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Systematic composition, life forms and chorology of fallow lands in Eastern Senegal and Casamance, Senegal

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ABSTRACT

Fallow plays an important role in weed flora management and soil fertility restoration. The aim of this study was to determine the structure of flora through systematic composition, life forms and chorology distribution. Thus, phytosociological surveys were carried out during 2015 and 2016 crop years on station in Eastern Senegal, Upper Casamance and Middle Casamance. The results revealed that flora consisted of 109 species distributed in 64 genera and 19 families. Dicotyledon was the most important form. Indeed, it represented 69% of the species, 69% of the genera and 79% of the families. This flora was more diverse in Kolda where it was composed of 91 species, distributed in 57 genera and 15 families. In Sefa, the flora contained 52 species, 38 genera and 11 families while in Sinthiou Maleme, the flora is rich of 43 species, 31 genera and 9 families. The overall analysis of the biological spectrum showed a large dominance of therophytes (78.9%) followed by phanerophytes (9.2%) and hemicryptophytes (6.4%). The biogeographical distribution of the species revealed that african species (49 species) were the most important and followed by pantropical species (29 species). The present study allowed pointing out the flora of fallow lands in Eastern Senegal and Casamance which is essential before elaboration of any management plan for improving crop production.

Keywords: Fallow, weed flora, systematic composition, Senegal.

INTRODUCTION

In Senegal, agriculture sector involves 50 to 60% of the active population and contributes to 10-15% of the Gross Domestic Product (GDP) (ANSD, 2014). It is largely dominated by small farms, and constitutes the most activities in rural area. More than 8 out of 10 agricultural households practice family farming (FAO, 2007; ANSD, 2014; Guèye, 2016). The most important crops in terms of

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area harvested and production are pearl millet, groundnut, cowpea, maize, rice and sorghum (ANSD, 2014). Despite its importance, agricultural production covers approximately half of the national food needs (PNIA, 2008). Expect irregular rainfall, this low production is mainly due to weed pressure and low soil fertility (Noba, 2002; Mbaye, 2014). Low soil fertility constitutes a major constraint on agriculture and grass cover causes up to 30% of production losses (N'Goran and Kanga 2002; Le Bourgeois and Marnotte, 2002). Thus, weed management and soil fertility restoration are major problems for farmers. It requires sustained weeding and clearing of new land, as poverty levels do not permit large-scale use of chemical herbicides and fertilizers because of their high cost (Mbaye, 2013). In this context, it becomes necessary to promote sustainable and accessible farming systems such as fallows. Indeed, fallows land play a major role in restoring soil fertility and controlling crop weeds (Akpo et al., 2000).

In Senegal, a lot of botanical studies have been carried out on the floristic composition of fallows and majority of them was conducted in a farmers' field. Further, none of them focused on floristic composition and its geographical distribution. The objective of this study was to characterize the flora present in these fallows and indicate the life forms and the geographical distribution of the species.

MATERIALS AND METHODS

Materials

Senegal is a sahelian country which is located at the extreme west of Africa. The country is divided into six agro-ecological zones. This study was carried out in three research stations, Sinthiou Maleme, Kolda and Sefa (Figure 1).

Station of Sefa

Created in 1949, the station of Sefa (12 ° 47'N, 15 ° 32 'W) is located in Southern Senegal (District of Sedhiou, Middle Casamance). Climate is Sudanian with a rainy season (June to October) and a dry season (November to May). Over the period 1981-2010, the annual rainfall is 1034 mm in the town of Sedhiou. Cumulative rainfall in 2015 is 1201.2 mm in 70 rainy days, 981.8 mm in 34 rainy days in 2016. Soils are sandy, acidic and of low natural fertility.

Station of Sinthiou Maleme

Sinthiou Maleme (13 ° 49'N, 13 ° 55 'W) is situated in the region of Tambacounda, in the north of Eastern Senegal and is opening since 1937. Climate is Sudano-Sahelian with a rainy season (mid-July to late September or mid-October). Over the period 1981-2010, the annual rainfall is 685 mm. Cumulative rainfall is 567.5 mm in 43 rainy days in 2015, 548 mm in 43 rainy days in 2016. Soils are sandy texture.

Station of Kolda

Open more recently (1979), the center of Kolda (12 ° 53 'N, 14 ° 57'W) is located in the district that carries the same name in Upper Casamance. The climate is Sudano-Sahelian with alternating rainy season from June to October and a dry season for the rest of the year. Over the period 1981-2010, the annual rainfall is 959.3 mm. Cumulative rainfall is 1070 mm in 60 rainy days in 2015 and 1192 mm in 54 rainy days in 2016. Soil texture varies from sandy-clay to clay.

