EFFECT OF HOMEMADE BIOCOMPOST AND BIOENZYMES FOR GROWING EXOTIC VEGETABLES

Project Thesis submitted in fulfillment of major project of

BACHELORS OF TECHNOLOGY

IN

BIOTECHNOLOGY

By

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UNDER THE SUPERVISION OF

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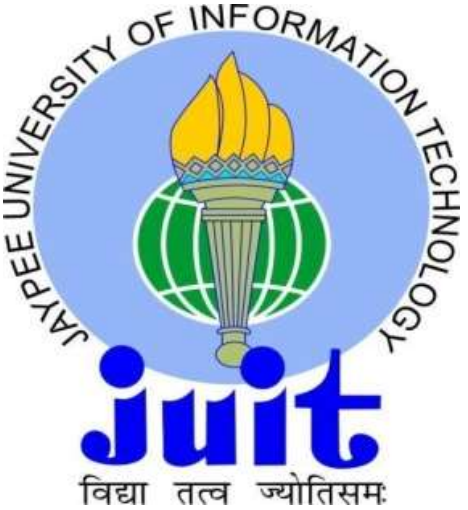


JUNE-2021

DEPARTMENT OF BIOTECHNOLOGY AND BIOINFORMATICS

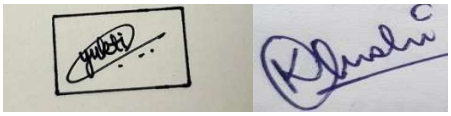
JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY WAKNAGHAT,

SOLAN

TABLE OF CONTENT

DECLARATION

We hereby declare that the major project work entitled "**Effect of Homemade Biocompost and Bioenzymes for growing exotic vegetables**" has been solely submitted to the Department of Biotechnology and Bioinformatics, Jaypee University of Information Technology, Waknaghat have carried out under guidance of our supervisor **DR. HEMANT SOOD.**



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Date: 16 JUNE 2021

SUPERVISOR'S CERTIFICATE

This is to certify that the major project work titled "**Effect of Homemade Biocompost and Bioenzymes for growing exotic vegetables**" by **Yukti and Khushi Maheshwari** during their 8th semester in June 2021 in fulfillment for the project thesis in Biotechnology of Jaypee University of Information Technology, Solan has been carried out under my supervision. This work has not been submitted partially to any other University or Institute for the award of any degree or appreciation.

Signature of Supervisor

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ACKNOWLEDGEMENT

We take this opportunity to express our first and foremost gratitude to our "DEPARTMENT OF BIOTECHNOLOGY AND BIOINFORMATICS" for showing confidence in us and entrusting our project titled "**Effect of Homemade Biocompost and Bioenzymes for Growing Exotic Vegetables**".

We feel honored in expressing our sense of gratitude and deepest appreciation to **Dr. Hemant Sood,** for believing us, providing guidance, motivation and guidance throughout the time. We thank her of being continuous source of inspiration for us and for giving insightful advices and suggestions. The help and support we got from her side helped us to successfully complete our major project on time.

Special thanks to our parents for their infinite patience and understanding and project partners for the constant support and most importantly God who in his mysterious ways always made things work out in the end for us.

In gratitude,

Yukti (171826)

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LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Biocompost and Bio-enzymes produced from household and animal waste are used to cultivate organic food at home. This has become a major area in research for building up new strategies in producing nutritious crops in very simple and sustainable manner. The study involves the process of optimizing the composition of Biocompost prepared using wet waste from kitchen, dry leaves, coconut husk powder, sour buttermilk, semi done compost and Bio enzymes prepared using lemon and orange peel, ripened banana, jaggery, sugar and tap water. The effect of different combination of Biocompost and Bioenzyme is carried out in different exotic vegetables (Broccoli, Red Ball Cabbage, Cherry Tomato, Lettuce). The Biocompost and Bioenzyme have been produced in batches. The seeds were germinated in potting mixture containing Biocompost which was supplemented with Citrus peel enzyme, Banana Enzyme, Liquid Lactic Acid Bacteria, to enhance the growth of vegetables in shortest possible time. The composition was used for better growth of plant and for enhanced fruit yield. The germination rate, plant height and fruit weight were compared with the test sample after regular interval of time. In this study we received best results in initial one month of time. The plants started giving fruits in about 2 to 2.5 months of growth and had much higher yield than the test plants which did not have compost and enzyme. The citrus peel enzyme showed the best growth pattern followed by banana enzymes and then Lactic Acid Bacteria. We have observed the best growth of lettuce (Average height=5.5±0.50 inches; average weight= 75 grams) and cherry tomato (average height=39.89±0.50 inches; average weight= 88 grams) using citrus peel enzyme while Broccoli (average height= 12.25±0.60 inches; average weight= 550grams) has given best results with Liquid LAB enzyme. Red Ball Cabbage has given the best average height of 9.84±0.40 inches with Banana enzyme while best average weight 0f 780 grams has been observed with fruit and vegetable peel enzyme. On comparison of all experimental plants to test plants, it is observed that the cherry tomato has given the best results on use of Biocompost and fruit and vegetable peel Bioenzyme of all other plants. This study provides future scopes for growing cost effective exotic vegetables in shorter duration of time with minimum and renewable resources.

Keywords: Biocompost, Bioenzyme, Exotic vegetables, Organic Farming, Renewable Resources

CHAPTER 1

INTRODUCTION

During the present time, the trend of organic farming has increased a lot. The people have found out many alternate modes of growing these crops at home or even in farms via utilizing renewable resources such as manure or Biocompost which they prepare at home in order to combat the environmental issues caused by pesticides, insecticides, etc. Somehow, this trend could be in fashion nowadays as people have started growing in their balconies, gardens and terrace. So, this study is also an attempt to carry out such kind of exploration where we have carried out Biocompost and different Bioenzymes preparation which we have utilized in observing the change in growth of these exotic plants using the prepared Biocompost and Bioenzymes.

Biocomposting is the process of breakdown of organic matter into something that plant can absorb easily. Food scraps and yard waste together make up around 28 percent of what we throw away and may be used as compost instead. Biocomposting has many benefits like enriches the soil, helping retain moisture and suppress plant diseases and pests, reduces the necessity for chemical fertilizers, encourages the assembly of beneficial bacteria and fungi that help to degrade the organic material, an upscale nutrient-filled material, and reduces methane emissions from landfills and lowers your carbon footprint.

Bio enzyme is a healthy and completely natural multipurpose cleaner produced by fermenting citrus peels with jaggery and water. It can be used to clean floors, clothes, plants and even dishes. It's a natural fertilizer for crops, promote strong healthy flowers and good quality fruiting. Apart from this, citrus enzyme can be used as floor cleaner, facial cleaner, clean greasy surface, hair conditioner, insect repellent, drain and sewage cleaner (1 Litre of Bio enzyme can clean approx. 1000 Litre of sewage water).

Bioenzyme have the power to remove unpleasant odor from air and purify it. Also eliminated odor from drainage pipes and also smell of tobacco.

[1.1] The exotic plants taken into account for our research

a) LETTUCE

It has various names such as goose vegetable, Daun Panjang, Yao mak, Ku mak, Ku mak Chi and Sawi Rana. It is a leaf vegetable but sometimes grown for its seeds and stem. It is an annual crop and requires relatively low temperature so that it does not flower quickly. It is prone to nutrient deficiencies, bacterial and viral infections as well as pests. It has enormous amount of vitamin A and vitamin K and a moderate amount of folate and iron. It takes around 7 to 10 days for lettuce to germinate. Lettuce needs the right amount of sunlight, moisture and temperature between 18° to 20° C during germination. The homegrown lettuce is shown in figure 1.

