

PREPARATION OF LOW DENSITY LIQUID FERTILIZER FOR USE IN AGRICULTURAL DRONES

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Technology degree in Chemical Engineering

by

ANJALI PRASAD (37190010)

DEVAPRIYA M (37190019)



**DEPARTMENT OF CHEMICAL ENGINEERING
SCHOOL OF BIO & CHEMICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

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Accredited with "A" grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai-600019



www.sathyabama.ac.in

DEPARTMENT OF CHEMICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ANJALI PRASAD (37190010)**, **DEVAPRIYA M (37190019)**, who carried out the project entitled **"PREPARATION OF LOW DENSITY LIQUID FERTILIZER FOR USE IN AN AGRICULTURAL DRONES"** under our supervision from September 2020 to March 2021.

Internal Guide

Dr. A. ANNAM RENITA, Ph.D.

Head of the Department

Dr. S. SATHISH, M.E., Ph.D

Submitted for Viva voice Examination held on _____

Internal Examiner

External Examiner

DECLARATION

I **DEVAPRIYA M (37190019)** hereby declare that the Project Report entitled **“PREPARATION OF LOW DENSITY LIQUID FERTILIZER FOR USE IN AGRICULTURAL DRONES”** done by me under the guidance of **Dr. A. ANNAM RENITA, Ph.D.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Chemical Engineering.

DATE: 17 March, 2021

PLACE: CHENNAI



SIGNATURE OF CANDIDATE

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ABSTRACT

In the past Unmanned Aerial Vehicles (UAV) were used for carrying out military operations. The advancement of technology has now opened the gates for implementing the remarkable features of these miniature flying robots in agricultural purposes. Lack of skilled labors and improper application of fertilizer significantly decreases the crop yield. Hence, there is a need for an automated intelligent tool to carry out these tasks efficiently. Multipurpose agri-drones in addition to scanning and detecting the soil conditions can also be useful for spraying fertilizer and pesticides uniformly over wide ranges. Liquid fertilizer is not only suitable for the purpose of spraying but also possesses certain benefits over solid fertilizers as it is faster in action and promotes faster absorption. In this project we prepare different formulations of varying ratios of liquid fertilizer with majority of the constituents readily available in nature such as farm waste, agricultural residues and vegetable market wastes. Our ultimate aim is to find the optimum formulation capable of delivering maximum yield and also possessing a low density which is well within the payload capacity of the Agri-drone. With the motto of reducing organic wastes, we experimented with 3 different formulas : Formula 1 comprising of cow dung, vegetable waste and epsom salt; Formula 2 comprising of *Calotropis gigantea*, *Tephrosia purpurea* and Cow Urine and Formula 3 comprising of Algae, Sugarcane bagasse, Banana stem, banana flower and cow urine. The ingredients were allowed to decompose for a month and the compost leachate or liquid extract formed was taken and applied on plants weakly. The physicochemical and biological characterization studies of the liquid extract revealed that the best performance was shown by the ratios having more quantities of Cow dung, *Tephrosia purpurea* and Banana stem in Formula 1, 2 and 3 respectively. The maximum fruit yield was obtained for the F2T1 batch having the maximum content of *Tephrosia purpurea*.

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CHAPTER 1

INTRODUCTION

One of the major problems often ignored in metropolitan cities is the accumulation of wastes - wastes that have the potential to be turned into something useful! In Mumbai around 72.60 % of the total garbage accounts for food waste. Over the years, the practise of turning kitchen waste into black gold has seen various transformations, with compost finding a place in the markets as a commercial organic fertilizer. In villages people usually tend to decrease the organic wastes in their households by turning it into some form of manure for their garden or fields. However, in places like Mumbai, where people are confined to living in flats, they are very likely to dump their wastes into the garbage which ultimately finds its way into the landfills, left out in the open leading to air, water and soil pollution and also being serving as breeding grounds for mosquitoes and flies.

During this research, we found that out on a daily basis around 2 plastic crates of vegetable wastes were generated from just one vegetable vendor in Lokhandwala, Kandivali (E), Mumbai. Their peak sale time starts from evening. In the night they are left with the rotten vegetables, vegetable peels and scraps. In Mumbai, vegetable markets comprise of numerous such vendors who sell different kinds of vegetables and fruits. These wastes, which could otherwise be converted into solid manure and liquid fertilizer is usually found in big heaps in landfills surrounded by flies, street animals and other kinds of waste. Negligence of such issues has led to and is still leading to serious environmental problems.

In village farms and agricultural fields, weeds, farm waste and after harvest residues deliver products that can be turned into plant food. Weeds usually have longer roots and hence absorb a good deal of nutrients from the soil. Thus it can be considered as a nutrient rich food for the plants. If one only looks at these organic wastes with the motto of deriving the best out of these wastes they could explore the potential that each material carries and extract it, rather than letting it harm the environment.

With the increase in population the demand for food, one of the most basic amenities of mankind, is constantly rising. In countries like India wherein more than half of the population relies on agriculture for meeting their food demands, there arises a need for efficient fertilizers which could supply the required nutrients to stimulate their growth and produce high yields. Plants need nutrients for proper growth and maintaining their life cycle. These nutrients fall under two categories :

1. Macronutrients - required in large quantities such as Nitrogen, Phosphorus and Potassium
2. Micronutrients - required in lesser quantities. Example : Calcium, Magnesium, Iron, Sulphur, Boron, Copper, Manganese, Zinc etc. Though they are required in lesser quantities, absence of these in soil may lead to nutrient deficiency in plants and related diseases.

Generally these essential nutrients are present in the soil. However, continuous cropping leaves the soil devoid of these nutrients and hence there is a need to replenish the soil with the lost nutrients, which is achieved by Fertilizers. Fertilizers are produced commercially in solid as well liquid form. Majority of the fertilizers applied to plants are in solid granular or powdered form. However solid fertilizers may not be absorbed properly by plants and may also be leached during surface run-off. Liquid fertilizers on the other hand are not only easy to use, but also offers two pathways for absorption, one through the soil and the other through the stomata present in the leaves, which means they can be applied onto the soil or used as a foliar spray promoting faster and immediate absorption of the served nutrients into their food factories, that is, leaves.

Fertilizer application demands certain extent of precision. Too little of it would leave the soil deficient of the essential nutrients and too much of it would result in toxicity. In both cases the plant health is at stake. Unskilled labors or non availability of labors significantly affects the crop yield. Hence there arises a need to transform the labor intensive task of fertilizing plants to be automatically handled by Agricultural drones. The multipurpose agricultural drones that we intend to use for spraying

fertilizers and pesticides comes with a list of features which are listed in Table 1.1. Applying a liquid fertilizer via drones onto fields ensures uniform application, better yield and also brings down the cost of labors and errors caused by them. This is extremely useful in modern times where there is a non-availability of skilled labors available for such tasks.

Table 4.1 Technical specifications of the multipurpose drone

Flying speed	50 mph
Maximum takeoff weight	15 kg
Economy payload	12 kg
Control radius	3 km
Spraying width	3-4 m
Spraying speed range	3-8 m
Efficiency of spray	667 - 1330 sq.m/min
Spraying height	1.2 - 3 m
Average spray area per day	166750 sq.m/ day (6 hours)

Through this project we aim to prepare an efficient liquid fertilizer of low density which is well under the payload capacity of this drone and able to contribute towards the growth of agriculture industry by increasing the crop yield. To find out the optimum ratio of ingredients we have taken the raw materials in different proportions and come to a conclusion based on the trends observed and the yield obtained. The optimum formulation with the lowest density will be chosen, keeping the payload of the drone in mind.

CHAPTER 2

LITERATURE SURVEY

In the past Unmanned Aerial Vehicles (UAV) were used for carrying out military operations. The advancement of technology has yet again proved to be a blessing with the expansion in the applications of these miniature flying robots for agricultural purposes. Manual application of fertilizer is usually time consuming. Also lack of skilled labors results in non uniform application of fertilizers. These drawbacks are overcome by automatic drones which are capable of uniform and widespread distribution of fertilizers. However one of the major challenges brought by spraying a liquid fertilizer via drones is that of its density. The lower the density of the product, the lesser the resistance offered for flight. Thus the requirement is not just for a fertilizer that serves the desired nutrients to plants but also one which is of low density which can be easily carried by drones.

Increasing population results in increased demands for food and other necessities and ultimately paves ways for increased waste generation. These waste are generated in amounts that makes it difficult to be dealt with. The choice we are left with is reduce and recycle the waste. After every harvest season agricultural farms are left with agricultural residues like wheat and rice stalks, husks, banana stem and flower etc. Once the yield time is over the farmer sells only the fruits and the remaining part of banana stem and flowers are wastes commonly found in Kolathur, Salem, Tamil Nadu.

Weeds also known as “farmers enemies” are called so because of their ability to absorb most of nutrients in the soil, competing with the useful crops and decreasing their yield. Weeds have longer roots because of which they can penetrate deep into the soil and absorb nutrients. This makes them rich in nutrient content. Hence converting it into manure would turn it into a tasty meal the plants will definitely love! As they grow rapidly, it will not be difficult to acquire this readily available material. In Kolathur, Salem, Tamil Nadu, the *Calotropis gigantea* (commonly known as giant milkweed) and *Tephrosia purpurea* (commonly known as Kolinji) are weeds which

grow in wild land which are sources of a variety of plant nutrients. *Calotropis gigantea* has medicinal properties because of which it can be used during fever, cough, cold, diarrhea etc. However, the leaves and stems contain toxic substances and are thus left unutilized. Due to harmful substances present in the leaves and stem, the creatures do not feed on it.

Cow dung and cow urine are major waste produce of a typical dairy farm. These have been well in use from the age old times owing to their remarkable properties. Cow dung brings back life into the soil by improvising the aeration and replenishing it with organic matter. Cow urine, a drain out waste material from farmer household, is a good source of nitrogen, potassium, phosphate, magnesium, calcium, sulphate and chlorite. It contains 95% water, 2.5% urea, 2.5% others (mineral salts, hormones and enzymes).

Composting is the art of converting organic wet and dry waste into black gold. However, a major problem associated with composting is the production of leachate. During composting the top product is the compost and the bottom product is the compost leachate. This compost leachate is rich in plant nutrients like nitrogen, potassium, phosphorus, carbon and other trace elements. Leachate are concentrated with salts, which is why they have high Electrical conductivity values and hence they cannot be applied directly on plants. Prior to application they ought to be diluted with water.

