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Research Article

Adaptation and Yielding Ability of Local Accessions of *Ricinus communis* L. In Sudano-Guinean Climate of Adamawa-Cameroon

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Abstract: Field trials were carried out to investigate the agronomic parameters of five castor bean accessions cultivated in the environmental conditions of Sudano-Guinean zone of Cameroon. Planting was done following a randomized block design with 03 replications and five treatments (04 castor bean accessions from Adamawa Cameroon : Vina, Martap, Nyambaka and Bélel ; 01 castor bean from North Cameroon). Growing parameters and seeds yield were evaluated. Growing parameters and seeds yields were significantly different ($p<0.05$) between castor bean accessions. Among the four castor bean from Adamawa region, Nyambaka accession adapted better in our study area : this accession possessed the highest seeds yield (1018 ± 25.71 kg/ha) while the smallest is from Vina accession (804 ± 10.50 kg/ha). Seeds yield of Nyambaka accession is 2.10 folds lower than that of Ndoutourou accession and seeds yield of Martap, Vina and Bélel accessions are respectively 2.34; 2.66 and 2.19 folds lower than that of Ndoutourou accession. Considering the results obtained in this study, Nyambaka accession can be used in the program of implementation of castor bean as alternative crop for Cameroonian agriculture. However, seeds oil content and physico-chemical properties of oil from studied castor bean accessions need to be investigated.

Keywords: Castor bean accessions, growth, seeds yield, Sudano-Guinean zone, Cameroon.

INTRODUCTION

Ricinus comminus L. (castor bean) is an oleaginous that seeds oil content ranges between 40 and 60%. Castor bean is cultivated for its seeds which yield viscous, pale and non-volatile yellow oil (Pina *et al.*, 2005). The oil has many industrial applications notably it is used in the manufacture of paints, dyes, inks, waxes, varnishes, lubricants and brake fluids (Devendra and Raghavan, 1978; Ramos *et al.*, 1984; Ogunniyi, 2006). Oil obtained by cold pressing of castor bean seeds is also used in household for soap production and as purgatives and laxatives (Weiss, 2000).

The major production countries are Brazil, China, India and the countries of the former Soviet Union. Seeds yields in these countries are generally low, between 400 and 900 $kg.ha^{-1}$ (Bonjean, 1991), mainly as a result of growing unimproved cultivars and extensive cultivation. The major producing genotypes found in the literature varied from 2000 to 2620 $kg.ha^{-1}$ in France and 1500 to 2500 $kg.ha^{-1}$ in Italy (Laureti and Marras, 1995). The seed oil content depends on genotype but is also affected by the environmental conditions, cultural practices and time of harvesting (Koutroubass *et al.*, 1999 ; Tchuenteu *et al.*, 2013).

Castor bean cultivation is not popularized in Subsaharan Africa. Our recent investigation on *R. communis* in Cameroon revealed the presence of some accessions in the Sudano-guinean savannah zones where they are used in traditional medecine for treatment of many deseases ; 04 castor bean accessions (Vina, Martap, Nyambaka and Bélel) were listed in the Sudano-Guinean zone of Cameroon. The agronomic characteristics of these four castor bean accessions cultivated in field in Adamawa Cameroon region are not known. The research question on this study concerned then the evaluation of the performance of four local accessions of castor beans in Cameroon.

In Adamawa Cameroon, with a Sudano-Guinean climate, castor plants could be adapted satisfactorily taking into account their environmental requirements. However, since castor plants have not been systematically cultivated in Cameroon, information about the performance and the seeds yield

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of the crop are lacking. Such data are necessary in order to explore the feasibility of the castor oil as an alternative crop in Cameroon agriculture.

The purpose of this work was to study the adaptability of 04 castor beans originated from Sudano-Guinean savannah of Cameroon and to evaluated their seeds yields during the 01 year of experimentation. The importance and usefulness of this study follows from the fact that the castor bean accession that adapts best in Sudano-Guinean zone of Cameroon and has a better seeds yield will be popularized.

