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Effect of intercropping with maize on weed diversity in cassava

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Abstract

A study to assess the degree of weed species diversity in cassava/maize intercrop and cassava monoculture was conducted at the Teaching and Research Farm of the Federal University of Agriculture Abeokuta in 2010 late wet season and 2011 early wet season using 0.5 × 0.5 m plots. In total, 33 weed species belonging to 12 families were identified. From these, 10 and 23 were perennials and annuals, respectively, while 15, 16 and two were forbs, grasses and sedges, respectively. *Brachiaria jubata, Cyperus rotundus, Dactyloctenium aegyptium, Phyllanthus amarus* and *Spigelia anthelmia* were associated with the two locations in both seasons. *Cyperus rotundus* was the most frequent species in cassava/maize intercrop in both seasons with 40.08 and 17.82% relative frequency, respectively. However, *Brachiaria jubata* with 17.82% and *Tridax procumbens* with 33.33% relative frequency followed the same trend in cassava monoculture plots in the late and wet seasons, respectively. In both seasons, only two weed species: *Cyperus rotundus* and *Phyllanthus amarus* consistently had relative density ≥ 5% in the two systems. In cassava/maize intercrop fields, *Cyperus rotundus* was the most frequent (40.08%) and most dominant species (relative importance value = 29.85%) in cassava/maize intercrop in both seasons, while *Brachiaria jubata* (relative importance value = 19.7%) and *Tridax procumbens* (relative importance value = 27.08%) constituted the dominant species in cassava monoculture field during the late 2010 and early 2011 seasons, respectively. The future incidence of *Cyperus rotundus* may probably be brought under control with shallow tillage at frequent intervals.

Key words: cassava; early wet season; intercropping; late wet season; maize; monoculture; relative frequency; relative density; weeds.
Abbreviations: AF, annual forb; AG, annual grass; CM, cassava monoculture; C/M, cassava/maize; FPY, Farm Practical Year; FUNAAB, Federal University of Agriculture, Abeokuta; IFSERA, Institute of Food Security, Environmental Resources and Agricultural Research; PBL, perennial broadleaf; PG, perennial grass; PS, perennial sedge; RD, relative density; RF, relative frequency; RIV, relative importance value.

Introduction

A weed is a plant growing out of a place where is not desirable and without any economic value. The agricultural impact of weeds differs with various crops and locations, because many of them are crop- and location-specific (Olorunmaiye et al. 2011), although the perceived negative ecological and economic effects on agricultural or natural systems remain obvious. The weeds exhibit diversity in distribution and levels of occurrence or infestation at various locations and different seasons. Weeds occurring in one particular situation may not occur in another situation. Weed diversity is the estimate of the number of species and their relative abundance in an ecosystem. Some weeds are crops and site-specific while others will thrive over a wide range of habitats (Karaye et al. 2007). Recent studies have shown that weed shifts occur in continuously cultivated land, depending on intensity and type of tillage practice, cropping systems, weed control and other changes in the habitat (Smith, Akinde 2000; Olorunmaiye, Olorunmaiye 2008). Reminson (1978), and Nangju (1980) reported on the reductive effect of weeds on crop production and indicated that a 51% reduction in cowpea yield can occur due to weed infestation, 65% in cassava, 73% in yam and 80% in maize.

Intercropping of two or more crops generate beneficial biological interactions between and among the crops, resulting in increased productivity and yield stability as a result of more efficient utilization of available resources as well as reduced weed pressure (Eskandari et al. 2009; Kadziuliene et al. 2009). The component crops also release allelopchemicals, which in addition to reduction in light quantity and quality, limit the germination, growth, establishment and competitiveness, hence the occurrence of weeds (Oleszek 1994; Wanic et al. 2004). Weed suppression in intercropping system through more efficient use of environmental resources by component crops has been reported (Liebman and Dyck 1993; Mashingaizde et al. 2000; Mashingaizde 2004; Poggio, 2005; Eskandari and Kazemi 2011). Irrespective of cropping systems practiced, the weed problem remains a major cause of yield loss in crops and detailed knowledge and understanding of their biology, survival mechanism and life cycle can help in further research to reduce devastating effects of weeds

on agricultural farms. The objective of this study was to evaluate the effect of intercropping with maize on cassava weed species composition and diversity.

