International Journal of Agriculture, Environment and Bioresearch

Vol. 07, No. 06; 2022

ISSN: 2456-8643

GERMINATION AND MONITORING OF THE GROWTH OF MORINGA OLEIFERA LAM. SEEDLINGS IN NURSERY

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https://doi.org/10.35410/IJAEB.2022.5794

ABSTRACT

The study evaluates the germination of the Moringa oleifera Lam. seeds and growth of the seedlings in nursery. The seeds of species M. oleifera have been collected in the city of Brazzaville on the site of the semi-industrial nursery of the National Reforestation Service (SNR) of Kintele located 15 km from Brazzaville. A complete device of two blocks (owing to 100 seeds per block) has been set up in nursery. Each batch of 100 seeds has been subdivided as follows: the first batch of 50 seeds and/or seedlings treated with NPK 12-12-17 and the second batch of 50 seeds and/or seedlings untreated considered as a control block. For the NPK treatment, we have taken 10 grams of NPK (i.e. a full a box of tomatoes soaked in a 10 liter watering). Germination tests have been carried out in nursery at an average temperature of 22°C and an average humidity of 60%. The seeds have been individually and immediately sowned after treatment, and placed on a previously sterilized substrate composed of 25% sawdust and 75% humified earth in 0.5 liter phytocel bag. Overall, the results reveal 146 seeds germinated on 200 seeds sowned, i.e. 73% of seeds germinated. The number of days had a very highly significant effect on the seeds germination (p-value < 0.005). The average height of the seedlings varies from 8.971 to 21.54cm. The highest mean height was 21.91±6.12cm whose the coefficient of variation was 27.94%. On the other hand, the lowest average height was 12.71±2.01cm, with a coefficient of variation of 15.80%. Overall, the seedlings displayed an average height growth of 34.18 cm. Nonetheless, the Student's t test demonstrates a very highly significant influence on the height growth of the seedlings between fertilized and unfertilized blocks (p-value < 0.005). The study suggests that efforts should be deploy for species M. oleifera, used generally in Africa. Reforestation of M. oleifera species with seedlings from nurseries would seem to be the essential technique to ensure the sustainability of the plant.

Keywords: Moringa oleifera, seedlings, seeds, germination, nursery, Republic of Congo.

1. INTRODUCTION

Tree species *Moringa oleifera* Lam. is native to the north-eastern regions of India and south of the Himalayan mountain chain, widely cultivated in all tropical and sub-tropical regions of the world (Rajangam et al., 2001). The plant is used since millennia as a miracle plant in the Roman, Greek and Egyptian civilizations for its healing and cosmetic properties (Foidle et al., 2001; Anjorin et al., 2010; Anjum et al., 2019). Its introduction in Africa took place at the beginning of

Vol. 07, No. 06; 2022

ISSN: 2456-8643

the 20th century through trade and maritime exchanges during this period (Foidle et al., 2001). Nevertheless, this species can be found in Africa, Arabia, Southeast Asia, Pacific Islands, South America where it is used as a medicinal and food plant (Ashfaq et al., 2012; Malo, 2014).

M. oleifera, is an multiple use plant, and is passed from status of marginal plant, even unknown, plant to that of a new food and economic resource. Amabye (2016) demonstrates that each part of the plant has enormous potential, and would have beneficial properties for humanity. The plant is very rich in nutrients (vitamins, minerals and proteins) and owns dietary, agronomic, medicinal and agroforestry virtues (Hamdad, 2015; Amabye, 2016; Fokwen et al., 2018; Anjum et al., 2019). The *M. oleifera* species is an fast growing plant whose leaves can be harvested from the first months of cultivation (Bidima, 2016).

To guarantee an management of the plant long-term populations, it would be appropriate better understood the mechanisms involved in seed germination should be The seeds of *M. oleifera* species are not dormant and they can be collected under the seed trees for germination tests in nursery (Pamo et al., 2004).

Nevertheless, the germination term generally applies to the recovery of the growth of embryo after the period of vegetative rest, or dormancy (Debroux et al., 1998). For to facilitate the germination of the seeds of M. oleifera species, it would be appropriate soake in water for 48 hours to soften the shell (Hamdad, 2015; Anjum et al., 2019). Germination usually takes place from 5 to 12 days after sowing (Pamo et al., 2004). According to Malo (2014) in Burkina Faso, the germination average rate is 52% with an germination period of between 4 to 10 days. However, Pamo et al. (2004) in Cameroon demonstrates a germination rate of 90%. These authors deduce that soil fertilization would be the best way so that *M. oleifera* plant to produce large amounts of leaves.

