Growth Response of Cucumber (*Cucumis sativus*) to Organic and Inorganic Fertilizers under Shade House Conditions

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Abstract— *The germination and growth of Cucumis sativus were studied by comparing the efficacy of selected organic (rabbit manure, goat manure, and fermented fruit tea) and inorganic Nitrogen Phosphorus Potassium (NPK) 11-22-22 fertilizers at a rate of 40g applied in 2 intervals. Cucumis sativum was grown for 3 months under shade house conditions in grow bags using a randomized complete block design (RCBD) with five treatments and four replications. Each block represented 40 plants with 8 plants per treatment. Although there was no statistical significance between the organic manures within the parameters tested, all organic manure was significantly different from the NPK in their effects. The fermented fruit tea treatment had the highest seedling growth rate as well as the highest germination percentage. The fruit tea also had the highest germination rate index after 5 days however the rabbit manure had the highest overall germination rate index as well as the highest number of plants flowering at the start of measurement. The NPK showed the lowest values overall. One-way analysis of variance was utilized for group comparison with significance noted at P<0.05 in germination rate and flowering. These comparisons were performed on essential germination rate and percent along with the time of flowering. This study shows that these organic treatments can have a positive effect on the germination percentage, germination rate, and plant growth of cucumbers. This research has provided valuable and statistically significant information to augment claims that organic fertilizers such as rabbit and goat manures along with fermented fruit tea, offer essential nutrients and can be used as a suitable alternative to inorganic fertilizers for those farmers wishing to move into organic farming of cucumbers.*

Keywords—* *Inorganic fertilizer, fruit tea, goat manure, rabbit manure.

I. INTRODUCTION

The importance of soil fertility to plant growth is widely studied and is one of the most important factors for crop production. Soil quality which is sometimes used interchangeably with soil fertility is defined as the capacity of the soil to function within the boundaries of ecosystems to sustain biological activity, maintain environmental quality and promote plant and animal health (Krishna, 2002). Where plant production is concerned, soil fertility is a combination of the chemical, physical, mechanical and biological aspects of the soil that contributes to agricultural yield (Krishna, 2002). According to Krishna (2002) Soil fertility and crop management are the two most important ingredients of modern agricultural activity, he defined soil as the medium for crop production where the texture, soil composition, and aggregation along with other factors such as aeration, are essential considerations. The inclusion of soil additives to support the cultivation of crops is often indispensable to farming and many farmers rely heavily on fertilizer or other enriched material to support the growth of their plants. Soil additives may be in the form of fertilizers or other soil-enhancing inputs that affect the various production aspects of plants. In addition to soil additives, microorganisms play an important role in crop production whether positively or negatively. Bacteria and fungi in the soil may act as great advantages or disadvantages to crop growth and yield.

Plants take up nutrients easily from fertile soils and where there is biological balance, productivity is high, this allows for healthy plants to grow in a healthy environment (Sari et al. 2007). Deficiency due to the scarcity of single or multiple nutrients occurs regularly in agricultural soils and is made worse by intensive cropping practices as soil fertility drives crop productivity and thus crop yields. The scarcity of essential nutrients limits crop yield if not replenished. Fertilizer utilization in agriculture has assisted in increased crop production and helped in spreading agricultural zones to once infertile lands (Krishna 2002).

Plants need more than just inorganic fertilizers, as the soil is a living system it needs to have a balance of organic, inorganic, and microorganisms as well as other important structural components.

Many countries around the world (IFOAM Organics Europe 2020) are focusing on sustainable agriculture and food safety (FAO, IFAD, UNICEF, WFP and WHO. 2019). A major focus for many sustainability-conscious farmers is to reduce the number of inorganic fertilizers used on the farm. Commercial farmers are therefore looking at different ways of improving yield and balancing the fertility of the soil. Some amendments studied (Minu Singh 2014), (Sari 2007), (N. Karagiannidisa 2011), (Tarraf W 2017), (Abay Ayalew 2012) and used effectively in other countries include a mixture of NPK and other fertilizers, compost, raw animal manure, microorganisms (IFOAM Organics Europe 2020).

The use of inorganic fertilizers has been the norm for a very long time and we see the effects of the depleted soil fertility from the use of inorganic fertilizers on our sugarcane (Chi L. 2017) and banana (Zake Y.K. 2000) production. Alternate ways of nourishing the soil are therefore necessary, these alternatives must also be available and adaptable to local conditions. These ways must be proven, economical, and can support the long-term fertility of the soil. There is a need for formal research and adequate testing of locally available soil nutrient sources.

