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Effects of different doses of mycorrhizae on the growth and yield of a local accession of castor bean (*Ricinus communis* L.) grown in the field of Bini-Dang (Adamaoua, Cameroon)

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Abstract
Castor bean (*Ricinus communis* L.) is an oleaginous plant having multiple uses on the artisanal level and in the chemical industry. With the aim of determining the extent of this biofertilization, the effect of this biofertilizer is studied in the local field (Ndoutourou) in the locality of Bini-Dang (Adamaoua, Cameroon). The experimentation is led by the University of Ngaoundere campus, following a completely randomized block design, with six treatments (0, 5, 10, 15, 20 and 25 g of mycorrhiza per seed hole), repeated three times. The germination rates and survival of the seedlings, the parameters of growth (the size and number leaves), diameter of the stem, dry biomass of seedlings, number of fruits by ears, number of ears by plants, mycorrhization rate of root and seed yield are evaluated. The amounts of mycorrhiza significantly increased (*p* <0.05) the productivity of castor bean compared to the control. In a general way, the seedlings of castor resulting from the plots to have received 5, 10, 15, 20 and 25 g of mycorrhiza do not show a significant difference in the germination rate, survival, size, and number of leaves, diameter of the stem, dry biomass, and number of fruits, mycorrhizal rate of roots and seed yield. Looking at the results obtained from our work, the amount of 5 g represents the minimum quantity of mycorrhiza which would ensure optimal productivity of castor s in the field. The seedlings of castor resulting from the plots enriched with this quantity by mycorrhiza have the biomass of 27.23 ± 4.66 g in flowering and a seed yield of 29.39 Kg / ha in 175 days after sowing. This ratio is the largest of 25.96 and 33.85% compared to the control.

Keywords: castor bean, mycorrhizae, growth, yield, Ngaoundere-Cameroon

1. Introduction

The common castor (Ricinus *communis* L.), an oleaginous plant native to tropical Africa is a multipurpose species that has been the subject of numerous studies in Asia [1, 2], the United States [3], Europe [4] and in West Africa [5]. Castor is a small, fast-growing tree and is widely distributed around the world. This plant has annual varieties and perennial varieties. It grows in all warm temperate and tropical regions and grows on alkaline or acidic soils as long as they are permeable and well drained [6].

This plant used in the construction of roofs of houses, and also in the artisanal manufacture of oil and soap [7]. Castor is also grown for its seeds, which give a viscous, pale yellow, non-volatile oil [1] In the industrial field, castor oil is used mainly in the chemical industry and medicine where it has multiple uses [8] This oil is a source of biofuel and is used in the manufacture of pharmaceuticals (purgatives and laxatives) and plastics [7]. Castor oil is also used in the manufacture of paints, stains, inks, waxes, varnishes, lubricants, hydraulic oils and brake fluids [8] In addition, [9] and [10], report that castor-seed meal can be used in agriculture as a natural fertilizer in the restoration of depleted soils and as a fungicide for the control of plant-parasitic nematodes. What follows, one can wonder about the minimum dose of mycorrhizae that would ensure optimal performance of castor in the field? The mycorrhizae are safe for the environment and increase food production. The use of this natural fertilizer is part of the practices of organic farming that contributes to sustainable agriculture [11].

The objective of this work is to search for the minimum quantity of mycorrhizae which ensures a better productivity of the accession Ndoutourou of the castor in the field in the locality of Bini-Dang (Adamaoua, Cameroon).

2. Material and Methods

2.1 Presentation of the experimental site

Work is carried out in the field in the region of Adamaoua (Ngaoundéré-Cameroun), in the locality of Bini-Dang. The climate of the region is Sudano-Guinean with a dry season from October to March and a rainy season covering the rest of the year. The site is located at an altitude of 1155.8 m, at 7 ° 26 '16' 'north latitude and at 13 ° 33' 34 " east longitude. The soil of the site is reddish- brown of the ferrallitictype developed on basalt (Megueni *et al.*, 2006). The work period extended from mid-July to February 2014. The average rainfall is 857.9 mm during this period.

2.1.1 Plant material

The seeds of the castor accession Ndoutourou (Department of Benue, North Cameroon region) are used for this study. Indeed [12], Realize the cultivation of three local accessions of castor oil (Motso 1, Motso 2 and Ndoutourou) under the environmental conditions of the Far North Cameroon and report that the accession Ndoutourou adapts better in this region. It has a seedling emergence rate and yield of major seeds and is more resistant to environmental conditions [13, 14]. The physical characteristics of the seeds of this castor accession are shown in Table 1.

