Journal of Sustainable Technology JoST Volume 4, No. 1, April, 2013

JoST

ISSN: 2251-0680

Journal of Sustainable Technology

Volume 4, No. 1, April, 2013

CERAD
CENTRE FOR RESEARCH AND DEVELOPMENT
THE FEDERAL UNIVERSITY OF TECHNOLOGY,
AKURE, NIGERIA.

www.jost.futa.edu.ng

Centre for Research and Development (CERAD) JoST 2013
The Federal University of Technology, Akure, Nigeria

Post-harvest seed mineral composition of some common cereal weeds in the rainforest zone of southwestern Nigeria

SMITH, M.A.K.[1] and AMOO, I.A.[2]
[1]Department of Crop, Soil and Pest Management, The Federal University of Technology, Akure, Ondo State, Nigeria.
[2]Department of Chemistry, The Federal University of Technology, Akure, Ondo State, Nigeria.

ABSTRACT: Seeds of eight common cropping and fallow weed associates of maize *(Zea mays* L.*)* were collected after crop harvest from mature plants in the rainforest zone of southwestern Nigeria and analysed for their P, K, Ca, Mg, Na and Fe contents. Seed mineral contents varied differently with year, weed species and weed taxa. The following weeds had the highest 2-yr. average seed content of specified minerals *Ageratum conyzoides* L. (P), *Aspila africana* (Pers.) C.D. Adams (Ca, Mg, Na) and *Melanthera scandens* (Schum & Thonn.) Roberty (K, Fe). Seed Fe content of both *A. africana* and *Senna occidentalis* L. was comparable to that of *M. scandens.* The lowest mineral contents were observed for *S. occidentalis* (P, K), *Calcopogonium mucunoides* Desv. (Ca, Mg, Na) and *C. olitorius* (Fe). Asteraceae had considerably higher seed P and Ca contents but fairly higher contents of K, Mg, Na and Fe than the other weed families. Seed mineral contents were poorly correlated across weed species and years of sampling, except for Na and Ca. In Asteraceae, Mg and Ca or Na, Na and Ca or Fe and Fe and K were highly correlated. Also, only *T. procumbens* and *M. scandens* were significantly correlated in seed mineral contents. It is concluded that weeds with very high seed mineral contents, especially P, K, Ca and Mg may be left in the field after crop harvest and allowed to shed their seeds. From the standpoint of soil fertility restoration, the decay of such seeds in the soil releases more locked-up nutrients in addition to that recovered from weed debris. However, there is a need to prevent weed resurgence during subsequent cropping by application of suitable pre-emergence herbicide.

Key words: *Weeds, seed, nutrients, soil fertility, weed resurgence.*

JoST. 2013. 4(1): 74-81.
Accepted for Publication, July 31, 2012

INTRODUCTION

Weedy vegetations are primarily undesirable to man, animals and the environment, because they interfere with human activities, particularly agriculture and contaminate harvested crop produce and animal products (Bailey *et al*., 1980; Akobundu, 1987). Similarly, weed seeds also contaminate harvested grain. However, weed seeds contain varying amounts of nutrients such as crude protein, amino acids, fats and oils, fibre and minerals, which are of food value to both man and livestock (Friedman and Levin, 1989; Oderinde and Tairu, 1998; Tanji and Elgharous, 1998).

From the point of view of weed management on croplands, herbicides applied pre-emergence usually affect the emerging weed seedlings when

*Correspondence to: Smith, M.A.K.; kenziesmith2013@yahoo.com

the only source of energy is the stored materials in the seed (Schroeder *et al.,* 1974), which differ in both quantity and quality in seeds of various plant species. Much is known about differences in seed content of protein, fat, nitrogen-free extracts (NFE) and their influence on the relative sensitivity of various weed families to herbicides (Shroeder and Warren, 1971). Deli and Warren (1971) and Schroeder *et al.* (1974) reported significant correlations between seed size and sum of the percent protein plus fat plus NFE and relative sensitivity to diphenamid and dinoseb, respectively. Certain seed components such as lipids, are also speculated to be involved in the inactivation of herbicides (Hilton and Christiansen, 1972).