Otherwise, Bidima (2016) affirm that the contribution of compost and manure would be essential for the development of the plant. Nevertheless, Abdulkarim et al. (2007) and Broin et al. (2002) demonstrate that the plant can produce large quantities of the leaves when it receives sufficient organic inputs. Thus, nutrient needs can be satisfied compared mineral or organic manure according to the objectives of the study (Malo, 2014).
The general objective of this study is to evaluate the germination of the *Moringa oleifera* Lam. seeds and growth of the seedlings in nursery. Our hypothesis are the following : the number of germinated seeds varies in terms of the weeks ; the height growth of the seedlings varies in terms to the weeks ; the contribution of nitrogen, phosphorus and potassium (NPK) fertilizers significantly influences the height growth of the seedlings.

2. MATERIAL AND METHODS

2.1. Study site

The seeds of the species *M. oleifera* have been collected in the city of Brazzaville and the experimental device was installed in the site of the semi-industrial nursery of National Reforestation Service (SNR) of Kintélé located 15 km from Brazzaville on the cataracts plateau whose altitude varies between 500 to 800m. The Kintélé SNR semi-industrial nursery is located between 4°10' and 4°20' of South latitude and 15°20' East longitude (Figure 1). It extends on

Vol. 07, No. 06; 2022

ISSN: 2456-8643

sandy soil impoverished in mineral matter (N'zila, 2013). The semi-industrial SNR Kintélé nursery covers an area of 12ha, of which only 4ha are used. According to Samba-Kimbata (1978), the city of Brazzaville and its surroundings has a equatorial climate of Bas-Congolese type which is observed in the south-east of Congo. Temperatures are between 21°C and 36°C, with humidity ranging from 70 to 80% (Nzila, 2013). Two types of dry and rainy seasons are observed (Aubréville, 1949). The great dry season extends from June to September, and the great rainy season from February to May (Vennetier, 1977). The rains begin very lightly in September, are established in October and end in May (Nzila, 2013).

Figure 1. Location of the Kintele semi-industrial nursery (red dots = forest stations; blue dots = Pilot Unit for Developing, Reforestation and Agroforestry "U.P.A.R.A"; green dots = nurseries of the National Reforestation Service "SNR" in Congo; yellow dot = Kintele semi-industrial nursery (SNR, 2012).

2.2. Experimental device, germination tests and measurement of the seedlings

The seeds of *Moringa oleifera* Lam. have been collected under each seed tree, totaling a effective of 200 seeds. They have been sent and then received in July 2020 at the Kintele semi-industrial nursery and kepted cold for 7 days in a refrigerator at a temperature of around 5°C. A complete device of two blocks (at the rate of 100 seeds per block) has been set up in semi-industrial nursery of Kintele. Each batch of 100 seeds has been subdivided as follows: the first batch of 50 seeds and/or seedlings treated to NPK 12-12-17 and the second batch of 50 seeds and/or untreated seedlings taken as a control block. For the NPK treatment, we took 10 grams of NPK (i.e. a full can of tomatoes soaked in a 10 liter watering can). After having stired and ensuring that the NPK was dissolved, it is estimated that the block was fertilized. The choice of the fertilization based on previous studies bearing on of the species *M. oleifera* (Malo, 2014;

Vol. 07, No. 06; 2022

ISSN: 2456-8643

Fokwen et al., 2018). The germination tests have been realized in a semi-industrial nursery of Kintele at an average temperature of 22°C and an average humidity of 60%. The seeds have been individually and immediately sowned after treatment, placed on a substrate previously sterilized and composed of 25% sawdust and 75% humified earth in 0.5 l phytocel bags, the July 16, 2020.