As the world battles the unpredictable climatic variations it has become increasingly obvious that each nation needs to ensure its adequate food security. Global impacts such as the sudden decline in global trade and the uncertainty in the continuation of the crisis brought on by this pandemic, many countries are using more of their resources internally as opposed to exporting them (The World Bank 2020). The need for sustainable agriculture and food security ties in well with the United Nation's Sustainable Developments goals number 2, 6, 12, 13, and 15 (FAO, IFAD, UNICEF, WFP and WHO. 2019); Sustainable development goals: # 2: Zero Hunger, # 6: Cleaner Water and Sanitation, # 12: Responsible Consumption and Production, # 13: Climate Action, # 15: Life on Land. And therefore augments the need for such a local assessment as is being proposed.

In an FAO 2019 report on, the state of food security and nutrition in the world, safeguarding against economic slowdowns and downturns‘ the authors highlighted that there is a trend in severe food security in the world, this they say is an indication of increasing hunger (FAO, IFAD, UNICEF, WFP and WHO. 2019). This trend started before the current COVID19 pandemic and has thus been exacerbated. The report warned of; slowing and stalled economic growth in many countries, including emerging and developing economies; episodes of financial stress; elevated trade tensions, declining commodity prices, and tightening financial conditions. All these warnings are a reality in this current time, not only for Jamaica but for many countries of the world. To make recommendations, the FAO pointed to the need for individual countries to implement short-term measures such as strengthening savings capacity when the economy is growing, as well as implement longer-term measures to ‘invest wisely during periods of economic booms to reduce economic vulnerabilities and build capacity to withstand and quickly recover when economic turmoil erupts” (FAO, IFAD, UNICEF, WFP and WHO. 2019). The FAO called for the transformation of the agriculture and food systems to include the types and quality of food production. If this was necessary before December 2019, we are now in a serious state of urgency to consider our food systems.

We can no longer rely on food, fertilizers, and other recourses coming from the USA and China, these are restricted by the internal need of these countries, trade tensions, and poor purchasing power among other factors (The World Bank 2020). Besides, if the FAO's call for the transformation of the agriculture and food system to include the 'quality of the food' (FAO, IFAD, UNICEF, WFP and WHO. 2019) is to be considered at all, we must improve our food production to ensure food security. We are already constrained by our low storage capacity and must therefore find ways of producing food year-round. Locally grown foods when consumed also contribute to sustainability.

This research aims to test and identify sustainable methods of increasing the crop yield of *Cucumis sativus*, through the use of organic fertilizer treatments.

II. LITERATURE REVIEW

The benefit of fertile soil to plant growth and crop yield is unquestionable. The use of soil additives such as farmyard manure, poultry manure, and inorganic fertilizer among others is well documented and highlights the benefits e.g., (Adhikari A. 2020). It is also true that the intensive use of chemical fertilizers has a deleterious effect on the soil (Stoate C. 2001) among a host of other negative effects including eutrophication of water supplies (Vitousek PM. 1997), loss of biodiversity (Green RE. 2005). To alleviate the pressure on the environment farming systems are now being reviewed to implement more sustainable practices such as the use of organic amendments for the soil e.g. (Kong L. 2014), (Ambachew ZG. 2018), (Ram M. 2012).

The use of microorganisms such as bacteria and fungi is also widely studied and used as soil or seed inoculants to improve growth and yield (American Chemical Society 1991). The use of these microorganisms has been verified in studies such as (Tarraf W 2017) and (Umesha S. 2014).

TABLE 1
CONCEPTS DEFINITIONS

Concept	Definition
Compost/ Composting	Compost is a fertilizer produced from animal dung and other organic material. Composting is a method of obtaining a biological and chemically stable and rich product from the decomposition of plants and animal residues. Bacteria are usually active in breaking down the waste material in compost. The resulting product promotes the growth of beneficial bacteria, and earthworms build soil structure and support healthy plant growth when added to the soil (Yaqub 2018).
Raw animal manure	Raw animal manure is the dung from animals such as cattle, sheep, and goats (Yaqub 2018).

