Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 01, pp.11913-11918, January, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

GROWTH AND DEVELOPMENT OF *MORINGA OLEIFERA* LAM. IN THE SUDANO-SAHELIAN ZONE (CAMEROON)

[1, 2,*]Claudette Bayé-Niwah and [2]Pierre Marie Mapongmetsem

[1]Department of Life Sciences and Earth, Higher Teachers' Training College, University of Maroua, BP. 55 Maroua
[2]Laboratory of Biodiversity and Sustainable Development, Department of Biological Sciences, Faculty of Science, University of Ngaoundere BP 454

ARTICLE INFO

Article History:
Received 19th October, 2014
Received in revised form
25th November, 2014
Accepted 17th December, 2014
Published online 31st January, 2015

Key words:

Moringa oleifera, Germination, Growth, Isohyets, Flowering.

ABSTRACT

The influence of the source of seeds was evaluated on the germination and growth of *Moringa oleifera* Lam. in the Sudano-Sahelian zone of Cameroon. The device is a randomized complete block with 3 replications and 4 treatments. Provenances or isohyets represent treatment (4). The experimental unit consists of 30 seeds. The results of this study appear that the origin of isohyets has no influence on the growth and germination of seedling. However, seed weight differs significantly with isohyets (0.0047 <0.01). It varies from 268.44 ± 76.02mg to isohyets 4 to 309.28 ± 64.89mg for isohyets 2. After 6 months the average height of seedlings from isohyets is 175.45 ± 9.6cm and that of the radial is 2.17 ± 0.09cm. How early or late the floriculture production depends on the origins of the seeds (0.015 <0.05). Thus plants derived isohyets 2 and 3 rather than flowery plants from seeds isohyets 1 and 4. However, the flower and fruit production rate is not influenced by rainfall sources.

INTRODUCTION

M. oleifera is a very common vegetable consumed in the Sudano-Sahelian zone of Cameroon. Marketing in local markets provides significant income for households in the area. In the markets of Maroua, 63.30% of the vegetable-retailers sell the leaves of *M. oleifera* (Madi *et al*., 2012). The sale of the leaves of this Moringaceae is more profitable than other vegetables. Indeed, the price of a kilogram of seeds varies from 35 000 to 45 000frs (Nasir, 2012). Unfortunately that price is beyond the reach of the middle peasants, especially the Sudano-Sahelian zone of Cameroon which is one of the poorest in the country (INS, 2008). Despite its nutritional value and its socio-economic importance, the culture of *M. oleifera* remained there in the traditional state hence the interest of this work. In Cameroon, to our knowledge, very little scientific research has been devoted to the plant except those of Tedonkeng *et al.* (2004) Bayé-Niwah and Mapongmetsem (2014) who are interested in seed germination. However, no study has followed the plant throughout the phases of its growth and development cycle from germination to fruiting. The present work is a contribution to the identification of good seed sources by considering the different agro-ecological zones of the region. The objective of this work is to study the influence of the isohyets on seed characteristics, germination capacity and phenology of *M.oleifera*.

Corresponding author: Claudette Bayé-Niwah
Department of Life Sciences and Earth, , Higher Teachers' Training College
University of Maroua, BP. 55 Maroua.

MATERIALS AND METHODS

Study Site

The pods were harvested in 12 locations across 4 different rainfall zones (Table 1) in the region of the Far North Cameroon.

Table 1. Eco-geographic characteristics of populations of *Moringa oleifera*

Isohyets	Villages covered	Altitude (m)	Latitude (°N)	Longitude (°W)
600	Djouta Bébal	323	11°00'692"	014°30'040"
	Guirvidik	334	10°34'767"	015°18'497"
	Pétté	344	10°58'531"	014°29'475"
700	Guidiguis	360	10°13'123	014°70'208"
	Papata	337	10°56'351"	014°25'574"
	Yagoua	343	10°33'576"	015°22'794"
800	Boula	505	10°33'095"	014°02'047"
	Gazawa	479	10°32'526"	014°08'047"
	Maroua	402	10°60'499"	014°35'528"
900	Kosséhone	914	10°43'192"	013°38'699"
	Mandaka	775	10°45'252"	013°50'263"
	Mokolo	836	10°44'270"	013°47'247"

