ISSN 2320-5407 International Journal of Advanced Research (2015), Volume 3, Issue 12, 277 – 284

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Evaluation of yam (*Dioscorea cayenensis – Dioscorea rotundata*) seed germination grown in Centre Benin

YOLOU Mounirou[1]*, ZOUNDJIHEKPON Jeanne[1], TIAMA Djakaridia[2], ANIZEHOU Sèssi Ida[1], ASSABA Elie Idossou [1] ADECHOKAN Hibath Audrey Agbékè Mahougnon[1] ZONGO Jean Didier[2] et AKOEGNINOU Akpovi[3]

1- Ecological Genetics Laboratory, Department of Genetics and Biotechnology, Faculty of Science and Technology , University of Abomey - Calavi - 01 BP 4521Tri-postal Cotonou - Benin Republic

2- Laboratory of Genetics and Plant Biotechnology, UFR Life and Earth Sciences - University of Ouagadougou - Burkina Faso

3- Laboratory of Botany and Plant Ecology, Department of Plant Biology, Faculty of Science and Technology, University of Abomey, Benin

Manuscript Info

Manuscript History:

Received: 14 October 2015
Final Accepted: 22 November 2015
Published Online: December 2015

Key words:

Yam, *D. cayenensis - D. rotundata* cultivars, germination rate, substratums.

Corresponding Author

YOLOU Mounirou

Abstract

Yam (*Dioscorea cayenensis - Dioscorea rotundata*) is an important subsistence crop for food security in tropical countries. In many countries where it has been cultivated the plant is usally propagate through vegetative multiplication. However surveyed in the farmers field showed yam flowering and production of the fruits with seed which can be used as seed for yam production in order to reduce to the tuber used at the planting moment. This study aims to evaluate the rate of seven seed yams germination on two substratums (blotting paper and ground). For each cultivar and on each substratum, three repetitions were applied in randomized complete block. Observed parameters were the first germination period of the seed after sowing, and the final germination rate by cultivar. These parameters were subjected to analysis of variance. Statistical analysis showed that there is no difference in the time of the first seed germination after sowing ($p = 0.273$) on the two substratums. For the germination rate, the difference observed between the two substratums is not more significant ($p = 0.148$) with 47.05% in the ground and 42.09% in the paper. However, cultivar Dodo presented the highest germination rate at both in ground 68% and using paper 57.32%. These results suggest that yam seeds germinate and take on average of 25 days to germinate, with an included germination rate from 26% to 68%. These results also showed also that yam seed can be used as sources of yam multiplication by yams' farmers'.

INTRODUCTION

Yam is a major tropical tuber crop grown in many countries around the world, particularly in West Africa wich provide about 95% of world production (FAOSTAT 2013). It belongs to the *Dioscorea* genus which contains over than 600 species grouped into 59 sections and Enantiophyllum is considered as the most important which contains almost all the cultivated species grow for food and income generating (Coursey 1967). This area land dedicaded for yam production and its production have been increase since the last four decades. Yam is the second most cultivated root and tuber plant behind cassava and its annual production is estimated at 48.3 million tonnes (FAOSTAT, 2013). According Dumont et al., (2010), Loko et al., (2013), Dioscorea cayenensis- D. rotundata considered as "**complex species**" provides nearly 90% of the total production of african's yams. In this region, yam is one of the most and

important crops for food and for billion of the population (Mignouna et al., 2002; Adejumo et al., 2013). It is a also used as staple food and an important source of income generating for over than 75% of the rural population (Loko et al., 2013).

Yam is vegetatively propagated used tubers, while wild species is annually reproduce sexually through seed. Many studies in North Benin (Dumont, 1977), in northern Côte d'Ivoire (Stessens, 2002) and (Yolou et al., 2015b) in Benin Centre showed that each farmer cultivates 800 and 4500 plants, producing respectively 4,800 and 27,000 seeds. Some of these plants from seeds are integrated in cultivated yam population by farmers without realizing it (Dumont et al., 2010). In Benin, more than 70% of yam cultivars held by farmers flower (Dansi et al., 1999; Tostain et al., 2005, Yolou et al., 2015b). The seeds of wild and cultivated yams are not exploited by farmers neither for domestication or for cultivation (Dumont et al., 2005). Now through sexuality, domestication and cultivation of yam will have other beneficial effects. First, there will be a removal of deleterious mutations and viruses. Then, there may be an adjustment of the homeostatic balance value in the event of environmental changes. Very little scientific study (Trouslot et al., 1993; Zoundjihékpon 1993) have been focused of yam seed germination. Now, the cultivated and wild yams produce viable seeds can germinate and produce tuber. The general objective of this work was to study the yams seeds germination. Specifically, it is to describe the fruits and seeds of yams, to determine the seed germination period, to assess the rate of germination of these seeds of several cultivars grown by farmers' and to identify the most favourable substratum to seed germination.

