

Effect of Egg Shell Manure on Growth of Fenugreek Plants

^[1] Hemlata U. Karne, ^[2]Pranov Harale, ^[3]Rushi Firodiya, ^[4]Shreyas Gandhi, ^[5]Shreya Gore, ^[6]Rutuja Khalse

^[1.2.3.4.5.6] Department of Chemical Engineering, Vishwakarma Institute of Technology, Pune, Maharashtra, India.

^[1]hemlata.karne@vit.edu, ^[2]pranov.harale20@vit.edu, ^[3]rushi.firodiya20@vit.edu, ^[4]shreyas.gandhi20@vit.edu, ^[5]shreya.gore20@vit.edu, ^[6]rutuja.khalse20@vit.edu

Abstract. It is crucial to increase production using a range of strategies as agricultural demand rises with increase in population. Fertilizers, which are the most frequent crop development treatments, are used to increase production. However, the depletion of important minerals in the soil caused by the usage of synthetic chemical fertilizers has had a severe effect on soil. Bio fertilizers like eggshell manure and animal waste are possible remedies for this issue. The objective of this work was to increase the fertility of soil by using organic fertilizers and also to use the waste food remains i.e. Egg Shell and Fruit Peels for betterment of the soil. In this study, bio fertilizers made from fruit waste and eggshells were created. Also, a series of experiments were conducted on Fenugreek plants to demonstrate the effects of egg shell tea and egg shell powder for different concentrations on plant growth, height, and root length. NPK values, pH level, and other parameters of the soil were measured, and comparison of soil with fertilizer and without fertilizer was carried out. On comparing the results, it was found that the one with 10g concentration of egg shell powder has performed the best in all parameters. Further soil analysis reports found that the tested soil was deficient in calcium carbonate, available nitrogen, and was also slightly acidic, so research was conducted on the composition of various fruit peels to compensate for this deficiency.

Index Terms- Fertilizer, Egg Shell Tea/Powder, Fenugreek plant, Fruit peels, NPK and pH value.

I. INTRODUCTION

Since the food industry contributes significantly to pollution, finding a solution is becoming more and more important. It is essential to create efficient methods for the handling of food waste since environmental limitations are getting increasingly strict. Due to the increasing amount of food waste, there are a few solutions suggested for this problem, [1]. One of them is a movement to increase awareness of food waste, [2]. Across the world, enormous amounts of eggshells are produced daily as bio-waste. Eggshell odor serves as a breeding ground for flies and is abrasive. Eggshell, which makes up around 11% of the entire egg's weight, comprises roughly 91% CaCO3 [3, 4]. In addition to ensuring the food security of the world's expanding population, the agriculture sector plays a significant role in improving the economic growth of emerging nations. One billion people worldwide lack access to appropriate nourishment and food everywhere. To meet the demands of the predicted 9 billion people by 2050, the anticipated agricultural production must be doubled. Nowadays, there are over 870 million chronically hungry people, many of whom are small farmers [5].

Soil organic fertility is unanimously attributed to the multiple and complex functions exerted by organic components in soil [6]. Organic matter is universally recognized to highly contribute to maintain the global fertility status and productivity of soil by governing most physical, chemical, nutritional and biological equilibria and processes in the soil-plant system [7, 8].

Fertilizers are crucial for improving agricultural yield. Chemical fertilizers, however, are expensive, harmful to the environment, eutrophication-causing, and diminish organic matter and microbe activity in the soil [9]. However, the rigorous use of chemical fertilizers has led to the deterioration of the dynamic equilibrium of soil, flora and fauna ecosystems as well as water streams contamination. The need for sustainable fertilization with minimal environmental impact has given rise to the search for alternative fertilizer sources for use in agriculture [10]. They plunder the soil layers for phosphate. To restore the soil's fertility, bio fertilizers are necessary. Use of chemical fertilizers over a long period of time damages the soil and reduces crop output [11]. On the other hand, bio fertilizers improve the soil's ability to hold water while also adding vital minerals like nitrogen, vitamins, and proteins. Types of bio-fertilizers are Rhizobium & Azospirillum [12].

