Restoration of degraded land using "VEAZCOMUTECH": case of MarouaI Municipality, Far North Region of Cameroon

ABSTRACT

This study was carried out in the Sahelian zone of Cameroon. It aims to contribute to the restoration of degraded land in the township of Maroua I; to set up a sustainable soil restoration technique based on*Chrysopogonzizanioides, Azadirachta indica* eggshell and *Musa paradisiaca* peel; to assess the restoration of this land through the crop set up and to take stock of the "VEACOMUTECH" technique on an area of 103.5 m^2. The method envisaged in this research is based on the new modern technique "VEAZCOMUTECH": Technique of *C.zizanioides, A. indica, M. paradisiaca* and eggshell" with a view to restoring the fertility of the soil and diversifying the sources of income of the population by using this technique. The study was carried out in the Maroua I municipality on experimental plots at the Technical School of Agriculture. The most vigorous species were chosen to measure growth and yield parameters. The main plot where "VEAZCOMUTECH" was applied shows that P1B1M6 (Morelle 6 in Block 1 of Plot 1 (32 cm)) is the plant with the longest leaf, followed by P1B1M3 (Morelle 3 in Block 1 of Plot 1), the average height is 71 cm and at the end 87 leaves are observed on P1B2M12 (Morelle 12 in Block 2 of Plot 1). 23 flower buds were observed on plant P1B1M8 (Morelle 8 in Block 1 of Plot 1) and plant P1B1M3 had the highest number of flowers. The control plot had the longest leaf on plant P0M2 (Morelle 2 in the control plot) at 15 cm, with a height of 17 cm, a number of leaves of 15 cm and 2 flower buds, while plant P0M1 (PoM1: Morelle 1 in the control plot) had no flowers.

Key words: Municipality, land restoration, VEAZCOMUTECH, *Chrysopogonzizanioides*, flower buds.

1. INTRODUCTION

Soil degradation worldwide is mainly caused by human activities: intensive agriculture, irrigation, deforestation, overgrazing and industrial pollution [1]. Ranging from slight to severe degradation, this phenomenon affects about 20 million km^2, or almost 60 % of arable land. Uncultivated soils are already degraded by water or wind erosion, salinisation or deforestation [2, 3]. In 2001, at the 2nd International Conference on Land Degradation and Desertification, it was reported that desertification affects 33 % of the total land surface in the world, representing 42 million km^2[4, 5]. However, it is often assumed that land degradation in Africa has had a very negative impact on agricultural ecosystems and food production, creating a handicap to achieving food security and improving livelihoods. Thus, the cost of action against soil degradation includes investments to restore degraded soils [6, 7]. In contrast, Cameroon has 12 million hectares of degraded land, including 8 million in its northern part. The incidence of poverty in this Sudano-Sahelian zone is increasing, mainly because of land degradation and the resulting loss of productivity [8]. However, the situation is worrying in the Far North Region of Cameroon, where soil degradation and rainfall variability are compounded by land saturation, low yields and difficulties in marketing certain products. Since 1960, the centre of gravity of the cotton production basin has been in the Far North of the country (Diamare and Mayo-Kani Division). However, this Region is heading for increasing drought, and above all an imbalance between uncontrolled population growth and available space. In 2010, Cameroon had a population of 19.5 million, with a demographic rate of 2.6 % per year, above the world rate of 2.6 % per year [9]. The main objective of this work is to contribute to the restoration of degraded lands in Maroua I. Specifically, the aims are to: set up a sustainable soil restoration technique based on *Chrysopogonzizanioides - Azadirachta indica- Musa paradisiaca* and eggshell peel; assess the restoration of these lands through the cultivation set up; take stock of the "VEACOMUTECH" technique on an area of 103.5 m^2.

2. MATERIALS AND METHODS

2.1Presentation of the study area

Maroua I is a district of the Sub-division of Cameroon, located in the Far North Region and more precisely in the Diamare Division, between the geographical coordinates 10°36'42’’N latitude and 14°22'51’’E longitude. It is borders to the north by the municipalities of Maroua II and Meri, Mindif and Moutourwa to the south, Maroua III to the east and Gazawa and Ndoukoula to the west (Fig. 1).

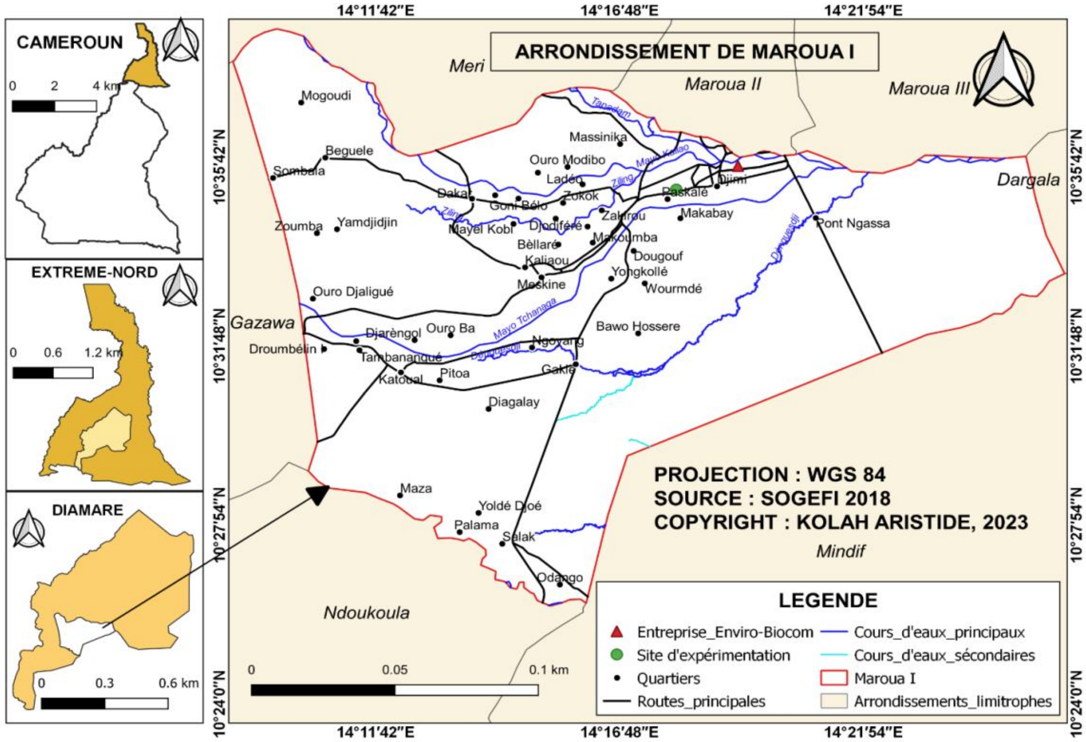


Fig. 1.Map showing the location of the study area

The Maroua I Municipality covers an area of 660 km^2 and has an estimated population of 60,000 inhabitants, giving a population density of 91 inhabitants/km^2. The population of Maroua I is cosmopolitan, made up of the Guiziga (the majority ethnic group), the Peulhs, the Haoussa, the Bornouans, the Moufou, the Mafa, the Toupouri, the Massa, theMoundang, the Betis, the Bamilekes and the Sarahs. All these ethnic groups live together in perfect harmony [10].

The rainfall gradient in the study area varies between 500 and 1,000 mm. The annual rainfall is mainly concentrated in the 4 to 5 months from June to October [11]. The average annual temperature is around 28°C, with very large thermal differences between extreme values (7.7°C average annual temperature). In addition, the high variability of rainfall in space and time constitutes a major risk [12]. The relief of the Region is characterised by plains and mountains. It is not very hilly. In fact, the territory of the Maroua I Municipality is made up of plains topped by two mountains: Mount Makabaye and Mount Yamdjidjim[13]. The soils of the Maroua I Municipality are very diverse. There are bare, clay-textured soils found in the karals; the hardes; sandy-clay-textured soils and alluvial soils with a sandy-loamy texture, which are found in the plains and especially on the edges of the mayos and which support intense agricultural activity [14].