Although previous research on the seed mineral contents of weed species emphasized the nutritional implications to man, the possibility of a significant relationship between seed mineral content and herbicide selectivity in different weed families exists, judging from the varying concentrations of mineral nutrients in both weed and crop (Sammour, 1987; Tanji and Elgharous, 1998). However, unlike Schroeder *et al.* (1974) who experimented on weed species used in herbicide selectivity studies, the present study considered weed species, which are commonly found in cereal fields in a rainforest environment of southwestern Nigeria. The objectives were therefore to determine the mineral composition of seeds from eight weed associates of maize (*Zea mays* L.) (Table 1); assess the possible relationship between weed families and mineral composition of the seed; and find possible correlations between mineral contents, which will guide in the understanding of soil reaction under the selected weeds to the herbicides used for pre-emergence weed control.

MATERIALS AND METHODS

Copious quantities of mature dry unprocessed seeds of the selected weeds were collected in August 1998 and 1999 from the Teaching and Research Farm, The Federal University of Technology, Akure (327 m above sea level; $5^{0}12'$E, $7^{0}16'$N), in the rainforest zone of southwestern Nigeria. The weeds were goatweed (*Ageratum conyzoides* L., family Asteraceae), haemorrhage plant (*Aspilia africana* (Pers.) C.D. Adams, family Asteraceae), melanthera [*Melanthera scandens* (Schum & Thonn.) Roberty, family Asteraceae], tridax (*Tridax procumbens* L., family Asteraceae), calopogonium (*Calopogonium mucunoides* Desv., family Fabaceae), coffee senna [*Senna occidentalis* (L.) Link, family Fabaceae], ricegrass paspalum (*Paspalum scrobiculatum* L., family Poaceae) and Jew's mallow (*Corchorus olitorius* L., family Tiliaceae). The average annual rainfall in this zone is 250 cm. The plot had been under continuous maize cultivation after traditional land clearing with bush burning, and the maize was regularly fertilized with NPK 15-15-15 fertiliser at the rate of 300 kg/ha. The seeds were cleaned and dry-milled into a powder form using a Kenwood blender.

Five (5) gramme of three replicate powdered samples of each weed was placed in the furnace at 550^{0}C for 5 h. Thereafter, they were transferred to the desiccator to cool, and weighed. The process of heating, cooling and weighing was continued until a constant weight was obtained. The cooled ash was dissolved in 10% perchloric acid. Phosphorus was determined with UV spectrophotometer (Spectronic 20 model, Banch and Lomb, Rochester, New York, USA) according to the procedure used by Pearson (1976). Potassium and sodium were determined with a flame photometer (Corning model 405; U.K.).

Calcium, magnesium and iron were determined using the atomic absorption spectrophotometer (PYE Unican SP9; England).

The mean concentration, standard error (SE) and coefficient of variability (CV) of the mean value of each nutrient were calculated across weed species, and separately for the Asteraceae versus other weed families. Correlation analysis was carried out to determine the relationship among the various mineral nutrients across weed species.

Table 1: Seed mineral contents (g/kg) in selected cereal weeds

Weed taxa	Plant family	P	K	Ca	Mg	Na	Fe
1998							
Ageratum conyzoides	Asteraceae	2308.33	689.8	1110.8	729.2	705.8	79.2
Aspilia africana	Asteraceae	1270.00	840.0	2850.0	925.0	1017.0	116.0
Melanthera scandens	Asteraceae	1114.04	842.1	526.3	822.8	669.3	73.7
Tridax procumbens	Asteraceae	1153.85	594.6	1025.4	826.9	651.5	80.8
Calopogonium mucunoides	Fabaceae	184.03	638.9	359.0	590.3	635.4	95.1
Senna occidentalis	Fabaceae	148.57	666.4	392.9	660.7	871.4	127.9
Paspalum orbiculare	Poaceae	663.46	897.1	464.4	769.2	879.8	71.2
Corchorus olitorius	Tiliaceae	277.78	802.8	632.4	902.8	784.3	68.5
Mean		765.01	746.5	920.2	778.36	776.83	89.04
SE±		272.96	39.62	292.92	40.74	48.08	7.80
CV%		35.7	5.3	31.8	5.2	6.2	8.9
1999							
Ageratum conyzoides	Asteraceae	1.16	665.32	225.17	512.57	635.90	107.49
Aspilia africana	Asteraceae	3.87	608.89	319.97	495.47	1043.47	165.95
Melanthera scandens	Asteraceae	5.42	758.30	471.19	467.26	922.77	220.35
Tridax procumbens	Asteraceae	4.06	556.84	171.04	513.11	703.58	110.79
Calopogonium mucunoides	Fabaceae	3.39	557.42	276.51	442.94	659.57	95.99
Senna occidentalis	Fabaceae	4.35	443.82	289.90	408.88	596.80	135.98
Paspalum orbiculare	Poaceae	6.77	448.84	393.10	497.60	764.31	113.45
Corchorus olitorius	Tiliaceae	9.19	576.41	336.40	361.46	615.93	100.25
Mean		4.78	576.99	310.41	462.41	742.78	131.28
SE±		0.85	36.98	33.18	19.30	56.75	15.08
CV%		17.8	6.4	10.7	4.2	7.6	11.5

