Farmers' perception of *Calotropis procera* on the productivity of off-season sorghum (Sorghum durra) in Magoumai, Gawar and Laf (Far North Cameroon)

Abstract

The present study focuses on farmers' perception of *Calotropis procera* on the productivity of off-season sorghum in Magoumai, Gawar and Laf (Far North Cameroon). The main objective of this work is to contribute to a better understanding of the impact of *C. procera* on the yield of off-season sorghum. Ethnobotanical surveys were carried out in three (3) villages of the study sites, where 346 individuals were randomly selected from the population of these areas. The data collected were analyzed in terms of the percentage of respondents reporting the impact of *C. procera*on off-season sorghum productivity. This analysis showed that *C. procera* impacts the soil in which off-season sorghum is grown: 57.67 ± 1.52% and 39.67 ± 4.35% respectively of respondents felt that *C. procera*sucks up soil moisture and impoverishes the soil. With regard to the development stages of off-season sorghum, *C. procera*has a much greater influence on plant growth, with a percentage of 95 ± 3.05%. With regard to the agricultural yield of off-season sorghum, it is most visible on panicle weight, with an average percentage of 47 ± 4.58%. These impacts are more visible in terms of crop yield. This work has enabled us to acquire knowledge on the impact of the crop on the yield.

Keywords: Farmer perception, *Calotropis procera*, productivity, off-season sorghum, Far North Cameroon

1.INTRODUCTION

Calotropis procera is a species of the Apocynaceae family found in tropical Africa, the Indian Ocean islands and northern South Africa (Ahmed et al., 2005). Its extremely wide range suggests that the shrub is endowed with great ecological flexibility (Rivas et al., 2020). It is found throughout the Sudano-Sahelian zone (Gillet, 1968). *C. procera* came from the margins of the desert and is gradually moving southwards (Seignobos, 2016). It is very common in all dry regions of East and West Africa and part of Central Africa (Ahmed et al., 2005). Roots, bark, latex, leaves and flowers are all used in traditional medicine (Al-Rowaily et al., 2020). Use in traditional pharmacopoeia has shown that the extract from the flowers of this species causes

degeneration of the sexual organs of individuals, and the decoction of dried leaf powder cures coughs and madness (Sharma, 1934). In most developing countries, rural populations use it as a source of wood and food (Baba-Moussa et al., 2007). However, *C. procera*destabilizes ecosystems in arid environments (Dhileepan, 2014).

It is in this sense that Gillet (1968) in his Ecological and ethnobotanical Note on *C. procera*, presents it as a "colonizer of ruined lands' where the most prosperous individuals are seen on the poorest soils". It appears as an indicator species for desertification of the Sudano-Sahelian zone (Kaur et al., 2021). It also persists widely in crop fields and can therefore have harmful effects on crops through allelopathy (Hassan et al., 2015). Off-season sorghum is an important cereal in the cropping systems and diets of many sub-Saharan African countries (Manssour et al., 2014). The northern zone of Cameroon is one of the most important production areas of this cereal (MINEPAT, 2015) (figure). In the Far North, off-season sorghum has developed rapidly and currently represents 40% of total cereal production. It occupies a privileged position in time and space. Over time, because the work it requires does not compete with that of cash crops (cotton, peanuts, rice). In space, because it occupies land which is generally not devoted to other crops (Barrault et al., 1972; Germain, 1973; Ndembou, 1987). This cereal gives higher yields than rainfed crops, and allows a second cereal harvest in the middle of the dry season (Mathieu, 2002). However, its implementation requires the cutting and grubbing of trees, necessary conditions for the establishment of the crop, in order to reduce competition for water and limit the presence of perches for seed-eating birds (Mathieu *et al.*, 2007). Likewise, the permanent exploitation of cultivated plots without fallowing has led to problems of soil degradation. It is in this context of soil degradation that we are interested in indicator tree species.