The Maroua I Municipality is irrigated by three mayos: the mayo Tsanaga which has its source in the mountains of the Mayo-Tsanaga Division, the mayo Boula which has its source in the northern Region and the mayo Kaliao which has its source in the mountains of Meri and the surrounding area. These rivers are irregular and dry for much of the year. Their surface run-off only lasts three to four months: July, August, September and October (rainy season)[15]. They cross the entire Municipality and divide, giving rise to the mayoZileng.The dominant vegetation is the shrubby savannah characteristic of the Sudano-Sahelian zone. The flora is fairly diversified and includes species such as *Faidherbia albida, Zizyphusmauritiana, Tamarindus indica, Azadirachta indica, Acacia seyal,* etc. Some of these species are used in the production of oil and gas. Some of these species are used in traditional pharmacopoeia [16].

2.2Study materials

- ***Vetiveriazizanioide* (vetiver)**

*Chrysopogonzizanioides*formerly known as *Vetiveriazizanioides* L. Nash (Vetiver) is a perennial graminaceous plant. The vetiver system, based on the application of the vetiver species is the main restorative plant used in the VEAZCOMUTECH technique due to its integration in agroforestry systems, improving the efficiency of reforestation and bioengineering. The vetiver system (VS) is very simple, practical, cheap, extremely effective and requires very little maintenance. It is used for soil and water conservation, sediment control, soil stabilisation, rehabilitation and phytoremediation. As a plant, it is not harmful to the environment [17]. Vetiver has several parts: the leaves are sheathing, growing in clumps up to 1-2 m high, and are long and thin with serrated, sharp edges. The stems are straight and 1 to 3 m high. What’s more, vetiver's extremely deep and thick root system, which can reach a depth of 3 to 4 m, attaches itself to the soil, making it very difficult to dislodge by high-speed water flows. The very deep, fast-growing root system also makes vetiver a very drought-tolerant plant, highly suitable for stabilising steep slopes. This plant was the main material used to restore the soil in this study (Photo 1).

Photo 1.*Chrysopogonzizanioides* (Vetiver grass)

- ✓ The leaves of *Azadirachta indica* A. Juss. (Neem leaves) are evergreen and green in colour. They are broad, alternate and pinnate. They were used as an amendment and insect barrier in this study (Photo 2).

Photo 2. Leaves of *Azadirachta indica*

- ✓ The hen's eggshells, which are more or less resistant, mineralized envelopes covering the hen's eggs. They also act as a source of organic almonds and an insect barrier (Photo 3).

Photo 3. Eggshells

- ✓ The peel of *Musa paradisiaca* (Banana peel) is the outer part of the banana, also known as banana waste. It can be any colour, green or yellow, as long as it is ripe. In our study, we used chartreuse green peels, which acted as a rooting hormone, facilitating the attachment of *Chrysopogonzizanioides* and providing kernels photo 4.

Photo 4.*Musa paradisiaca* peel

- ***Solanum nigrum* L.**

S. nigrum is one of the most common French domestic plants. It belongs to the Solanaceae family and is an annual herbaceous plant. It has branches bearing dark green, simple alternate leaves with toothed or wavy margins. In this experiment, it is used as a soil restoration indicator (Photo 5).

Photo 5.*Solanum nigrum*

2.3Methods

In order to achieve our research objectives, we adopted the "VEAZCOMUTECH" technique. This method involves several activities, such as collecting shells, neem leaves, banana peel, transplanting vetiver and growing our crop, *S. nigrum*, and monitoring plant growth parameters.

- **Choice and planning of the site**

A prospective visit to the site was carried out in order to get a concrete idea of the realities on the ground before sampling. The aim of this mobilization was to recognize the site and familiarize ourselves with the study area. This gave us a superficial knowledge of the nature of the soil, the previous crops, which were maize and other legumes, and then the dimensions of our experimental site. The second stage consisted of laying out the site, the different plots and planting vetiver around the main plot. Vetiver cultivation began four days after the selection of the experimental site, followed by the *S. nigrum* nursery two weeks later. The dimensions of the experimental area were measured using a decametre (dm), giving a surface area of 103.5 m^2, i.e. a length of 11.5 m and a width of 9 m for the vetiver plot. The control plot was 9 m long and 2.5 m wide, with a total surface area of 22.5 m^2. After this phase, the site was secured with stakes, thorns and used sacks.

- **Preparation of raw material**

This decisive stage consists of choosing our raw material and making the best choice among the different existing varieties, *Chrysopogonzizanioides*, which is the best known variety in Haiti and in several countries around the world and used for its environmental benefits and in traditional medicine [18]. We began by collecting vetiver strains from Lake Porhi in the MayoKani Division, more precisely in the Porhi Sub-division, capital of Touloum. These strains were then kept in humid conditions until they reached the experimental plot to optimize transplanting (Photo 6).

Photo 6. Vetiver after sampling

- **Collecting the eggshells**

This phase involves carefully collecting the clean eggshells because they help to reduce soil acidity and combat parasites and diseases. They are also an organic fertilizer for plant growth and provide calcium for the plants. After the collection phase, we moved on to shredding using a mortar and pestle. Then we put 0.25 kg in each hole. See Plate 1, where A represents the collection stage, B the crushing and C the introduction into the holes.

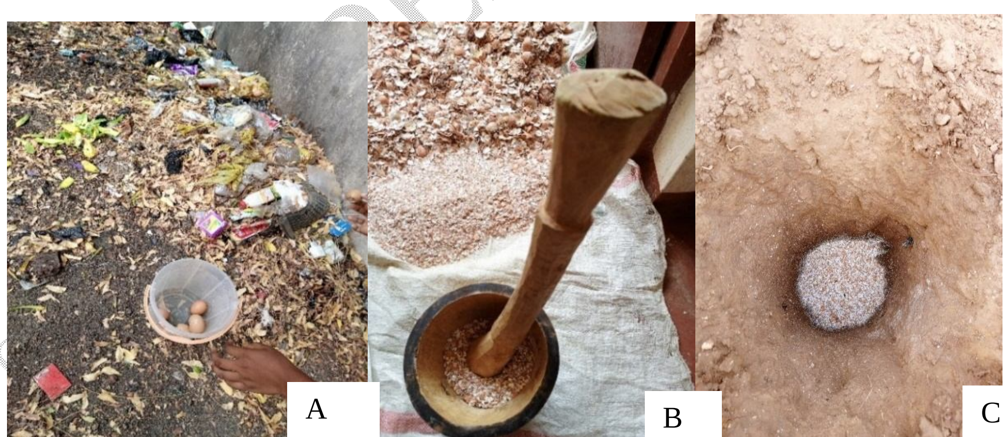


Plate 1. Stages in the use of eggshells

- **Collecting the green leaves of *Azadirachta indica***

This stage involves collecting the green leaves of neem because of its bioinsecticidal, bionematicidal, bioacaricidal, bioantifungal and biofertilizing properties, then drying the leaves in the shade, as this technique allows the leaves to retain their natural colour and better preserve the vitamins and mineral salts. After two weeks of drying, we moved on to crushing the leaves using a pestle. A quantity of 0.25 kg was introduced into each hole that would receive the vetiver and *Solanum nigrum*. See Plate 2 with A: collection, B: drying and C: crushing.

Plate 2. Stages in the processing of Neem leaves

- **Obtening the *Musa paradisiaca* peel**

This stage allowed us to collect banana peels and bananas in poor condition from banana sales outlets at the Maroua artisanal market and then from rubbish bins. The banana peel is used in our plot because it has many properties and virtues. It is rich in fibre, potassium, magnesium, iron, copper and vitamins (A, B6, B9, B12 and C). We sorted the collected peels and cut them into pieces using a knife, then buried 0.25 kg in the holes as shown in Plate 3 with A: banana peel and B: introduction into the hole.

Plate 3. Collecting the banana peel and introducing it into the holes

- **Soil preparation, breaking up the vetiver**

We began by preparing the soil by digging the vetiver holes 40 cm deep using a crowbar at 80 cm intervals to create a loose germination bed with a very wide crown. This is followed by the removal of the mature vetiver clumps. Transplanting involves dividing the tillers from a mother clump, which require care, so that each plant has at least two or three splinters and part of the crown. After separation, the splinters are cut to a length of 20 cm, as shown in Figure 4, with A: the preparing of the holes and B: the splitting of the vetiver plant, Plate 4.