Choudhary et al. (2011) investigated Fenugreek growth in his study. The impact of organic and inorganic nutrients on the growth and yield of fenugreek has been covered in this research. According to the literature analysis, higher fenugreek growth, development, and yield can be achieved by applying 20 kg N ha-1 and 40 kg P2O5 ha-1 and inoculating the seed with PSB and Rhizobium [13]. Anugrah et al (2021), studied the effect of eggshell organic fertilizer on vegetative growth of cayenne pepper. The treatment of eggshell organic fertilizer with a dose of 0; 45; 60; 75; 90; and 105 g. The best application of eggshell organic fertilizer was a treatment for parameters of root length and plant wet weight, respectively, 20.10 cm and 17.96 g, and a treatment for parameters of plant height and plant dry weight, respectively 54.80 cm and 3.00 g. The percentage of root length and wet weight of plants with eggshell organic fertilizer were 130.52% and 269.67% respectively [14].

Khairnar et al. (2019) reported an increase in the efficiency of the eggshell fertilizer with treatment by various fruit peels. They reported analysis of the carbon (C), nitrogen (N) and hydrogen (H) content from eggshell powder and fruit peels using CHNS Analyzer. The final result showed that sweet lime peel powder had a higher percentage of nitrogen (1.197 % in 2.114 mg) and carbon (38.053 % in 2.114 mg) whereas Banana peel powder had a higher percentage of hydrogen (6.153 % in 2.256 mg) compared to remaining samples [15].

Dlamini et al. (2021), investigated the effect of organic food waste on the condition of soil and the yield of vegetables. Treatment 1inorganic fertilizer (2:3:2 (37)), treatment 2 fertilized with organic liquid waste fertilizer, and treatment 3 - control (not fertilized). After application of treatments in the soil, the results of the study showed that vegetable waste had the highest yield per head (355.5 g) followed by synthetic fertilizer and no fertilizer treatment (control) with 283.2 g, and 253.1g. Similarly, vegetable food waste had the higher moisture holding capacity of 0.237 cm3/cm3 while synthetic fertilizer and the control both were 0.139 cm3/cm3 [16].

Lal et al. (2015), studied the effect of different levels of sulphur and zinc nutrients on growth and vield of Fenugreek. They reported that the highest number of primary branching plants and the number of pods plants with maximum seed yield was obtained with application 30kg/ha sulphur. Further, of this investigation revealed that interactive effects of sulphur and zinc did not significantly influence the days to seed germination and plant height at all the growth stages [17]. Nehara et al. (2006) studied the effect of different levels of phosphorus, sulphur, and plant growth regulators on growth of fenugreek. The yield-attributing characteristics, the seed, straw, and biological yields of the fenugreek plant were shown to be greatly boosted by increasing the P level up to 50 kg P2O5 ha-1 and the Sulphur level up to 50 kg S/ha [18].

Overuse of chemical fertilizers has resulted in a number of problems, including substantial soil deterioration, nitrogen leaching, soil compaction, loss of soil carbon, and reduction in soil organic matter. Moreover, chemical fertilizers' ability to increase agricultural productivity has been less effective over time. Biofertilizers are materials that have microorganisms in them; when added to the soil, they make the soil more fertile and encourage plant development. The main objective of our study was synthesis of organic manure such as egg shell tea and egg shell powder and application of it to increase fertility of soil. It includes the result for above mixtures for different concentrations of egg shell powder & tea

for concentrations of 2g, 4g, 6g, 8g & 10g. The best result from this was then added with different fruit peels to increase the fertility and then based on the result of the test of soil at the laboratory for different parameters the best from each research was chosen. Furthermore, we have also compared the best outcome with Urea for the sake of comparing the outcomes from our bio fertilizer with the widely used chemical fertilizer. Our bio-fertilizers enrich the soil with macronutrients including nitrogen, phosphorus, and potassium. Also, it increases the amount of calcium carbonate in the soil, which promotes greater stem development. This occurs when the roots absorb the nutrients in the bio-fertilizers, giving them the strength to spread out farther into the soil.

