THE EFFECT OF EARTHWORMS (*Lumbricus terestris*) ON THE GROWTH OF MONGO PLANTS (*Phaseolus aureus*)

A research paper

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APPROVAL SHEET

This research paper entitled "The effect of earthworms (*Lumbricus terestris*) on the growth of mongo plants (*Phaseolus aureus*)" submitted by Aiza C. Agao, Christine Joy D. Garcia and Janis O. Genterola, in fulfillment of the requirements in Science Research II, has been examined and is recommended for acceptance and approval.

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Dr. Josette T. Biyo
Science Research II Consultant

This research paper is accepted and approved in fulfillment of the requirements in Science Research II.

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Prof. Rebecca V. Yandog
Director, PSHS-WVC

A C K N O W L E D G E M E N T

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And lastly, to everybody else who in one way or another helped us accomplish this research. Thank you very much.

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A B S T R A C T

This study was conducted to determine the effect of earthworms on the growth of mongo plants. Zero, two, four, six and eight earthworms were placed in control treatments one, two, three and four respectively. Growth of plant was measured in terms of length of stems, number of leaves, dry weight and number of pods produced after harvest time.

One-way ANOVA ($\alpha 0.05$) was used to determine the effect of the different treatments on the growth of the mongo plants. Scheffe test was used as a post-hoc test to determine which treatment was significantly different from each other.

Results showed that the effectivity of the different treatments in terms of number of leaves also made a significant difference.

On the other hand, there was no significant difference found between the different treatments in terms of length of stems, dry weight and number of pods.

THE EFFECT OF EARTHWORMS (*Lumbricus terrestris*) ON THE GROWTH OF MONGO PLANTS (*Phaseolus aureus*)

Chapter 1

Introduction

A. Background of the Study

Since the beginning of time, human beings considered themselves superior among other life forms. Human beings always thought that they could do everything. But they can't. There are a lot of things other life forms can do but human beings can't. An example of another life form is the earthworm. In the following chapters, earthworms and their role in plant growth and soil structure are further elaborated for more understanding of the said topic.

Mung beans, *Phaseolus aureus*, commonly known as green gram or mongo in the Philippines, is native to India and cultivated in tropical and subtropical regions chiefly as vegetable crop. The slender crops contain up to 15 small edible seeds, which can be dried and stored or germinated in the dark to produce bean sprouts. Mung bean cultivation commonly occurs in soil. They come from the family *Leguminosae*. Because of its rapid growth and germination, the researchers chose this plant.

It will only take less than two weeks for the plant to be mature (Muller, 1979).

Agriculturally speaking, soil refers to the thin layer of loose earth materials composed of weathered materials and decaying organic matter. Such structure consists of an intimate mixture of mineral materials, organic matter, water, and air in varying proportions. The water and air are in the pore spaces, which are between and within the solid particles. The basic framework of the soil consists, then, mainly of small fragments of mineral matter derived from solid rock (bedrock) by long periods of weathering (Grolier Encyclopedia of Knowledge, 1993).

The source of organic material that is converted to humus is the great variety of living organisms found in the soil, their secretions and excretions when living, and their tissues when they die (The New Book of Popular Science, 1991).

One of the most important animals in the soil is the earthworm. The common earthworm, *Lumbricus terrestris*, has long served a classical example of the phylum. The body of this worm has more than 100 segments, which are very noticeable because of the grooves extending around the body. Each segment, except the first and the last, bears setae, which are moved by muscles within the body wall (The New Book of Popular Science, 1991).

Earthworms in this experiment were used as an alternative to other harmful kinds of soil enrichment to avoid possible pollution and contamination of surrounding bodies of water if they are lost from the bodies of soils.

B. Statement of the Problem and Hypothesis

This study aimed to determine the relationship among the common earthworms and the plant growth.

Specifically, it sought answers to this question:

What is the effect of the earthworm in the growth of Mongo plants in terms of .