Materials and methods

The survey was conducted on two selected farms of the Federal University of Agriculture, Abeokuta (FUNAAB) viz: Farm Practical Year (FPY) and Institute of Food Security, Environmental Resources and Agricultural Research (IFSERA) fields; both located on the permanent site of the University (longitude 07°15'N and latitude 03°25'E) in the forest-savanna transition agro-ecological zone of Nigeria. In the FPY field, cassava and maize was grown as an intercrop, while the IFSERA field had a cassava monoculture. The survey was conducted in November, 2010 and April, 2011, during late and early wet seasons, respectively. In each season, weeds were evaluated using 0.5 × 0.5 m plots which were randomly selected along a transect of "M" shape in each location. Five plots were described in the IFSERA field (< 5 ha) and 13 in the FPY field. Weeds within each plot in each location were identified using a standard manual by Akobundu and Agyakwa (1987), counted and recorded to compute the relative frequency (RF), relative density (RD) and relative importance value (RIV) of each species according to Das (2011) as follows:

RF (relative frequency) = number of occurrence of a named species / total of occurrence of all species × 100;
RD (relative density) = density of a named species / total density of all species × 100;
RIV (relative importance value) = relative density + relative frequency.

Results

A total of 33 weed species were identified at the two locations, of which 23 were annuals and 10 were perennials, comprising 18 forbs, 13 grasses and two sedges (Table 1). The weed species represented 11 families, including Poaceae with16 species, followed by Asteraceae, Commelinaceae, Cyperaceae, Euphorbiaceae with six, two, two and two species, respectively. Rubiaceae, Passifloraceae, Portulacacaeae, Loganiaceae, Fabaceae had one species each.

Twenty weed species were recorded in the cassava/maize field in 2010 late wet season and 18 in 2011 early wet season while the corresponding numbers in the cassava monoculture field were 18 and nine species (Table 2).

In the two seasons and locations, *Brachiaria jubata, Cyperus rotundus, Dactyloctenium aegyptium, Imperata cylindrica, Phillanthus amarus* and *Spigelia anthelmia* were present in both cassava/maize and cassava monoculture fields. However, *C. rotundus* was predominant in the cassava/maize intercrop field in both seasons, with higher relative frequency (RF) of 40.00 and 23.11%, respectively compared with other weeds (Table 2), *B. jubata* with 17.82% in the late wet season and *Tridax procumbens* (33.33%) in the early wet season also exhibited predominance in the respective field.

In the cassava/maize intercrop field seven and nine weed species occurred at relative density (RD) ≥ 5% in 2010 late and 2011 early wet seasons, respectively. In both cases *C. rotundus* had the highest values of 19.61 and 16.33% in 2010 and 2011, respectively (Table 2). *Phillanthus amarus* with 9.8%, *Aspilia latifolia* and *Leptochloa caerulescens* each with 7.84% as well as *B. jubata, Commelina erecta* and *Mariscus alternifolius* each with 5.88% also exhibited high RD in the late season, while *A. africana, Commelina diffusa* and *I. cylindrica* each with 6.12% similarly had high values in the wet season. However, in the cassava monoculture field, nine and eight weed species had RD of ≥ 5% in 2010 late and 2011 wet seasons with *B. jubata* and *C. rotundus* having 13.33 and 10.00%, respectively, while *D. aegyptium, D. longiflora, I. cylindrica, Paspalum orbiculare, Passiflora foetida, P. amarus* and *S. anthelmia* each had the lowest density of 6.67% in the late wet season (Table 2). In the early wet season, only eight weed species had relative densities > 5%, with *T. procumbens* being the most abundant (RD value of 20.83%), while *D. aegyptium, I. cylindrica* and *P. orbiculare* each had the lowest value of 8.33%.

