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Effect of Pruning on Disease Incidence and Field Development of a Local Cassava Variety *(Manihot esculentus* C.)

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Authors' contributions

This work was carried out thanks to the contribution of all the authors cited upstream, the author OJA wrote the protocol, collected the data, reviewed the literature and wrote the first version of this article. Author BB was responsible for analyzing the data and plotting the other figures. Authors DYT and MMF facilitated the work. All authors read and approved the final manuscript.

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ABSTRACT

This study was conducted at the Nkoemvone Agricultural Research Station in southern Cameroon on cassava in September 2022. Its aim was to provide farmers with good cultivation techniques so that they can improve their yield. The objective of this work is to evaluate the effect of pruning on the growth of cassava stems. Specifically, the aim is to find the right time of the year when pruning could optimize growth and reduce disease incidence. A large 450m² plot was divided into three units and each unit corresponded to a treatment. These treatments were randomly placed on the

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large plot, thus we have T1= pruning in rainy weather, May 30; T2= in absence of rain, July 01 and T0= not pruned. The evaluation of these treatments was carried out on two parameters, namely the number of regrowths and the presence of diseases, more precisely mosaic. The study was conducted on 150 stems, i.e. 50 per treatment. The ANOVA allowed us to make the different analyses. The protocol used to assess the effect of pruning is a completely randomized system. The results show that there is a significant difference between T0, T1 and T2 on the number of regrowths with the respective means T0= 2, T2= 4 and T1= 6 regrowths per stem. In addition, significant differences were observed for the severity well illustrated here by the severity index which is 16.8% for T1, 19.6% for T0 and 63.8% for T2. These results indicate that cuttings should be harvested during the rainy season to ensure the sustainability of a seed field, and pruning during this season would reduce the presence of diseases. On the other hand, pruning in the dry season is very harmful and could even lead to the drying out of the stems.

Keywords: Pruning; apical dormancy; severity index; severity; cassava stem.

1. INTRODUCTION

Cassava, with the scientific name Manihot esculenta Crantz, suffers from fungal, bacterial and even viral attacks due to environmental and anthropic effects. Good cultivation techniques could alleviate these problems mentioned above. It is native to Central America from Brazil, Paraguay, Colombia and Venezuela. It was introduced in Africa by the Portuguese at the end of the 16th century [1]. Cassava belongs to the Euphorbiaceae family, the cultivated species is Manhiot esculenta, all species of the genus Manihot have 2n =36 chromosomes which sometimes favors sexual reproduction when creating new varieties [2]. Depending on the variety, cassava can measure between 1 to 6 meters in height and present several architectural types related to its branching mode [3]. The tuberization of its roots can go on cycles of 6 months to 3 years and a cutting can produce one or more stems in relation to the environment where it is found [4]. The leaves are alternate, simple and deciduous with the different colors going from the green to the red purple. The flowers form an inflorescence and the fruits are dehiscent capsules with 3 lobes each containing one seed [5]. The roots of cassava are divided into bundles of tubers measuring between 30 and 50 cm long and 5 to 10 cm in diameter. Each tuber can weigh between 2 and 5kg [6]. Cassava has the advantage of being sold from leaves to roots. The tubers can be subjected to different transformations, which increases its potential for local industrial growth, and which allows the transport of products nationally and internationally [7].

Cassava is a primary food for more than 800 million people in the world and 500 million in Africa [2]. It is the 6th most important food crop after wheat, rice, maize, potato and barley in the world [8]. Cassava represents 32% of the world production of food tubers after potato which contributes to a rate of 45% of the total, 13% for sweet potato, 8% reserved for yams and 2% remaining for other roots and tubers [9]. The production of cassava is about 250 million tons per year in the world, and thus 47% of global production held by Africa with Nigeria in the lead, then the DRC, Angola, Ghana and Mozambique, then 33% for Asia including Thailand, Indonesia, India, China and Vietnam and finally 20%. For Latin America. Currently, cassava production in Cameroon is relatively low, varying between 1000 and 200 thousand tons per year and 10 to 30 tons per year and per hectare [10]. In 2020, Cameroon ranked 16th in the world with a production of 4.9 million tons per year [11].