This area is between 10° and 13° North latitude and 12° and 15° East longitude. The climate is much Sahelian and has already subdesert affinities. The Sahelian climate with two seasons, a short rainy season and a long dry season. The annual average temperature is 28°C. The prevailing wind is the

harmattan mass of continental tropical air which is of Sahelian origin, but from April to October monsoon flows in a southwestern direction. The region has a wide variety of soil by their nature and their use, the most important are vertisols, poorly developed soils, hydromorphic soils, ferruginous soils, planesols the fersialitic soils and raw mineral soils (Brabant and Gavaud, 1985). The test was conducted in the experimental field of the Institute of Agricultural Research for Development (IRAD) in Maroua, which has a sandy loam soil type. It is located about 402m above sea level, at latitude 10° 60' North and longitude 14° 02' East.

Methodology

Selecting and collecting seeds

The capsules were collected on individuals of *Moringa oleifera* in home gardens in twelve localities: Boula Djouta Bebal, Gazawa, Guirvidik, Guidiguis, Kosséhone, Mandaka, Maroua (Makabaye, Zeling) Mokolo (Kapsiki quarter) Papata, Pette and Yagoua (Hleké). These villages are divided into four isohyets annual precipitation ranges from 600 to 900mm. These pods were collected from individuals in production, healthy and have not undergone any trauma. After harvest, the pods are stored in polyethylene bags labeled and transported to the laboratory. Each bag has a label on which the name of the source is mentioned (ISO1, ISO2, ISO3 and ISO4). In the laboratory the pods were ripped from each and seeds were harvested. Thereafter, the following qualitative and quantitative data were collected: the color, shape and weight of the seeds. Seeds from each isohyet were weighed using an electronic balance sensitive to 0.0001 Teldo mark. The weights were made seed after seed. The shapes and colors of the seeds were noted. Ninety seeds were weighed for each provenances or isohyets. The experimental design used is a Completely Randomized Block 3 replications The experimental unit consists of 30 seeds.

Land preparation and sowing

The Field of 6m by 18m was plowed a month before planting. This area was irrigated every four days before the planting season when the rains were scarce. The device is a randomized complete block with 3 replicates and 4 treatments. Provenances or isohyets represent treatment (4). The experimental unit consists of 30 seeds and each replication was made in an area of 2m x 6m. The spacing between the planting holes is 30cm between column and 20cm between lines, in each planting hole, only a seed is sowed. The test took place during the rainy season; the seeds were sown on July 6, 2012. The evaluation of germination was stopped 30 days after sowing according to Tedonkeng *et al.* (2004). Data collected every four days were the number of seeds germinated. The follow-up consisted simply in making the weeding of the adventitious

Assessment of growth

After germination, the seedlings are followed and the development parameters recorded until fruiting (branching, flowering, fruiting, leaf number) to determine early provenance (Isohyet) the most efficient in the pod. At day 30, 10 seedlings were labeled at random for each isohyet. These seedlings measurements were made on the air axis (height and diameter) using a caliper and a ruler. In addition to the number of axes/plant and number of side branches in each air line, the numbers of leaves were evaluated. This evaluation was done every 10 days. The height was initially measured using a ruler, later a board was graduated. The height of the board reached 3m. This scale has been made in order to facilitate the measurement of the height of the shrub. These measures on vegetative parameters were inspired by the work of Mapongmetsem *et al.* (2004) on *Parkia biglobosa* in Cameroon. The measurements were all made every 10 days until the appearance of the flowers. After the appearance of the flowers, we measure these parameters every 20 days. The evaluation was to determine for each source, the percentage of feet with flowers and fruits on the total number according to Diouf *et al.* (2004) on *M. oleifera* in Senegal. Taking data in the test ended at 180 days after sowing when the plants no longer flourished and produced more pods. The data were subjected to analysis of variance.

RESULTS

Seed characteristics

Seed color

According to their color, two types of seeds were observed, black seeds and the brown seeds. Black seeds are majority (72.50%), whereas brown color is only 27.50%.

