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Taxonomic diversity and abundance of weed flora in upland rice fields of Southern Groundnut Basin, Senegal

Samba Laha KA [a,*], Moustapha GUEYE [b], Mame Samba MBAYE [a], Modou NGOM [b], Abdou Aziz CAMARA [a], Moussou Kéba CISSOKHO [a], Rahimi MBALLO [a], Mamadou SIDYBE [a], Ndongo DIOUF [a], Djibril DIOP [a], Jules DIOUF [a], Kandioura NOBA [a]

a Laboratoire de Botanique-Biodiversité, Faculté des Sciences et Techniques, Université Cheikh Anta DIOP, BP:5005 Dakar, Senegal.

b Centre National de Recherches Agronomiques de Bambey, Institut Sénégalais de Recherches Agricoles, B.P.53 Bambey, Diourbel, Senegal.

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ABSTRACT

In Southern Groundnut Basin of Senegal, weed management is one of the biggest challenges for improving upland rice production. This study aimed to evaluate the systematic composition and the infestation of weed species in order to promote a sustainable management in a context of biodiversity decreasing. Thus, phytosociological surveys were carried out during rainy season in upland rice fields. The results revealed that flora consisted of 62 species distributed in 47 genera and 15 families. The families with the highest species richness were Poaceae (24.2%), Fabaceae (12.9%) and Malvaceae (12.9%) which account for half of recorded species. Biological spectrum analysis showed that the flora is largely dominated by therophytes, with 95% of recorded species. Infestation diagram based on weeds abundance and frequency showed eight groups of species reflecting their degree of infestation. Among them, *Digitaria horizontalis*, *Mariscus squarrosus,* and *Spermacoce stachydea* belonged to major weeds and potential general weeds were potentially the most injurious against upland rice because of their high recovery and frequency.

Introduction

In Senegal, rice is one of the most important rainy crops in terms of production mainly in Casamance, the South-Eastern Senegal and Southern Groundnut Basin (FAO, 2013; ANSD, 2014). It's generally practiced by women. In this system, the work is still manual with small areas, without

Corresponding author, email: kasam74@gmail.com (Samba Laha Ka).

inputs and rarely improved variety. The per hectare productivity of the crop is quite low (1.5 to 3 $t.ha^{-1}$) while in Senegal River and Anambé Basin, the irrigated average yield range from 3 to 9 tons per hectare (FAO, 2013). After irregular rainfall and low soil fertility, poor management of weeds was identified as one of the major production constraints in rice production. According to Chauhan and Openña (2012) yield losses in rice due to inadequate weed control can range from 50 to 90%. Weeds compete with crops for nutrients, light and water (Yildirim and Turna, 2016) which are already insufficient. Poverty do not allows farmers to widely using herbicide because of their high cost. Therefore, weed infestation is an important agronomic constraint and successful weed control is essential for improving crop production. Various studies of weed flora have been carried out in some part of Southern Groundnut Basin for groundnut and pearl millet (Noba, 2002); intercropping pearl millet/cowpea (Mbaye, 2013) and maize (Bassène, 2014).

The present study aimed to characterize the weed flora and to found out the most common and covering weed species in rainfed rice fields through the floristic composition and the degree of infestation. This information could be helpful for a better management of weed species in rainfed rice.

Materials and Methods

Senegal is a Sudano-Sahelian country which is located at the extreme west of Africa. This study was carried out in the southern Groundnut Basin. The climate is Sudano-Sahelian with alternating rainy season from late June to early October and a dry season for the rest of the year. Floristic survey was carried out during 2018 rainy season in rice farmer's field. The first inventory was made at 15 days after rice plants emergence and continued subsequently within a periodicity of 15-20 days until harvest. The "field tower" technique, which consists of taking stock of all species in a defined area, has been adopted (Le Bourgeois, 1993). For each survey, all the species found in survey plot were reported and a cover value assigned according to the Braun-Blanquet scale (Le Bourgeois, 1993). Botanical identification was done by analysis of the external morphological characteristics of plant parts and according to literature (Hutchinson et al. 1958; Le Bourgeois and Merlier, 1995). The floristic list with families and species was organized according to the classification system established in the Angiosperm Phylogeny Group III guidelines (APG III, 2009) and African Plant Database. The study of the infestation is carried out by the positioning of the species on a graph (Traoré and Maillet, 1992) where the relative frequency of the species and their recovery are plotted on a curve. It reports the potential injurious of each species.

