EFFECTS OF SIMULATED LIGHTNING ON THE GROWTH OF MONGGO SEEDS IN AN ISOLATED AREA

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This research paper entitled "EFFECTS OF SIMULATED LIGHTNING ON THE GROWTH OF MONGGO SEEDS IN AN ISOLATED AREA" submitted by Shyr Lynn D. Albao, Kim Shelly T. Escrupulo, Lorelie C.Ramos in fulfillment of the requirements in Science Research II, has been examined and recommended for acceptance and approval.

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

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Acknowledgement

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Abstract

This study was conducted to determine if simulated lightning has a significant effect on the growth on legumes specifically monggo plants grown in isolated area.

Two groups were set up. One served as the control group and the other was the experimental group wherein it was treated with simulated lightning. After the fifth day of planting, observations were made daily on the number of leaves and height of the stems. The total dry weight per pot was recorded at the end of the experimental period. Results showed that the values taken from the experimental group were larger compared to the values taken from the control group. To determine if the results have a significant effect, the researchers used T-test for equal sizes. The statistical findings showed that there is a minimal difference on the growth of the plants and the difference is considered to be not significant.

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Chapter 1

Introduction

A. Background of the Study

As we all know, lightning is a source of electricity. In some countries, the production of lightning varies even in small areas. One square meter may receive more lightning than the square meter next to it (Miller 1997). Since lightning could help in the production of nitrates (Miller 1997), which is vital for the plant's growth, it could possibly affect the growth of the plant itself.

The electricity in the form of lightning may affect the growth of plants, especially the legumes. In the nitrogen cycle, nitrogen fixation involves electricity in the form of, mostly, ammonium ions and nitrate ions by converting atmospheric nitrogen gas into chemical forms that are useful to plants (Miller 1997).

Plants are the producers by which the food chain starts. They produce oxygen for human respiration and use carbon dioxide for photosynthesis. Most of the legumes are the main source of nutrients in the Philippines.

In an isolated environment, the researchers determined the effects of simulated lightning on the growth of legumes, specifically monggo plant.

A. **Statement of the Problem**

This paper answered the following problems:

1. Will simulated lightning have an effect on the growth of monggo seedlings in an isolated area?
2. Is there any significant difference on the growth of monggo seedlings subjected to and not subjected to simulated lightning in terms of number of leaves per pot, height of the stem and total dry weight.

B. **Objectives of the Study**

This study was conducted for the following reasons:

1. To determine the effect of simulated lightning on the growth of monggo seedlings in an isolated area in terms of number of leaves per plant, height of stem and total dry weight.
2. To compare the difference in the growth of monggo seedlings with and without simulated lightning in terms of number of leaves per plant, height of stem and total dry weight in grams of seedlings in an isolated area.

C. Hypothesis of the Study

It was hypothesized in this study that simulated lightning has no significant effect on the growth of monggo plants in an isolated area in terms of The mean height of the stems per pot, the mean number of leaves and its total dry weight.

D. Significance of the Study

This study was conducted to get a more comprehensive knowledge on the effect of simulated lightning on the growth of monggo. Monggo is one of the legumes, which are essential in the Filipino diet. They are the primary source of nutrients our body needs.

This study gave us a clearer view on the difference between lightning-exposed monggo seeds and monggo seeds that were not exposed to simulated lightning. This helped us determine whether to plant monggo on areas prone to lightning or not.

Chapter II

Related Research

A. Biological Nitrogen Fixation

Biological nitrogen fixation (BNF) refers to the process of micro-organisms fixing atmospheric nitrogen, mostly within subsoil plant nodules, and making it available for assimilation by plants. Nitrogen supply is a key limiting factor in crop production. Rhizobium is the most studied and important genera of nitrogen fixing bacteria. It is able to fix atmospheric nitrogen in symbiosis with some types of leguminous plants.

Biofertilizers have the potential of increasing yields of legumes as well as reducing the use and cost of chemical nitrogen fertilizers (Odame, 1997).

BNF requires energy. Those microbes that fix nitrogen independent of other organisms are called free living. The free-living diazotrophs require a chemical energy source if non-photosynthetic, where as the photosynthetic diazotrophs utilize light energy. They contribute little fixed nitrogen to agricultural crops. Associative nitrogen fixing microorganisms are those diazotrophs that live in close proximity to plant roots and can obtain energy materials from the plants. They make a modest contribution of fixed nitrogen to agricultural and forestry, but quantification of their potential has not been established. The symbiotic relationship between diazotrophs called rhizobia and legumes can provide large amounts of nitrogen to the plant and can provide large amounts of nitrogen to the plant and can have a significant impact on agriculture.