MATERIALS AND METHODS

Description Of Experimental Sites

The field study was carried out from June to December 2018 in the Sudano-Guinean zone of Adamawa Cameroon. Table 1 shows some agro-pedological characteristics of the studied site. The study was carried out at the locality of Bini-Dang in Ngaoundere region situated at 7°25'449" north latitude, 13°32'364" east longitude and 1106 m altitude. The vegetation of the cultivated area is herbaceous savanna dominated by *Imperata cylindrica* and *Pennisetum purpureum*, some shrubs, such as *Annona senegalensis*, *Hymenocardia acida* and *Terminalia* spp.

Table 1: Physico-chemical properties of growing soil

Parameters	Growing soil	Parameters	Growing soil
Color	reddish brown	C (%)	7.04±0.10
moisture content	5.83 ±0.15	C/N	1.66
Mo (%)	12.11±0.10	Fe^{2+} (‰)	1.81±0.07
pH	4.57±0.20	Mg (%)	0.10±0.02
conductivity (µS/cm)	39.31±0.19	Ca (%)	0.49±0.00
N (%)	4.23±0.59	P (%)	0.41±0.02

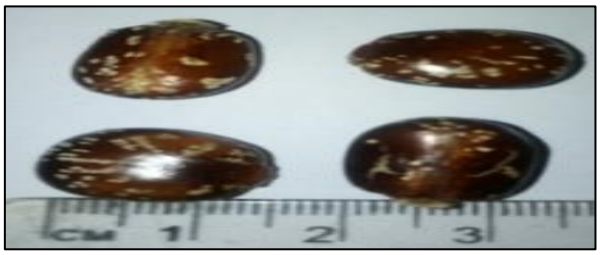
Seeds samples

The principal treatments comprised five accessions of castor beans namely Vina, Martap, Nyambaka and Bélel and Ndoutourou. The seeds of Vina, Martap, Nyambaka and Bélel accessions was harvested in the both Departements, Vina and Mbéré of Adamawa Cameroon region on castor bean plants grown in the wild in March 2018. Ndoutourou accession seeds was obtained from the SODECOTON of Garoua in Cameroon, a governmental industry interested in the production of castor oil. The seeds were all brown in colour with black lines (figure 1) and distinguishable on the basic of their size. Nyambaka accession has larger seeds size while Ndoutourou has the smallest seeds size.

a : Ndoutourou accession

b : Vina Accession

c : Martap Accession



d : Nyambaka Accession

e : Bélel Accession

Figure 1 : Castor bean Seeds of Ndoutourou, Vina, Martap, Nyambaka and Bélel accessions

Experimental Design

All wild plants were cut off from the study area. Thereafter each site was plowed to 30 cm depth and ridges of 10 m × 3 m (30 m^2) were formed. Space between two consecutive ridges was 1 m. The experimental site used for this work measured 608 m². The experimental design consisted of five treatments (castor bean accessions) lay out randomly and repeated in three blocks. Each unit plot measured 10 m×3 m.

Seeds Sowing

Sowing was done on June 2018. The seeds had not undergone any treatment before sowing. Seeds were chosen just based on their phenotypic traits, the best being the seeds with a large thick. After plowing, castor bean seeds were sown at 4 to 5 cm depth to 1 m intervals on the same unit plot. Each row contained 10 planting holes and 3 seeds were sowed per planting hole. Each experimental unit received three rows and 90 planting holes. The distance between two consecutive unit plots was 1 m. Thinning was done one month after sowing so as to leave one plant per planting hole.

Studied parameters and statistical analysis

Data regarding dates of plants emergence, flowering and capsule maturity were collected. During the vegetative phase, the number of leaves per plant and plant height were took on 30 targeted plants at regular intervals of 30 days. The dry biomass, diameter of stem at collar and the number of branches per plant were evaluated at flowering on 6 targeted plants at the center of the plot. Also at flowering, The rates of roots mycorrhization were assessed according to Kormanick et Mc Graw (1982). At maturity, seeds yields expressed in kg/ha were assessed.

Data were subjected to variance analysis following by the Duncan multiple range tests when any significant effect was observed. The statistical software "Statgraphics plus" was used for this propose.

RESULTS

Emergence Rate and Stage of Development of Plants

The emergence of castor bean plants was observed at 14 days after sowing (DAS). Emergence plants rates of Ndoutourou, Vina, Martap, Nyambaka and Bélel accessions of castor bean were respectively 25.93%; 56.14%; 45.18%; 88.15% and 14.81%. The greatest emergence rate was observed on Nyambaka accession of castor bean while Bélel accession presented the lowest value of this parameter.