In Cameroon in general, more precisely in the Far North Region, few studies have been carried out concerning the impact of *Calotropis procera*on the productivity of off-season sorghum, hence the absence of scientific information on its impact on off-season sorghum productivity. The present study aims to fill this gap. Therefore, the main objective of this work is to contribute to a better knowledge of the impact of *C. procera*on off-season sorghum. Specifically, it is about

- show the peasant perception of *C. procera*on the soil;
- present the peasant perception of *C. procera* on the productivity of off-season sorghum.

2. MATERIALS AND METHODS

2.1 Study site

The study is carried out in three villages in the Far North Region, Cameroon (Magoumaï, Gawar and Laf) respectively in the Districts of Bogo, Mokolo and Moutourwa. Bogo is a district of Diamaré located between 10°44' North, 14°36' East. It is limited to the South-West by the district of Dargala, to the North-East by the district of Maga, to the North by Petté, to the North-West by the Commune of Maroua 3rd and to the South-East by the district of Moulvoday. It covers an area of 93,000 ha for a population of 95,230 inhabitants (BUCREP, 2005). The climate is of the Sahelian type characterized by a dry season which lasts 7 months with high temperatures (28-35°C) and a rainy season of 5 months. The relief consists of a large plain (310-330 m) and a few hills to the southwest in the canton of Bgalaf (HosséréGoboré, 493m) and to the northwest in the canton of Balda (Hosséré Balda, 679m) (Wakponou, 2004). The average annual rainfall varies between 95mm and approximately 835mm. The ethnic groups encountered are the Fulani, Guiziga, Moufou. Musghun and Sirata. Economic activity is marked by agriculture, livestock, and trade.

Mokolo is a district of Mayo-Tsanaga located between 10°44' North, 13°48' East. It is limited to the North by Koza and Mozogo, to the South by Mogodé and Hina, to the East by Gazawa and Souledé-Roua and the West by Bourha and the Republic of Nigeria. It covers an area of 1,650 km2 for a population of 310,000 inhabitants (BUCREP, 2005). The climate is Sahelian, characterized by a long dry season of 7 months and a short rainy season of 5 months. Harmattan winds blow from the Sahara towards the south in December and January. The temperature is high during the dry season around 43.3°C (CVUC, 2014). The relief is marked by a set of high-altitude plateaus characteristic of the Mandara Mountains which are part of the mountain ranges constituting the Cameroonian ridge. The average rainfall varies between 700 mm and 1000 mm. The different types of soils present are: clay soils, sandy clay soils and sandy soils. The ethnic groups encountered are the Mafa, the Fulani, the Moufou, the Kapsiki. The main activities of the populations of this region are dominated by agriculture, livestock breeding and small commerce (UNDP, 2002). Moutourwa is a district of Mayo-Kani located between 10°11' North, 14°10' East. The climate of the commune is Sudano Sahelian type, characterized by two seasons: A long dry season lasting approximately eight (08) months, going from October to May and a rainy

season of four (04) months covering the months of June to September. Annual rainfall varies between 700 and 1000 mm with an average of 800 mm. The average annual temperature is 34°C, with March, April and May as the hottest months and December, January and February as the coldest months. The relief of the commune of Moutourwa is characterized by vast plains crossed by a few mountain ranges which peak at 400 meters (PCD Moutourwa 2014). The different types of soils encountered are: vertisols (Karal), planosols (Hardé), ferruginous soils and hydromorphic soils (Yaéré) The main activities of the populations of this region are dominated by agriculture, livestock and small commerce. The ethnic groups encountered are Guiziga, Moufou, Mafa, Toupouri (PCD Moutourwa 2014).