Table 1: Physical characteristics of seeds of Ndoutourou origin

		Settings	
Length (mm)	Width (mm)	Thickness (mm)	Weight of the seed (g)
(8.70 at 9)	(5.65 at 5.87)	(4.16 at 4.33)	(0.09 at 0.11)

Fig 1: The Seeds of *Ricinus communis* (accession Ndoutourou)

2.1.2 Biofertilizers

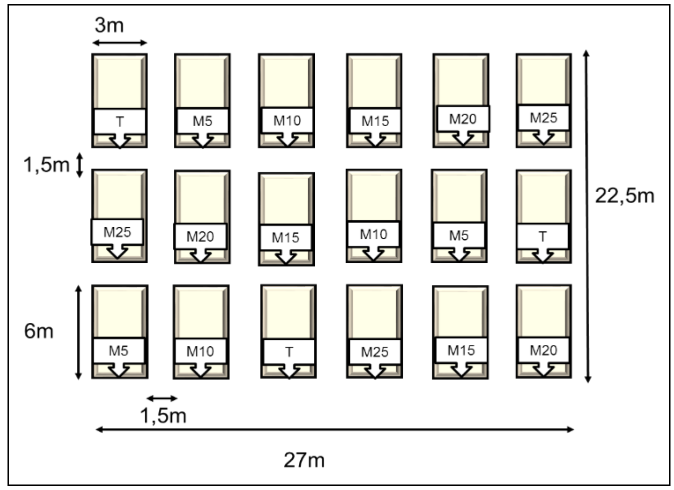
The mycorrhizal inoculum used for this work is offered by the Biotechnology Research Laboratory of the University of Yaounde I. It consists of a mixture of soils (clay, sand grains), root fragments with spores of like Gloms and Gigaspora concentration of 7 spores/g [15].

Fig 2: Mycorrhizal Inoculum

2.2 Methodological approaches

2.2.1 Implantation and development of the experimental plot

After cleaning the field, 18 boards are constituted according to the device of Figure 4. The experimental setup is completely randomized blocks with six treatments. The 3 blocks contain 18 elementary plots of 6 x 3 meters (18 m^2). Six treatments are applied and repeated three times: (0, 5, 10, 15, 20 or 25 g) of mycorrhizae per pouch. The experimental site has a total zone of 607.5 m^2. The elementary parcels are 1.5 m apart. The blocks are also 1.5 m apart. Figures 4 and 5 show diagrams of the experimental device.



T, M5, M10, M15, M20, M25 represent, respectively, the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch.

Fig 3: Schematic of the experimental device completely randomized blocks

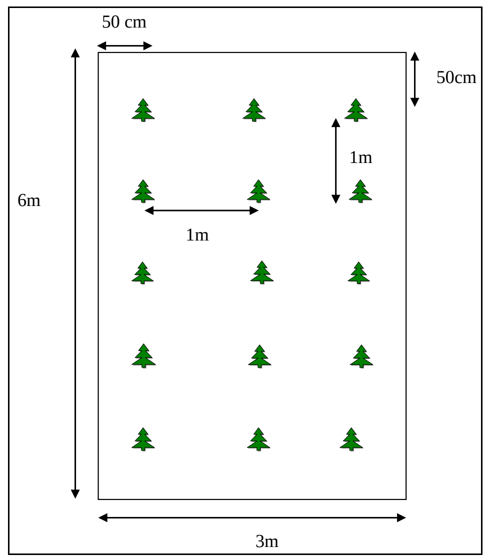


Fig 4: The arrangement of plants within a unit Experiment ale

2.2.2. Sowing and maintenance of culture

The sowing phase took place on July 20, 2013. Seeds with a good physical shape, and therefore better phenotypes, are chosen and are sown per pooch at a depth of about 3 to 5 cm [29] (Laoukain, 2008). Within each elementary parcel 15 pockets are formed, and 5 x 15 seeds are sown for the experimental site. The plots are maintained by manual weeding, once every 2 weeks. Mating took place 15 days after emergence when the plants are about 2 cm tall. A foot of Ricinus communis is left by the pouch in order to guarantee to each plant the maximum of mineral elements and space during the study period. A total of 15 plants are maintained per experimental unit; Forty-five plants per treatment. Each experimental unit is marked to facilitate surveys.

2.2.3 Sampling and measurement of parameters

One month after sowing, the rate of emergence of the plants is evaluated and the unmasking is carried out, so as to leave one plant per pocket. During the vegetative phase, the number of leaves and the height of the plants are evaluated at regular intervals of 14 days during growth out of a total of 30 plants per treatment. The date of flowering and fruiting is noted. Dry biomass and stem diameters are evaluated at bloom on a total of 18 plants, or 3 per treatment. The rate of survival, the rate of root mycorrhization, the number of ears per plant, the number of fruits per ear and the seed yield of the seedlings are evaluated at maturity.

2.2.4 Plant emergence and survival rates

The emergence and survival rate of the plants is evaluated by treatment. After counting two weeks after sowing the number of plants present in the 18 experimental units of the six treatments, the ratio (100 X Number of plants raised) / 225 is carried out. Seventy-five plants should grow per experimental unit, 225 plants per treatment. As for the survival rate, the count of flowering of the number of plants on the 18 experimental units of our 6 treatments is carried out, the ratio $\frac{\text{number of plants present at flowering}}{45} X100$ is achieved.15 plants should arrive at flowering for each experimental unit, 45 plants per treatment.

