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Agronomic characterization of eighteen cucurbitaceae cultivars used for food in Niger.

Haoua SABO [1] , Hassimi SADOU [1], Ibrahim Adamou AMOUKOU [3] , Mousbahou MALAM ALMA [1] , Mahamane Saadou[2] .

[1] Department of Chemistry, Abdou Moumouni University. BP: 10662. Niamey. Niger.

[2] Department of Biology, Faculty of Sciences, Abdou Moumouni University. BP: 10662. Niamey. Niger.

[3] Faculty of Agronomy, Abdou Moumouni University. BP: 10662. Niamey. Niger.

*Corresponding Author: hseinisabo@yahoo.frTel: 00 (227) 96 28 84 92 Fax: 00 (227) 20 31 50 72.

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ABSTRACT:

Objective: Agronomic potentialities of 18 cucurbitaceous cultivars from two species were assessed in a period of two years on the experimental field of the University Of Niamey Faculty Of Sciences. The experiment was a complete random block. Seventeen (17) cultivars of the *Lagenaria siceraria* species of which only one species from the *Citrullus colocynthis*.

Methodology and results: Thirteen (13) characteristics were studied. Variance analyses showed that there was very significant difference (p= 0.05) between cultivars for all studied characteristics, except the duration of the emergence, the date of fructification, the width of the fruit and the weight of the seed the first year. In this way, short-cycle and long cycle cultivars, as well as productive and less productive cultivars are identified. Correlations between the different characteristics showed that the yield in berries is very positively correlated to the weight of a berry (r = 0.76) and the number of seeds per berry (r = 0.61) and negatively with the width (r = -0.66) and the length (r = -0.73) of a seed. The average production in berries is 17 per plant in the first year against 6 the second year. Better productivity is achieved with *Citrullus colocynthis*, which gave 82 berries per plant the 1st year. The average yield in seeds was 180.15 kg / ha in the first year and 704.30 kg / ha, in the second year.

Conclusion and application of results: Niger cucurbitaceous are unknown and the results of this study show that they have a lot of potentiality and can contribute to achieve the Millennium Development Goals, especially in its food security and fight against poverty programs, since they represent an important source of income for the population.

Key words: cucurbitaceous, *Citrullus colocynthis*, *Lagenaria siceraria,* agronomic characteristics, Niger.

INTRODUCTION

In developing countries, the exploitation of local plant resources is certainly a way to achieve food security, especially in countries with a high demographic growth. However, it requires the preservation and availability of a high level of genetic diversity of these resources (Barilla, 2012). Many local plant resources valorisation research programs have been developed to support the government of Niger in its poverty alleviation programs and food its security effort, through qualitative and quantitative improvement of alternative foods, scientifically less known, but widely used by Nigeriens. All parts of the plant (leaves, flowers, seeds and mature and immature berries) can be used for food depending

on the species. Starch can be extracted from roots (Ismail *et al*., 2010; Mohammed, 2011). Some cultivars of *Lagenaria siceraria* are cultivated in a strictly utilitarian purpose to obtain utilities such as (calabashes, spoons, water containers). Growing cucurbitaceous ("Tanda" local name in Zarma) represents a potential source of additional income as well as a source of immediate food needs of the family unit. In most rural African communities, *Lagenaria siceraria* primitive roots are generally distinguished by the size and shape of the berry, and are designated by a common name related to these morphological differences (Beshir and Babiker, 2009; Nyam *et al*., 2009). In Ivory Coast, farmers refer to seed size when talking about plants with edible seeds. In addition, in the Cucurbitaceous family, the important contribution of the characteristics of berries and seeds to the morphological variability has been reported for some species (Abiodun and Adeleke, 2010; Gundele *et al*., 2013). Research on agronomic and botanical characteristics of cucurbitaceous in West Africa is very recent. (Leonie *et al*., 2009). In Niger, despite the nutritional, socio-economic and cultural importance of cucurbitaceous, very few studies have been conducted for the characterization, the development and promotion of this biological material. If many studies have examined the biochemical compositions of seeds (Abiodun and Adeleke, 2010; Gundele *et al*., 2013), very few studies, on the contrary have addressed production aspects. In addition, it was important to assess the agronomic characteristics of these species in Niger considering varietal aspects. Two species namely *Citrullus colocynthis (linn.) Schrad* and *Lagenaria siceraria (Molin.) Standl,* were chosen as their products and by-products are commonly used for food in Niger. The seeds are used for the production of dough, cakes and edible oils in the Zinder region. The seeds of *Citrullus Colocynthis* represent an important source of income for the population and depending on the season, the price of a 100 kg sack varies between 77 and 154 € (100 and 200 USD). Thus, the study was carried out on the one hand for the determination of characteristics related to the germination, the emergence, the flowering, the fructification, berries, seeds parameters and yields on the other, the setting of performance criteria for different cultivars. The work on cucurbitaceous is significant because of their seeds. The work on cucurbitaceous was chosen because their seeds, considered by some analysts as "saviours of arid regions with multiple purpose." (Schafferman *et al.*, 1998).

MATERIALS AND METHODS

Experimental site: The tests were carried out at the Faculty of Sciences and Technology at Abdou Moumouni University of Niamey experimental site located (13°30'N; 2°08'E; 216 a.s.l). The soil is made of alluvial sediment deposits (mud, sands, gravels, stones). The climate is characterized by a rainy season (from June to October), a cold season (from November to February) and a hot season (from March to May). It rains 522.3 mm per year in average [NIS, 2013].

Plant Material: Botanists of the Faculty of Sciences and Technology identified different varieties to which they gave names according to their fruits shape or aspect (figure 1), then, they used codes and a number to refer to species (table 1). This led to 18 cultivars including 17 (LS1 to LS17) of the *Lagenaria siceraria* species and a cultivar of the *Citrullus colocynthis* species (Table 1). There are climbing and creeping cultivars. The berry can be big or small, of varied shapes (calabash, gourd and ladle) smooth or rough aspect (Figure 1).