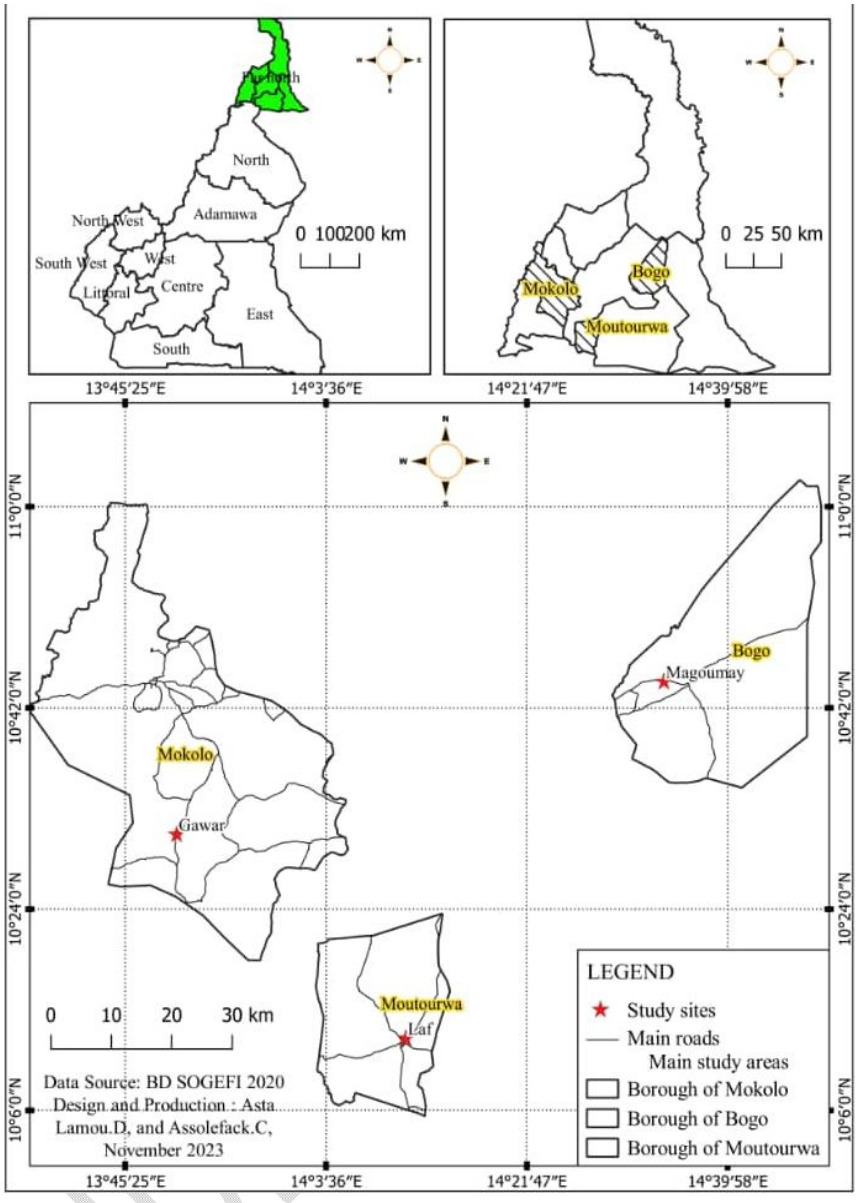


Figure 1:Study site

2.2 Field data collection

Data collection took place in the three study area sites. It consisted of carrying out surveys with traditional chiefs and producers. These sites were chosen based on accessibility, the presence of off-season sorghum fields and the density of *C. procera*.

2.3 Sampling method

This interview was carried out using the probabilistic method where the choice of surveys was random. This made it possible to embrace all layers of respondents.

2-4 Sample size

The people interviewed are previously defined using the following formula: $n = (t^2p \times P (1 – P) \times N) / (t^2p \times P (1 – P) + (N–1) \times y^2)$ n: sample size: size of the actual or estimated target population; P: expected proportion of a population response or actual proportion. In our case the study is multi-criteria and has not been carried out, it is set at 0.05 by default, which allows us to have the largest possible sample; tp: sampling confidence interval y: margin of sampling error.