With a focus on soil composition, one of the major components and important soil factors is nitrogen. Nitrogen is a basic component of structural and functional proteins in plant cells and organs. Enzymes and co-enzymes which are important for biochemical reactions have nitrogen as their core constituent. DNA and RNA are also made up of nitrogen which is a basic component of structural and functional proteins in plant cells and organs. Besides, nitrogen is a key nutrient that influences soil fertility and crop production (Krishna 2002, Singh et al., 2014). It is the most widely studied essential nutrient element as it relates to its relevance to crop physiological activity and yield as well as its behaviour in the soil. It is required in comparatively greater proportions of plants than any other essential nutrient derived from the soil (Krishna et al., 2002). Thus, nitrogen is a very important factor to be considered in soil fertility. Nitrogen is a key source for plants to achieve their potential yield. Nitrogen fertilizers are generally expensive, leach easily from the soil, and cause environmental pollution with this in mind alternatives are desirable. Some alternatives include the use of soil microorganisms which can fix atmospheric nitrogen or solubilize phosphorus or stimulate plant growth through the synthesis of growth regulators (Krishna 2002).

Various organic soil additives such as raw animal manure, treated animal manure, compost, and inorganic material are used to enhance plant growth and other output. These additives may or may not contain a mixture of nutrients including nitrogen.

Poultry manure has been long used in Jamaica and other countries as a source of soil additive to improve crop growth and yield. Poultry manure is the excrement along with the dry matter used as bedding in intensively grown broiler chicken operations. This waste is generally removed from the coop and allowed to mature for some time before it is used in the field. Poultry manure proved to increase the yield and growth performance in Abelmoschus esculentus L. Monech more than nitrogen alone, farmyard manure, and goat manure (Adhikari A. 2020).

In a recent study to investigate organic amendments and microbial application on sodic soil properties and growth of basil plant, it was found that organic amendments help improve the Physico-chemical properties of sodic soil and increase crop production (Trivedi et al., 2017). The researchers used microbial inoculation of bacteria, vermicompost, and sludge. The study concludes that the treatments positively affected, soil pH, electrical conductivity (EC), exchangeable sodium (Na), soil microbial biomass carbon (SMBC), soil microbial biomass nitrogen (SMBN), soil respiration (SR), the microbial quotient (Cmic:Corg), and metabolic quotient (qCO_2) as they were significantly higher in incubated soils than non-inoculated soils. Also, vermicompost, sludge, and microbial inoculants enhance the yield and oil quality of basil (Trivedi et al., 2017).

In a field study to look at the effects of organic and inorganic fertilizer on biomass, essential oil yield, essential oil content and compositions and antioxidant activity of denaian thyme, the researchers found that application of combined fertilizer significantly increased the biomass and essential oil yield. The treatments were: no fertilizer (control), chemical fertilizer (NPK) cow manure, vermicompost (VC) and combined fertilizers (chemical fertilizer+cow manure+vermicompost). The main essential oil was thymol. The highest amount of thymol was obtained under the application of combined fertilizers (Bistgania et al., 2018). This is in contrast to a study done by Hoseini-Mazinai et al., (2017) in which he found that the biofertilizer was the main influencer for the essential oil output. In Hoseini-Mazinai et al., (2017) study the authors found that a mixture of biofertilizers generally produced positive effects on biologically active substances. Treatments of beneficial soil bacteria (nitroxin and super nitro plus), mycorrhizae (Glomus intraradices), animal manure, chemical fertilizer (NPK) and control (no fertilizer) were added to the soil. The results showed that biofertilizer had significant effects on studied characteristics. 42

components were detected in the essential oil of *C. Officinalis* representing 94.3% of the total oil of these 29 constituents that were affected by the application of biofertilizer. The highest essential oil content and essential oil yield were obtained by using the biofertilizer (Hoseini-Mazinai 2017). The positive effects of biofertilizer over inorganic fertilizer correspond with Faramawy et al., (2014) study. This study investigated the response of *Prosopis Chilensis* to biofertilization under calcareous soil. The researchers used as treatments, active strains of *Azotobacter chroococcum* (as nitrogen-fixing bacteria), Bacillus megatherium (as phosphate dissolving bacteria), *Bradyrhizobium japonicum* (as symbiotic nitrogen fixer bacteria) and vesicular-arbuscular mycorrhizal fungi (as phosphate solubilizer symbiont) and control with no additive. The authors highlight that this quantitative variation of the flavonoids must be derived from induction by microbial inoculation (Faramawy et al., 2014).