Plate 4. Preparing the holes and splitting the vetıver

- **Planting (transplanting) the vetiver**

This consists of introducing the splinters (shoots) into the holes around the vetiver plot. The vetiver chips obtained are introduced into the holes containing the *Musa paradisiaca* peel, the eggshells and the Neem leaves. In this way, the planting points are known, the vetiver is transplanted like rice and the roots are firmly planted. Planting should be done after a good watering because the soil must be well soaked with water, and the vetiver plants should be watered abundantly immediately after planting until the new leaves appear. Watering should be done twice a day during the first week and once in the evening from the second week to minimize evaporation losses during the day. The third week after transplanting is used to weed around the vetiver plot before watering (Photo 7).

Photo 7. Vetiver transplanting

- **Cultivation of *Solanum nigrum***

- **Soil preparation and sowing of *Solanum nigrum***

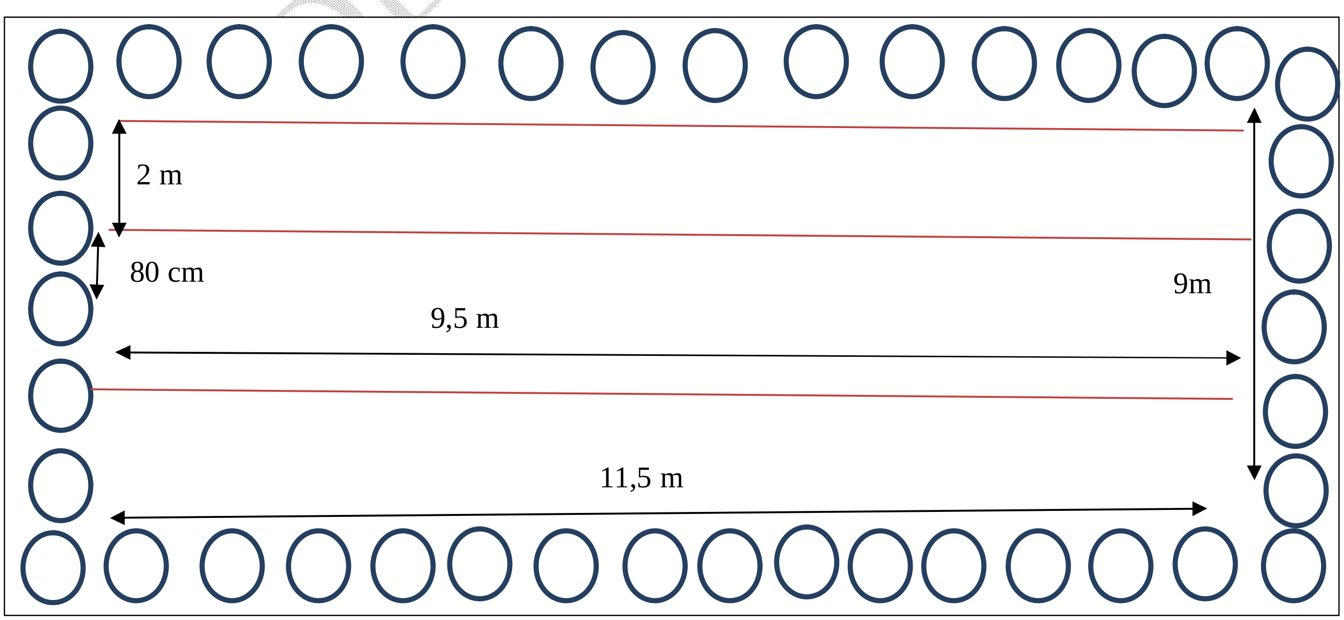
This consists of ploughing the inside of the vetiver and control plots with a hoe, then burying the Neem litter and eggshells. The nursery is watered beforehand, then the plots where the young seedlings will be planted, and proceed to mark out the holes with a 30 cm spacing between the lines and the seedlings. Next, we transplant vigorous, healthy plants with 3 to 4 true leaves, with one plant per hole. Transplanting should be done in the evening to allow the seedlings to take root properly, then watered immediately afterwards.

- **Labelling the plots**

One month after rooting the *Chrysopogonzizanioides*, we transplanted the *S. nigrum* and made 21 plates indicating the different plots and the plants to be chosen, then took their parameters. The system chosen for this purpose was a block containing two (02) plots, illustrated in Plate 5, with A the main plot and B the control plot.

A B

Plate 5. Labelling of plots



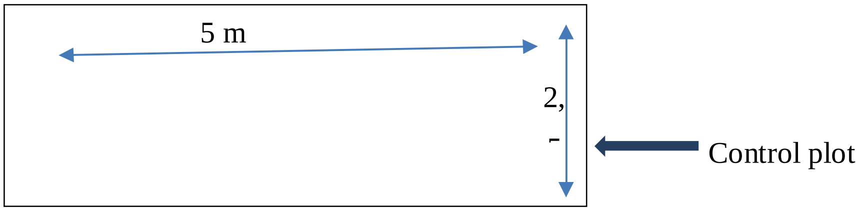


Fig. 2. Experimental design of the growing environment

- **Overall process of the VEAZCOMUTECH technique**

The process of implementing the new land restoration technique in the Maroua I Municipality involved the following 9 stages (Fig. 3):