2.5 Investigations

The interview was carried out in the form of a structured and semi-structured interview, which allowed us to guide the procedures. The questionnaire included three types of questions: open questions through which the respondent will freely express their opinion; closed questions to be answered with Yes or No and leading questions in which the respondent will choose one or more answers. This interview was carried out using a questionnaire previously tested (Martin and Segalen, 1996) respectively with traditional leaders and people belonging to large communities (local populations). This interview is carried out on the basis of a section such as: identification of respondents, perception of the population of the impacts of *Calotropis procera* on the soil, perception of the population of the impacts of *C. procera*on the yield of sorghum against season. To better understand the impact of *C. procera*on off-season sorghum, surveys are carried out in 3 villages of the study sites.

The criteria for choosing the people surveyed:

be at least 20 years old;

have resided in the study area for at least 15 years.

A total number of 345 individuals in three villages were surveyed: 115 in Laf, 115 in Gawar and115 in Magoumai.

2.6 Data analysis

The percentage of respondents on the impact of *C. procera* (Maregesi et al., 2007) was calculated using the formula: S = (n/N) *100

Where S: calculated response percentage;

n: number of people who gave a positive response (Yes) for the use of the organ concerned;

N: total number of people surveyed.

The results are statically analyzed using Statgraphics 5.0 software, which made it possible to perform the Duncan test and analysis of variance (ANOVA).

3.RESULTS AND DISCUSION

The ethnicity of the populations surveyed in our explored sites is represented in (table 1). Generally speaking, the respondents from these three localities are of Guiziga origin (40.67 ± 13.20%). However, there are other ethnic groups such as the Fulani with an average percentage of (38.54 ± 19.86%) followed by the Moufou (9.07 ± 4.45%), Mafa (5.72 ± 3.46). %), Toupouri (4.62 ± 5.08%), Musgum (1 ± 1.73%) and Sirata (0.33 ± 0.57%). The analysis of variance shows a significant difference between ethnic groups ($p<0.05$). This result could be explained by the fact that the Guiziga are indigenous and have enough land for cultivation, thus promoting their economic development, while the Peulhs are mostly nomadic breeders and the Toupouris come from Mayo-Danay, because they are areas with a source of development.These results are consistent with the work reported by Kapi *et al.*, (2020) who affirm that the Guiziga are the most numerous in the Diamaré plain and are the indigenous peoples of Laf.

Table 1: Distribution of respondents by ethnicity (%)

Ethnic groups	Magoumai	Gawar	Laf	Avg ± Diff
Guiziga	38	29	55	40.367 ± 13.20^{b}
Peulh	51	49	15.63	38.54 ± 19.86^{b}
Moufou	4.32	13	10	9.07 ± 4.45^{a}
Musgum	3	0	0	2.33 ± 1.73^{a}
Mafa	2.13	6	9.04	5.72 ± 3.46^{a}
Sirata	4,18	0	0	0.33 ± 0.57^{a}
Toupouri	1,61	3,33	10,33	4.62 ± 5.08^{a}

Numbers assigned different letters are significantly different at the 5% threshold.

In all of these villages, the average percentage of respondents by age group is low 7 ± 1% in the interval at [20-29] years, followed by 10 ± 1% in the interval [30-39] years, comes 18.67 ± 4.16% in the interval [40-49] years and finally 64.33 ± 6.02% for the age group greater than or equal to 50 years (Table 2). The analysis of variance shows a significant difference between the age groups ($p<0.05$). The majority of respondents are concentrated in the age group greater than or equal to 50 years (65.66±4.53%). This could be because older people are the heads of

households who must feed their families. These results corroborate those reported by Rousgou (2016) in the Department of Mayo-Kani where people in the age group between 50 and 60 years are the majority in agriculture.

Table 2: Distribution by age group (%) of populations

Age range	Magoumai	Gawar	Laf	Avg ± Diff
[20-29]	8	4	7	6.33 ± 2.08^{a}
[30-39]	15	9	10	11.33 ± 3.21^{ab}
[40-49]	22	19	13	18.00 ± 4.58^{b}
≥50	55	68	70	64.33 ± 8.14^{c}

Numbers assigned different letters are significantly different at the 5% threshold.