Soil organic matter was highlighted as an important soil feature to increase active substances in the plant *Sinopodophyllum hexandru*. In a study to look at the "Influence of Ecological Factors on the Production of Active Substances in the Anti-Cancer Plant *Sinopodophyllum hexandrum*" the important active ingredients are quercetin and kaempferol. The researchers highlighted that primary ecological factors influencing the active substances included the annual average precipitation, July mean temperature, frost-free period, sunshine duration, soil pH, soil organic matter, and rapidly available potassium in the soil. They conclude that organic matter was the most important limiting factor and was significantly and positively correlated with the active substances (Liu et al., 2015). Organic amendments help to increase soil respiration and enzyme activity leading to better cycling of nutrients while making nutrients more available to the plant Khan et al., (2015). Carrots fertilized with pelleted chicken manure had 6–7% lower total soluble sugar content than carrots manured with 50 t ha^{-1} of composted or fresh manure. The falcarinol to total falcarinol-type polyacetylenes ratio was 15.4% in carrots manured with 50 t ha^{-1} of composted or fresh manure and 14.7% in carrots fertilized with pelleted chicken manure. The researchers also observed that seasonal fluctuations in falcarinol-type polyacetylenes were more pronounced in carrots manured with fresh or composted manure than in carrots fertilized with pelleted chicken manure. The authors conclude that manuring organic carrots with compost may be the most beneficial strategy in organic farming (Kjellenberg et al., 2015).

III. MATERIAL AND METHOD

3.1 Experimental site:

This pot experiment was carried out under shade house conditions at the Northern Caribbean University farm in Mandeville Manchester.

- The average daytime temperature at the research site: 27° C
- Duration of study: August 2021 – October 2021

3.2 Experimental design:

Cucumis sativum was grown for 3 months under shade house growth bag conditions. Randomized Complete Block design (RCBD) with five treatments and four replications was employed. Each block represents 40 plants with 8 plants per treatment.

3.3 Plant material and Treatment:

Plant: cucumber

- Brand: semisis
- Specie: hybrid slicing
- Variety: Thunderbird 88%+CQ 12%
- Days to harvest:50
- Fruit description: straight fruit, 4lbs per vine

Grow bags were set 2 feet * 18 inches apart.

Treatment application was done at planting and then 4 weeks after planting as a top dressing.

Irrigation was done by manually watering on the requirement.

Treatments: mature goat manure, mature rabbit manure, fruit tea (8 weeks fermented mango and **Otaheite** apple.), NPK (11:22:22) and control.

Treatments were applied in two doses of top dressing at planting and one month after planting. Forty (40) grams of each treatment was used with the first application of 20g and the second application of 20g.

3.4 Evaluation and measurements:

Plants were observed throughout the growing season.

3.4.1 Germination time:

The time is taken for germination of seeds under different treatments: observed and recorded for each plot (bi-weekly observation).

Germination rate: record made of the number of seeds germinated weekly from each plot.

(definition given consideration here is the emergence of green seedlings with one (mono) or two (di) cotyledons from the soil surface (Thomas B., Murray D. and Murphy D. 2017), Principal growth stage 0: Germination-Emergence: cotyledons break through soil surface ((BBCH working group 1997)

3.4.2 Seedling growth:

For the determination of seedling growth, the distance from the soil surface to the highest tip of the seedling was measured on all seedlings. This was done weekly starting 1 week after seed planting.

3.4.3 Time to flowering:

The time to flowering for each treatment was measured by counting the number of open flowers in each plot and treatment two times each week. Flowering was observed at principal growth stage 6: the first flower appears on the main stem (BBCH working group 1997).

3.5 Statistical Analysis:

One-Way Analysis of Variance was performed on all parametric measurements to determine significance within and between groups. Where there was significance the Turkey post hoc multiple comparison tests were used. The Spss version 28 was the software package used.