Figure 1: Form of berries of the studied cultivars

The seeds were acquired from Niamey markets and other localities of Niger (Zinder, Doutchi, Keita and Goubèye)

(Table 1). The vernacular names are reported in (Hausa and Zarma) the two most spoken languages in Niger (Peyre, 1979).

Table1: Composition of plant material according to the type of growth, shape and / or aspect of the berry, vernacular names and provenance.

Varieties	Type of Growth	Berry shape and / or aspect	Djerma	Haussa	Berries provenance
LS 1	Climbing	guitar	Souta'n	Chantu	Katako market, Niamey
LS 2	Climbing	rough	Kassa kassa	Sana'a	Niamey big market
LS 3	Climbing	smooth	Kassa kassa	Sana'a	Katako market, Niamey
LS 4	Creeping	Big calabash	Gassu	Koriya	Zinder
LS 5	Climbing	big ladle	Gombo	Liddeye	Niamey big market
LS 6	Climbing	Small gourd	Zoloo	Djandama	Katako market, Niamey
LS 7	Climbing	big gourd	Zoloo	Djandama	Niamey big market
LS 8	Climbing	Small calebash	Gassu	Koriya	Doutchi
LS 9	Creeping	ladle with small tip	Gombo	Liddeye	Doutchi
LS 10	Climbing	Ladle wth big tip	Gombo	Liddeye	Doutchi
LS 11	Climbing	rough	Kassa kassa	Sana'a	Doutchi
LS 12	Climbing	smooth	Kassa kassa	Sana'a	Doutchi
LS 13	Climbing	big gourd	Zoloo	Djandama	Keita
LS 14	Climbing	Cucumber like	-	Zoungourou	Niamey
LS15	Climbing	rough	Kassa kassa	Sana'a	Goubèye (Doutchi)
LS 16	Climbing	rough	Kassa kassa	Sana'a	FAST site
LS 17	Climbing	rough	Kassa kassa	Sana'a	Goubèye (Doutchi)
CC	Creeping	smooth	Kaney	Kafurdu/Guna	FAST site

LS = *L. siceraria* CC = *C. Colocynthis*

Methods

Experimental design in the field : The ground was weeded, drilled and the distance between the planting holes determined. The experiment for both years (2009 and 2010) took place on the 21st July, during the rainy season; two types of cultivars, (climbing and creeping) were tested in two different trials without using any fertilizer.

For climbing cultivars: During the two years of experiment, the climbing cultivars (4 in the first year and 14 in the second year) were followed in a complete random block device in three replication plots. In each, replicate plot three plants per sample. The distance between the planting holes was 4 m and the one between the blocks 1. Supports were immediately placed at the bottom of plants at the appearance of the first tendrils. According to (Achigan, 2002) tutors help support the weight of berries.

For the creeping cultivars: The same type of device was used for creeping cultivars (2 in 1st year and 4 in 2nd year) with a distance of 6 m between the planting holes and 1 between the replication plots. Observations and measurements on the duration of the emergence in Days After Sowing (DAS) were made, the rate of emergence, the date of flowering and fructification, the duration of the cycle, the yield in berries and in seeds, the widths and lengths of berries and seeds. The correlation between the shape of berries and the number of seeds could help

researchers to know beforehand the number of seeds in relation to the height of berries.

Statistical analysis: An analysis of variance was performed for all characters observed by using Statitix software. In case of significant difference between cultivars, comparison of averages' tests (Tukey HSD test) was conducted for the concerned characteristics to determine the groups of homogeneous cultivars. Then a correlation analysis was made among the various characteristics.

RESULTS AND DISCUSSION

Results of variance analysis: The variance analysis in table 2 shows that there is a significant difference between cultivars for all measured parameters over the two years except for the level of the emergence duration, of the date of fructification, the width of the berries and the weight of a first year seed. The following results on the comparison of averages will enlighten us on the different cultivar groups for all these characters.

Table 2: Variance analysis for measured parameters.

Character	Test	DF	SS	MS	F	P
DL in DAS	Year 1	5	12.44	2.48	2.22 ns	0.1329
	Year **2**	17	84.00	4.94	4.04**	0.0003
RL (%)	Year 1	5	5357.61	1071.52	3.65*	0.0387
	Year **2**	17	10416.7 0	612.74	2.78 **	0.0055
FLO	Year 1	5	316.94	63.38	63.38**	0.0003
	Year **2**	17	1253.65	73.74	12.86**	0.0000
FRU	Year 1	5	65.61	13.12	0.62 ns	0.6888
	Year **2**	17	1342.67	78.98	11.82**	0.0000
NBP	Year 1	5	15421.20	3084.23	7.91**	0.0030
	Year **2**	17	728.59	42.85	1.95*	0.0484
WtB	Year 1	5	334401	66880.20	40.54**	0.0000
	Year **2**	17	1746793	102753	11.31**	0.0000
WB	Year **1**	5	21.54	4.30	1.37 ns	0.3141
	Year 2	17	1928.60	113.44	9.48**	0.0000
LB	Year **1**	5	2794.89	558.97	95.31**	0.0000
	Year **2**	17	1653.62	97.27	3.89**	0.0004
NSB	Year 1	5	324082	64816.50	16.94**	0.0001
	Year **2**	17	1381245	81249.70	37.39**	0.0000
WSB	Year 1	5	2609.95	521.99	6.98**	0.0047
	Year **2**	17	12740.70	749.45	6.85**	0.0000
LS	Year 1	5	1.15	0.23	16.28**	0.0002
	Year **2**	17	24.79	1.45	3.13**	0.0023
WS	Year **1**	5	0.20	0.04	22.73**	0.0000
	Year **2**	17	38.57	2.26	3.01**	0.0031
WtS	Year 1	5	26.96	5.39	0.84 ns	0.5480
	Year **2**	17	21.74	1.27	2.85**	0.0046

DF = Degree of freedom, SS = Sum Score, MS = Mean score, F = Fisher, P = probability,* significant at the 5% level ** Significant at 1% ns = not significant. DE: duration of emergence; ER: emergence rate; FLO: flowering, Fru: fructification; NBP: number of berries per plant ; WtB: weight of berry, WB: width of berry, LB: length of a berry; NSB: number of seeds per berry; WSB: weight of seeds per berry, LS: length of a seed, WS: width of a seed , WtS: weight of a seed.