2.2.5 Dry biomass, number of ears per plants and number of fruits per ears

Three plants, 18 per treatment, are chosen at random and are removed from the soil with their rhizosphere. Their roots are washed in tap water to remove all the soil. The plants thus cleaned are put in the newsprint after being cut into several fragments and are dried in the oven at 120 ° C for 48 hours before the evaluation of the weight of dry matter. The sequestered carbon estimate is made by multiplying the dry biomass produced by the factor 0.42 [16]. The collection of data on the different parameters of growth and development of castor such as the number of ears per plant was done at random on thirty plants per treatment, or ten per experimental unit. As for the average number of fruits per ear, it is also evaluated on 18 plants or 3, by treatment at harvest.

2.2.6 Size, diameter at the neck of the stem, rate of root mycorrhization (RRM) and seed yield of plants

The size of the plants is measured using a decametre and the diameter at the neck of the stem using a Vernier caliper on 18 plants randomly selected, 3 plants per treatment. The method used to estimate the percentage of mycorrhizal colonization used is that of [17]. The rate of mycorhization was given by the following formula:

$$RRM = \frac{Number\ of\ colonized\ root\ fragments}{\text{Number of colonized root fragments}} x100$$

At maturity, the total weight yield of the seeds per treatment is evaluated on a total of 10 plants per experimental unit, 30 plants per treatment chosen at random, the grains are weighed and the result expressed in kg/ha.
The grain yield of beans in Kg / ha is calculated according to the formula of [18]:

$$\text{Rdt(Kg/ha)} = \frac{\text{Mgr(g)}}{\text{NPr}} + \frac{10000\ (\text{m2})}{\text{Ds (m2)}} \text{x} \frac{1 (\text{Kg})}{1000\ (\text{g})} \text{x } 100$$

Where Yield: Represents the seed yield, Mgr: seed mass, NPr: number of feet harvested and Ds: seedling density (seedling density is equal to the number of plants sown per square metre or on an experimental unit).

2.2.7 Methods of statistical analysis of the results

The results are statistically analysed using the "Stratigraphic XLSTAT 2012" software, which performs analysis of variance (ANOVA) to determine interactions between treatments. Duncan's test is used to judge the difference between the averages of the treatments and the correlation test is also performed to study the relationship between the different parameters.

3. Results and Discussion

3.1 Plant emergence rate

The different doses of mycorrhizae used do not influence significantly ($p > 0.05$) the emergence rate of castor seedlings (Figure 6). The emergence rates of the plants from the plots receiving doses of 5, 10, 15, 20 and 25 g of mycorrhizae are respectively 79.3 ± 5.43; 83.5 ± 3.08; 84.4 ± 2.94; 85.7 ± 1.26; 86.2 ± 1.72 and 86.2 ± 4.49%. But significant relative ($p < 0.05$) to the control.
These results obtained on the emergence of the plants are consistent with those reported in the literature. Indeed, it has been demonstrated that the emergence of castor seedlings occurs between 11 and 26 days after sowing and varies with time [4]. According to [6], the emergence of castor seedlings usually ends between 15 and 21 days after sowing. In the present study, seedling emergence from castor was observed at 14 days after sowing. Castor beans sown in control burrows have an average emergence rate of 79.3%. This value on the emergence of castor seedlings is much higher than that obtained by [12] who report that the seeds of the Ndoutourou accession under the environmental conditions of the Ngaoundéré Cameroon region have an average emergence rate of 54.8%. As a result, we can say that the emergence of castor seedlings varies with time.

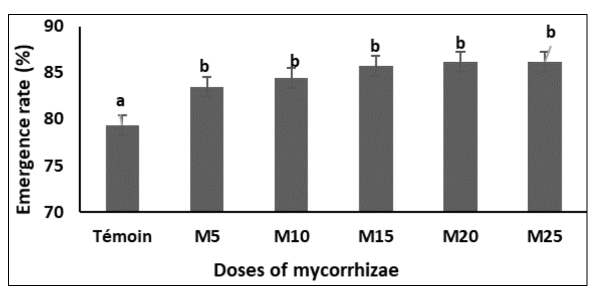


Fig 5: Plant emergence rate according to the different doses of mycorrhizae

T, M5, M10, M15, M20, M25 represents the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch, respectively.

Values of the same line followed by the same letter are not significantly different ($p < 0.05$).

3.2 Effect of mycorrhizae on growth parameters of castor

3.2.1 Effect of mycorrhizae on plant size according to different treatments

It can be seen from Table 2 that between the different castor treatments used. The difference starts to be significant (p <0.05) at 49 DAS. The size of the plants at 175 JAS from the pouches that received doses of 0, 5, 10, 15, 20 and 25 g of mycorrhizae are respectively 0.98 ± 0.41; 1.31 ± 0.33; 1.33 ± 0.18; 1.32 ± 0.17; 1.34 ± 0.20 and 1.35 ± 0.27 m. There is no significant difference in 175 JAS between the size of castor seedlings from plots receiving 5, 10, 15, 20 and 25 g of mycorrhizae per flock.

