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Research Article

EARLY ESTABLISHMENT PERFORMANCE OF *MORINGA OLEIFERA* LAM.SEEDS ACCORDING TO DIFFERENT STORAGE DATES

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ABSTRACT

Moringa oleifera, a multi-purpose woody species that is increasingly being cultivated in Burkina Faso. The purpose of this study is to determine the best way to produce Moringa seedlings. The study was conducted at AMIFOB, Ouagadougou in (12°7'32''N et 01°40'24''W). Germination tests of Moringa seeds and seedling growth were carried out with newly harvested seeds, one and two-year-old, in plastic pots and directly on the ground, arranged together in ambient atmospheres receiving a daily water supply of 250 ml. Seedlings from the pots are transplanted to the same substrate on the 35th day after sowing. The results showed that the age of the seed has a significant effect on the germination rate of the seeds ($p<0.05$). Older seeds have a low germination rate (42.33%). After 35 days after germination, the height and collar diameter growth of potted seedlings is higher than that of direct seeding. Seedlings emerging from the ground have a recovery rate of 81.35%. On the other hand, those in the pots have a 100% recovery rate. Sixty-five days after transplanting, potted seedlings and those growing on the ground showed no significant difference in growth in height and diameter ($p>0.05$). The recovery rate for seedlings from pots is 83.33% compared to 65.56% for those from direct seeding on the ground. The germination rate of older seeds is low and the water content of the substrate influences the germination rate of Moringa seeds.

Keywords: Field, Growth, Leaves, Seedlings, Transplantation.

INTRODUCTION

Moringa oleifera Lam., a woody species of the Moringaceae family native from India, is increasingly cultivated by people in the Sahelian zone because of the multiple uses of its leaves, roots, bark, fruits, and seeds. The populations use the fresh leaves as powder and the seeds as an oil for their food, for medicinal purposes and as a source of monetary income through marketing on local and international markets (De Saint sauveur *et al*., 2010). This plant contains important mineral elements and vitamins (Foidl *et al*., 2001) and is considered by Bationo *et al.*, (2001) as an alternative to fight against malnutrition in Sahelian countries. Despite its importance, pod production is low. The quantity and quality of the pods and leaves produced are still below the expectations of producers and buyers nationally and internationally (Dao *et al.*, 2015). In Burkina Faso, small producers who constitute the majority of Moringa farmers in Burkina Faso do not have access to state-approved seeds that are of high quality because their cost is considered too high. Many producers continue to sow stored seeds for a long time in worth conditions that do not always guarantee their viability for future sowing. This is a handicap to improvement tree yield. Growers may need to modify the cultural practices to suit good establishment and emergency conditions. Authors such as Kouami *et al*., (2001); Goss, (2012); Nerson, (2002) Dao *et al.*, (2015) showed that seed quality was the basis of low seed germination and low seed yield and leaf yield. Others have established the link between the storage time of seeds with seed viability and the speed of emergence (Chastin *et al.*, 1996; Besse, 1996; Bosch, 2004). However, there are currently few studies

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describing the germination and growth of Moringa seedlings in the Sahelian zone in relation to the storage time of seeds. Thus, it was hypothesized that Moringa seeds newly harvested and sowed immediately could enable producers to increase the germination rate and early growth performance. The study aims to compare the germination rate of Moringa seedlings under three different stages of seeds stored at room temperature in a traditional box covered with straws of *Andropogon gaillanus*.

MATERIAL AND METHODS

Study site

The field trial was carried out in the home garden of the women association group named *Amicale des Forestières du* Burkina Faso (AMIFOB),located at 12°7'32''N et 01°40'24''W, 300 m altitude in Ouagadougou in Burkina Faso, West Africa. It is located in the north sudanian climatic area of Burkina Faso which has a mean annual rainfall during 2020 years of about 822, 36±95, 14 mm year^{-1}. The rainfall is lasting mainly for 04 months from June to September. Average monthly temperatures rarely exceed 35°C (Pigeonnier *et al.*, 2001).

Row material

The seeds used in this study were collected directly from Moringa plants of AMIFOB garden which covering an area of 4 ha. Seeds were collected from five-year-old plants intended for seed production. The stands were watered regularly every two days during the dry season to maintain the foliage of the plants. Seeds collected from the trees were stored in batches of different ages in plastic bags and kept at room temperature (20 - 35^{o}C).

Figure 1. Moringa seedling seven days after germination.

