Growth And Yield Performance Of Mungbeans (Vigna Radiata L.) Applied With Organic Fertilizer With Rhizobium Microbial Inoculants

DG Brian A. Guayan, Kathleen Grace S. Paraguas, Denis A. Tan

Abstract: The Earth has been facing a lot of climate change lately due to global warming. This gives rise to being more innovative with our waste and start recycling and producing it into another substance that would also help us in terms of agriculture. Since there is also an ongoing pandemic that is happening it is also best to stay at our households and start practicing healthy living. This study assessed the effects of organic fertilizer made from chicken manure, carbonized rice hull and mud press with microbial inoculant on the growth and yield performance of the mungbeans. To determine what composition of organic fertilizer (OF) and garden soil (GS) would give a better or best growth and yield performance of mungbeans, treatments with varied proportions were tested with T0 (100% GS), T1 (25% OF + 75% GS), T2 (50% OF + 50% GS), T3 (75% OF + 25% GS) in plot beds with three replicates using Randomized Completed Random Block (RCBD) design. Results showed that T2 produced the highest plant height, most numbered leaves and branches. Analysis of Variance (ANOVA) test indicated a significant difference in the number of pods per plant between treatments but no significant difference in the number of seeds per pod and the weight of 1000-seeds. Post hoc test revealed that T2 produced best yield performance of mungbeans in terms of the number of pods per plant. This suggests that among the treatments of organic fertilizer, its suitable mixture with garden soil is 50%-50% giving a very high significant difference ($p<0.000$) of yield performance compared to the other treatments in the study.

Keywords: Carbonized Rice Hull, Chicken Manure, Mud press

1 INTRODUCTION

These recent years, the world is facing the threat of climate change due to global warming which is brought about by Green House Gases (GHGs). Many scientists, agriculturists, world leaders, educators, researchers and other stakeholders take initial steps to mitigate the effect of global warming to mankind especially that we only have the Earth as a place to live in. Some initiatives like solid waste management, utilizing sustainable organic farming and the like have been implemented. Researches on harnessing the solar power to make solar panel using mathematical concepts by high school students were also conducted as examples of these ingenuities [1] – [2]. In the study on "Climate Change Mitigation Beyond Agriculture" stressed out that utilization of inputs such as fertilizers can provide benefits for food security and minimize agricultural expansion when coupled with land governance and sustainable efficiencies, providing net reductions to GHGs [3].

With the ongoing pandemic that is happening it is also best to stay at our individual households and practice healthy living or urban farming by planting vegetables in our backyards.

As for the vegetable, the mungbean had the ability to fix atmospheric nitrogen (N) in the area and not only that it also contains good nutritional value but mungbean seems to had an imbalanced nutrition [4]. Therefore, using the rhizobium and organic fertilizer would enhance its results. The effects of rhizobium had been proven [5], he stated that "rhizobium application increased the plant height, total number of pod, and 1000-grain weight significantly". Combined with using organic fertilizer contains carbonized rice hull, chicken manure, mudpress with microbial inoculant to encourage people to recycle these so called agricultural wastes into organic fertilizer. With this development of urban farming at the time of pandemic is a good practice for both helping reduce global world issues as well as promoting better recycling mindset.

- *DG Brian A. Guayan is a senior high school student of Central Mindanao University Laboratory High School, Bukidnon, Philippines. He is currently enrolled in the Science, Technology, Engineering, and Mathematics (STEM) strand of the Academic track +639367479700 s.guayan.dgbrian@cmu.edu.ph*
- *Kathleen Grace S. Paraguas is a faculty of the CMu Laboratory High School teaching science courses. She serves as adviser and panel members of the investigatory projects of students for the past years. f.kathleengrace.paraguas@cmu.edu.ph*
- *Denis A. Tan is a faculty of the College of Education, Central Mindanao University (CMU), Philippines. She is the former School Principal of the CMU Laboratory High School and currently the Director of the Office of Admissions, Scholarships and Placement (OASP) in the same university. +639177103100, teacher.tansined@gmail.com*

1.1 Objectives of the Study

The study aimed to assess the effect of organic fertilizer made from chicken manure, carbonized rice hull and mud press with microbial inoculant on the growth of mungbeans and more specifically to:

1. assess the effects of organic fertilizer with Microbial Inoculant on the growth of Mungbean base of the following parameters:
   a) Plant height;
   b) Number of leaves
   c) Number of branches
2. assess the effects of organic fertilizer with Microbial Inoculant on the Yield of Mungbean base of the following parameters:
   a) Number of pods per plant
   b) Number of seeds per pods
   c) Weight of 1000-seed
3. determine if there is a significant different on the yield of mungbeans applied with organic fertilizer with microbial inoculant.