Methods

Phytosociological survey was carried out in a semi-controlled environment in the three locations. The first inventory was done 15 days after the first rainfall and continued subsequently within a periodicity of 20 days until harvest. The "field tower" technique, which consists of taking stock of all species in a defined area, has been adopted (Noba, 2002; Noba et al., 2004; Le Bourgeois, 2005). The main plot has an area of 2739 m^2 and was subdivided into nine subplots of 60 m^2. A Total of 79 floristic surveys were conducted during 2015 and 2016 crop years. For each survey, all the species found in survey plot were reported and a cover value assigned for each species according to the Braun-Blanquet scale (1952). Identification of species was carried out using different floras (Hutchinson et al., 1958, Berhaut, 1967, 1971-1991; Merlier and Montegut, 1982; Le Bourgeois and Merlier, 1995). For unknown species, we

produced the herbarium. We also used Lebrun and Stork (1991-1997) for the botanical classification in agreement with the APGIII classification. For the biological spectrum, Raunkier's classification (1934) adapted to the tropical zone where the unfavorable season corresponds to the dry season, was used (Trochain, 1966; Lebrun, 1966). This classification distinguishes 6 biological forms (Table 1). To elaborate chorological spectrum, species were classified according to their geographical origin (Hutchinson & Dalziel, 1972; Berhaut, 1971-1991). The following species have been identified by this classification: african species (Af), african-american species (Am), afro-american and asian species (Am As), afro-asian species (As) asian and australian species (Asu), afro-malagasy species (M), afro-malagasy and asian apecies (Mas), afro-asian-american and australian species (Masue) and pantropical species (Pt).

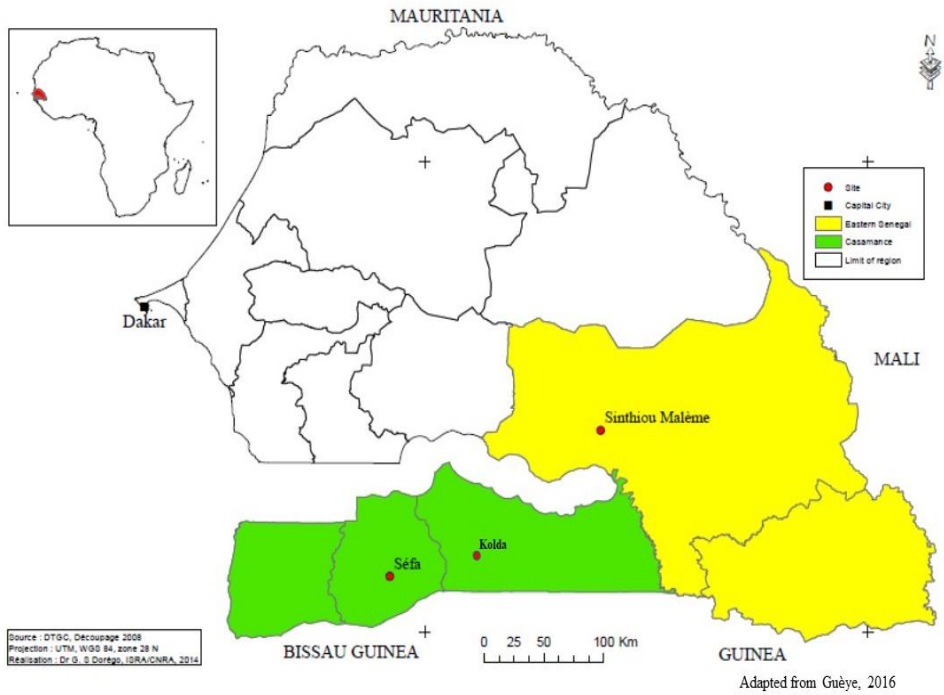

Figure 1: Geographical distribution of study area.

Table 1: Biological types.

Life forms	Code	Signification
Phanerophytes	P	Woody plant that the renewal bud above 50 cm from soil surface.
Chamephytes	C	Woody plant or suffrutescent perennial that the renewal bud situated at 50 cm above of the soil.
Hemicryptophytes	H	Perennial plant that the renewal bud is at the soil surface.
Geophytes	G	Plant that the renewal bud is buried within the soil.
Therophytes	T	Annual plants that form their spores or seeds within only one period of life.
Parasitical plants	Par	Annual or perennial plant that derives some or all of its nutritional requirements from another.

RESULTS

Taxonomic spectrum

The floristic inventory across the three agro-ecological zones was composed of 109 species which belong to 64 genera and 19 families (Table 2) Dicotyledons form was the most important. It represented the majority of species (68.8%), genera (68.7%) and families (78.9%). This flora was more diverse in Kolda compared with Sinthiou Maleme and Sefa. In Sefa, the flora contained 52 species, 38 genera and 11 families while in Sinthiou Maleme 43 species, 31 genera and 9 families were reported. Dominance of dicotyledons is more significant at Kolda (71. 4%) than Sinthiou Maleme (69.8%) and Sefa (68.8%) (Table 3).