Studies have shown that raw and digested municipal waste compost leachate have shown better performance than commercial fertilizer. The authors have thus concluded that municipal waste is an economically viable option as it not only brings down production and energy cost associated the manufacturing of commercial fertilizer but also gives better yield in comparison to the commercial one (Romero, 2013). Municipal waste is a mixture of different kinds of wastes such as wet organic waste, plastic waste, e-waste, biomedical waste etc. Improper segregation of wastes results in a leachate containing heavy metals and other toxic contaminants. This could be harmful for the plants. Hence proper arrangements need to be made to ensure the composting is done the right way. It is necessary to maintain the carbon to

nitrogen ratio in the compost bed. The physicochemical characteristics of the leachate varies depending the nature of the waste material. The nutrient content of the bio-wastes used in this project are listed in Table 2.1.

Apart from compost leachate, liquid fertilizers can also be obtained by fermenting the bio-waste in a liquid source preferably water. Water being a universal solvent is capable of dissolving the nutrients. Hence the nutrients present leach out and nutrient rich liquid extract can be filtered and diluted for plant use. Fermentation of leaves, grasses, weeds, bagasse etc. with or without carbon sources like molasses which supply nutrients to the microbes used is also being studied. Liquid fertilizers utilizing seaweeds and fish wastes have also gained popularity in the recent times. Some are even being sold in the market.

Table 5.1 Nutrient elements present in various organic waste materials.

Raw Material	Nutrient elements present
Banana flower	Magnesium, Phosphorus, Potassium, Iron, Copper, Calcium, Fiber, vitamins
Banana Stem	Protein, fat, fibers, Nitrogen
Calotropis gigantea	Protein, fats, fiber, Magnesium, Phosphorus, Zinc, Calcium, Iron
Cow dung	Nitrogen, potassium, Zinc, Copper, Cobalt, manganese, iron
Cow urine	Nitrogen, potassium, phosphate, magnesium, calcium, sulphate and chlorite
Sugarcane Bagasse	Carbohydrates, fibers, fat, enzymes
Tephrosia Purpurea	Protein, fibres, Nitrogen, Phosphorus, Potassium, Sodium, Ascorbic acid

Vegetable waste	Nitrogen, potassium, phosphorus and a variety of micronutrients
-----------------	---

CHAPTER 3

AIM AND SCOPE

AIM :

Following are the aim of this project :

1. To develop a low density liquid fertilizer for use in agricultural drones
2. To determine the optimum formulation of substrates that constitute the fertilizer
3. To reduce the organic wet waste and its harmful impacts on the environment by turning it into a fertilizer for applying on plants.

SCOPE :

1. Innovation in the agricultural field can be taken to a whole new level with implementation of fully automates drones for scanning and monitoring the field, spraying fertilizer and pesticides.
2. Improvising the agricultural practices and crop yield with a strategy to apply fertilizer uniformly to plants automatically via drones.
3. Proper utilization of organic wet wastes such as vegetable waste, farm waste and agricultural residues, thereby reducing air, water and soil pollution.

CHAPTER 4

MATERIALS AND METHOD

This research aims to find an optimum fertilizer formulation that not only has adequate nutrients which promote plant growth and high yield, but also one which is of low density so that it can be easily carried in Unmanned Aerial Vehicles or drones and sprayed on agricultural fields. In order to achieve that, we studied the performance of different formulations in different proportions. The materials common among different setups are Plastic containers, Plastic tap and a mesh or net. The requirements specific to the Formulas are :

Formula 1 :

The raw materials required are Cow Dung, Vegetable waste and Epsom salt.

Formula 2 :

The raw materials required are Calotropis gigantea, Tephrosia pururea and Cow Urine.

Formula 3 :

The raw materials required are Algae, Sugarcane bagasse, Banana stem, banana flower and cow urine.

4.1 EXPERIMENTAL SETUP

The decomposition process is carried out Aerobically in Formula 1 and Anaerobically in Formula 2 and 3.

4.1.1 Setup for Aerobic decomposition (Formula 1)

1. This setup requires plastic containers with lids. Inside each container, a net is spread out which acts as a filter and prevents the solids from escaping into leachate.
2. The containers are also provided with sufficient holes around the upper side wall which functions as an inlet for oxygen required for the decomposers.
3. At about 1 inch from the bottom of each container a tap is fitted for collecting the liquid fertilizer.

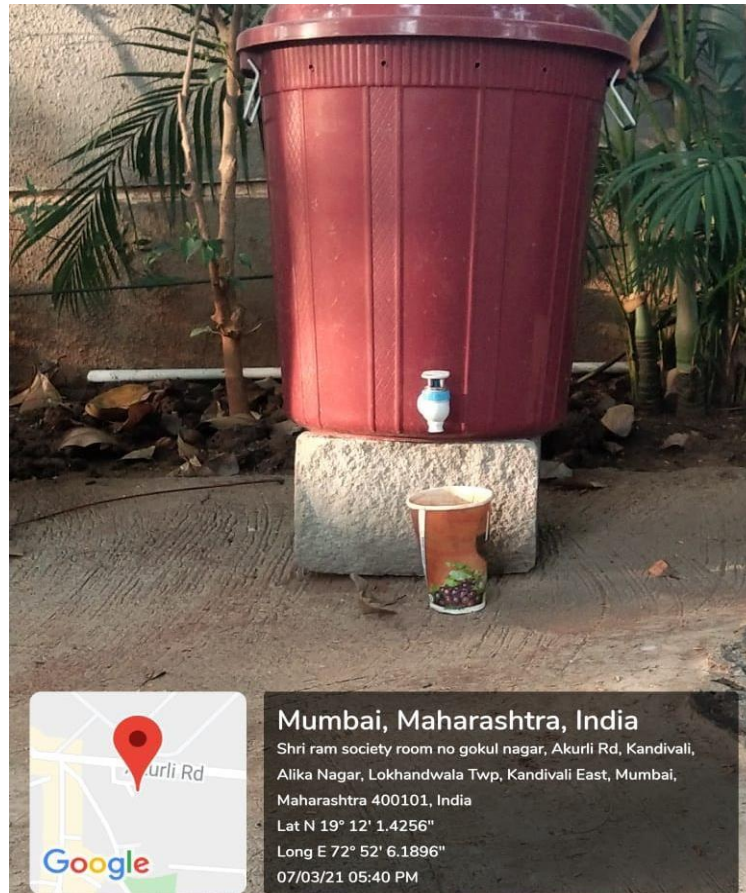


Fig 4.1.1 : A typical arrangement to collect the liquid extract from the container.



Fig 4.1.2: Inside view of a container. Air holes facilitate aerobic respiration (formula 1)

4.1.2 Setup for Anaerobic Decomposition (Formula 2 and 3)

1. The setup requires plastic containers with lids.
2. At about 1 inch from the bottom of each container a tap is fitted for collecting the liquid fertilizer.

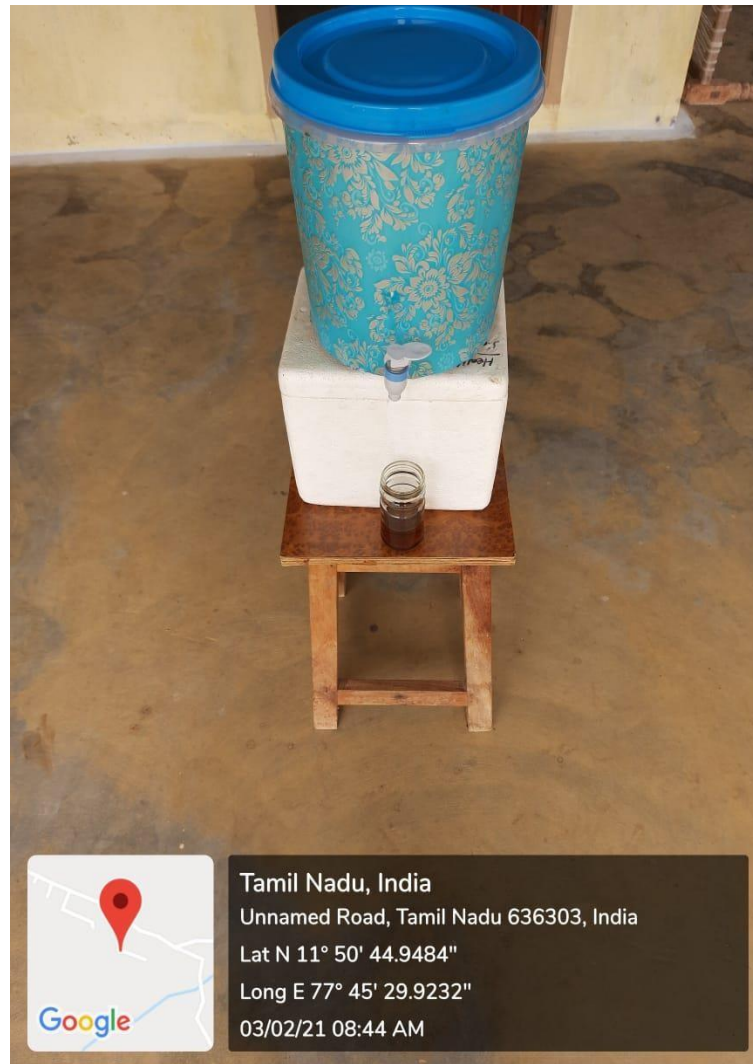


Figure 4.1.3 : A typical arrangement for collecting the liquid extract from containers designed for Anaerobic decomposition

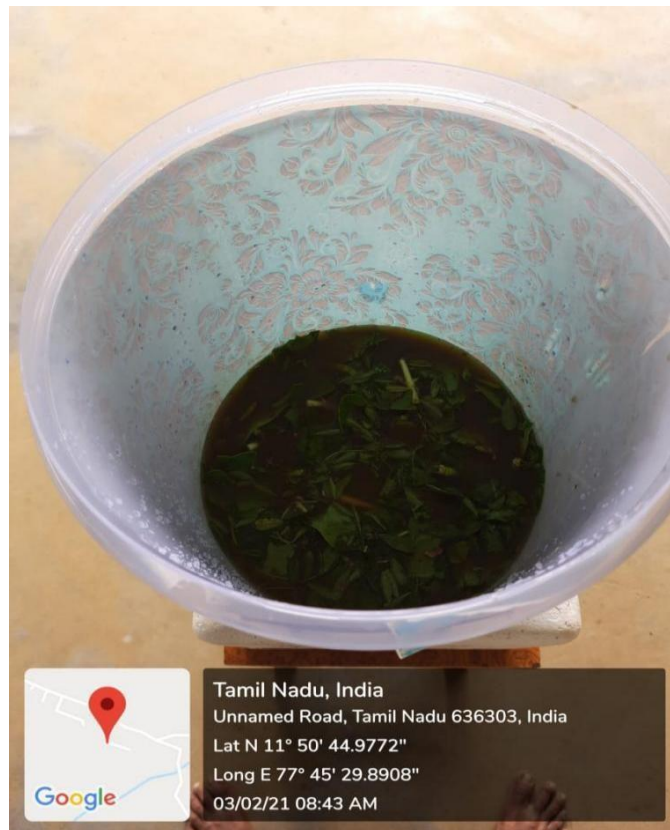


Fig 4.1.4 : Inside view of the container designed for Anaerobic decomposition

4.2 METHODOLOGY

1. Formula 1 : Cow Dung + Vegetable waste + Epsom salt

The raw materials required are Cow Dung, Vegetable waste and Epsom salt.