Experimental design

The experiment was carried out on May 11, 2019 using a fisher design with three replications in two designs. The first design therefore consisted of three treatments. The treatment 1 included newly harvested seeds, the treatment 2 with one-year-old seeds and treatment 3 with two-year-old seeds. The seeds were sowed the same day in a plastic bag of dimensions 30cmx196cm 2 at 05 cm deep and one seed per pocket. The water content of the newly collected Moringa seeds was 5, 8%. The design was arranged on a frame laid out in the open air (Figure 1). Standard nutrition, irrigation, weeds control and pest and disease management practices were followed according to the plant's development stage and planting date (Berries 2021). At the end of the 35th day after emergence, the seedlings in plastic pots were transplanted into the field (Design 2).The physical and chemical properties of the soil used in both designs are summarized in the table 1.

Data collection

The first seeds that emerge are monitoring daily using record sheet. Germination is considered complete when there is no more seedling emergence counted for at least 15 days. Growth monitoring (height of the seedlings and diameter at the collar) took place every 2 days, from day 1 to day 34, after emergence. There were carried out respectively using a tape measure and a caliper. The number of leaves was counted per seedling. After the transplantation in the field the monitoring was done weekly from the first day of transplantation until the 35th day and a final monitoring on the 65th day.

Data analysis

Data were processed and analyzed using Excel 2013, and XLSTAT software version 2015.4.01. The analysis of variance (ANOVA) was done by comparing all the variables measured, and the production methods of the Moringa seedlings. A correlation coefficient (R) was done between the number of leaves produced and the morphological parameters of the seedlings before and after transplantation.

RESULTS AND DISCUSSION

The seeds germinate from May 16 to 22. The average germination time according to the treatment is 6 days for each of the three treatments. Our results show that the dates of conservation of the Moringa seeds does not have an influence on the time of the seed germination ($p > 0.05$) (Table 2).The average germination rate varies with the age of the seeds. From the fifth day, it reaches more than 80% for newly harvested seeds against less than 70% for those of one year old and less than 50% for those of two years old (Figures 2). For conservation methods, it is 90% for newly harvested seeds, 63.33% for one-year-old seeds and 42.33% for two-year-old seeds. The final germination rate in the plastic pots is 68%. The analysis of variance test (Table 2) indicates a highly significant difference between the germination rates of newly harvested seeds, those of one (1) year and those of two (2) years ($P < 0.05$).

Table 1. Soil physical and chemical parameters collected in the study site of the «Amicale des Forestières du Burkina Faso» in Ouagadougou.

Soil depth (cm)	Physical parameters					
	Sand (%)	Silt (%)	Clay (%)	Texture	Field Capacity (%)	Permanent Wilting Point (%)
0-15	81.1	8.0	12.2	Sandy loam	7.02	1.29
Soil depth (cm)	Chemical parameters					
	pH	Total N (%)	Extr.P (mg kg-1)	Exch.K (mg kg-1)	Exch.Ca (mg kg-1)	Exch. Mg (mg kg-1)
0-15	5.15	0.23	4	19	302	27

Table 2. ANOVA table of seed germination parameters in the plastic pots.

Treatment	Germination time (j)	Interval first and late germination (j)	Germination rate
T1	6±0,0 a	0 à 6±0,5 a	90±1,31 a
T2	6±0,0 a	0 à 4±0,6 a	63,33±2,12b
T3	6±0,0 a	0 à 4±0,7 a	42,33±3,13c
Mean	6±0,0	0 à 6 ±0,0	68±1,81
p-value	0,37	0,12	0,001*