The symbiosis between legumes and the nitrogen fixing rhizobia occurs within the nodules mainly on the root, and in few cases, on the stem. A similar symbiosis occurs between a number of woody plant species and the diazotrophic *Acytinomycete frankia.* The plant supplies energy materials to the diazotrophs, which in turn reduce atmospheric nitrogen to Ammonia. This Ammonia is transferred from the bacteria to the plant to meet the plant's nutritional nitrogen needs for the synthesis of proteins, enzymes nucleic acids, chlorophyll, and so forth.

B. Expansion of BNF Research

Biological nitrogen fixation is an essential natural process that supports life on this planet. Higher plants and animals obtain nitrogen fertilizers. Available soil nitrogen, which originates from decomposing plant residues and microorganisms, is normally deficient for intensive crop production. This is the compelling reason to improve our understanding of BNF for application.

C. Global Nitrogen

As a basic building block of plant and animal proteins, nitrogen is a nutrient essential to all forms of life. In a research of the global sources of fixed nitrogen biologically available, results show that legumes and other plants account for 40 teragrams while soil bacteria, algae, lightning, etc. account for 140 teragrams in the annual release of fixed nitrogen (Vitousek et al., 1997). Until relatively recently, the contribution of the nitrogen fixation to the global nitrogen cycle probably had not changed for centuries, having been approximate balance with the denitrification process that converts combined nitrogen back to atmospheric nitrogen.

D. Sustainability

Advances in agriculture sustainability will require an increase in the utilization of BNF as a major source of nitrogen for plants (Ladja et al. 1992). The process of biological nitrogen fixation offers as economically attractive and ecologically sounds means of reducing external nitrogen input and improving the quality and quantity of internal resources.

Richard Harwood (1990) defined sustainable agriculture as "an agriculture that can evolve indefinitely toward greater human utility, greater efficiency of resource use, and a balance with the environment that is favorable both to humans and other species."

E. Inoculants

Inoculation is important because it assures the early formation of effective nodules and an adequate supply of nitrogen for the developing plant. Under conditions prevalent in many areas, the plant will often not fix enough nitrogen on its own. This may be the case in fields where the crop has not been grown recently or where conditions make it difficult for the survival of Rhizobia bacteria. For instance, prolonged flooding and drought are both harmful to Rhizobia populations (also see "Soil and field factors that impact fixation").

Certain common production practices put stress on the legume seedling, which in turn can reduce the nodulation process. For instance, conservation tillage may leave the soil cooler and more compacted than it would be under heavier tillage. Soil compaction and cool soil temperatures both reduce nodulation and, therefore, make inoculation more critical to production.

Without inoculation, soil that has never grown a particular legume before may exhibit no fixation since there are no bacteria present to infect the root. On land, which has had the crop recently, the "native" bacteria may provide some level of fixation, but often these bacteria are not optimal for peak yield potential. Inoculants allow for the addition of specialized, selected bacterial strains that increase the plant's ability to fix higher amounts of nitrogen.

F. Legumes

There are more than 18,000 kinds of plant belonging to pea family are known as legumes. The leguminosae if the third largest family of the flowering plants, being exceeded in number of species only by the Compositae and Orchiaeae (Gibbons, 1995). Most of the legumes are source of food especially on Philippine diet.

Except for the grasses, legumes are the most important plants in the world from economic standpoint. It is important in such a way that it is a food source for humans (peas, beans, peanuts) and at the same time for livestock.

It provides timber and dyes, although some are economic nuisance to farmers and ranchers (Gibbons, 1995).

A plant's ability to host colonies of nitrogen-fixing Rhizobia bacteria in root nodules is the most significant difference between legumes and nonlegumes. The most economically significant legumes are soybeans, alfalfa, dry edible beans, peanuts, peas, lentils and clover. Being able to supply their own nitrogen, legumes are able to produce higher yields without additional nitrogen applications.

Nonlegumes, however, often require the application of supplemental nitrogen fertilizer as a means of obtaining the appropriate amount of nitrogen for optimum plant growth. This major difference between legumes and nonlegumes is advantageous from both ecological and economical points of view. Consequently, many researchers have made biological nitrogen fixation their top research priority.