Cow Dung was obtained from a dairy farm in Kandivali (E). Vegetable waste was obtained from vegetable sellers in the market (Lokhandwala, Kandivali (E)). About 2 cartons of vegetable wastes can be obtained from each vegetable vendor per day. The vegetable waste obtained was sorted to remove plastics and other unwanted waste and then shredded.

The raw materials were weighed as per the proportions mentioned in Table 4.1. The experimental setup for Formula 1 is shown in Fig. 4.2.1. The compost bed was arranged inside the plastic containers in alternate layers of cow dung and vegetable

waste with simultaneous sprinkling of epsom salt. Once the bed was ready, the containers were closed with lids and left for decomposition. The compost pile was turned over twice in a week. After 21 days, the leachate was collected and its physicochemical properties were studied.

Table 4.6 : Amount of various raw materials taken in Formula 1.

Test Batch No	Vegetable waste (in kg)	Cow dung (in kg)	Epsom salt (in g)
F1T1	1	3	20
F1T2	1	3	40
F1T3	1	1	20
F1T4	1	1	40
F1T5	3	1	20
F1T6	3	1	40



Figure 4.2.1 : Experimental Setup for Formula 1 containing 6 Test Batches

2. Formula 2 : Calotropis gigantean (milkweed) + Tephrosia purpurea (kolinji) + cow urine

The raw materials required are Calotropis gigantean (milkweed), Tephrosia purpurea (kolinji) and cow urine. Calotropis gigantean and Tephrosia purpurea leaves were collected from home grown plants in Kolathur (Mettur-Salem, Tamil Nadu). The leaves collected were then washed and cut into small pieces. Cow urine was procured from the dairy farm maintained at home (Kolathur, Tamil Nadu). The raw materials were weighed as per the ratios mentioned in Table 4.2.2. The experimental setup for Formula 2 is shown in Fig 4.2.2. The leaves were put inside the containers onto which cow urine was added. The containers were then closed with lids and left for decomposition. After 21 days, the leachate was collected and the physicochemical properties were studied.

Table 4.2.2 : Amount of various raw materials taken in formula 2.

Test Batch No	Calotropis gigantean (in g)	Tephrosia purpurea (in g)	Cow urine (in L)
F2T1	1	2	0.5
F2T2	1	2	1
F2T3	2	1	0.5
F2T4	2	1	1
F2T5	1	1	0.5
F2T6	1	1	1

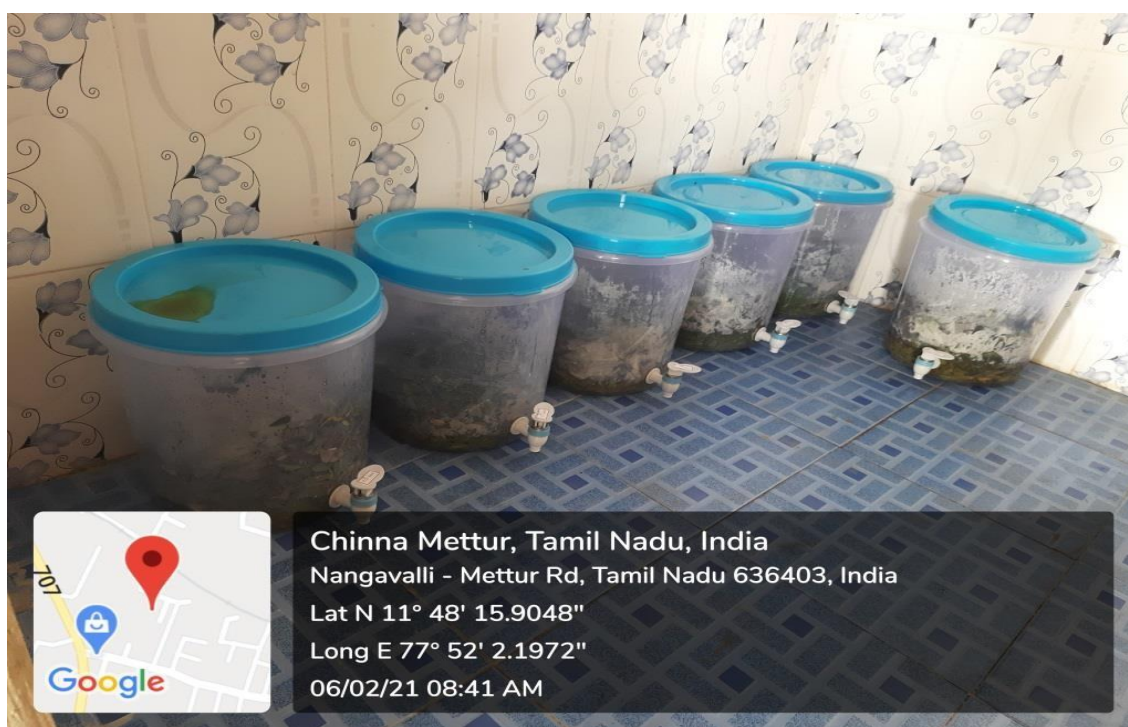


Fig 4.2.2: Experimental Setup for Formula 2 containing 6 Test Batches

3. Formula 3 : Algae + Banana stem + Banana flower + Sugarcane bagasse + cow urine

The raw materials used for Formula 3 were Algae, Banana stem, Banana flower, Sugarcane bagasse and cow urine. Algae was obtained from the wells (Kolathur, Tamil Nadu). Banana stem, Banana flower and cow urine were collected from the fields in home (Kolathur, Tamil Nadu). The raw materials were weighed as per the given ratio was mentioned in Table 4.2.3.

The experimental setup for Formula 3 is shown in Fig 4.2.3 . The raw materials was shredded into small pieces and then put inside the plastic containers. Cow urine was poured into the container until three- fourth of the container was full. The raw materials were suspended in cow urine. The containers were closed with the lids tightly and set aside for decomposition. After 21 days, the liquid from each plastic container were collected to study its physiochemical properties.

Table 4.2.3 : Amount of various raw materials taken in formula 3.

Test Batch No	Algae (in g)	Banana stem (in g)	Banana flower (in g)	Sugarcane baggase (in g)	Cow urine (in L)
F3T1	1	2	1	1	0.5
F3T2	1	2	1	1	1
F3T3	2	1	1	1	0.5
F3T4	2	1	1	1	1

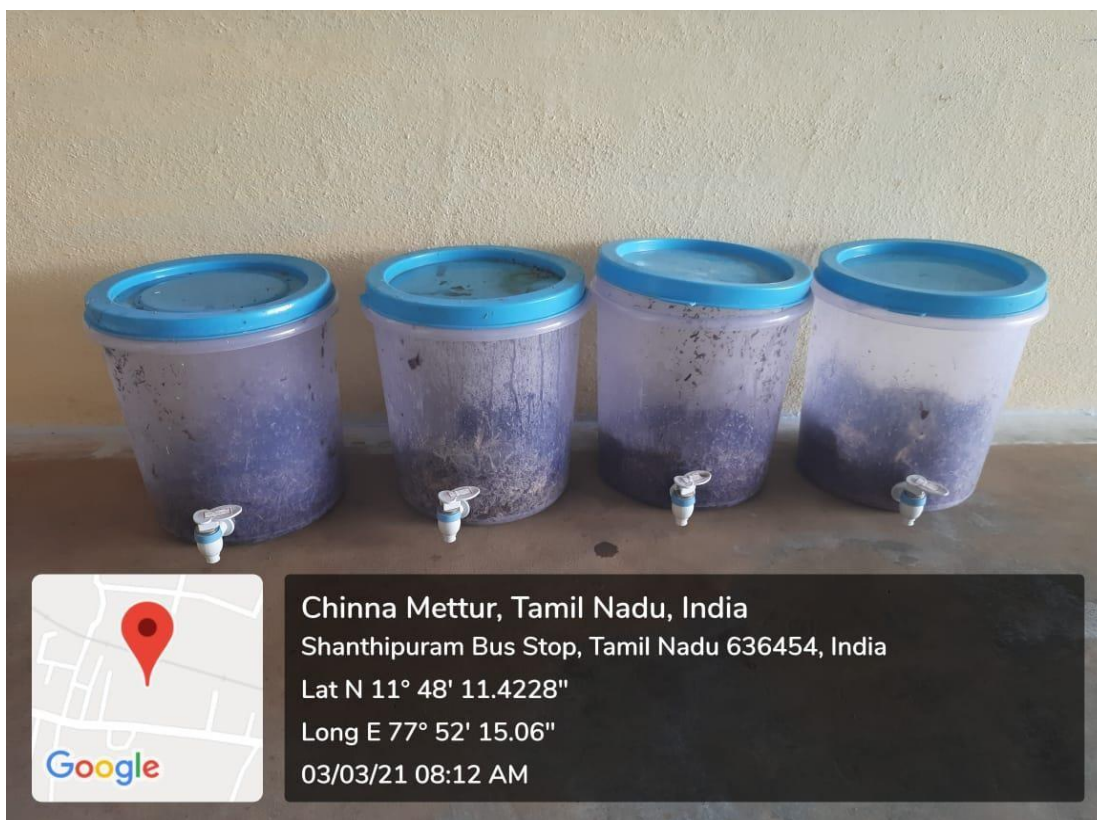


Fig 4.2.3 : Experimental Setup for Formula 3 containing 4 Test Batches

4.3 PHYSICOCHEMICAL CHARACTERIZATION OF THE LIQUID EXTRACT

4.3.1. Color :

Fig 4.3.1 shows the liquid extract belonging to Test Batches 1 to 6 of Formula 1. The Test batches exhibited different shades of brown, with the color intensifying to a richer darker shade as the content of vegetable waste increases.