Seed quality

The observation of seeds following rainfall areas reveals that the percentage of weevil seeds varies from 1.11% (isohyet 1) to 3.33% (isohyets 3 and 4). The seeds rotten rate fluctuated between 1.11% for isohyet 3 to 3.33% for isohyet 1. The capsules from isohyets 4 and 3 abort less (4.44%) than those of the isohyet 1 (7.77%). The differences observed between the seeds are only apparent, as the analysis of variance shows no significant difference whatever the considered parameter ($P > 0.05$) (Table 2).

Seed weight

The average weight of seeds following the isohyets was 293.30 ± 77mg. The seed weight varies significantly from 268.44 ± 76.02mg for the seeds from the isohyet 4 to 309.28 ± 64.89mg for those from the isohyet 2 (0.0047 <0.01). Seeds from isohyets 1, 2 and 3 are identical and are heavier than those of isohyet 4 (Table 2).

The germination capacity of seeds

On germination, the first seeds germinated 7 days after sowing. The overall germination rate was 79.44%. This rate fluctuates between 70 ± 5.71% for the seeds from the isohyet 4 to 87.77 ± 1.52% for those from the isohyet 2. The amount of rain has no significant effect on the seed germination of this Moringaceae ($P > 0.05$). From the seventh day to the 23rd day, we see that the germination rate is higher among the seeds from the isohyet 2.

Table 2. Seed weight based on isohyets

Isohyets (amount of rainfall)	Weevil seeds (%)	Rotten seeds (%)	Aborted seeds and / or absent	Seed weight (mg)
Isohyet 4 (900mm)	3.33a	2.22a	4.44a	268.44±76.90a
Isohyet 1 (600mm)	1.11a	3.33a	7.77a	293.78±79.37b
Isohyet 3 (800mm)	2.22a	1.11a	4.44a	301.68±81.02b
Isohyet 2 (700mm)	3.33a	2.22a	5.55a	309.28±64.58b
Average	2.39	2.22	6.55	293.30±77

Means followed by the same letter are statistically identical

Since the beginning of germination until the 15th day, the seeds from isohyet 2 germinate higher than those from other isohyets (Fig.1).

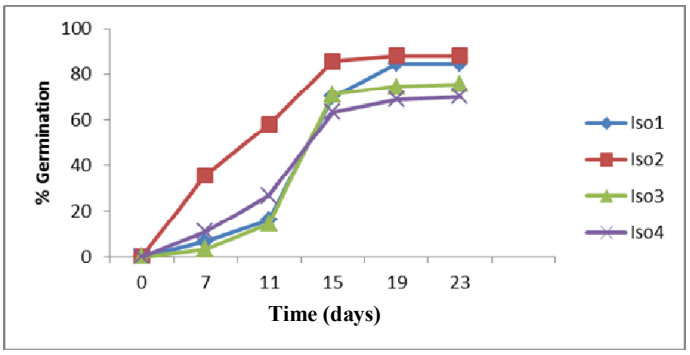

Fig. 1. Seed germination of *Moringa oleifera* in field

The 23rd day after seeding, the average rate of germination was 79.43 ± 4.40 (Table 3). Changes in germination time is confirmed by the analysis of variance (0.0004 <0.001).

Table 3. Seed Germination Percentage

Sources	Percentage of germination
Seeds resulting from the isohyet 4 at 900mm	70.00±5.71
Seeds resulting from the isohyet 3 at 800mm	75.55±5.13
Seeds resulting from the isohyet 1 at 600mm	84.43±1.52
Seeds resulting from the isohyet 2 at 700mm	87.77±1.52
Average	79.43±4.40

Means followed by the same letter are statistically identical

Seed germination continues with the growth process which may vary with the agro-ecological zones.

Evaluation of the growth of *Moringa oleifera*

After germination, the seedlings from different isohyets have developed, flourished and fruited. Thus, after 180 days (6 months) the average height of seedlings from the isohyets is 175.45 ± 9.6cm. The height of shrubs varies from 151.2 ± 56.62cm (Isohyet 1) 196.5 ± 64.22cm (isohyet 4). Disparities in growth between provenances from the four isohyets are not established because the analysis of variance does not indicate the existence of a significant difference between them (P> 0.05).