Classification of lettuce is given below:

Kingdom: Plantae

Clade: Tracheophytes

Clade: Angiosperms

Clade: Eudicots

Clade: Asterids

Order: Asterales

Family: Asteraceae

Tribe: Cichrieae

Genus: *Lactuca*

Species: *L. sativa*

Binomial name: *Lactuca sativa L.*

Figure 1: Lettuce

b) CHERRY TOMATO

It is a small round type of tomato which is an intermediate and a genetic admixture of wild-currant type and domesticated garden tomatoes. It takes around 55 to 65 days for a plant of cherry tomato to bear fruit while some are ready in less than 45 days and some can even take around 80 days for maturation. They are grown best during warm weather but can also be grown after the last frost of the area. Seeds begin to germinate within 7-14 days of being sown. The homegrown organic cherry tomato is shown in figure 2.

Classification of Cherry Tomato is given below:

Kingdom: Plantae

Clade: Angiosperms

Clade: Eudicots

Clade: Asterids

Order: Solanales

Family: Solanaceae

Genus: *Solanum*

Species: *S. lycopersicum*

Variety: cerasiforme

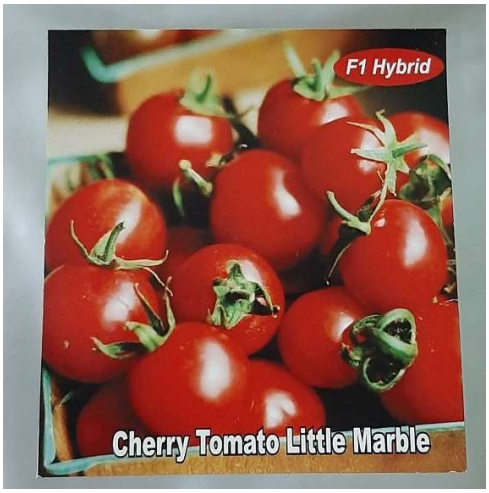


Figure 2: Cherry Tomato

c) RED BALL CABBAGE

It has dark red/purple coloured leaves. After preparation, it is also called Blaukraut. It has a pigment know as anthocyanin due to which the cabbage gets its characteristic color which also depends on pH of soil. It gives greenish-yellow color in alkaline soil, purple color in neutral soil whereas dark reddish color in acidic soil. Its juice can even be used as a pH indicator. It loses its color on cooking and turns blue, so we need to add edible acidic solution such as vinegar to retain its characteristic color. They grow well in moist and cool environment. Fertilized soil is a must as it is prone to diseases. You can see the homegrown red ball cabbage bellow in figure 3.

Classification of Red Ball Cabbage is given below:

Kingdom: Plantae

Clade: Angiosperms

Clade: Eudicots

Clade: Rosids

Order: Brassicales

Family: Brassicaceae

Genus: *Brassica*

Species: *B. oleracea*

Figure 3: Red Ball Cabbage

d) BROCCOLI

It belongs to the family of cabbage. It looks a bit like a cauliflower. It consists of enormous amount of vitamin C and vitamin K. For many of its nutrients to stay intact, it is preferred to steam, stir-fry or microwave rather than boiling. They show poor growth pattern in hot summer weather and shows its best growth between 18°-23°C. It must be harvested before the yellow flowers show up on the head of broccoli. The homegrown broccoli can be seen in figure 4 below the classification.

Classification of Broccoli is given bellow:

Kingdom: Plantae

Division: Magnoliophyte

Class: Magnoliopsida

Order: Brassicales

Family: Brassicaceae

Genus: *Brassica*

Species: *B. oleracea*

Cultivar Group: *Brassica oleracea* Italica Group

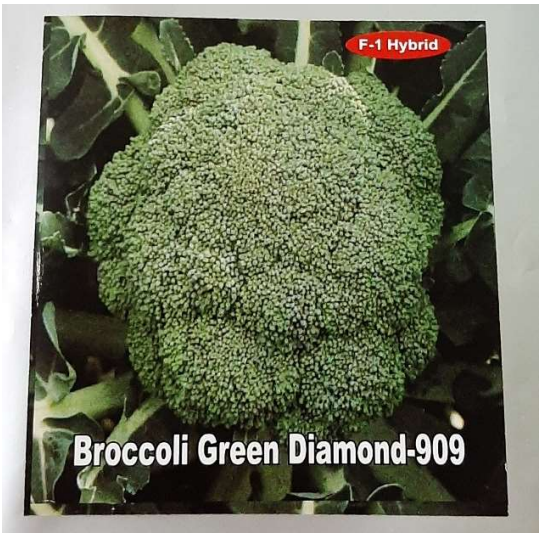
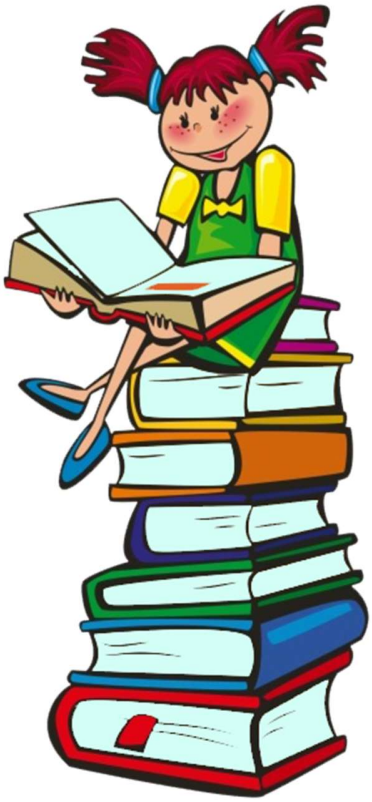


Figure 4: Broccoli

These four plants were studies in detail for carrying out the research.

CHAPTER 2

REVIEW OF LITERATURE



[2.1] Biocompost and Bioenzymes

In today's world, the use of agro-waste, home waste and animal waste has been used in preparing bio-compost, manure and fertilizers for better seed germination and plant growth. It is an economic, sustainable and eco-friendly way of cultivation. Different compositions were used for seed germination and measured their growth parameter at a regular time interval. Result showed that pineapple pulp and coconut husk helped for the better growth of plant. [1] The diversity and role of insects in household Biocompost has been discussed in the paper "Biocompost – A niche for insect diversity". It included the methods of selecting compost samples, methods for extraction of insect fauna and techniques of preserving and identifying. A total of 12 insects were found that talk about their diversity which created their niche in the compost. Also, their contribution in the making and development of compost was observed. The work therefore concludes that the household compost also contains other invertebrates rather than only earthworms and is equally helpful for the formation of compost. [15]

[2.2] Process of Compost formation

Compost requires three ingredients:-

- Browns- It includes dead leaves, branches, and twigs.
- Greens- They contains grass clippings, vegetable waste, fruit scraps, etc.
- Water

Having the proper amount of water, greens and browns are extremely important for compost development. The compost has an equal quantity of browns to greens which can be alternated with layers of different-sized particles of organic materials. The brown materials provide carbon for the compost, the green materials provide nitrogen, and thus the water provides moisture to assist break down the organic matter.