Families repartition

Across the locations, flora was dominated by Fabaceae (30.3%) and Poaceae (17.4%) families (

Table ***4***). They were followed by Malvaceae (11,0%), Cyperaceae (9.2%), Rubiaceae (6.4%) and Convolvulaceae (6.4%). At Kolda, Flora was dominated by 3 families which together account for 60.3% of the listed species. These include Fabaceae (31.9%), Poaceae (17.6%) and Malvaceae (10.9%). The presence of Convolvulaceae (7.7%), Cyperaceae (7.7%) and Rubiaceae (6.59%) were also noted. Sefa flora is dominated by Fabaceae (26.9%), Poaceae (21.2%), Cyperaceae (15.4%), Malvaceae (9.6%) and Convolvulaceae (9.6%) which include 82.7% of species. At Sinthiou Maleme, 83.7% of recorded species was distributed between Fabaceae (27.9%), Poaceae (20.9%), Malvaceae (13.9%), Rubiaceae (11.6%) and Convolvulaceae (9.3%) families. Furthermore, Kolda had the most diverse flora with 91 species, followed by Sefa (52 species) and at least Sinthiou Maleme (43 species).

Biological spectrum

The overall analysis of the biological spectrum showed a large dominance of therophytes (78.9%) followed by phanerophytes (9.2%) and hemicryptophytes (6.4%) (Figure **2**). This dominance of therophytes is more important at Sinthiou Maleme (88.4%) compared with Sefa (80.8%) and Kolda (78%). Other life forms such as chamephytes, geophytes and parasitical plants were less represented. The parasitic plants were absent in Sefa and Sinthiou Maleme.

Chorological spectrum

The chorological spectrum of the recorded species showed that african species constituted 27% (49 species) of the total flora (Figure 3**).** They are followed by pantropical species (29 species). Furthemore, afro-asian and australian species (6,4%), afro-asian species (5,5%), afro-malagasy and asian species (4,6%) were well represented. Other phytogeographical types such as cosmopolites, afro-american species were less represented. The dominance of african species was more pronounced in Kolda with 46.2% of the total species recorded compared with Sefa (35%) and Sinthiou Maleme (33%).

Table 2: List of weeds recorded in the fallow plots.

Species names	Families	Cotyledon Type	Life forms	Chorotype	Station		
					KD	SM	SF
Achyranthes aspera L.	Amaranthaceae	D	T	Cosm	+	-	-
Celosia trigyna L.	Amaranthaceae	D	T	As	+	-	-
Leptadenia hastata (Pers.) Decne.	Apocynaceae	D	T	Af	+	-	-
Stylochaeton hypogaeus Lepr.	Araceae	M	G	Af	+	-	-
Blainvillea gayana Cass.	Asteraceae	D	T	Af	-	+	-
Combretum apiculatum Sond	Combretaceae	D	P	Af	+	-	-
Combretum collinum subsp. geitonophyllum (Diels) Okafor	Combretaceae	D	P	Af	+	-	-
Guiera senegalensis J.F. Gmel.	Combretaceae	D	P	Af	+	-	-
Terminalia macroptera G. et Perr.	Combretaceae	D	P	Af	+	-	-
Commelina benghalensis L.	Commelinaceae	M	T	As	+	+	+
Commelina forskaolii Vahl.	Commelinaceae	M	T	Mas	-	+	-
Commelina gambiae (C.B. Clarke)	Commelinaceae	M	T	Mas	+	-	+
Ipomoea eriocarpa R. Br.	Convolvulaceae	D	T	Masu	+	+	+
Ipomoea heterotricha F. Didr	Convolvulaceae	D	T	Asu	+	-	+
Ipomoea ochracea (Lindl.) G. Don	Convolvulaceae	D	T	Af	+	-	-
Ipomoea vagans Bak.	Convolvulaceae	D	T	Af	+	+	+
Jacquemonthia tamnifolia (L.) Griseb.	Convolvulaceae	D	T	Am	+	+	+
Merremia aegyptiaca (L.) Urban.	Convolvulaceae	D	T	Af	+	-	-
Merremia pinnata (Hochst.) Hallier.	Convolvulaceae	D	T	Af	+	+	+
Citrullus lanatus (Thunb.) Mansf.	Cucurbitaceae	D	T	Cosm	-	+	+
Cucumis melo L.	Cucurbitaceae	D	T	As	-	+	+
Bulbostylis barbata (Rottb.) CB Clarke	Cyperaceae	M	T	Pt	+	-	-
Cyperus amabilis Vahl.	Cyperaceae	M	T	Pt	+	-	+
Cyperus cuspidatus Kunth.	Cyperaceae	M	H	Pt	+		+
Cyperus esculentus L.	Cyperaceae	M	G	Cosm	-	-	+
Cyperus sphacelatus	Cyperaceae	M	T	Pt	+	-	-