Concerning the lateral growth, the average diameter of the seed after 6 months, ranges from 2.01 ± 0.64cm for the plants from the isohyet 1 to 2.27 ± 0.73cm to those of isohyet 4 (Fig. 2b). This variation between rainfall zones is only apparent; variance analysis makes no significant difference (P> 0.05).

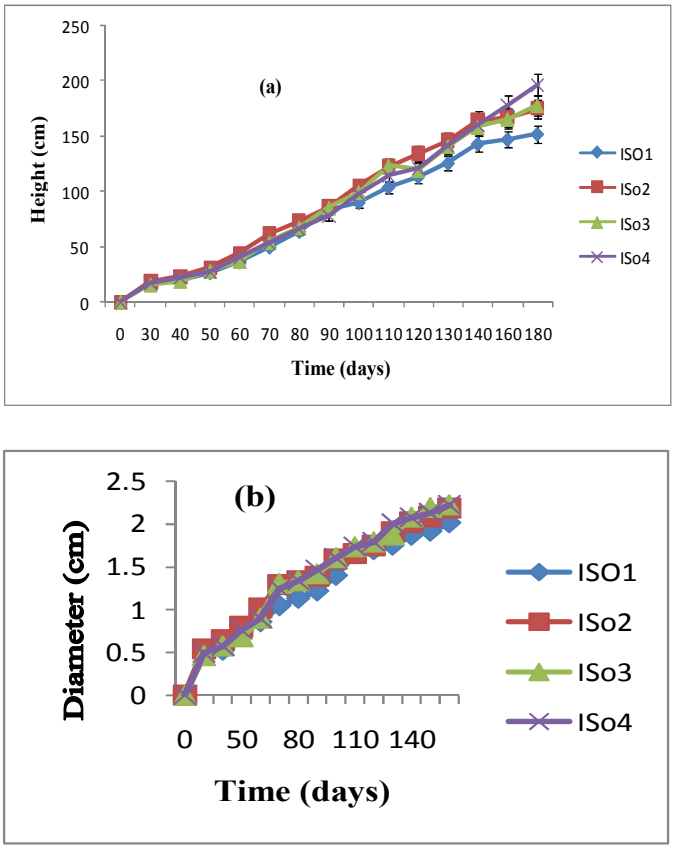

Fig. 2. Vertical (a) and radial (b) growth of *Moringa oleifera* plantlets in field

Number of branches and leaves of the seedlings

Six months after planting, the average number of leaves per plant was 22.03 ± 6.4. The number of leaves varies between 21.13 ± 5.66 for plants originating in isohyet 2 and 23.73 ± 6.96 for those of isohyet 3 (Table 4).

Regarding the number of port, all the seedlings are single-stemmed, none has more than one axis. With respect to the side branch, the number of branched feets by isohyet varies from 5 ± 2.16 for isohyet 4 to 6.66 ± 2.86 for isohyet 2 (Table 4). The variation of the branching is not significant between isohyets, since the analysis of variance is not established (P>0.05).

Flowering and fruiting shrubs

The first blooms occur 130 days after sowing in plants from isohyets 2 and 3. From that date until the 150th day, significant differences were established between the different plants from

the different isohyets (0.015 <0.05). At 180 days, 43.88 ± 4.33% of the plants have flowered on average.

Table 4. Number of leaves and branches after 180 days

Isohyets	Number of leaves	Number of branch feet	Number of branches
Iso2-700mm	21.13±5.66a	6.66±1.52a	2.78±0.20a
Iso4-900mm	21.36±6.39a	5±2.16a	3.42±0.68a
Iso1-600mm	21.9±6.28.a	6.33±2.86a	2.43±0.04a
Iso3-800mm	23.73±6.96	5.66±8.51a	3.43±1.14a
Average	22.03±6.4	5.91±0.73	3.03±0.51

Means followed by the same letter are statistically identical

The percentage of flowering in this Moringaceae ranges from 40 ± 0.81% for shrubs from isohyets 4 to 51.11 ± 2.25% for those from isohyet 2 (Table 5). The difference noted at that date between plants of different isohyets is not established as the analysis of variance showed no significant difference from the 160th day (P> 0.05).