We cannot use every other thing as compost. Therefore, the materials which may be utilized in bio composting are as follow:-

- Black walnut leaves or twigs- Release substances that might be harmful
- Coal or charcoal ash- has substances harmful for plants

- Dairy products (e.g., butter, milk, soured cream, yogurt) and eggs-create odor problems that may attract rodents and flies.
- Diseased or insect-ridden plants- may survive and can be transferred to another plants
- Fats, grease, lard, or oils
- Meat or fish bones and scraps- not easily decomposable
- dog or cat feces, soiled cat litter and other pet wastes
- Yard trimmings treated with chemical pesticides-have the ability to kill microorganism necessary for decomposition of organic matter. [1]

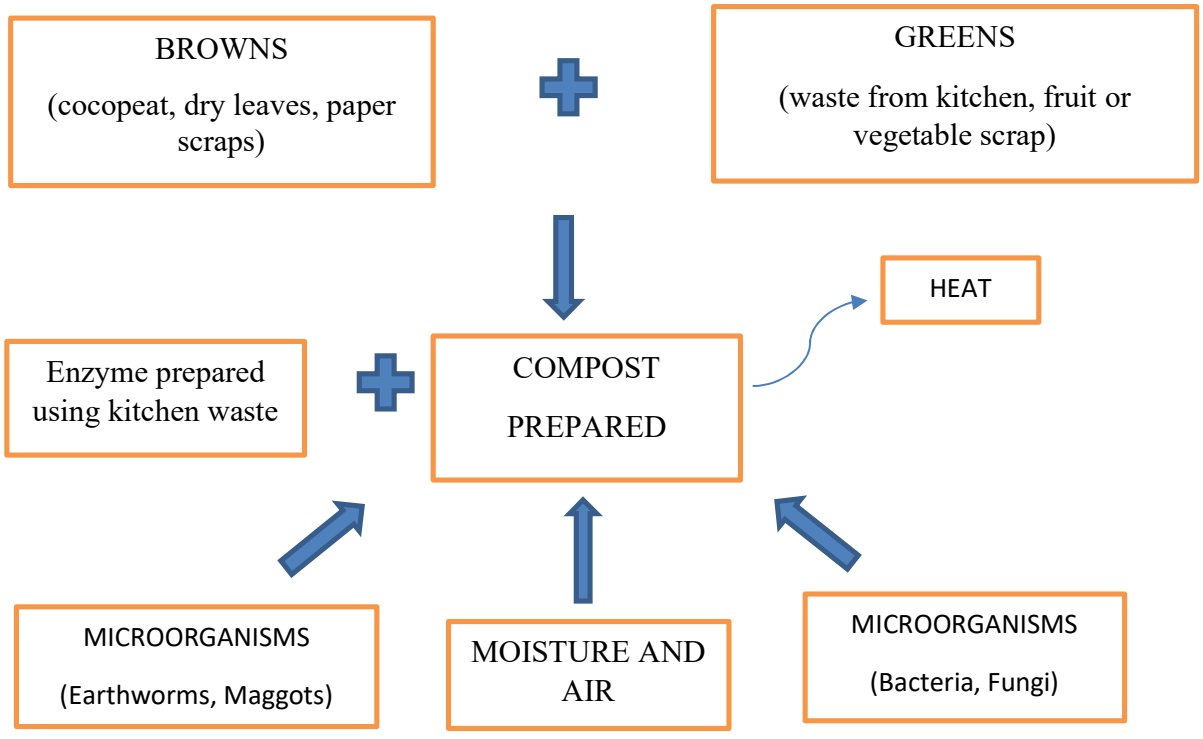


FIGURE 5: PREPARATION OF COMPOST

[2.3] Process of Bioenzyme formation

Points to remember while preparing enzyme-

- Use plastic container instead of glass container because during fermentation gas accumulates within the container due to which glass can break.
- Use of brown sugar or jaggery as it contains high level of minerals.
- Use large amount of fruit waste to get a pleasant aroma.
- If worms seen over the sides of the container, by addition of addition 100g of jaggery and tightly sealing the cap can let go worms easily.
- After the enzyme is prepared, the left over waste can be either transferred to compost bin or directly to garden. [6]

[2.4] Phases of Compost formation

1. Mesophilic Phase: The bacteria present in the compost pile produce carbon dioxide and energy which is directly used by the microorganism for their survival. Some mesophilic bacteria start to grow in the initial phase of the composting at about 44˚C. As the process is carried forward, the temperature inside the compost bin increases leading to the death of mesophilic bacteria (For ex: *E. coli*) and providing the environment for the growth of thermophilic bacteria. [1,25]
2. Thermophilic Phase: during this phase, the bacteria involved in the process breakdown the matter and produce a lot of heat taking place at a temperature of 70˚C. sometimes such high temperature is not favorable for the compost. This phase last for few days only which indicated that the particles have been digested leaving behind some particles which need to be digested in the further steps. [1,25]
3. Cooling Phase: the microorganisms that were unable to survive in the extreme hot condition return back to the compost bin and start the process of decomposition of the remaining food. The process may last for days to months depending upon the type of waste you are adding to the bin. For ex. If it's lignin, then it takes months to be decomposed as they come from wood and provide resistant when bacteria try to break them up. [1,25]

4. Curing Phase: this is known as the maturing stage or the resting phase which is the long and most important stage of the whole process of composting because if we add unprocessed compost to the soil, it can be harmful for the plants and can kill the natural microorganisms present in the soil and can also deplete available oxygen and nitrogen from the soil. So, it is very necessary for the compost to form properly All the phases are shown in figure 6. [1,25]

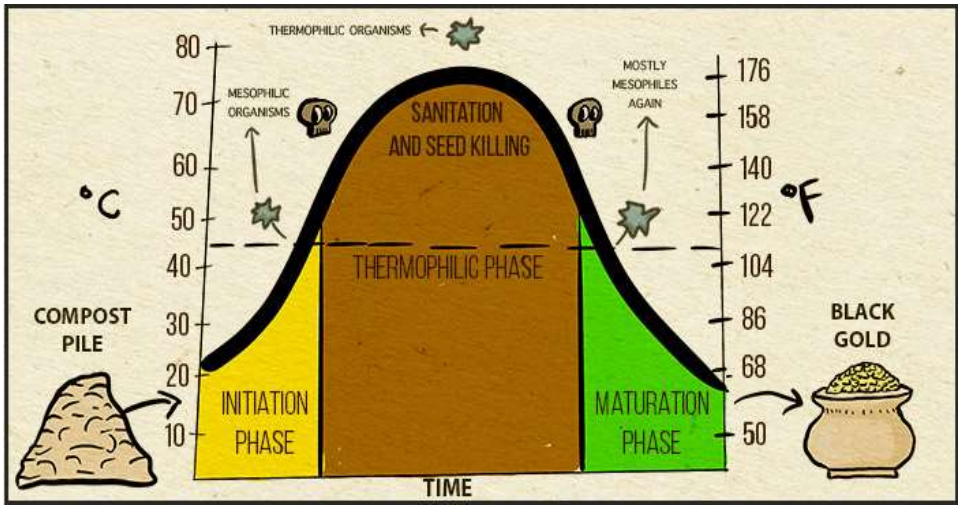


Figure 6: Different phases of Biocomposting

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[2.5] Composition and parameters affecting active formation of Biocompost and Bioenzymes

The bio-wastes from the urban areas and the family household were collected during different climate seasons and the difference in twelve components and twenty parameters were observed. Urban waste was almost steady in all the season in contrast to family household waste. Urban bio waste consisted mostly of fruit and vegetable peels (around 60%) whereas the other consisted of seasonal garden components. The result of this research may help in making up a new composition of bio-wastes and could be suitable for bio-waste processing. [12]

Compost comes out to be one of the best and effective ways of providing organic matter to soil and also improves the carbon content. Composting can be done at any scale from as small as home garden to as big as waste treatment plants. Composting is an aerobic phenomenon. Its requirements include oxygen, optimum moisture, optimum temperature and porosity for stabilization of wastes. Proper C/N ratio is also a must for compost to be effective. The decomposition and fractional humification of complex organic matter into nutritious soil supplement depends on the activity of microbes. It can further help to reduce environmental pollution by adding nutrients to soil naturally without any help of chemicals. It is even cost-effective and efficient alternative. The enzymatic activities which are important for biochemical process of the ability of soil to perform several functions. When compared to soil which does not contain Biocompost, the soil having the Biocompost showed much enhanced enzymatic activity as seen in β- glucosidase activity which increased to 200%. Even microbial biomass and activity enhanced to 100% on use of organic compost. It effected the plant growth, development and yield positively. It transforms insoluble matter into nutrients and degrades harmful substances. [23]