II. MATERIAL AND METHODOLOGY

The bio-fertilizers aid the soil in overcoming its lack of macronutrients like (Nitrogen, Phosphorus & Potassium) & calcium. As a result, egg shells were employed as a calcium-rich source of biofertilizer. For the creation of egg shell powder, egg shells from different sources were gathered and crushed and split into concentrations of 2g, 4g, 6g, 8g, & 10g. Considering, the aforesaid concentration for the production of Egg Shell Tea by diluting it in 113 ml of water in order to further boost the bio-fertilizer.

Different fruit peels like those from orange, pomegranate, and sweet lime was used along with egg shells to synthesize bio fertilizers that help us regulate certain parameters like nitrogen and potassium. The aforementioned process was taken into consideration for the fruit peel powder and tea in order to compare the soil fertility.

A. Materials.

bio-fertilizers The used in this experimental work were Egg-shell Tea and Egg-shell powder which were prepared from eggshells. Sufficient amount of an unfertilized soil was collected from the local nursery (Shree siddhi plant nursery, Link Road, PCMC, Pune, Maharashtra 411033) and fenugreek plant seeds were used. Orange, Sweet Lime and pomegranate waste peels were collected from household waste and canteen waste.



Fig. 1 Egg shell Tea



Fig.2 Egg shell Powder



Fig. 3 Fruit peel Tea



Fig. 4 Fruit peel powder

B. Methodology.

Similar to animal manure, particularly cow dung, eggshells offer a good supply of nutrients required for plant growth. We chose eggshell since eggs are frequently used as a raw material in the market for a wide range of products, on the other hand their shells are of no use.

i. Bio fertilizer using Egg Shell Tea & Powder.

Egg shell was sourced from a variety of locations, including poultry farms, households, hotels, bakeries, and fast food restaurants. Because eggs are so widely used, a sizable amount of eggshells were gathered from diverse sources.

Egg shell powder was made by crushing eggshells which was carried out by grinding it with

a home grinder. The advantage of using crushed eggshell is less energy needed for preparation, but the disadvantage relies on the time needed for eggshell degradation before it can provide nutrients for plants [19]. Also, an Egg Shell Tea was made by taking 113ml of boiled water at 50°C and adding the different Concentration of powder like 2g, 4g, 6g, 8g and 10g and these solutions were allowed to settle down for the next 3-4 business days. The boiling process helps to break down the eggshell and release nutrients to the water.

The main disadvantage of using egg shell tea relies on the tendency of liquid fertilizer to coagulate [20]. 5 pots of fenugreek plants were planted with dry powder and 5 with egg shell tea of different concentrations and 1 pot without any powder and egg shell tea which was for the reference and in each pot 15 fenugreek seeds were sowed and in each pot 1Kg of soil was used and further we monitored the growth of plants at every alternate day and noted the observations like height of plant and root, number of sprouts grown, quality of leaves & relative height with respect to other saplings. Also from soil tests, we compared different parameters such as Nitrogen, Phosphorous, Potassium, pH & Calcium carbonate.

The best results obtained from both the cases that are from Egg Shell Tea and Egg shell powder were considered for further experimental study.



Fig.5 Plants at Day 3 after adding fertilizers



Fig. 6 Plants at Day 20

ii. Egg Shell Bio Fertilizer and Urea.

Urea was used in this work which is one of the most widely used fertilizers by farmers for comparison between Urea and the best two cases of egg shell manure. For comparison, we have taken 0.5g urea (from our survey) in 1kg of soil and we monitored the growth of plants at every alternate day and noted the observations like height of plant and root, number of sprouts grown, quality of leaves & relative height with respect to other saplings. Also from soil tests, we compared different parameters such as Nitrogen, Phosphorous, Potassium, pH & Calcium carbonate.



Fig. 8 Egg Shell 6g pot at day 20

iii. Addition of fruits peels to the Bio fertilizer.

Fruit peels are very rich in macro and micronutrients that are beneficial for plant growth. By using fruit peel as fertilizer, we can reduce the load of wastes and can get more benefits than inorganic fertilizer. A sizable amount of Citrus fruit peels of orange, sweet lime and pomegranate were gathered from the diverse sources and these peels were allowed to dry in an open sunlight for removing moisture content from it and fine citrate peel powder was made by grinding the dried peels with the help of grinder. Different concentrations of fruit peel powder were used along with the best results obtained in case of Egg shell fertilizer to compare the plant growth. In the case of the best result of Egg shell powder, different concentrations of fruit peel powder like 2g, 4g, 6g, 8g and 10g were taken. Same was done in the case of Egg shell tea where the solution of fruit peel powder was made. Then this peel powder was added with different concentrations into 113ml of water. Then, allow it to settle and after 3 days at each alternate day the growth of plants was monitored.