Rottb.							
Fimbristylis hispidula (Vahl) Kunth	Cyperaceae (	M	T	Af	-	+	+
Kyllinga squamulata Thon.et Vahl.	Cyperaceae	M	T	Am As	+	+	+
Mariscus cylindristachyus Steud.	Cyperaceae	M	T	Pt	+		+
Mariscus squarrosus (L.) C.B.Clarke	Cyperaceae	M	T	Pt	+	-	+
Pycreus flavescens (L.) P. Beauv. ex Rchb.	Cyperaceae	M	T	Pt	-	-	+
Chrozophora senegalensis (Lam.) A. Juss.	Euphorbiaceae	D	T	Af	-	-	+
Aeschynomene indica L.	Fabaceae	D	T	Pt	+	-	-
Alysicarpus ovalifolius (Schumach.) Léonard	Fabaceae	D	T	Pt	+	+	+
Cassia absus L.	Fabaceae	D	T	Af	+	-	-
Cassia sieberiana DC.	Fabaceae	D	P	Af	+	-	-
Chamaecrista mimosoides (L.) Greene	Fabaceae	D	C	Af	+	-	+
Chamaecrista nigricans (Vahl) Greene	Fabaceae	D	T	Af	+	-	+
Crotalaria comosa Baker	Fabaceae	D	T	Af	+	-	-
Crotalaria deightonii Hepper	Fabaceae	D	T	Pt	+	+	-
Crotalaria goreensis Guill.et Perr.	Fabaceae	D	T	Af	+	+	+
Crotalaria retusa L.	Fabaceae	D	T	Pt	+	+	+
Desmodium hirtum Guill. & Perr.	Fabaceae	D	T	Af	+	-	-
Desmodium setigerum (E. Mey.) Benth. ex Harv.	Fabaceae	D	H	Af	-	-	+
Dicrostachys cinerea (L.) Wight et Am.	Fabaceae	D	P	Af	+	-	-
Indigofera arrecta A. Rich.	Fabaceae	D	T	Asu	+	-	+
Indigofera dendroides Jacq.	Fabaceae	D	T	Af	+	-	-
Indigofera diphylla Vent.	Fabaceae	D	T	Af	-	+	-
Indigofera hirsuta L.	Fabaceae	D	T	Amu	+	+	+
Indigofera macrocalyx G. et Perr.	Fabaceae	D	T	Af	-	-	+
Indigofera nigritiana Hook. f.	Fabaceae	D	T	Af	+	-	-
Indigofera pilosa Poir.	Fabaceae	D	T	Af	+	+	+
Indigofera stenophylla G. et Perr.	Fabaceae	D	T	Af	+	-	-
Macrotyloma daltonii	Fabaceae	D	T	Af	+	-	-

(Webb) Verdc.							
Parkia biglobosa (Jacq.) Benth.	Fabaceae	D	P	As	+	-	-
Piliostigma reticulatum (OC.) Hochst.	Fabaceae	D	P	Af	+	+	-
Piliostigma thonninghii (Schum.) M.-Readh.	Fabaceae	D	P	Af	-	-	+
Rhynchosia minima (L.) DC.	Fabaceae	D	T	Am As	+	-	-
Senna obtusifolia L.	Fabaceae	D	T	Pt	+	+	+
Sesbania pachycarpa DC.	Fabaceae	D	P	Asu	+	+	+
Stylosanthes fruticosa (Retz.) Alston	Fabaceae	D	T	Af	+	-	-
Tephrosia bracteolata Guill. Et Perr.	Fabaceae	D	T	Af	+	+	+
Tephrosia linearis (Willd) Pers	Fabaceae	D	T	Af	+	-	-
Tephrosia pedicellata Back.	Fabaceae	D	T	Af	+	-	-
Tephrosia platycarpa G. et Perr.	Fabaceae	D	T	Af	+	+	-
Hyptis spicigera Lam.	Lamiaceae	D	T	Am As	+	-	-
Hyptis suaveonlens (L.) Poit.	Lamiaceae	D	T	Am As	+	-	-
Corchorus olitorus L.	Malvaceae	D	T	Pt	-	+	+
Corchorus tridens L.	Malvaceae	D	T	Asu	+	+	+
Hibiscus cannabinus Hochr	Malvaceae	D	T	Af	+	+	+
Hibiscus diversifolius Jacq.	Malvaceae	D	T	Af	+	-	-
Hibiscus sabdariffa L.	Malvaceae	D	T	Af	+	+	
Sida alba L.	Malvaceae	D	T	Pt	-	-	+
Sida linifolia Juss. ex Cav.	Malvaceae	D	T	Am	+	-	-
Sida rhombifolia L.	Malvaceae	D	T	Pt	+	+	+
Sida stipulata Cav.	Malvaceae	D	T	Pt	+	-	-
Triumfetta pentandra A. Rich.	Malvaceae	D	T	Pt	+	+	
Walteria indica L.	Malvaceae	D	C	Pt	+	-	-
Urena lobata Linn.	Malvaceae	D	H	Pt	+	-	-
Striga hermonthica (Delile) Benth.	Orobanchaceae	D	Par	Mas	+	-	-
Phyllanthus amarus Schumach. & Thonn.	Phyllanthaceae	D	T	Pt	+	-	+
Scoparia dulcis L.	Plantaginaceae	D	T	Pt	+	-	-
Andropogon gayanus Kunth.	Poaceae	M	H	Af	+	-	+
Andropogon pseudapricus Stapf.	Poaceae	M	T	Am	+	+	-