2 METHODOLOGY

2.1 Research Design

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four (4) treatment and replicated thrice. Group of four (4) plots representing three (3) replication inside the plot with a distance of thirty (30)

centimeter from each group were made. Randomization was done through drawing of lots.

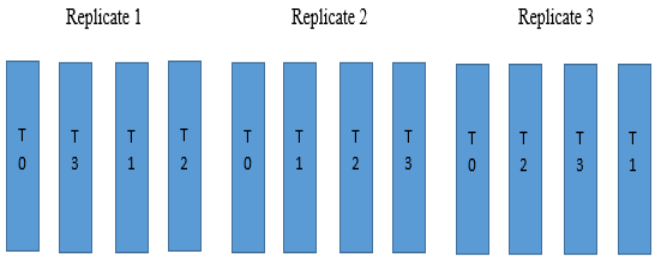

Figure 2. Randomized layout of the experimental plots in Randomized Complete Block Design (RCBD).

2.2 Treatment Design

A total of three (3) treatments and one control were utilized in this study. Each was replicated thrice and consists of 20 plants per replicate. The treatments were as follows:

T_0 – Pure Garden Soil (Control Group)
T1 - 25% organic fertilizer with MIs and 75% garden soil
T2 - 50% organic fertilizer with MIs and 50% garden soil
T3 - 75% organic fertilizer with MIs and 25% garden soil

Treatment 1 was prepared by mixing 2 sacks of prepared organic fertilizer with 6 sacks of garden soil. Treatment 2 was prepared by mixing 4 sacks of organic fertilizer with 4 sacks of garden soil. Treatment 3 was prepared by mixing 6 sacks of organic fertilizer with 2 sacks of garden soil. T_0 or the control group consist of about 8 sacks of pure garden soil with no Microbial Inoculant addition.

2.3 Preparation of Organic Fertilizer with Microbial Inoculant

A total of 36 sacks of organic fertilizer (12 sacks per block/set of replicates) had been used in this study. The organic fertilizer was produced group of scientists [6] and by composting chicken manure, carbonized rice hull and mud press in 4:3:3 ratio. About 200ml of prepared *Rhizobium* Microbial Inoculant solution (MIs) was added in the said compost. The prepared *Rhizobium* Microbial Inoculant solution (MIs) was bought from Biolife Company in R. Castillo, Davao City. The Chemical and Biological Composition of the Organic Fertilizer used in this study is reflected in Appendix Table 1.

2.4 Seedbed Preparation

Strip tillage method was employed in the preparation on Mungbean seedbed. The land was sub soiled and a strip of soil of about 20-30 cm was tilled leaving, the soil between the rows remains undisturbed. This was done by manually loosening the soil to allow the pegs to penetrate easily with the use of bolo and other garden tools for a deep of 8 – 9 inches. The seedbeds were watered thoroughly to ensure enough soil moisture was available [7]-[8]. The dimensions of the seedbed were 100cm by 300cm by 15cm and a gap of 30 cm.

2.5 Planting

About three (3) mungbean seeds were sown at a depth of 4 cm to 6 cm depth in each hole in each seedbed. Each seedbed had sixty (60) mungbeans planted at least 50 cm apart from each other. Only intact Mungbean seed was planted as seeds that splits do not germinate. The seeds were planted early in the morning. The seedlings were watered as to maintain soil moisture as needed through misting. Thinning of germinated seeds were done until the healthiest seedling were left in each hole of the seedling tray [8]. The seedlings were allowed to grow until harvest.