I. Nitrogen Cycle

Nitrogen is important to all life. Nitrogen in the atmosphere or in the soil can go through many complex chemical and biological changes, be combined into living and non-living material, and return back to the soil or air in a continuing cycle. This is called the nitrogen cycle.

Plants need nitrogen to grow, develop and produce seed. The main source of nitrogen in soils is from organic matter. Soils in Missouri commonly contain one to four percent organic matter. Organic matter largely arises from plant and animal residues. The nitrogen in organic matter is largely in organic forms that plants cannot use. Bacteria found in soils convert organic forms of nitrogen to inorganic forms that the plant can use. Nitrogen is taken up by plant roots and combined into organic substances in the plant, such as enzymes, proteins and chlorophyll. Chlorophyll gives the plant its green color. When the plant dies, it decays and becomes part of the organic matter pool in the soil (Killpack et al., 1993).

Chapter III

Methodology

A. Materials to be used

100 grams of monggo seeds

2 aquarium of the same size

6 plant pots of the same size

Garden soil (loam)

1 tank of pressurized nitrogen gas

25 ml graduated cylinder

Distilled water

Spark plug

B. General Procedures

B.1 Planting of Monggo Seeds

Six plant pots for monggo seeds were prepared. All the pots contained 540 grams of garden soil. Each pot was planted 20 monggo seeds of the same kind. The researchers chose the assignment of monggo seeds in each pot randomly.

B.2 Set-Up

Two aquariums were set on a table where sunlight is readily available. In each aquarium, three plant pots of monggo seeds were placed randomly. The three pots were labeled pot 1, pot 2, and pot 3.

The first aquarium acted as the control group. In the control group of the experiment, nitrogen gas was sprayed but lightning was not simulated. This became Aquarium A. The second aquarium was the experimental group of the research. This group, like the first, was also sprayed with nitrogen gas. Lightning was simulated in the form of the electricity from the spark plug. This is Aquarium B.

The number of plant boxes in each aquarium allowed replication of the experiment inorder to provide the researchers greater accuracy of results.

Variables that were controlled were the type of monggo seeds, room temperature, time of watering plants, type of soil, kind of water, and the amount of sunlight.

B.3 Preparation of Simulated Lightning

The tool that was used to simulate lightning was the spark plug. This served as the source of electricity.

The electricity that was produced served as the simulated lightning.

B.4 Treatment

Right after the monggo seeds were planted, Aquarium B, the experimental group, was subjected to simulated lightning at 6:30 in the evening. The pressurized tank was opened and faced to the aquarium for 30 seconds. Sparks from the spark plug was produced and subjected to the aquarium. Each pot was exposed to ten sparks, one second for each spark. This procedure was repeated for another nine days.

B.5 Growth of Plant

Five days were given for the growth of the legumes. On the sixth day and so on, observations on the said experiment were recorded. The researchers recorded the growth of the monggo seeds based on the number of leaves of each plant. The researchers determined the number of leaves each plant has by taking its average.

The height of the stem each plant in cm has been also determined everyday for nine days using a ruler.

B.6 Oven Drying

After the ninth day of observation, all monggo plants were harvested from each set-up. Plants were cleared of soil adhering to roots. Plants were placed in petridishes and into the oven to be dried at 80°C for 42 hours. The dry weight of the plants was measured using a top loading balance.

C. Statistical Analysis

The mean number of leaves, height, and the total dry weight of the plants were measured. Inorder to determine if the results have a significant effect, the researchers used T-test for equal sizes.