Table 3 shows that, all of the cultivars had the same emergence duration (7 DAS) the 1st year. However, in the 2nd year two groups of cultivars can be distinguished: The LS5 cultivar represents the latest with 10 days duration in soil. Otherwise, all of the other cultivars of *Lagenaria siceraria* had a fast emergence of 5 to 6 DAS and 4 DAS for *Citrullus colocynthis*. As for the first year emergence rate, it varies from 27 to 84% with an average of 47%. Thus forming three groups of cultivars (Table 3). The best group is *Citrullus Colocynthis* cultivar with 84% of

germinating rate. The weakest group is LS1 with 28%. The intermediary group has a germinating rate, which varies from 41-45%. In this group, we have LS2, LS3 of the same form. They constitute with LS5 the climbing cultivars with a germinating rate of 41.66%. In the 2nd year, we also find three homogeneous groups of emergence rate different from those of year 1. The best outstanding cultivars have all germinated at 100%. These were LS1, LS3, LS4, LS5, CC, LS7, LS8, LS11 and LS15. The LS2 cultivar is the less outstanding with 50% emergence rate. Intermediate cultivars germinated between 66 and 84%.

Averages comparison for emergence duration and rate

Table 3: Averages comparison of different cultivars for emergence duration and rate.

Cultivars	Duration of emergence (DL) in DAS		Rate of emergence (RL) in %	
Year	1st Year	2nd Year	1st Year	2nd Year
LS1	7.00 ± 1.00a	6.00 ± 2.00b	27.66 ± 4.62b	100.00 ± 0.00a
LS2	7.00 ± 1.00a	6.00 ± 2.00b	41.66 ± 14.43ab	50.00 ± 0.00b
LS3	7.00 ± 0.00a	6.00 ± 2.00 b	41.66 ± 14.43ab	100.00 ± 0.00a
LS4	5.00 ± 1.00a	5.00 ± 0.00b	44.33 ± 9.81ab	100.00 ± 0.00a
LS5	7.00 ± 2.00a	10.00 ± 1.00a	41.66 ± 14.43ab	100.00 ± 0.00a
CC	7.66 ± 1.15a	4.00 ± 1.00b	83.33 ± 28.87a	100.00 ± 0.00a
LS6		5.00 ± 1.00b		83.33 ± 28.87ab
LS7		6.00 ± 2.00b		100.00 ± 0.00a
LS8		4.00 ± 0.00b		100.00 ± 0.00a
LS9		5.00 ± 1.00b		66.67 ± 28.87ab
LS10		6.00 ± 2.00b		83.33 ± 28.87ab
LS11		5.00 ± 1.00b		100.00 ± 0.00a
LS12		6.00 ± 2.00b		100.00 ± 0.00a
LS13		6.00 ± 1.00b		100.00 ± 0.00a
LS14		6.00 ± 2.00b		100.00 ± 0.00a
LS15		6.00 ± 2.00b		100.00 ± 0.00a
LS16		5.00 ± 1.00b		83.33 ± 28.87ab
LS17		5.00±1.00b		83.33 ± 28.87ab
Average ± SD	6.77 ± 1.30	5.66 ± 1.76	46.72 ± 22.37	91.66 ± 18.80

LS = L. siceraria (Molin.) Standl CC = C. Colocynthis (Linn.) Schrad , SD = Standard deviation; There is no significant difference between the means that have the same letters in each column.

Averages comparison for the date of flowering, fructification and the yield in berries at harvest.: Table 4 shows that there are no significant differences between cultivars for flowering and fructification in the 1st year. They flowered and bore fruits respectively 83 and 101 DAS. In 2nd year, cultivars flowered between 32 and 49. Concerning the number of berries per plant, the averages comparison highlighted two homogeneous groups in the 1st year, a low production in berries were observed in *Lagenaria siceraria* cultivars (3-10 berries), an important production for *Citrullus colocynthis* (83 berries in average). In the 2nd year, the same trend was observed but with three groups for all cultivars. *Citrullus colocynthis* has always been the most productive with 16 berries per plant, then between 2 and 9 berries for the median and one berry for the less productive

Table 4: Averages comparison of different cultivars for the date of flowering, fructification and the number of berries.