Seeds sowned (NGS, number of seeds sowned) have been watered every one day on two, and the germination has been monitored daily. The experiment has ended the october 17, 2020, i.e. after 3 months of follow-up. At the end of experiment, the number of seeds having effectively germinated (NGG), the height growth of the seedlings have been estimated for each block (De La Mensbruge, 1966; Mbolo, 1991; Danthu, 1993; Elazazi, 2016). The germination percentage (TG%) has been then calculated (Maguire, 1962). The measurement of the seedlings began one week after the first emergences. The measurement of the height of the seedlings took place after every two days, i.e. is right of three days by week, with a graduated ruler.

2.3. Data analysis

Data have been to input into Excel spreadsheet to generate graphs. After checking the normality of the data distribution by the Kolmogorov-smirnov and Shapiro-wilk tests, the Pearson correlation test has been performed to check the relationship between time and the average height growth of the seedlings of species *Moringa oleifera*. To verify the influence of NPK 12-12-17 treatment on the height growth of the seedlings, the Student's t test has been chosen to compare the mean groups of the two blocks. Thus, the Kolmogorov-smirnov and Shapiro-wilk tests showed that our data followed the normal law. Consequently, the conditions were required for the Student's t test. Student's t test has been calculated at the threshold of 5%. These analyzes have been performed using SPSS version 17.0 software.

3.RESULTS

3.1. Evolution of the germination of *M. oleifera* seeds in terms of time

Figure 2 illustrates the evolution of the seeds germination during the three months of experimentation. We recorded 146 seeds germinated on 200 seeds sowned, i.e. 73% of the seeds germinated (figure 2). Beyond of the ninth week, no germination was not observed. Nonetheless, the number of days had a very highly significant effect on the seeds germination (p-value < 0.005) (Table 1).

Vol. 07, No. 06; 2022

ISSN: 2456-8643

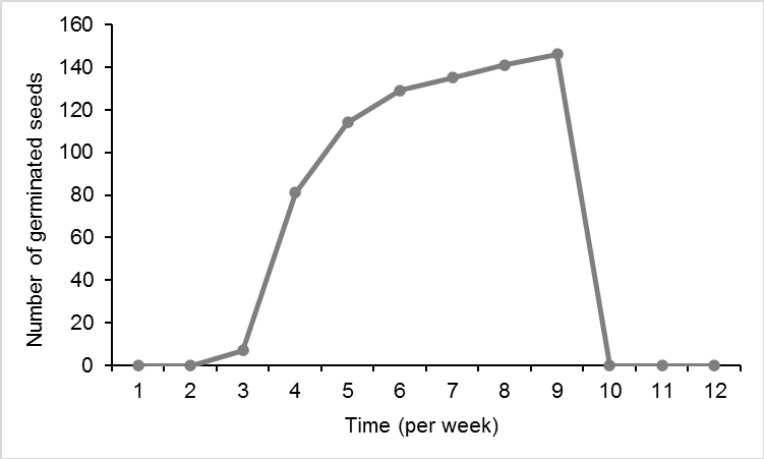

Figure 2. Evolution of number of the germinated seeds in terms of time

Table 1. Effect of time on the evolution of the seeds germination

ANOVA[a]						
Model		Sum of squares	ddl	Medium square	F	*p-value*
1	Regression	28645.35	1	28645.35	49.847	0.000b
	Residual	4022.65	7	574.664		
	Total	32668	8			

3.2. Evolution of the height growth of seedlings in terms of time

Figure 3 illustrates the variations of the average height of the seedlings in terms of time. The average height of the seedlings varies from 8.971 to 21.54cm. This variation seems to increase relatively with the pace of the curve (figure 3). The highest average height was 21.91± 6.12cm with a coefficient of variation of 27.94%. On the other side, the lowest average height was 12.71±2.01cm, with a coefficient of variation of 15.80%. Nonetheless, the correlation coefficient between time and mean seedlings height was r = +0.932 with P<0.05 (Table 2). Consequently, this coefficient being very close to 1, turned out to be very significant. This wich could translate that variation in time could imply the variation in the average height of *Moringa oleifera* seedlings (Table 2).