2.6 Care, Maintenance and Harvesting

Mungbeans were uniformly watered in each seedbed every other day or as needed to maintain soil moisture and to obtain maximum growth. Insect pests and weeds were controlled manually through handpicking. Mungbean had been harvested when seventy five percent (75%) of the crop had black or yellowish-black pods. Harvesting was done manually by carefully hand picking the matured dried pods [9].

2.7 Data Collection Procedure

Emergence of plants was counted from starting to a constant number of plants in each plot. Experimental data were determined from 7 days of growth duration and continued until harvest. The growth and yield parameters were measured using the succeeding methods [10] which includes the following:

2.8 Crop Growth Parameters. Growth parameters was measured from five (5) selected plants from each plot and it was measured weekly from sowing up to 6 weeks.

A. **Plant Height (cm).** The height of the plant was determined by measuring the distance from the soil surface to the tip of the leaf of main shoot. Measurement was done with the use of a ruler and was measured in centimeters (cm).
B. **Number of leaves.** The number of leaves from five selected plants was determined by counting each available leaf and calculating the average from the counted leaves.
C. **Number of Branches in Plant.** Branches number were counted from ten pre-selected plants per replicate per treatment and the mean value was determined.

2.9 Crop Yield Parameters. Yield parameters was measured from ten (10) selected plants in each plot. The 10 selected plants was different from the five selected plants for the growth determination. Yield parameters were measured during harvest.

A. **Number of Pods per Plant.** Pods of ten pre-selected plants were counted and the average pods for each plant was determined.
B. **Number of seeds per pod.** Seeds from the ten pre-selected pods were counted and the average number of seeds per pod were determined.
C. **Weight of 1000-seed.** One thousand dried seeds were counted from each replicate per treatment and was weighed using a digital electronic weighing scale.

2.10 Data Analysis

The gathered data during the experiment were analyzed using descriptive statistics to assess the effects of the organic fertilizer on the growth and yield performance of mungbeans. To determine which of the treatments has better agronomic characteristics and growth performance, Analysis of Variance

(ANOVA) was used. Post hoc tests using Least Square Difference (LSD) and Duncan Multiple Range Test (DMRT) were utilized when a significant difference existed in the ANOVA tests.

3 RESULT AND DISCUSSION

3.1 Growth Parameters

Mungbeans plant height, number of leaves and number of branches under T0 (Pure Garden Soil); T1 (25% organic fertilizer with Microbial Inoculants (Mis) and 75% garden soil), T2 (50% organic fertilizer with Microbial Inoculants (Mis) and 50% garden soil) and T3 (75% organic fertilizer with Microbial Inoculants (Mis) and 25% garden soil) were monitored and recorded weekly for six (6) weeks to determine its vegetative growth. Results were as follows:

3.1.1 Plant Height

The data obtained for plant height were summarized and presented in the bar graph (fig. 4).

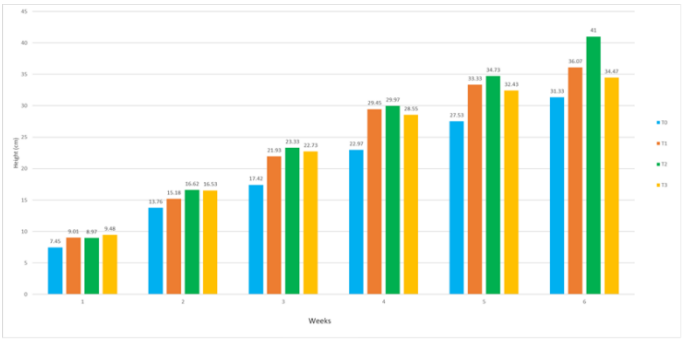

Figure 3. Plant Height of Mungbean from week 1 to week 6.