Brachiaria deflexa (Schumach.) C.E. Hubb. ex Robyns	Poaceae	M	T	Mas	+	-	+
Brachiaria stigmatisata Stapf.	Poaceae	M	T	Af	+	-	-
Brachiaria villosa (Lam.) A. Camus	Poaceae	M	T	Pt	+	-	+
Chloris pilosa Schum. Et Thonn	Poaceae	M	T	As	-	+	-
Ctenium elegans Kunth.	Poaceae	M	T	Af	+	-	+
Dactyloctenium aegyptium Beauv.	Poaceae	M	T	Pt	+	+	+
Digitaria exilis (Kippist) Stapf	Poaceae	M	T	Af	+	-	-
Digitaria horizontalis Willd.	Poaceae	M	T	Pt	+	+	+
Eleusine indica (L.) Gaertn.	Poaceae	M	T	Pt	+	-	-
*Eragrostis ciliaris (*L.) R. Br.	Poaceae	M	T	Pt	-	+	-
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult.	Poaceae	M	T	Af	+	-	-
Eragrostis tremula Steud.	Poaceae	M	T	As	+	+	+
Pennisetum pedicellatum Trin.	Poaceae	M	T	Asu	+	+	+
Pennisetum polystachion (L.) Schultes	Poaceae	M	T	Asu	-	+	-
Panicum laetum Kunth.	Poaceae	M	T	Af	+	-	+
Paspalum scrobiculatum L.	Poaceae	M	H	Mas	+	+	+
Setaria pumila (Poir.) Roem. & Schult.	Poaceae	M	T	Asu	+	-	+
Diodia sarmentosa Sw.	Rubiaceae	D	H	Pt	+	+	
Mitracarpus villosus (Sw.) DC.	Rubiaceae	D	T	Am As	+	+	+
Oldenlandia corymbosa L.	Rubiaceae	D	T	Pt	-	+	
Oldenlandia herbacea (L.) Roxb.	Rubiaceae	D	T	Pt	+	-	-
Spermacoce chaetocephala DC.	Rubiaceae	D	T	Af	+	-	-
Spermacoce radiata (DC.) Sieb. Ex Hiern.	Rubiaceae	D	T	Af	+	+	-
Spermacoce stachydea (DC.) Hutch. Et Dalz.	Rubiaceae	D	T	Af	+	+	+
Cissus palmatifida (Baker) Planch.b	Vitaceae	D	H	Af	+	-	+

G= Geophytes ; H= Hemicryptophytes ; P=Phanerophytes ; Par= Parasitical plant ; T= Therophytes ; D=Dicotyledons ; M=Monocotyledons ; +=presence ;-=absence ; SM= Sinthiou Maleme ; KD= Kolda ; SF= Sefa.

Table 3*:* Structure of flora.

Station	Dicotyledons						Monocotyledons					
	Family		Genius		Species		Family		Genius		Species	
	N	%	N	%	N	%	N	%	N	%	N	%
KOLDA	11	73.3	40	70.2	65	71.4	4	26.7	17	29.8	26	28.6
SEFA	8	72.7	22	57.9	31	59.6	3	27.3	16	42.1	21	40.4
SM	6	66.7	21	67.7	30	69.8	3	33.3	10	32.3	13	30.2
Total	**15**	**78.9**	**44**	**68.8**	**75**	**68.8**	**4**	**21.1**	**20**	**31.2**	**34**	**31.2**

Table 4: Families repartition.