RESULTS

Weed seed nutrient content

Generally, seed mineral contents were higher across weed species in 1998 than in 1999 (Table 1). Specifically, average P content in 1999 (4.78 ± 0.85 g/kg) was distinctly lower than in 1998 (765.01 ± 272.96 g/kg). Also, seed P, Ca and Mg contents varied more widely in 1998 than in 1999, while seed K, Na and Fe contents varied more widely in 1999 than in 1998. Pooled (2 yr.) data (Table 2) showed that the following weeds had distinctly higher seed content of the specified nutrients than other weeds: *A. conzoides* (P), *A. africana* (Ca, Mg, Na) and *M. scandens* (K, Fe).

However, fairly high seed nutrient contents were observed for *A. africana, M. scandens* and *T. procumbens* (P), *A. conyzoides* and *T. procumbens* (Ca) and other weeds (Mg, Na). Also, *A. africana* and *S. occidentalis L.* had comparatively high seed Fe contents as *M. scandens*. In contrast, *S. occidentalis* had the lowest seed P and K contents, *Calopogonium mucunoides* the lowest seed Ca, Mg and Na contents and *Corchorus olitorius* the lowest seed Fe content.

Asteraceae versus other weed families

The family Asteraceae had considerably higher average (pooled data) seed P and Ca contents than other weed families combined (Table 3). In particular, seed P content was about five times higher in the Asteraceae than in the other weed families, while seed Ca was two times higher. Similarly, other seed nutrient contents were fairly higher in the Asteraceae than in the other weed families.

Correlation analyis

Of the correlation coefficients recorded among all pairs of nutrients averaged over 2 yr., only the Ca x Na correlation (r = 0.81, df = 5) was significant (P = 0.05) in all the weed families. Similarly, in the Asteraceae, only the Ca x Na correlation was significant (r = 0.88, df = 3). In addition, of all the members of the latter family sampled (n = 4), only *T. procumbens* and *M. scandens* were significantly (r = 0.88, df = 3) correlated with respect to seed mineral contents.

Table 2: Pooled (2-yr.) seed mineral contents (g/kg) of selected cereal weeds

Weed taxa	P	K	Ca	Mg	Na	Fe
Ageratum conyzoides	1154.75	677.56	677.99	620.89	670.85	99.35
Aspilia africana	636.94	724.45	1584.99	710.24	1030.24	140.98
Melanthera scandens	559.73	800.27	498.75	645.03	796.01	147.03
Tridax procumbens	578.96	575.72	598.22	670.01	677.54	95.80
Calopogonium mucunoides	93.71	598.16	317.76	516.62	647.49	95.55
Senna occidentalis	76.46	555.11	341.14	534.79	734.10	131.94
Paspalum orbiculare	335.12	672.97	428.75	633.40	822.06	92.33
Corchorus olitorius	143.49	689.61	484.27	632.13	700.12	84.38
Mean	447.40	661.73	615.23	620.39	759.80	110.17
SE±	129.06	28.98	144.63	22.96	44.27	8.93
CV%	81.64	12.39	23.51	3.70	16.49	22.94

Table 3: Average seed mineral contents (g/kg) of the family Asteraceae relative to other cereal weeds