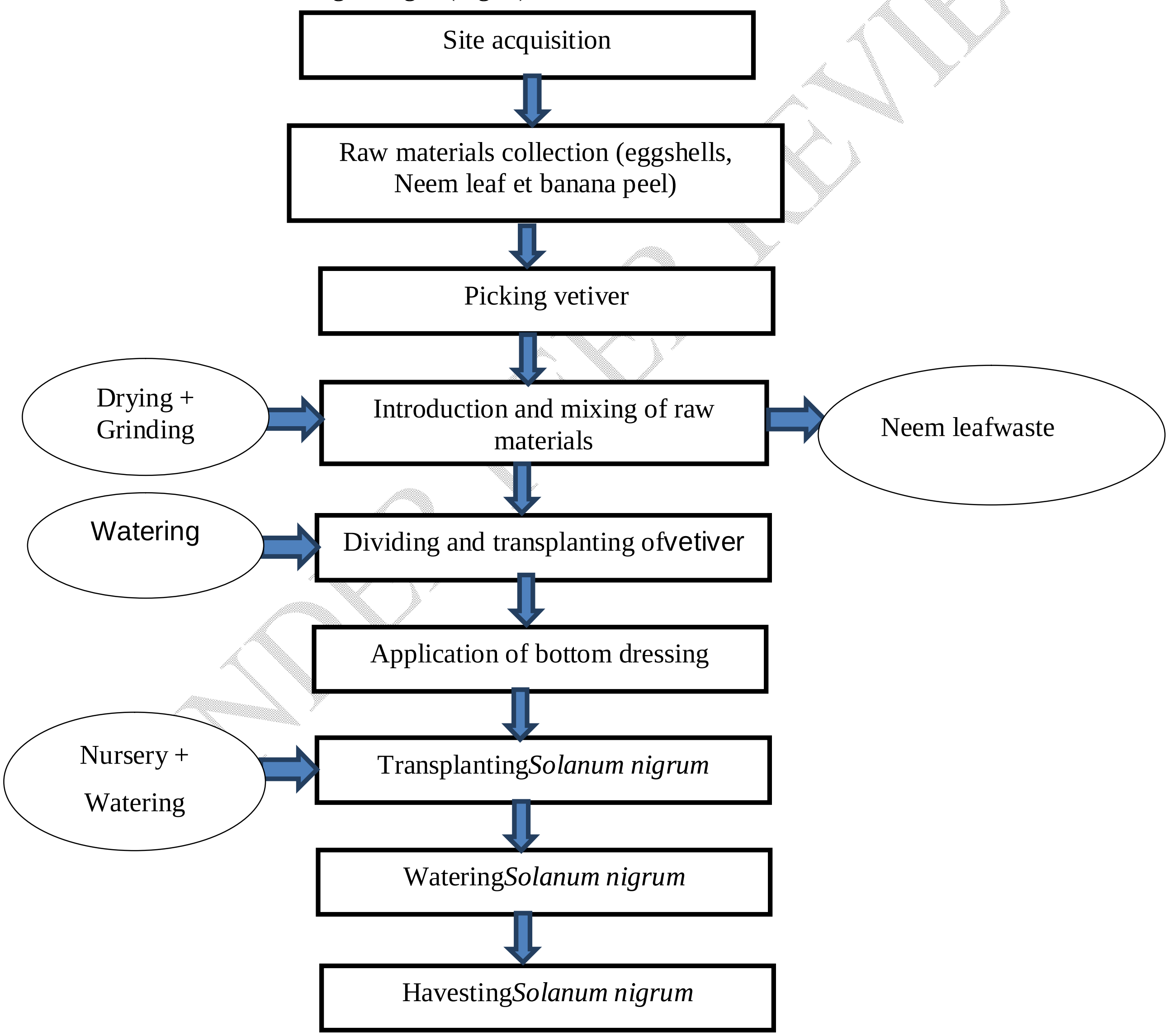


Fig. 3. Overall land restoration process using the VEAZCOMUTEC technique

➢ **Monitoring of *Solanum nigrum***

- **Monitoring parameters of *Solanum nigrum***

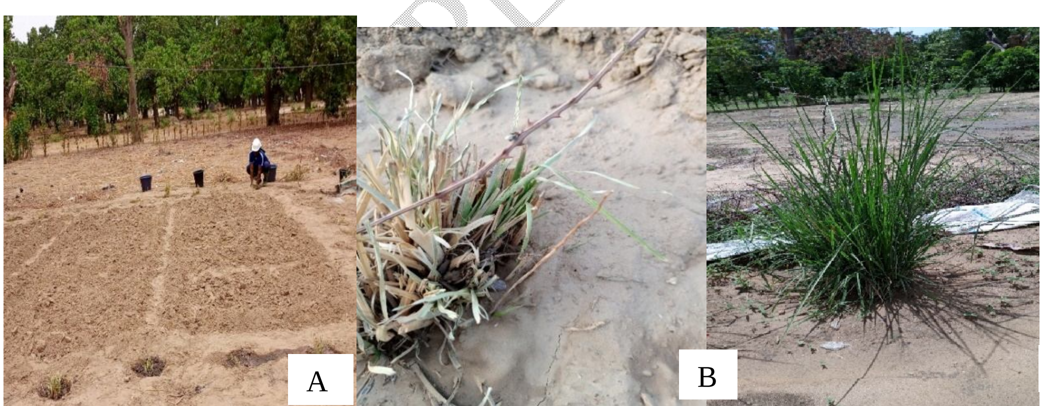
Data collection in the field was carried out over a period of one (01) month, depending on the growth of *S. nigrum*. This stage consisted of selecting 18 plants from the main plot and 3 from the black nightshade control plot on which we recorded the parameters every week. The parameters monitored were: height, number of leaves, flowers and flower buds, and success rate. The analysis of all these parameters allowed us to evaluate the effectiveness of the new modern "VEAZCOMUTECH" technique.

3. RESULTS

3.1Development of a sustainable soil restoration technique based on *Chrysopogonzizanioides*, *Azadirachta indica*, eggshell and *Musa paradisiaca* peel

3.1Plant growth on the experimental site

Plate 6 illustrates vetiver growth up to June 2023 with A: vetiver growth one week after transplanting, B: vetiver growth after two weeks and C: vetiver growth afer nine weeks.The results of this study show that the application of "VEAZCOMUTECH" on the site increases plant growth. This development depends on the plant's ability to emerge from its sluggish life. However, it is not uniform throughout the plot. In addition, some plants have lost the leaves of the transplants, while others are still growing.



C

Plate 6. Vetiver growth

3.2Effect of VEAZCOMUTECH on the average length of *Solanum nigrum* leaves

The analysis of this parameter for monitoring the length of *S. nigrum* leaves using the "VEAZCOMUTECH" technique was carried out over a period of three weeks. In this study, P represents the block plot and M the*S. nigrum* (Fig.4).

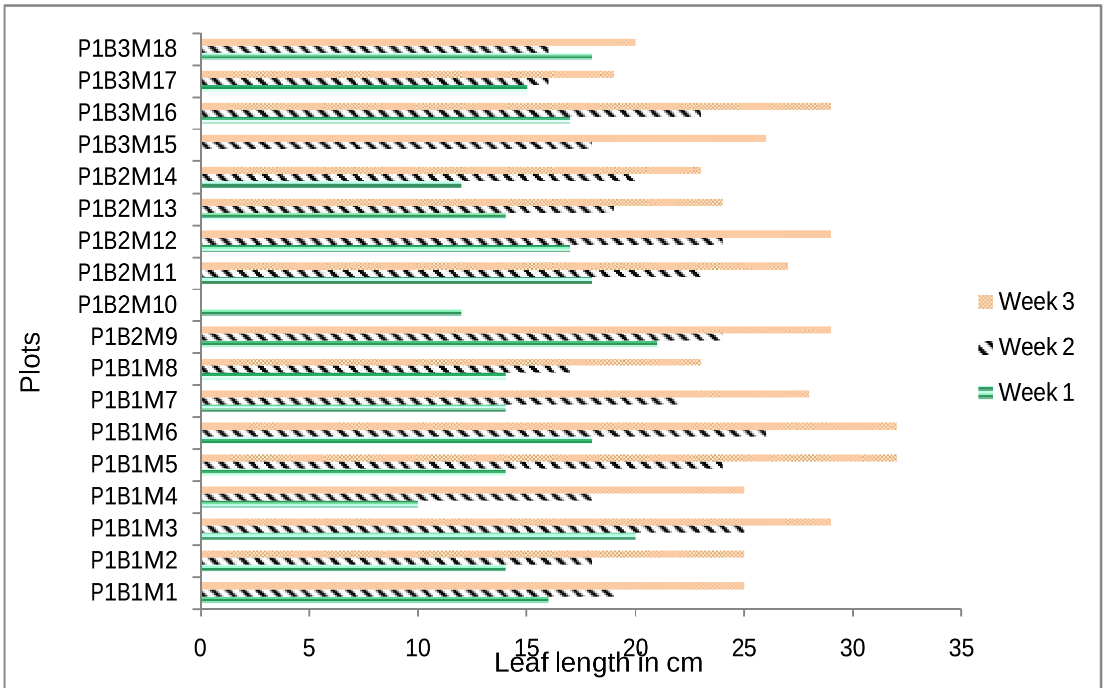
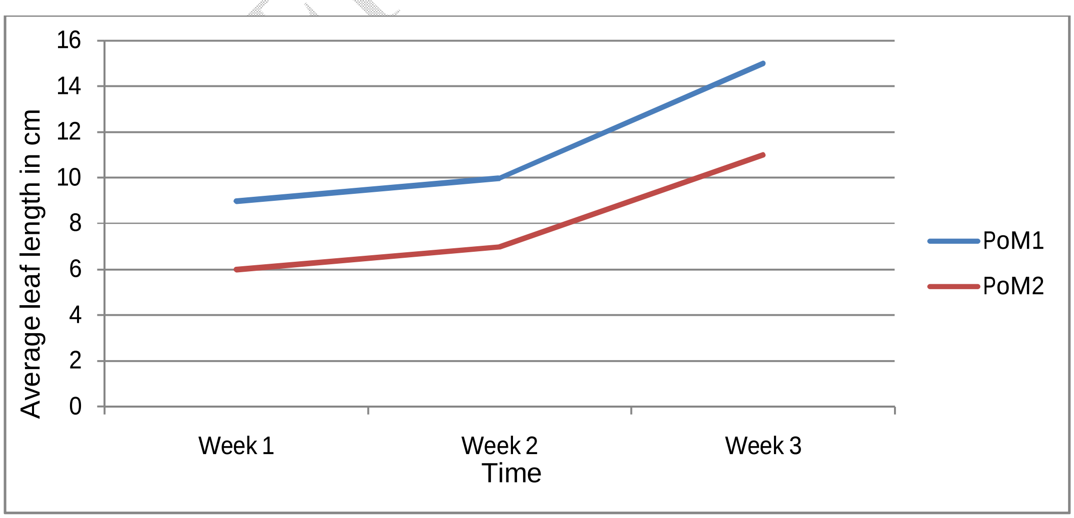


Fig.4. Changes in average leaf length in the main plot

P1B1M1: Morelle 1 in block 1 of plot 1; P1B1M2: Morelle 2 in block 1 of plot 1; P1B1M3: Morelle 3 in block 1 of plot 1; P1B1M4 : Morelle 4 in block 1 of plot 1; P1B1M5: Morelle 5 in block 1 of plot 1; P1B1M6: Morelle 6 in block 1 of plot 1; P1B1M7: Morelle 7 in block 1 of plot 1; P1B1M8: Morelle 8 in block 1 of plot 1; P1B2M9 : Morelle 9 in block 2 of plot 1; P1B2M10: Morelle 10 in block 2 of plot 1; P1B2M11: Morelle 11 in block 2 of plot 1; P1B2M12: Morelle 12 in block 2 of plot 1; P1B2M13: Morelle 13 in block 2 of plot 1; P1B2M14 : Morelle 14 in block 2 of plot 1; P1B3M15: Morelle 15 in block 3 of plot 1; P1B3M16: Morelle 16 in block 3 of plot 1; P1B3M17: Morelle 17 in block 3 of plot 1; P1B3M18: Morelle 18 in block 3 of plot 1.