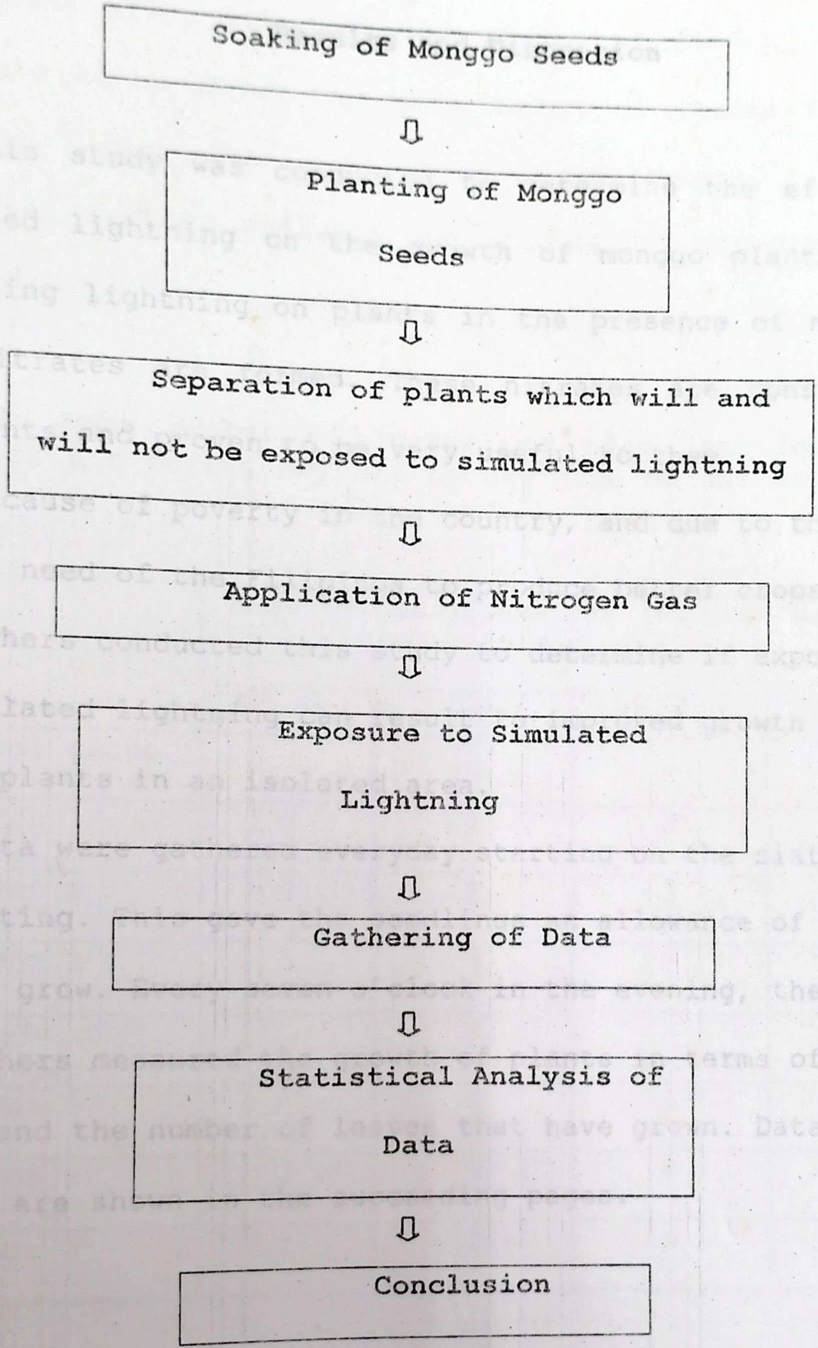

Figure 1.0 The diagram showing the Summary of the Methodology

Chapter IV

Results and Discussion

This study was conducted to determine the effect of simulated lightning on the growth of monggo plants. When simulating lightning on plants in the presence of nitrogen gas, nitrates are formed. These nitrates are consumed by the plants and proven to be very useful to them.

Because of poverty in the country, and due to the growing need of the Filipinos to produce better crops, the researchers conducted this study to determine if exposure to simulated lightning can result to improved growth of monggo plants in an isolated area.

Data were gathered everyday starting on the sixth day of planting. This gave the seedlings an allowance of five days to grow. Every seven o'clock in the evening, the researchers measured the growth of plants in terms of its height and the number of leaves that have grown. Data and results are shown in the succeeding pages.

After the fifth day of planting, the researchers have gathered this data which will be the basis if there is a significant effect on the mean number of leaves per pot. The table below shows the mean number of leaves from day six to day ten of the experimental period.

After further analysis, no significant difference was observed.

Table 1. Mean number of leaves per plant and height of stems per pot during day six to day nine of the experiment (N=3).

	Mean no. of leaves per pot from day six to day nine			
	6th day	7th day	8th day	9th day
Control group				
Pot 1	3	2	3	3
Pot 2	2	2	3	3
Pot 3	3	3	2	3
Experimental group				
Pot 1	3	3	3	2
Pot 2	3	3	2	2
Pot 3	2	2	3	3

This table shows the mean height of stem per pot. These measurements were taken from day six to day ten of the experimental period. Researchers have observed that the recorded results taken from experimental group were bigger in value compared to that of the control group. Further statistical calculations proved that there is no significant difference between the experimental and controlled setup in terms of height of stems per pot.

Table 2. The height of stems per pot from day six to day nine (N=3).