Material and methods

Origin and description of the fruits and seeds of yams.

The Different yam fruits used in this suty were harvested at the maturity at the end of December 2013 in yam farmers' fields of the four areas (Dassa - Zoumé , Glazoué , Savalou and Savè) in Central Benin. They are dried in the sunlight for 21 days and then, the fruits were carefully and manually removed. 50 fruits and 50 seeds were described using data relative to yam seed and fruit descriptions. The concerned cultivars are Mafobo, Kratchi, Mondji, Dodo, Kpakala, Gnanranbou and Gnidou. For the description of the fruits and seeds, seven parameters were taken into account. For fruits, we considered the shape, pubescence, plums, and the presence of black spot. To the seeds, the shapes, the structure of the wing, the color of the wing and of the embryo were selected. Seeds are conserved at room temperature in the laboratory.

Experimental and study Midium.

The test was conducted in the nursery at the experimental site of the Department of Genetics and Biotechnology at the University of Abomey - Calavi, and in the Ecological Genetics Laboratory of that Department. The experimental site is located in the Guinean area, 15 km at north from Cotonou (6 ° 24'E 30'Nord and 2). It has a sub-equatorial climate with rainfall kind bimodal with two rainy seasons (April to July and October to November) interspersed with two dry seasons (August-September and December-March). Annual rainfall ranges from 1100 to 1300 mm, with the annual temperature around 25 ° C in average and amplitude of 4 ° C. Maxima of temperatures are often recorded in March, while the minima are generally registered in August. As for the relative humidity, it reaches 96-97% at the end of the rainy season (June-July and November) and 34-36% by the end of the dry season (January-February), an annual average of 74.2%. From December to February, the harmattan, a dry continental air occurs during a few days (Adam and Boko, 1993).

The seeds of the seven cultivars mentioned above were sown in the 50 cm (length), 25 cm (width) and 15 cm (depth) seed tray, and in boxes of 25 cm (length), 10 cm (width) and 10 cm (depth). Seed trays contain soil as substratum and boxes blotting paper. This paper has the same properties as wattman paper 3. Seedlings were held March 7, 2014, with 50 seeds per seed tray or by box and three repetitions for each cultivar on each substratum. Seed tray and boxes are stored in 3 blocks following a completely randomized respectively in the greenhouse and in the laboratory.

Collection and Data Processing

Base on the color of the embryo and of the membrane, the yams seeds were classified into group. After sowing, records of the germination were taken every day. Observations were concerned on the date of first germination in each batch of 50 seeds and the number of germinated seeds for each treatment. The seedlings were watered with tap water when necessary, in the morning between 7 and 8 o'clock and afternoon between 4 and 5 o'clock GMT as recommended by Aho and Kossou (1997). Germinated seed is counted when the growth of the gemmule emerges above the ground or paper.

Germination rate by cultivar and substratum was calculated as the ratio of the number of germinated seeds and the total number of sown seeds. The number of the first seed yam germination is noted from the date of sowing to the day when the first seed is germinated. To ensure the normality and the homogeneity of variances required for the

application of analysis of variance, data related to the number of days of the first germination and germination rate have undergone logarithmic transformation of base 10. They were then subjected to analysis of variance. In addition, Fisher's test was applied for prioritizing medium in case of significant differences. Statistica 7.1 software was used for this purpose.

Results

Characteristics of fruits and seeds of yams

The fruits of the yam cultivars collected from the central Bein were capsules with three lobes (Figure1A). These capsules were greenish fresh, but they take a brown color when dried (Figure 1B). In each lobe, there are two seeds, making a total of six seeds per fruit well formed. Each seed is composed of a central embryo surrounded by a membranous wing (Figure 1C).