[2.6] Properties of compounds added in potting mixture

There are many compounds added to Biocompost to make it more effective for production of desired plants.
The compounds added in potting soil for enhancing its effectiveness are as follows:-

- **Perlite:** It makes soil porous and light. It alters the sub-structure of soil by making it loose, well-draining and defying compaction. These are found in volcanic deposits and are natural glass. It contains 2-5% of water. It shows capillary activity and is able of holding 3 to 4 times of water to its weight. It has a neutral pH and is a sterilized product due to production at very high temperature. It is a stable material which cannot be altered by any microorganism or other chemicals. It cannot be re-used for next crop slot without processing. Steam sterilization is recommended to process used perlite but it is a bit expensive. Perlite is re-used as it is not an organic material. [16]

- **Vermiculite:** It is also good for providing aeration in soil and helps in retaining more water and nutrients. It is a hydrated mineral. The one we use in our potting mixture is heat treated. It has many properties as it is sterile, pest and mold resistant, non-toxic and odorless. It has potassium and magnesium ions. [24]
- **Coco Peat:** It is also known as coir. It has great pore space, moisture retaining capacity, very slow biodegradation, low bulk density and renewable. It is light in weight, good source of nutrients and water holding capacity. [8]
- **Cow Dung:** It is a bio-fertilizer and used for production of energy in many developing countries. It is a great alternative for chemical fertilizers. Its productivity in long term. It increases organic matter in soil which leads to high water holding capacity and cation exchange capacity. It is renewable and thus can replace other fossil fuels easily. [12]

[2.7] Effect of Biocompost and Bioenzyme on plants

The Biocompost and Bioenzymes have a very positive effect on the plant growth and development. These are cheap as they can be prepared easily without any expensive compounds. The compounds needed are easily available and are environment-friendly. It is observed that these improve the soil, crop yield and plant development. The addition of Bioenzymes may add on microbes which further increase the value of the soil. Use of these organic components help to reduce the use of chemical fertilizer, insecticides and pesticides which are harmful for the environment. Compost even stabilizes the nutrients which include lowering the level of leaching of nitrogen, reducing the risk of spread of diseases, pests and insects which would come along the use of organic manure.[5]

[2.8] Soil Analysis for extended growth of plants

The soil of Rajasthan sandy and has various forms of dunes in it. The rainfall is very less in this area, has high temperature and high wind storms in summer. The soil suffers a lot with soil erosion and high content of sand in it. It has low water holding capacity and low moisture content. Physical and chemical properties of soil depend on various factors such as the pattern of use of land, porosity, and water holding capacity, climatic conditions and many more.[4] Fertility of soil plays an important role in production of healthy crop. The presence of type of

macronutrients and micronutrients also is an important aspect of soil analysis. [3] Soil health is required for production of good and healthy crops. The soil health is also required for absorption and utilization of fertilizers and other nutrients. Soil testing is done to know the quality and nutrient availability of soil. Now, the issuing of soil health card is being done which provides the data on physical and chemical properties as well as available nutrients in the soil. [2]

Addition of Biocompost and Bioenzymes to the soil of Rajasthan has helped to extend the period of crops to withstand and give good and healthy crop production which would otherwise have been an issue.

CHAPTER 3

RATIONALE OF THE STUDY

1. There is no availability of any scientific data on these exotic vegetables (Broccoli, Red Ball Cabbage and Lettuce).
2. There is no study available on these homemade Biocompost and Bioenzyme composition and preparation and their study in these exotic vegetables.
3. Combinations of Biocompost and Bioenzyme are used for growing cost effective exotic vegetables in shorter duration of time with minimum and renewable resources.

OBJECTIVE

1. To optimize the composition of Biocompost and Bioenzymes for growing exotic vegetables.
2. To study the effect of Biocompost and Bioenzyme on growth and development in exotic vegetables (Cherry tomato, Broccoli, Red Ball Cabbage and Lettuce)

CHAPTER 4

MATERIAL AND METHODOLOGY

[4.1] PROCURING OF MATERIAL

For carrying out this study, first we have to select the planting materials in which we have selected lettuce, cherry tomato, red ball cabbage and broccoli by procuring their seeds via Amazon. The germination protocols have been optimized at home.

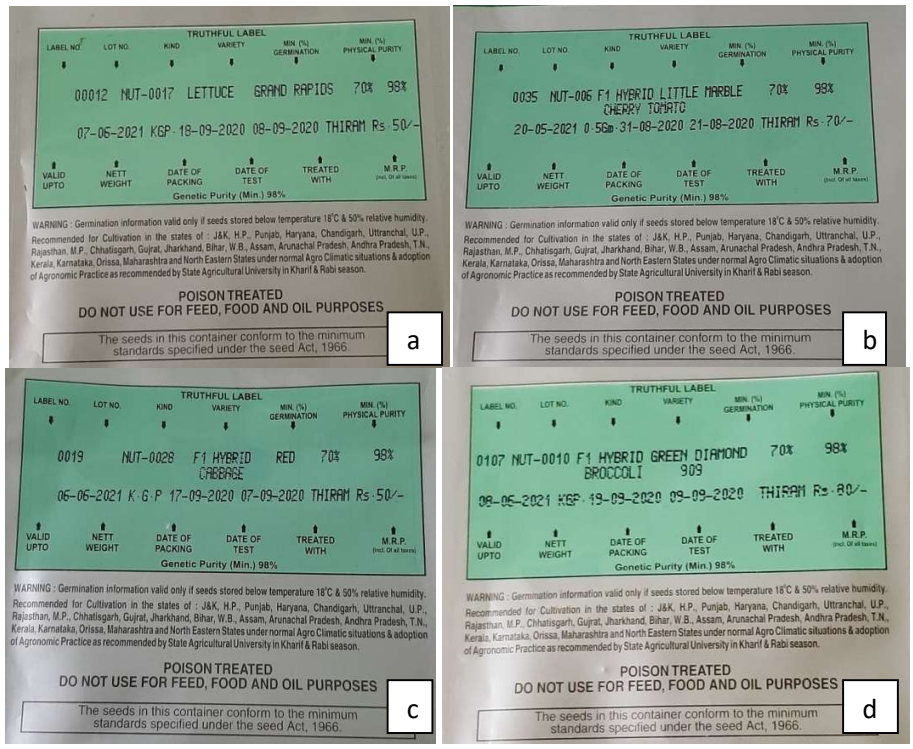


Figure 7: Seeds used of Different Plants (a)Lettuce; (b)Cherry Tomato; (c)Red Ball Cabbage; (d) Broccoli.

For carrying out this study, needed Biocompost, **B**ioenzymes and germinated seeds whose preparations are shown below.

[4.2] PREPARATION OF BIOCOMPOST

Bio compost has been prepared at home using the ingredients listed below in a batch which was prepared on 2nd October 2020. Figure 8 shows how the Biocompost has been prepared where figure 8(a) shows the ingredients used; 8(b) shows how the ingredients have been mixed; 8(c)

shows the compost bin which has holes for exchange of gases and has been labelled properly; and 8(d) shows the condition of compost after 10 days.

(a) Ingredients and Equipment used

1. Bucket with lid and holes (vertically on the walls for aeration)
2. Big tub to mix all the ingredients before adding to the bucket
3. Kitchen waste (can be anything)
4. Leftover food items (green tea leaves, tea leaves)
5. Cocopeat (have the property to hold water for longer duration of time)
6. Soil
7. Vegetable and fruit peels
   potato peels- rich in N, P, k and Mg
   banana peels-K and potassium
   orange peels- nitrogen
   nutshells- carbon
8. Dry leaves (mixed with all the items so that they can soak the moisture and does not allow the growth of unwanted microbes)
9. Stick- for mixing ingredients time to time

(b) Procedure

Batch 1- 2nd October 2020

1. All the ingredients were collected and mixed firmly with the dry leaves to evenly distribute the content.
2. A bed of crushed dry leaves was made on the base of the bucket.
3. The mixed over material was then added to the bucket along with some amount of cocopeat.
4. A spoonful of buttermilk was added on daily or alternate days and content was mixed gently.
5. Again, a thin bed of crushed leaves was made at the top of the bucket.