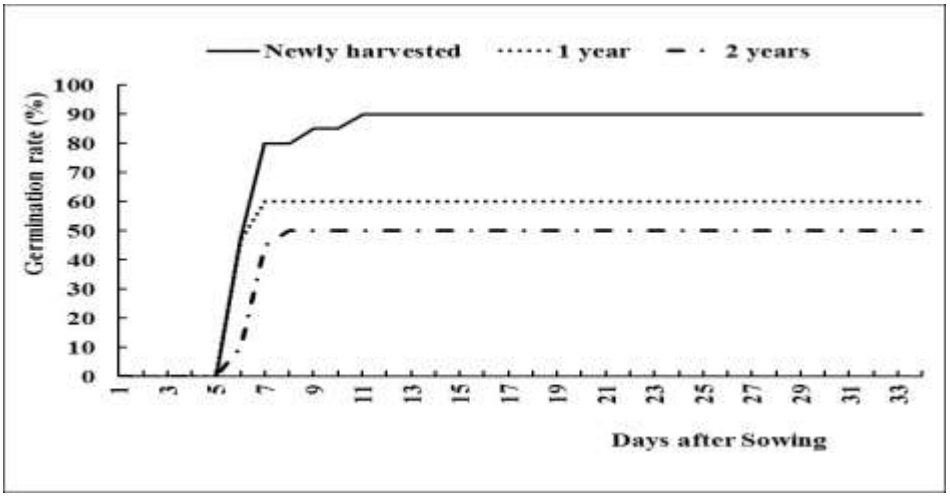

Figure 2. Germination rate in the plastic pot at the nursery.

The ANOVA test shows that the growth in height of the seedlings in the pots is significantly different ($p < 0.05$) at the 34th day before transplanting to the fields. After 65 days, when seedlings have been transplanted in the field, the ANOVA test at the 5% threshold shows a significant difference in height growth between the treatments ($p < 0.05$) (Table 3).

Table 3. Analysis of variances of seedlings growth parameters before and after transplanting plants to the fields.

Treatments	Seedlings at the nursery in the plastic pots			Seedlings transplanted in the field		
	Average Height (cm)	Average Diameter (cm)	Average number of leaves	Average Height (cm)	Average Diameter (cm)	Average number of leaves
T1	29.12±2,31	10.021±3,12	14.31±2,02	78.43±12,65a	10.98±3,12a	10.42±2,12a
T2	27.413± 1,20	No	No	77.68±21,13a	10. 02±1,23a	10. 15±3,14a
T3	27.129±2,67	8.023±2,89	13.23±0,24	77.34±13,41a	9.31±1,56a	9.12±1,76a
Probabilité	0.674	0.321	0.734	0.017	0.126	0.502
Significance	No	No	No	Yes	No	No

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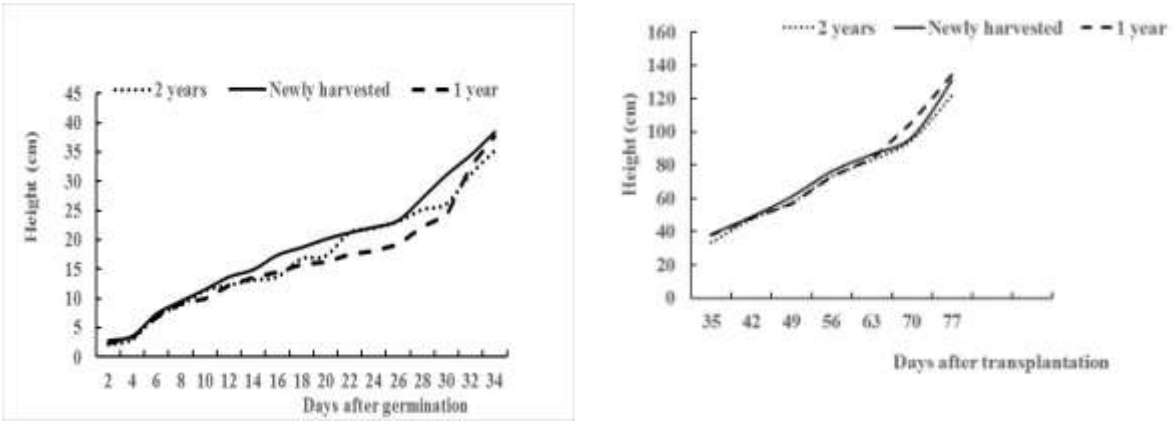