IV. RESULTS

4.1 Germination Percentage:

TABLE 2
ANOVA COMPARISON BETWEEN AND WITHIN GROUPS

ANOVA					
Germination %					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	21062.5	4	5265.625	39.186	<.001
Within Groups	2687.5	20	134.375		
Total	23750	24			

There was a statistically significant difference between the groups as determined by one-way ANOVA- $F(4,20) = 39.186$, $P<0.001$. We can see from the table below that there is a statistically significant difference in germination % with the NPK fertilizer (20 +/- 20.9 %, $p<0.001$). Fruit tea had a germination percentage of 97.5+/-5.59%, P=0.997, Rabbit manure 95 +/- 6.85%, P=0.997, goat 87.5+/-8.83%, P=0.656 and the control group having mean germination % of 87.5 +/- 8.87, P=0.656. There were hence no statistically significant differences between the groups of organic treatments (p >0.05) when comparing germination percentage.

TABLE 3
TURKEY POST HOC OF GERMINATION % COMPARISON

Dependent Variable: Germination %						
Tukey HSD -POST HOC						
(I) Fertilizer type	**(J) Fertilizer type**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Fruit Tea	NPK	77.50000*	7.33144	<.001	55.5616	99.4384
	Rabbit	2.5	7.33144	0.997	-19.4384	24.4384
	Goat	10	7.33144	0.656	-11.9384	31.9384
	Control	10	7.33144	0.656	-11.9384	31.9384
NPK	Fruit Tea	-77.50000*	7.33144	<.001	-99.4384	-55.5616
	Rabbit	-75.00000*	7.33144	<.001	-96.9384	-53.0616
	Goat	-67.50000*	7.33144	<.001	-89.4384	-45.5616
	Control	-67.50000*	7.33144	<.001	-89.4384	-45.5616
Rabbit	Fruit Tea	-2.5	7.33144	0.997	-24.4384	19.4384
	NPK	75.00000*	7.33144	<.001	53.0616	96.9384
	Goat	7.5	7.33144	0.842	-14.4384	29.4384
	Control	7.5	7.33144	0.842	-14.4384	29.4384
Goat	Fruit Tea	-10	7.33144	0.656	-31.9384	11.9384
	NPK	67.50000*	7.33144	<.001	45.5616	89.4384
	Rabbit	-7.5	7.33144	0.842	-29.4384	14.4384
	Control	0	7.33144	1	-21.9384	21.9384
Control	Fruit Tea	-10	7.33144	0.656	-31.9384	11.9384
	NPK	67.50000*	7.33144	<.001	45.5616	89.4384
	Rabbit	-7.5	7.33144	0.842	-29.4384	14.4384
	Goat	0	7.33144	1	-21.9384	21.9384

. The mean difference is significant at the 0.05 level

The average germination rate between the treatments was between 97% to 20% after 10 days. The NPK had the lowest germination rate out of the treatments applied at 20% (Figure 1). The highest germination percentage was observed in the fruit tea treatment at 97.5%. All treatments except the NPK had a germination rate above 87%. There was no overall significant difference in germination between the treatments (ANOVA- df = 4, p= .997).

