	85a	90a	65b	85a
	C	90a	25c	85a	95a	20d	80a
	D	90a	20c	90a	90a	20d	80a
	E	95a	20c	90a	90a	30c	

Means followed by same alphabets along the column are not significantly different at 5% level of probability.

Table 4: Mean germination counts(%) as affected by decomposing mulches of Emilia sonchifolia

Mulch Type	Mulch	Percent seed Germination					
	Level	Maize	Melon	Okro	Cowpea	soyabean	Groundnut

Emilia	A	100a	95a	100a	95a	100a	90a
sonchifolia	B	85b	65b	55b	85b	75b	90a
	C	75c	55c	40c	75c	85b	90a
	D	75c	55c	40c	85b	80b	75b
	E	40d	30d	10d	85b	80b	80b

Means followed by same alphabets along the columns are not significantly different at 5% level of probability.

Table 5: Mean germination counts(%) as affected by decomposing mulches of Crotolariaretusa.

Mulch Type	Mulch	Percent seed Germination					
	Level	Maize	Melon	Okro	Cowpea	soyabean	Groundnut
Crotolaria	A	100a	100a	100a	100a	100a	100a
retusa	B	100a	50b	55b	85b	75b	85c
	C	85b	15c	30c	90b	55c	80d
	D	90b	15c	10d	90b	55c	90b
	E	90b	15c	10d	90b	30d	90b

Means followed by same alphabets along the columns are not significantly different at 5% level of probability.

Table 6: Mean germination counts(%) as affected by decomposing mulches of Chromolaena odorata.

Mulch Type	Mulch	Percent seed Germination					
	Level	Maize	Melon	Okro	Cowpea	Soyabean	Groundnut

Chromolaena	A	100a	100a	100a	95a	100a	100a
odorata	B	85b	65c	35b	100a	25b	85b
	C	85b	75b	15c	100a	0e	85b
	D	65c	30d	15c	75b	0e	65c
	E	30d	5e	5d	60c	5d	30d

Means followed by same alphabets along the columns are not significantly different at

5% level of probability.

Table 7: Mean germination counts (%) as affected by decomposing mulches of Panicum maximum.

Mulch Type	Mulch	percent seed Germination					
	Level	Maize	Melon	Okro	Cowpea	soyabean	Groundnut
Panicum	A	100a	90a	100a	95a	100a	100a
maximum	B	70b	55b	40b	80b	40b	65b
	C	70b	35c	10c	75c	10c	25c
	D	35c	15d	0d	55d	10c	25c
	E	15d	5e	0d	35e	5d	10d

Means followed by same alphabets along the columns are not significantly different at

5% level of probability.

Table 8: mean germination counts(%) as affected by decomposing mulches of Cyperusesculentus.

Mulch Type	Mulch	Percent seed Germination					
	Level	Maize	Melon	Okro	Cowpea	Soyabean	Groundnut
Cyperus	A	95a	90a	90a	100a	100a	100a
esculentus	B	65b	10b	55b	55b	0b	30b
	C	30c	0e	0d	5d	0b	5c

D	0d	0e	0d	5d	0b	5c
E	0d	5d	10c	10c	0b	0d

Means followed by same alphabets along the columns are not significantly different at

5% level of probability.

References

Aliotta, G., G. Cafiero and A. Martinez – Otero. 2006. Weed germination, seedling growth and their lesson for allelopathy in agriculture. *In: Allelopathy: A Physiological Process for Ecological Implications*.Springer.The Netherlands.p. 285 – 297.

Alam, S. M., S. A. Ala, A. R. Azmi, M. A. Khan and R. Ansari. 2001. Allelopathy and its role in agriculture. *Online Journal of Biological Science*. 1(5):308 – 315. UK: Cambridge University Press

Appleton, B. and K. Kathy. 1999. Selection and use of mulches and landscape fabrics. Virginia Cooperation Extension. 430 – 019

Awodun, M. A. and S. O. Ojeniyi. 1991. Use of weed mulches for improving soil fertility and maize performance. *Applied Tropical Agriculture* 2:26-30.

Barners, J. P. and A. R. Putnam. 1986. Evidence of allelopathy by residues and aqueous extracts of rye (Secalecereale). *Weed Sci*. 34:384.