Vol. 07, No. 06; 2022

ISSN: 2456-8643

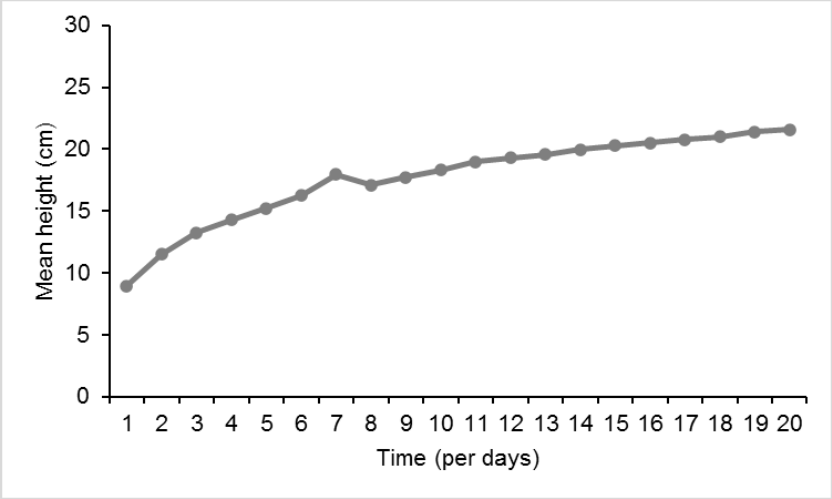

Figure 3. Evolution of the average height of seedlings in terms of time

Table 2. Pearson's correlation between time and mean height

Correlations			
		Days	Mean height
Days	Pearson correlation	1	932**
	p-value	19	0.000
	N		19
Mean height	Pearson correlation	932**	1
	p-value	0.000	19
	N	19	

3.2. Effects of Nitrogen, Phosphorus and Potassium (NPK) on the seedlings height growth

Figure 4 illustrates the pace of evolution of the growth of fertilized and unfertilized seedlings in terms of time. In the beginning of the fertilization until the eighth day of observation, growth appeared unchanged between the two blocks (fertilized and unfertilized) (Figure 4). Beyond the eighth day, the fertilized seedlings seem to have an relatively significant height growth to that of the unfertilized seedlings which seem fairly constant during the 26 days of observation. Overall, seedlings displayed an average height growth of 34.18 cm. Nonetheless, the Student's t test demonstrates an highly significant influence on the seedlings height growth between fertilized and unfertilized blocks (p-value < 0.005) (Table 3).

Vol. 07, No. 06; 2022

ISSN: 2456-8643

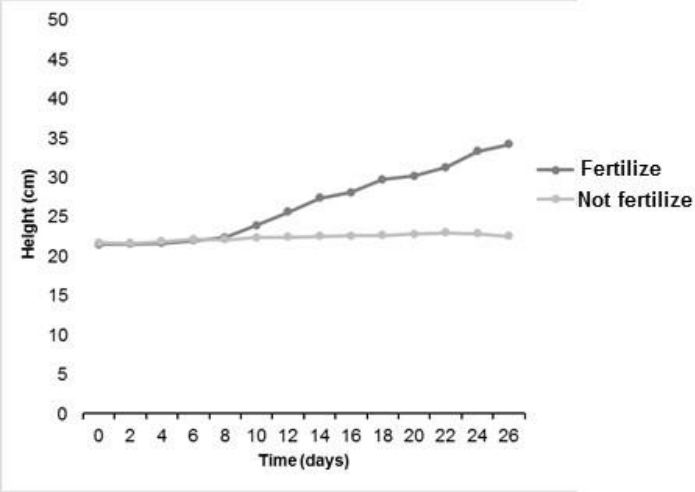

Figure 4. Influence of NPK on the growth of *Moringa oleifera* seedlings

Table 3. Comparison of the groups means of fertilized and unfertilized blocks

		Levene's test on the equality of variances		Means equality test						
		F	*p-value*	t	ddl	p-value	Means difference	Standard Error	95% confidence interval	
									Inferior	Superior
Height (cm)	Hypothesis of equal variances	44.396	0.000	-3.439	26	0.002	-4.24544048	1.234583142	-6.78316247	-1.70771848
	Hypothesis of unequal variances			-3.439	13.222	0.004	-4.2454404	1.234583142	-6.9080559	-1.58282497

4.DISCUSSION

4.1. The germination of the seeds of *Moringa oleifera* Lam. varies in terms of time

In the present study, we recorded 73% germinated seeds after 16 days. This relatively high rate could be explained by the agro-ecological and climatic factors of the study area, in particular the type of soil (sandy), an altitude below to 600m and an tolerant temperature between 25 and 35°C. This germination rate is higher to that of Malo (2014) who worked on the effect of the fertilization on the growth and production of local *Moringa oleifera* and *Moringa oleifera* PKM-1 in the Cascades region in Burkina Faso. It obtains a average rate of 52% with an germination duration of between 4 and 10 days using the seeds soaked in water for 17 hours. Likewise, Pamo et al. (2004) worked on the germination potential of *M. oleifera* under different treatments in Cameroon and obtained a germination rate of 90% with seeds soaked in water for 12 hours. Indeed, the first emergence was observed the 4th day after sowing and beyond of 16 days, no germination was not observed.