Family	CRZ		SEFA		SM		Total	
	Number	%	Number	%	Number	%	Number	%
Amaranthaceae	2	2.2					2	1.8
Apocynaceae	1	1.1					1	0.9
Araceae	1	1.1					1	0.9
Asteraceae					1	2.3	1	0.9
Combretaceae	4	4.4					4	3.7
Commelinaceae	2	2.2	2	3.8	2	4.7	3	2.8
Convolvulaceae	7	7.7	5	9.6	4	9.3	7	6.4
Cucurbitaceae			2	3.8	2	4.7	2	1.8
Cyperaceae	7	7.7	8	15.4	2	4.7	10	9.2
Euphorbiaceae			1	1.9			1	0.9
Fabaceae	29	31.9	14	26.9	12	27.9	33	30.3
Lamiaceae	2	2.2					2	1.8
Malvaceae	10	11.0	5	9.6	6	14	12	11
Orobanchaceae	1	1.1					1	0.9
Phyllanthaceae	1	1.1	1	1.9			1	0.9
Plantaginaceae	1	1.1					1	0.9
Poaceae	16	17.6	11	21.2	9	20.9	19	17.4
Rubiaceae	6	6.6	2	3.8	5	11.6	7	6.4
Vitaceae	1	1.1	1	1.9			1	0.9
Total species	**91**	**100**	**52**	**100**	**43**	**100**	**109**	**100**

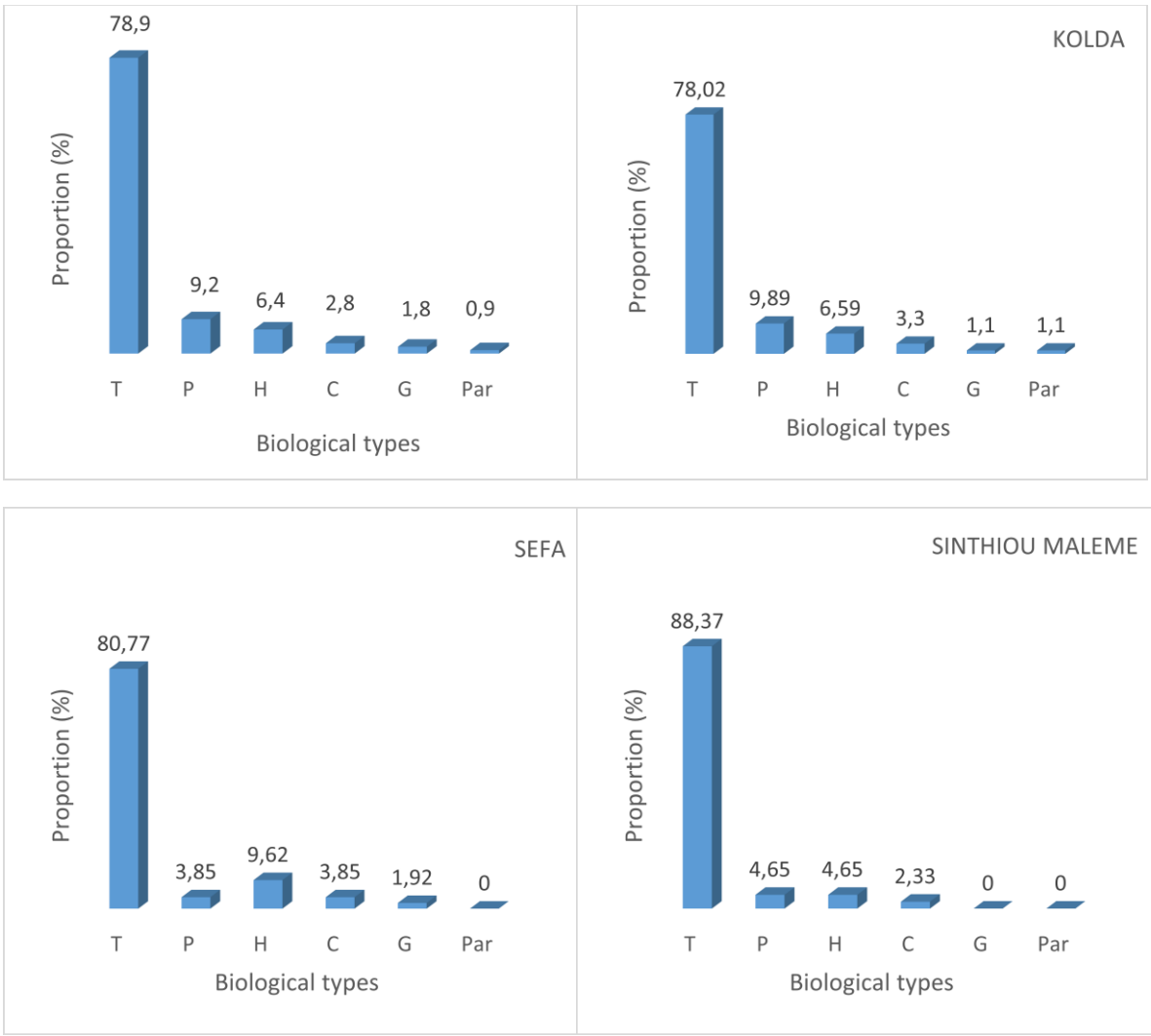

Figure 2 : Biological distribution of species recorded. T=Therophytes ; P=Phanerophytes ; H=Hemycryptophytes ; C=Chamephytes ; G=Geophytes Par= Parasitical plants