Variety	Date of flowering		Date of fructification		Number of berries/plant*	
Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
LS1	74.00 ± 2.00a	49.00 ± 6.00a	96.67 ± 8.02a	59.33 ± 8.02a	2.33 ± 1.15 b	3.33 ± 0.58ab
LS2	83.00 ± 2.65a	47.00 ± 2.00abc	101.00 ± 3.61a	58.00 ± 2.00ab	2.33 ± 1.53 b	1.33 ± 0.58b
LS3	85.00 ± 3.00a	48.00 ± 2.00ab	101.67 ± 3.06a	57.33 ± 1.53abc	10.00 ± 0.00 b	4.66 ± 2.52ab
LS4	87.33 ± 3.21a	47.00 ±1.00abc	101.00 ± 3.61a	54.33 ± 3.21abcde	3.66 ± 1.53 b	8.66 ± 8.02ab
LS5	84.33 ± 3.06a	41.00 ± 2.00bcde	99.00 ± 6.56a	49.66 ± 1.53cdefg	2.33 ± 2.31 b	2.00 ± 1.00ab
CC	82.00 ± 2.65a	32.00 ± 1.00f	102.33 ± 1.53a	40.66 ± 2.52h	82.33 ± 49.54a	16.00 ± 14.00a
LS6		42.00 ± 2.00abcde		50.33 ± 2.52bcdefg		5.33 ± 1.53ab
LS7		42.00 ± 4.00abcde		51.33 ± 4.51bcdefg		5.66 ± 1.53ab
LS8		36.00 ± 1.00ef		45.00 ± 1.00gh		3.00 ± 1.00ab
LS9		37.00 ± 1.00ef		45.66 ± 3.06fgh		1.33 ± 0.58b
LS10		43.00 ± 6.00abcde		53.33 ± 4.16abcdef		5.33 ± 3.21ab
LS11		35.66 ± 4.16ef		46.66 ± 4.04efgh		8.66 ± 1.53ab
LS12		40.00 ± 4.00cde		51.66 ± 3.21abcdefg		10.33 ± 9.29ab
LS13		41.00 ± 2.00bcde		49.66 ± 2.52cdefg		2.00 ± 1.00ab
LS14		45.00 ± 2.00abcd		54.66 ± 4.73abcd		6.00 ± 1.00ab
LS15		38.00 ± 2.00def		47.66 ± 3.06defgh		4.66 ± 2.08ab
LS16		38.00 ± 1.00def		47.33 ± 0.58defgh		9.66 ± 2.52ab
LS17		48.00 ± 1.00ab		57.33 ± 3.51abc		4.66 ± 8.02ab
AVR±SD	82.61 ± 4.91	41.64 ± 5.54	100.28 ± 4.57	51.11 ± 5.80	17.16 ± 34.60	5.70 ± 5.32

LS = L. siceraria CC = C. Colocynthis SD = Standard deviation, There is no significant difference between the means that have the same letters in each column.* Sabo *et al*., 2014. Accepted for publication

Average comparison of cultivars for the weight and dimensions of berries : According to table 5, the weight and the length of a berry help distinguish the cultivars in the 1st year. Indeed, two groups were observed for weight and three for length. *Citrullus Colocynthis* cultivar gave the heaviest berries with 475 g and the shortest with 9.5 cm. Lighter berries weighed between 88 and 156 g. LS1 and LS5 cultivars gave the highest berries with respectively 40 and 35 cm of length and guitar form and big ladle. LS3 is intermediate among berries of 21 cm of length and the other form the same group as CC with berries of 10 cm in height. The variance Analysis showed that the difference was not significant between cultivars for the width of berries. The second year we found *Citrullus colocynthis* berries heavier with 777 g. followed by LS3 and LS4 cultivars with 420 and 223 g of berry weight respectively. Less heavy cultivars berries weighed between 26 and 54 g. The highest berries measured

between 14, 24 cm, and the widest 15 cm. CC Berries, LS4 cultivars were circular with for the two years respectively and 9.40 12 cm and 10 cm and 15 cm diameter.

Table 5: Comparison of different cultivars averages of weight, width and length of the berries.

cultivar	Weight of a berry (g)		Width of a berry (cm)		Length of a berry (cm)	
	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
LS1	149.67± 16.50b	53.33 ± 34.64c	7.36 ± 2.80a	8.22 ± 2.55cd	40.06 ± 0.81a	21.77 ± 5.98abc
LS2	66.67 ± 28.87b	30.00 ± 20.00c	7.00 ± 1.00a	12.25 ± 5.58cd	10.66 ± 1.15c	18.29 ± 8.54abc
LS3	36.33 ± 84.10b	419.89 ± 33.36b	10.03± 3.46a	14.88 ± 4.35bcd	20.71 ± 2.13b	23.55 ± 6.67abc
LS4	88.33 ± 1.53b	223.00 ± 79.99bc	9.25 ± 2.41a	14.86 ± 0.21bcd	10.00 ± 2.50c	14.86 ± 0.21abc
LS5	156.00 ± 5.29 b	26.67 ± 11.55c	8.50 ± 0.50a	8.49 ± 3.68cd	35.33 ± 4.25a	19.24 ± 5.63abc
CC	474.67± 57.77a	776.33 ± 25.56a	9.38 ± 0.39a	12.02 ± 0.70cd	9.39 ± 0.38c	12.02 ± 0.70c
LS6		110.78 ± 108.35c		17.16 ± 9.69bc		28.19 ± 12.18ab
LS7		253.00± 41.55bc		14.13 ± 1.58cd		28.55 ± 3.10a
LS8		150.33 ± 20.50bc		13.04 ± 0.90cd		12.99 ± 0.90bc
LS9		67.00 ± 15.00c		8.74 ± 0.72cd		11.70 ± 0.66c
LS10		107.33 ± 99.73c		29.33 ± 4.51a		29.33 ± 4.5a
LS11		30.67 ± 30.75c		7.24 ± 3.33cd		18.22 ± 6.05abc
LS12		110.00 ± 104.40c		10.65 ± 3.90cd		16.44 ± 2.50abc
LS13		95.33 ± 55.00c		25.11 ± 2.50ab		25.11 ± 2.50abc
LS14		77.33 ± 83.19c		6.33 ± 0.31d		26.89 ± 4.40abc
LS15		134.33 ± 99.38bc		8.66 ± 1.76cd		18.44 ± 6.62abc
LS16		1.67 ± 0.58 c		8.99 ± 0.58cd		18.77 ± 0.69abc
LS17		74.33 ± 51.73c		8.00 ± 0.35cd		18.11 ± 1.17abc
AVG ± SD	178.61± 145.01	152.30 ± 200.78	8.58 ± 1.02	12.67 ± 1.99	21.02 ± 1.39	20.11 ± 2.88

LS = L. siceraria, CC = C. Colocynthis, SD = Standard deviation There is no significant difference between the means that have the same letters in each column.