Regarding the activities of the respondents, 77.73 ± 3.05% of respondents have agriculture as their main activity, followed by 17.33 ± 1.53% of respondents as breeders and finally 5.33 ± 2. 51% of respondents trade (Figure 1). The analysis of variance shows a significant difference between the activities of the population surveyed ($p<0.05$). This situation is understandable insofar as agriculture feeds them and remains the main source of income for the respondents who associate it with livestock farming. Livestock breeding is the activity which is parallel to agriculture because cow dung is used as manure in the fields and crop residues as fodder for animals. This result corroborates that of Kemeuze (2015) who certifies that agriculture and livestock breeding constitute the main daily activities of the populations of the Far North of Cameroon.

Figure 2: Population activities in the different sites

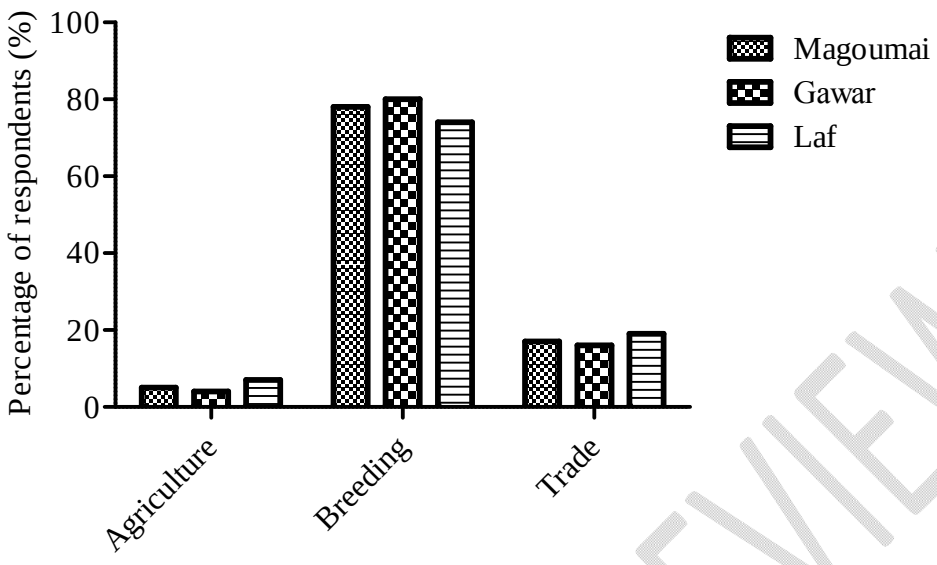
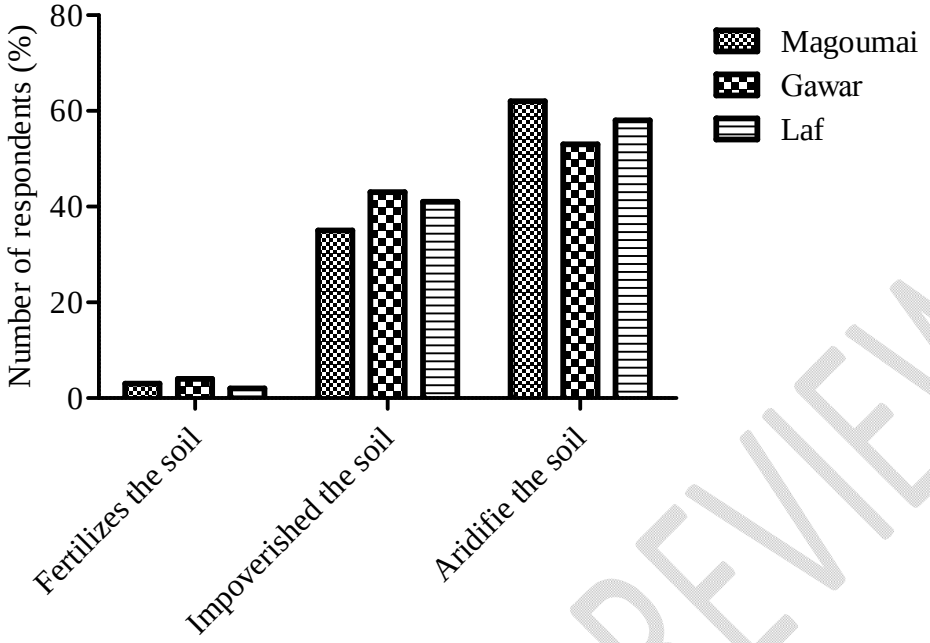