PoM1: Morelle 1 in the control plot (p0), PoM2: Morelle 2 in the control plot (p0)

Fig.5. Changes in leaf length in the control plot

Observation of these two figures shows a variation in the average size of each plant, but there is a considerable difference between the main and control plots. We also note that leaf length in the main plot varies from ten (10) to thirty-two (32) cm in P1B1M4, the shortest leaf, and P1B1M6, the longest leaf. This was also the case for P1B2M10, which was only monitored during the first week. That of the control plot ranged from six (06) to fifteen (15) cm in length, with P0M2 the shortest leaf and P0M1 the longest. This figure clearly shows the difference in leaf length, where A was the plant with the longest average leaf length in the main plot and B was the control.

Plate 7. Plants with the longest leaves in the two plots

Photo 8. Impacted plant P1B2M10

3.3Effect of VEAZCOMUTECH on the average height of *Solanum nigrum*

Analysis of the average height of *S. nigrum* over three weeks using the "VEAZCOMUTECH" technique enables us to assess the height of the plants (Fig.6).

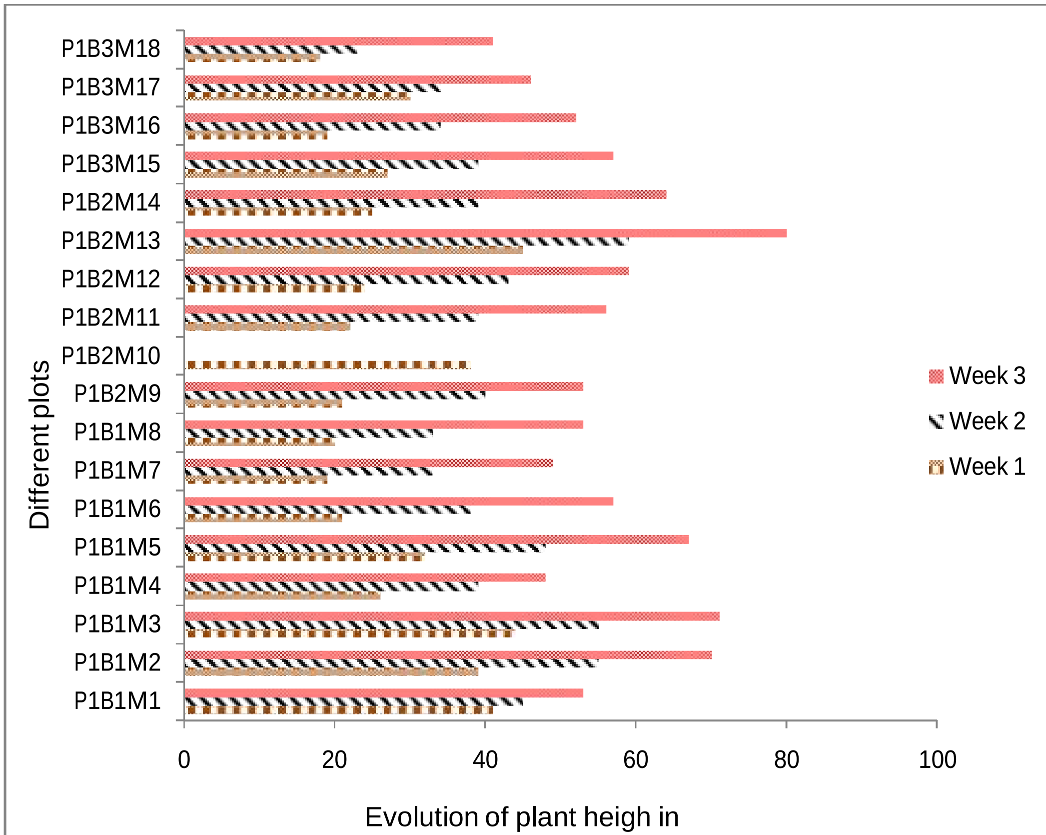
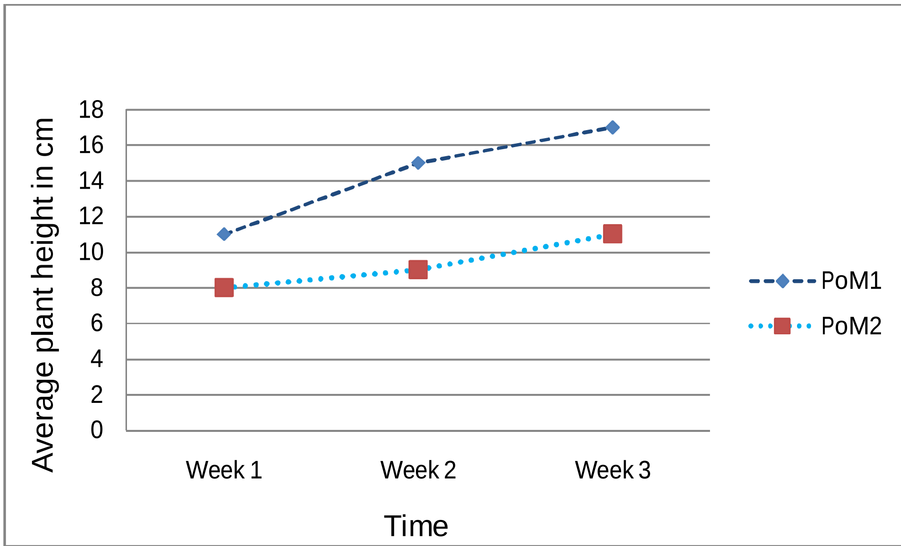


Fig. 6. Changes in the evolution plant height in the plots

P1B1M1: Morelle 1 in block 1 of plot 1; P1B1M2: Morelle 2 in block 1 of plot 1; P1B1M3: Morelle 3 in block 1 of plot 1; P1B1M4: Morelle 4 in block 1 of plot 1; P1B1M5 : Morelle 5 in block 1 of plot 1; P1B1M6: Morelle 6 in block 1 of plot 1; P1B1M7: Morelle 7 in block 1 of plot 1; P1B1M8: Morelle 8 in block 1 of plot 1; P1B2M9: Morelle 9 in block 2 of plot 1; P1B2M10 : Morelle 10 in block 2 of plot 1; P1B2M11: Morelle 11 in block 2 of plot 1; P1B2M12: Morelle 12 in block 2 of plot 1; P1B2M13: Morelle 13 in block 2 of plot 1; P1B2M14 : Morelle 14 in block 2 of plot 1; P1B3M15: Morelle 15 in block 3 of plot 1; P1B3M16: Morelle 16 in block 3 of plot 1; P1B3M17: Morelle 17 in block 3 of plot 1; P1B3M18: Morelle 18 in block 3 of plot 1.

The average height of the control is shown in Fig.6.



PoM1: Morelle 1 in the control plot (p0), PoM2: Morelle 2 in the control plot (p0)

Fig.7. Changes in the average height of plants in the control plot

We can see a great difference between the plants in the main plot, whose height varies between 49 and 80 cm, with P1B1M7 the smallest plant and P1B2M13 the tallest. However, the average height of the control varied between 08 and 20 cm, with P0M1 being the tallest. In addition, the difference in height at the second week was not very great for some plants, such as P1B1M1, because they were affected by the strong wind, and it should be noted that the plants in the control plot are dwarfed. Plate 8 below shows the tallest plants in the two plots, with A the plant from the main plot and B the control.