6. Bucket was then covered with the lid.
7. Left it in a corner away from sunlight for few days.

***added a tablespoon full of sour buttermilk once in a week to add sufficient microbes to quickly decompose the waste and acts a reaction accelerator. Compost require minimum 40 to 45 days to fully decompose**

FIGURE 8: Bio-compost preparation a) kitchen waste including vegetable and fruit peels , flowers, nut shells, dry leaves, cocopeat b) Mixed the waste properly for even distribution c) compost bin with holes d) compost after 10 days.

[4.3] GERMINATION OF SEEDS

After the Biocompost preparation, the seeds of different plants need to be sown separately in water bowls for 24 hours so that the seed coat softens which would fasten the process of seed germination. The seeds that have been used are shown in figure 7. Pat-dried the soaked seeds then added them to the different pots 0.5 cm deep as shown in figure 9(b) having the potting mixture.

Seed starting tray is a common practice for gardeners to plan and start in succession, transplant healthy seedlings to final planned containers or beds, avoid seeds, seedlings eaten up by squirrels, snails, ants and birds and most importantly sed to monitor germination rates of seeds. Seed tray of different sizes and depths can be used depending on what you're sowing. A regular small tray is sufficient for tomato, cabbage, cauliflower, chili , capsicum. Deeper-holed trays are needed for squash, melon, pumpkins, beans etc. Many of these plants benefit from direct sowing, but due to other challenges seeds must be first start in trays and can be then carefully transplanted later.

Some important points to keep in mind before and after sowing seeds

1. Prepare the potting mixture- 30% cocopeat, 30% compost, perlite, vermiculite and a small amount of cow dung powder (optional). Add small amount of Bioenzyme to make the mixture fluffy.
2. Fill the tray and then press down so that medium is packed tight. Pressing with another tray is easiest way to pack in the medium. Make holes for approx. 0.5cm (depth should be equal to the size of seed- avoid making deep holes).
3. Draw a grid in your notebook the size of the tray to intend to fill.
4. Start sowing by just dropping the seeds into the hole and noting into the grid. For starting just sow 1 or 2 seeds per hole. If sowing more seeds make sure they are not clumped together. Cover the seeds with more medium.
5. Use a sprayer to mist water- don not use a pipe or mug unless you are gentle. Another method which will ensure the seedlings don't get toppled by watering is to place the seed tray in a larger tray and fill a little water in the outer tray. The medium will pick up the water. Ensure you don't let seeds tray remain standing in water as this will lead to rotting seeds. Ensure the medium doesn't dry up.
6. Place the seeds in a spot that gets bright light but is protected from rain and pests till seeds sprout. (Figure 7)

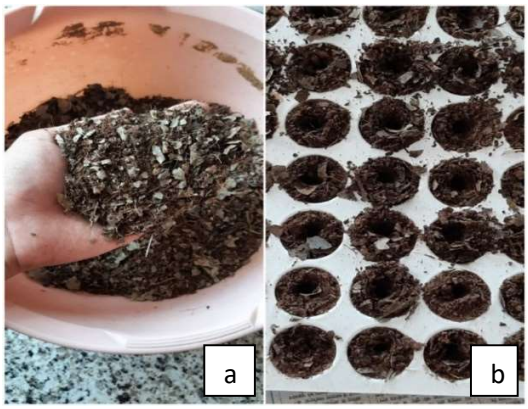


Figure 9: (a) Prepared potting mixture including compost, cocopeat, vermiculite, perlite and cow dung powder by mixing them. (b) Pots having potting mixture in which seed are sown 0.5 cm deep.

[4.4] PREPARATION OF BIOENZYME

Different bioenzymes have been used to study their effect on plants along with the use of biocompost.

[4.4.1]Traditional bio-enzyme using citrus peels

The preparation of Citrus bioenzyme has been shown in figure 10 which consist of jaggery, citrus peels and how the enzyme is prepared.

(a) Ingredients and Equipment used

1. Citrus peels
2. Jaggery
3. Water
4. Air tight container

(b) Procedure

1. All the ingredients are mixed in the ration of 3:1:10 (citrus peels, jaggery, water)
2. Take a big bottle with air tight cap and mix all the ingredients into it.
3. Seal tight the bottle and keep it in dark for approx. 2 months and more.

4. After every weak, loosen the cap a little bit for the gas to escape out from the fermentation chamber.
5. Bubble arising over the walls of the bottle show that the reaction is taking place in the right direction.
6. After the full decomposition of jaggery and citrus peels , strain the solution in another bottle and store it for further use.
7. Now the enzyme is ready to be given to the plants.(Figure 10)

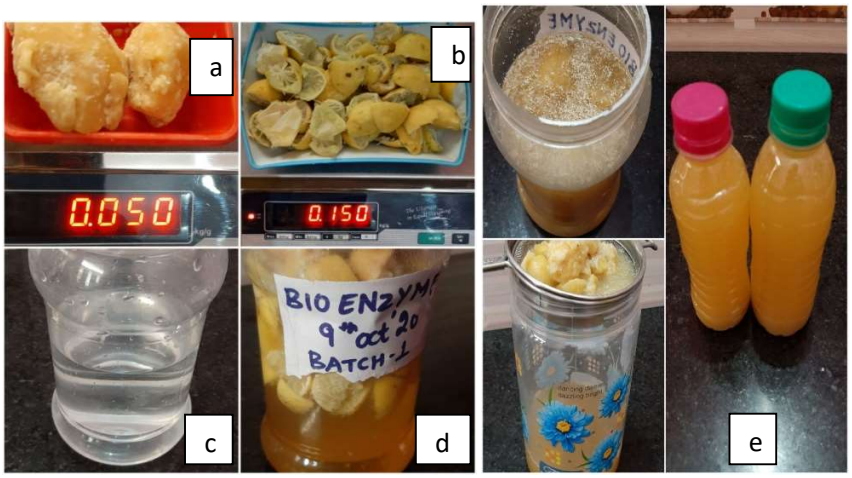


Figure 10: Bio-enzyme preparation (ingredients in ratio of 1:3:10) (a)jaggery (50gm) (b) citrus peels (lemon- 150 gm) (c) 500 ml water (d) batch 1 kept for 45 days in cool and dry place away from sunlight. (e)Enzyme after fermentation period strained the solution and stored in bottles.

[4.4.2] BANANA ENZYME

An excellent liquid nutrient for your plants that are in their flowering fruiting stage. This is one of the several methods to use banana peels or overripe fruit as a garden input. The process is simple and there is no use of water. Use it for flowering plants, veggies and fruits. The process creates a highly concentrated nutrient with long shelf life that delivers many required nutritional elements to your plants at a critical stage of their lifecycle. The prepared banana Bioenzyme after 21 days of fermentation period, mixed small teaspoon of enzyme in 200ml of water is shown in figure 11.