(a) length of stems

(b) number of leaves

(c) its dry weight and

(d) number of pods it has produced at harvest time

H_o: The number of earthworms on the soil has no significant effect on the growth of mongo plants.

C. Objectives of the Study

This study was conducted with the following objective:

To determine the effect of the earthworms on the growth of the mongo plant in terms of

(a) length of stems

(b) number of leaves

(c) its dry weight

(d) the number of pods it has produced at harvest time

D. Significance of the Study

Agriculturally speaking, earthworms are very useful. They do a lot of things to the soil. Unlike other animals, earthworms are easy to find. They don't bite, suck, or harm human beings. Therefore convenient to whomever wants to use it as alternative to other animal's wastes.

Earthworms, in this generation, are set aside to make way for modern technologies. Fertilizers and other chemicals are used, replacing natural processes, not knowing that this may further cause abnormalities to the growth of the plant and its surroundings.

This study is most useful to farmers, gardeners and other people involved in agriculture who spend so much money on fertilizers and other types of technological advances that are sometimes not that effective.

E. Scope and Limitations

Attempting to determine the effectivity of earthworms on the growth of mongo plants, the actual experiment was conducted within the Philippine Science High School campus, at the medicinal garden, just beside the biology laboratory; though gathering the materials required the researchers to go beyond. Final results were obtained after 6 weeks after the experiment proper.

F. Definition of Terms

Lumbricus terrestris- the scientific name of the common earthworms, which are elongated, limbless animal of 100 segments, covered with shiny cuticle, and darker on the dorsal surface, living on the ground. They are hermaphrodite but are always cross-fertilized. Their burrows, which are prevented from crumbling by the worm's exuded mucus, help to aerate, loosen and drain the soil (The New Book of Popular Science, 1991).

In this study, it refers to the treatment or the independent variable. It is needed in order to obtain results of the growth of the mung bean.

Phaseolus aureus- scientific name of mung bean. When grown, its seeds are edible (Webster's Family Encyclopedia, 1995).

In this study, it refers to the dependent variable in which it depends upon the earthworm for results.

Effect- the result produced by the cause (The New Lexicon Webster's Dictionary of the English Language, 1991).

In this study, the term effect is being referred to the result or the change that happens during germination of the mung bean. It may also refer to the measurement of the quality of the soil after treatment.

Growth- the process of growing or developing, an increase in size (The New lexicon Webster's Dictionary of the English Language, 1991).

In this study, growth refers to the germination of the mung bean; specifically in terms of time, as to the length of the stem and the number of leaves after treatment.

Chapter 2

Review of Related Literature

A. Germination

Germination is defined as the sprouting of a seed or other reproductive body, usually after a period of dormancy. Absorption of H_2O, passage of time, chinning, warming, oxygen availability, and light exposure may all operate in initiating the process (Encyclopedia Britannica, 1981).

The first stage in germination is a general swelling; a take-in of water by the whole seed until each cell has absorbed enough so that its cell components can go to work. Once this is accomplished, the embryo can actually start growing (Went, 1988). This usually occurs when environmental conditions - particularly temperature, moisture and oxygen - are favorable (The Harper Encyclopedia of Science, 1963).

Brady (1974) stated that the essential elements are only one of the environmental factors influencing the growth of plants. In addition to the absence of disease and freedom from insect pests, six such external factors are recognized: light, mechanical support, heat, air, water and nutrients.

It is well to remember that plant growth is dependent upon a favorable combination of these factors and that anyone of them, if out of balance with the others, can reduce or even entirely prevent the growth of plants. Sufficient food and minerals are stored in almost all seeds, so that these factors do not limit germination. A source of light for photosynthesis enables the young plant to manufacture its own food as soon as leaves have developed (Muller, 1979). Population biology of plant embryos would describe their demography and study the factors responsible for their survivorship, mortality and growth (Nakamura, 1988).

B. Factors Affecting Growth of the Mongo Plant

The mung beans (*Phaseolus aureus*), also known as green gram, belong to the family *Leguminosae* (Webster's Family Encyclopedia, 1995).