Results and Discussion

Structure of the flora

The results revealed that flora consisted of 62 species distributed in 47 genera and 15 families (Table 1). The families with the highest species richness were Poaceae (24.2%) followed by Fabaceae (12.9%) and Malvaceae (12.9%) which account for half of recorded species. This finding is in agreement with previous studies conducted in this zone by authors including Noba, (2002); Mbaye, (2013); Bassène (2014) who reported that Poaceae was the most common family in sudano-sahelian zone of Senegal. However, the proportion of Fabaceae was low compared to the southern country. Bassène et al. (2014) and Ka et al (2017) showed that Fabaceae was the dominant family in farmer's field in the southern Senegal where rainfall can reach up 1000 mm per year. Dicotyledons were the most important form and represent the majority of species (59.7%), genera (59.6%) and families (66.7%). The dominance of dicotyledons was also observed in weed survey in Western Senegal (Sarr et al. 2007), Senegal River (Mballo et al. 2018) and Casamance (Bassène et al. 2014; Ka et al. 2017) and is one of the specificity of weed flora under Sudano-Sahelian conditions of West Africa.

Similarity of weed community in upland rice compared to those reported in groundnut (Noba, 2002), pearl millet (Noba et al. 2004) and maize (Bassène, 2014) shows that, there is no specific weed flora for a specific crop except for parasitical plants (Le Bourgeois and Marnotte, 2002). This study indicated that except three geophytes (*Cyperus esculentus*, *Ledebouria sudanica* and *Stylochaeton hypogaeus*) the flora is largely dominated by therophytes, which includes 95% of the recorded species. According to Bourgeois et al. (2019), therophytes were the mostly weeds because of some adaptability among them higher specific leaf area, earlier and longer flowering, sunny and dry environments. Higher number of small sedge (*Cyperus amabilis, Cyperus esculentus, Fimbristylis hispidula, Mariscus squarrosus* and *Kyllinga squamulata*) found in this study is a characteristic of degraded land and showed the effect of rotation with others rainy crop mainly Groundnut and Maize. Except in lowland valley located near the Gambian border, where *Echinochloa colona* was the most infesting species, crop rotation with Groundnut is widely used by farmers in this part of the country.

Table 1. Weed flora recorded in rice crop.

Family	Weed species	C.T.	L.F.	L.M.
AMARANTHACEAE	*Achyranthes aspera* L.	D	T	Broad-leaf
	Amaranthus Graecizans L.	D	T	Broad-leaf
	Amaranthus spinosus L.	D	T	Broad-leaf
	Celosia trigyna L.	D	T	Broad-leaf
ARACEAE	*Stylochaeton lancifolius* Kotschy & Peyr.	M	G	Broad-leaf
ASPARAGACEAE	*Ledebouria sudanica* (A. Chev.) Burg	M	G	Broad-leaf
ASTERACEAE	*Acanthospermum hispidium* DC.	D	T	Broad-leaf
	Blainvillea gayana Cass.	D	T	Broad-leaf
COMMELINACEAE	*Commelina benghalensis* L.	M	T	Broad-leaf
	Commelina gambiae (C.B. Clarke)	M	T	Broad-leaf
CONVOLVULACEAE	*Ipomoea eriocarpa* R. Br.	D	T	Broad-leaf
	Ipomoea pes-tigridis L.	D	T	Broad-leaf
	Ipomoea vagans Bak.	D	T	Broad-leaf
	Jacquemonthia tamnifolia (L.) Griseb.	D	T	Broad-leaf
	Merremia aegyptia (L.) Urb.	D	T	Broad-leaf
	Merremia pinnata (Hochst.) Hallier.	D	T	Broad-leaf
CUCURBITACEAE	*Citrullus lanatus* (Thunb.) Mansf.	D	T	Broad-leaf
	Cucumis melo L.	D	T	Broad-leaf
	Cucumis maderaspatanus L.	D	T	Broad-leaf
CYPERACEAE	*Cyperus amabilis* Vahl.	M	T	Sedge
	Cyperus esculentus L.	M	G	Sedge
	Fimbristylis hispidula (Vahl) Kunth	M	T	Sedge
	Kyllinga squamulata Thon.et Vahl.	M	T	Sedge
	Mariscus squarrosus (L.) C.B. Clarke	M	T	Sedge
	Pycreus flavescens (L.) P. Beauv. ex Rchb.	M	T	Sedge
EUPHORBIACEAE	*Chrozophora senegalensis* (Lam.) A. Juss.	D	T	Broad-leaf
FABACEAE	*Alysicarpus ovalifolius* (Schumach.) Léonard	D	T	Broad-leaf
	Crotalaria goreensis Guill.et Perr.	D	T	Broad-leaf
	Crotalaria retusa L.	D	T	Broad-leaf
	Indigofera hirsuta L.	D	T	Broad-leaf
	Senna obtusifolia L.	D	T	Broad-leaf
	Sesbania pachycarpa DC.	D	T	Broad-leaf
	Stylosanthes fruticosa (Retz.)Alston	D	T	Broad-leaf
	Tephrosia pedicellata Back.	D	T	Broad-leaf
MALVACEAE	*Corchorus aestuans* L.	D	T	Broad-leaf
	Corchorus olitorius L.	D	T	Broad-leaf