Flowering and fruiting of Ndoutourou accession took place at 105 and 119 DAS respectively and are precocious compared to those of other local castor bean studied. Dates of 50% flowering vary from 105 DAS for Ndoutourou accession and Martap accession to 145 DAS for Bélel accession of castor bean. In addition, fruiting dates ranged between 119 DAS for Ndoutourou accession and 153 DAS for Bélel accession of castor bean. The fructification of Vina, Martap and Nyambaka accessions appeared at 133 DAS. 50% fruiting of Ndoutourou accession took place 34 days before that of Bélel accession and 14 days before that of Vina, Martap and Nyambaka accession (table 1).

Table 1 : Flowering and fruiting dates depending on castor bean accessions

Castor bean accessions	50% flowering dates (DAS)	50% fruiting dates (DAS)
Ndoutourou	105	119
Vina	110	133
Martap	105	133
Nyambaka	115	133
Bélel	145	153

DAS= Days after sowing

Effect of Local Castor Bean Accessions on Plants Growth and Seeds Yield

Overall, the analysis of variance (ANOVA) showed that there is a significant ($p<0.05$) difference between different treatments (accessions of castor bean) on growing parameters studied (plant height, number of leaves per plant, diameter of stem at collar, dry biomass of plants and number of branches per plant) as well as the seeds yield of our local castor bean accessions at 133 days after sowing.

Plants Height and Number of Leaves per Plant

Variation on plants height and on number of leaves per plants according to time of our local castor bean is presented in figure 2 and figure 3 respectively. At maturity (133 days after sowing (DAS), Martap accession exhibited the highest plant height (113.5 ± 39.43 cm) while the smallest plant height (89.6 ± 28.88 cm) was observed on Nyambaka accession. The plants height of Ndoutourou, Vina and Bélel accessions are respectively 98.86 ± 32.20 cm, 108.03 ± 34.87 cm and 89.67 ± 28.57 cm.

At maturity (133 DAS), Bélel accession exhibited the highest number of leaves per plant (42.16 ± 20.80); Ndoutourou accession presented the smallest value (17.4 ± 13.05) of this growing parameter. The numbers of leaves per plant of Vina, Martap and Nyambaka accessions of castor bean are 35.86 ± 12.56; 38 ± 24.06 and 20.5 ± 7.89 respectively.

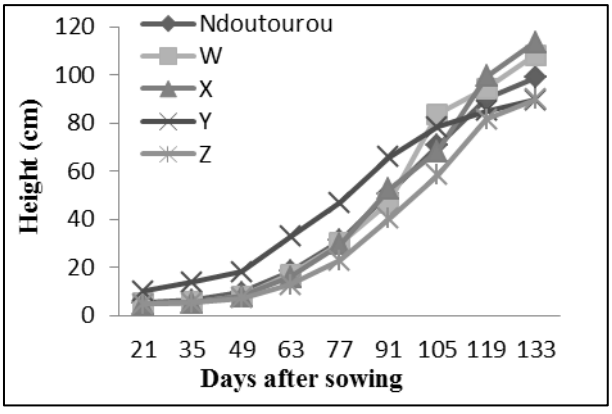


Figure 2: Variation on plants height according to time and castor bean accession W: Vina accession; X: Martap accession; Y: Nyambaka accession; Z: Bélel accession

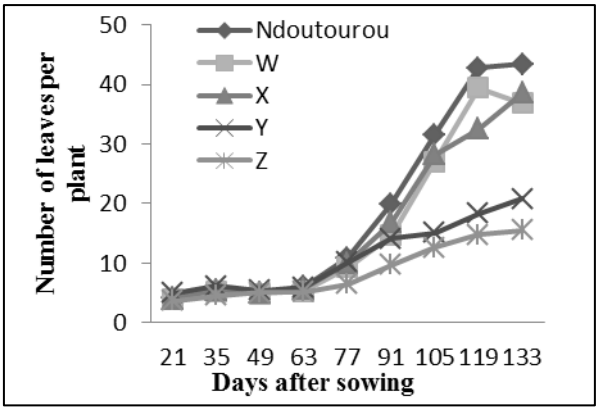


Figure 3 : Number of leaves per plant according to time and castor bean accession W: Vina accession; X: Martap accession; Y: Nyambaka accession; Z: Bélel accession