	Height of stem per pot from day six to day nine			
	6th day	7th day	8th day	9th day
Control group				
Pot 1	64.94	102.50	141.47	152.95
Pot 2	57.10	104.10	131.52	155.94
Pot 3	52.74	93.40	106.79	148.90
Experimental group				
Pot 1	97.17	103.68	147.83	165.42
Pot 2	103.83	113.50	141.83	171.53
Pot 3	76.50	86.57	122.53	155.00

After the experimental period, the plants were harvested, cleaned, and cut. The plants were then placed inside the oven for forty-two hours to free them from moisture. The total dry weight of the plants was taken. The table below shows the total dry weight of the plants per aquarium as well as the mean height of stems per aquarium. Recorded results shows that the experimental group yields bigger values than that of the control group. However, no significant difference was observed.

Table 3. Summary of mean the height of the stem and the total dry weight of plants per aquarium (N=3).

	Mean height of stem (mm)	Total dry weight (g)
Control Group	162.92	1.5063
Experimental Group	172.12	1.7869

Chapter V

Conclusion and Recommendation

Conclusion

In this study, the effect of simulated lightning on the growth of legumes was observed. The effect of which will show the difference between the mean height of the stems, mean number of leaves, and total dry weight of monggo plants subjected and not subjected to simulated lightning. The experimental group was subjected to simulated lightning five days after the monggo seeds were planted. After considering all observations and calculated data, the researchers found out that there is a difference on the growth of monggo seeds subjected to simulated lightning such that the researchers were able to gather larger values. However, the difference is not significant.

Recommendation

In this study, the researchers used the spark plug as a simulation of lightning. To further extend this study, the researchers would like to suggest using another medium having greater voltage to closely imitate the behavior of lightning.

The researchers used monggo seeds as a medium in this experiment. These seeds are fast growing. It would be better to use a slower growing seed for it to absorb more nitrates before it has fully grown.

The researchers recommend other researchers to expand this study further using other source of simulated lightning and other legumes. The researchers also recommend conducting this study for a longer period of time.

Definition of Terms

Monggo Seeds - These are the group of legumes the researchers used in the experiment.

Legumes - Legumes are budding plants. The seeds of which are planted under the ground. The seeds open up to make way for the new plant to grow.

Lightning - Lightning is a form of electricity that converts nitrogen into nitrates, which, when fixed by the nitrogen-fixing bacteria, becomes very useful to plants.

Simulated Lightning - The researchers simulated lightning in the form of a spark plug.

Nitrogen - Nitrogen is the fifth most abundant gas on earth. At a certain part of the nitrogen cycle, it is converted to a form that is most useful to plants.

Nitrogen-fixing Bacteria - Bacteria responsible for the conversion of nitrates into a form useful to plants especially to legumes.

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Statistical Analysis

Aquarium A

	$\sum x$	$\sum x^2$
Pot 1	156.95	24633.3025
Pot 2	173.72	30178.6384
Pot 3	148.85	22156.3225
x =	159.84	25656.0878

$s_2 = \sqrt{n\sum x^2 - (\sum x)^2 / n(n-1)}$

$= \sqrt{3(25656.0878) - (159.84)^2 / 3(3-1)}$

$s_2 = 92.57378841$

Aquarium B

	$\sum x$	$\sum x^2$
Pot 1	172.71	29656.2841
Pot 2	181.42	32913.2164
Pot 3	162.74	26484.3076
x =	172.12	29684.6027