(a) Ingredients and procedure used

1. Take equal quantities of whole overripe banana or banana peels. Hop them into smaller pieces with a clean dry knife. Measure the volume of chopped fruit and/or peels.
2. Take an equal quantity of powdered jaggery. Now fill a clean, dry, air-tight plastic container with the chopped banana and jaggery layering as you go. The container must be large enough so you don't fill it more than 2/3rd.
3. Shut the lid tight and let this sit for 21 days in a cool spot out of sunlight. Do not open the container during this period. You can occasionally shake it.
4. At the end of this period, check if there is a sweet slightly alcohol like smell. The mix should look same as in picture.
5. This enzyme can be stored up to 6 months at room temperature.
6. Always use a dry spoon to mix your fertilizer. The ratio of the foliar spray must be 1 o 2 teaspoon of this mix diluted in a litre of water. Mix it in a bottle then filter into your sprayer with a cloth or tea strainer to avoid clogging.
7. Apply late evening or very early morning to your plants.
8. For soil application use 50ml in a litre of water.(Figure 11)

Figure 11: Banana Enzyme after 21 days of fermentation period, mixed small teaspoon of enzyme in 200ml of water.

[4.4.3] LACTIC ACID BACTERIA ENZYME

LAB is one of many active biofertilizer and helps improve nutrient availability from compost and organic material, and increase soil fertility and porosity by stimulating the growth of beneficial bacteria in the soil. LAB can be mixed with other liquid fertilizer to improve healthy fresh growth.

To store it for a longer duration of time, add 1 or 2 tablespoons of powdered jaggery, mix well and refrigerate as shown in figure 12. Not to be stored beyond 3 weeks.

(a) Ingredients and equipment used

1. Wash about a cup of raw rice in 1 cup of water rubbing the grains well to get the water milky.
2. Place the rice washed water in a clay pot or glass jar, cover it with clean cloth and let it sit for 3-4 days to start fermenting.
3. On day 5, mix 4 cup raw cow milk with fermented solution. Place in a wide mouthed container and cover with 2 layers of cloth or clean white paper, secure with string or rubber band and set aside in a cool place for 4 to 5 days.
4. After 5 days, the solution will form 3 layers. The top layer is rich fat protein and starch- can be carefully removed and put in compost bin. The second layer is the liquid LAB. The 3rd layer at bottom is waste and to be discarded by simply straining.
5. To use, dilute 1ml LAB in 1 litre of water. The mix can be added to soil by spraying or sprinkling on top sol. This can also be used as a foliar spray for young plants in vegetative stage or older plants after pruning to stimulate healthy fresh growth. (Figure 12)

Figure 12: Liquid LAB enzyme prepared using rice water and raw cow milk. For use, diluted 1 ml in 100 ml of water.

[4.5] PREPARATION OF POTTING MIXTURE FOR GROWING THE PLANTS

The potting mixture for transferring seedlings and growing the plants need to be prepared. The steps for preparation of potting mixture have been shown below.

1. Mixture was prepared with 30% Biocompost and diluted Bioenzyme was respectively added to small and big seed tray.
2. Seeds were sown and tray was kept in sunlight. Subsequently on alternate days, Bioenzyme was sprayed onto the tray during early morning and late night.
3. Observation is carried out on regular interval.

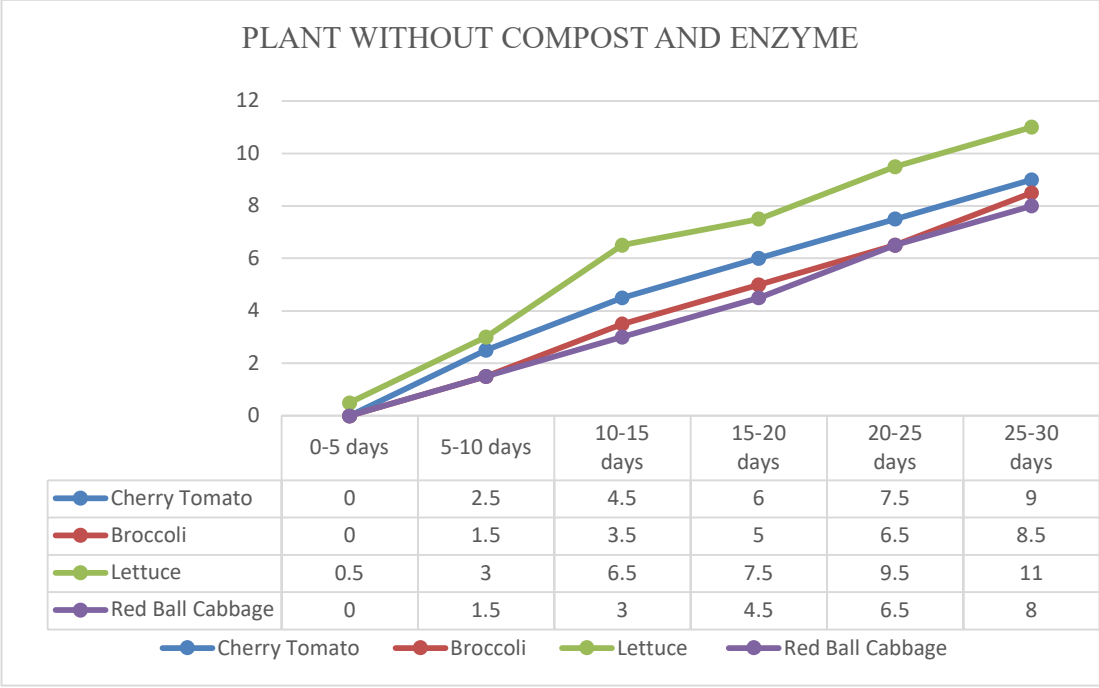
All these experiments are carried out in three replicates and data has been recorded for analysis.

CHAPTER 5

RESULT

[5.1] Effect of Biocompost and Bioenzyme on seed germination and plant growth in Exotic Vegetables

The seed germination of Cherry tomato, broccoli and Red ball cabbage was seen best with citrus peel enzyme in about 0-5 days whereas of lettuce was seen best with Lactic Acid Bacteria enzyme in 0-5 days as well. The study and analysis has been carried out in 0-5 days, 5-10 days, 10-15 days and so on till 25-30 days where we have found that the effect of biocompost along with different Bioenzymes (Figure 14,15,16) and control plants on seed germination and growth was studied as seen in graphs below. (Figure 13)



	0-5 days	5-10 days	10-15 days	15-20 days	20-25 days	25-30 days
Cherry Tomato	0	2.5	4.5	6	7.5	9
Broccoli	0	1.5	3.5	5	6.5	8.5
Lettuce	0.5	3	6.5	7.5	9.5	11
Red Ball Cabbage	0	1.5	3	4.5	6.5	8

Figure 13: Effect of Seed germination under controlled conditions

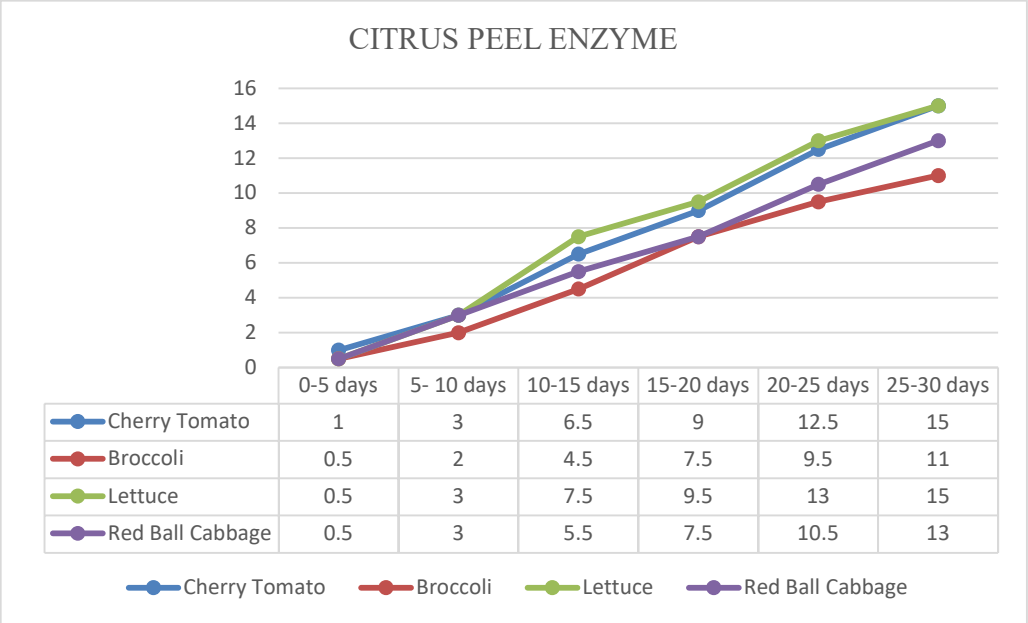


Figure 14: Effect of seed germination with Biocompost and enzyme prepared using fruits and vegetable peels.