The improvement of productivity and efficiency of the cassava sector will require knowledge of much more advanced techniques to greatly reduce current imports, not only of rival products, but also to slightly reduce imports of cereals from large producing countries such as Russia and Ukraine. By observing several fields and conducting some small surveys we found that some practices are done lightly, this is the pruning. The pruning is a technique that allows to get rid of all kind of bulky elements, for an optimization of its potential. It is done at several levels firstly eliminate the dwarf and thin stems, which are considered as the gourments, to leave only one or two well bearing stems. Secondly, remove diseased branches, branches that are too inclined or very high in order to balance the stem. Pruning the stems of cassava would seem to some farmers to be a technique that has little effect on the development and even the yield of the crop. Pruning is a cultivation technique used in cassava, sweet potato and even cocoa to

reduce height and length in these species. Pruning also reduces apical dormancy (a biological phenomenon that contributes to the vigorous growth of the main stem at the expense of the secondary branches). The apical top uses enough water and improved sap for growth and this does not allow the plant to store carbohydrates in the tubers in an efficient way. Many growers do the pruning to reduce the height simply, others by following and some even if they know the importance of this technique, it remains to notice that the majority does it in a hazardous way without taking into account the right moment, the level of development of the plant, the weather and even to the detriment of some deficiencies and diseases observed in the plant. When should we prune cassava to have an efficient effect? In order to provide an answer to all these concerns highlighted above for an improvement of cassava yield, once its potential will be fully expressed by applying cultural practices ensuring a good vigor and that the constraints on production will be mitigated through the acquisition of adequate techniques. This study is undertaken to evaluate the development of pruned cassava compared to pruneless stems in terms of regrowth and disease susceptibility.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Study site

The work was carried out in the plots of the IRAD station of Nkeomvone in the locality of Ebolawa. This site is located in the agro-ecological zone of Cameroon, namely zone V, called the humid forest zone with bimodal rainfall. The zone is located in the tropical region in the south of the country, characterized by four seasons, including two dry seasons and two rainy seasons. The short dry season which runs from June 30 to August 15 and the long dry season from November 15 to March 15 and the rainy season from March 15 to June 30 for the long season and from August 15 to November 15 for the long season, taking into account climate change. This station is located at 580m altitude, at 24º95'4.1" N latitudes and 11º08'12.4" E longitude. The temperature is about 25ºc and rainfall varies between 1500 and 2000mm.

2.1.2 Biological material

The biological material used for the test is a local variety called (Ecobeli) taken from the local field in Ebolawa.it is very popular in the region, having a development cycle of 09 to 12 months. Its production is less expensive and generally gives a high yield under optimal maintenance conditions. The morphological criteria in the field can be observed on (Fig. 1).

Fig. 1. Image of a stem of the local variety with mosaic sympyom (march to august 2022)

2.1.3 Statistical analysis

To analyze and compare the different treatments we used an analysis of variance (ANOVA) finally to determine the correlation that may exist between the results obtained in the field at a threshold by 5%.

2.2 Methods

2.2.1 Experimental device

The test was implamented on March 01, 2022 on a plot of 450 m². The plot was divided into three elementary units of 150 m² and corresponding to a treatment. The treatments were arranged randomly on the large plot. The vigorous and well developed stems were selected. Three treatments were applied and thus the first treatment was carried out 03 months after sowing precisely on May 30 on 50 well developed stems. The second treatment was done one month later, on July 1st of the same year, and finally, the absolutely unpruned stems were the control. This allowed us to observe 150 stems and thus 50 per treatment. Data collection began a month and half (August 15 to be precise) after the second treatment. The treatments were defined as follows: T0 corresponds to the unpruned control, T1 = pruning during rainy periods and T2 = pruning at

Fig. 2. The five severity classes and the mosaic symptoms observed in the field

the end of rainy periods. The evaluation of these different treatments was done on the parameters such as the number of regrowths on the pruned stems and for the control we considered the branches of the first branching and finally the presence of the mosaic.