$s_1 = \sqrt{n\sum x^2 - (\sum x)^2 / n(n-1)}$

$= \sqrt{3(29684.6027) - (172.12)^2 / 3(3-1)}$

$s_1 = 99.52166115$

T-test for Equal Sizes

$t = x_1 - x_2 / \sqrt{s_1^2 + s_2^2 / n}$

$= 172.12 - 159.84 / \sqrt{(92.57378841)^2 + (99.52166115)^2 / 3}$

$= 12.2833333 / 78.47391783$

$t = + 0.16$

t = + 0.16 = no significant effect

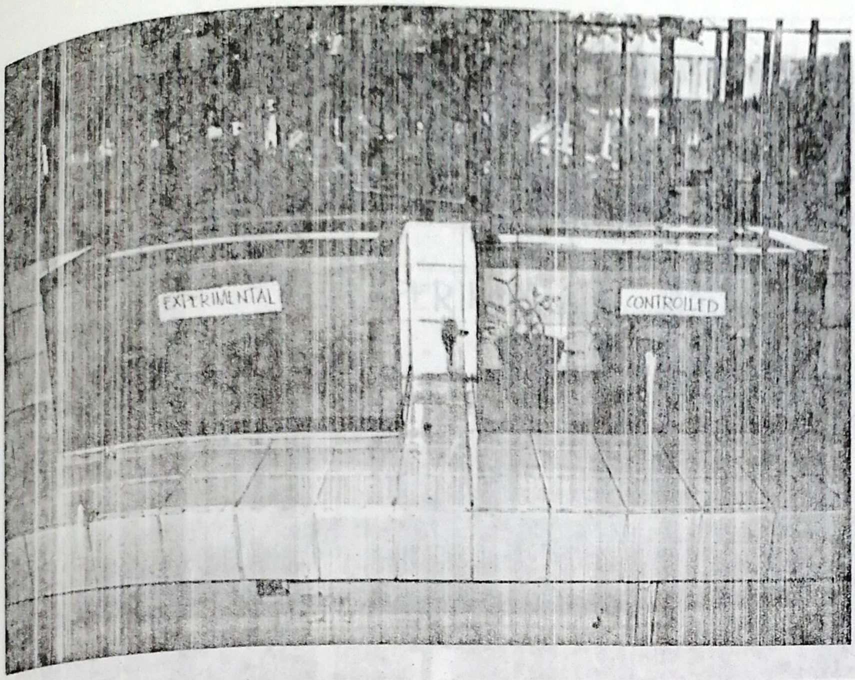

Plate 1. The controlled and Experimental set-up.

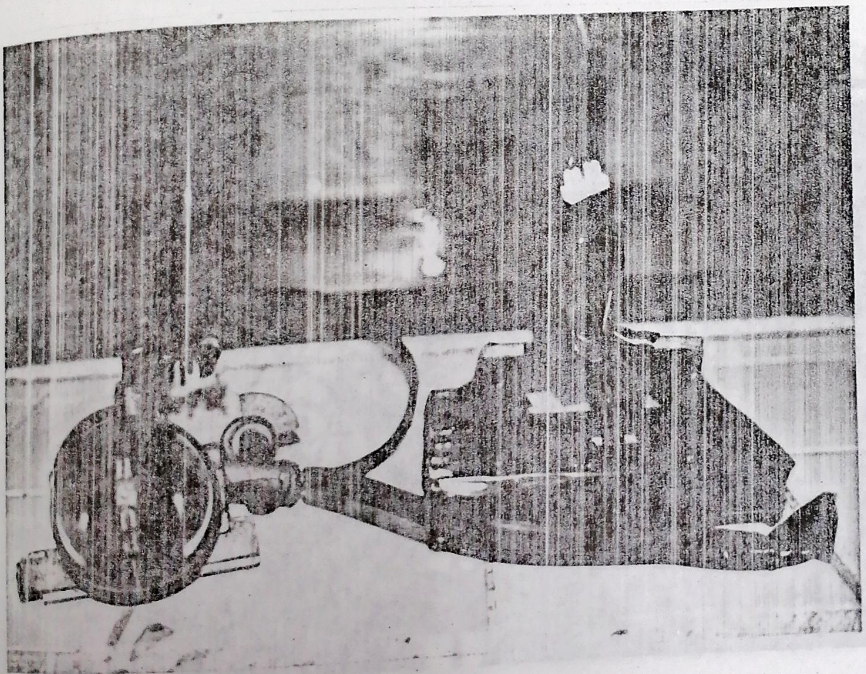

Plate 2. Device used for simulating lightning.