Table 5. Percentage of shrubs that flourished following the isohyets

Dates	Isohyet 1 (%)	Isohyet 2 (%)	Isohyet 3 (%)	Isohyet 4 (%)
130days	0a	3.33b	4.44b	0a
150 days	2.22a	8.81ab	10ab	12.5b
160 days	8.88a	11.11a	13.33a	14.44a
180 days	41.11a	51.11a	43.33a	40a

Means followed by the same letter are statistically identical

For the first flowering of *Moringa oleifera* in the ecological conditions of the Sudano-Sahelian ecological zone, the average number of bunches of flowers is 13.16 ± 1.46. The number of bunches of flowers varies from 12 for plants of isohyet 4 to154.33 for those of isohyet 2 (Table 6).

The difference was not significant (P> 0.05). All flowers produced do not always lead to the formation of the fruit. During evolution, some fall (wind, abortion, etc.) while others are not pollinated. In terms of fruit production, the average amount of pods is 17.33 ± 3.63. The number of pods producedts varies from 13.66 for the shrubs of the isohyet 4 to 22.33 for those of isohyet 2 (Table 6).

Table 6. Number of flower bunches and pods according to agro-ecological zones

Agro-ecological zones	Number of flower bunches	Number of pods
Isohyet 1 at 600mm	13.2±2.16a	17±2.1a
Isohyet 2 at 700mm	15.33±2.35a	22.33±4.49a
Isohyet 3 at 800mm	12.33±1.69a	16.33±1.69a
Isohyet 4 at 900mm	12±0.81a	13.66±2.6a
Average	13.16±1.40	17.33±3.63

Means followed by the same letter are statistically identical

As before, the difference observed between the bushes next isohyets is only apparent and that the analysis of variance showed no significant difference (P> 0.05). In 150 days after sowing, the pods were observed for the first time in plants from isohyets 2 (2 pods) and 3 (1 pod). Only after 20 days the fruits have been observed in the shrubs of all agro-ecological zones. Agro-ecological zones will not have a significant influence on the quantity of flowers and fruits in *M.oleifera.*

DISCUSSION

The low weight of the seeds would be related to topographic position and rainfall of isohyet 4. Isohyet 4 is the area where rainfall is higher (900mm). Moreover, the villages belonging to this isohyet are located at an altitude between 775m and 914m. This result indicates that seed weight decreases with altitudes and very high rainfall. The heavier seeds exhibited an important germination. The heavy seeds germinate better than light seeds. Seeds of isohyet 2 which are the heaviest also gave the highest germination. Similar results are reported by Nkongmeneck *et al.* (1996) and Mapongmetsem *et al.* (2004) on *Tetrapleura tetraptera* and *Parkia. biglobosa* respectively.

The average rate of germination (79.44 ± 4.40%) seeds obtained in this study is in agreement with Bosch *et al.* (2011) and Bayé-Niwah and Mapongmetsem (2014). This result, however, is less with that of Jahn (2003), 94% in Sudan. The difference between these two results would be linked to the developed methodology and seed packs. Our predecessors worked in the shade and soil mulched condition unlike us mulching increases the soil moisture. The germination of a seed is characterized by its delay, the timing of exercise and germination. The first seeds germinated from the 7th day. This period of germination is longer than that observed in the work of Ofoh *et al.* (2010) which is spread over 4 days. Some varieties are able to germinate after only 5 days, it is the case of the ecotype of Madagascar. However according to the specialists of the National Silo of the Forest Seeds (S N. G. F), the seeds of *M. oleifera* germinate on average after 8 days of sowing (Ratsifehera, 2004). The seeds of this work have met this duration

This result suggests that the source of seeds does not affect the height growth of *M. oleifera*. Mapongmetsem *et al*. (1999) showed significant differences between the eight species of the forest zone of Cameroon. Moreover, Barro *et al*. (2013) noted a significant variation in plant height of *Jatropha curcas* according to sources in Senegal. The studies were carried on plants of 12 month raised in nurseries. Similarly, the works of Gnangle *et al.* (2010) in Benin have also reported the change in height of seedlings of *Parkia. biglobosa* from 4 sources. The lack of significant differences between the sources of our seedlings would be linked to the species of *Moringa oleifera*. Indeed, the density plays a role in the growth of some plants by acting on the competition (density) between trees in a stand. According to Voui (2008), when the trees grow in population, a competition ensued between them for access to the resources they need to grow (light, water and nutrients). Therefore, the growth of the crown and trunk for access to light and the roots in access to nutrients is controlled by that stand density (Zobel and Van, 1989). This situation does not allow provenances of plants to express themselves in terms of growth.