Fig 4.3.2 shows the liquid collected from Test Batches 1 to 6 of Formula 2. It shows different shades of brown, starting from lighter pale brown to greenish dark brown. This change in color could be due to the increase in the content of the *Tephrosia purpurea* (kolinji) leaves waste increases.

Fig 4.3.3 shows the liquid extract collected from Test Batches 1 to 4 of Formula 3. The liquid showed different shades of brown color. The color intensifying to a richer darker brown shade as a amount of the banana stem waste increases.



Fig 4.3.2 : Liquid Extract (labeled 1 to 6) corresponding to test batches 1 to 6 of Formula 1.



Fig: 4.3.2 : Liquid Extract (labeled 1 to 6) corresponding to test batches 1 to 6 of Formula 2.



Fig: 4.3.3 : Liquid Extract (labeled 1 to 4) corresponding to test batches 1 to 4 of Formula 3.

4.3.2 pH and Electrical Conductivity :

The leachate or the Liquid Fertilizer collected from each of the plastic containers belonging to different formulas were analyzed for pH and Electrical conductivity. A pH meter and EC meter (Conductivity - Range = 200 mS, Temperature = 35°C, Cell constant = 1) was used to determine the pH and EC values of Batches 1 to 6.

4.3.3 Nutrient Content Analysis and Specific Gravity :

For further characterization, 100ml of sample from each test batch belonging to Formula 1,2 and 3 were taken and sent to NutriScience Research Laboratory Pvt. Ltd, Analytical & Quality Testing Services, Salem, Tamil Nadu for the determination of the following parameters :

- Total Nitrogen content
- Available Nitrogen content
- Total Phosphorus content

- Available Phosphorus content
- Total Potassium content
- Available Potassium content.
- Specific gravity



Fig 4.3.4 : Kjeldhal Distillation Unit used for Nitrogen content analysis

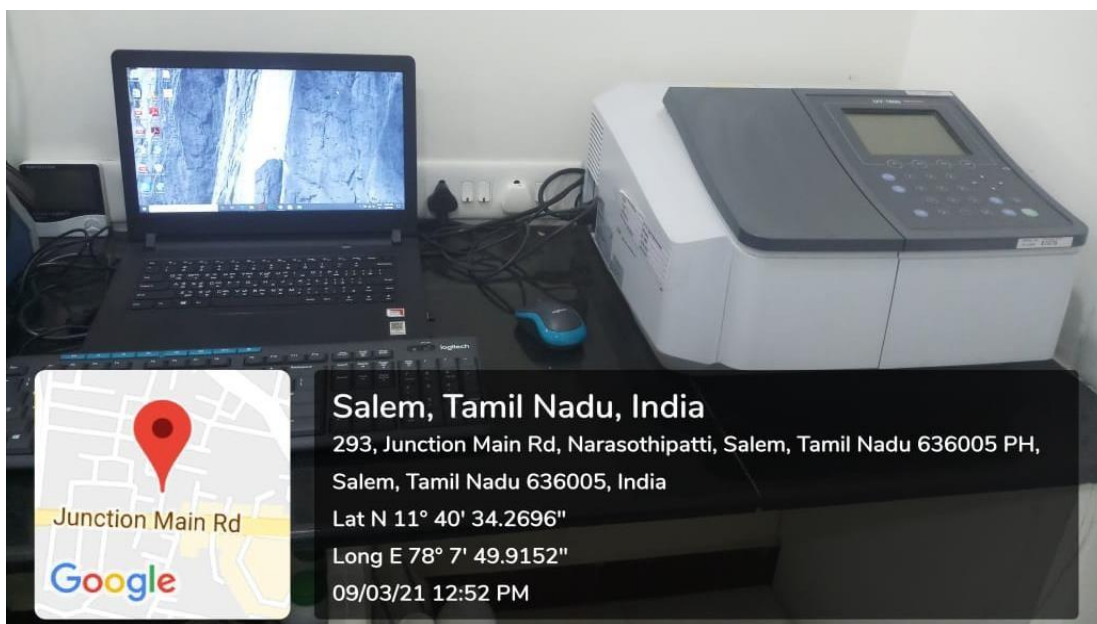


Fig 4.3.5 : UV Spectrophotometer for Phosphorus analysis

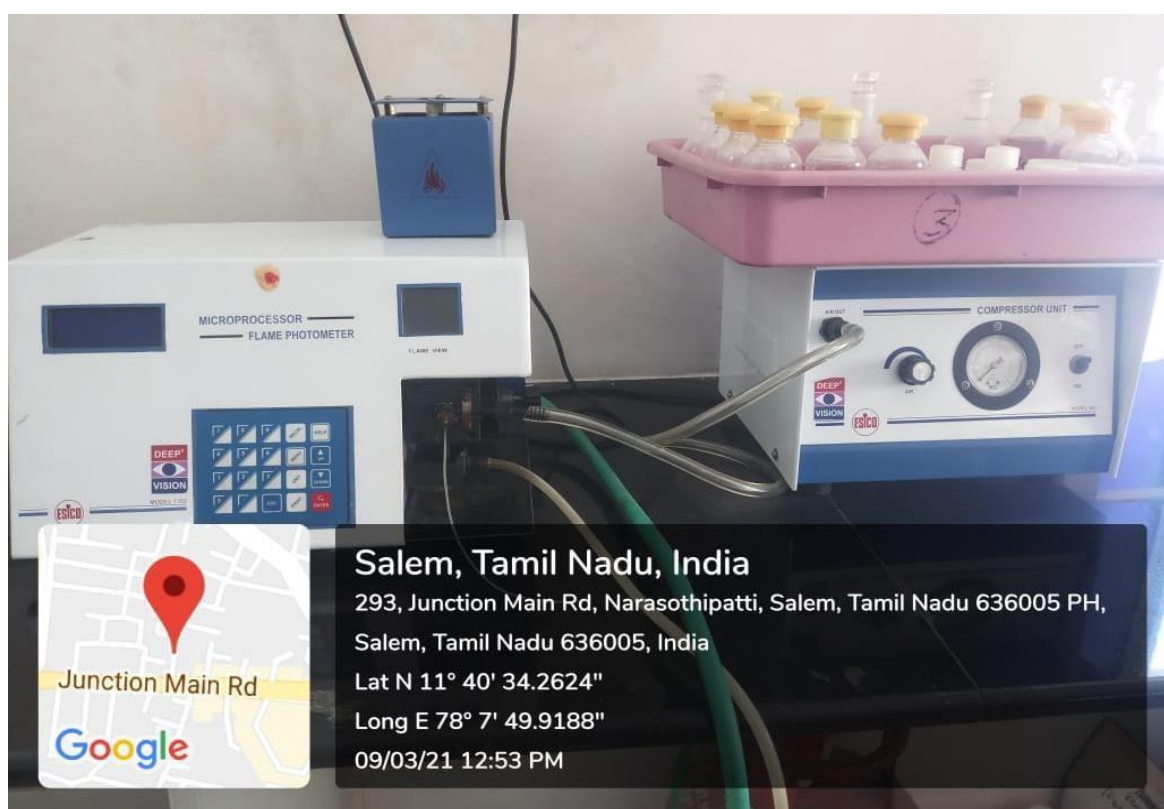


Fig 4.3.6 : Flame Photometer for Potassium content analysis

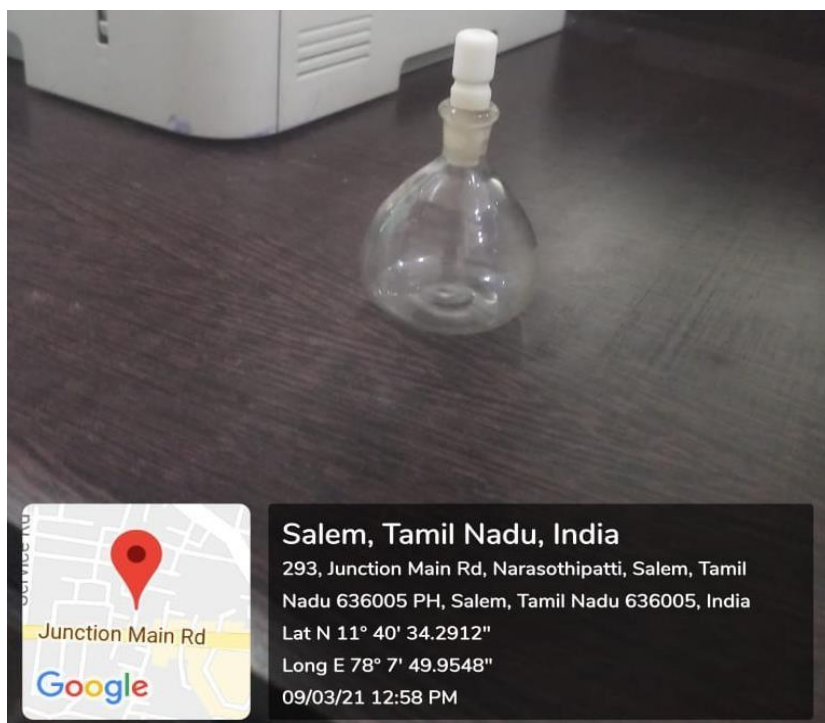


Figure 4.3.7 : Pycnometer - Apparatus used for determination of specific gravity

4.4 Seed Germination Studies

The seed germination studies were conducted using the paper towel-baggy method. A paper towel (20 x 20 cm) was folded twice (10 x 10 cm) and one half was dampened using the Liquid fertilizer extract of different batches diluted to 1:10 ratio (i.e. 10ml liquid fertilizer with 100ml water). A total of 15 Tomato seeds were spread onto it. It was then covered with the other half and put into a ziplock cover and labeled as per their test batch numbers. An additional test batch 7 was added in which the paper towel was dampened with only water. This was taken as the Control (only water) for this experiment. The seeds were left to germinate in this arrangement in a shady place at room temperature. The number of seeds germinated from Day 1 to Day 6 was studied. The germination percentage was calculated to analyze the performance of the fertilizer prepared



Fig 4.4.1 : Seed Germination Studies

4.5 Plant Growth Studies

1. Plant Growth studies for Formula 1 using Tomato plants

The plant growth studies of formula 1 was carried out in Kandivali (E), Mumbai, Maharashtra during the month of February to March. For Formula 1, tomato seeds were used to test the efficiency of the fertilizer. The plants were grown in pots of diameter 8 cm and height 11.5 cm. Tomato seeds were planted 3.5 cm deep into the soil. The seeds that germinated were narrowed to one healthy plant. Three such plants were studied per test batch. For each test batch the average results of the set of 3 plants were analyzed. An additional set of 3 plants were also studied without any application of Liquid fertilizer formulations, also known as the Control - F1T7(i.e only water). As tomato plants require less water, the plants were watered once daily. Additionally the plants were also watered whenever the soil was found dry. Liquid fertilizer application began two week after the seeds germinated. Following that the

plants were fertilized once in a week. As liquid fertilizers should not be applied directly in the concentrated state, the Liquid extract collected from each container was diluted in 1:10 ratio (10 ml Liquid extract in 100 ml water).