Mung beans, *Phaseolus aureus*, commonly known as green gram or mongo in the Philippines, is native to India and cultivated in tropical and subtropical regions chiefly as vegetable crop. The slender crops contain up to 15 small edible seeds, which can be dried and stored or germinated in the dark to produce bean sprouts. Mung bean cultivation commonly occurs in soil. They come from the family *Leguminosae*. The growth and its germination are rapid. It will only take less than two weeks for the plant to be mature (Muller, 1979).

C. Factors Affecting Soil Quality

According to Baylon (1999), growing medium is as important as the kind of plant being grown. From it the plant derives important minerals, which are necessary for the normal growth and function of the plant body.

Soil is used to grow most of the world's food and much of its fiber. Soil provides the basic growth factors to plants. They support the roots and provide adequate temperature, water, nutrients, and oxygen (Donato, Lagora and Luces, 1999).

The soil on the earth's surface is underlying continual change. Each soil has a life cycle in terms of geologic time. This dynamic and evolutionary nature is embodied in a definition of soil as unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors of: parent material, macro and microorganisms, topography, all acting over a period of time and producing a product-soil that differs from the material from which it is derived in many physical, chemical, biological properties and characteristics (Donato, Lagora and Luces, 1999).

Plants will not grow well when the soil is too acidic. These conditions interfere with the availability of plant nutrients for the growth of both plants and microorganisms.

When the soil is favorable to plant growth, plants will grow rapidly (Sangutanan and Sangutanan, 1983).

The continual removal of nutrients through continuous cropping, leaching, run-off and erosion render the soil depleted of the vital nutrients needed for plant growth, due to inherent differences among soils and variations in cropping and management practices, some soils contain higher amount of plant nutrients than others. These differences and variations in soil condition may be corrected by supplying nutrients to the soil (Polido, 1992).

Soil management is the proper use of soils with respect to the many factors affecting crop production, such as crop rotation, use of green manure crops, irrigation and appropriate cultivation and proper fertilization (Encyclopedia Britannica, 1981).

Fertilizers are chemicals added to the soil in much the greatest amount (Greenland and Hayes, 1981). The three "primary" nutrient elements, those needed by plants in greatest amounts, are nitrogen, phosphorus, and potassium (Collier's Encyclopedia, 1993).

Nitrogen, the most important food element in protein, is needed for growth and development of all living tissues. It is found in important molecules like purines and pyrimidines, essential for protein synthesis; porphryin structures found in chlorophyll and cytochrome enzyme essential in photosynthesis and

respiration and coenzymes that are essential to the function of many enzymes. Without nitrogen, plant cannot complete its life cycle (Gachs, 1996).

Many legumes including the clovers are valuable also for soil enrichment because their roots produce nodules that become infected with nitrogen-fixing bacteria. These bacteria convert nitrogen in the air into a form that is used by the plants (Encyclopedia Americana, 1996).

Respiring organisms and decaying organic matter produce carbon dioxide that hydrolyzes in water to produce hydrogen ions, which may exchange with calcium, potassium, or other ions in the soil solution. The latter ions may, in turn, be absorbed and removed by the plant or drainage water (The Harper Encyclopedia of Science, 1963).

D. Earthworms

Earthworms belong to the phylum Annelida, the annelids and their relatives have a true body cavity that is called coelomates (Encyclopedia Americana, 1993).

Lumbricus terrestris, the common earthworm, is about 20 centimeters (8 inches) long. Its body is divided into more than 100 segments separated externally by grooves and internally by septa. The mouth is located in the first segment, the anus in the last.

The earthworm's body is protected from drying by a thin, transparent cuticle, secreted by the cells of the epidermis. Mucus secreted by glandular cells of the epidermis forms an additional protective layer over the body surface. The body wall has an outer layer of circular muscles and an inner layer of longitudinal muscles.