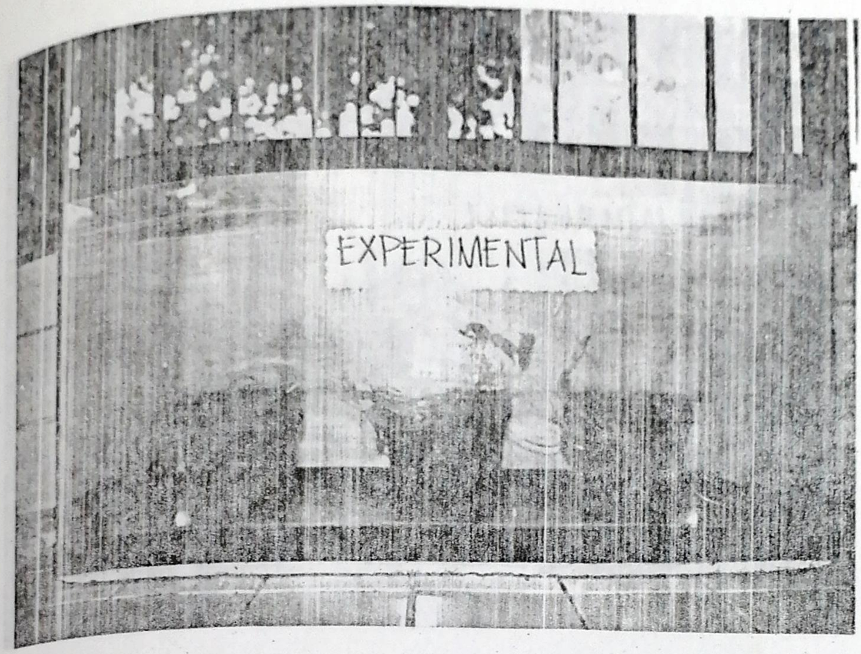

Plate 3. The experimental set-up.