The results obtained at the height of the plants are comparable to those reported by [12], who report that the size of the seedlings varies on average between 1.1 and 2.1 m. By the way [4], also studied the adaptation potential and yield of 19 Mediterranean castor genotype and observed that the height of the plant depends mainly on the genotype and the experimental site and that the size of the castor seedlings varies. Between 0.79 and 2.30 m. In this study, the average height of the plants is 1.27 m.

Table 2: Evolution of the average size (m) of plants from treatments as a function of time

Treatments	T	M5	M10	M15	M20	M25
49 DAS	0.13 ± 0.16 ^{ab}	0.24 ± 1.83^{a}	0.24 ± 1.2 ^{a}	0.25 ± 1.90^{a}	0.25 ± 1.49^{a}	0.25 ± 1.67^{a}
63 DAS	0.17 ± 1.24^{b}	0.31 ± 1.73^{a}	0.31 ± 1.29^{a}	0.32 ± 1.90^{a}	0.32 ± 1.49^{a}	0.32 ± 1.76^{a}
77 DAS	0.27 ± 1.38^{b}	0.39 ± 1.73^{a}	0.39 ± 1.29^{a}	0.39 ± 1.90^{a}	0.39 ± 1.49^{a}	0.39 ± 1.76^{a}
91 DAS	0.30 ± 0.07^{b}	0.44 ± 0.31^{a}	0.44 ± 0.28^{a}	0.46 ± 0.28^{a}	0.46 ± 0.26^{a}	0.46 ± 0.32^{a}
105 DAS	0.36 ± 0.09^{b}	0.54 ± 0.37^{a}	0.54 ± 0.34^{a}	0.56 ± 0.32^{a}	0.56 ± 0.30^{a}	0.56 ± 0.45^{a}
119 DAS	0.40 ± 0.09^{b}	0.64 ± 0.35^{a}	0.64 ± 0.35^{a}	0.65 ± 0.28^{a}	0.65 ± 0.31^{a}	0.66 ± 0.46^{a}
133 DAS	0.45 ± 0.14^{b}	0.74 ± 0.42^{a}	0.75 ± 0.39^{a}	0.77 ± 0.26^{a}	0.77 ± 0.28^{a}	0.77 ± 0.48^{a}
147 DAS	0.57 ± 0.21^{b}	0.83 ± 0.36^{a}	0.85 ± 0.33^{a}	0.87 ± 0.29^{a}	0.87 ± 0.19^{a}	0.88 ± 0.36^{a}
154 DAS	0.62 ± 0.23^{b}	0.94 ± 0.30^{a}	0.95 ± 0.28^{a}	0.96 ± 0.31^{a}	0.97 ± 0.24^{a}	0.97 ± 0.34^{a}
161 DAS	0.73 ± 0.36^{b}	1.03 ± 0.30^{a}	1.10 ± 0.16^{a}	1.10 ± 0.17^{a}	1.11 ± 0.26^{a}	1.11 ± 0.25^{a}
175 DAS	0.98 ± 0.41^{b}	1.31 ± 0.33^{a}	1.32 ± 0.17^{a}	1.33 ± 0.18^{a}	1.34 ± 0.20^{a}	1.35 ± 0.27^{a}

T, M5, M10, M15, M20, M25 represent, respectively, the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch; DAS (Day after sowing).

Values of the same line followed by the same letter are not significantly different ($p < 0.05$).

3.2.2 Variation of the number of castor bean leaves according to the doses of mycorrhizae

It can be seen from Table 3 that the number of leaves varies between different treatments. Seedlings derived from mycorrhizal inoculated pouches produced significantly (p <0.05) more leaves at 91 DAS than those from control pouches. In addition, there is no significant difference in the number of leaves of plants from plots receiving doses of 5, 10, 15, 20, 25 g of mycorrhizae per pouches 154 DAS.

[6] which reveals that annual accessions of castor ripen between 140 and 170 DAS. In this study, the maximum number of leaves is obtained 154 days after sowing for all treatments. The increase in the number of leaves could play a very important role in the regions of Adamawa-Cameroon in that it could limit sunstroke, increase the relative humidity of the soil and reduce erosion. These leaves represent a biomass that can be recycled into organic matter and can release the mineral elements necessary for plant nutrition [19] In addition, according to [20], the number of leaves and the height of the plant are among others determining factors of seed yield. Indeed, the more a plant produces the leaves, the higher the photosynthetic intensity and therefore the seed yield is large. Several studies have shown a positive and significant correlation between the number of leaves and the yield of seeds. We can mention the works of [21], which carries the culture of the common bean in Cameroon Adamawa region with use of compost and report the existence of a positive and significant correlation between the size and number of leaves. The works of [12] reveal that there is a positive and significant correlation on the size and the number of castor leaves (p <0.05). In the present study, there was a positive and significant correlation between the size and number of leaves of castor seedlings from the hens receiving the different doses of mycorrhizae.