Seed mineral	Family Asteraceae	Other weeds
P	732.60 $\pm$ 141.67	162.20 $\pm$ 59.37
K	694.50 $\pm$ 46.98	628.96 $\pm$ 31.65
Ca	837.49 $\pm$ 251.58	392.98 $\pm$ 38.69
Mg	661.54 $\pm$ 19.08	579.24 $\pm$ 31.13
Na	793.66 $\pm$ 83.94	725.94 $\pm$ 36.66
Fe	119.29 $\pm$ 14.33	101.05 $\pm$ 10.56

Table 4: Correlation coefficients of average seed mineral contents of selected cereal weeds

Seed mineral	P	K	Ca	Mg	Na	Fe
P	-					
K	0.38					
Ca	0.45	0.38	-			
Mg	0.54	0.56	0.72	-		
Na	0.13	0.51	0.81	0.61	-	
Fe	0.05	0.39	0.41	0.18	0.63	-

r value greater than 0.76 significant at P= 0.05 (df= 5).

DISCUSSION

Weed presence on farmlands benefits crop production not only as manure, mulch and cover species but also through nutrient additions from decaying weed seeds. In the current study, seed mineral contents of selected cereal weeds varied differently in concentration, and with weed family and year of seed collection. The predominant presence of major minerals in most of the weed species therefore indicates a significant contribution of the seed mineral additions to the soil nutrient status. The characteristic aggressive, persistent growth and high seed outputs of the weeds in the dry season fallow have great positive implications on build-up of soil fertility prior to subsequent cropping in the early rainy season.

In particular, the type of ions present in the soil solution affects the chemical decomposition of herbicides in soils. The persistence of herbicides such as atrazine is affected by soil acidity (Akobundu, 1987). Similarly, many other s-triazines are less persistent in acid soil than in slightly alkaline soils. Apparently therefore, weed seeds that decay and liberate either anions or cations create either acidic or alkaline soil conditions. In the current study, weed seeds consistently contained predominantly considerable contents of exchangeable cations. The implications of the alkaline soil reaction resulting from seed decomposition on the activity and persistence of pre-emergence herbicides in such agro-ecosystems is strongly indicated. In addition, the release of seed nutrients and organic material not only favours the activity of many soil organisms but facilitate microbial breakdown of soil-applied herbicides. Interspecific differences in seed nutrient contents may be due to weed growth habit, nutrient requirement, capacity to absorb nutrients from soil and capacity to allocate absorbed nutrients to seed production. Similar observations have been reported among other types of weeds (Sammour, 1987; Tanji and Elgharous, 1998; Oderinde and Tairu, 1998). The apparently low variability recorded for all weed species in K and Mg, and particularly Fe contents, also agree with previous observations with respect to N among 39 weed species (Tanji and Elgharous, 1998). However, seed mineral contents were higher in yr. 1 than in yr. 2 and this can be attributed to weather conditions, soil fertility and weed growth in the sample site. Also, the greater variation in average P, Ca and Mg in yr. 1 than in yr. 2 may be due to possible higher native levels of mineral nutrients arising from considerable crop residue decomposition. Ojeniyi (1998) reported considerable increases in soil nutrient contents due to wood ash addition and weed residue decomposition, especially *Chromolaena odorata*. In yr. 2, more weedy vegetation decayed and increased mineral returns to the soil. For P, the considerable reduction in seed contents probably arose from immobilization, deficiency and nutrient antagonisms.

Pooled data on seed mineral contents indicate higher levels of P in *A. conyzoides,* Ca, Mg and Na in *A. africana* and K and Fe in *M. scandens* than in other weeds. These, in addition to *T. procumbens* are members of the Asteraceae which this study has shown to accumulate higher seed nutrient contents, especially P and Ca than the other three weed families: Fabaceae, Poaeceae and Tiliaceae. These findings are consistent with the rankings reported by Tanji and Elgharous (1988) especially for P, Ca, Na and Fe. Also, Singh and Singh (1939) demonstrated the superiority of *Diplotaxis tenuisilique* Delile (Cruciferae), *Beta macrocarpa* Guss., *Chenopodium murale* L. (Chenopodiaceae) in their seed contents of P, Ca, Na, K and Fe over the other weeds and weed families. In contrast, seed K contents obtained in the current study viz. Asteraceae > Tiliaceae > Poaceae > Fabaceae, contrasted the reports of Tanji and Elgharous (1998), which ranked Fabaceae > Asteraceae > Poaceae. The difference in ranking may be due to soil K status between the two ecological zones (semi-arid vs. humid).