An earthworm literally eats its way through the soil, ingesting its 5own weight in soil and decaying vegetation every 24 hours. During this process, the soil is turned, aerated, and enriched by nitrogenous wastes from the earthworm. This is how earthworms enhance the formation and maintenance of fertile soil (Solomon, Berg, Martin and Villee, 1985).

Earthworms prefer moist, well-aerated, warm (70°F or 21°C) soils with soil pit between 5.0 and 8.4, with plenty of palatable organic matter, with low salt concentrations but high available calcium, with fairly deep soil of medium or fine texture, and undisturbed by tillage (Donahue, Miller, Shickluna, 1977).

All in all, these factors comprise the researcher's study about the effect of earthworms (*Lumbricus terrestris*) in the growth of the mongo plant (*Phaseolus aureus*).

Chapter 3

Methodology

This study aimed to show the relationship among the common earthworms and plant growth.

Specifically, it sought answers to the effect of the earthworm in the growth of Mongo plant in terms of length of stems, number of leaves, its dry weight after experimentation and number of seeds it has produced at harvest time. Therefore, stating that the number of earthworms on the soil has no significant difference on the growth of mongo plants.

A. The Research Design

The research design plan used is pre-test, post-test control group design. This research design involved a control group and variables to be experimented upon. Variables are in random and treatment is needed to obtain results. The earthworm is the treatment (independent variable) and the mung bean and its growth (dependent variable) is the one examined as to the effect of the treatment or the earthworm.

B. Procedure

B.1 Preparation of variables

Ten mongo seeds were planted per pot. The control group was left alone and was allowed to grow naturally, i.e., without the effect of the earthworms on its growth.

In the first setup, 3 pots were prepared. Each pot was planted with 10 mongo seeds to make sure that even if the other seeds will die, the experiment can still go on. With that, 2 earthworms were placed per pot. In the second setup, still 3 pots were prepared but with 4 earthworms per pot; the third with 6 per pot and the fourth with 8 earthworms per pot.

B.2 Gathering of Materials

The following materials were used: Mung beans, Soil, earthworms, 8 meters of screen, (8) 1x1x8 meter wood and 15 pots.

The mung beans were bought at the nearest high-quality supermarket and the wood and the screen were bought at a certain hardware store in Jaro, Iloilo City. The soil and the earthworms were delivered together from Oton, Iloilo and the pots were purchased at Hibao-an, Iloilo.

B.3 Soil Preparation and Planting

The planting of the Mung bean, drying of soil and applying of treatment and the recording of data were done in PSHS-WV campus.

After the soil was gathered, it was oven-dried at 150° C for two hours to ascertain that all organisms present in the soil are killed before experimentation.

In the first setup (3 pots per setup), 2 earthworms per pot were placed. In the second: 4, third: 6, fourth: 8 and fifth: none serves as the control group. It was left for 2 weeks so that the earthworms can adjust to the new environment.

After 2 weeks of settlement, ten mung bean seeds were planted in the pot.

B.4 Controlling weather and other external factors

Wire screen was placed around each pot to protect the plants from strong winds and harmful insects.

C. Measurement of Plant Growth

The plants were watered every noon. Throughout the afternoon, the plants were left outside and were exposed to moderate sunlight. Everything that was done for the first day was recorded. The same process is being followed everyday until the seeds are fully-grown and mature. Recording of observation was done at the end of the experiment where the plant has already produced pods; the plant was measured, specifically the number of leaves, length of stem, its dry weight and the number of pods it has produced for the time given.

D. Statistical Data Analysis

The t-test was used to record or differentiate the organic matter content of the soil initially (without treatment) and quality of soil in each treatment after the study.

The One-way ANOVA at 0.05 α was used to determine the effect of the different number of earthworms on the growth of the mung beans in terms of: length of stem, number of leaves, total dry weight and number of pods. Scheffe's test was used as a post-hoc test to determine which treatment was significantly different from each other.

Chapter 4

Results and Discussions

This study was conducted to determine the effect of the earthworms on the growth of the mongo plant in terms of

(a) length of stems
(b) number of leaves
(c) dry weight and
(d) number of pods it has produced at harvest time.