Fig. 9 Block diagram for Addition of Fruit Peels to the Bio Fertilizer

Fertilizer in powdered form (Citrate peel powder)	Amount of Powder [in g]	f Amount of orange peel powder [in g]	Amount of sweet lime peel powder [in g]	Amountofpomegranatepeelpowder[ing]
	2	0.75	0.75	0.5
	4	1.5	1.5	1
	6	2.25	2.25	1.5
	8	3	3	2
	10	3.75	3.75	2.5

Table 1 Composition of different fruits to be added in soil.

III. RESULTS AND DISCUSSIONS

After the span of 20 days and observing

all the pots keenly within these days several parameters were considered and

taken readings at certain span of days and the parameters were plant height, root length, similarity in height for all plants, quality of leaves, etc. Addition of all types of fertilizers was done on day 3 after the germination of seeds so that seeds should not experience the overpowering of fertilizer. All the readings for the height of the plant were noted from day 4 till day 20 with an interval of 2 days after every particular reading. For root length reading, it was noted on the last day which is 20th day and averages of all the root length were taken.

i. Bio fertilizer using Egg Shell Tea & Powder.

a) Egg Shell Tea

Fenugreek plants were planted in pots with different quantities of concentration of Tea and Powder i.e., 2, 4, 6, 8 & 10g and diluted it with 113ml of water, the rest period for the addition of fertilizer was of 3 days. After the addition of fertilizer, at day 8 major changes were noticed. 2g and 4g plants was having small height but all plants have near about same height, for 6g, 2 plants were dead till that day and height if the other plants were not even. For 8g and 10g all the plants were of the same height but compared to others they were tiny. On day 10, for 6g of tea 8 plants were dead out of 10. Quality of leaves was also noticed and for 2 and 4 g leaves were of good quality at primitive level, for 6 g leaves were moderate and for 8 g and 10 g leaves were small and not as good as 2 and 4 g. But after day 12, the quality of the 2, 4

and 6 g was the same as that of day 8 but then for 8 and 10g quality of leaves improved as that from day 8.

b) Egg Shell Powder

Fenugreek plants were planted pots with different quantities of concentration of Tea and Powder i.e., 2, 4, 6, 8 & 10g and grinded it into thin powder, the rest period was the same for powder as well. After day 8, major changes were noticed. 2g and 4g were having very uneven height and for all of its plants and also a decent size and quality of leaves. For 6g, half of them were small and half were tall and the leaf size was moderate to good. Whereas, talking about the 8g and 10g good quality of leaves, height and equality in height was observed.

• Best results in Egg Shell Tea Manure were given by 8g tea and 10g tea.

• Whereas somewhat similar results were observed in 6g, 8g and 10g pots in Egg Shell Powder manure.

• Talking about the overall result, Pot having 10g Egg Shell Powder has given the best result as compared to other concentrations.

From Fig. 10, it was observed that the root length of egg shell powder for 10g concentration has marked the length of 14.68 cm as compared to 12.43 cm which is of 10 g egg shell tea. It is well known that greater the root length the more the ability of roots to absorb nutrients and water from soil.



Fig. 10 Comparison between the root length of Egg Shell Tea and Egg Shell Powder for different concentrations.

From Fig. 11 & Fig. 12, the height of 10 g powder is better than 10 g tea amongst all other concentrations. So, for Fig. 11 & Fig. 12, 10 g Egg Shell Powder had taller plant height than 10 g Tea, also regarding the number of

plants, maximum plants were taller amongst 15, whereas in 10 g Tea only few plants were tall, and majority were short amongst 15 saplings. Comparing the quality of leaves, 10g Egg shell powder was greener, than 10 g Egg Shell Tea.



Fig. 11 Comparison of height of plant at day 10 for Egg Shell Tea and Egg Shell Powder for different concentrations.