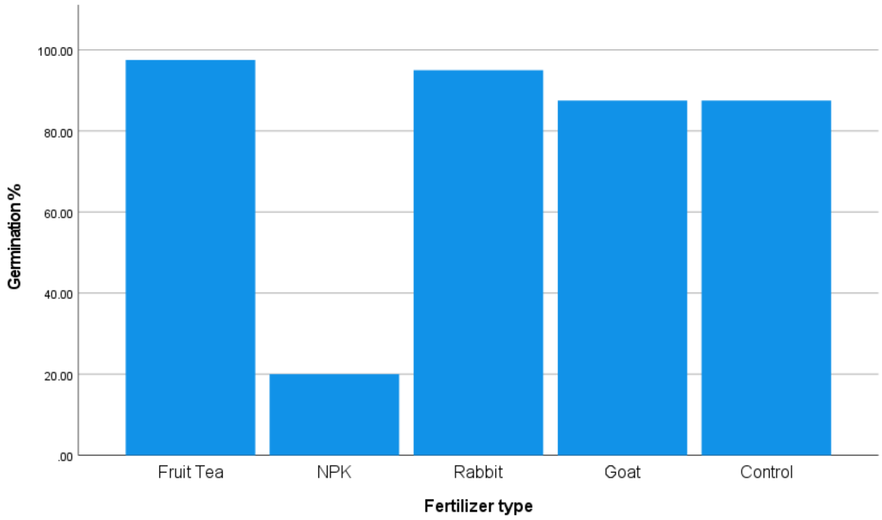

FIGURE 1: Germination percentage for treatments

It was revealing for the NPK to have such limited germination out of all the treatments, however, with further research, it was garnered that chemical fertilizers and especially its nitrogen component may harm germination. In a study done by Tange A., 2018, it was found that when chemical fertilizer was added at seed planting, it did not increase germination. It was pointed out by Kilmer J., et al, 1973, as early as the 1970s that biurets if placed near seeds in excess amount have the effect of inhibiting germination and injuring or killing seedlings. It has been found that some nitrification inhibitors may reduce seed germination (Bremner J. and Krogmeier M. 1989). These factors coupled with the close application of the NPK to the seeds may have affected their germination. It was also observed that some seedlings under the NPK treatment were burnt by the fertilizer at the second fertilizer application. These seedlings did not recover.

In a study looking at organic and inorganic manure on germination of beans, it was found that the highest germination percentage was observed in vermicompost application of the seedling (Vaithiyanathan T. and Sundaramoorthy P. 2016). This showed that organic treatments have the potential to contribute significantly to the germination of seeds.

4.2 Germination rate index:

GRI = Germination rate index (The GRI reflects the percentage of germination on each day of the germination period.)

Germination was measured at 5, 7, 10 and 13 days. The fruit tea had the lowest germination percentage at the beginning of the measurements but had the highest germination percentage after 13 days. Table 3 highlights the Germination rate Index (GRI) for the treatments at 5, 7, 10 and 13 days after planting.

The fruit tea treatment had the lowest germination at 5 days however it had the highest germination after 13 days. It had the highest increase in germination rate over 2 days (see Table 2). The control had the best germination rate index with 80% germination on day 5 after planting.

The ANOVA between-group effect showed a significant difference between the 5-, 7- and 10-day germination (ANOVA- df = 4, p.= <.001). Significant differences between treatments using Tukey's multiple comparisons test were observed as follows:

- On day 5, the rabbit, goat and control were significantly different from the fruit tea, p <.001, .006 and <.001 respectively. While at day 10, only the NPK remained significantly different from all the others (p <.001). This germination difference, in the end, may be attributed to a possible negative effect of the NPK on germination which may have been impacted by the proximity of the placement of the fertilizer to the seed when sown.

The positive germination rate index of the control is a strong indication that cucumber seeds can germinate without any assistance in the form of fertilizer application.

TABLE 3
GERMINATION RATE AT DAY AT 5, 7,10 AND 13

Day	FT	NPK	R	G	C
5	2	3	30	16	32
7	37	4	38	31	35
10	39	8	38	33	35
13	39	8	38	35	35
The TOTAL number of seedlings germinated	**117**	**23**	**144**	**115**	**137**

4.3 Seedling growth:

The ANOVA test of between group's effects showed that there was a significant difference (p=0.028) between the groups as it relates to seedling growth. Tukey's post hoc multiple comparison test did not reveal the difference observed between the groups. There was an overall difference which could not be identified in the multiple comparisons. The homogenous subsets moving together were NPK, Goat, Control and Rabbit.

The Fruit tea treatment was however observed to have the highest seedling length followed by the rabbit treatment (Figure 2). The favouring of seedling growth due to organic fertilizer treatment was consistent with Vaithiyanathan T. et al 2016 and Rajasekaran S., et al, 2015 who found that organic fertilizer had a higher growth rate in seedlings than NPK alone. Again

Jalaluddin M. and Hamid M. 2011 found that cow dung was comparable to triple phosphate when tested on seedling growth. In yet another study it was found that NPK harmed shoot length (Badar R., et al. 2015).

Though there was an overall difference in the change in plant height it could not be seen in the individual treatment comparison. No treatment could then be selected to indicate as favouring change in plant height/plant growth.