Bruce, R. R., C. W. Langdale, T. West and W. P. Miller. 1995. Surface soil degradation and soil productivity restoration and maintenance. *Soil Sci. Soc. Am. J*. 59: 654 – 660.

Carlson, C. R. 2000. Mulching Basics: are you covered.*Ground Maintenance*. Primedia Business Magazine and Media Inc. Ohio

Chick, T. A. and J. J. Kielbaso. 1998. Allelopathy as an inhibition factor in ornamental tree growth: implications from the literature. *Journal of Agriculture* 24(5):274 – 279.

Chou, C. H. 2006. Introduction to allelopathy. In: M. J. Reigosa, N. Pedrol and L. Gonzalez (eds). *Allelopathy: A Physiological Process with Ecological Implications.* Springer, The Netherlands. P 1 – 9.

Gawronska, H. and A. Golisz. 2006. Allelopathy and biotic stresses. *In*: M. J. Reigosa, N. Pedrol and L.Gonzalez (eds). *Allelopathy : A Physiological Process with Ecological Implications*. Springer, The Netherlands. P 211 – 227.

Inderjit, K. and S. O. Duke. 2003. Ecophysiological aspects of allelopathy.*Planta* 217:529-539.

International Allelopathy Society, 1996. Department of Biochemistry, Oklahoma State University, Stillwater, USA.

Ishii-Iwamoto, E. L., D. Abraham, M. A. Sert, C. M. Bonato, A. M. Kelmer – Bracht and A. Bracht. 2006. Mitochondria as asite of allelochemical action. *In: Allelopathy: A Physiological Process with Ecological Implications*.Springer.The Netherlands. P. 267 – 284.

Kiran, K., Y. S. Bedi, and K. Kaul. 1995. Allelopathic influence of *Tagetes* species on germination and seedling growth of radish (*Raphanussativus*) and lettuce (*Lactuca sativa*).*Indian Journal of Agricultural Sciences*.68:599 – 601.

Lal, R. 1995. Sustainable Management of Soil Resources in the Humid Tropics. United Nations University Press, New York.

Vol. 1, No 1, pp.23-33

Limore, C. D.1995. Assessment of allelopathic effect of weeds on field crops in the humid south: the chemistry of allelopathy. *Biochemical Interactions Among Plants*. pp 21 – 22. Amer. Chemical Society, Washington D. C. USA.

Mohler, C. L. 2001. Weed life history: identifying vulnerabilities. In:*Ecological Management of Agricultural weeds*. L. Matt, C. L. Mohler and C. P. Staver (eds).

Narwal, S. S. 2006.Allelopathy in ecologically sustainable agriculture.*In*: M. J. Reigosa, N. Pedrol and L. Gonzalez (eds) *Allelopathy : A Physiological Process with Ecological Implications*. Springer, TheNetherlands. pp 537 – 564.

Ndaeyo, N. U., B. U. Udo and G. N. Udom. 2008. Effects of mulching and tillage practices on the growth and yield of cowpea (*Vignaunguiculata L*). Proceedings of the 42nd Annual Conference of the Agricultural Society of Nigeria, Ebonyi State University, Abakaliki, Nigeria. October 19 – 23. pp.272 – 277.

Okon, P. B. and U. C. Amadu. 2003. Weed to fight weed. LEISA 19(4).The Netherlands.

Rice, E. L. 1979. Allelopathy – an update. The Botanical Review 45:15 – 109.

Rosolem, C. A. 2011. Exchangeable basic cations and nitrogen distribution in soil as affected by crop residues and nitrogen. Braz. Arch. Biol. Technol. 54(3):441 – 450.

Slylesh, B. S., S. A. Nair and A. Subbramonia. 2005. Induction of cell specific apoptosis and protection from Dalton's lymphoma challenge in mice by an active fraction of *Emilia sonchifolia*. *Indian Journal Pharmacol*. pp. 232 – 237.

Smith,A. E. and L. D. Martin. 1994. Allelopathic characteristics of 3 cool-season grass species in the forage ecosystem. *Agron J*. 86:243 – 246.

*Corresponding author:dennis.edem@gmail.com