Family	Weed species	C.T.	L.F.	L.M.
	Corchorus tridens L.	D	T	Broad-leaf
	Hibiscus cannabinus Hook. F.	D	T	Broad-leaf
	Sida rhombifolia L.	D	T	Broad-leaf
	Sida urens L.	D	T	Broad-leaf
	Triumfetta pentandra A. Rich.	D	T	Broad-leaf
	Urena lobata L.	D	T	Broad-leaf
NYCTAGINACEAE	*Boerhavia diffusa* L.	D	T	Broad-leaf
ONAGRACEAE	*Ludwigia hyssopifolia* (G. Don) Exell	D	T	Broad-leaf
POACEAE	*Brachiaria lata* (Schumach.) Hubb.	M	T	Grass
	Brachiaria stigmatisata Stapf.	M	T	Grass
	Brachiaria villosa (Lam.) A. Camus	M	T	Grass
	Cenchrus biflorus Roxb.	M	T	Grass
	Cenchrus pedicellatus (Trin.) Morrone	M	T	Grass
	Chloris pilosa Schum. &Thonn	M	T	Grass
	Dactyloctenium aegyptium (L.) Willd.	M	T	Grass
	Digitaria horizontalis Willd.	M	T	Grass
	Echinochloa colona (L.) Link	M	T	Grass
	Eleusine indica (L.) Gaertn.	M	T	Grass
	Eragrostis atrovirens (Desf.) Trin ex Steud.	M	T	Grass
	Eragrostis ciliaris (L.) R. Br.	M	T	Grass
	Eragrostis tremula Steud.	M	T	Grass
	Paspalum scrobiculatum L.	M	T	Grass
	Setaria pumila (Poir.) Roem. &Schult.	M	T	Grass
RUBIACEAE	*Mitracarpus villosus* (Sw.) DC.	D	T	Broad-leaf
	Spermacoce stachydea (DC.) Hutch. & Dalz.	D	T	Broad-leaf
	Oldenlandia corymbosa L.	D	T	Broad-leaf

C.T.= cotyledon type; D= dicotyledons; G=geophyte; L.F. =life forms; L.M.= leaf morphology; M=monocotyledons; T= therophyte.

Degree of infestation

The pattern of infestation based on the abundance-dominance mean and frequency showed 8 groups of species reflecting their potential of infestation (Figure 1 and Table 2). Major weeds (G1), potential general weeds (G2) and general weeds (G3) which include seven species are the most common weeds in rainfed rice fields. Among them *Digitaria horizontalis*, are potentially the most injurious. This species are the most dominant (AD mean > 1.25) and encountered (90% of survey plot). Success of *Digitaria horizontalis* is related to their adaptation on farmer's field and ecological conditions. It produces an important number of seed, have an early emergence and short cycle (Le Bourgeois and Marnotte, 2002).