In southern Nigeria, Ofoh *et al.* (2010) have worked on the same species, they recorded a height of between 46-69cm after 49 days. Bosch *et al.* (2011) after 2 months, noted that the height varies between 15 and 25cm. The average height of

seedlings of this investigation is more than 39.65 ± 9.6 cm after planting for two months. Moreover, in the highlands of West Cameroon, Tedonkeng *et al.* (2004) obtained a height of 77.9 ± 8.9 cm after 6 months without fertilizer application on clay soil grounds on which were led(driven). These differences in seedling height are attributed either to the ecotypes used or to soil types on which they were tested. To this end, Palada and Chang (2003) emphasize the difficult development of *M. oleifera* on clay soils.

The height of *Moringa oleifera* compared to other species like *Pilisotigma reticulatum* (Yelémou *et al.,* 2007) reveals that this Moringaceae is a fast growing species. Concerning the lateral growth, this result is contrary to that obtained by Nkongmeneck *et al.* (1996) on *Tetrapleura tetraptera* in the forest area. Also, radial growth after 6 months of *M. oleifera* is much higher than that of the species of the forest area (7 months after sowing) (Mapongmetsem *et al.,* 1999). This means that *M.oleifera* is a fast growing species. This rapid growth is reported by several researchers (Saint Sauveur, 2001; Bosch *et al*., 2011). Agro-ecological zones do not influence the production of leaves (P> 0.05). However, conflicting results have been obtained in Benin; indeed Gnangle *et al*. (2010) noted a change in the number of leaves in seedlings of *Parkia biglobosa*, the seeds from five shea parks (*Vitellaria paradoxa*) and Néré (*P. biglobosa*). Furthermore, Mapongmetsem *et al.* (2004) note a variation of branching in seedlings of two months of *P. biglobosa* in high guinea savannah of Adamawa. This result indicates that the flowering shrubs are early in isohyets 2 and 3 and late in those of isohyets 1 and 4. Similar results are reported in the same species in Senegal (Diouf *et al.,* 2004).

In the ecological conditions of the Sudano-Sahelian zone of Cameroon, the plants fruited and seeds were matured within 6 months. The seeds from the 700 mm isohyets can be a good source of seed because of their early flowering and fruiting. According to Bosch *et al.* (2011), the young trees grown from seeds begin to bloom after 2 years; but trees from cuttings, hopefully the first fruits are matured 6-12 months after planting. However, there are varieties that bloom and bear fruits in the first year as the variety Mbololo Kenya. The results of the present study are similar to those of Pratt *et al.* (2002) and Price (2007). According to the first authors, flowering can occur within 4-5 to 12 months after planting. For the second author, after 8 to 12 months, the tree begins to bloom on an ongoing basis throughout the year.

During the data collection, a drop of flowers was observed. This partly explains the low number of fruits per plant. An inflorescence was to produce more pods, but the results have shown the opposite inflorescences and some have not even been able to form capsules. Flower falls were also mentioned on *P. biglobosa* (Hopkins, 1983; Sina, 2006). This fall flowers are accentuated in the Sudano-Sahelian zone and one of the causes of the loss of flowers is the harmattan. This behavior could obey a need for natural regulation of flowering and fruiting (Sina, 2006). Trees would adjust the number of flowers and fruits depending on the availability of their food reserves. Moreover, the burden would be quite unbearable for the tree if all fertile flowers evolved fruit. This natural regulation process would also be identical in *M oleifera* and confirms once again the low production of our fruit seedlings which can contain large food reserves. According to the work of HDRA (2002) after 36 months of age, *M. oleifera* produces about 300 to 400 pods. The result of this investigation shows that after three months the plant produced about 13.66 to 22.33 pods, which means that our 36 months plants will produce between 113.48 and 185.51 pods. This number of pod is 2 to 3 times lower, but this small amount is treated as the high density of our plants and inadequate intake of additional nutrients in the fields. Indeed, Palada and Chang (2003) recommended spacing of 3 to 5 m between the lines for production of pods and seeds. The reserve is low due to the young and the high density of plants (without fertilizer). Some plants have not even been able to flourish. Especially as these reserves are heavily used for growth; these seedlings are growing in full swing.