Table 6 demonstrates that, averages comparison highlighted four groups for the number of seeds per berry and three for seeds' weight. In the same way as for the previous characters, *Citrullus Colocynthis* cultivar distinguished itself with 473 seeds per berry. Less productive in seeds were LS4 and LS5 with 107 and 104 seeds. The heaviest seeds were obtained in LS3 cultivar with 47 g and the less heavy were obtained with LS5, LS2 and LS4 for fluctuating values between 11 and 16 g. An important variability has been observed for these two characters in the 2nd year. Indeed, 12 groups were formed for the number of seeds and 8 for their weights. *Citrullus Colocynthis* cultivar was more productive with 747 seeds. Low production was obtained with LS5 for 43 seeds per

berry. The highest weight of seeds per berry was observed in LS4 (61g), followed by LS3 (55g). The lightest seeds were obtained with LS5 (5g).

Table 6: Comparison of average for cultivars seeds number and for seeds weight per berry

cultivar	Number of seeds/berry * (g)		Weight of seeds/berry (g)	
Year	1st Year	2nd Year	1st Year	2nd Year
LS1	156.67 ± 50.64bc	161.56 ± 85.09cdefg	26.36 ± 4.53ab	16.60 ± 7.08cd
LS2	123.33 ± 37.87bc	54.22 ± 33.28fg	11.85 ± 25.83b	8.89 ± 1.51cd
LS3	291.00 ± 61.44b	282.00 ± 59.27c	46.56 ± 16.85a	54.65 ± 28.77ab
LS4	106.33 ± 94.24c	436.67 ± 24.88b	11.93 ± 2.50b	60.85 ± 3.15a
LS5	103.33 ± 25.77c	43.00 ± 10.39g	15.49 ± 4.27b	4.37 ± 0.65d
CC	472.67 ± 115.00a	746.45 ± 69.32a	23.92 ± 6.01ab	30.53 ± 2.60abcd
LS6		155.11 ± 16.44cdefg		29.73 ± 5.28abcd
LS7		241.78 ± 52.92cde		53.39 ± 14.61ab
LS8		221.33 ± 46.80cde		35.32 ± 11.89abcd
LS9		113.78 ± 4.29efg		16.42 ±0.44cd
LS10		66.33 ± 19.47fg		17.60 ± 5.02cd
LS11		129.89 ± 77.73defg		18.29 ±11.76cd
LS12		147.78 ± 37.68cdefg		24.06 ± 8.44bcd
LS13		121.11 ± 24.54defg		17.28 ± 1.65cd
LS14		172.56 ± 45.04cdefg		27.39 ± 11.63bcd
LS15		262.89 ± 130.81cd		39.80 ± 23.91abc
LS16		196.56 ± 22.34cdef		31.52 ± 6.00abcd
LS17		136.44 ± 30.39defg		19.15 ± 4.45cd
AVG ± SD	208.89 ± 150.52	204.97 ± 166.96	22.68 ± 14.47	28.10 ± 18.06

LS = L. siceraria, CC = C. Colocynthis, SD = Standard deviation There is no significant difference between the means that have the same letters in each column. * Sabo *et al*., 2014. Accepted for publication

Average Comparison test of cultivars for seeds parameters : Table 7 shows that two groups were observed for each of the characters. In the first year, the highest seeds measured between 1 to 1.5 cm and the less high 0.55 cm. In the second year, the highest seeds were obtained in LS2 for 4.23 cm and the less high 0.86 cm. As for the width, 4 groups were formed the first year and two the 2nd year. The LS2 cultivar distinguished itself with 4.34 cm, year 2. We also note that CC seeds were the smallest on the two years with 0.31 cm year 1 and 0.52 cm year 2. The width length ratio that provides information on seeds form highlighted lying seeds (ratio less than 1) for all cultivars except LS2 cultivar the 2nd year which produced large seeds (ration higher than 1).No difference has been observed between cultivars for the variable weight of a seed year 1. In the 2nd year, two groups were identified with LS2 coming in first position with 3 g. The lightest seeds were observed in CC with 0. 04 g.

Table 7: Comparison of different cultivars averages for the length, the width, the width length ratio and weight of a seed.