Diameter of stems, dry biomass and number of ramifications per plant

The diameter of stem at collar, dry biomass of plants and number of branches per plant according to castor bean accession at flowering are reported in Table 2. Among the 04 castor bean accessions native of Adamawa Cameroon region used in this work, the diameter of stem at collar varies from 1.96 ± 0.35 cm for Bélel accession to 2.20 ± 0.30 cm for Martap accession ; Martap accession exhibited the highest dry biomass (0.35 ± 0.14 Kg / plant) while the smallest value of this parameter (0.19 ± 0.05 Kg / plant) was from Vina accession. The dry biomass of Nyambaka accession (0.31 ± 0.01 kg / plant) and Bélel accession (0.24 ± 0.07 kg / plant) presented the intermediate values. Plants of Martap accession provided the greatest number of branches (13.43 ± 4.74 branches per plant) and conversely for Bélel (6.27 ± 3.04 branches per plant) and Nyambaka accessions (7.7 ± 4 branches per plant). The number of branches per plant of Martap accession is lower than that of Ndoutourou accession.

Tableau 2 : Growth parameters according to castor bean accessions

Parameters	Castor bean accessions						
	Ndoutourou	Vina	Martap	Nyambaka	Bélel	Total	P value
DSC (cm)	1.90±0.81^{a}	2.09±0.31^{a}	2.20±0.30^{a}	1.97±0.23^{a}	1.96±0.35^{a}	2.02±0.4^{a}	0.9308
DBP (kg)	0.19±0.03^{a}	0.19±0.05^{a}	0.35±0.14^{b}	0.31±0.01^{c}	0.24±0.07^{d}	0.25±0.06^{d}	0.0495
NBP	14.23±5.09^{a}	13.70±4.74^{a}	13.43±4.11^{a}	7.70±3.69^{ab}	6.26±2.04^{b}	11.06±4.13^{ab}	0.0324

DSC : Diameter of stem at collar ; DBP : Dry biomas of plants ; NBR : Number of branches per plant ; Values of a line affected by the same letter are not different significantly ($p<0.05$)

Seeds yields

There was a significant ($p<0.05$) difference between treatments (castor bean accessions) on seeds yield (figure 4). Among the 04 castor bean accessions native of Adamawa Cameroon region used in the present work, the highest seeds yield (1018 ± 25.71 kg / ha) was from Nyambaka accession while the lowest (804 ± 10.50 kg / ha) was from Vina accession. The seeds yields of Martap and Bélel accessions are respectively 911 ± 20.62 and 978 ± 10.48 kg/ha. The seeds yield of Ndoutourou accession is 2138 ± 14.25 kg / ha; thus 2.10 fold higher than that of Bélel accession.

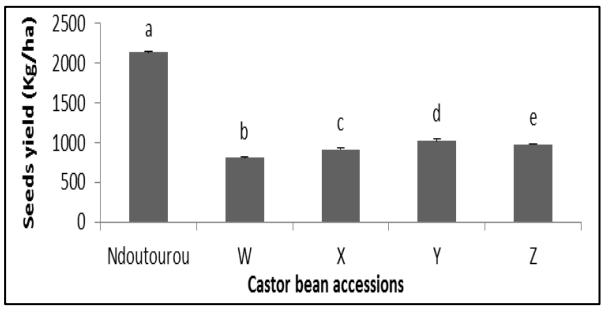


Figure 4 : Seeds yield according to castor bean accession W: Vina accession; X: Martap accession; Y: Nyambaka accession; Z: Bélel accession Values of a bands affected by the same letter are no significantly different ($p<0.05$)

Rate of Roots Mycorrhization

The rate of roots mycorrhizartion of Ndoutourou, Vina, Martap, Nyambaka and Bélel accessions of castor bean are presented in figure 5. The analysis of variance shown that there are significant differences ($P < 0.05$) between the 05 castor bean accessions used in this work on rate of roots mycorrhization. Bélel accession presented the greatest rate of roots mycorrhization (90 ± 9%), followed by Nyambaka accession (83.33 ± 8.81%). The lowest rate of roots mycorrhization (33.33 ± 4.41%) was from Ndoutourou accession. The rate of roots mycorrhization of Vina and Martap accessions are respectively 56.67 ± 3.51 and 53.33 ± 5.54%.