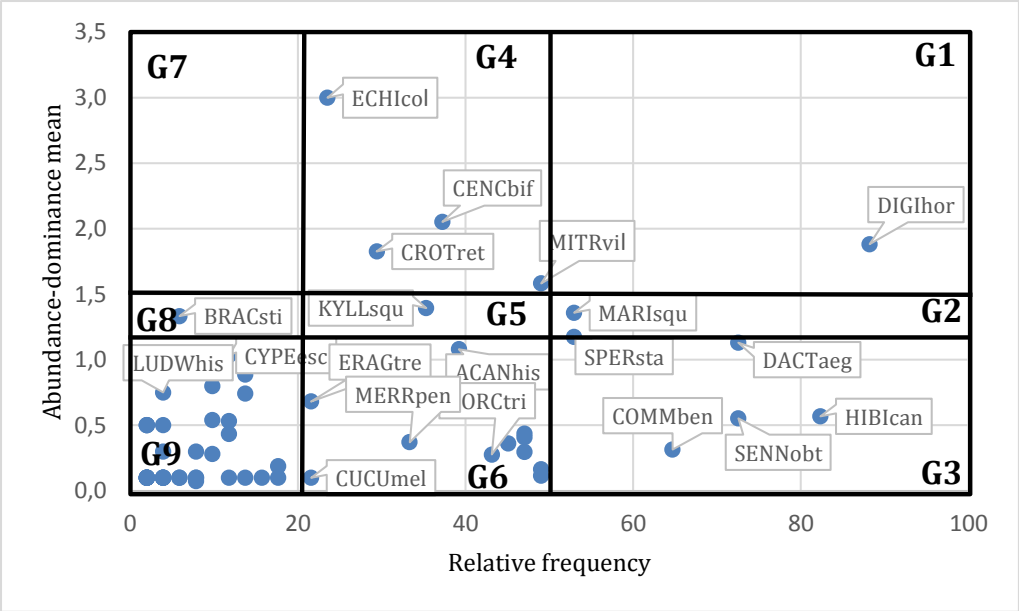

Figure 1. Diagram of Infestation (Letters represent the names of the species (in capital letters, first four letters of the genius and in lower case, first three letters of the epithets of species)).

Table 2. Distribution of weeds according to their degree of infestation.

GROUP	WEED SPECIES	AF	RF	AD mean
Group 1 Major weeds	*Digitaria horizontalis*	45	88	1.9
Group 2 Potential general weeds	*Mariscus squarrosus*	27	53	1.4
	Spermacoce stachydea	27	53	1.2
Group 3 General weeds	*Dactyloctenium aegyptium*	37	73	1.1
	Hibiscus cannabinus	42	82	0.6
	Senna obtusifolia	37	73	0.6
	Commelina benghalensis	33	65	0.3
Group 4 Potential regional weeds	*Echinochloa colona*	12	24	3.0
	Cenchrus biflorus	19	37	2.1
	Crotalaria retusa	15	27	1.8
Group 5 Regionals weeds	*Kyllinga squamulata*	18	35	1.4
Group 6 Major local weeds	*Acanthospermum hispidium*	20	39	1.1
	Corchorus tridens	22	43	0.3
	Eragrostis tremula	11	22	0.7
Group 8 Potential local weeds	*Brachiaria stigmatisata*	3	6	1.3
Group 9 Minor weeds	*Cyperus esculentus*	6	12	1.0
	Ludwigia hyssopifolia	2	4	0.8
	Commelina diffusa	4	8	0.1

AF=absolute frequency, AD= abundance-dominance, RF= relative frequency

Besides, the species can be propagated by cuttings from the fragments of the stems that are rooted at the nodes. The general potential weeds (G2) is formed by ubiquitous species (*Mariscus squarrosus* and *Spermacoce stachydea*) that are common in rice field (> 50%) however, their recovery is low or localized when it is important. The group of general weeds is formed by regular species but with low recovery. A total of four species (*Dactyloctenium aegyptium*, *Commelina benghalensis*, *Senna obtusifolia,* and *Hibiscus cannabinus*) is recorded in this group. However, majority of species (40 species, 64.5% of flora) belong to minor weeds (G9) and are not currently a big constraint.

Conclusion

The purpose of this work was to characterize the weed flora of upland rice in Southern Groundnut Basin by assessing the floristic composition and the degree of infestation. The results revealed that flora consisted of 62 species distributed in 47 genera and 15 families. The most represented families were Poaceae (24.2%), Fabaceae (12.9%) and Malvaceae (12.9) with half of recorded species. This study also showed that weedy upland rice flora is dominated by 3 groups of species namely general major weeds, general potential weeds and general weeds. Thus, 7 species form the pool of the most infesting weed species in upland rice crops among which, *Digitaria horizontalis*, *Mariscus squarrosus* and *Spermacoce stachydea* were potentially the most harmful. Knowing these target species is essential before elaboration of any integrated weed management (IWM) strategies for increasing upland rice yield under Sudano-Sahelian conditions of Southern Groundnut Basin.

Conflicts of Interest

No conflicts of interest have been declared.

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