Table 3: Variation of the number of leaves of *Ricinus Communis* according to time

Treatments	T	M5	M10	M15	M20	M25
91 DAS	25.23 ± 1.54^{ab}	27.56 ± 2.20^{a}	27.56 ± 2.24^{a}	27.73 ± 2.97^{a}	27.83 ± 2.39^{a}	27.90 ± 2.31^{a}
105 DAS	31.03 ± 1.81^{ab}	34.20 ± 4.00^{a}	34.36 ± 3.81^{a}	34.40 ± 4.55^{a}	34.50 ± 4.42^{a}	34.60 ± 4.29^{a}
119 DAS	38.73 ± 3.53^{b}	43.10 ± 0.97^{a}	43.16 ± 0.45^{a}	43.46 ± 1.58^{a}	43.50 ± 0.50^{a}	43.50 ± 1.05^{a}
133 DAS	43.06± 12.43 ^{b}	56.70± 12.38^{a}	56.86 ± 7.87^{a}	56.90± 14.97^{a}	56.90± 14.27^{a}	57.13± 15.36^{a}
147 DAS	52.93± 20.06 ^{b}	64.26± 15.78^{a}	64.83± 14.35^{a}	64.86± 20.49^{a}	64.96± 14.34^{a}	65.33± 14.93^{a}
154 DAS	55.13± 23.49 ^{b}	67.03± 19.39^{a}	68.40± 19.41^{a}	68.43± 24.13^{a}	68.56± 18.97^{a}	68.58± 18.91^{a}

T, M5, M10, M15, M20, M25 represent respectively the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch; DAS: Days after sowing.
Values of the same line followed by the same letter are not significantly different ($p < 0.05$).

3.3 Effect of different doses of mycorrhizae on plant survival

The numbers of mycorrhizae used significantly increased ($p < 0.05$) the survival rate of the plants at 105 days after sowing compared with the control treatment (Table 7). These rates are 82.22±1.24; 88.88±1.24; 91.11±0.47; 97.77±0.23; 97.77±0.47; 97.77±1.18 respectively on the plots to receive the doses of 0, 5, 10, 15, 20 and 25 g of mycorrhizae per pouch. However, there is no significant difference in plant survival from plots receiving 5, 10, 15, 20 and 25 g mycorrhizae per pox at 105 days post sowing.

Table 4: Survival Rate of 105 DAS Plants

Treatments	T	M5	M10	M15	M20	M25
SR%	82.22±1.24[b]	88.88±1.24[ab]	91.11±0.47[ab]	97.77±0.23 [a]	97.77±0.47[a]	97.77±0.47[a]

T, M5, M10, M15, M20, M25 represent respectively the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch; SR: Survival rates.
Values followed by the same letter are not significantly different ($p < 0.05$).

3.3.1 Effects of mycorrhizal doses on the dry weight of plants

The Figure 6 shows that mycorrhizae significantly ($p < 0.05$) increased the dry matter weight of plants. The dry matter weights of the plants from the plots to receive the doses of 0, 5, 10, 15, 20 and 25 g of mycorrhizae per pouch are respectively 20.16±2.19; 27.23±4.66; 27.53±2.25; 27.72±0.87; 27.84±0.84 and 27.92±1.72 g. The increase in dry biomass induced by mycorrhizae compared to the control is respectively 27.8%. There is no significant difference between the plants and the plots receiving doses of 5, 10, 15, 20, 25 g of mycorrhizae per flock on dry biomass.
These results showed that different strains of mycorrhizal fungi with arbuscules and vesicles improve the productivity of castor oil and the dry biomass of young plants between 0.26 and 1.34 g. In this study, the average dry biomass of plants at maturity is 26.4 g. However, this value is very low compared to that reported by [12] who found that home Ndoutourou castor field grown has an average biomass of 0.05 to 0.17 kg. This difference was made to varying climatic and soil conditions. This is in line with the work of [4], who cultivates the genome and report that the genus and experimental site.
According to [16] the estimate of sequestered carbon in the pastoral system is made by multiplying the dry biomass produced by 0.42. As a result, the higher a plant has a high dry biomass, the higher the sequestered carbon yield.