Across the seasons, three and six weed species which occurred in cassava/maize intercrop and in cassava monoculture fields had RD ≥ 5%. Only two species, *C. rotundus* and *P. amarus* consistently had RD ≥ 5% in the two systems and seasons (Table 3). *Brachiaria jubata* had RD ≥ 5% in the cassava/maize intercrop in the late wet season and cassava monoculture fields in both seasons while *I. cylindrica* and *P. obiculare* had RD ≥ 5% in the cassava/maize field in the early wet season and in the cassava monoculture in both seasons (Table 2).

Cyperus rotundus and *P. amarus* consistently had a high relative importance value (RIV) ≥ 5% in both locations and seasons (Table 2). Furthermore, *C. rotundus* had the highest RIV of 29.85 and 19.70% in 2010 late and 2011 wet seasons, respectively, in the cassava/maize intercrop field. In addition to those already mentioned, inter alia *B. jubata, L. caerulescens, I. cylindrica* and *A. africana* had high RIV in 2010 late season while *M. alternifolius, P. maximum, P. orbiculare, S. anthelmia*, and *T. procumbens* also had high RIV values in the cassava/maize system. In the cassava monoculture system, *C. rotundus* and *T. procumbens* had the highest RIV values of 15.58 and 27.08% in 2010 late and 2011 early wet seasons, respectively. The respective RIV for weed species which also exhibited dominance in the 2010 late and 2011 early wet seasons in the cassava monoculture field were 15.58, and 19.39% for *B. jubata*, 8.47 and 10.00% for *C. rotundus*, 6.31and 7.37% for *D. aegyptium*, 5.81 and 7.50% for *I. cylindrica*, 5.32 and 5.13% for *P. obiculare*, 6.80 and 8.50% for *P. amarus* as well as 10.27 and 10.02% for *S. anthelmia*. Futhermore, in addition to those indicated

Table 1. Weed species found in cassava/maize intercrop and cassava monoculture during 2010 late wet and 2011 early wet seasons at FUNAAB, Abeokuta, Nigeria. AF, annual forb; AG, annual grass; PF, perennial forb; PG, perennial grass; PS, perennial sedge

Weed species	Growth form	Family
Acroceras zizanioides (Kunth) Dandy	PG	Poaceae
Ageratum conyzoides L.	AF	Asteraceae
Aspilia africana (Pers.) C.D. Adams	AF	Asteraceae
Aspilia latifolia Oliv. & Hiern	AF	Asteraceae
Boerhavia diffusa L.	AF	Nyctaginaceae
Brachiaria arrecta (Hack. ex T. Durand & Schinz) Stent	AF	Poaceae
Brachiaria jubata Staph	PG	Poaceae
Centrosema pubescens Benth.	PF	Fabaceae
Chromolaena odorata (L.) R. M. King & H. Rob.	PF	Asteraceae
Commelina diffusa Burm. f.	AF	Commelinaceae
Commelina erecta L.	AF	Commelinaceae
Cyperus rotundus L.	PS	Cyperaceae
Dactyloctenium aegyptium (L.) Willd.	AG	Poaceae
Digitaria longiflora (Retz.) Pers.	AG	Poaceae
Euphorbia heterophylla L.	AF	Euphorbiaceae
Imperata cylindrica (L.) Raeusch.	PG	Poaceae
Leptochloa caerulescens Steud.	AG	Poaceae
Mariscus alternifolius Vahl	PS	Cyperaceae
Oldenlandia corymbosa L.	AF	Rubiaceae
Oplismenus burmannii (Retz.) P. Beauv.	AG	Poaceae
Panicum maximum Jacq.	PG	Poaceae
Panicum repens L.	PG	Poaceae
Paspalum conjugatum P.J. Bergius	AG	Poaceae
Paspalum orbiculare G. Forst.	AG	Poaceae
Passiflora foetida L.	AF	Passofloideae
Pennisetum pedicellatum Trin.	AG	Poaceae
Phyllanthus amarus Schumach. & Thonn	AF	Euphorbiaceae
Portulaca oleracea L.	AF	Portulacaceae
Rhynchelytrum repens (Willd.) C.E. Hubb.	AG	Poaceae
Spigelia anthelmia L.	AF	Logainaceae
Synedrella nodiflora (L.) Gaertn.	AF	Asteraceae
Tridax procumbens L.	AF	Asteraceae
Urena lobata L.	PF	Malvaceae

inter alia, *D. longiflora, M. alternifolius* and *P. foetida* had high RIV in the cassava field during the late wet season of 2010 (Table 2). Across the seasons, the number of dominant weeds was comparatively higher in the late wet season in both fields than in the early wet season.