Figure 2 represents the respondents' perception of the impact of *C. procera* on vertisol. The analysis of variance, however, shows that there is a significant difference between the impacts of *C. procera* on the soil ($p<0.05$). Generally speaking, 3 ± 3.05% of respondents judge that *C. procera* fertilizes the soil, others estimate that the species impoverishes the soil with an average percentage of 39.67 ± 4.35% and 57.67 ± 1.52% of respondents think that *C. procera* sucks moisture from the soil. The high proportion of respondents leans towards soil aridity, followed by the depletion of soil mineral elements by *C. procera*. In fact, the evapotranspiration surface of the species is larger and it captures morelight and nutrients (air nitrogen, phosphorus) compared to the cultivated plant. This result disagrees with that of Manssour *et al*., (2014) on the productivity of sorghum in a growing system based on Acacia Senegal.

Figure 3: Influence of *Calotropis procera* on soil



Impact of *Calotropis procera* on soil

Table 3 shows the effect of *C. procera* on different developmental stages of muskwaari. According to the respondents, it impacts more during growth (95 ± 3.05%) followed by fruiting (2.70 ± 1.80%) and germination (1.3 ± 0.83%). The analysis of variance shows a significant difference between the stages of plant development ($p<0.05$). The development of the plant takes place in three stages (germination, growth and fruiting). During off-season sorghum growth, it needs water, light and mineral salts. According to the respondents, *C. procera* is competing with the crop at the moment because the size, the diameter at the collar and the number of leaves slow down during this phase.

Table 3: Impact of *C. procera* on the development stages of transplanted sorghum

Stade of development	Magoumai	Gawar	Laf	Moy ± Ecart
Germination	2	1,53	0,37	$1,3 \pm 0,83^{a}$
Growth	93	95	99	$95 \pm 3,05^{b}$
Fructification	4	3,47	0,65	$2,70 \pm 1,80^{a}$

Numbers assigned different letters are significantly different at the 5% threshold.

Figure 4 represents the impact of *C. procera* on the different off-season sorghum yield parameters across the sites. Analysis of variance shows a significant difference between the impacts of *C. procera* on the size, girth and agricultural yield of off-season sorghum. It appears from this survey that 6.42 ± 32% of respondents believe that *C. procera* reduces the circumference of the transplanted sorghum stem, 20.67 ± 10.96% of respondents believe that it reduces the size of the plant and 47 ± 4.58% think that it reduces the yield of muskwaari. This can be justified by the fact that during growth, the plant competes with *C. procera* for nutrients and water needed for its growth. On vertical soils *C. procera* proves more dangerous because of its powerful root system through which it pumps water to the detriment of the transplanted sorghum (Seignobos, 2016). This result is not in agreement with those of Manssour *et al.*, 2013 who showed that *Acacia senegal* is a legume which, thanks to the symbiosis with rhizobia and mycorrhizal fungi at the root level, is capable of stimulating significant development a great diversity of microbial colonies which are a source of nitrogen and phosphorus in the soil. Concerning the agricultural yield of off-season sorghum in recent years of cultivation, farmers say that it is declining. This could be due to the colonization of off-season sorghum fields by *C. procera* compared to previous years. Indeed, some respondents told us that the presence of the species impacts the yield of off-season sorghum. The denser *C. procera* is, the lower the yield of off-season sorghum.