Vol. 07, No. 06; 2022

ISSN: 2456-8643

However, Bidima (2016) in Cameroon, observes the first emergence the 5th day after sowing and an end of germination the 12th day after sowing with the seeds soaked in water for 48 hours.

4.2. Treatment based on nitrogen, phosphorus and potassium (NPK) has significantly influenced seedlings height growth

In the present study, the average height of *Moringa oleifera* in the nursery was of 21.57 cm after 45 days of sowing. Stimulation of the height growth by nitrogen, phosphorus and potassium (NPK) appears to be preceded by an latency period of at least 7 days. But, this latency period for Malo (2014) is at least 45 days.

The block treated by the NPK shows considerable growth with an average height of 34.18cm against 21.57cm of untreated block after 26 days of measurement. The significant acceleration caused by the NPK at the level of the various parameters can be justified by the importance of the mineral elements in the growth and development of the plants. Indeed, the application of NPK increases the content of the elements, nitrogen (N), phosphorus (P) and potassium (K) in the soil. Whereas, nitrogen (N) is a main element, used to make the building materials of the plant tissues, it represents between 1 to 3% of the dry matter (DM) of the plants and up to 4-6% in growing plants (Hamdad, 2015). Nonetheless, the contribution of nitrogen (N) allows to the plant to ensure the cell multiplication and thus vegetative growth thanks to the formation of auxin which promotes the proliferation of the buds (Abdulkarim et al., 2007).

Phosphorus represents 0.2 to 1.5% of the dry matter, and enters into the junction of the nucleotides and in the constitution of the phospholipids of plant membranes (Hamdad, 2015). Phosphorus plays a role in activating of the growth of buds and roots as well as the synthesis of the carbohydrates and their storage, and participates in the transfer of energy in the plant. According to Fokwen et al. (2018), the potassium represents 2 to 4% of the dry matter, and is present in high concentration in the young growing tissues. Potassium plays a important role in the maintenance and regulation of the osmotic pressure. It participates to the reducing of the risk of wilting by its direct action on the opening and closing of the stomata and promotes the development of root system and the flexibility of the tissues.

The contribution of NPK allowed to satisfy the needs of the plant by improving their growth compared to non-fertilized plants. Consequently, NPK had a significant influence on the growth of *M. oleifera* and would thus be the best growth-stimulating fertilizer during the first 6 months after sowing (Tedonkeng Pamo et al., 2005). Malo (2014) affirms that NPK 14-23-14 reveals to be the best fertilizer for local *M. oleifera* on the sandy ground.

Also, Fokwen et al. (2018) demonstrated that NPK 21-7-20 allows maintain a good level of growth of *M. oleifera* on a soil to more than 95% sand.

5.CONCLUSION

We have effectively showed that the treatment based of nitrogen, phosphorus and potassium (NPK) had a significant effect on the height growth of *Moringa oleifera* Lam. seedlings. Overall, the germination was 73% or 143 seeds germinated at the end of 16 days after sowing. Consequently, our hypotheses have been confirmed. Nevertheless, efforts must be deployed for

Vol. 07, No. 06; 2022

ISSN: 2456-8643

this plant mostly used in Africa. If nothing is done, it is probable that the density of the plant will regress sharply according to the multiple uses of which it is a part. Reforestation of the plant with seedlings from nurseries would seem to be the essential technique to ensure the sustainability of the plant.

ACKNOWLEDGMENTS

The authors thanks the Marien N'gouabi University (Republic of Congo), the National Forest Research Institute (IRF), Department of Forest Ecology, the staff of the semi-industrial nursery of the National Reforestation Service (SNR) of Kintele for their technical, scientific and financial support.

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Vol. 07, No. 06; 2022

ISSN: 2456-8643

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