Base on the color of the embryo and seed membrane, cultivars were divided into two groups (Figure 2): Cultivars group of Mafobo, Kratchi, Mondji and dodo with dark brown membrane and embryo (Figure 2). In this group of cultivars, there is not a clear difference between the embryo and the membrane. The secong group composed of Kpakala, Gnanranbou and Gnidou cultivars is characterized by membrane with brown yellowish or brown clear (Figure 2) and the embryo is brown. In this group, embryo and membrane are clearly separated.

Duration of seed germination

Seed germination were observed start to 25 days after sowing on the blotting paper on average. Kratchi and Mafobo cultivars germinated 23 days after sowing (Table 1). Gnidou and Mondji cultivars germinated 25 days after sowing. Considering ground substratum, the seeds germinate 26 days after sowing on the average. Cultivars Dodo and Mondji were the first cultivars which germinated at 24 days after sowing. Cultivars Kratchi, Mafobo, Gnidou, Kpakala and Gnanranbou germinated respectively 25, 26, 26, 28 and 29 days after sowing seeds (Table 1). Analysis of variance showed that they is significant difference at the 5% level between the germination periods of different cultivars on the same substratum (Table 2). However to one substratum to another substratum the data analisis showed that there is no significant difference (Table 2). Figure 3 showed the germinated seed of yam on both substratums. On the blotting paper, the stem is longer than the germinated plant in the ground. Furthermore, the first leaf coming from germinate seed on ground is more wide than leaf obtained with seed germintated on paper substratum.

Seed germination rate

Germination rate on paper varies between 26% and 57.32% with an average of 42% (Table 1). On this substratum, cultivars Dodo, Mondji and Kratchi showed the highest germination rate which is 57.32% for each. The cultivar Kpakala presented the lowest germination rate 26%. On the ground substratum, the rate varies between 32% and 68% respectively for cultivars Gnanranbou and Dodo (Table 1).

The analysis of variance (Table 2) shows that the type of substratum used has no significant effect on seed germination period or on the germination rate for the same cultivar. But the differences observed for germination between different cultivars on the same substratum are statistically significant. This shows that the germination period and seed germination rate are not influenced by the nature of the substratum, but are influenced by the nature of the genotype.

Influence of the day number on the evolution of yam seed germination

Figures 4 and 5 show the seed germination kinetics for each cultivar, respectively on the blotting paper and ground. These curves represent the number of germinated seeds for a cumulative period of 12 weeks. We can conclude that on both types of substratums (paper blotting and ground), seed germination starts three weeks after the seed planting. The nature of the substratum does not have a remarkable effect on the start of seed germination and germination speed. The results obtained on the different substratums, showed that germination rates are best on the ground substratum than the blotting paper.

Table 1: Time and germination rates observed on both substratums for the seven cultivars

Cultivars	Germination period in day		Germination rate (%)	
	Paper	Ground	Paper	Ground
Mafobo	23a	26bc	39,32d	50^{e}

Kratchi	23a	25ab	57,32e	56,66f
Dodo	24ab	24a	56,66e	68g
Mondji	25bc	24a	57,32e	48ad
Gnidou	25bc	26bc	30c	40,66c
Kpakala	28d	28d	26a	34b
Gnanranbou	29[e]	29e	28b	32a
Average	25 ± 2	26 ± 1	42,09 ± 14,65	47,05 ± 12,77

NB: The number with the same letter in the same column are not significantly different at the 5% threshold.

Table 2: ANOVA Results

Sources of variation		**Probability**	
	df	**Germination period**	**Germination rate**
Substratum	1	0,273577ns	0,148602ns
Cultivars	6	0,001761***	0,021763*
Substratum + cultivars	6	0,859455ns	0,4409130ns
Erreurs	28	-	-
Total	41	-	-

NB : df : degree of freedom ; ns: non-significant difference at the 5% threshold; *: Significant difference at the 5% threshold; ** : Significant difference at the 1 % ; *** Very highly significant difference at 0.1 % level.