Fig. 12 Comparison of height of plant at day 20 for Egg Shell Tea and Egg Shell Powder for different concentrations.

From Fig. 12, it is evident that 10 g tea and powder gives the best results for the growth of fenugreek plant amongst other concentrations. From the aforementioned figure, there is not much difference in 10 g & 8 g concentration for Tea but apart from plant height, it was observed that in 10 g Tea all of the 15 seeds turned into saplings whereas only 13 was the count of seed which were germinated in the 8 g concentration for Egg Shell Tea. For 6 g initially, only 14 seeds were grown out of 15 but as we approached day 12, only 3 saplings were alive where the rest were found dead. Therefore, the comparison between the best of both ways is done in Fig. 13.



Fig. 13 Comparison between best results of Egg Shell bio fertilizer (10g Tea Vs. 10g Powder).

Parameters	Preferred Range	Unfertilized Soil	Rating	Fertilized soil			
				10g Tea	Rating	10g Powder	Rating
рН	6.5 - 7.0	6.52	Slightly Acidic	7.07	Neutral	7.17	Neutral
Calcium Carbonate [%]	0.5-2.0	0.25	Low	5.25	High	3.00	Moderately High
Nitrogen [kgha ⁻¹]	281 - 420	178.89	Low	168	Low	158	Low
Phosphorus [kgha ⁻¹]	15 – 22	16.58	Medium	08	Low	14	Low
Potassium [kgha ⁻¹]	151 - 240	416.83	Very High	307	Very High	302	Very High

Table 2. Soil Report.

Table 2 is the evidence that the unfertilized soil is slightly acidic in nature with low concentration of nitrogen and calcium carbonate and medium to very high for phosphorous & potassium respectively. And for bio fertilized soil, the pH is neutralized whereas the nitrogen and phosphorous content were reduced; potassium and calcium carbonate contents were increased altogether.

ii. Egg Shell Bio Fertilizer vs. Urea Phase.

After comparing the results from our Egg Shell bio fertilizer, it was clear that the best result was observed by two of the pots: 10 g egg shell powder and 10 g egg shell tea as there was not much difference between them. In this part, the most used chemical fertilizer in today's world, which is Urea, was compared with our best result. So, 4 pots were prepared with the best in the egg shell powder category, one with the best in the egg shell tea category, Urea and Reference and then results were noted with the similar parameters as taken earlier i.e. height of the plants grown, no. of seeds germinated and root length at the end.

Fig. 14 shows the comparison between the heights of plants grown with Urea, 10 g Egg Shell Powder, 10 g Egg Shell Tea and Reference. For the comparison, in this part again both the pots with egg shell powder and egg shell tea performed better. The pot containing Urea does not show the best result due to the reason like overdose of the chemical Urea for the recently grown small saplings in that pot which was not able to withstand the power of Urea and this is the main disadvantage of chemical fertilizers. After getting the report from the lab, it was seen that the soil in which urea was added was found out to be acidic in nature with pH reading to be at 5.5, also it made the soil less mushy. Such was not the

favorable condition for the roots as their

Whereas in the case of 10 g Egg shell powder, soil was mushy enough to felicitate the movement of roots inside the soil. This leads to absorption of more nutrients from the soil. The temperature was recorded at 25-30°C during the run. Multiple runs were carried and obtained similar results.



Fig. 14 Plant height comparison between 10g Egg Shell Tea, 10g Egg Shell Powder, Urea and Reference.

iii. Effects of temperature on plants growth.

Since that our Egg Shell Bio fertilizer's greatest results for 10 g of egg shell powder and 10 g of egg shell tea—12.5 cm and 12.3 cm, respectively—came during the winter season, we replanted 10 g of egg shell powder and 10 g of egg shell tea in summer with our pots containing Fruit Peels to compensate for the change in season. As a result, the height of the 10 g egg shell powder and 10 g egg shell tea planted in summer will be used as the reference height for the best results of winter. These new values are 8.9 cm and 6.8 cm, respectively. Fig. 15 shows the

compensation in the height of the plants of 10 g Egg Shell Powder and 10 g Egg Shell Tea for the change in the season.