As shown in the figure above, there is an increasing trend in the height of Mungbean from the first week to the 6 weeks of treatments. Recorded mean height for T_0 is 7.45, 13.76, 17.42, 22.97, 27.53 and 31.33 for week 1, 2, 3, 4, 5 and 6 respectively. For T_1, recorded mean height were 9.01, 15.18, 21.93, 29.45, 33.33, and 36.07 for week 1, 2, 3, 4, 5 and 6 respectively. For T_2 mean height of 8.97, 16.62, 23.33, 29.97, 34.73 and 41 for week 1, 2, 3, 4, 5 and 6 respectively. While for T_3, recorded mean height were 9.48, 16.53, 22.73, 28.55, 32.43 and 34.47 for week 1, 2, 3, 4, 5 and 6 respectively. It can also be observed that T2 has the highest recorded mean height from week 2 – week 6. While the control had showed to have the least recorded mean height from week 1-6 consistently. Results can be attributed to the effect of microbial inoculant in each treatment. Microbial inoculants increase plant growth by promoting root development and alter root architecture *via* the production of phytohormones like Indole-3-Acetic Acid (IAA) [11]. It results in increased root length, root surface area numbers of root tips and volume leading to increase nutrient uptake. It is also reported that the presences of microbial hyphae in soil provides an efficient pathway for nutrient and water up taking and transporting, allowing a more efficient exploitation of water and nutrient reservoirs to be available for plant [12].

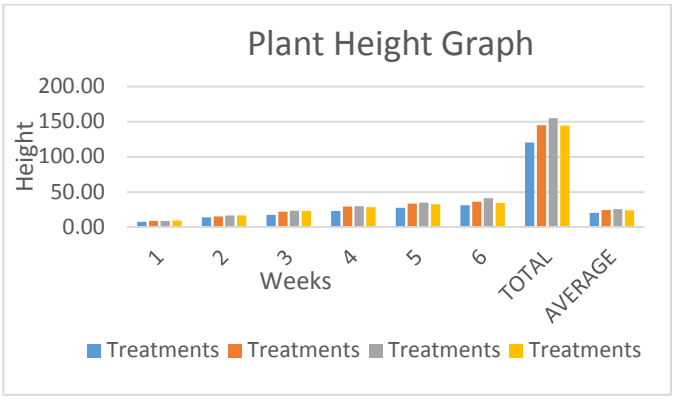

Figure 4. Graph of Plant Height (cm) within 6 weeks

3.1.2 Number of Leaves

The data obtained were summarized and presented in bar graph (fig. 5). As shown in figure below, there is an increasing trend in the number of leaves of Mungbean from the first week to the 6 weeks of treatments. Recorded number of leaves for T0 were 2, 5.44, 8.8, 13.07, 15, and 16.4 for week 1, 2, 3, 4, 5, and 6, respectively. For T_1, recorded mean height were 2, 5.8, 8.8, 13.07, 15, and 16.4 for week 1, 2, 3, 4, 5 and 6 respectively. For T_2 mean height of 2, 6, 11.2, 15.4, 18.07 and 19.07 for week 1, 2, 3, 4, 5 and 6 respectively. While for T_3, recorded mean height were 2, 5.8, 10.4, 14.6, 15.87, and 17.13 for week 1, 2, 3, 4, 5 and 6 respectively. It can also be observed that T2 has the highest recorded mean height from week 2 – week 6. While the control had showed to have the least recorded mean height from week 1-6 consistently.

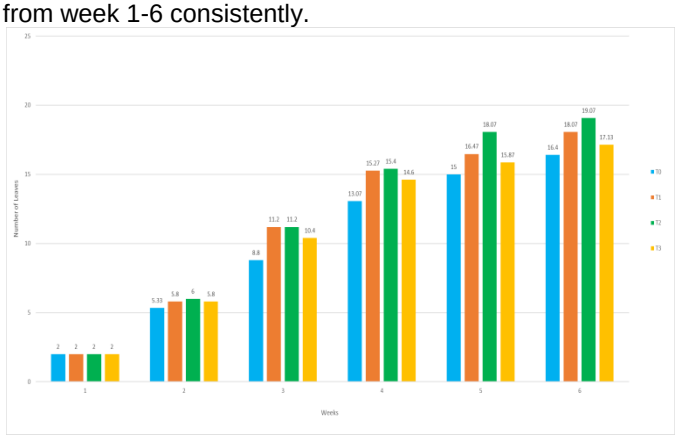

Figure 5. Mean Number of Leaves in Mungbean from week 1 to week 6.