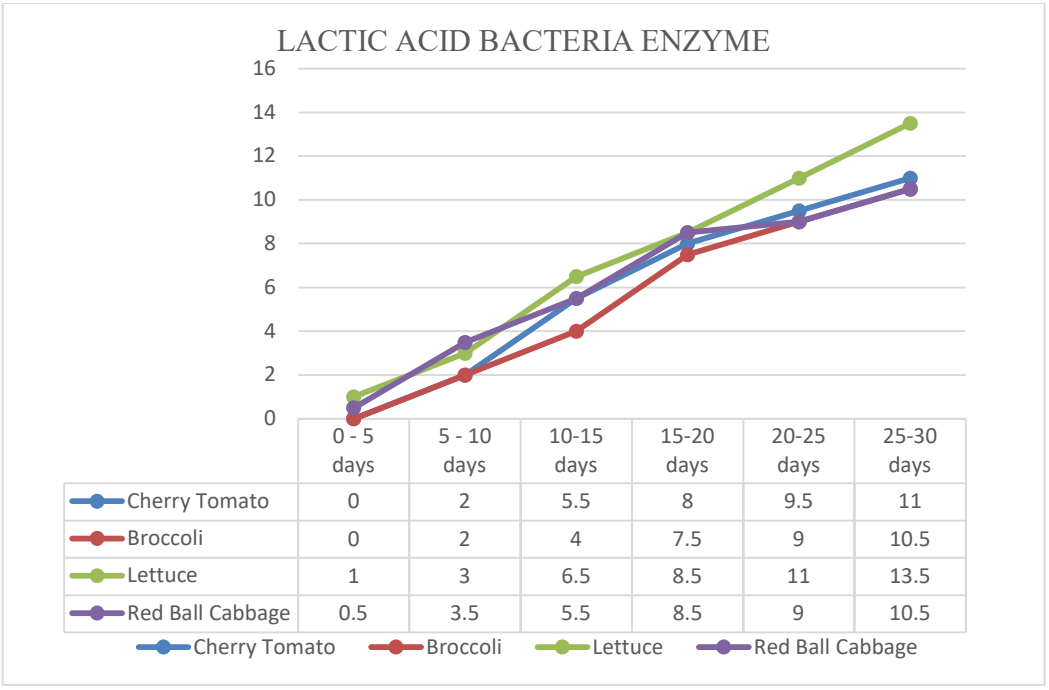


Figure 15: Effect of seed germination with Biocompost and Lactic acid bacteria enzyme

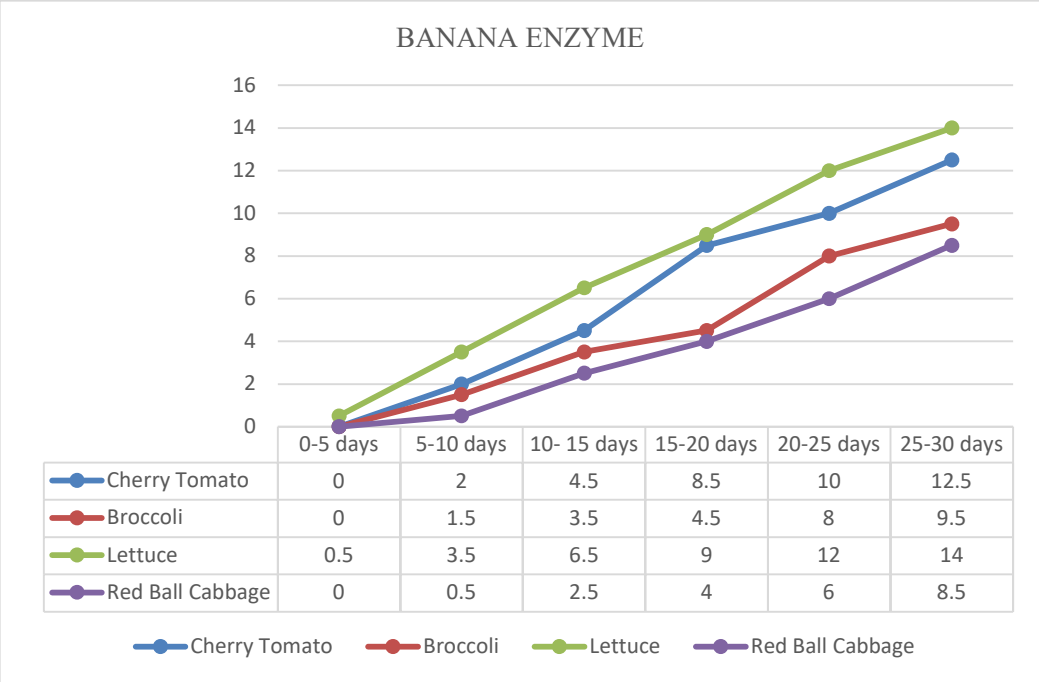


Figure 16: Effect of seed germination with Biocompost and Banana enzyme.

[5.2] Comparative analysis of plants in Biocompost and Bioenzyme.

The growth of plant was from the initial days after sowing the seeds in the potting mixture which was prepared using Biocompost and soil, which was then supplemented with Bioenzymes for better growth and fruit yield. We have carried out the comparative analysis of Red Ball Cabbage, Cherry tomato, lettuce, and Broccoli under the mixture of Biocompost and soil which has been supplemented with cocopeat, perlite, vermiculite and cow dung as shown in figure 18 and 19. The control experiment was also carried out where Biocompost was not added and seeds were kept only in soil as shown in figure 17. The graphs of the seed germination in the observed data have been shown above. (Figure 13, 14, 15, 16)

Control Plants

Figure 17: Control plants grown under soil and simple potting mixture of Red Ball Cabbage, Broccoli, Cherry tomato and Lettuce

Test samples

Figure 18 &19: Experimental samples grown in Biocompost and Bioenzymes

After seed germination, when the plant started growing in their respective Biocompost and Bioenzyme they showed good growth after 20-30 days are as follows.

[5.3] OBSERVED GROWTH AND SAMPLE ANALYSIS WITH RESPECT TO HEIGHT AND FRUIT WEIGHT

[5.3.1] IN LETTUCE PLANT

The lettuce plant gave best growth pattern with biocompost and fruit and vegetable peel enzyme as shown by the graph (figure14) and the final growth of plant with different enzymes is shown in following figures 20, 21, 22 and 23. A good average height of 5.5±0.50 inches and an average weight of 75 grams have been observed in plats in which fruit and vegetable peel enzyme has been used. as compared to control lettuce. (Table 1 and 2)

Figure 20: Growth observed in Control Plant after 20 days

Figure 21 & 22: Growth observed on application of enzyme prepared using fruits and vegetable peels, ripened banana respectively

Figure 23: Growth observed of plant on application of enzyme prepared using raw milk and rice water.