Cultivar	Length of a seed (cm)		Width of a seed (cm)		Width/length		Weight of a seed (g)	
Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
LS1	1.28 ± 0.10a	1.15 ± 0.04b	0.57 ± 0.05ab	0.60 ± 0.00b	0.45 ± 0.07	0.52 ± 0.08	1.29 ± 1.89a	0.12 ± 0.01b
LS2	1.06 ± 0.06a	4.23 ± 2.80a	0.58 ± 0.03ab	4.34 ± 3.66a	0.55 ± 0.15	1.03 ± 0.01	0.09 ± 0.03a	2.93 ± 2.82a
LS3	1.15±64.57a	1.49 ± 0.34 b	0.65 ± 0.05a	0.63 ± 0.09b	0.57 ± 0.11	0.43 ± 0.02	3.41 ± 5.70a	0.20 ± 0.10b
LS4	1.05 ± 0.13a	1.77 ± 0.07b	0.51 ± 0.06b	0.72 ± 0.04b	0.49 ± 0.02	0.41 ± 0.00	0.13 ± 0.02a	0.13 ± 0.03b
LS5	1.33 ± 0.12a	1.68 ±0.10b	0.50 ± 0.00b	0.65 ± 0.04b	038 ± 0.02	0.39 ± 0.41	0.14 ± 0.04a	0.30 ± 0.13b
CC	0.55 ± 0.03b	0.86 ± 0.06b	0.31 ± 0.03c	0.52 ± 0.01b	0.56 ± 0.00	0.61 ± 0.00	0.06 ± 0.01a	0.04 ± 0.00b
LS6		1.54 ± 0.07b		0.50 ± 0.07b		0.32 ± 0.20		0.17 ± 0.02b
LS7		1.62 ± 0.27b		0.65 ± 0.05b		0.40 ± 0.02		0.22 ± 0.03b
LS8		1.71 ± 0.03b		0.71 ± 0.03b		0.42 ± 0.00		0.17 ± 0.01b
LS9		1.68 ± 0.05b		0.67 ± 0.01b		0.40 ± 0.01		0.14 ± 0.01b
LS10		1.54 ± 0.17b		0.55 ± 0.05b		0.36 ± 0.00		0.30 ± 0.08b
LS11		1.23 ± 0.04b		0.70 ± 0.03b		0.57 ± 0.07		0.13 ± 0.04b
LS12		1.43 ± 0.17b		0.67 ± 0.13b		0.47 ± 0.34		0.18 ± 0.08b
LS13		1.58 ± 0.13b		0.62 ± 0.09b		0.39 ± 0.00		0.23 ± 0.03b
LS14		1.27 ± 0.07b		0.79 ± 0.03b		0.62 ± 0.05		0.15 ± 0.03b
LS15		1.32 ± 0.05b		0.84 ± 0.02b		0.64 ± 0.10		0.14 ± 0.03b
LS16		1.36 ± 0.07b		0.83 ± 0.09b		0.61 ± 0.01		0.15 ± 0.02b
LS17		1.19 ± 0.07b		0.72 ± 0.05b		0.61 ± 0.01		0.16 ± 0.01b
AVG ± SD	1.07 ± 0.27	1.59 ± 0.88	0.52 ± 0.11	0.87 ± 1.11	0.50 ± 0.08	0.51 ± 0.16	0.85 ± 2.41	0.32 ± 0.84

LS = L. siceraria, CC = C. Colocynthis, SD = Standard deviation There is no significant difference between the means that have the same letters in each column.

Results of the correlation analysis between the studied characters: It comes out from table 8 that there were positive and negative correlations between different variables. Year 1, cultivars which rose lately produced many berries (r = 0.6151) with a weight corresponding to (r = 0.6832) and having an important number of seeds per berry (r = 0.6303). Berries obtained were less large (r = -0.6223) and less long (r = -0.4929). In cultivars which

flowered and fructified late, we observed fewer berries (r = -0.5200 for the flowering and r = -0.4409 for the fructification). Those which produced many berries, give heavy berries (r = 0.7654), more seeds (r = 0.6121) of small heights (r = -0.6619 for width and -0.7288 for length). An important number of seeds was produced by the heavy (r = 0.8240) and large (r = 0.4717). The big berries were also very large (r = 0.5564) and provide many seeds (r = 0.5425) and we noted a positive correlation between the length of a berry and that of the seed (r = 0.6797). In table 9, cultivars which germinated late, fructified late (r = 0.4500). The high rate of emergence recorded gave less long seeds (r = -0.4214), less large (r = -0.4126) and of low weight (r = -0.4711). The big berries were obtained with productive cultivars (r = 0.4051), and they were the ones which provided many seeds (r = 0.5008). Berries of large dimensions gave the heaviest seeds (r = 0.9911 for length and 0.5313 for width). The heaviest seeds were also the longest (r = 0.9639). These later ones were also the largest (r = 0.9557).

Table 8: Correlation Matrix (Pearson) between the different characters in year one.

	DE	ER	FLO	FRU	NBP	WtB	LB	WB	NSB	WtSB	WtS	LS
ERP-value	-0.0926 0.7146											
FLO	-0.3711 0.1295	0.1499 0.5528										
FRU	0.0502 0.8431	0.2802 0.2601	0.2433 0,3306									
NBP	0.0323 0.2228	**0.6151** **0.0066**	0.0575 0.8207	0.2368 0.3440								
WtB	0.3613 0.1406	**0.6832** **0.0018**	-0.1839 0.4650	0.1687 0.5034	**0.7654** **0.0002**							
LB	0.1653 0.5121	**-0.4929** **0.0377**	**-0.5200** **0.0270**	**-0.4409** **0.0671**	-0.3780 0.1219	-0.1876 0.4561						
W B	0.0594 0.8150	0.1018 0.6876	0.0981 0.6986	0.3721 0.1284	0.1417 0.5749	0.3050 0.2184	-0.1060 0.6755					
NSB	0.2671 0.2839	**0.6303** **0.0050**	-0.1084 0.6685	0.1779 0.4799	**0.6121** **0.0069**	**0.8240** **0.0000**	-0.3014 0.2241	**0.4717** **0.0481**				
WtSB	0.1063 0.6748	0.0488 0.8474	-0.1638 0.5160	0.0394 0.8767	0.0312 0.9020	0.2310 0.3563	0.2087 0.4060	**0.5564** **0.0165**	**0.5425** **0.0200**			
WtS	-0.0081 0.9745	-0.0536 0.8329	0.1441 0.5684	0.1662 0.5097	0.0925 0.7149	0.0569 0.8224	0.1666 0.5088	**0.4795** **0.0440**	0.1529 0.5446	**0.7275** **0.0006**		
LS	-0.2028 0.4195	**-0.6044** **0.0079**	-0.1546 0.5402	-0.3057 0.2173	**-0.7288** **0.0006**	**-0.6955** **0.0014**	**0.6797** **0.0019**	-0.2139 0,3941	**-0.7338** **0.0005**	0.0616 0.8081	0.3012 0.2245	
WS	-0.1453 0.5650	-0.6223 0.0058	0.0282 0.9116	-0.1424 0.5730	**-0.6619** **0.0028**	**-0.7870** **0.0001**	0.2911 0.2412	-0.1740 0.4900	**-0.5575** **0.0162**	0.2695 0.2794	0.3587 0.1438	**0.7332** **0.0005**

DE: date of emergence; ER: emergence rate; FLO: flowering FRU: fructification; NBP: number of berries per plant. WtB: weight of berry. LB: length of berry; WB: width of Berry; NSB: number of seeds per berry; WtSB: weight of seeds per berry. WtS: weight of a seed. LS: length of a seed; WS: width of a seed. Bold = p < 5%<

Table 9: Matrix Correlation (Pearson) between different characters in year 2.