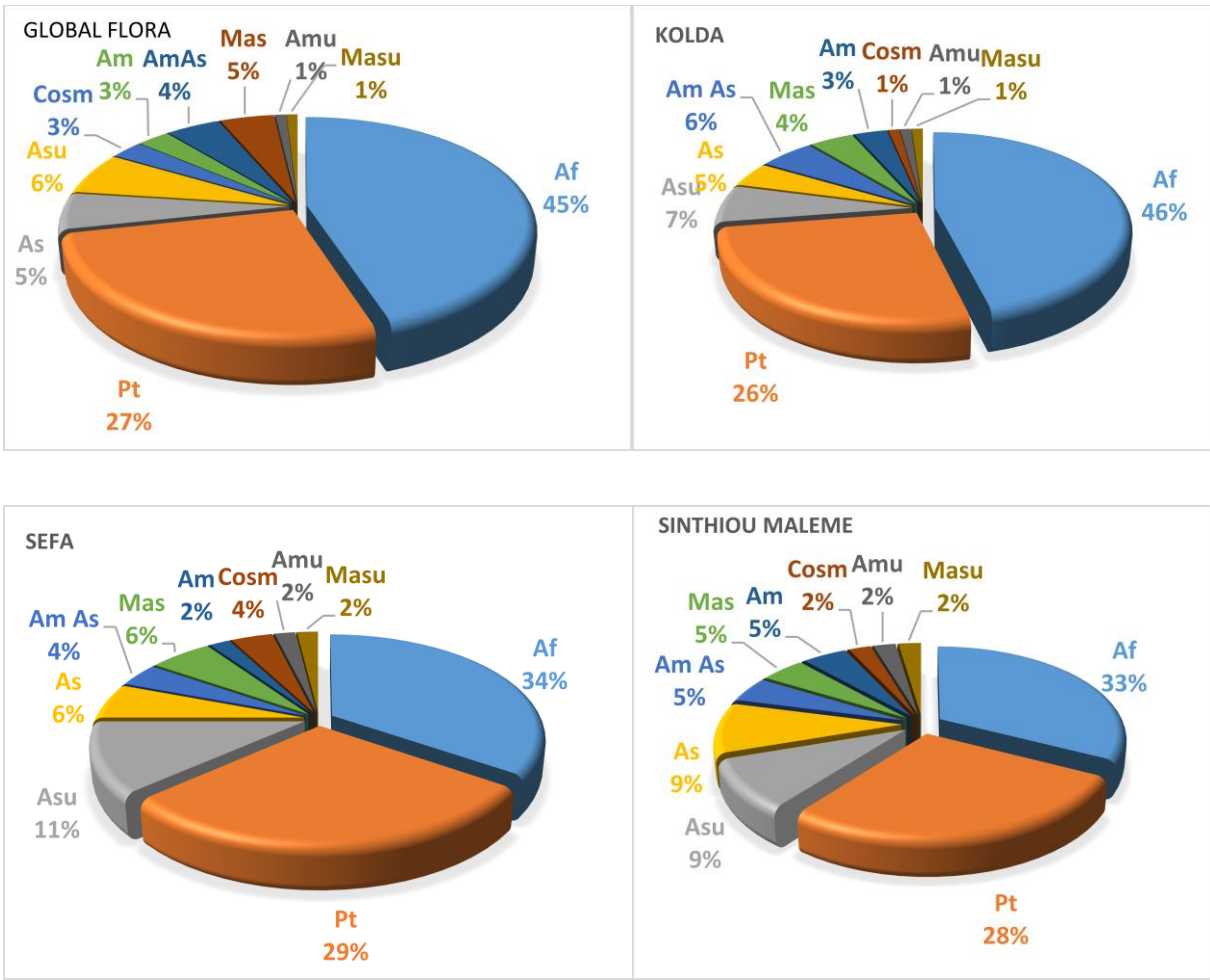

Figure 3: Chorogical distribution of the species recorded. african (Af), african-american (Am), afro-american and asian (Am As), afro-asian (As), afro-asian and australian (Asu), afro-malagasy (M), afro-malagasy and asian (Mas), afro-asian-american and australian (Masue), pantropical (Pt).