Fig 4.5.1 : Diluted Liquid extract (1:10) for applying on plants [F1T1 to F1T6]



Fig 4.5.2 : Weekly application of Liquid Extract (F1T1 to F1T6 & control) onto the first replication of test plants

2. Plant Growth Studies for Formula 2 and 3

The plant growth studies of formula 2 and 3 was carried out in Kolathur, Salem, Tamil Nadu during the month of January to March 2021. Onion sprout were used to test the efficiency of the fertilizer. The land was cleaned by removing unnecessary substances or grass using cutting tools, then the land was cultivated by hoeing. After that, the land was leveled. The next stage involved making garden beds of 27x6 square feet. The distance maintained between each test batch was 2 square feet and between replications was 1 square feet. The test batches were arranged row wise. Onions seeds(sprouted) were purchased from market. These were medium sized having a shoot and root part. The root part was planted inside the soil and shoot part was on the outside of the leveled land. Later the onion plants were narrowed to one healthy plant corresponding to each test batch. For each test batch the average results of a set of 3 plants were analyzed and compared with an additional set of 3 plants grown

without any application of liquid fertilizer formulations (also known as the control – F2T7 in formula 2 and F3T5 in formula 3). The plant were watered only once daily since onion plants require less water. In addition to that whenever the soil was found dry, the plants were watered. Twice in every week the liquid fertilizer prepared was applied on the plants at a dilution ratio of 1:10 (10 ml Liquid fertilizer and 100 ml water) .

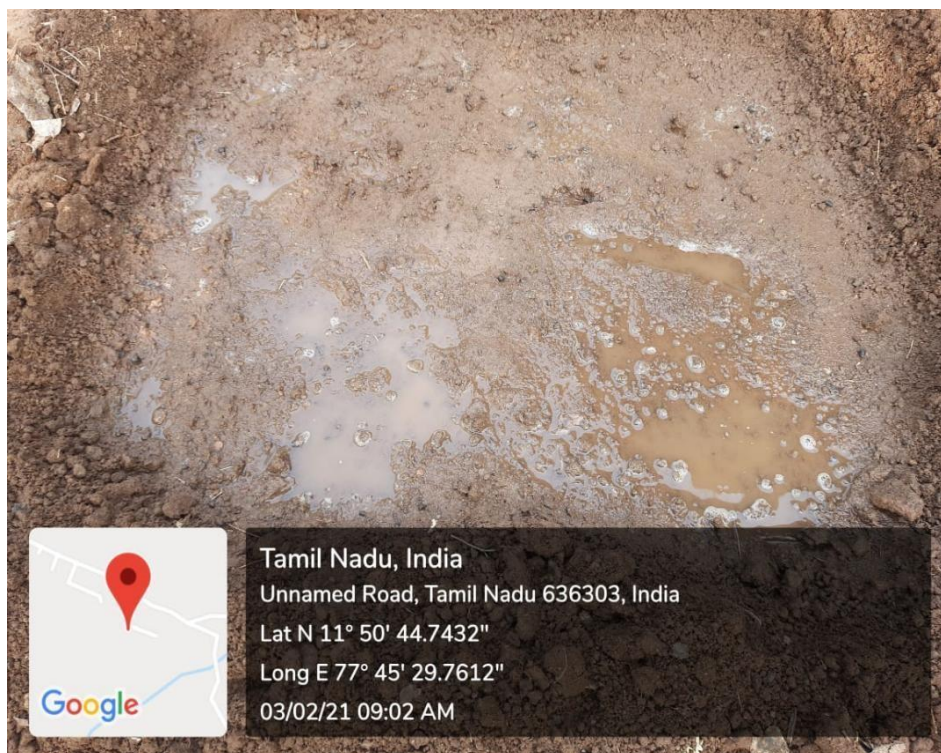


Fig 4.5.3 : Preparation and Leveling of land for plant growth studies



Figure 4.5.4 : Plant growth studies for Formula 2 and 3

Once the harvest time was over the crops were harvested. The total weight and the total number of onions obtained for each test batch replications were recorded to study and analyze the performance of each test batches. Within each test batches there were 3 replications denoted by A, B, and C respectively.



Fig 4.5.5 : Weighing of the onion yield obtained.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 PHYSICOCHEMICAL CHARACTERISTICS OF THE LIQUID EXTRACT

5.1.1 pH and Electrical Conductivity

The pH and Electrical conductivity values of the different test proportions of formula 1 are listed out in Table 5.1.1. It was observed that pH values of the various proportions ranged from 6 to 7 while the Electrical conductivity values ranged from 50 to 60 mS/cm. Test Batch F1T1 is the most acidic when compared to other five test batches. Test Batch F1T3 containing cow dung and vegetable waste in 1:1 ratio with 20 g epsom salt showed a neutral pH of 7. An increase in pH value is observed with an increase in vegetable waste content. Test batches with 40 g of Epsom salt have shown greater EC values in comparison to those with 20g of Epsom salt.

Table 5.1.1 : pH and EC values of the different test batches of Formula 1

Test Batch No.	Ph	Electrical conductivity
F1T1	6.2±0.1	50
F1T2	6.3±0.1	59.8
F1T3	7.0	50.1
F1T4	6.75±0.15	56.3
F1T5	6.6±0.1	58.4
F1T6	6.75±0.05	59.4

Table 5.1.2 shows the values of the pH and Electrical conductivity for liquid collected from the test batches belonging to Formula 2. The pH of the test batches ranged from 5.1 to 5.2. From the pH values, it can be concluded that all the formulations are acidic in nature. The test batch no F2T1 has the highest electrical conductivity (EC = 110 mS/cm). The electrical conductivity values of test batches for formula 2 ranged from 102 to 110 mS/cm.

Table 5.1.2: pH and electrical conductivity values for formula 2

Test Batch No	pH	Electrical conductivity (mS/cm)
F2T1	5.2	110
F2T2	5.2	109
F2T3	5.2	109
F2T4	5.2	107
F2T5	5.15	102
F2T6	5.15	104

Table 5.1.3 lists the values of the pH and Electrical conductivity for liquid extracted from the test batches belonging to Formula 3. EC values was ranged from 62 to 75mS/cm. Test batch no F3T4 showed the highest EC value (EC = 74.5mS/cm). All test batches of Formula 3 were acidic in nature. The pH value ranged from 5.2 to 5.65. Test batch no F3T1 has high pH values in formula 3.

Table 5.1.3: pH and electrical conductivity values for formula 3

Test Batch No	pH	Electrical conductivity (mS/cm)
F3T1	5.65	73.4
F3T2	5.45	65.5
F3T3	5.3	62.3
F3T4	5.25	74.5

5.1.2 Nutrient Content Analysis and Specific Gravity

Further characterization studies involved the determination of total Nitrogen content, available Nitrogen content, total Phosphorus content, available Phosphorus content, total Potassium content, available Potassium content and Specific gravity. The values obtained for each test batches corresponding to the different formulation have been consolidated and listed in the Table 5.1.4 for Formula 1. For Formula 2 and 3 the best performing samples as per plant growth studies data were sent for characterization . The values obtained for those test batches from Formula 2 and 3 have been furnished in Table 5.1.5

Table 5.1.4 : NPK data of the Test Batches of Formula 1

Test Batch No.	Total N content (%)	Available N content (%)	Total P content (%)	Available P content (%)	Total K content (%)	Available K content (%)	Specific gravity (g/cm ³)
1	0.08	0.05	0.08	0.05	0.08	0.06	1.0060
2	0.31	0.22	0.10	0.09	0.12	0.10	1.0124
3	0.07	0.03	0.05	0.03	0.08	0.07	1.0095
4	0.05	0.02	0.09	0.08	0.13	0.12	1.0171
5	0.07	0.05	0.07	0.07	0.14	0.12	1.0180
6	0.09	0.05	0.09	0.07	0.16	0.14	1.0185

Table 5.1.5: NPK and Specific gravity values for Test Batches of Formula 2 and Formula 3:

Test Batch No.	Total N content (%)	Available N content (%)	Total P content (%)	Available P content (%)	Total K content (%)	Available K content (%)	Specific gravity (g/cm ³)
F2T1	0.43	0.18	0.20	0.16	0.28	0.21	1.0163
F2T3	0.37	0.11	0.24	0.18	0.34	0.26	1.0170
F2T5	0.32	0.13	0.17	0.14	0.24	0.21	1.0105
F3T1	0.18	0.09	0.24	0.18	0.41	0.33	1.0102
F3T3	0.13	0.08	0.18	0.10	0.37	0.29	1.0063

5.2 SEED GERMINATION STUDIES

The seeds began germinating from Day 3 onwards. The number of seeds germinated from Day 1 to Day 6 was studied. Table 5.2.1 lists the number of seeds germinated from Day 1 onwards and the germination percentage of each test batch. The germination percentage was calculated using the formula :

$$\text{Germination \%} = (\text{Number of seeds germinated} / \text{Total number of seeds taken}) \times 100$$



Fig 5.2.1 : Seed Germination studies - Day 3 (Test Batch 4)