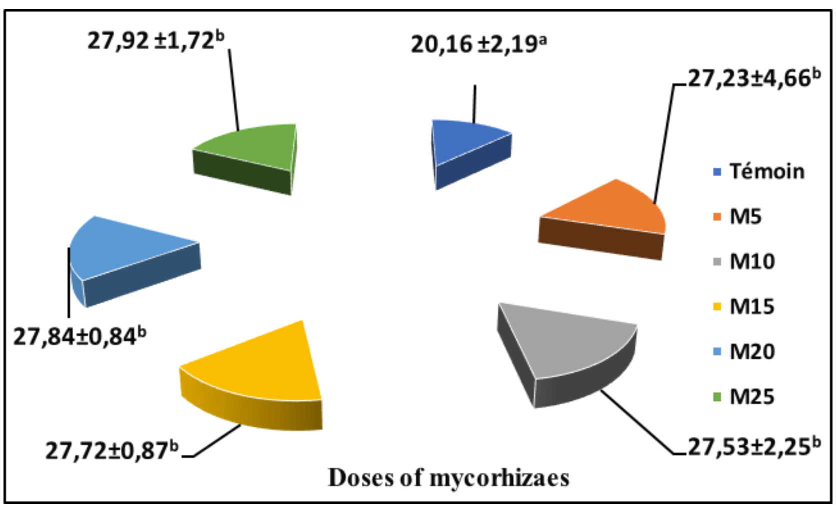


Fig 6: Dry weight of plants from different treatments at flowering

T, M5, M10, M15, M20, M25 are respectively the doses 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch.
Values followed by the same letter are not significantly different ($p < 0.05$).

3.3.2 Effects of mycorrhizal doses on plant diameter at flowering

It is apparent from Figure 8 that there is a significant difference ($p < 0.05$) between the control and the other treatments on the flowering plant. The diameters of the plants are 0.8±1.88; 1.56±1.24; 1.60±1.88; 1.64±0.81; 1.67±1.41 and 1.67±0.81 cm respectively for plants from the plots to receive the doses of 0, 5, 10, 15, 20 and 25 g of mycorrhizae per pouch. There is also a positive and significant correlation ($p < 0.05$) between the diameter and dry matter of the treatment planes. This correlation is stronger when the dose of mycorrhizal increases and less strong in control. The diameters of the seedlings resulting in the pockets inoculated with mycorrhizae are not significantly different.

These results obtained on the diameter of the plants corroborate [22] who reveals that castor seed diameter varies between 1.2 and 4.7 cm according to castor bean accessions. Moreover, according to [12], the diameters of Cameroon castor accessions are between 1.1 and 3.3 cm. In this study, the average diameter of plants is 1.49 cm.

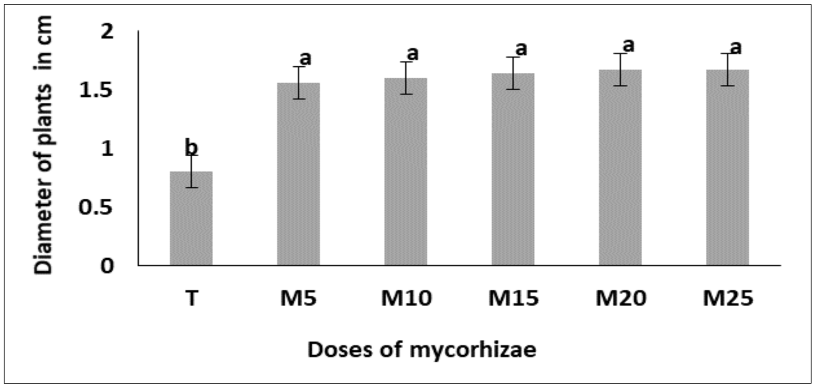


Fig 7: Diameter of plants from different treatments

T, M5, M10, M15, M20, M25 are, respectively, the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch.

The values of the bands are not significantly different ($p < 0.05$).

3.2.3 Effects of mycorrhizal doses on the number of ears of wheat grown per plant

The effect of mycorrhizal was significant (p <0.05) compared to the control treatment (Figure 8). Ear development began 77 days after sowing for other treatments, with the exception of the next month. The average results are 4.06±1.63; 6.20±2.41; 6.23±1.56; 6.26±1.52; 6.33 ± 1.01 and 6.36 ± 1.53 ears per plant, respectively, for receiving plates 0, 5, 10, 15, 20 and 25 g mycorrhizae per pouch. There is no significant difference in the number of ears grown by plants from different plots.

The results obtained on the issue of corroborating in part those of [23] who has shown that local accessions of castor bean have 2 to 15 ears and [22] who reports that Cameroon castor accessions have 2 to 21 ears per plant, this number depending on the accession of the castor and type of fertilizer. Moreover, [12] carrying out the cultivation of castor oil in the environmental conditions of the Far North Cameroon report that the number of ears per plant of castor varies from 3.9 to 5.6 ears per plant, this according to the accession of castor and the growing zone. In this study, the overall average of ears per castor seedling obtained was 5.9. In this study, the overall average of ears per castor seedling was obtained 5.9.