Table 1 shows the average length of stems (cm) of mongo plants per treatment at harvest time. Values are mean ± standard deviation of three replicates. One-way analysis of variance shows that there is no significant difference ($p<0.05$) between the values of the control group and the different treatments.

Table 2 shows the average number of leaves of mongo plants per treatment at harvest time. Values are mean ± standard deviation of three replicates. One-way analysis of variance shows that there is a significant difference ($p<0.05$) between the values of the control group and the different treatments.

Table 2. Average number of leaves of mongo plants per treatment at harvest time. Values are mean ± standard deviation of three replicates. Values of the same letter (superscript) do not differ significantly (Scheffe, $p<0.05$;n=3)

Treatment	Number of leaves	ANOVA
Control	$5.79 \pm .3450^{a}$	
Treatment 1	3.06 ± 3.7649^{a}	
Treatment 2	12.23 ± 2.0656^{b}	
Treatment 3	3.23 ± 0.9443^{c}	
Treatment 4	10.90 ± 3.2639^{d}	

Table 3 shows the average dry weight (g) of mongo plants per treatment at harvest time. Values are mean ± standard deviation of the three replicates. One-way analysis of variance shows that there is a significant difference ($p<0.05$) between the values of the control group and the different treatments.

Table 3. Average dry weight (g) of mongo plants at harvest time. Values are mean ± standard deviation of three replicates. Values of the same letter (superscript) do not differ significantly (Scheffe, $p<0.05$;n=3)

Treatment	Dry Weight (g)	ANOVA
Control	0.25 ± 1.00E-2[a]	
Treatment 1	0.15 ± 9.48E-2[a]	
Treatment 2	0.52 ± 0.2145[a]	
Treatment 3	0.18 ± 3.79E-2[a]	
Treatment 4	0.49 ± 0.2075[a]	

Table 4 shows the average number of pods of mongo plants per treatment at harvest time. Values are mean ± standard deviation of three replicates. One-way analysis of variance shows that there is no significant difference ($p<0.05$) between the values of the control group and the different treatments.

Table 4. Average number of pods of mongo plants per treatment at harvest time. Values are mean ± standard deviation of three replicates. Values of the same letter (superscript) do not differ significantly (Scheffe, $p<0.05$; $n=3$)

Treatment	Number of pods	ANOVA
Control	0 ± 0^a	
Treatment 1	$4.77E\text{-}2 \pm 8.26E\text{-}2^a$	
Treatment 2	0.47 ± 0.5033^a	
Treatment 3	0 ± 0^a	
Treatment 4	0.60 ± 0.5388^a	

Discussion

One-way analysis of variance showed that there is no significant difference ($p<0.05$) between the values of the control group and the different treatments in terms of the length of stems (cm).

One-way analysis of variance showed that there is a significant difference ($p<0.05$) between the values of the control group and the different treatments in terms of the average number of leaves.

One-way analysis of variance showed that there is a significant difference ($p<0.05$) between the values of the control group and the different treatments in terms of the average dry weight (g).

One-way analysis of variance showed that there is no significant difference ($p<0.05$) between the values of the control group and the different treatments in terms of the average number of pods.

Chapter 5

Summary, Findings, Conclusion and Recommendation

Summary

The aim of this research was to determine the relationship among the common earthworms and plant growth.

Specifically, it sought answers to the following question:

1. What is the effect of the earthworm in the growth of Mongo plants in terms of
   - (a) length of stems
   - (b) number of leaves
   - (c) its dry weight and
   - (d) number of pods it has produced at harvest time?

Findings

(a) One-way analysis of variance showed that there is no significant difference ($p<0.05$) between the values of the control group and the different treatments in terms of the length of stems (cm).

(b) One-way analysis of variance showed that there is a significant difference ($p<0.05$) between the values of the control group and the different treatments in terms of the average number of leaves.

(c) One-way analysis of variance showed that there is a significant difference ($p<0.05$) between the values of the control group and the different treatments in terms of the average dry weight (g).