	DE	ER	FLO	FRU	NBP	WtB	LB	WB	NSB	WtSB	WtS	LS
ERP-value	0.0567 0.6839											
FLO	0.4552 0.0005	- 0.1191 0.3908										
FRU	**0.4500** **0.0006**	- 0.1383 0.3187	0.9608 0.0000									
NBP	**-** **0.2967** **0.0293**	0.2102 0.1271	- 0.2470 0.0718	- 0.2527 0.0653								
WtB	**-** **0.3434** **0.0110**	0.1789 0.1954	0.2752 0.0440	**-** **0.3136** **0.0209**	**0.4051** **0.0024**							
LS	0.0737 0.5963	- 0.0711 0.6092	0.2545 0.0633	0.2247 0.1023	- 0.1365 0.3250	- 0.0421 0.7627						
W S	- 0.0249 0.8583	- 0.1407 0.3102	0.0525 0.7061	0.0213 0.8784	- 0.1192 0.3905	0.1586 0.2520	**0.5313** **0.0000**					
NSB	**-** **0.3834** **0.0042**	**0.2788** **0.0412**	**-** **0.3132** **0.0211**	**-** **0.3750** **0.0052**	**0.5008** **0.0001**	**0.8458** **0.0000**	- 0.2016 0.1437	- 0.0120 0.9315				
WtSB	**0.3364** **0.0129**	**0.2701** **0.0482**	0.0016 0.9909	- 0.0745 0.5924	0.2255 0.1010	**0.4880** **0.0002**	0.2047 0.1377	0.1328 0.3382	**0.5766** **0.0000**			
WtS	0.1333 0.3365	**-** **0.4111** **0.0020**	0.2132 0.1216	**0.2739** **0.0451**	- 0.1625 0.2403	- 0.1429 0.2797	- 0.1570 0.2569	- 0.0839 0.5462	- 0.2354 0.0866	- 0.2103 0.1270		
LS	0.1245 0.3698	**-** **0.4214** **0.0015**	0 .2178 0.1137	0.2553 0.0624	- 0.2417 0.0783	- 0.1980 0.1512	- 0.1523 0.2715	- 0.0156 0.9109	**-** **0.2799** **0.0403**	- 0.1210 0.3833	**0.9639** 0.0000	
WS	0.0951 0.4940	**-** **0.4126** **0.0019**	0.1994 0.1482	0.2624 0.0552	- 0,1401 0.3124	- 0.1566 0.2583	- 0.2190 0.1116	- 0.1594 0.2497	- 0.2030 0.1409	- 0.1884 0.1724	**0.9911** **0.0000**	**0.9557** **0.0000**

DL: date of emergence; RL: emergence rate; FLO: flowering FRU: fructification; NBP: number of berries per plant. WtB: weight of berry. LB: length of berry; WB: width of Berry; NSB: number of seeds per berry; WtSP: weight of seeds per berry. WtS: weight of a seed. LS: length of a seed; WS: width of a seed. Bold = p < 5%.

DISCUSSION

The results showed a great variability of germinating characteristics. Several parameters (species and seeds age) can influence the duration and rate of emergence. Indeed, according to (Dje *et al*.,2006) in c. melo the rate