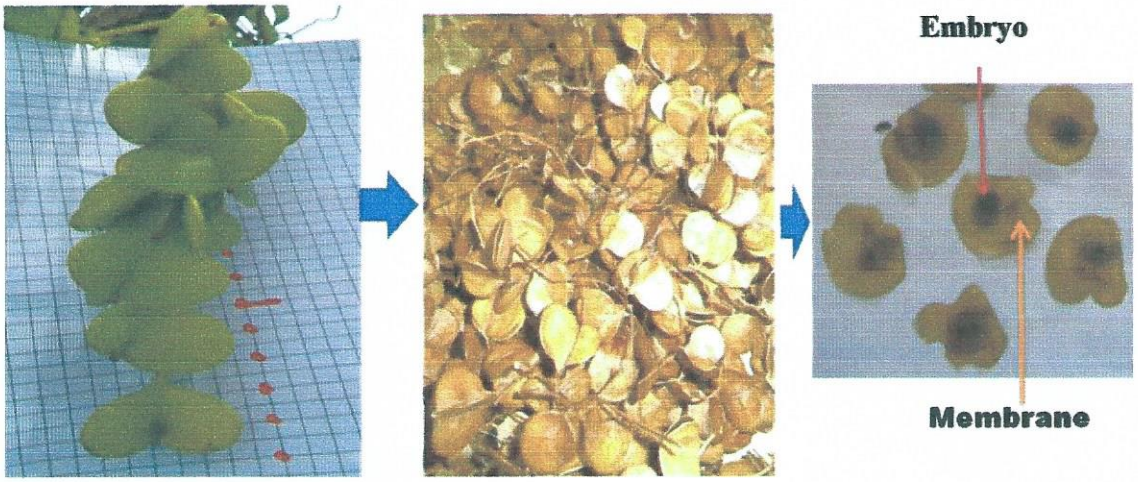

Figure 1 : Fruit and seed of yams species-complex *D. cayenensis - D.rotundata*

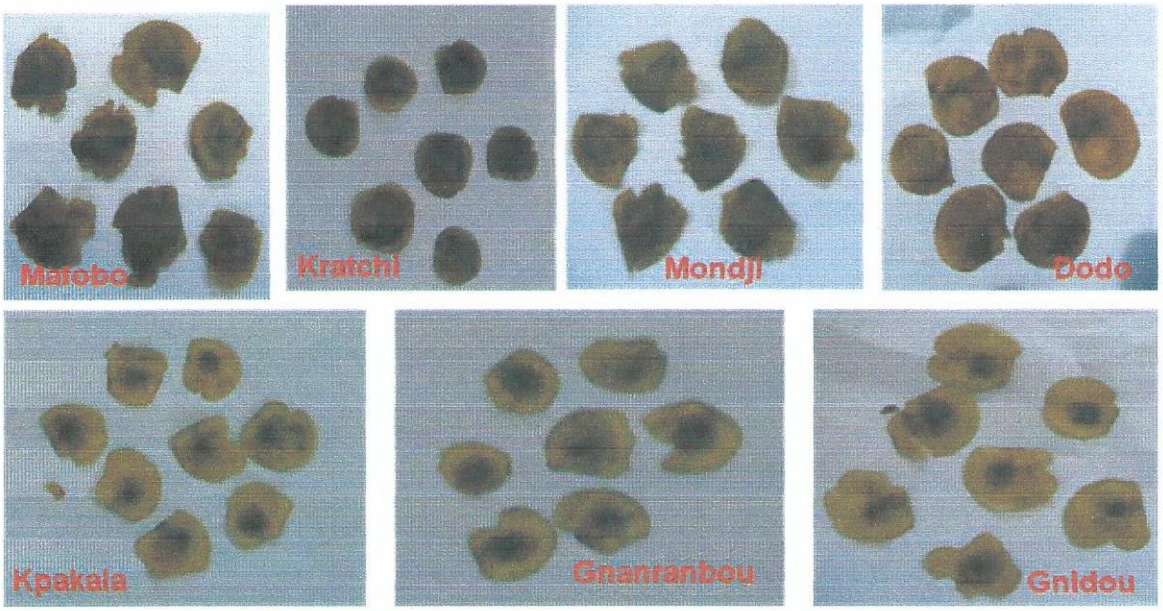

Figure 2: Diversity of yam seeds of the complex D. cayenensis - D.rotundata

A : Germinated seeds on blotting paper substratum

B : Germinated seeds on ground substratum

Figure 3: Seedlings from yam seeds sown on blotting paper (A) and ground (B)