DISCUSSION

Characterization of fallows revealed that the flora was composed of 109 species, distributed in 64 genera and 19 families. Fabaceae and Poaceae families are dominant in all study areas. Similar findings were reported previously in Senegal (Noba, 2002; Diallo et al., 2011; Bassène et al., 2014). Their success depends largely on the conditions of the agrosystem. Furthermore, most of the Fabaceae species produce seeds with high longevity in the soil (Baskin, 1998); conversely, Poaceae family species richness is related to high production of seeds such as *Digitaria horizontalis* and *Eleusine indica* (Le Bourgeois and Marnotte, 2002). These families were followed by Malvaceae, Cyperaceae, Rubiaceae and Convolvulaceae.

Some species were found in these families (*Cyperus rotundus*, *Cyperus sphacelatus*, *Senna obtusifolia*, *Eleusine indica*, *Eragrostis ciliaris* and *Ipomoea eriocarpa)* indicating great plasticity with adaptability and stress tolerance imposed by

weed management practices used by farmers (Costa and Mesquita, 2015; Le Bourgeois, 1993). In addition, the *Cyperaceae* family occupies an important place in Sefa where the most characteristic species of degraded lands are found. On the other hand, some species found in fallows such as *Andropogon gayanus* are the most frequently mentioned by farmers in West and Central Africa as plant indicator of soil fertility (Norgrove and Hauser, 2015).

Moreover, the dicotyledons were dominant. This finding is in agreement with previous studies conducted in diverse agro-ecological zones located in Senegal (Sarr, 2007; Mbaye, 2013; Bassene, 2014). According to Ba and Noba (2004) predominance of dicotyledons is a characteristic of senegalese flora. This dominance was more important at Kolda than Sinthiou Maleme and Sefa. Compared with Sinthiou Maleme and Sefa, it indicates the effect of longest agricultural and anthropic pressure on cotyledon type. Biological type analysis showed that therophytes dominated in the study areas. This high annual rate is an indication of crop habitats disturbed by agronomic interventions (Fenni, 2003). This herbaceous life form has fragile vegetative body, produces abundant seeds and is fast growing at the slight of rain. These factors and the tropical nature of the study areas may be responsible for their abundance (Osawaru et al., 2014). In addition, these research stations are subjected to anthropic pressures and soil pressure which reduce the perennial species and increase the annual species. Then, therophytes are more adapted to cultural disturbances (Maillet, 1981; Traoré, 1991; Noba, 2004). Sinthiou Maleme, where low rainfall was recorded, had the highest proportion of therophytes. According to Negre (1966 *in* Traore 1991) this situation is mainly due to proportion of therophytes which increase from wetlands to dry lands. Perennial species found in this area may have resulted as a regrowth in fields established by vegetative stems which is a form of savannization (Noba, 2004; Bassène, 2014; Diatta, 2016). Based on geographical distribution, african and pantropical species constitute more than half of the species recorded. African species domination compared with the adventitious flora of food crops in the Southern Groundnut Basin (Noba et al., 2004) and weeds flora in the Niayes (Sarr et al., 2007) appears to be related to the continental nature which is tropical and semi-arid. In addition, proportion of african species was higher in Kolda than two other sites. Importance of pantropical species seems to be related to the geographical position of Senegal which is more western and oceanic than the other sahelian countries (Sarr et al., 2007). High proportion of the other groups is due to exchange of seeds between continents (Traoré, 1991; Noba et al., 2004). This situation is accentuated by the fact that these studied areas are the place of introduction of new crops and new varieties before their extension in farmers' field.

Conclusion

The floristic inventory reported 109 species belonging to 64 genera and 19 families. This flora was more diverse in Kolda compared with Sinthiou and Sefa. Fabaceae and Poaceae were the most represented botanical families. Also, the study showed that therophytes dominated in all the stations with 78.9% of recorded species. This is mainly due to their adaptations to agro-ecological conditions and to the strong anthropic pressure from which these spaces suffer. Moreover, geographical distribution of the species showed a domination of african species (45%) followed by pantropical species (29%). However, the other geographical types are also well represented and their contribution can exceed 5% such as afro-asian and australian species.

COMPETING INTERESTS

The authors state that they have no conflict of interest.

AUTHORS' CONTRIBUTIONS

SLK wrote the experimental protocol, contributed to the surveys, contributed to data analysis and the writing of the first draft of the article; BB contributed to the surveys and the

writing of the first draft; MOL contributed to the surveys and the writing of the first draft. MSM and MG wrote the experimental protocol and the writing of the first draft. They also supervised the surveys, data analysis and the writing of the draft.

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