Plate 4. The controlled set-up

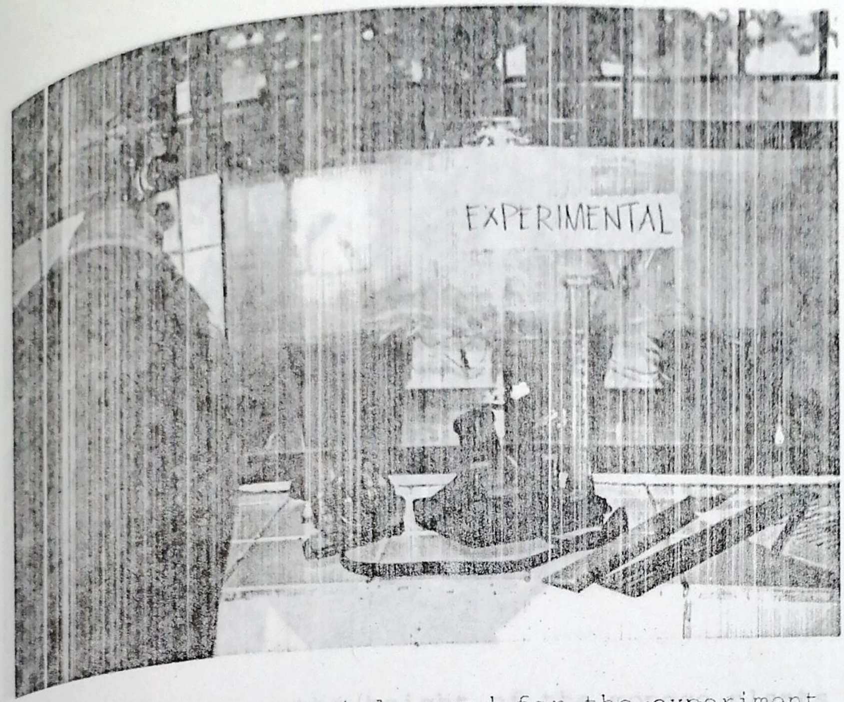

Plate 5. The materials used for the experiment

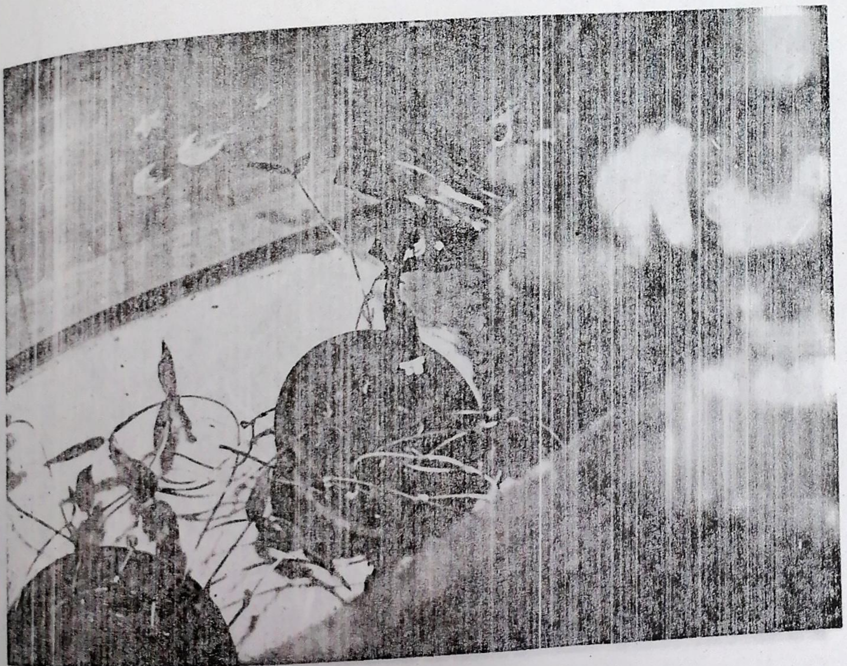

Plate 6. Subjecting the experimental set-up to simulated lightning

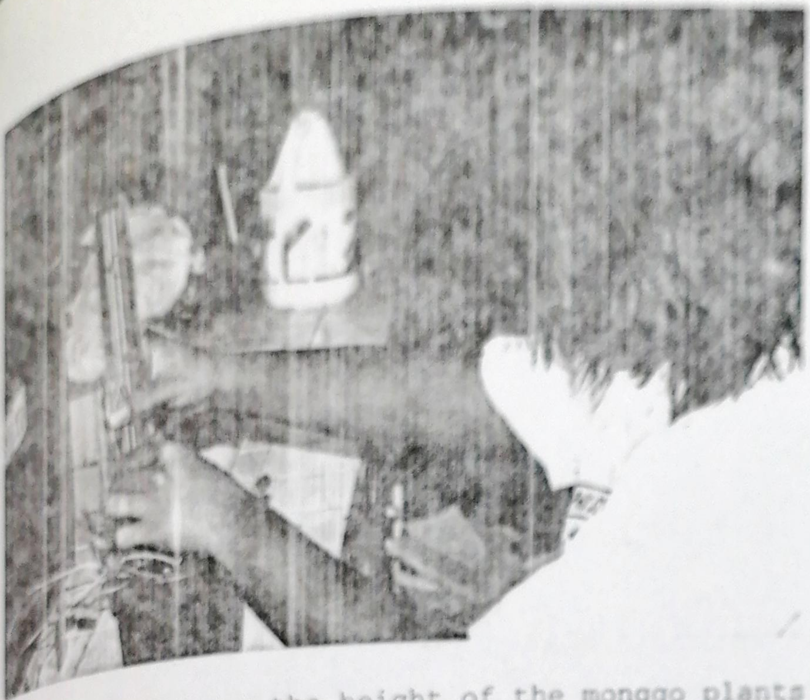

Plate 7. Measuring the height of the monggo plants

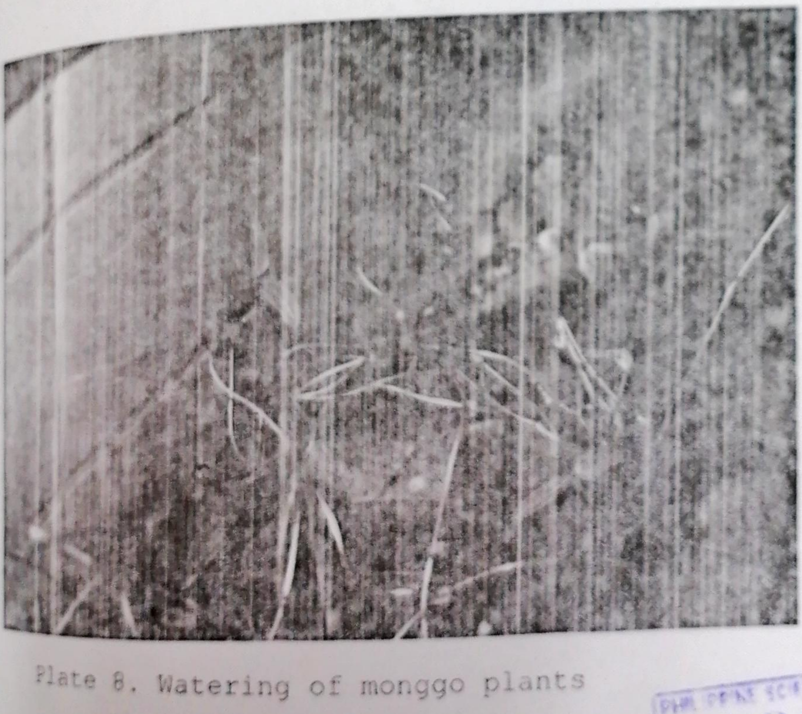

Plate 8. Watering of monggo plants