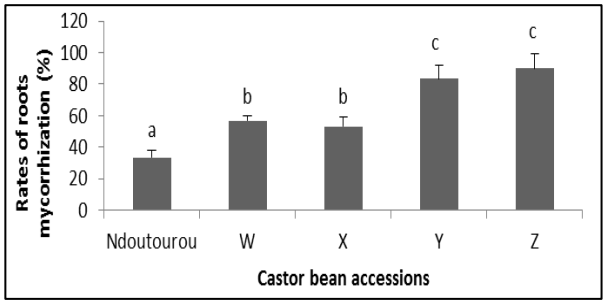


Figure 5 : Rate of roots mycorrhization of castor bean W: Vina accession; X: Martap accession; Y: Nyambaka accession; Z: Bélel accessionValues of a bands affected by the same letter are no significantly different ($p<0.05$)

DISCUSSION

In this study, plants emergence is observed at 14 days after sowing (DAS), this is in accordance to data found in the literature: Koutroubass *et al.,* (1999) study the adaptation and yielding ability of castor plant genotypes in a Mediterranean climate and reported that seeds germination took place between 11 and 26 DAS; Maroyi (2007) showed that the emergence of castor bean seeds usually ends between 15 and 21 DAS. In addition, in this study seeds emergence rates of our local castor bean accessions ranged from 14.81% to 88.15%. This result obtained on the germination rate of castor bean seeds corroborates in part the data encountered in literature. Tchuenteu *et al.,* (2013) study the adaptability potential of three local castor bean accessions in the both agroecological zones of Far North Cameroon (Sudano-Guinean and Sudano-Sahelian zones) and revealed that the average seeds emergence rate is 54.8%. In this study, the emergence seeds rate varies according to castor bean accession and Nyambaka accession exhibited the highest emergence seeds rate.

It is observed in this work that fruiting date varies according to local castor bean accession and ranged between 133 and 153 DAS. The fruiting dates obtained in this study corroborate the work of Koutroubass *et al.,* (1999) who reported that fruiting dates of castor bean varies depending on genotype and ranges between 100 and 137 DAS. The knowledge of plants life cycle is avantageous for farmers in the sense that plants with short life cycle indicate the greater number of crops per year.

Results obtained on plants height in the present work corroborate in part data found by koutroubass *et al.,* (1999) who study the potential of adaptability of 19 castor bean genotypes under Mediterranean climate and reported that plants height varies between 0.79 and 2.30 m depending on genotype. The knowledge of castor bean height is an important morphological parameter of harvesting process: Tall plant indiquates the harder fruits harvesting. According to this criterion, Koutroubass *et al.,* (1999) revealed that the harvesting of castor bean fruits is easy when plants height is less than 2 m. In this study, height of our local castor bean accessions is less than 2 m, thus suggesting that harvesting of fruits of castor bean accessions studied would be easy. Moreover, Tchuenteu (2014) revealed that there is a positive and significant correlation between plants height and number of leaves per plants ($r = 0.70$, $p < 0.01$) and between plants height and seeds yield ($r = 0.42$, $p < 0.05$) of castor bean native of North Cameroon.

The increase of foliar production could play a very important role in Adamawa Cameroon region because it could limit sun intensity on soils with consequence the increasing of soil relative humidity and the reducing of soil erosion. Plants leaves represent a biomass that can be recycled into organic matter and can release the mineral elements needed for plants nutrition (Bunch, 2004). Leaves and plants height are growth parameters that determining the seeds yield. Indeed, leaves are the organs responsible for photosynthesis, increased of castor bean leaves suggest an increase of photosynthetic activity, consequently an improved of seeds yield. Several studies shown a positive and significant correlation between foliar production and seeds yield (Reddy and Matcha, 2010). Tchuenteu (2014) study the agronomic characterization of castor oil native of North Cameroon in the both agroecological zones of Far North Cameroon and reported the existence of a positive and significant correlation between the number of leaves per plant and seeds yield ($r = 0.70$, $p < 0.01$). In this work, Martap accession has the greater number of leaves per plant, thus suggesting that this castor bean accession would exhibited the highest seeds yield compared to those of other local castor bean accessions studied, but this remains to be investigated.