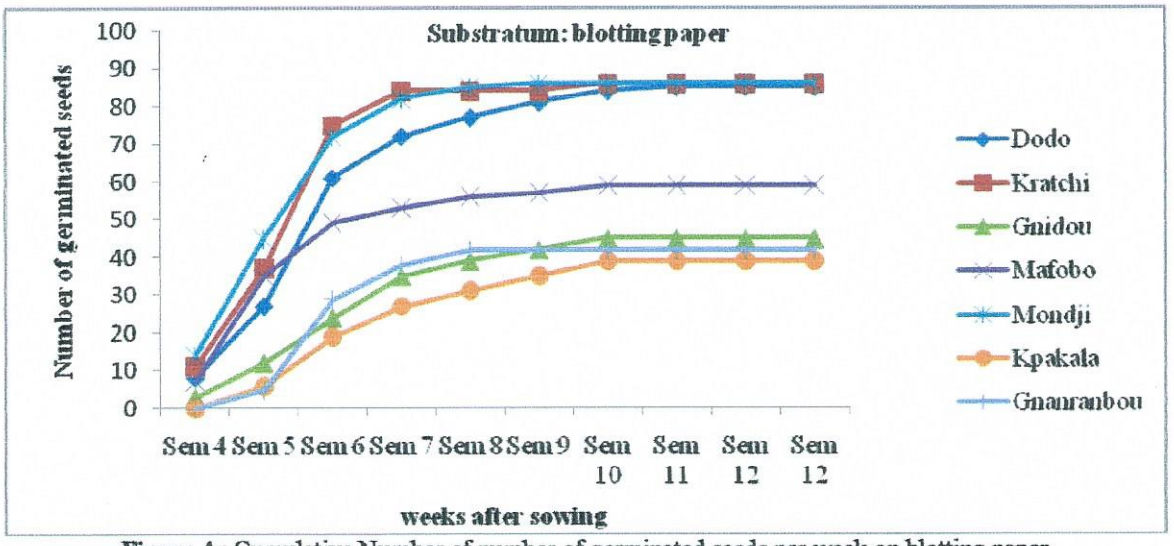

Figure 4 : Cumulative Number of number of germinated seeds per week on blotting paper

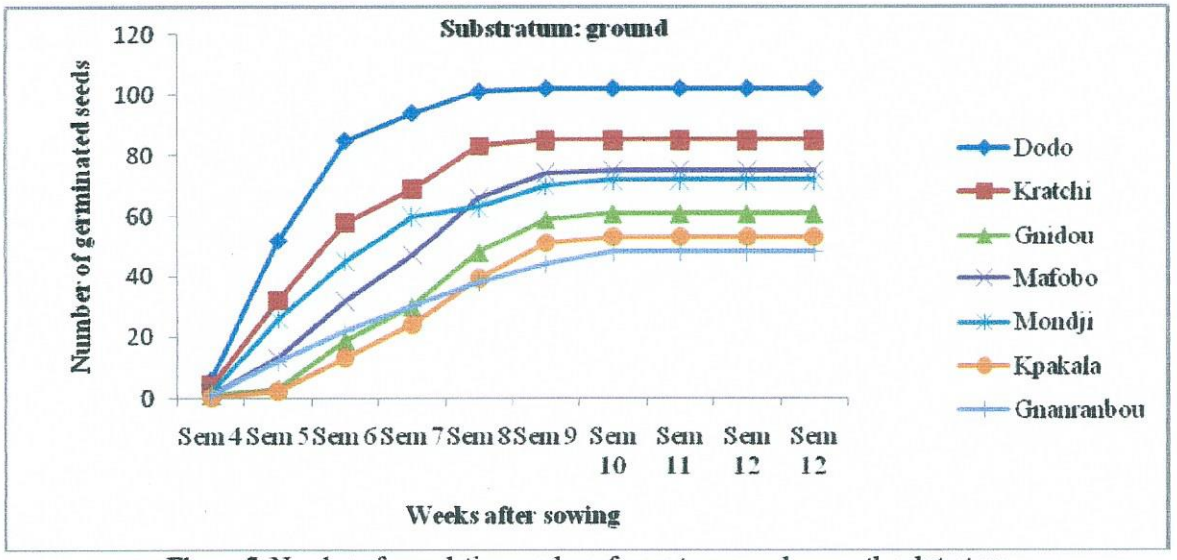

Figure 5: Number of cumulative number of sprouts per week on earth substratum

Discussion

The effect of the substratum and the type of cultivar of species-complex *Dioscorea cayenensis - D. rotundata* on the germination period for the first seed, the germination rate were evaluated in this study. The results showed that the seeds of yams take on average 25 and 26 days respectively on paper and ground to germinate. Similar results have been noted previously by Trouslot (1983). However, Zoundjihékpon (1993) in the same work in Cote d'Ivoire noted that the seeds of this cultivars yam germinate 15 days after sowing. This difference observed in the yam seed germination period could be explained by their different origin (Dangasuk et al., 1997 ; Hessou et al., 2009). Our results indicated that the germination rate varies from 26% to 57.32% on paper and 32% to 68% on the ground substratum. These results are in concordance with those observed by Trouslot (1983). This author showed that the germination rate in species-complex varied from 0% to 85%.