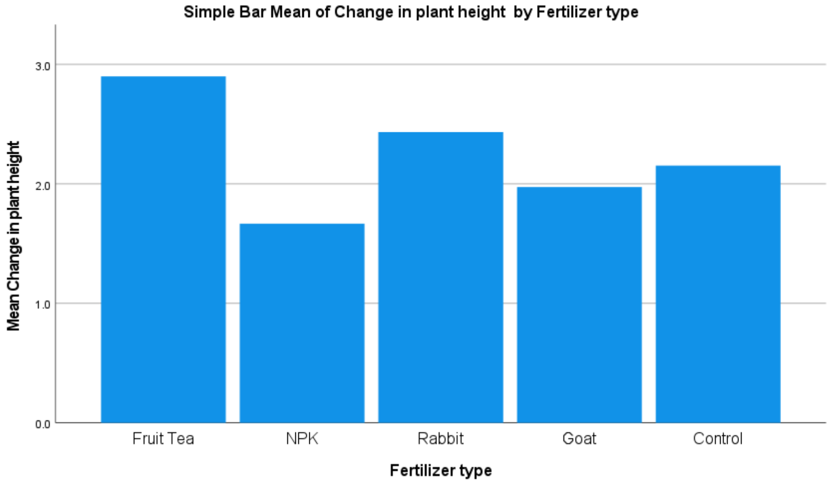

FIGURE 2: Chart showing mean change in plant height

4.4 Flowering:

Flowering in the NPK treatment was significantly different from the other treatments ($p < .001$) in both the between-group effect and the post hoc multiple comparison effect test. As it relates to homogenous subsets, the NPK was moving alone while the other treatments were grouped. This significant difference could be attributed to the low number of plants available at the time of measurement.

The treatment comprising the rabbit manure had the highest number of plants flowering at the time of measurement. This is noteworthy as it was not the treatment with the highest number of plants. The highest number of plants were in the fruit tea treatment.

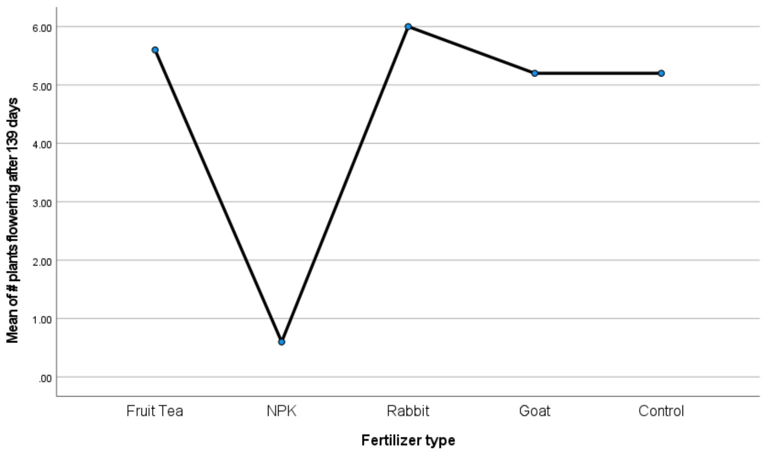

FIGURE 3: Line graph showing flowering after 139 days

V. DISCUSSION AND CONCLUSION

Germination is a critical phase in the lifecycle of a plant. This study shows that organic fertilizer treatments can have a positive effect on germination, plant growth and flowering. There is consistent evidence to show that organic manure can be highly competitive with inorganic fertilizers when used for germination, plant growth and plant yield (Jalaluddin M. and Hamid M. 2011, Vaithiyanathan T. and Sundaramoorthy P. 2016). Vaithiyananthan found that although triple phosphate had a greater germination rate than organic manure (cow dung), the cow dung gave a faster growth in the plants (Vaithiyanathan T. and

Sundaramoorthy P. 2016). Jalaluddin found that the highest germination (99%), root length, shoot length, fresh weight and dry weight were seen in combined biofertilizer application (Jalaluddin M. and Hamid M. 2011).

Organic sources such as the ones used in this research as well as green manure and compost not only increase soil fertility but also add organic matter to the soil (Ram M. 2012, Adhikari A. 2020). Organic manure provides organic acids that help dissolve soil nutrients and make them available for the plants (Obasi N., et al. 2013). Each type of organic fertiliser used has its benefits to the growth of the plant throughout its life cycle. Care needs to be taken in ensuring that plants are given the correct balance of macro and micronutrients that will aid in promoting optimal plant performance and increasing fruit yield. This research has provided valuable and statistically significant information to augment claims that organic fertilizers such as rabbit and goat manure along with fermented fruit tea offer essential nutrients and can be used as a suitable alternative to inorganic fertilizers for those farmers wishing to move into organic farming.

The shade in the greenhouse was a limitation to the normal development of the cucumber plants. Additional follow-up research is recommended in an area with sufficient light as well as recommendation to conduct yield measurements with these treatments.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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