2.2.2 Evaluation of the number of regrowths on the treatments

The evaluation of the number of regrowths per treatment was made by counting the regrowths on the pruned stems and for the control, the branches of the first ramification. A number of volunteers will allow us to estimate the quantity of cuttings that we could have in the case of a seed field.

2.2.3 Evaluation of the degree of disease on the treatments

The presence of the disease was due to the environment as the cuttings were disease free. The evaluation of the incidence of the disease on the treatments was done by observing the symptoms on the stems. Then the severity and the severity index were calculated and compared. This allowed us to say with precision which treatment is less sensitive or more tolerant. To quantify the severity, five classes were established to measure the intensity of the symptoms and to calculate the severity index according to the following formula: Severity index (SI in %) = $(\sum(Ni \times Si)/(Nt \times 5)) \times 100$ [12].

Ni: Number of plants in severity class i, i ranging from 1 to 5.
Si: Severity class number.
Nt: Total number of plants observed per treatment

0: no symptoms.
1: slight attack covering less than 20% of the leaves.
2: slight attack less than 50% of the leaves.
3: attack involving a very large number of leaves.
4: attack affecting all the leaves, with a reduction in the leaf area.
5: An intensity of 5 is sometimes used and applies when there is deformation and reduction of leaf surfaces (Fig. 2).

3. RESULTS AND DISCUSSION

3.1 Results

The results obtained showed some variation of the different treatments on parameters such as the number of regrowths and susceptibility to diseases

3.1.1 Effect of pruning on the number of regrowths

The number of regrowths, represented here by the first node branches for the absolutely untreated control (T0 = voluntary branching) varies from 1 to 3 with an average of 2 regrowths per selected stem. The number of regrowths in the treatment (T1 = pruning during the rainy season) varies from 4 to 8 with an average of 6 regrowths per stem. The number of regrowths of the treatment (T2 = the size at the end of the rains) varies from 2 to 6 with an average of 4 regrowths per stem (Fig. 3). Similarly, the analysis of variance shows that there is a significant effect between these three treatments on the number of regrowths (Table 1) below. In order to better visualize this result, we then extracted a regression line that shows a normal distribution of the facts (Fig. 5).