The periods of germination and germination rates observed for each substratum and in each cultivar would be influenced by the integument of seeds that are relatively hard and waterproof. Also, these integuments can also

induce a slight and differential seed dormancy, which is opposed to a bundled and homogeneous germination. Thus, we observed a staggering of seed germination which spans five weeks. This staggering in time of seed germination, in situ, can be explained by the deferred staggered ripening of seeds from fertilization of female flowers in time. It is also an adaptation strategy of yam to the use of the sexual reproduction.

As regards the effect of the substratum on the germination of seeds, the relatively strong average rate of germination is noted for the ground substratum for all cultivars. This is explained by the fact that in natural conditions, scarification factors for seeds are grains of sand and insects. They act on the seed integument and promote water penetration into the seeds and thus their germination. Furthermore, both on blotting paper and on soil substratum, the high values of standard deviations mean that average rates of each cultivar vary widely. This variability between cultivars germination rate may be related to the influence of edaphic and environmental parameters (temperature and humidity) on germination, which was not taken into account in this study. However, no significant difference observed in the interaction between the factors "substratum" and "cultivar", regarding the time of the first seed germination after sowing shows that this behavior of seeds don't depend on the substratum used for sowing. Then we can conclude that the seeds need only water and oxygen for germination and that the best substratum is the ground (soil).

The difference in behavior noted in the present study between seven cultivars, concerning the time and the seed germination could be related to a genetic differentiation between the different cultivars. Thus, we observed that the cultivars with brown seeds and without distinction between the embryo and the winged membrane have a shorter germination period while exhibiting superior or equal to 50% germination rate. As suggestions, genetic variations are linked to parental genotypes that produced seeds and influenced the time and seed germination.

Conclusion

This study shows that the seeds of yam cultivars can germinate with a high germination rate 26-68%. The time taken by these seeds to germinate is four weeks after sowing. The maximum germination rate is obtained after seven weeks after sowing. The nature of the substratum used has no influence on the germination period. The ground substratum can be considered as the best for yam seed germination. However little of yam farmers in Central Benin have adopted this practical in term of yam production. In term of participatory breeding breeding program and reduction of the quantity of tuber used by yam farmers of yam multiplication as seed they should be informed about this methodology.

References

Adam, K.S., et Boko, K. (1993) : Le Bénin. Editions du Flamboyant: Cotonou.

Adejumo, B.A., Okundare, R.O., Afolayan, O.I., et Balogun, S.A. (2013) : Quality attributes of yam Flour (Elubo) as affected by blanching water temperature and soaking time. Intl. J. Engr. Sci. (IJES), 2(1):216-221

Aho, N., et Kossou, D.K. (1997) : *Précis d'Agriculture Tropicale. Bases et Eléments d'Applications*. Editions du Flamboyant: Cotonou.

Akoroda, M.O. (1984) Floral biology in relation to hand pollination of white yam.Euphytica, 32: 831-838.

Coursey, D.G. (1967): Yams.an account of the nature, origins, cultivation and utilization of the useful members of the *Dioscoreaceae*. Tropical Agriculture Series, (Ed.) Longmans 229p.

Dangasuk, O.G., Gudu, S., et Okaebo, J.R. (1997): Early growth Performance of sixteen populations of *Faidherbia albida*in semi arid Baringo district of Kenya. In *Sustaining Global Farm*, Stott D.E, Mohtar RH, Steinhardt GC (éds). Purdue University press: Perdue; 412-418.

Dansi, A., Mignouna, H.D., Zoundjihékpon, J., Sangare, A., Asiedu, R. et Quin, F.M. (1999) : Morphological diversity, cultivar groups and possible descent in the cultivated yams (*Dioscorea cayenensis – Dioscorea rotundata*complex) of Benin Republic. *Genet Resour Crop Evol 46: 371–388.*

Dumont, R., Zoundjihékpon, J., et Vernier, P. (2010) : Origine et diversité des ignames *Dioscorea rotundata* Poir. Comment le savoir-faire des paysans africains leur permet d'utiliser la biodiversité sauvage dans l'agriculture. *Cahiers d'Agriculture* vol 19 (4): 255-61pp.