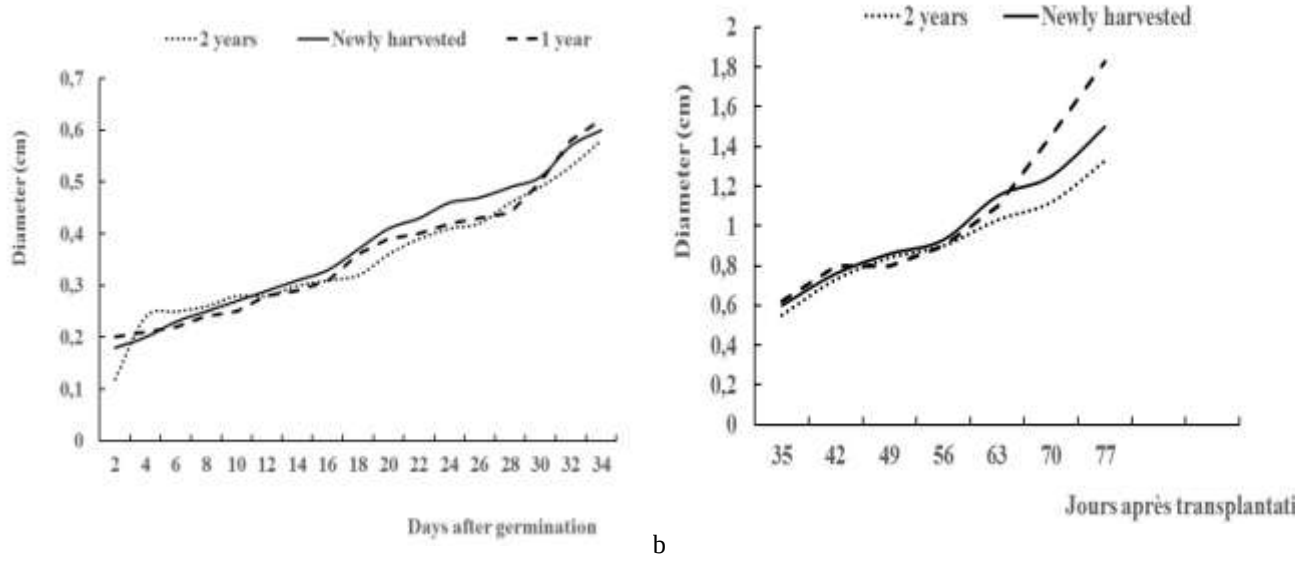
a b

Figure 3. .Height growth of seedlings of Moringa(a= from day one to day 35 at the nursery in the plastic pots ; b= seedlings transplanted in the field from day 35 today 65.

Height growth in Moringa is almost identical in pots and direct sowing from the 1st to the 35th day except at 14 days when a slight drop in growth is observed in direct sowing (Fig. 4a). We record a growth of From the 35th to the 65th day this growth is always maintained almost identically in pots and direct sowing (Figure 3b). Indeed, the potted plants recorded an average of 38.44 cm against 34.71 cm for those developing on the ground on the 34th day after germination. This difference in height is maintained and increases as the days go by. But, sixty-five days after transplanting the seedlings in pots, we noted at the level of the seedlings resulting from the seedlings in the pots an average height of 67.29 cm ± 16.16 against 64.33 cm ± 14.46 for those emerging from direct seeding into the ground. Figure 4b shows that the seedlings from the pots grow substantially at the same rate in height as those emerging from the ground after 65 days after transplantation. The curves obtained reveal that for the first days before transplanting, the plants have an almost identical growth in diameter. Sixty-five (65 days) after transplanting, we noted in the seedlings from the seedlings in the pots an average diameter of 1.01 ± 0.16 cm against 1.08 ± 0.25 cm for those emerging directly from the ground. . The ANOVA test at the 5% threshold does not show a significant difference between the growth in diameter and the shelf life of Moringa seeds. Figure 4b shows that the seedlings from the pots of the treatments have diametrically different growth after 65 days of transplantation.

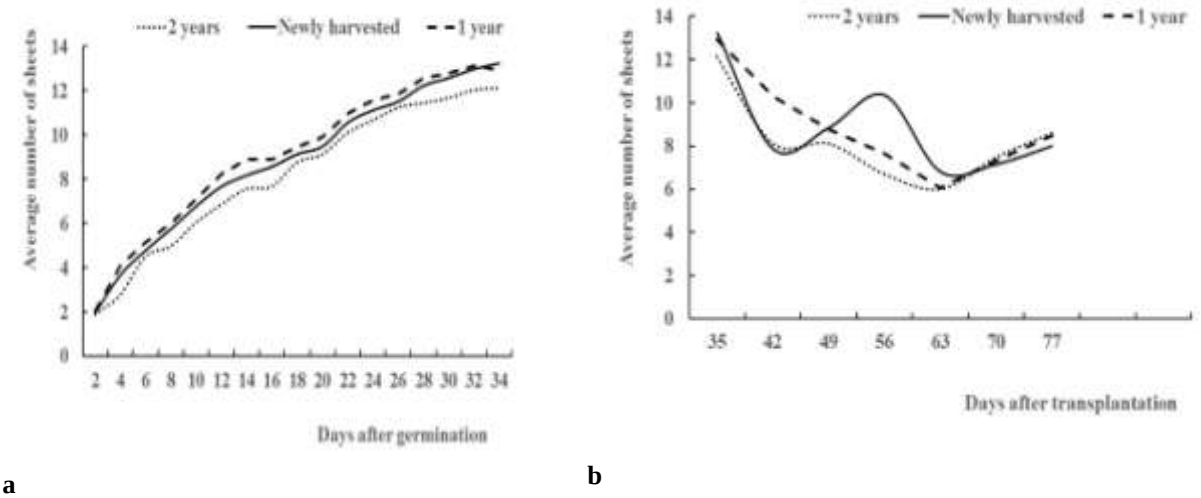
The production of leaves during these 34 days before transplanting remains substantially identical both for the seedlings which have emerged on the ground and for the seedlings developing in the pots (Figure 6a). However, the rate of leaf production decreases after 34 days of seedlings in the nursery. This drop in leaf production is observed in the field by an abscission of the leaves located at the base of the seedlings (Figure 5b). The ANOVA test at the 5%