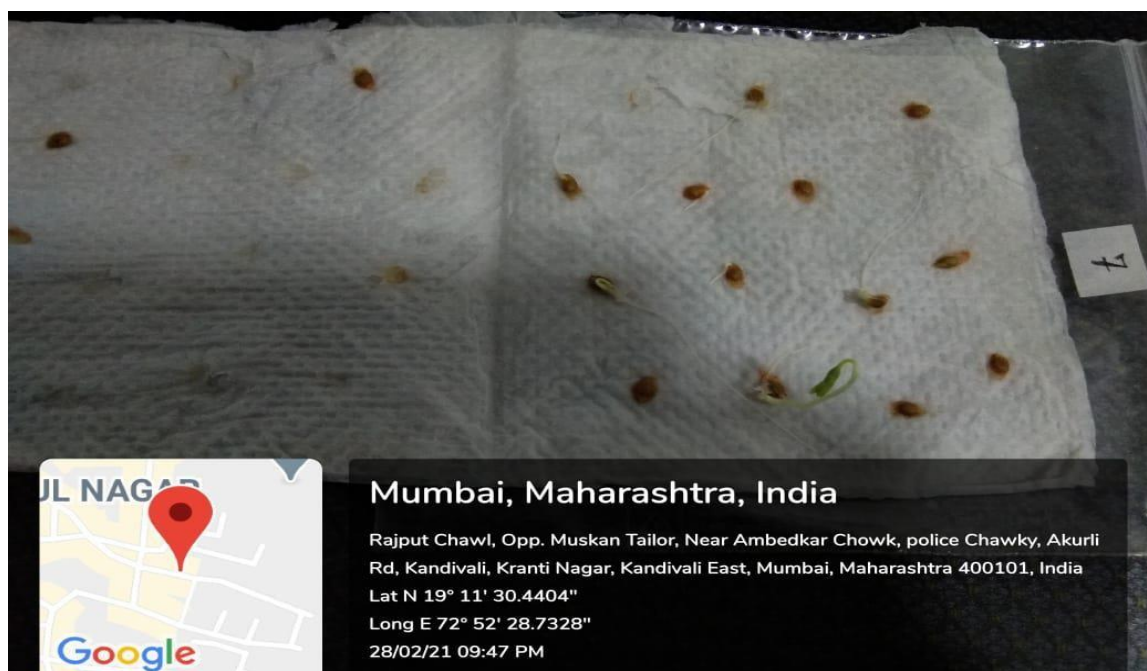


Fig 5.2.2 : Seed Germination studies - Day 3 (Test Batch 7)

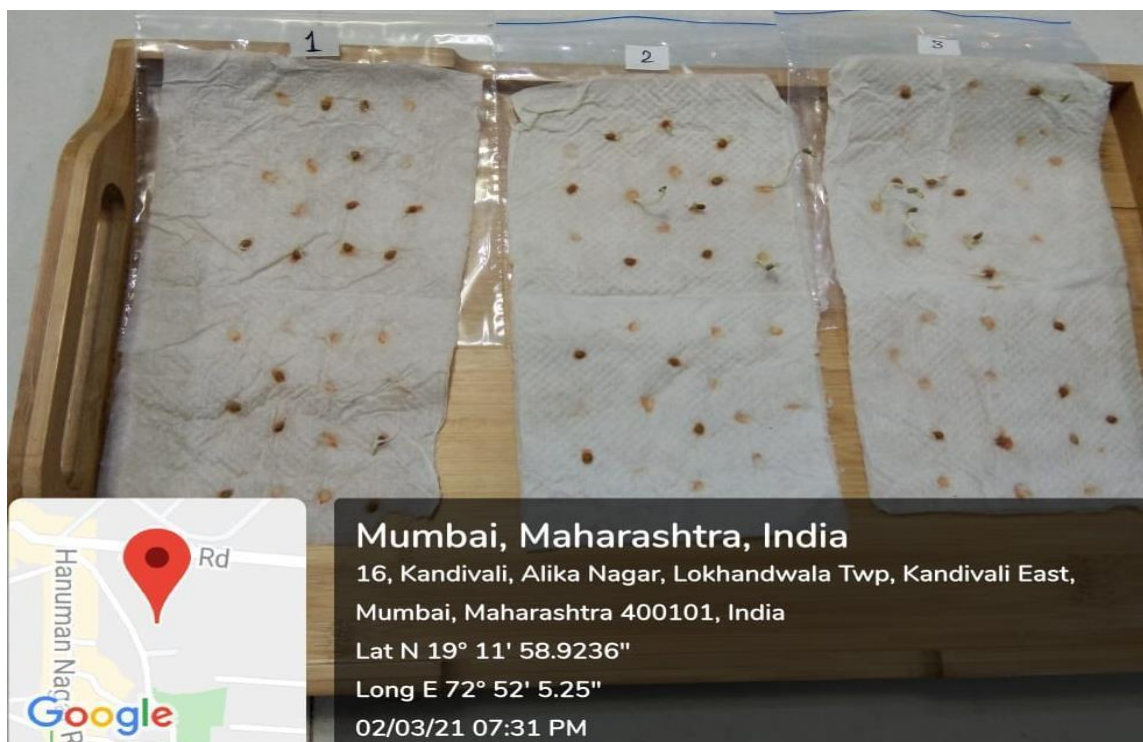


Fig 5.2.3 : Seed Germination studies - Day 6 (Test Batch 1-3)

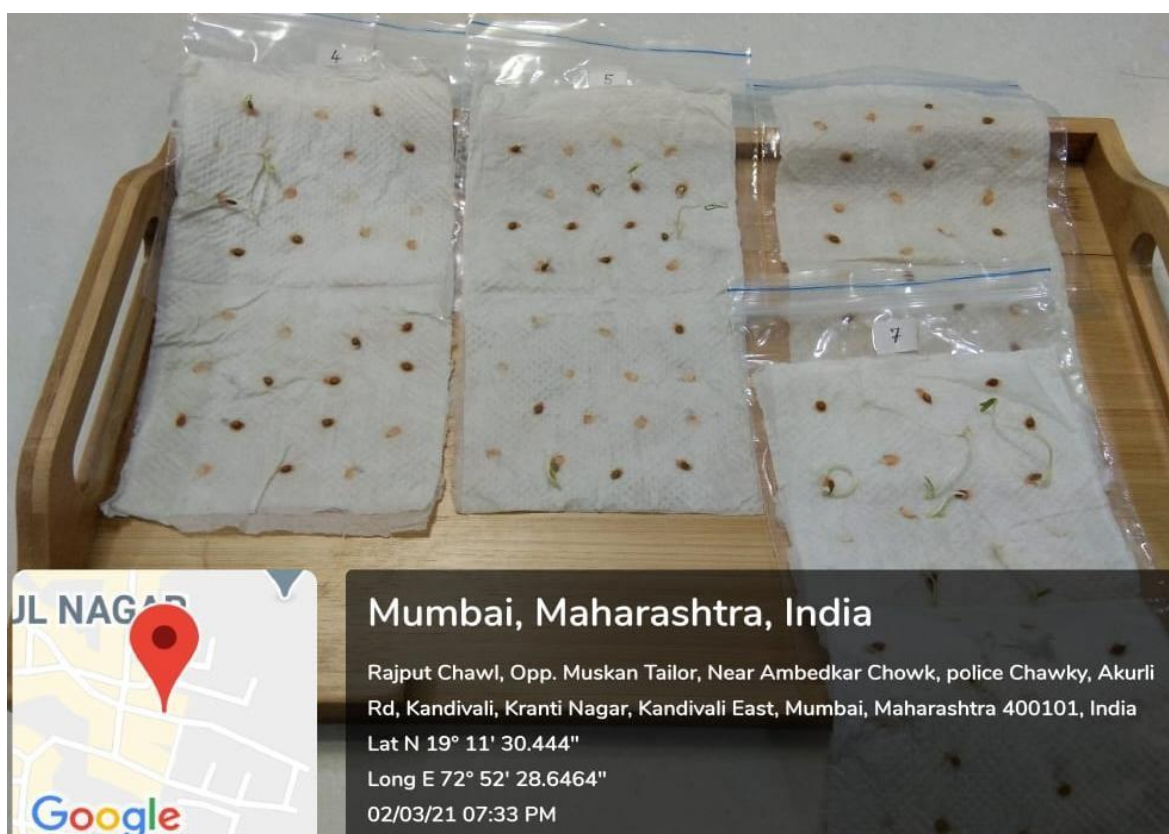


Fig 5.2.4: Seed Germination studies - Day 6 (Test Batch 4-7)

Table 5.2.1 : Seed Data for Germination studies of Tomato seeds for Formula 1

Formula 1 Test Batch No.	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Germination %
1	-	-	-	4	6	7	46.7
2	-	-	3	6	8	10	66.7
3	-	-	4	6	7	9	60
4	-	-	3	3	4	5	33.33
5	-	-	2	5	6	8	53.33
6	-	-	-	1	1	2	13.33
7	-	-	7	8	9	9	60

5.3 PLANT GROWTH STUDIES

The growth of a set of 3 plants per test batch were studied for plant height and number of leaves. An additional set of three plants were grown without the application of any fertilizer and the data was recorded with the notation F1T7, F2T7 and F3T5 (control for formula 1, formula 2 and 3 respectively). The fertilizer was applied weakly at a dilution ratio of 1:10. The average results of the three test replications are furnished in Table 5.3.1 , Table 5.3.2, Table 5.3.3 for Formula 1, Formula 2 and Formula 3 respectively

Table 5.3.1 : Average results of plant growth studies for Test Batch(F1T1 to F1T7)

Test Batch No.	Plant height (in cm)	Number of leaves
F1T1	12.7	20
F1T2	17.3	32
F1T3	15.2	26
F1T4	11.5	21
F1T5	14.7	29
F1T6	9.3	18
F1T7	15.8	28