The result displays that the treatments have different number of portions of organic fertilizer with microbial inoculant and the number of leaves along with the plant height of the mungbean is directly proportional with Treatment 2 being highest in the plant height. The use of bacterial bio stimulant can modify seedling growth and its response to nutrient availability allowing promoted plant growth and development and allowed seedlings to reach the highest height and biomass production as reported by researchers [13]. This is in consonance with the study which reported that seed inoculation significantly increased the growth parameters of mungbean [14].

3.1.3 Number of Branches

The data obtained for the number of branches were summarized and presented in bar graph (fig. 6) Recorded mean number of branches for T_0 were 0, 1.13, 2.27, 3.67, 5.93 and 8 for week 1, 2, 3, 4, 5 and 6 respectively. For T_1, recorded mean number of branches were 0, 1.27, 3.07, 4.47, 7.47 and 9.53 for week 1, 2, 3, 4, 5 and 6 respectively. For T_2 mean number of branches of 0, 1.33, 3.07, 4.47, 7.8 and 10.8 for week 1, 2, 3, 4, 5 and 6 respectively. While for T_3, recorded mean number of branches were 0, 1.27, 2.8, 4.2, 7.33 and 9 for week 1, 2, 3, 4, 5 and 6 respectively. The highest mean number of branches was recorded in T_2 on its six (6) weeks with a mean of 10.8. T_0 consistently have the lowest mean number of branches throughout the study.

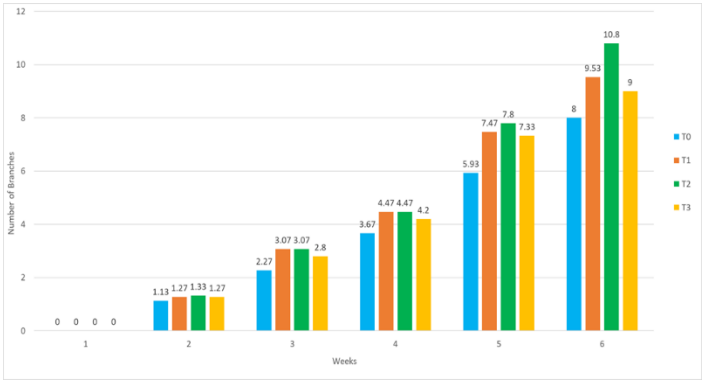

Figure 6. Mean Number of Mungbean branches from week 1 to week 6.

The result is attributed to the growth stimulating effect of microbial inoculant among plants. Treatment 2 having the greathest number of branches is directly proportional to the plant height. This is in agreement with the researchers' findings that plant height was strongly associated with main branches per plant and pods per plant [15].

3.2 Yield Parameters

The number of pods per mungbean, number of seeds per pods and the eight of 1000 mungbean seeds grown under T_0 (Pure Garden Soil); T_1 (25% organic fertilizer with Microbial Inoculants (Mis) and 75% garden soil), T_2 (50% organic fertilizer with Microbial Inoculants (Mis) and 50% garden soil) and T_3 (75% organic fertilizer with Microbial Inoculants (Mis) and 25% garden soil) were monitored to determine its yield. Data were collected during harvest. Results were presented in the succeeding paragraphs.

3.2.1 Number of Pods per Plant

The data that are presented below were gathered around the 8th week during the conduct of the study. The data gathered during this week is insufficient to generate data of significant difference among treatments especially that flowers were not yet fully turned into pods. For the number of pods per plant, the result shows that treatment 2 has the largest, having 11.63 and followed by treatment 1, control group, and treatment 3. The pod formation has been affected by the amount of organic fertilizer with microbial inoculant per treatment. Among the other treatments the maximum number of pods is at Treatment 1 having 23 maximum number of pods. Compared to result of other study [16], the maximum pod formation is at 24 pods and having it at 42.11% higher than the controlled group. Though treatment 1 only has a mean of 10.87, treatment 2 has a more stable and higher pods per plant compared to treatment 1. Putting the results in a higher scale of mungbean plants and if the study was implemented in a larger scale, the disparity would be greatly visible.