(d) One-way analysis of variance showed that there is no significant ($p<0.05$) between the values of the control group and the different treatments in terms of the average number of pods.

Conclusion

The number of earthworms in the soil has a significant effect on the growth of the mongo plant in terms of length of stems, number of leaves and its dry weight.

The number of earthworms in the soil has no significant effect on the growth of mongo plant in terms of number of pods.

The researchers therefore conclude that the number of earthworms affects the growth of the mongo plants with regards to its length of stems, number of leaves and the dry weight but does snot affect the number of pods the plant will produce at harvest time.

Recommendation

The researchers therefore recommend that when conducting the experiment, certain factors should be observed like the weather, the place or location of the experimentation and careful and precise measurements should be observed.

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Plate 1.

Oven-drying of soil

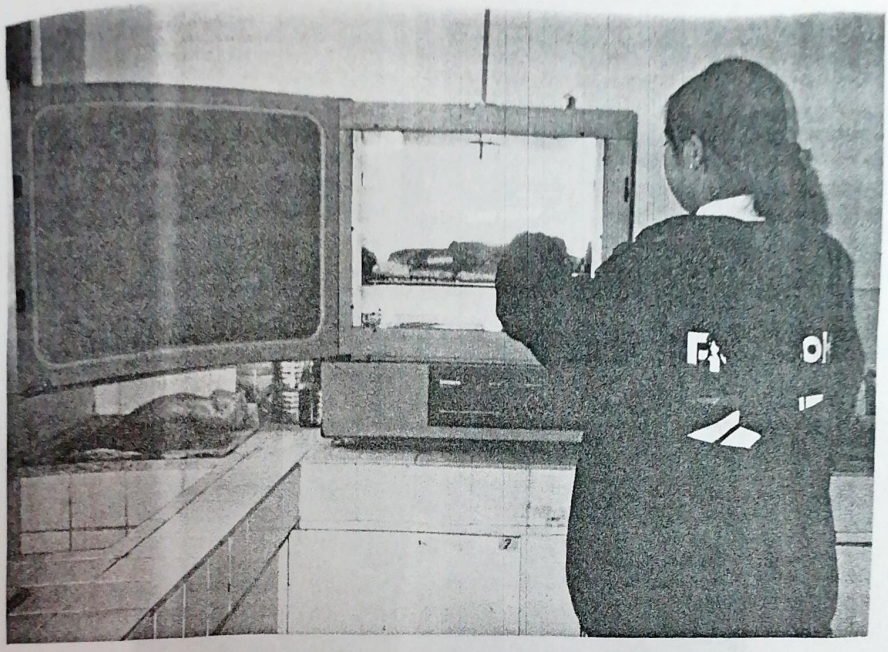

Plate 2.

Counting of earthworms

Plate 3.