[5.3.2] IN CHERRY TOMATO PLANT

The best growth pattern of cherry tomato was also given by the use of citrus peel enzyme as shown by graph (figure 14). The final growth of plant with different enzymes is shown in following figures 24, 25, 26 and 27. A good average height of 39.89±0.50 inches has been observed with fruit and vegetable peel enzyme whereas good average weight of 90 grams has been observed with banana enzyme. (Table 1, 2, 3)

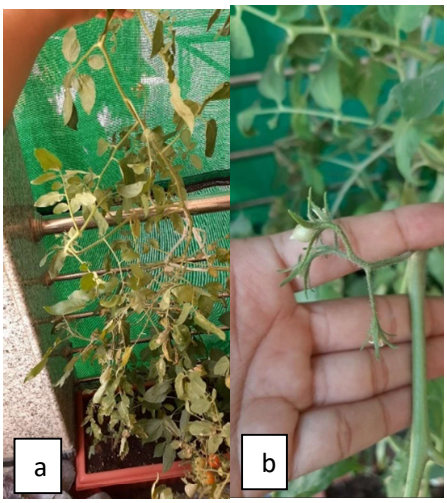


Figure 24 (a;b): Control Plant- No growth of fruit observed till date

Figure 25(a;b) : Growth observed on application of enzyme prepared using ripened fruits.

Figure 26(a;b): Growth observed on application of enzyme prepared using fruits and vegetable peels.

Figure 27: Growth observed on application of enzyme prepared using raw milk and rice water.

[5.3.3] IN BROCCOLI PLANT

The best growth pattern of broccoli was also given by the use of citrus peel enzyme as shown by graph (figure 14). The final growth of plant with different enzymes is shown in following figures 28, 29 and 30. A good average height of 12.25±0.60 inches has been observed with LAB enzyme

whereas good average weight of 550 grams has been observed with banana enzyme as well as fruit and vegetable peel enzyme. (Table 1, 2, 3, 4)

Figure 28: Seed saplings in initial growth phase

Figure 29: Growth observed in test plant and on application of enzyme prepared using raw milk with rice water and ripened fruits.

Figure 30: Growth observed on application of enzyme prepared using fruits and vegetable peels.

[5.3.4] IN RED BALL CABBAGE

The best growth pattern of red ball cabbage was also given by the use of citrus peel enzyme and after that ripened banana enzyme as shown by graph (figure 14). The final growth of plant with different enzymes is shown in following figures 31, 32, 33 and 34. A good average height of

9.84±0.40 inches has been observed with banana enzyme whereas good average weight of 780 grams has been observed with fruit and vegetable peel enzyme. (Table 1, 2, 3)

Figure 31: Growth observed of control Plant

Figure 32: Growth observed on application of enzyme prepared using fruits and vegetable peels

Figure 33: Growth observed of plant on application of enzyme prepared using ripened fruits

Figure 34: Growth observed of plant on application of enzyme prepared using raw milk and rice water

Table 1: Control plants without compost and enzyme

S. No.	Plant Type	Avg. Height (in inches)	Avg. weight (in grams)
1.	Lettuce	4.5±0.45	80.55
2.	Cherry Tomato	0	0
3.	Broccoli	11.81±0.30	350
4.	Red Ball Cabbage	9.84±0.50	200

Table 2: Experimental plants with Biocompost and fruits and vegetable peel enzyme

S. No.	Plant Type	Avg. Height (in inches)	Avg. weight (in grams)
1.	Lettuce	5.5±0.50	75
2.	Cherry Tomato	39.89±0.50	88
3.	Broccoli	11.81±0.60	550
4.	Red Ball Cabbage	8.87±0.40	780

Table 3: Experimental plants with Biocompost and Banana enzyme

S. No.	Plant Type	Avg. Height (in inches)	Avg. weight (in grams)
1.	Lettuce	4.8±0.40	68
2.	Cherry Tomato	27.5±0.50	90
3.	Broccoli	11.81±0.60	435
4.	Red Ball Cabbage	9.84±0.40	650

Table 4: Experimental plants with Biocompost and Liquid LAB enzyme

S. No.	Plant Type	Avg. Height (in inches)	Avg. weight (in grams)
1.	Lettuce	4±0.45	65
2.	Cherry Tomato	32.5±0.50	88
3.	Broccoli	12.25±0.60	550
4.	Red Ball Cabbage	9.65±0.40	580

CHAPTER 6
DISCUSSION

The effect of Biocompost and Bioenzyme on seed germination and plant height was recorded regularly every week. After analysis , citrus peel enzyme showed good growth pattern in plant height and fruit productivity followed by enzyme prepared using ripened fruits and at last Liquid LAB. The presence of cocopeat showed good water holding capacity which protected the plants from not being water deficient. The compost and enzyme help in seeds to germinate early. The practice has great impact on agriculture and environment sciences as people are shifting towards eating food which are high in nutritional level but due to their cost and availability they are not consumed by the people leading them to shift towards synthetic food.[13]

Germination of seed: The combination of Bioenzyme and Biocompost showed good growth pattern and gave good quality of heavy weighted fruit. Thus, in fig. 15,16,17 experimental plant with Biocompost and fruit and vegetable peel enzyme showed faster seed germination rate as compared to other combinations. The composition metabolized the food stored in embryo which helped in germination of seed. [14]

Fruit weight: Final weight was calculated after the full growth of plant was achieved. As the plant growth increased, changes were observed in good size green leaves and enhanced metabolic activities [1]. In table [1, 2, 3, 4] test sample showed least weight followed by plants grown with enzymes prepared using fruit and vegetable peels, banana enzyme and at last Liquid LAB. Heavy weight and healthy fruit depicts the good uptake of nutrients from soil which enhanced the quality of fruit and fit for consumption.

Plant Height: As mentioned by R, Paradelo., et al. the plant height totally depends on the absorption of nutrients from the soil. After adding the compost and enzyme in the potting mixture, plant height was comparatively better than the test plant. The height progressed on regular interval till the saturation point was achieved and plant started moving towards senescence. The degradation of components of compost was done by enzyme prepared using different components. [15]

CHAPTER 7
CONCLUSION AND FUTURE PROSPECTS

The study shows the importance of using homemade Biocompost and Bioenzyme for growing variety of vegetables. Taking into consideration municipal waste constitutes of approximately half of the household kitchen waste. If the soil quality is poor definitely it will require use of heavy chemicals and fertilizers which shows its adverse effects in animals and humans thus, deteriorating ecological balance. Biocompost which contains the inorganic minerals enhances the seed growth and increases biomass production and soil fertility. The nutrients are slowly absorbed by the plants, maintaining insect diversity, soil quality and water retention capacity. The practice reduced the release of tones of household waste to the landfills and help in reducing the use of inorganic and synthetic fertilizers. In addition to it, natural fertilizers more likely known as Bioenzymes are also prepared using the waste which when combines with compost enhances the metabolic activity and helps in germination of the developing embryo by breaking outer seed coat. So, this study has generated good data where we have optimized indigenous conditions for the growth of cherry tomato, lettuce, broccoli and red ball cabbage via use of Biocompost and Bioenzyme in which cherry tomato and lettuce have given the best results with Biocompost and fruit and vegetable peel enzyme whereas broccoli has not responded well. The work will give a good opportunity for shifting towards pure organic methods for growing plants in complete natural environment with biodegradable and cheapest resources in short duration of time. Knowing that the cost of exotic vegetables in the marketplace is very high, the technique will make us to convert the waste from our household into black gold for plants which will help in easy growing of vegetables and fruits.

CHAPTER 8

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CHAPTER 9

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[1] K. Maheshwari, Yukti, H. Sood, "Effect of Homemade Biocompost and Bioenzymes for Growing Exotic Vegetables," in *International Conference on Innovations in Biotechnology and Life Sciences ,* December 18-20,2020. Accessed on Feb. 19, 2021. [Online].Available: ISBN: 978-93-88647-33-5; DOI : 10.6084/m9.figshare.13947833, pp. 107

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