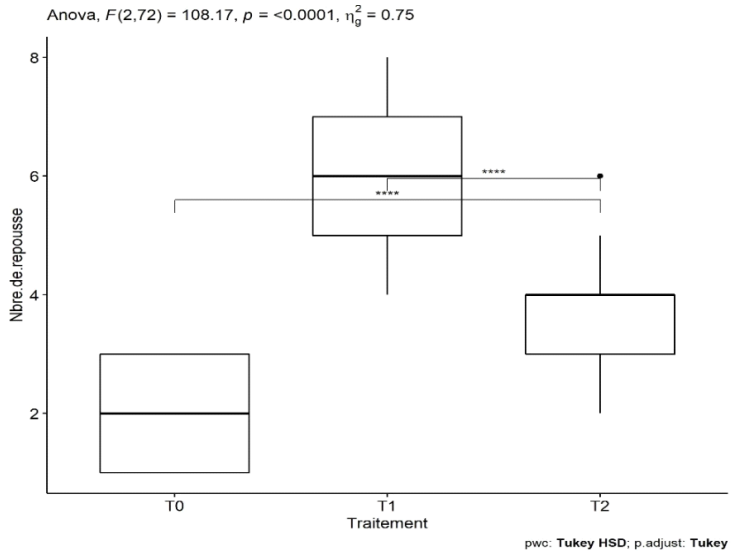

Fig. 3. Number of regrowths according to the different treatments Table

Table1. ANOVA of the effects of treatments on regrowths

Effect	DFn	DFd	F	p	p<0.0001	ges
Treatment	2	72	108,173	2,03E-22	*	0,75

**indicates a significant effect at the 0.0001 level*

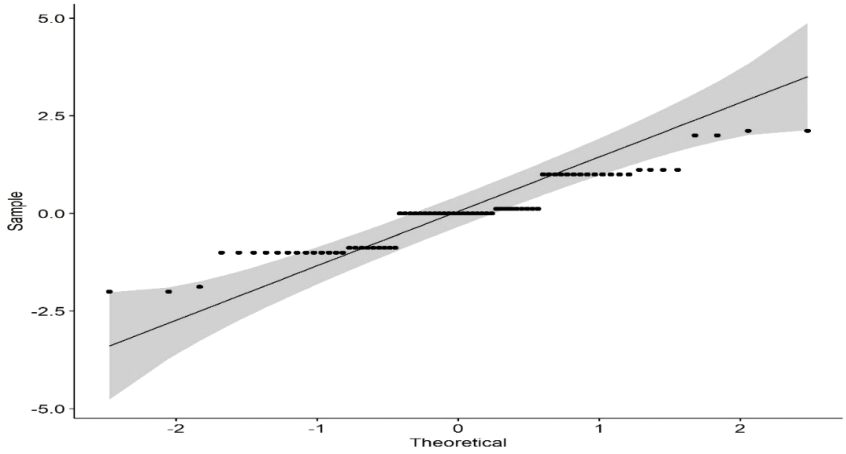

Fig. 4. The regression curve of the number of regrowths

3.1.2 Effect of pruning on the presence of mosaic disease

The presence of diseases according to different treatments was made based on the severity and the severity index of each treatment. The average severity varies from one treatment to another ranging from 1.2 for T0, 1 for T1 and 3.1 for T2 illustrated by (Fig. 5). The results indicate that the degrees of severity of the stems of the treatments T0 and T1 are less important, remaining around 1 compared to T2 which is greater than 3. At the same time, an analysis of variance indicates that there is an effect highly significant of T2 compared to T0 and T1 shown by (****). In addition, the regression curve shows a normality of the point cloud along the curve (Fig. 6). The difference in severity between these three treatments is even more visible with the noted severity index (SI) calculated in (Table 2). These results show that the severity indices of T1 and T0 are different but without a significant effect, on the other hand the T2 is highly significant than the treatments T0 and T1 at the 5% threshold.