Discussion

Although the two locations were infested with forbs, grasses and sedges in both seasons, more grass weeds were associated with cassava/maize intercrop in both seasons compared to cassava monoculture. The reduction in weed species abundance in the cassava-maize intercrop was probably due to shade, as earlier reported by Chee et al. (1991) and Akobundu (1987), weed control methods and changes in season (Subramania 1991).

Similarly, the cassava/maize intercrop showed higher species richness than the cassava monoculture. This was more obvious in the late wet season than in the early wet season. The piece of land used for the survey had previously been under continuous cropping, and this might have affected the species composition over the years. The composition and abundance of weed species in a crop have earlier been attributed to history of previous crops, cropping systems and cultural practices (Thomas 1985). Conversely, the low species richness observed in the cassava monoculture field during the survey in the early wet season of 2011 might be as a result of dormancy exhibited by some weed seeds, while changes in flora abundance in the intercrop was probably due to seasonal dispersal of weeds

Table 2. Relative freqyency, relative density and relative importance value of weed species found in cassava/maize intercrop (C/M) and cassava monoculture (C) during 2010 late wet season and 2011 early wet season in FUNAAB, Abeokuta, Nigeria

Species	Relative frequency (%)				Relative density (%)				Relative importance value (%)			
	Late wet season		Early wet season		Late wet season		Early wet season		Late wet season		Early wet season	
	C/M	C	C/M	C	C/M	C	C/M	C	C/M	C	C/M	C
Acroceras zizanioides	0.81	–	–	–	1.96	–	–	–	1.39	–	–	–
Ageratum conyzoides	0.41	1.98	–	–	1.96	3.33	–	–	1.39	2.66	–	–
Aspilia africana	4.05	1.98	1.89	–	3.92	3.33	6.12	–	9.79	2.66	4.01	
Aspilia latifolia	1.22	–	–	–	7.84	–	–	–	2.57	–	–	–
Boerhavia diffusa	–	2.97	–	–	–	3.33	–	–	–	3.15	–	–
Brachiaria arrecta	–	2.97	–	–	–	3.33	–	–	–	3.15	–	–
Brachiaria jubata	7.69	17.82	4.72	26.28	5.88	13.33	4.08	12.50	6.79	15.58	4.40	19.39
Centrosema pubescens	1.62	–	3.77	–	3.92	–	2.04	–	2.77	–	2.91	–
Chromolaena odorata	0.41	–	–	–	1.96	–	–	–	1.19	–	–	–
Commelina diffusa	2.43		7.55	–	5.88	–	6.12	–	4.16	–	6.84	–
Commelina erecta	–	0.99	–	–	–	3.33	–	–	–	2.16	–	–
Cyperus rotundus	40.08	6.93	23.11	7.79	19.61	10.00	16.33	12.50	29.85	8.47	19.7	10.10
Dactyloctenium aegyptium	2.83	5.94	1.89	6.41	1.96	6.67	2.04	8.33	2.40	6.31	1.96	7.37
Digitaria longiflora	4.45	6.93	3.30	–	3.92	6.67	2.04	–	4.19	6.80	2.67	–
Euphorbia heterophylla	0.41	–	2.36	–	1.96	–	2.04	–	1.19	–	2.20	–
Imperata cylindrica	6.48	4.95	3.30	5.77	3.92	6.67	6.12	8.33	5.20	5.81	4.71	7.50
Leptochloa caerulescens	11.74	–	–	–	7.84	–	–	–	9.79	–	–	–
Mariscus alternifolius	1.22	8.91	10.38	–	5.88	3.33	2.04	–	3.55	6.12	6.21	–
Oldenlandia corymbosa	–	0.99	–	–	–	3.33	–	–	–	2.16	–	–
Oplismenus burmannii	–	–	–	3.21	–	–	–	4.17	–	–	–	3.69
Panicum maximum	–	–	7.55	–	–	–	8.16	–	–	–	7.86	–
Panicum repens	–	–	0.47	–	–	–	2.04	–	–	–	1.26	–
Paspalum conjugatum	–	–	0.94	–	–	–	2.04	–	–	–	1.49	–
Paspalum orbiculare	–	3.96	4.72	1.92	–	6.67	8.16	8.33	–	5.32	6.44	5.13
Passiflora foetida	–	4.95	–	–	–	6.67	–	–	–	5.81	–	–
Pennisetum pedicellatum	0.81	–	––	–	1.96	–	–	–	1.39	–	–	–
Phyllanthus amarus	7.29	6.93	3.77	4.47	9.80	6.67	10.20	12.50	8.55	6.80	6.90	8.50
Portulaca oleracea	3.64	3.96	–	–	1.96	3.33	–	–	2.80	3.65	–	–
Rhynchelytrum repens	–	–	–	0.64	–	–	–	4.17	–	–	–	2.41
Spigelia anthelmia	0.81	13.86	6.60	11.54	3.92	6.67	8.16	12.50	2.37	10.27	7.38	10.02
Synedrella nodiflora	–	–	1.87	–	–		2.04	–	–	–	1.97	–
Tridax procumbens	–	1.98	11.79	33.33	–	3.33	10.2	20.83	–	2.66	11.00	27.08
Urena lobata	0.81	–	–	–	3.92	–	–	–	2.37	–	–	–