A large number of weeds were also distinguished by maximum and minimum seed mineral contents of P, Ca, Mg, Na, K and Fe as in previous studies. *S. occidentalis* is commonly associated with wastelands, noncrop land and degraded agricultural land which are essentially impoverished. This may account for the markedly low P and K in *Senna* seeds. Although the Fabaceae requires large quantities of Ca, Mg and Na essentially for pod formation, the minimum contents recorded for *C. mucunoides* seeds indicate that these nutrients do not subsequently accumulate in the seed after seed formation. In a previous survey, Tanji and Elgharous (1998) also obtained a relatively low ranking for the Fabaceae in respect of Ca and Na.

Generally, comparative analysis of seed mineral contents among weed families showed a considerably higher P and Ca and fairly higher K, Mg, Na and Fe in the Asteraceae than in the other weed families. This agrees with the report of Tanji and Elgharous (1998) especially in respect of the superiority of the Asteraceae in seed P, Ca and Na over the Fabaceae. However, the latter authors ranked the Asteraceae fifth in seed K content after the Apiaceae, Chenopodiaceae, Fabaceae and Polygonaceae. The differential K content between the Asteraceae and Fabaceae could be due to climatic region; K is relatively low in tropical soils. The significant relationship among seed nutrients in the Asteraceae is remarkable, and could be attributed to the consistently high mineral contents in this weed family.

CONCLUSION

The following implications are evident from this study:

1. there is a great need to prevent cross-contamination of arable fields with weed seeds especially the Asteraceae which exhibit potentially high seedling vigour and aggressive growth.
2. there is a need to prevent the removal of mature heavily seeded fallow vegetation from *in situ* stands, to restore lost soil fertility
3. the considerably high seed mineral contents of the Asteraceae strongly indicate that the species are very strong feeders on soil nutrients; and
4. the possible soil reaction to soil-applied herbicides suggests higher herbicide rates on heavily infested lands and/or integrated weed management to prevent crop losses or failures.

REFERENCES

AKOBUNDU, I.O. (1967). Weed Science in the Tropics: Principles and Practice. John Wiley & Sons, Inc. 527 pp.

BAILEY, J.I., HOVELAND, C.S. and BUCHANAN, G.A. (1980). Nutritive value of 22 weed species for forage. *Agronomy Abstracts,* **72**:122.

DELI, J. and WARREN, D.G. (1971). Relative sensitivity of several plants to diphenamid. *Weed Science,* **19**:70-72.

FRIEDMAN, M. and LEVIN, C.E. (1989). Composition of Jimson weed *(Datura stramonium)* seeds. *Journal of Agriculture and Food Chemistry* **37**: 998-1005.

HILTON, J.L. and CHRISTIANSEN, M.N. (1972). The lipid contribution to selective action of trifuralin. *Weed Science,* **20**: 290-294.

ODERINDE, R.A. and TAIRU, A.O. (1989). Utilisation of yellow nutsedge tuber for composite flour. In: *Weed Research,* **38**: 79-86.

OJENIYI, S.O. (1998). Use of ash for soil fertility and crop yield improvement. Programme of Activities and Abstract of Papers, 24th Annual Conference of Soil Science Society of Nigeria, Dec. 7-10, Abubakar Tafawa Balewa University, Bauchi, Nigeria, 48 pp.

PEARSON, D. (1976). Chemical analysis of Food. Churchill Livingstone, London.

SAMMOUR, R.H. (1987). Chemical constituents and electrophoresis of seed proteins of some species of *Vicia*. In: *Weed Research,* **38**:79-86.

SCHROEDER, M. AND WARREN, G.F. (1971). Relative sensitivity of several plants to dinoseb. *Weed Science,* **19**:671-674.

SCHROEDER, M., DELI, J., SCHALL, E.D. and WARREN, G.F. (1974). Seed composition of 66 weed and crop species. *Weed Science*, **22**:93-100.

SINGH, B.N. and SINGH, L.B. (1939). Relative absorption of nutrients of weeds of arable land. *Soil Science,* **47**:227-235.

TANJI, A. and ELGHAROUS, M. (1998). A survey of mineral composition of weed seeds. *Weed Research,* **38**: 79-86.