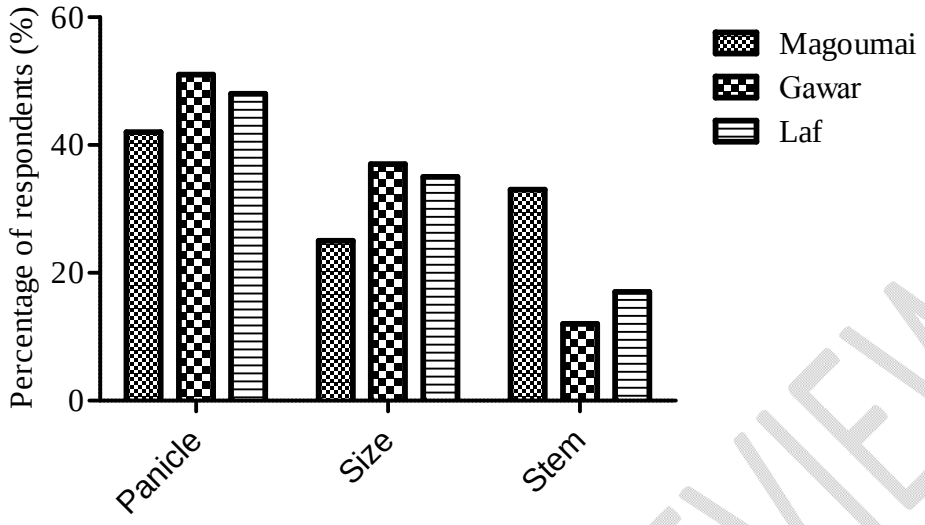


Fig 4. Impact of *C. procera* on off-season sorghum yields.

4.CONCLUSION

Having reached the end of our analysis, it was a question for us of showing the peasant perception of *Calotropis procera* on the productivity of off-season sorghum. In view of the results obtained, Concerning the ethnicity of the respondents, the Guiziga are the most represented, are indigenous and have enough land for cultivation. According to the age of the respondents, the majority is concentrated in the age group greater than or equal to 50 years. Livestock breeding is the most practiced activity after agriculture. Concerning the stages of development, respondents affirm that *C. procera* has a greater impact during growth and reduces the yield of off-season sorghum. *C. procera* degrades soil through absorption of nutrients and water. Therefore, we must look for a means of combating the invasion of this species in off-season sorghum fields.

REFERENCES

Ahmed K. K. M., Rana A. C., and Dixit V. K., 2005. *Calotropis species* (Asclepiadaceae). *Pharmacognosy Magazine*, 1(2): 48-52.

Al-Rowaily S. L., Abd-El Gawad A. E. G., Mohamed T. A. et al., 2020. Essential oil of *Calotropis procera*: comparative chemical profiles, antimicrobial activity, and

allelopathic potential on weeds. *Molecules* (25): 03 – 52 doi: 10.3390/molecules 25215203

Baba-Moussa L., Toukourou F. and Sanni A., 2007. Coagulant properties of *Calotropis procera* and its possibilities for use in the food industry. *CAMES magazine*. 5(1): 7-12

Barrault J., Eckebil J.P., Vaille J. 1972. Update on IRAT's work on transplanted sorghums in North Cameroon. *Tropical Agronomy*, 27 (8): 791-814

Central Bureau of Censuses and Population Studies of Cameroon (BUCREP) 2010. Third general population and housing census, 3rd RGPH, volume 1, Yaoundé, 190p.

Commune United City of Cameroon (CVUC), 2014. Available at http://cvuc.cm/national/index.php/fr/carte-communale/region-de-l'Extrême-nord. Accessed June 11, 2019.