Dumont, R. (1977) : Etude morphobotanique des ignames *Dioscorea cayenensis- D. rotundata* cultivées au Nord – Bénin. L'agronomie tropicale, 32 : 225-241.

Dumont, R., Dansi, A., Vernier, P., et Zoundjihékpon, J. (2005) : Biodiversité et domestication des ignames en Afrique de l'Ouest. Pratiques traditionnelles conduisant à *Dioscorea rotundata*. Collection repère. Montpelier: CIRAD, éd., 2005.

FAOSTAT – Food and Agriculture Organization of the United Nations, (2013): Production crops. Available at: http://faostat.fao.org/ site/567/default.aspx#ancor. Accessed at: 7 December 2013.

Hessou, C., Glèlè kakaï, R., Assogbadjo, A.E., Odjo, T. et Sinsin, B. (2009) : Test de germination des graines de *Caesalpinia bonduc* (L.) Roxb au Bénin *Int. J. Biol. Chem. Sci. 3(2): 310-317,*
Loko, Y.L., Dansi, A., Agre, A.P., Akpa, N., Dossou-Aminon, I., Assogba, P., Dansi, M., Akpagana, K., et Sanni, A. (2013) : Perceptions paysannes et impacts des changements climatiques sur la production et la diversité variétale de l'igname dans la zone aride du nord-ouest du Bénin. Int. J. Biol. Chem. Sci. 7(2): 672-695.
Mignouna, H.D., Dansi, A., et Zok, S. (2002): Morphological and isozymic diversity of the cultivated yams (*Dioscorea cayenensis/Dioscorea rotundata* complex) of Cameroon. Genet. Resourc. Crop Evol. 49:21 – 29.
Stessens, J. (2002) : Analyse technique et économique des systèmes de Production agricole au nord de la côte d'ivoire. Thèse de Doctorat No. 530. Katholieke Universiteit Leuven. 302p
Trouslot, M.F. (1983) : Analyse de la croissance et morphogenèse de l'igname *D. cayenensis – D. rotundata.* Thèse de doctorat d'état. Université de Clermont-Ferrand II, France, 247P.
Tostain, S., Chaïr, H., et Scarcelli, N. (2005) : Diversité, origine et dynamique évolutive des ignames cultivées *Dioscorea rotundata*Poir. au Bénin. Colloque national BRG sur un dialogue pour la diversité génétique, Lyon. Les actes du BRG ; 5 : 465-82.
Trouslot, M.F., Champagnatz, M., Tort, M., Loiseau, M. et Eraud, C. (1993) : Developmental morphology of seedlings of *Dioscoreacayenensis - D. Rotundata* complex. *Phytomorphology, 43 (1 et 2), pp. 49-57.*
Yolou, M., Anizèhou, I., Dossou-yovo, R., Akoègninnou, A., Zongo, J.D. et Zoundjihékpon, J. (2015a) : Etat des lieux de la reproduction sexuée des ignames africaines *Dioscorea cayenensis – Dioscorea. rotundata* cultivées au Bénin. *Int. J. Biol. Chem. Sci.*9(2): 737-750, April 2015.
Yolou, M., Zoundjihékpon, J., Assaba, E.I., Anizehou, I., et Akoègninou, A. (2015b) : La floraison des ignames africaines cultivées (*D. cayenensis – D. rotundata et D. dumetorum*) dans les champs des producteurs du Centre-Bénin. *J. Appl. Biosci. 91:8480 – 8492 ISSN 1997–5902.*
Zoundjihékpon, J. (1993) : Biologie de la reproduction et génétique des ignames cultivées de l'Afrique de l'Ouest, *Dioscorea cayenensis - rotundata*, Thèse de Doctorat d'Etat, Université Nationale de Côte d'Ivoire. p.306.

Acknowledgments

We thank yam producers of Central Benin who provided useful information during the data collecting and their fully implication in this work. We are also grateful to Agence Universitaire de la Francophonie (AUF) who financial contribuated to this research "Genetic diversity and rights of local communities in yam growing areas in West Africa: Case of Benin Centre and Passoré (Burkina Faso)".