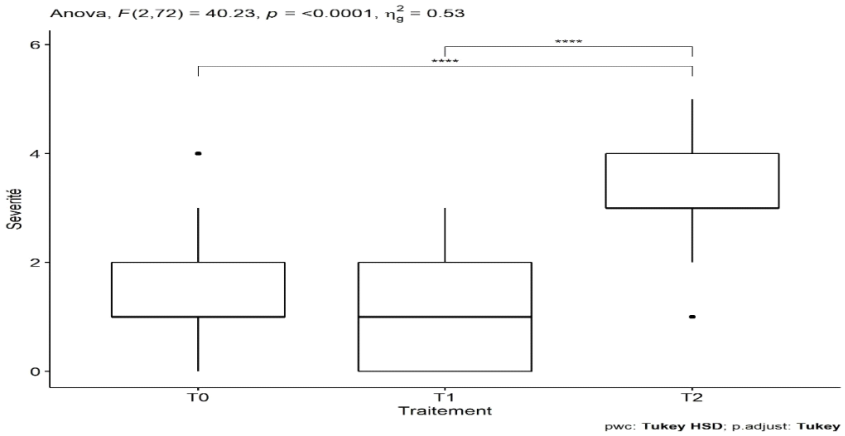

Fig. 5. The severity of the disease according to the treatments

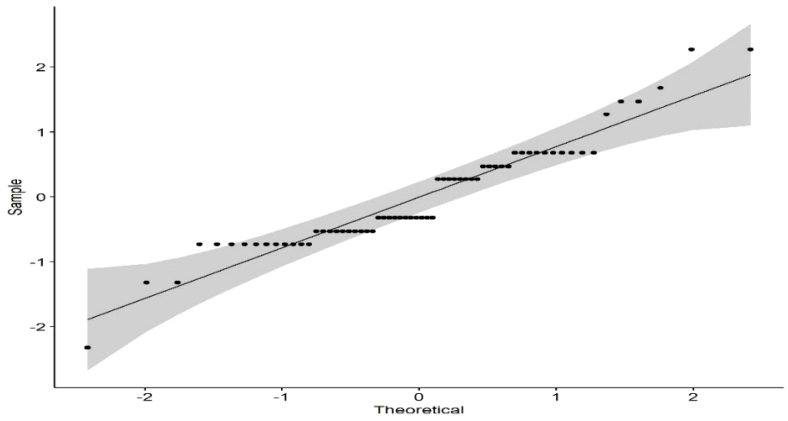

Fig. 6. The severity regression curve

Table 2. Severity indices by treatment

Traitements	T0	T1	T2
Indice of severity%	19,6%	16,8%	63,8%

3.2 Discussion

The experimental design carried out here allowed us to evaluate the effectiveness of pruning on the growth and incidence of cassava mosaic disease. This allowed us to observe significant effects whatever the trait (number of regrowths and disease severity). The effect of pruning in the first stage remains very advantageous when it is done at the right time from April 01 to May 30, this is the case of T1 which is highly significant compared to T0 and T2, with a very high number of regrowth. These results, comparable to those of [13] working on the capacity of the cocoa tree to emit orthotropic shoots and of [14] on cocoa certification and high-risk strategies, showed that pruning, if carried out correctly, more precisely one month after the beginning of the rainy season, not only rejuvenates the plant but also to rebalance its crown, which would increase its diameter at the collar and even improve the production of the cocoa tree, and thus the cassava regrowth is numerous and vigorous at this period compared to those whose pruning was done in the dry season case of (T2), below the size. However, this result is partly similar to those of [15] in conducting this work on potato varieties, indicated that the size of vegetative organs such as the stem and leaves positively influenced the development of the plant and even the diameter of the main stem.

On the other hand, significant differences were noted between the T2 treatment which presents a very high severity, confirmed here by its severity index which is three times those of the T0 and T1 treatments. Indeed, the presence of diseases is very accentuated in this treatment

(T2), this being due to the fact that the plant is subjected to a stress caused by the lack of water, a second stress caused by the pruning probably makes the plant vulnerable to diseases. In fact, this work is closely related to the work of [16] on vineyards, which emphasizes that cultural practices that cause injuries, such as pruning, increase the sensitivity of vines to infection by the main pathogens associated with this decline. On the other hand, the treatment (T1) is very resilient to diseases compared to the control (T0) but without a significant effect between the two. This can be explained by the fact that the young shoots of T1 are very vigorous and remain less or very little susceptible and even disease-free. This work shows that some diseases such as mosaic can be controlled by eliminating parts of the plant infected by them. In addition, this can contribute to the reduction of the impact of the disease. This result is consistent with those of [17] working on apple, meant that, summer pruning reduced the incidence of fly speck on apples by about 50% in each of the 2 years in trees where no fungicide was applied. Furthermore [18] in studying the yield potential in tomato they found it necessary to prune the plants for better aeration as well as limiting the development and spread of diseases. This reflection can indeed be complemented by that of [19] which shows that previous work on grapevine trunk diseases indicates that minimal or no pruning of grapevines under certain circumstances may not significantly reduce the risk of symptom expression [20].

4. CONCLUSION

The objective of this study was to evaluate the effect of pruning on two parameters which are the number of regrowth and the presence of diseases in cassava. At the end of this study, it appears that the pruning presents a strong possibility of improvement and the sustainability of the plant in the case of seed fields. Indeed, it has been observed that, if the cuttings are harvested in rainy weather, recovery is rapid and regrowth is vigorous and numerous. On the other hand, when it is done in the dry season, the recovery is slow and the regrowth is frail. Moreover, pruning during the rainy season would drastically reduce the severity of diseases and allow the young shoots to be disease-free. However, pruning in times of drought significantly increases the severity of the disease, in which case it is advisable not to prune.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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