Furthermore, the small amount of pods may be related to the structure of the seedlings which is not thick; our seedlings have not been pruned. Producers of cloves always cut the branches at the approach rainy season (Saint Sauveur, 2009). The plants will be monitored over 3 years to confirm the present results. The pods are mature two months after flowering. This result corroborates that of Jahn (2003) in Sudan, where two months after flowering, mature and dry seeds were harvested. *M. oleifera* plants of this study fruited early (130 days after planting). In the literature, some varieties of *M. oleifera* begin to produce flowers around the age of 3 years. In Sudan, flowering plants appear after 10 to 11 months (Jahn, 2003).

Conclusion

Seed weight depends on agro-ecological zones. The average rate of seed germination is 79.43 ± 4.40. The germination rate, the radial and vertical growth and the number of sheets are not influenced by isohyet. The early flowering varies significantly depending on the agro-ecological sources (0.015 <0.05). Fruit production is independent of the agro-ecological zones. The phenology of plants should be followed after several cycles. To further refine this work, the number of seeds in the pods needs to be evaluate as well as the identification and monitoring of the main pollinators of the plant in the ecological conditions of the area.

REFERENCES

Barro L., Samba N. A. S., Diatta M. and Akpo E. L., 2013. Effet du travail du sol sur la productivité de différentes provenances de *Jatropha curcas*. Oléagineux, Corps gras, Lipides. Agonomie. 20 (3): 165-170

Bayé-Niwah C. and Mapongmetsem P.M., 2014. Seed germination and initial growth in *Moringa oleifera* Lam. 1785 (Moringaceae) in Sudano-sahelian zone. *Int. Res. J. Plant Sci*., 5(2):23-29.

Bosch C. H., Okuda T. et Gunnel, 2011. Moringa sp.(Nervedier). *Formand environnement.,* 32p

Brabant, P. et Gavaud, M., 1985. Les sols et les ressources en terre du Nord-Cameroun, Paris, ORSTOM. 214p.

Diouf M., Gueye M., Faye B., Dieme O., Lo C., Gningue D, Ba C. O., Ba T.B., Niang Y., Diao M. Ba, Tamba A. and Mbaye A. A., 2004. *Moringa oleifera* Lam (ou nebedaay ou woloff) un légume feuille d'avenir au Sénégal: utilisation et strategies de conservation . *In Proceeding of*

regional workshop on Plant genetic resources for food and security in west and central africa. Pp 143-151.

Gnangle P. C., Glele Kakaï R., Oumorou M., N'djolosse K., Bonou W. and Sokpon N., 2010. Tests de croissance des jeunes plants de Néré (*Parkia biglobosa* Jack, R. Br.) en pépinière. *International journal of Bilogical chemical Sciences.* 4(6): 1939-1952.

HDRA, 2002. *Moringa oleifera* A multi-purpose tree. 12P.

Hopkins H.C., 1983. The taxonomy, reproductive biology and economic potential of *Parkia biglobosa* (Leguminosae: Mimosoideae) in Africa and Madagascar. *Botanical Journal of the Linnean Society,* 87: 135-167.

INS., 2008. Tendances, profil et déterminants de la pauvreté au Cameroun entre 2001-2007. Troisième enquête auprès des ménages (ECAM3). 108P

Jahn S. M., 2003. « L'arbre qui purifie l'eau: Culture de *Moringa* spp au Soudan ». La génétique et les forêts d'avenir, Unasylva. 6 p

Madi P.O., Bourou S. and Woin N., 2012. Utilisations et importances socio-économiques du *Moringa oleifera* Lam. en zone de savanes d'Afrique Centrale. Cas de la ville de Maroua au Nord-Cameroun. *Journal of Applied Biosciences*, 60: 4421– 4432.