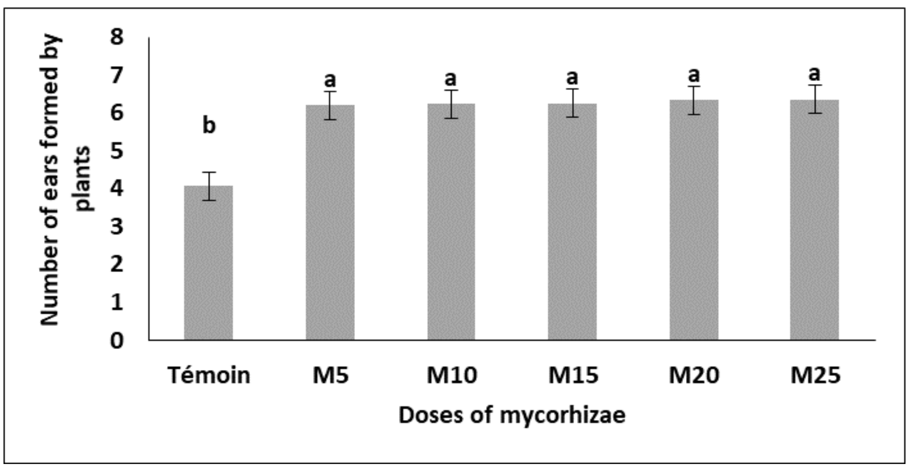


Fig 8: Number of ears formed on the plants according to the different treatments

T, M5, M10, M15, M20, M25 represents the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch, respectively.

The values of the bands are not significantly different ($p < 0.05$).

3.2.4 Effects of mycorrhizal on the number of fruits per plant

The average number of fruits developed per plant is evaluated at 105 days after sowing. The seedlings obtained from the fortified with the doses of mycorrhizae used developed significantly (P <0.05) more than those from the control plots (figure 9). Respectively, the average number of fruits per eye of the plots to receive the doses of 0, 5, 10, 15, 20 and 25 g of mycorrhizae per pouch is 72 ± 6.16; 119.66 ± 42.89; 122.33 ±

14.65, 125.33 ± 20.49, 125.33 ± 10.49 and 125.66 ± 17.24 fruits per ear. The mycorrhizal infection causes an early fruition. However, there is no significant difference between the doses of 5, 10, 15, and 25 g of mycorrhizae per plant of the fruit developed plants.

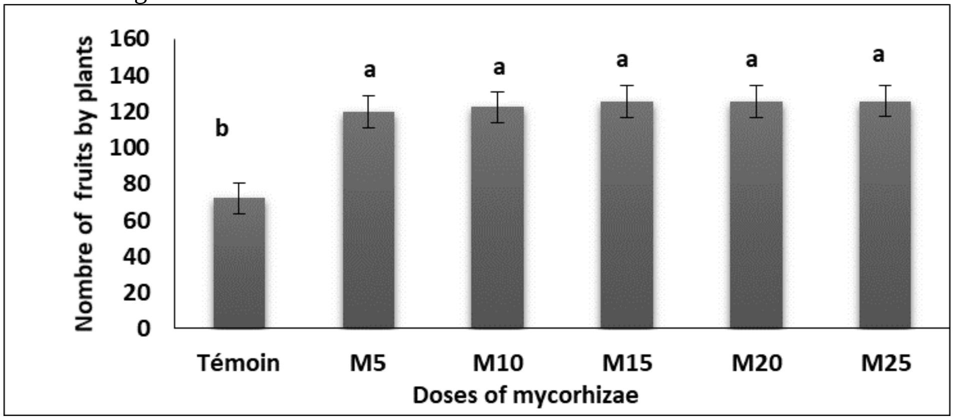


Fig 9: Average number of fruits per ear and treatment

T, M5, M10, M15, M20, M25 represents the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch, respectively.
The values of the curve are not significantly different ($p < 0.05$).

3.2.5 Effect of mycorrhizal doses one root mycorrhizal spleen

Table 5 shows a significant difference ($P < 0.05$) between the control plot and those receiving doses of 5, 10, 15, and 25 of mycorrhizae on root mycorrhization. There was no significant difference between the plants that received 5, 10, 15, and 25 mycorrhizae per plant on the spleen of mycorrhization roots.
The results obtained on root mycorrhization are consistent with those reported in the literature. Indeed, the work of [24], shows that seedlings of Jatropha curcas from pads enriched with mycorrhizae have a rate of mycorrhizal root significantly ($P < 0.05$) more elevated than those from unfertilized plots.

Table 5: Root mycorrhizal rate at different mycorrhizal doses

Treatments	T	M5	M10	M15	M20	M25
RMM	$21±9.42^b$	$83.33±9.42^a$	$86.66±4.7^a$	$83.33±16.99^a$	$90±8.16^a$	$90±8.16^a$

T, M5, M10, M15, M20, M25 are, respectively, the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch. RRM: Rate of root mycorrhization.
Values followed by the same letter are not significantly different ($p < 0.05$).