of germination is 5% for seeds of 18 months age and 32% for the seeds of 3 months age. The emergence time is 6 and 8 days for the seeds of 18 months age and 5 to 14 days for seeds of 3 months. This shows better rate obtained in the 2nd year, because the seeds were of the previous harvest. According to (Achigan, 2002), the duration of germination of the three studied species (Lagenaria sicerari, C. lanatus, C edulis) varies between 5 and 10 days. The same interval has been obtained by (Zoro *et al*., 2003) a germination rate, which varies from 85 to 96% in Lagenaria siceraria. These values were close to those, which we obtained in the 2nd year in this species (50-100%). According to (Walters *et al*., 2005), germinating power can be kept for a long time in this species. For the flowering, the 1st year, analysis of variance showed that there was no significant difference between cultivars. We note that the cultivars have been late in the first year. Several environmental phenomena could be associated to these variations, especially in the 1st year, where we noted drought periods in rainy season. In Dje *et al*., 2006, the first buds flowers appeared between 39 and 43 (DAS) in the dry season and between 70 and 78 DAS in the rainy season in c. melo. According to (Zoro *et al*., 2003), this duration varies significantly from one species to another, in c. lanatus from 35 to 38 days and in the Lagenaria siceraria cultivars from 40 to 52 days. This difference between Lagenaria cultivars has been already observed by (Achigan, 2002) who has indicated that the date of flowering is a discriminating character of Lagenaria siceraria populations. In terms of sex determination, we noted that there is a difference in sex appearance, the female flowers appear 8 to 10 days after male flowers. In the two species, female flowers close 24 hours after their opening up and development of the berry, which lasts about three weeks, starts immediately. This difference in sex has already been observed by (Dje *et al*., 2006), the appearance of males flowers proceeding from 7 to 10 days that of hermaphrodite flowers. The flowering is spaced out so that bud flowers appear on plants after full maturation of the first berries. According to (Achigan, 2002; Zoro *et al*., 2003) Lagenaria siceraria and Citrullus sp., are monoic species with an asynchronous flowering, the male flowering appearing first with an interval of seven days maximum, in comparison with the female flowering. In terms of fructification, it came out from our study that the cultivars, which have been early or late for flowering, did the same for fructification. At maturity, we observed a yellowing of peduncles of berries and a drying of peduncles three months after the beginning of fructification in Citrullus colocynthis and Lagenaria siceraria. Thus, the duration of fruits maturity cycle varies between 100 and 190 days. This is a very long period, which coincides with the liberation of fields for livestock. (Zhang & Jiang, 1990) found 120 days in four cultivars of Chinese Cucurbitaceae. (Dje *et al*., 2006) reported that this period is from 130 to 150 days during the rainy season and 110 to 120 days during the dry season. Indeed, in the dry season, the plant dries out completely while in the rainy season, the production of flowers and berries is much more ranged. At harvest, we recorded a variability of the production in berries from one cultivar to another in Lagenaria siceraria. Citrullus colocynthis has been more productive than Lagenaria siceraria. This production has dropped in the 2nd year. This could be due to the abundant rainfall. However, Citrullus colocynthis is a cultivar which cultivation does not require much water. (Achigan, 2002) indicated that cultivars of Citrullus produce three to four berries per plant; those of Lagenaria produce one to three berries per plant. According to (Dje *et al*., 2006), the very low production in berries could be resulted from a fertilization problem related to a small number of pollen seeds deposited on the stigma. However, attacks of flowers and fruits by cucurbitaceas ladybirds have been observed. Indeed, pollen seeds (16487 ± 231 per plant) were released a night before the opening of the flowers as it has been observed in c. pepo by (Nepi & Paccini, 1993). The amount of viable pollen seeds decreased rapidly during the 24 hours, after the opening of the flower. That is why the female flowers must be pollinated immediately after the opening; otherwise, the pollens will remain relatively viable (Vidal *et al*., 2006). It has been noted that the flowering date negatively influences the width of the berry and positively the number of seeds per berry. The duration of the emergence has a negative effect on the number of berry, the weight of a berry, the number of seeds per berry, the weight of seeds per berry. The number of berries per plant is positively correlated with the weight of a berry and the number of seed / berry. This strong positive correlation has been also observed in watermelon (Nerson, 2002). Therefore, the weight of Lagenaria siceraria berries could be used as a good criterion to select individuals with a greater number of seeds. This result is harmonious with the findings of (Achigan, 2002). During this study, the heaviest berries were harvested in Citrullus colocynthis, first, followed by LS1, LS3 and LS4. The significant weight of CC berries could be due to the fact that, even at maturity they were fresh, while L. siceraria berries were completely dehydrated and form hard shells. Concerning the length in Lagenaria siceraria the longest berries were observed in the second year in

LS1 and LS5.This concern guitar cultivar (LS1) and the large ladle (LS5).

As for the production of seeds, the most productive cultivars were Citrullus colocynthis, LS3 and LS4. The number of lowest seeds yield has been obtained with LS5 on the two years. This could be related to the form of the berry. Unlike other LS, all of the seeds were concentrated in the bulging base (which gave it its ladle form) whereas for others, the seeds were uniformly distributed throughout the berry. Seeds with high heights were obtained with LS2, LS3 and LS4. The smallest seeds were observed in Citrullus colocynthis with dimensions and weights always ranging in the last group. The seeds obtained were all lying. except those of LS4 which were large. This led to an average production in seeds of 181 kg / ha the first year and 705 kg / ha in the second year for the two species. However, it has to be noted that there were very interesting values in Citrullus colocynthis, which is cultivated for its seeds: 500 kg / ha in year 1 and 117 kg / ha in year 2. (Achigan, 2002) showed that the yield per hectare of the cultivars studied varies from 83 to 600 kg. ha^{-1}. (Zhang & Jiang, 1990) noted that the four Chinese cultivars produce 202.5 kg / ha in average.

The seeds, on which this study was centred, are of a great importance in many ways for the Niger Republic consumer. Among other important reasons: these plants require less rainfall and inorganic fertilizers to grow. The production of these seeds could help the country achieve food sufficiency, which is in line with the authorities' efforts for a sustainable agriculture based on local plants cultivars.

CONCLUSION

This study has highlighted on the short and long cycles cultivars, as well as productive and less productive cultivars. Over the two years, all of the characters allow to distinguish different cultivars apart from the duration of the emergence, the date of fruiting, the width of a berry and the weight of a seed, the first year. In Niger, these cultivars are cultivated for the socio-economic interests that provide berries and seeds. The study showed that production in berries and seeds cultivars from one cultivar to another. Unfortunately, there is little research work done on this family. The best yields in berries and seeds are obtained with *Citrullus colocynthis* followed by the cultivars LS3 and LS4 of *Lagenaria siceraria*. It has been noted that the low yield in Lagenaria siceraria berries and seeds was composed of large size and heavy berries and seeds comparatively to Citrullus colocynthis that produced seeds with small sizes. Despite the interesting agricultural potentialities of these cultivars, many parameters need to be better detailed, including berries yield, and the cycle of these plants. Mass selection efforts could be a way for performance improvement. Studies should be conducted to have a good command of pollination to improve production, increase the average weight of a berry and reduce their cycles. Indeed, the results gave a low productivity in berries and very long cycles. These long periods coincide with the liberation of fields. It most often leads to conflicts between pastoralists and farmers, which end in the loss of human lives. The production should be encouraged given their high nutritious and monetary values. In addition, a strong correlation was found between the yield in berries (number and weight average of a berry) and the yield in seeds. A better strategy for improvement would be to select individuals producing several large berries per plant. It is in such a way that a gain in seeds is more likely to be obtained. It is therefore important to focus forthcoming varietal improvement programs on seeds productivity. For more information, further studies should be conducted on the floral biology and the degree of sensitivity to parasites of these two species. At the end of this study, the extension of these species may be an important income generating activity and sources of essential nutriments that can help rebalance the nutritional status of the populations in general and children in particular.

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