Placing of earthworms into the pots

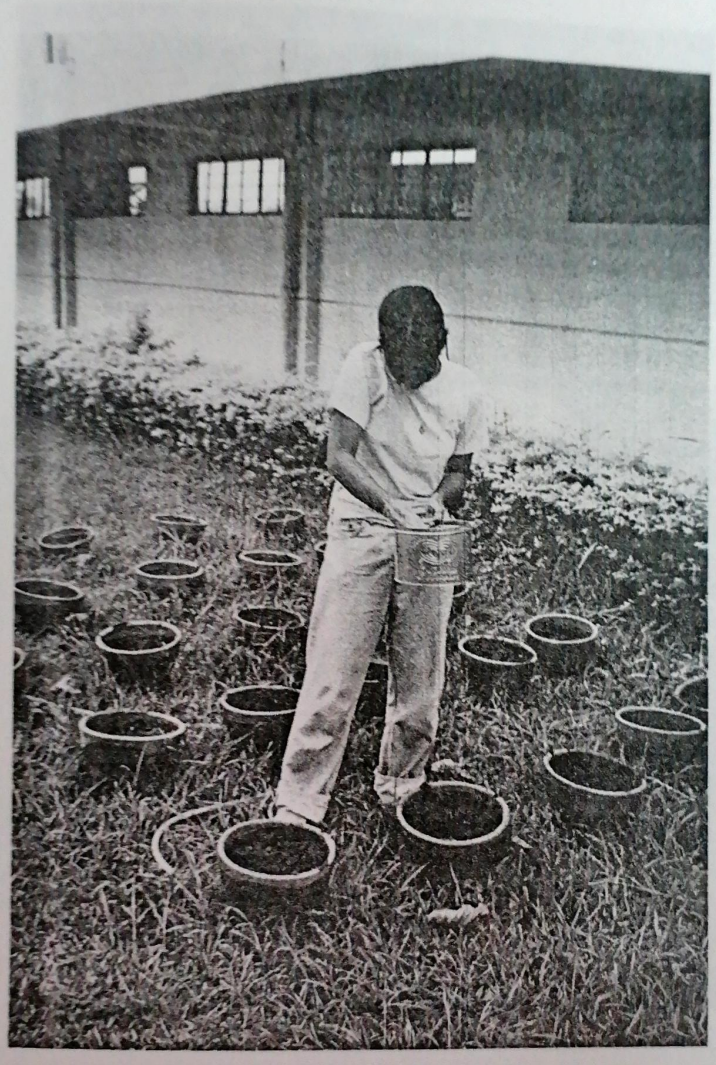

Plate 4.

Planting of mongo seeds

Plate 5.

Fencing

Plate 6.

Cleaning of the area

Plate 7.

Bird's eye view of the fenced pot

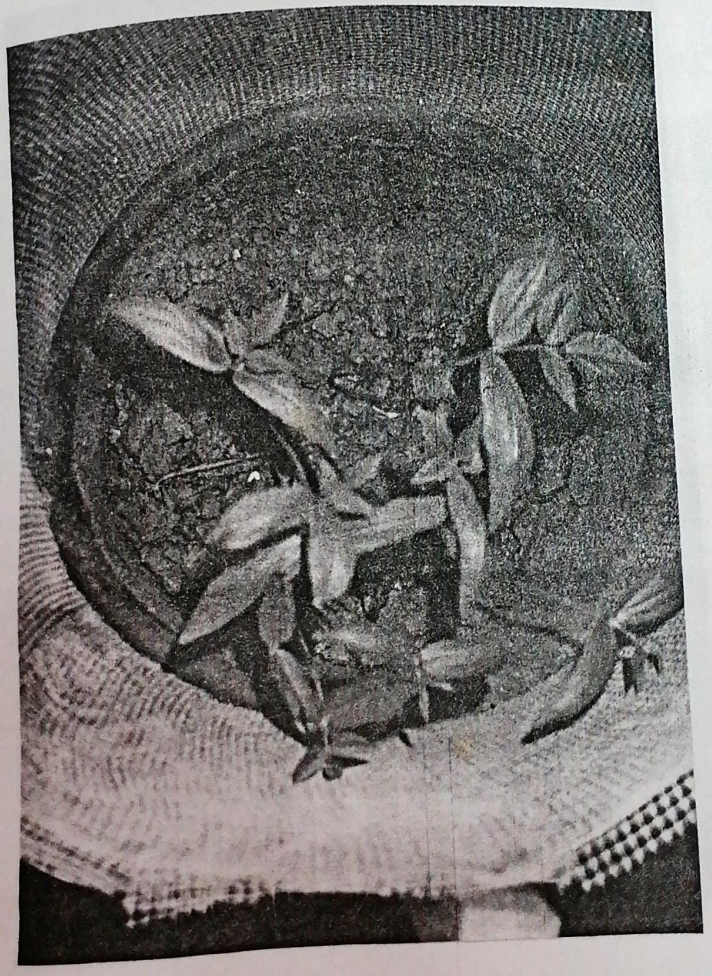

Plate 8.

Side view of the fenced pot