3.2.6 Effect of different doses of mycorrhizae on Ricinus comminus seeds yield at 175 days after sowing.

It can be seen from Figure 10 that the doses of mycorrhizae used significantly ($p < 0.05$) increase the seed yield of castor oil. Seed yields of plants from plots receiving 5, 10, 15, 20 and 25 g of mycorrhizae per flock are 19.44, 29.39, 29.50, 30.57, 30.62, respectively and 31.06 Kg / ha. There was no significant difference between plants receiving 5, 10, 15, 20 and 25 g of mycorrhizae per seedling on seed yield.
The results obtained on seed yield are low compared to those reported in the literature. According to [1] the European Union has attempted, particularly in France, the cultivation of certain clones with excellent yields of 2 to 3 tonnes per hectare. The values reported by [6], are even higher (1000 to 3000 Kg / ha) [25], has also shown that castor production per hectare varies from 1000 to 1200 kg / ha in culture associated with cowpeas, groundnuts or sesame. In this study, the average seed yield of the plants was 28.43 kg / ha. The differences between our results could be due to our working conditions, notably the mode of optimization of yield in fields; moreover, data collection was not carried out all year. By the way [4], reports that castor yield depends on genotypes, experimentation sites and years of experimentation.

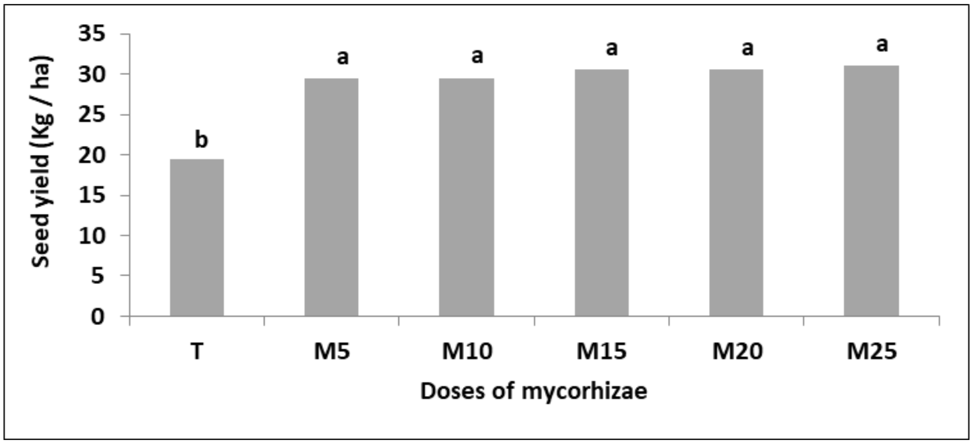


Fig 10: Seed yield (Kg / ha) at 175 DAS according to the different treatments

T, M5, M10, M15, M20, M25 are, respectively, the doses of 0, 5, 10, 15, 20, 25 g of mycorrhizae per pouch.
The values of the bands are not significantly different ($p < 0.05$).

4. Discussion

These results that there is a positive and significant correlation between dry matter diameter and weight, leaf size and number, and number of ears, size, number of leaves, and leaf yield. Seeds of the plants. The correlation is stronger in the inoculated treatments and less strong in control. This corroborates the work of [21] who obtained a positive and significant correlation between the size of the common bean and cultivated with compost (R = 0.79 on the 5% threshold) [12], also shown a positive and significant correlation (R = 0.42, p <0.05) between the size, number of leaves and the seed yield. These are important parameters for morphogenesis and seedling growth [20].
In general, castor seedlings from enriched mycorrhizal plots are significantly more productive (size, number of leaves, stem diameter at the collar, dry biomass of plants, number of ears per plant, amount of fruit per head and seed yield) compared to those from unfertilized pads. These results are consistent with those reported in the literature. Indeed [26], grow castor oil using mycorrhizae in the state of Georgia, USA, and find that mycorrhizae significantly (p <0.05) increase productivity growth (size, number of leaves, dry biomass). By the way [27], carrying out the cultivation of castor oil with the use of mycorrhizae in the region of Adamaoua Cameroon and reports that this biofertilizer improves the productivity of the field in the field. In this study, the results obtained in the seed yield recorded a significant increase of 14.61% compared to the work of [27]. The use of mycorrhizae is part of agricultural practices that contribute to sustainable agriculture [11]. This product supplies nutrients and water to plants and increases the production of food [11, 28].

5. Conclusion

At the end of this study, we can say that the mycorrhizae used to improve the productivity of the castor bean in the region of Adamaoua (Bini-Dang) compared to the control. In general, the seedlings obtained from the tubes that received the different doses of mycorrhizae. The dose, 5 g of mycorrhizae appears as the minimum effective dose of this organic fertilizer that ensures optimal performance of the castor bean in the field. This study showed that breast-fed seedlings had the biomass of 27.23±4.66 g and 29.39 kg/ha in 175 days after sowing, 25.96% and 33.85%, respectively. As regards, respectively, biomass and seed yield. The unfertilized plots had the highest results in emergence, survival, size, number of leaves, stem diameter, dry biomass, amount of fruit, number of ears, root mycorrhization, and seeds yield of plants. The highest results for these parameters were from the plots receiving doses of 5, 10, 15, 20 and 25 g of mycorrhizae per pouch. It follows from all this that the contribution of the doses of mycorrhizae used is beneficial for the cultivation of castor bean in the study zone.

6. References

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