Mapongmetsem P.M., Duguma B., Nkongmeneck B. A. et Selegny E., 1999. Germination, Croissance et développement des plantules de quelques essences forestières. *Tropicultura*., 4:175-179

Mapongmetsem P.M., Nkongmeneck B. A. and Denedoumba D., 2004. Germination et premiers stades de croissance de *Parkia biglobosa* (jacq.) Benth. Une Mimosaceae alimentaire locale. *Procédés Biologiques et Alimentaires*, Volume 2 (1): 37-52.

Nassir M., 2012. Production utilisation et enjeux actuel de *Moringa oleifera* dans la ville de Maroua. Mémoire d'ingénieur des travaux en beaux-arts. Institut Supérieur du Sahel de Maroua. 38P

Nkongmeneck B.A., Nwaga D., Ndemmeze A. and Hallé F., 1996. Caractéristiques et capacités de germination des graines de *Tetrapleura tetraptera* (Schum. and Thonn.) Taub.(Mimosaceae) d'après leur situation dans la gousse. Rev. Ecol., (Terre Vie), 51 :117-124.

Ofoh M. C., Obiefuna J. C., Onwuliri C. O. E., Ibeawuchi I. I., Ibe A. E., Ojiako F. O., Adikuru N. C., NkwochaV. I. and. Chukwueke. T. C., 2010. Nursery and field establishment of *Moringa oleifera:* the federal University of technology, Owerri experience. In "Moringa oleifera– A National Crop for Economic Growth and Development", From 7th -8th December, 2010.Abuja, Nigeria.302:148-156.

Palada M.C. and Chang L.C., 2003. Suggested Cultural Practices for Moringa. *International Cooperators' Guide,* AVRCD.5p

Pratt J.H., Henry E.M.T., Mbeza H.F., Mlaka E. and Satali L.B., 2002. Malawi Agroforestry Extension Project Marketing and Enterprise Program Main Report.139P

Price M. L., 2007. ECHO Technical Note: The Moringa tree .19p.

Ratsifehera A.N., 2004. Etude de la fraction lipidique des graines de *Moringa oleifera* de la région de Tamatave et conception d'une technologie semi-industrielle d'extraction d'huile. Mémoire en vue de l'obtention du Diplôme d'Ingénieur Agronome Spécialisation : Industries Agricoles et Alimentaires. Université d'Antananarivo. 164p.

Saint Sauveur de A., 2001. L'exploitation du Moringa dans le monde : état des connaissances et défis à relever. Bilan Moringa 2001. Potentiel de développement des produits du Moringa 29 octobre - 2 novembre 2001, Dar es Salaam, Tanzanie. 12p.

Saint Sauveur de A., 2009. Technique de production des feuilles de Moringa en exploitation agricole familiale. PROPAGE, CTA. Moringa News. 6P

Sina S., 2006**.** Reproduction et diversité génétique chez *Parkia biglobosa* (Jacq) G. Don. Thèse présentée pour l'obtention du (Ph.D).Département des Sciences végétales, Wageningen University, the Netherlands. 118p.

Tedonkeng P. E., Boukila B., Tendonkeng F., Kana J. R., Tonfack., L.B. and Momo M.C.S., 2004. Influence de la fumure organique, du NPK et du mélange des deux fertilisants sur la croissance de *Moringa oleifera* Lam. dans l'Ouest Cameroun.13p

Voui B., 2008. Régénération des plantations de Teck (*Tectona grandis* L. f. Verbenaceae) après coupe rase : évaluation de l'influence de la densité du peuplement sur la croissance et la qualité des plants de Teck dans la forêt classée de Téné, Oumé (Côte d'Ivoire). Mémoire de DEA, UFR Biosciences, Laboratoire de Botanique. Université de Cocody, 56 p.

Yelémou B., Yaméogo G., Millogo J. R. and Hein V. 2007. Germination sexuée et dynamique de développement de *Piliostigma reticulatum* (D.C.) Hoc . Sécheresse. 18 (3): 185-192.

Zobel B. and et Van B., 1989. Wood variation, its causes and control. Springer-Verl, Berlin, pp 363-368

****