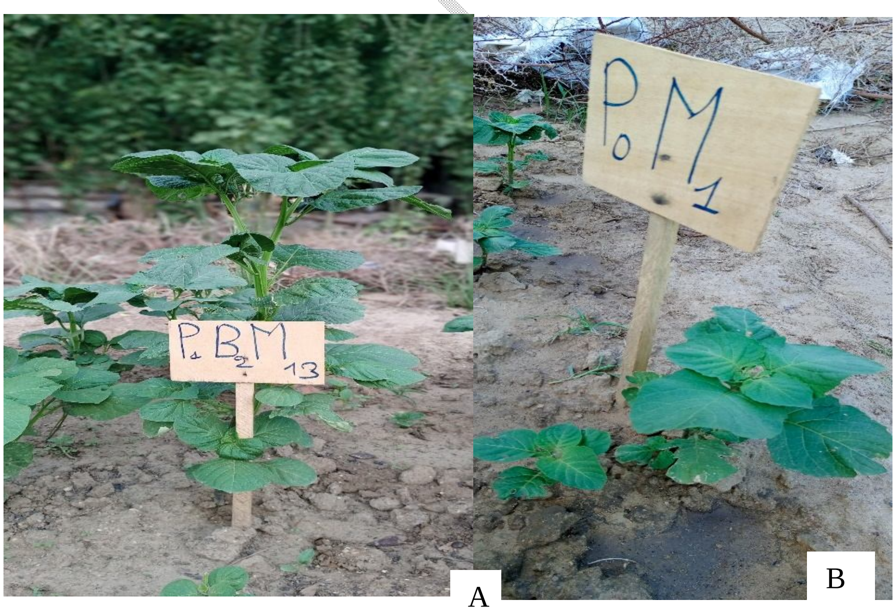


Plate 8. Average height of plants in the main and the control plots

3.4Effect of VEACOMUTECH on the average number of leaves of*Solanum nigrum*

The analysis of the data obtained from monitoring the average number of leaves of *S. nigrum* over three weeks is shown in Table 1, which represents the change in the number of leaves of the main plot in which the VEAZCOMUTECH technique was applied, and Table 2 for the control plot.

Table 1. Average change in the number of leaves in the main plot.

	Week 1	Week 2	Week 3
P1B1M1	11	35	51
P1B1M2	12	31	72
P1B1M3	15	29	59
P1B1M4	13	23	49
P1B1M5	10	20	29
P1B1M6	11	19	42
P1B1M7	11	24	76
P1B1M8	14	33	86
P1B2M9	11	29	60
P1B2M10	8	0	0
P1B2M11	12	27	58
P1B2M12	12	36	87
P1B2M13	11	28	73
P1B2M14	12	28	71
P1B3M15	10	21	63
P1B3M16	10	22	51
P1B3M17	12	21	44
P1B3M18	4	15	39

P1B1M1: Morelle 1 in block 1 of plot 1; P1B1M2: Morelle 2 in block 1 of plot 1; P1B1M3: Morelle 3 in block 1 of plot 1; P1B1M4: Morelle 4 in block 1 of plot 1; P1B1M5 : Morelle 5 in block 1 of plot 1; P1B1M6: Morelle 6 in block 1 of plot 1; P1B1M7: Morelle 7 in block 1 of plot 1; P1B1M8: Morelle 8 in block 1 of plot 1; P1B2M9: Morelle 9 in block 2 of plot 1; P1B2M10 : Morelle 10 in block 2 of plot 1; P1B2M11: Morelle 11 in block 2 of plot 1; P1B2M12: Morelle 12 in block 2 of plot 1; P1B2M13: Morelle 13 in block 2 of plot 1; P1B2M14 : Morelle 14 in block 2 of plot 1; P1B3M15: Morelle 15 in block 3 of plot 1; P1B3M16: Morelle 16 in block 3 of plot 1; P1B3M17: Morelle 17 in block 3 of plot 1; P1B3M18: Morelle 18 in block 3 of plot 1.

The average number of leaves in the control plot is given in Table 2.

Table 2. Mean numbers of leaves in the control plot

	Week 1	Week 2	Week 3
PoM1	6	9	15
PoM2	4	6	8

PoM1: Morelle 1 from the control plot (p0), PoM2: Morelle 2 from the control plot (p0)

In the main plot, the difference in the number of leaves was very small and even constant in plant P1B2M10 during the first week. Moreover, from the second week, we observe that the number of leaves increases exponentially in all the plants, following the example of P1B2M12, which has an average of 87 leaves. As for the control plot, the leaves were dwarfed, but P0M2 had more difficult in increasing the number of leaves than P0M1. Plate 9 shows this difference with (A) the plant with the highest average number of leaves in the main plot and (B) the plant with the lowest average number of leaves in the control. In the present study, "VEAZCOMUTECH" showed the best results in several growth parameters of black nightshade. This is explained by the fact that the concentrations of nutrients N, P and K were higher than those of the control plot, which were zero.

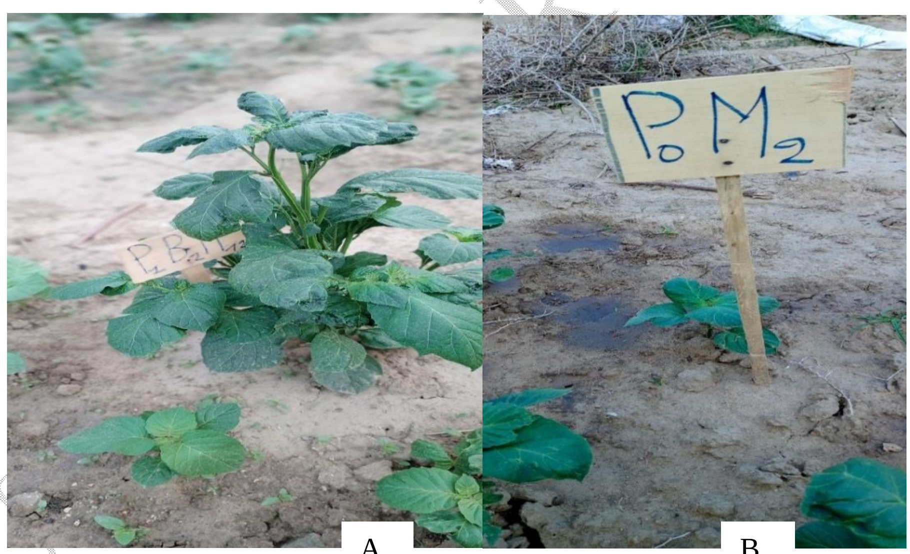


Plate 9. Difference between the numbers of leaves in the two plots

3.5Effect of VEAZCOMUTECH on the average number of flower buds of *Solanum nigrum*

The analysis of the average number of flower buds parameter on the evolution of *S. nigrum*allows us to evaluate the effectiveness of the "VEAZCOMUTECH" technique on the plants in the main plot and compare it with the control. Fig.8 illustrates the effectiveness of this technique.