in time and favourable conditions for weed emergence provided by the rainy season, as earlier reported by Olaoye (1997). The consistent occurrence of *B. jubata, C rotundus, D. aegyptium, I. cylindrica, P. amarus* and *S. anthelmia* in the cassava/maize intercrop and cassava monoculture fields in both seasons suggests their ability to adapt to a wide range of climatic conditions and this implies higher infestations on the crops. Their reproductive ability is likely enhanced by perennating organs and high prolificity, and the ability to make use of the available resources for survival in both seasons. An earlier study by Melifonwu (1994) listed *Imperata cylindrica* and *C. rotundus* as problem weeds in cassava, and their densities under cassava/maize intercrop can only be reduced if weed control methods are employed within the first eight weeks after planting, while cassava monoculture will require a weed free environment for the first 12 weeks after planting. In this study, *C. rotundus* was found to be dominant in cassava/maize intercrop in both seasons and this, according to Swarbrick (1997) might be due to its ability to grow in almost every soil type over a range of soil moisture, pH and elevation. It has been reported as a major agricultural weed, which grows best in

moist fertile soils, and its growth has also been suggested to be encouraged by frequent cultivation. The incidence of this weed can be controlled through proper planting densities of cassava/maize intercrop providing sufficient canopy to shade the weed, as it is less tolerant to shade. Increase in species diversity and low relative density was observed in cassava/maize intercrop and cassava monoculture in the late wet season compared to that in the early wet season. Similarly, the low relative frequency values observed in this study could be due to the sharing of resource space to minimize interactions among the species as earlier reported by Tsingala (1990). This could further be due to many different species encountered with few individuals represented by each weed species.

In conclusion, a relatively large number of weed species were found during the survey, with few individuals of each species across the seasons in both locations. Forb weeds infested the crops more than grasses and sedges, while *Cyperus rotundus* was found to be the most abundant and most dominant among the weed species found. *Cyperus rotundus* is less tolerant to shade, therefore proper planting densities of cassava and maize as an intercrop may be adequate to reduce the incidence of the weed.

References

Akobundu I.O. 1987. *Weed Science in the Tropics: Principles and Practices.* John Wiley & Sons, Chichester.

Akobundu I.O., Agyakwa C.W. 1987. *A Handbook of West African Weeds.* International Institute of Tropical Agriculture, Ibadan, Nigeria.

Chee Y. K., Lee S.A., Ahmed A.I., Teo L., Chung G.F., Khairudin H. 1991. Crop loss by weeds in Malaysia. In Lee S.A., Kon K.F. (eds) Proceedings of the 3rd Tropical Weed Science Conference. Malaysian Plant Protection Society, Kuala Lumpur. pp. 1–21.