threshold shows that there is no significant difference in the speed of leaf production according to the two production methods ($p > 0.05$). We obtained an average of 13.25 leaves ± 1.21 in pots and 12.95 leaves ± 0.92 in direct sowing on the 34th day after germination. The ANOVA test also applied to the leaf biomass production rate and the storage time of Moringa seeds does not show any significant difference up to the 65th day after transplantation ($P> 0.05$). The average leaf production is 9.769 leaves ± 02.55 in pots and 9.538 leaves ± 0.11 in direct sowing (Table III).



a b

Figure 4. Growth in diameter of seedlings (a= Before transplantation and b=After transplantation).



a b

Figure 5. leaf production rate of Moringa seedlings (a= Before transplanting and b=After transplanting).

Table 4. Testdecomparaisondesmoyennesdesplantsàpartirdesvariablesmesuréesavant et après transplantation.

	Hauteur (cm)	**Diameter (mm)**	**Number of leaves**
	Mean	Mean	Mean
Before Transplantation	28,362 ± 2,69 a	9,538 ± 02,55 a	13,25±1,21a
After Transplantation	77,79 ± 14,92 a	1,01 ± 0,16 a	9,769 ± 02,55 a

Au cours de la croissance, les plantules issues des pots enregistrent un taux de reprise de 96,67% contre 81,11% pour celles issues des semis au sol jusqu'au 34^{ième}jour après la germination. En effet la mortalité juvénile chez les plantules en pot a été très peu observée durant une période de 34 jours de croissance. Après transplantation au 34^{ième}jours, les plantules issues des pots nous avons remarqué un début de mortalité qui tend à s'accentuer juste avant la troisième semaine après la transplantation(Figure 6).

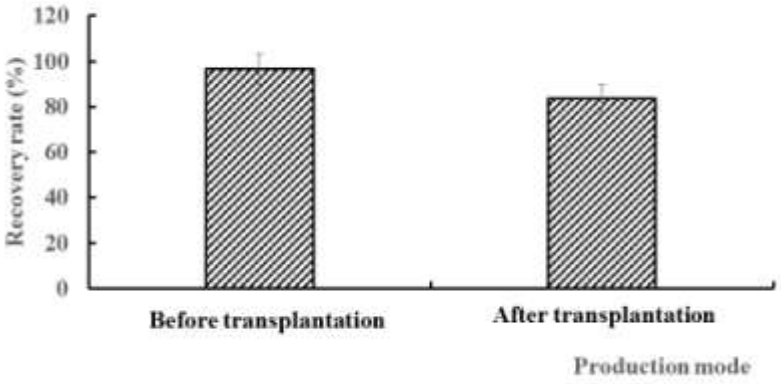


Figure 6. Survival rates of the seedlings (average ± ET) .

The dynamics of leaf production and diameter growth are strongly related (R^2=0.96) before transplanting in pots and direct seeding. 96% of the leaf production is explained by the correlation. On the other hand after transplanting we recorded a strong correlation between height and number of leaves for direct seeding (R2= 0.98) Table 5).

Table 5. Matrix of correlation coefficients (R) between the number of leaves produced and morphological parameters.