Dhileepan K., 2014. Prospects of the classical biological control of *Calotropis procera* (Apocynaceae) using coevolved insects. *Biocontrol. Sci. Technol*., (24): 977-998. doi:10.1080/09583157.2014.912611

Dubreuil P., 1962. Surface hydrology in the Diamaré. *Cameroonian research and studies*. 9(1): 31-41

Germain P., 1973. Improvement of *Muskwaari* culture. In: Analytical report 1972. Marouz and Toukou centers. Yaoundé: GERDAT-IRAT, 68-72p.

Gillet H., 1968. Ecological and ethnobotanical note on *Calotropis procera*. *Jatba*, 15(12): 543-545.

Hassan L. M., Galal T. M., Farahat E. A., and El-Midany M. M., 2015. The biology of *Calotropis procera* (Aiton) WT. Trees 29: 311-320. doi 10.1007/s00468-015-1158-7

Kapi D., Adamou I., and Abib Chimène F., 2020. Floristic characterization of the main types of land use and their management in the locality of Laf, Far North Cameroon. *Int. Mut. Jou of Sci* and Tec (IMJST), 5(1): 2528-9810

Kaur A., Batish D. R., Shalinder Kaur S. and Chauhan B. S., 2021. An Overview of the Characteristics and Potential of *Calotropis procera* from Botanical, *Ecological and Economic Perspectives. Forehead*. Plant Sci. (12): 690-806. doi:10.3389/fpls.2021.690806

Kemeuze V. A., Mapongmetsem P-M., Sonwa D., Fondzossie E. and Nkonmenec k., 2015. Plant diversity and carbon stock in Sahel grows of semi-arid areas of Cameroon: case of study of Mandara Mountain. *International Journal of Environment*, 4(2): 308-318

Manssour A.M., Zoubeirou A.M., Nomao D.L., Djibo E.S., Jean-MarieA. K., 2014. Productivity of sorghum cultivation in an agroforestry system based on *Acacia senegal* (L) Willd in Niger. *Journal of Applied Biosciences*, 82: 7339 – 7346

Mathieu B., 2002. Sorghum transplanted in North Cameroon: promoting the know-how of farmers and organizing the sector. The cultivation of flood recession sorghum in West and Central Africa, 161-180.

Mathieu B., 2007. The recent extension of *muskwaari* to North Cameroon: endogenous dynamics and new research needs. African Savannas: changing spaces, actors facing new challenges, 2003, Garoua, Cameroon. 12p.

MINEPAT, 2015: Annual report: Cameroon plans to double its sorghum production to 2 million tonnes by 2020. Available on xxxxx@investaucameroun.com

Ndembou S., 1987. *Muskuwaari* cultivation downstream of the Lagdo dam. Cameroon *Geography Review*, (7): 27 - 41

Municipal Development Plan (PCD), 2014.

Rivas R., Barros V., Falcao H., Frosi G., Arruda E. and Santos M., 2020. Ecophysiological traits of invasive C3 species *Caltropisprocera* to maintain high photosynthetic performance under high VPD and low soil water balance in semi- arid and seacoast zones. *Forehead. Plant. Sci.*, 11:717. doi: 10.3389/fpls.2020.00717

Rousgou N., 2016. The influence of A. indica reforestation on the conservation and restoration of local biodiversity in Guidiguis (Far North, Cameroon). Master's thesis, University of Ngaoundére, Cameroon, 57p.

Seignobos C., 2016. The *Calotropis procera* shrub, an episode in its history in the Lake Chad basin. *Journal of ethnoecology*. 9(1): 2-17.

Sharma G. K., 1934. *Calotropis procera* and Calotropis gigantea. *Indian J. vet. Sci. anim.* Husb., (4): 63-74

Wakponou A., 2004. Geomorphological dynamics of Sudano-Sahelian land bases in Far North Cameroon. *NR Doctoral Thesis*, Laboratory of Zonal Geography for Development, University of Remis Champagne-Ardenne 229p.