Similar to how we planted our best results against urea, we also planted a pot with no fertilizers (pure soil) for reference, and both of these pots were also planted in the winter. To account for the difference in season, we planted urea and the Reference pot in summer as well. Thus, from 10.3 cm and 11.3 cm to 8 cm and 4.5 cm, respectively, the values for urea and reference plants will also alter. Fig. 16 shows the compensation in the height of the Urea and Reference plants for the change in the season.



Fig. 15 Plant height comparison between Egg Shell Bio Fertilizer best results for Summer Vs. Winter.



Fig. 16 Plant Height comparison of Urea and Reference for Summer Vs. Winter.

iv. Bio fertilizer using Egg shell and Fruits peels.

After a successful advantage of Egg Shell Bio Fertilizer over Urea, we moved on to the addition of Fruit Peel powder to our Bio fertilizer, however as the pots with our Bio Fertilizer were grown during the winter; all observations were also made at that time. From Fig. 17 & 18, we can see that when the mixture of Egg shell & Fruit Peels Tea was added in a given concentration of 2 g, 4 g, 6 g, 8 g & 10 g. amongst all the concentration, composition of 6 g showed the best result in terms of height of the fenugreek plant. So, the overall results (after considering the parameter such as height of the roots, quality of leaves, a greater number of sapling grown & more number of taller plants) for 10 g of Egg Shell Powder Manure with Fruit Peel have shown the best result as can be seen in the Fig. 17 & 18.

Now this time, the best result in Egg Shell Tea Manure with Fruit Peel mixture was given by 6 g concentration. Whereas, in Egg Shell Powder Manure with Fruit Peel mixture, the best results were seen in 10 g concentration. Talking about the overall result, 10 g Egg Shell Powder with Fruit Peel mix has given the best result. In the case of 6 g, Egg Shell Tea Manure with Fruit Peels, the grown plants were less greenish in color but out of 15 seeds 14 were grown whereas, in case of 10 g Egg Shell Powder Manure with Fruit Peel, all the seeds were grown with proper height and length of roots.





Fig. 17 Comparison of plant height for all concentrations of Egg Shell Tea + Fruit Peel Tea

Fig. 18 Comparison of plant height for all concentrations of Egg Shell Powder + Fruit Peel Powder

Also the comparison between the roots is carried out, where the best result from bio fertilizers using Egg Shell Tea & Powder and from Bio fertilizers using Egg shell and Fruit peels is shown in Fig. 19. The best result was obtained from concentration of 10 g Egg Shell Powder + Fruit Peels as the soil was mushy enough and so the roots were long as well as talking about the physical conditions 10 g Egg Shell Powder + Fruit peels were having greener leave as compared to the 6 g Egg Shell Tea + Fruit Tea. Also, a greater number of plants was taller and seemed healthier in 10 g Fruit Peel Powder than 6 g Fruit Peel Tea.



Fig. 19 Comparison for Root length of best vs. best in Egg Shell Bio Fertilizer and Egg Shell Bio Fertilizer with Fruit Peels

Table 3 Best resul	t from Addition	of Fruit Peels to	the Bio Fertilizer
Parameters	Preferred Range	10g Egg shell Powder + Fruit peel Powder	10g Egg shell Tea + Fruit peel Tea
рН	6.5 - 7.0	7.21	6.94
Nitrogen [kgha ⁻¹]	281 - 420	464	439.4
Phosphorous [kgha ⁻¹]	15 – 22	19.1	24
Potassium [kgha ⁻¹]	151 - 240	211	231
Calcium Carbonate [%]	0.5 - 2.0	0.7	0.85

Table 3 represents the soil reports after the addition of fruit peels to the egg shell, all the parameters were within the preferred range or near to it.

v. Comparison of different Biofertilizers using Egg shell and Fruits peels.

After achieving the target of increasing the amount of calcium carbonate in soil by

addition of Egg Shell Powder/Tea, there was the addition of the fruit peels to

overcome the deficiencies of other macro nutrients in the soil.



Fig. 20 Comparison of pH for the key pots

In the above fig. 20, the comparison is done for the best result from our research with the unfertilized soil, chemically fertilized soil, soils with Egg shell + Fruit peels and with the Egg Shell Powder & Tea. It indicates that the Egg Shell Tea showed the most neutral pH value amongst all other outcomes.