Data obtained on diameter of stem at collar in this work corroborate the studies of Tchuenteu *et al.,* (2013) who reported that the diameter of stem of castor bean originated of Sudano-Sahelian savannahs of northern Cameroon is ranged between 1.1 and 3.3 cm. The average diameter of stem of castor bean accessions used for this work is 2.05 cm. Moreover, Tchuenteu (2014) revealed that there is a positive and significant correlation between the diameter of stem and the dry biomass of castor bean plants ($r = 0.91$, $p < 0.001$) and also between the stem diameter and plants height ($r = 0.68$, $p < 0.001$). In addition, Ibrahima and Habib (2008) reported that the higher dry biomass of plants indicates that amount of sequestered atmospheric CO_2 is important. Now in this work Martap accession of castor bean exhibited the greatest value of diameter of stem at collar, thus suggesting that the implantation of culture of Martap accession would contribute effectively to fight against climate change. The number of branches per plant is important for plant productivity because more a plant is branched, more seeds production would be important. It is observed in this work that Martap accession provided the greatest number of branches per plant, according to this result, Martap accession would also provide the greatest seeds yield, but this remains to be studied.

Data obtained on seeds yield in this study are small compared to those reported in the literature. According to Pina *et al.,* (2005), seeds yield of castor bean in France ranges from 2 to 3 t/ha; the values reported by Maroyi (2007) are even higher (1000 to 3000 kg/ha). In addition, Mana (2008) shows that seeds production of castor bean varies from 1000 to 1200 kg/ha in intercropping with cowpea, groundnuts or sesame. The low seeds yield obtained in this work would justified by the fact that our local castor bean accessions used and those used in the literature would

present different genotypic characteristics. In addition, the present experimentation did not established under the same conditions as our predecessors. In fact, several authors (Koutroubass *et al.,* 1999; Tchuenteu *et al.,* 2013; Derogoh *et al.,* 2018) reported that growth and seeds yield of castor bean vary according to genotype, experimental area and the year of experimentation. at maturity, among the 04 local castor bean accession from Adamawa-Cameroon region used, Nyambaka accession provided the highest seeds yield and its seeds yield was 1.27 folds higher than that of Vina accession, thus suggesting that Nyambaka accession can be used in the program of implementation of castor bean as alternative crop for Cameroonian agriculture.

In this study, rate of roots mycorrhization of castor bean ranged from 33.33 ± 4.41% for Ndoutourou accession to 83.33 ± 8.81% for Bélel accession. Among the 05 castor bean accessions used in this work, Ndoutourou accession exhibited the highest seeds yield and the lowest rate of roots mycorrhization, thus suggesting that castor bean productivity does not depend on roots mycorrhizalization. However, the study of the effect of mycorrhizal inoculum on the growth and seeds yield of local castor bean accessions used in this work remains to be investigated.

CONCLUSION

There is a significant ($p < 0.05$) incidence of local castor bean accessions used in this work on the variability of agronomic parameters studied. Flowering and fruiting of Ndoutourou accession took place at 105 days after sowing and is early compared to other local castor accessions studied. Among the 04 castor bean accessions native of Adamawa Cameroon region, Nyambaka accession provides the highest seeds yield (1018 ± 25.71 kg / ha) while the smallest value of this parameter is from Vina accession (804 ± 10.50 kg / ha). Seeds yield of Nyambaka accession is 2.10 folds lower than that of Ndoutourou accession and seeds yield of Martap, Vina and Bélel accessions are respectively 2.34; 2.66 and 2.19 folds lower than that of Ndoutourou accession. Considering the results obtained in this study, Nyambaka accession can be used in the program of implementation of castor bean as alternative crop for Cameroonian agriculture. However, seeds oil content and physico-chemical properties of oil from studied castor bean accessions need to be investigated.

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