	Désignation	Avant transplantation	Après transplantation
Height (cm)	R^2	0,06	0,98
	P-value	0,6	0,004**
Diameter (mm)	R^2	0,96	0,97
	P-value	0,001**	0,001**

Signif. codes: 0 '***' 0,001 '**' 0,01 '*' 0,05 '.' 0,1 ' ' .Test de Pearson Corrélation, seuil fixé à 0.05

The present study revealed that the germination window of *Moringa oleifera* is at 7.5±1.29 days with a germination delay of 6 days on average and this does not depend on the sowing medium or seed age in any way (p> 0.05). Our results corroborate with those obtained by Bosch (2014) who showed that Moringa germination takes place between the 7th and 14thdays after sowing. Our results contrast with those obtained by Fulgie and Sreeja (2001) who find that germination extended between the 5 th and 12 th days after sowing and that this duration is influenced by the age of the seed. We agree with Pamo (2004) who showed that the germination of Moringa is very fast compared to that of*Vitellaria paradoxa, Anacardium occidentalis, Afzelia africana, Pterocarpus erinaceus* etc., all local woody species of the Sudano-Sahelian zone. According to this author, species whose seeds germinate within two (2) weeks are considered to have rapid germination of the grouped type. This type of grouped emergence is an evolutionary strategy whose adaptive function is to saturate the needs of herbivores so that certain seedlings escape

herbivory, Poissonnet (2002). The germination rate of the newly harvested seeds is 90% in direct seeding as well as in pots and is the highest of the whole experiment. A significant decrease in the germination rate of seeds according to their storage time ($p<0.05$) was observed, which probably translates into a considerable decrease in the germinative power of seeds as the storage time of the seeds increases. In the same perspective, N'Gbesso *et al*, (2009) state that the germination rate of the Canarana variety of soybean seeds dropped from 95% to 46% depending on the storage method, after only 4 months. The results of our study are in line with the results of these authors when we reported on the influence of seed age on the germination of Moringa. On the other hand, we note that 2-year-old seeds were able to germinate during our experiment. This difference in results could be explained by the way the seeds were stored. The storage conditions of the seeds can affect the germinative power of the seeds very early. Besse (1996) estimates that the germination of Moringa seeds is in the order of 60 to 70% in West Africa. Note that the germination rate of newly harvested seeds is clearly higher than the range of results found by Besse (1996).

From these results we can say that age is a factor that considerably influences germination in *Moringa oleifera*. ANOVA results showed greater growth in height and crown diameter in seedlings emerging from pots than those from direct seeding ($p<0.05$) before and after transplanting. However, there was no significant difference in leaf production before and after transplanting ($p>0.05$).These results could be justified by the fact that in direct seeding, irrigation would seem to cause soil compaction making water infiltration and seedling growth more difficult. On the other hand, the pots would seem to cause a preservation of the humidity in the long term by limiting the losses of water by evaporation and by facilitating the infiltration of water in the ground. This allows the seedlings to acquire a good juvenile vigor. This attests to the recovery rate of 100% observed in the pots against 81.35% observed in direct seeding before transplanting. The recovery rate of seedlings from pots remains relatively high compared to those from direct seeding. The results obtained for the correlations between the height and the number of leaves, the diameter and the number of leaves produced show that the diameter and the number of leaves of *Moringa oleifera* in pots and in direct seeding after transplantation show a strong positive linear correlation. The height of seedlings from direct seeding after transplanting showed a strong correlation with the number of leaves produced. On the other hand, seedlings in pots after transplanting show a weak correlation between heights and the number of leaves produced. The height, the diameter at the collar of the *Moringa oleifera* seedlings has a good influence on the number of leaves and thus on the leaf biomass according to the production mode. Our results corroborate with those of (Boudechiche *et al.*, 2015) who showed experimentally that morphological parameters (diameter and number of branches) of *Calcyolone spinosa*. Has a strong correlation with the leaf biomass produced.

CONCLUSION

Moringa oleifera seeds observe a short germination time of 6 days on average. The germination of the species is influenced by the age of its seeds. In fact, the longer the seeds are stored, the more they lose their germinative powers. Newly harvested seeds show a better germination rate reaching 90% against 50% for those aged two years. The production method influences the height and diameter growth of Moringa seedlings in the nursery. Seedlings in pots show greater juvenile growth than those from direct seeding. On the other hand, there is no difference between treatments in relation to the average number of leaves per seedlings. Therefore, we suggest that producers use seeds less than one year old to hope to obtain a high germination rate.

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