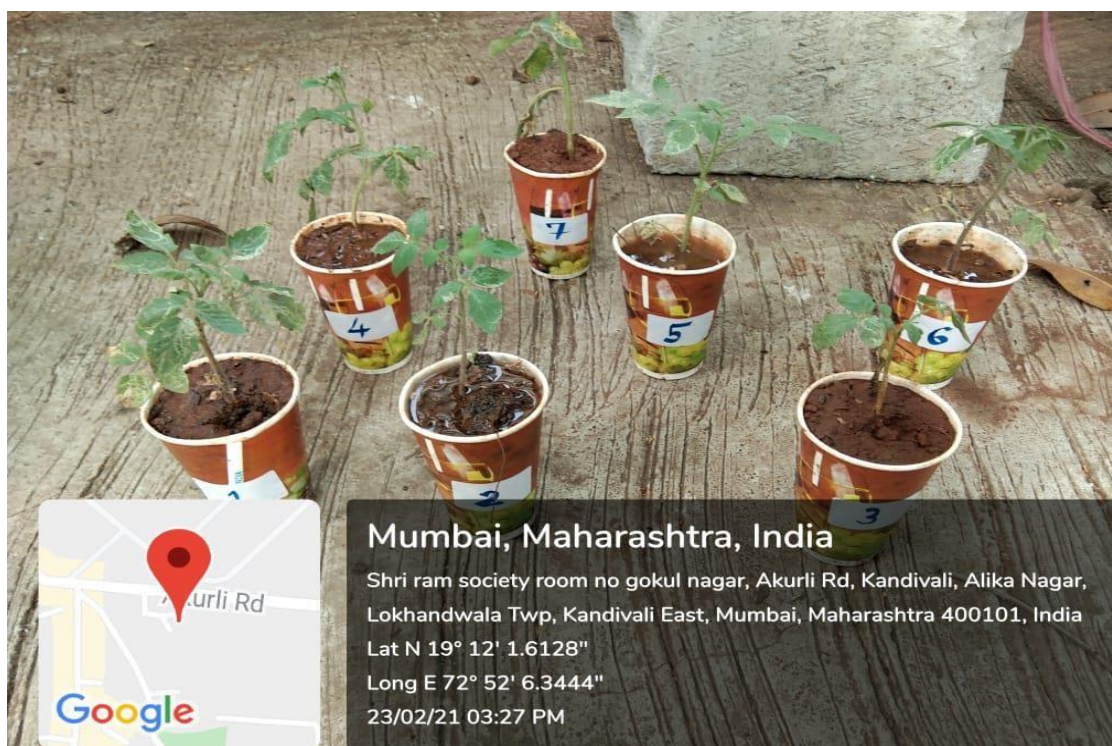


Figure 5.3.1 : Tomato plants grown to study the performance of each test batches

Table 5.3.2 : Average results of plant growth studies for Test Batch(F2T1 to F2T7)

Test Batch No	Plant height (cm)	Number of leaves
F2T1	40.4	25
F2T2	40	22
F2T3	38.5	24
F2T4	35	20
F2T5	39.2	21
F2T6	40.3	20
F2T7	32	24



Fig 5.3.2 : Plant growth studies for formula 2

Table 5.3.3 : Average results of plant growth studies for Test Batch(F3T1 to F3T5)

Test Batch No	Plant height (cm)	Number of leaves
F3T1	33	19
F3T2	34.2	16
F3T3	31	18
F3T4	34	17
F3T5	30	18

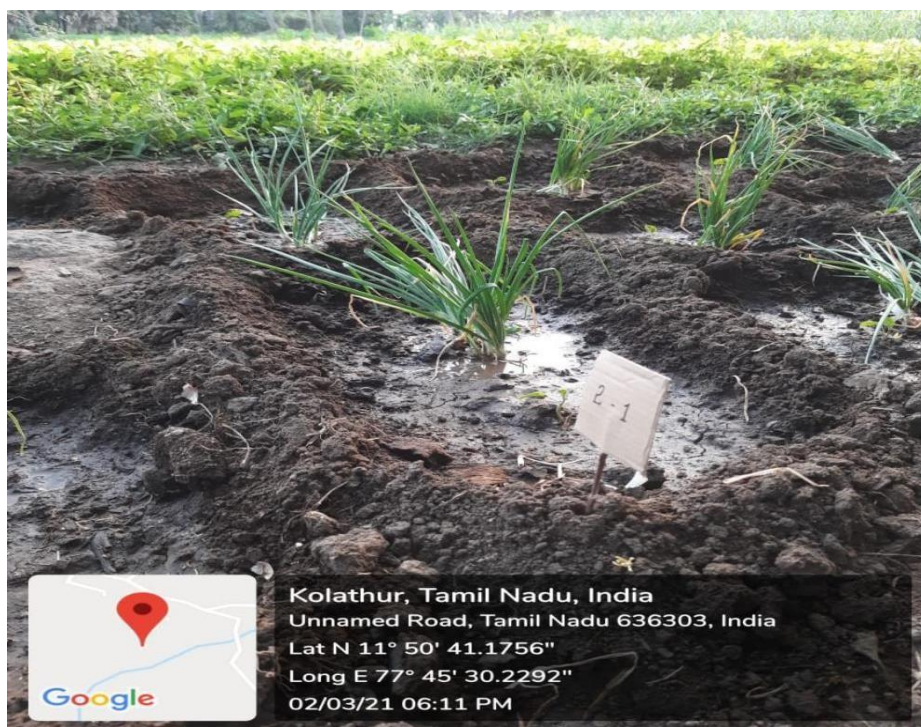


Figure 5.3.3 : Plant growth studies for formula 3



Figure 5.3.4 : Land plot arranged in blocks of 3 for studying the growth of 3 replications from each test batch.

The onion yield obtained for each test batch and their replications (denoted by A, B,C) are given in Fig. 5.3.5. These were studied to evaluate the fertilizer performance. The weight and number of onions produced per batch are furnished in the Table 5.3.4 and 5.3.5 for Formula 2 and 3 respectively. It was observed that in Formula 2 test batch no F2T1 gave the best results in terms of plant growth and fruit yield and in Formula 3 the test batch no F3T1 was gave more efficient yield. On comparing F2T1 and F3T1, F2T1 has given more yield. F2T1 formulation had greater content of *Tephrosia purpurea* than *Calotropis gigantea* (cow urine - 500ml). F3T1, had more banana stem, lesser algae content (cow urine - 500ml). Hence from the trend it was observed that the greater the *Tephrosia purpurea* content, the higher the yield. Similarly for formula 3 it was observed that the maximum yield was obtained for the test batch having greater banana stem content.



Fig 5.3.5 : Onion yield arranged in the order of the test batches



Fig 5.3.6 : Onion yield for F2T1 and its replications



Fig 5.3.7 : Onion yield for F3T1 and its replications



Fig 5.3.8: Onion yield for F2T7 (Control) and its replications



Fig5.3.9 : Onion yield for F3T5 (Control) and its replications

Table 5.3.4 : Data on the onion yield for test batches of Formula 2.

Test Batch No	Onion weight (g)			Total count of onions		
	A	B	C	A	B	C
F2T1	0.085	0.090	0.083	7	8	7
F2T2	0.065	0.075	0.055	5	6	4
F2T3	0.060	0.053	0.074	5	4	6
F2T4	0.072	0.070	0.066	6	6	5
F2T5	0.052	0.045	0.055	4	3	4
F2T6	0.072	0.075	0.054	5	6	6
F2T7	0.040	0.052	0.042	3	4	3

Table 5.3.5 : Data on the onion yield for test batches of Formula 3

Test Batch No	Onion weight (g)			Total count of onions		
	A	B	C	A	B	C
F3T1	0.089	0.074	0.082	8	6	7
F3T2	0.043	0.072	0.066	3	6	5
F3T3	0.054	0.056	0.067	4	4	5
F3T4	0.068	0.053	0.068	5	4	6

F3T5	0.030	0.049	0.039	2	4	3
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Table 5.3.6 : Comparing densities of the best performing test batches with some commercially available liquid fertilizers.

Test Batch No.	Density (g/ml)
F1T2	1.0124
F2T1	1.0163
F3T1	1.0102
Commercial Liquid fertilizers	
NUSTART Zn EDTA	1.31
Seaweed Liquid Organic Silicate fertilizer	1.1
Nutri-kelp	1.16
Humic Acid Liquid fertilizer	1.2
Headland Liquid Turf Hardener	1.45
Chitosan Liquid fertilizer	1.2
Liquid NPK fertilizer (Hibong)	1.26

5.4 CHARACTERIZATION REPORT OF DIFFERENT SAMPLES

1. Specific Gravity and Nutrient Content Report of F1T1



NutriScience Research Laboratory Private Limited

Analytical and Quality Assurance Laboratory

An ISO 9001 : 2015 Certified Company

TEST REPORT

REPORT No. NSRL/2021/3870

DATE: 05.03.2021

Issued To

: Anjali Prasad,
Sathyabama Institute of Science and
Technology

Name of the Sample

: Fertilizer

Sample Marking

: 1

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3870/2206

Sample Quantity Received

: 100ml

Date of Receipt of Sample

: 01.03.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.08	FCO- 1985
Available Nitrogen	%	0.05	FCO- 1985
Total Phosphorous	%	0.08	FCO- 1985
Available Phosphorous	%	0.05	FCO- 1985
Total Potassium	%	0.08	FCO- 1985
Available Potassium	%	0.06	FCO- 1985
Specific Gravity	g/cm ³	1.0060	FCO- 1985

End of Report

Remarks:

- The given results reflect our findings of the submitted sample only.
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- Samples will be retained for a period of one month from the date of issue of this test report until and unless definite Instructions to the contrary are received in the meantime.