Das T.K. 2011. *Weed Science: Basics and Applications.* Shri Sunil Kumar Jain Brothers, New Delhi.

Eskandari H., Ghanbari A. 2009. Intercropping of maize and cowpea as whole-crop forage: effect of different planting pattern on total dry matter production and maize forage quality. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* 37: 152–155.

Eskandari H., Kazemi K. 2011. Weed control in maize-cowpea intercropping system related to environmental resources consumption. *Notulae Scientia Biologicae* 3: 57-60.

Kadziuliene Z., Sarunaite L. Dereikyte I., Maiksteniene S., Arlauskiene A., Masilionyt L., Cenuleviciene R., Zekaite V. 2009. Qualitative effects of pea and spring cereals intercrop in the organic farming systems. *Agron. Res.* 7: 606–611.

Karaye A.K., Yakubu A.I., Aliyu M. 2007. Checklist of weeds in irrigated garlic (*Allium sativum*) and onion (*Allium cepa*) in Sokoto River Valley. *J. Weed Sci.* 20: 53–57.

Liebman M., Dyck E. 1993. Crop rotation and intercropping strategies for weed management. *J. Appl. Ecol.* 3: 92–122.

Mashingaizde A.B., Nyakanda C., Chivinge O.A., Washaireni A.M., Dube K.W. 2000. Influence of a maize pumpkin live much on weed dynamics and maize yield. *African Plant Protect.* 6: 57–63.

Mashingaizde A.B. 2004. Improving weed management and crop productivity in maize systems in Zimbabwe. Ph.D thesis. Wageningen University, Wageningen, Netherlands.

Melifonwu A.A. 1994. Weeds and their control in cassava. *African Crop Sci. J.* 2: 519–530.

Nangju D. 1980. Soybean response to indigenous *Rhizobia* as influenced by cultivar origin. *Agron. J.* 72: 403-406.

Olaoye S.O.A. 1997. The effect of slashing on the performance of Eupatorium ododratum in Nigeria. Proceedings of 7th Nigerian Weed Science Conferences (Abuja, Nigeria, 5–8 March 1997). S.M. Publishers, Abuja, pp. 23–28.

Oleszek K. 1994. Brassicacea as alternative plants for weed control in sustainable agiculture. *Fragm. Agron.* 4: 5–15.

Olorunmaiye K. S., Olorunmaiye P. M. 2008. Influence of weed control methods on weed flora of a cowpea plot in an ecological zone of southern Guinea savanna of Nigeria. *Biol. Environ. Sci. J. Tropics* 5: 146–150.

Olorunmaiye P.M., Egbenrongbe K.R., Adeoye P.O., Alamu O.O., Taiwo S. 2011. Weed species composition of citrus-based cropping systems at National Horticultural Research Institute Ibadan, Nigeria. *Agric. Biol. J. North Amer.* 2: 529–537.

Poggio S.L. 2005. Structure of weed communities occurring in monoculture and intercropping of field pea and barley. *J. Agric. Ecosyst. Environ.* 109: 48–58.

Remison S.V. 1978. Performance of cowpea *Vigna unguiculata* (L.) (Walp) as influenced by weed competition. *J. Agric. Sci.* 90: 523–530.

Smith M.A, Akinde A.A. 2000. Comparative weed succession in uncropped and cropped land in a tropical rain forest zone. *African J. Environ. Studies* 1: 104–114.

Subramania S. 1991. *All About Weed Control.* Kallyani Publisher, New Delhi.

Swarbrick J.T. 1997. *Environmental Weeds and Exotic Plants on Christmas Island, Indian Ocean: a Report to Parks Australia.* Weed Science Consultancy, 131 p.

Thomas A.G. 1985. Weed survey system used in Saskatchewan for cereal and oil crops. *Weed Sci.* 33: 34–43.

Tsingalia M.T., 1990. Habitat disturbances severity and patterns of abundance in Kakamega forest, Western Kenya. *African J. Ecol.* 28: 213–226.

Wanic M., Kostrzewska M., Jastrzebska M. 2004. Role of intercrop sowing in weeds control for spring barley in cereal crops rotation. *Fragm. Agron.* 1: 85–102.

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