Similarly, Egg shell powder & Fruit peel powder doesn't deviate much in the pH scale as compared to egg shell tea i.e., close to neutrality. Whereas the chemically fertilized soil showed the most acidic pH i.e., 5.5, resulting in the harmfulness to the soil.



Fig. 21 Comparison of Nitrogen for the key pots

The fig. 21, indicates the comparison of and 439.4 kg/Ha for 10 g Fruit Peel Powder and Nitrogen in our key pots as mentioned above. 6 g Fruit Peel Tea respectively which is higher

From Table 2, the preferred range for the Nitrogen is between 281 - 420 kg/Ha. It is quite evident that the unfertilized soil was deficient in nitrogen at a larger extent. It got even more depleted after adding the Egg Shell Fertilizer. After the addition of the mixed Fruit Peels powder/tea the level of Nitrogen in the soil drastically increased till 464 Kg/Ha

from the preferred range by very less margin. The reason for this is, in mixed Fruit Peel powder/tea there was a presence of orange peels and Sweet Lime peels which are rich in Nitrogen and by addition of this, the level of Nitrogen in soil increased and raised in limit.





In the fig. 22, the comparison of Phosphorous is carried out between the different key pots of the research. The result was as expected i.e., from Table 2, the expected value was 15- 22 kg/Ha. The Phosphorous content in the soil which was in the regular limits at first i.e. at 16.58 Kg/Ha in unfertilized soil. After the addition of Egg Shell powder/tea due to the higher concentration of only calcium in it, other parameters from the soil get

depleted and so the phosphorous amount in the soil get depleted to 14 kg/Ha and 8 kg/Ha for Egg Shell Powder and Egg Shell Tea respectively. The main aim of the addition of fruit peels was to increase the nutritional contents in the soil so the amount of phosphorous increased again after its addition and went to 19.1 kg/Ha and 24 kg/Ha for 10 g Fruit Peel Powder and 6 g Fruit Peel Tea respectively.



Fig. 23 Comparison of Potassium for the key pots

Also, another parameter was the very high amount of potassium content in soil which was 416.83Kg/Ha initially, from Fig. 23 it can be verified, so to balance it, the addition of pomegranate peel powder was done. Pomegranate peel is also rich in nitrogen to some extent; it has very less amount of potassium in it. Also the sweet lime peels and orange peels have less amount of

potassium so, by making a mixture of all these 3 fruit peels in the powdered form with the most efficient concentration (i.e., 10 g) of egg shell powder, we can predict an enhancement in the fertility of the soil which reflected in the reports that the amount of potassium decreased to 211 kg/Ha and 231 kg/Ha which are within limits.





From fig. 24, it was seen that the concentration of Calcium Carbonate in soil was less than the preferred range which is mentioned in Table 2 which is only 0.25%. So, the addition of the

the preferred range which is between 0.5 - 2.0%. So, to balance this increment, addition of mixed fruit peels was done which were rich in other nutrients and hence it was clear from lab

Egg Shell powder/tea was done as it was very rich in the calcium. So, it increased drastically to 3% and 5.25% for Egg Shell Powder and Egg Shell Tea respectively. But this went too high from

IV. CONCLUSION

Day by day food demand goes on increasing as the population goes on То satisfy demand increasing. of increasing population use of fertilizers increased to increase yield of crops. High doses of chemical fertilizers cause infertile land, contamination of water bodies and hamper ecosystems. In this work synthesis of bio-fertilizers carried out from egg shells. Effect of egg shell tea and powder on growth of fenugreek plants were studied here. The highest root length, height of plants and yield was obtained at 10 g egg shell manure concentration followed by 8 g and 10g egg shell tea. From soil reports it was clear that urea caused acidic soil which caused death of plants. On the other hand, egg shell manure balanced pH and other nutrients essential for growth of plants. Further addition of fruit peel was carried out to increase the nutrients in the soil. The best results in terms of yield of plants, height and root length were obtained at 10 g egg shell powder + fruit peels. Soil reports obtained for egg shell + fruit peel support this finding by showing balanced nutrients content required for growth of plants. Hence it was concluded that egg shell + fruit peel manure provides better nutrients to plants than chemical fertilizers urea.

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