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2. Specific Gravity and Nutrient Content Report of F1T2



NutriScience Research Laboratory Private Limited

Analytical and Quality Assurance Laboratory

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TEST REPORT

REPORT No. NSRL/2021/3871

DATE: 05.03.2021

Issued To

: Anjali Prasad,
Sathyabama Institute of Science and
Technology

Name of the Sample

: Fertilizer

Sample Marking

: 2

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3871/2206

Sample Quantity Received

: 100ml

Date of Receipt of Sample

: 01.03.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.31	FCO- 1985
Available Nitrogen	%	0.22	FCO- 1985
Total Phosphorous	%	0.10	FCO- 1985
Available Phosphorous	%	0.09	FCO- 1985
Total Potassium	%	0.12	FCO- 1985
Available Potassium	%	0.10	FCO- 1985
Specific Gravity	g/cm ³	1.0124	FCO- 1985

End of Report

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+91 91504 95495



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3. Specific Gravity and Nutrient Content Report of F1T3



NutriScience Research Laboratory Private Limited

Analytical and Quality Assurance Laboratory

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TEST REPORT

REPORT No. NSRL/2021/3872

DATE: 05.03.2021

Issued To

: Anjali Prasad,
Sathyabama Institute of Science and
Technology

Name of the Sample

: Fertilizer

Sample Marking

: 3

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3872/2206

Sample Quantity Received

: 100ml

Date of Receipt of Sample

: 01.03.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.07	FCO- 1985
Available Nitrogen	%	0.03	FCO- 1985
Total Phosphorous	%	0.05	FCO- 1985
Available Phosphorous	%	0.03	FCO- 1985
Total Potassium	%	0.08	FCO- 1985
Available Potassium	%	0.07	FCO- 1985
Specific Gravity	g/cm ³	1.0095	FCO- 1985

End of Report

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4. Specific Gravity and Nutrient Content Report of F1T4



NutriScience Research Laboratory Private Limited

Analytical and Quality Assurance Laboratory

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TEST REPORT

REPORT No. NSRL/2021/3873

DATE: 05.03.2021

Issued To

: Anjali Prasad,
Sathyabama Institute of Science and
Technology

Name of the Sample

: Fertilizer

Sample Marking

: 4

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3873/2206

Sample Quantity Received

: 100ml

Date of Receipt of Sample

: 01.03.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.05	FCO- 1985
Available Nitrogen	%	0.02	FCO- 1985
Total Phosphorous	%	0.09	FCO- 1985
Available Phosphorous	%	0.08	FCO- 1985
Total Potassium	%	0.13	FCO- 1985
Available Potassium	%	0.12	FCO- 1985
Specific Gravity	g/cm ³	1.0171	FCO- 1985

End of Report

Remarks:

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5. Specific Gravity and Nutrient Content Report of F1T5



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Analytical and Quality Assurance Laboratory

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TEST REPORT

REPORT No. NSRL/2021/3874

DATE: 05.03.2021

Issued To

: Anjali Prasad,
Sathyabama Institute of Science and
Technology

Name of the Sample

: Fertilizer

Sample Marking

: 5

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3874/2206

Sample Quantity Received

: 100ml

Date of Receipt of Sample

: 01.03.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.07	FCO- 1985
Available Nitrogen	%	0.05	FCO- 1985
Total Phosphorous	%	0.07	FCO- 1985
Available Phosphorous	%	0.07	FCO- 1985
Total Potassium	%	0.14	FCO- 1985
Available Potassium	%	0.12	FCO- 1985
Specific Gravity	g/cm ³	1.0180	FCO- 1985

End of Report

Remarks:

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6. Specific Gravity and Nutrient Content Report of F1T6



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TEST REPORT

REPORT No. NSRL/2021/3875

DATE: 05.03.2021

Issued To

: Anjali Prasad,
Sathyabama Institute of Science and
Technology

Name of the Sample

: Fertilizer

Sample Marking

: 6

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3875/2206

Sample Quantity Received

: 100ml

Date of Receipt of Sample

: 01.03.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.09	FCO- 1985
Available Nitrogen	%	0.05	FCO- 1985
Total Phosphorous	%	0.09	FCO- 1985
Available Phosphorous	%	0.07	FCO- 1985
Total Potassium	%	0.16	FCO- 1985
Available Potassium	%	0.14	FCO- 1985
Specific Gravity	g/cm ³	1.0185	FCO- 1985

End of Report

Remarks:

- The given results reflect our findings of the submitted sample only.
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- Samples will be retained for a period of one month from the date of issue of this test report until and unless definite Instructions to the contrary are received in the meantime.

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Checked by



M. H. H.
Authorized Signatory

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7. Specific Gravity and Nutrient Content Report of F2T1



NutriScience Research Laboratory Private Limited

Analytical and Quality Assurance Laboratory

An ISO 9001: 2015 Certified Company

TEST REPORT

REPORT No. NSRL/2021/3852

DATE: 05.03.2021

Issued To

: M. DevaPriya,
Sathyabama Institute of Science and
Technology

Name of the Sample

: Fertilizer

Sample Marking

: 1

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3852/2196

Sample Quantity Received

: 250ml

Date of Receipt of Sample

: 27.02.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.43	FCO- 1985
Available Nitrogen	%	0.18	FCO- 1985
Total Phosphorous	%	0.20	FCO- 1985
Available Phosphorous	%	0.16	FCO- 1985
Total Potassium	%	0.28	FCO- 1985
Available Potassium	%	0.21	FCO- 1985
Specific Gravity	g/cm ³	1.0163	FCO- 1985

End of Report

Remarks:

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8. Specific Gravity and Nutrient Content Report of F2T3



NutriScience Research Laboratory Private Limited

Analytical and Quality Assurance Laboratory

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TEST REPORT

REPORT No. NSRL/2021/3853

DATE: 05.03.2021

Issued To

: M. DevaPriya,
Sathyabama Institute of Science and
Technology

Name of the Sample

: Fertilizer

Sample Marking

: 2

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3853/2196

Sample Quantity Received

: 250ml

Date of Receipt of Sample

: 27.02.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.37	FCO- 1985
Available Nitrogen	%	0.11	FCO- 1985
Total Phosphorous	%	0.24	FCO- 1985
Available Phosphorous	%	0.18	FCO- 1985
Total Potassium	%	0.34	FCO- 1985
Available Potassium	%	0.26	FCO- 1985
Specific Gravity	g/cm ³	1.0170	FCO- 1985

End of Report

Remarks:

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9. Specific Gravity and Nutrient Content Report of F2T5



NutriScience Research Laboratory Private Limited

Analytical and Quality Assurance Laboratory

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TEST REPORT

REPORT No. NSRL/2021/3854

DATE: 05.03.2021

Issued To

**: M. Deva Priya,
Sathyabama Institute of Science and
Technology**

Name of the Sample

: Fertilizer

Sample Marking

: 3

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3854/2196

Sample Quantity Received

: 250ml

Date of Receipt of Sample

: 27.02.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.32	FCO- 1985
Available Nitrogen	%	0.13	FCO- 1985
Total Phosphorous	%	0.17	FCO- 1985
Available Phosphorous	%	0.14	FCO- 1985
Total Potassium	%	0.24	FCO- 1985
Available Potassium	%	0.21	FCO- 1985
Specific Gravity	g/cm ³	1.0105	FCO- 1985

End of Report

Remarks:

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10. Specific Gravity and Nutrient Content Report of F3T1



NutriScience Research Laboratory Private Limited

Analytical and Quality Assurance Laboratory

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TEST REPORT

REPORT No. NSRL/2021/3855

DATE: 05.03.2021

Issued To

: M. Deva Priya,
Sathyabama Institute of Science and
Technology

Name of the Sample

: Fertilizer

Sample Marking

: 4

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3855/2196

Sample Quantity Received

: 250ml

Date of Receipt of Sample

: 27.02.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.18	FCO- 1985
Available Nitrogen	%	0.09	FCO- 1985
Total Phosphorous	%	0.24	FCO- 1985
Available Phosphorous	%	0.18	FCO- 1985
Total Potassium	%	0.41	FCO- 1985
Available Potassium	%	0.33	FCO- 1985
Specific Gravity	g/cm ³	1.0102	FCO- 1985

End of Report

Remarks:

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11. Specific Gravity and Nutrient Content Report of F3T3



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Analytical and Quality Assurance Laboratory

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TEST REPORT

REPORT No. NSRL/2021/3856

DATE: 05.03.2021

Issued To

**: M. Deva Priya,
Sathyabama Institute of Science and
Technology**

Name of the Sample

: Fertilizer

Sample Marking

: 5

Appearance of the sample

: Brown Colour

Lab Code No / Job Code

: NSRL 3856/2196

Sample Quantity Received

: 250ml

Date of Receipt of Sample

: 27.02.2021

Date of Start of Analysis

: 01.03.2021

Date of Completion of Analysis

: 04.03.2021

Sampling Done by

: Customer

TEST RESULT

TESTING PARAMETERS	UNITS	RESULTS	TEST METHOD
Total Nitrogen	%	0.13	FCO- 1985
Available Nitrogen	%	0.08	FCO- 1985
Total Phosphorous	%	0.18	FCO- 1985
Available Phosphorous	%	0.10	FCO- 1985
Total Potassium	%	0.37	FCO- 1985
Available Potassium	%	0.29	FCO- 1985
Specific Gravity	g/cm ³	1.0063	FCO- 1985

End of Report

Remarks:

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CHAPTER 6

SUMMARY AND CONCLUSION

Innovations in agricultural practices can be taken to a new level with the implementation of drones for spraying fertilizers. This facilitates the need for a low density liquid fertilizer which can be carried by drones easily. In this project, we experimented with 3 different formulas for the preparation of a liquid fertilizer :

Formula 1 : Cow dung, vegetable waste and epsom salt.

Formula 2 : *Calotropis gigantea*, *Tephrosia pururea* and Cow Urine.

Formula 3 : Algae, Sugarcane bagasse, Banana stem, banana flower and cow urine.

The ingredients were allowed to decompose for a month in closed containers with and without air holes. The former for facilitating aerobic respiration and the later for anaerobic respiration. The compost leachate or liquid extract formed was taken from each test batch and applied on plants weakly. Each test batch had 3 replications A, B, and C. In addition to that a set of 3 replications were considered for the control (only water).The plant growth was studied. Around 100-250 ml of the liquid samples from each test batch was sent for characterization to determine the pH, electrical conductivity, specific gravity, total and available N, P, K content.

The important conclusions that can be made are :

- All the test batches had an acidic or neutral pH.
- The samples for all formulas exhibited high electrical conductivity indicating the presence of salts. Hence, the liquid fertilizer obtained should be diluted prior to application.
- The physicochemical and biological characterization studies of the liquid extract revealed that the best performance was shown by the ratios having more quantities of Cow dung, *Tephrosia pururea* and Banana stem in Formula 1, 2 and 3 respectively. That is F1T2, F2T1 and F3T1 exhibited the best performance.

- Upon comparing the 3 formulations the maximum fruit yield was observed in the F2T1 batch having the maximum content of Tephrosia pururea.
- The specific gravity of all the samples are in the range of 1.0 to 1.02. The specific gravity for the best performing test batches from each formula are in the order F2T1> F1T2> F3T1.
- On comparing the density of the best performing test batches with that of commercially available liquid fertilizer it was observed that the density of the test batches were lower than that of the commercial ones and are in the order F2T1> F1T2> F3T1.
- Out of all test batches F2T1 exhibited the best performance while F1T2 had the lowest density. Putting all these datas together it can be concluded that F2T1 and F3T1 can be considered as effective fertilizer whose density fall well within an appreciable range.

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