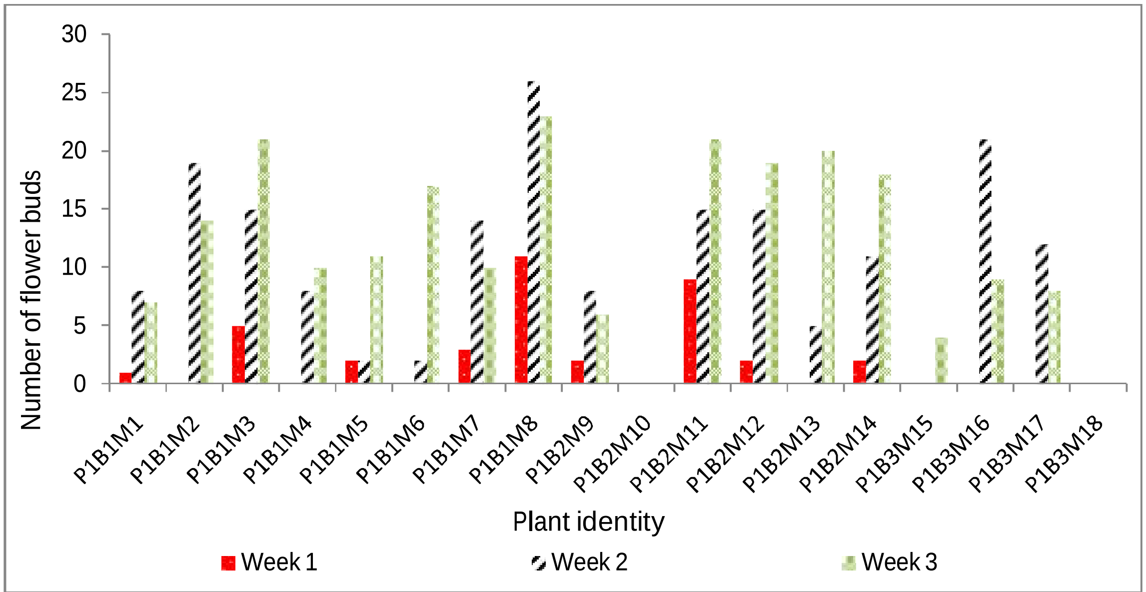


Fig. 8. Average change in the number of flower buds in the main plot

P1B1M1 : Morelle 1 in block 1 of plot 1; P1B1M2 : Morelle 2 in block 1 of plot 1; P1B1M3 : Morelle 3 in block 1 of plot 1; P1B1M4 : Morelle 4 in block 1 of plot 1; P1B1M5: Morelle 5 in block 1 of plot 1; P1B1M6: Morelle 6 in block 1 of plot 1; P1B1M7: Morelle 7 in block 1 of plot 1; P1B1M8: Morelle 8 in block 1 of plot 1; P1B2M9 : Morelle 9 in block 2 of plot 1; P1B2M10: Morelle 10 in block 2 of plot 1; P1B2M11: Morelle 11 in block 2 of plot 1; P1B2M12: Morelle 12 in block 2 of plot 1; P1B2M13: Morelle 13 in block 2 of plot 1; P1B2M14 : Morelle 14 in block 2 of plot 1; P1B3M15: Morelle 15 in block 3 of plot 1; P1B3M16: Morelle 16 in block 3 of plot 1; P1B3M17: Morelle 17 in block 3 of plot 1; P1B3M18: Morelle 18 in block 3 of plot 1.

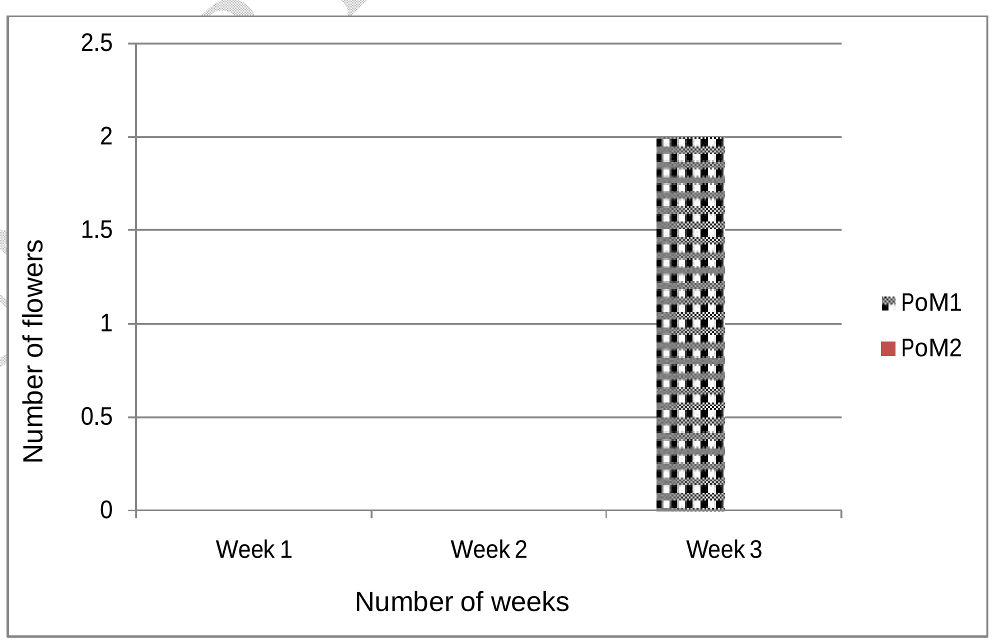


Fig. 9. Average change in the number of flower buds in the control plot

PoM1: Morelle 1 in the control plot (p0), PoM2: Morelle 2 in the control plot (p0)

The analysis of the graph for the main plot shows the absence of flower buds in plants P1B2M10 and P1B3M18 during the period when the parameters were taken, whereas P1B1M8 at 40 represents the highest average number of flower buds. In contrast to the control plot, P0M1 only showed the appearance of four small flower buds at the last measurement in the third week. Plate 10 illustrates these graphs with (A) plant 8 from the control plot and (B) plant 1 from P0.

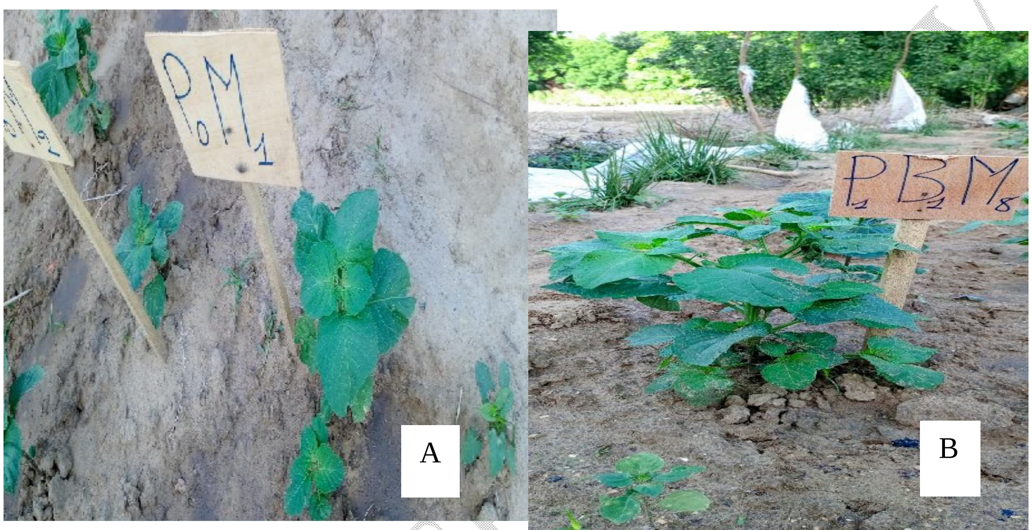


Plate 10. Difference between the average number of flower buds in the two plots

3.6Effect of VEAZCOMUTECH on the average number of flowers of*Solanum nigrum*

The analysis of the average number of flowers of *S. nigrum*allows us to assess the effectiveness of this technique by comparing the data of the main plot with those of the control plot. The following graph shows the evolution of the number of flowers in the main plot (Fig.10).

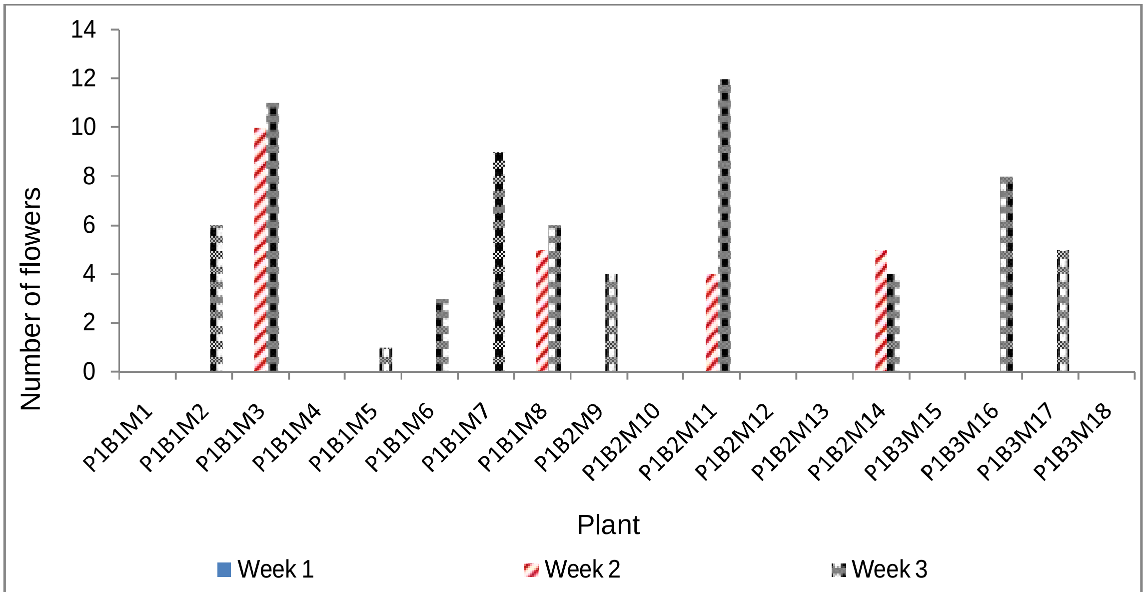


Fig.10. Average change in the number of flowers in the main plot

P1B1M1 : Morelle 1 in block 1 of plot 1; P1B1M2 : Morelle 2 in block 1 of plot 1; P1B1M3 : Morelle 3 in block 1 of plot 1; P1B1M4 : Morelle 4 in block 1 of plot 1; P1B1M5: Morelle 5 in block 1 of plot 1; P1B1M6: Morelle 6 in block 1 of plot 1; P1B1M7: Morelle 7 in block 1 of plot 1; P1B1M8: Morelle 8 in block 1 of plot 1; P1B2M9 : Morelle 9 in block 2 of plot 1; P1B2M10: Morelle 10 in block 2 of plot 1; P1B2M11: Morelle 11 in block 2 of plot 1; P1B2M12: Morelle 12 in block 2 of plot 1; P1B2M13: Morelle 13 in block 2 of plot 1; P1B2M14 : Morelle 14 in block 2 of plot 1; P1B3M15: Morelle 15 in block 3 of plot 1; P1B3M16: Morelle 16 in block 3 of plot 1; P1B3M17: Morelle 17 in block 3 of plot 1; P1B3M18: Morelle 18 in block 3 of plot 1.

Table 3. Evolution of the average number of flowers from P0

	Week 1	Week 2	Week 3
P0M1	0	0	0
PoM2	0	0	0

PoM1 : Morelle 1 of the control plot (p0), PoM2 : Morelle 2 of the control plot (p0)

The analysis of this parameter shows that from the first week to the second harvest in week 2, only plant P1B2M14 had two flowers. We also found that plants P1B1M1, P1B1M4, P1B2M10, P1B2M12, P1B2M13, P1B3M16 and P1B3M18 had no flowers throughout the period during which the parameters were measured. In addition, P1B1M3 has 19 flowers, which is the highest number of flowers in the entire main plot, while the control plant has no flowers at all.

3.7Overview of the VEAZCOMUTECH technique

It is necessary to briefly describe in great detail all the components that contributed to the development of the "VEAZCOMUTECH" technique. To do this, we determined the cost of restoring 103.5 m^2 of the experimental plot and 1 hectare. To restore 103.5 m^2, we used 10.25 kg of banana peels, 10.25 kg of eggshells and 3 tufts of vetiver grass, which yielded 55 plants after splitting, including 27 kg. Details of the costs involved in setting up the modern land restoration technique for 103.5 m^2 are given in Table 4.

Table 4. VEACOMUTECH Status Report

Constituents	Quantity (kg)	Unit price in FCFA	Total price in FCFA
Neem leaves	10,25	100	1025
Eggshells	10,25	150	1537,5
Banana peel	10,25	100	1025
The Vetiver	27	50	1350
Totals	57,75	400	4937,5

For 1 hectare we will need 990.33 kg of Neem leaves, 990.33 kg of banana peels, 990.33 kg of eggshells and 2608.69 kg of vetiver grass. So we could spend 477.050 FCFA to restore 10,000 m^2 using the "VEAZCOMUTECH" technique.

4. Discussion

Agriculture plays an important role in the socio-economic development in the northern Region of Cameroon. As such, its development is a priority for the Cameroonian government. Many efforts have been made to achieve sustainable growth in agricultural production. [19]state that organic fertilizer improves plant growth, number of bunches and fruits per plant, marketable fruit yield and P, K, Ca and Na content of tomatoes. The Rio Grande variety was more productive (32-44 t.ha). This difference in growth may be due to environmental factors, in particular sunshine, since the temperature was over 40°C and young plants exposed to the sun all day were unable to withstand the heat, whereas those that were able to withstand the very high temperature benefited from the shade of a tree in the neighbouring field. The lack of flower buds in plant P1B3M18 is probably due to the replacement carried out a week after transplanting, which slowed down its growth. In addition, the excessive increase in the number of flower buds in plant P1B1M8 would be the reason for its location, which is close to the vetiver. In addition, block 1 of the main plot and the entire control benefited from the shade of a tree located next to the plot. The absence of flowers on several plants in the main plot is probably due to their young age, as they were replaced a week after transplanting, unlike the number of flowers on plant P1B2M3, which is thought to be due to old age, as it is over the age of the first cut. As for the control plot, its number of flowers is due to the size of its population, which is dwarfed, and to the difficulty of growing on this land. In the control plot, the absence of flower buds during the first and second cut would be due to adaptation problems in the new, barren environment. This non-uniformity is linked to the trauma suffered by the plants during transport. Cameroon, like other Sahelian countries, is confronted with the phenomena of climate change and variability, which have caused, among other things, severe land degradation [20]. In recent years, however, the sector has been affected by continued degradation and a decline in the fertility of agricultural land [21]. However, the successful implementation of the strategy requires the commitment and participation of everyone in order to reverse soil degradation in a sustainable way, so as to make it healthy and more productive, with a view to making a better contribution to achieving food sovereignty and the sustainable development aims. To this end, [22] demonstrate that organic fertilizers (goat dung, cow dung and chicken dung) increase the height, leaf length, number of leaves and number of fruits of tomato. This difference in the length of *Solanum nigrum* leaves between the main and control plots may be due to the application of*Chrysopogonzizanioides*, Neem leaves, eggshells and *Musa paradisiaca* peels in the main plot, while the control plot was not amended. The absence of P1B2M10 could be due to a waterborne disease and this week's strong winds. Similar results were obtained with Chinese cabbage, whose vegetative growth parameters were improved by the addition of organic fertilizers such as chicken manure compost [23]. [24] showed that other types of fertilizer, such as termite mound soil alone without any combination, improved the growth parameters (stem height, diameter at the crown and number of leaves produced by the plants) of three black nightshade cultivars, due to the beneficial effect of the presence of nitrogen and phosphorus contained in termite mound soil. The climate-smart objective is to improve food and nutritional security, thereby strengthening peace and community cohesion [25].

5. Conclusion

In definitive, the main objective was to contribute to the restoration of degraded land in the municipality of Maroua I. In support of our ideas, this sustainable restoration technique based on *C.zizanioides, A. indica* leaves, eggshells and *M. paradisiaca* peels not only helps to clean up the environment, but also contributes to the recovery of biodegradable waste - Neem leaves, eggshells and banana peels. It also contributes to phytoremediation and biodiversity conservation by protecting the vetiver species. Secondly, the evaluation of the effectiveness of the restoration of this land through the cultivation of black nightshade shows that the growth of plants in the plot where the "VEAZCOMUTECH" technique was applied is faster than that of the control on all parameters, such as the length of the leaves of the P1B1M6 plants, which is 34 centimetres, while the largest plant in the control plot is 15 centimetres. In addition, plants such as P1B2M13 in the main plot were 90 cm tall, while the tallest plant in the control was 22 cm. In addition, the new, modern "VEAZCOMUTECH" technique effectively restores the soil fertility.

Declaration of data availability

All data used in the article and in materials and methods have been referenced in the article.

Further information

No additional information for this article.

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