Table 1: *Number of pods per plant*

Number of pods per plant /Treatments	N	Mean	SD
Treatment 0 (100% Garden Soil)	30	10.33	4.901
Treatment 1 (25% OF + 75% GS)	30	10.87	4.524
Treatment 2 (50% OF + 50% GS)	30	11.63	4.148
Treatment 3 (75% OF + 25% GS)	30	10.13	3.451
Total	120	10.74	4.275

Table 2 below presents the number of pods collected on the 10th week during harvest time. At this point, all flowers were turned into pods unlike the preceding table. It shows that treatment 2 has the highest number of pods per plant in all of the other treatments having a 15.90 mean pods and followed by treatment 3, treatment 1, and the controlled group, having 13.57, 13.10, and 10.70 mean pods, respectively. The 10th week data shows that it's similarly to the previous result of the number of pods per plant [16].

Table 2: *Number of Pods per Plant (10th week)*

Number of pods per Plant/Treatments	Mean	SD
Treatment 0 (100% Garden Soil)	10.70	2.628
Treatment 1 (25% OF + 75% GS)	13.10	3.845
Treatment 2 (50% OF + 50% GS)	15.90	2.893
Treatment 3 (75% OF + 25% GS)	13.57	4.819
Total	13.32	4.052

3.2.2 Number of Seeds per Pod

Observed number of pods per plant were summarized and presented in bar graph (fig. 8). The highest mean number of seeds per pod were recorded in T_2 with 10.2, followed by T_3 and T_1 with 9.83 and 9.8 respectively. While the lowest mean number of seeds per pod were recorded in T_0 with, recorded mean of 9.47. The height and number of branches per plant affects the results. It was reported that plant yield is significantly correlated with the number of grains per pod, pods per plant and main branches per plant and plant height. The findings of this study exemplify the previous investigation [15].

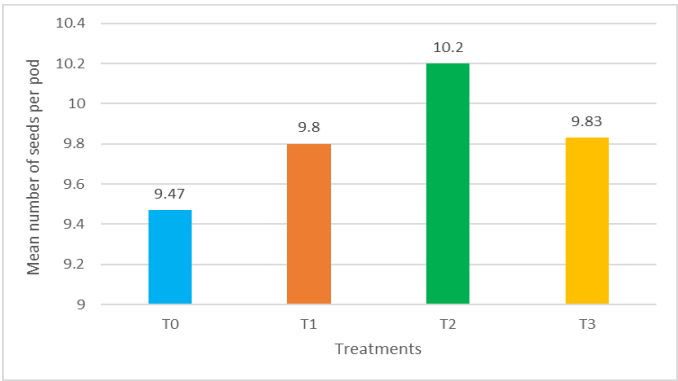

Figure 8. Mean number of seeds per pod.

3.2.3 Weight of 1000-seed

Observed number of pods per plant were summarized in Appendix Table 18 and is presented in bar graph (fig. 9).

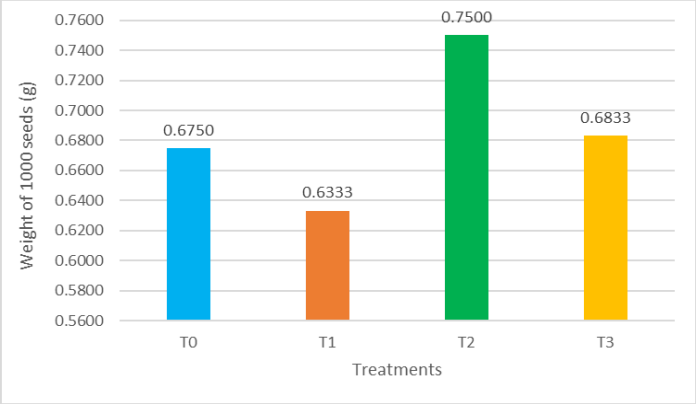

Figure 9. Weight of 1000-seeds per treatment

As observed from figure 9, T_2 have the highest recorded weight for 1000 seeds followed by T_3 and T_0 with 0.7500g, 0.6833g and 0.6750 g respectively. T_1 has the lowest recorded weight of 0.6333g. Results can be attributed to the growth response of mungbean on the effects of the microbial inoculant. Salihi et al. (2018) reported that inoculation increased nitrogenase activity in nodules and concentration of micronutrients causing a high formation of seeds and nodules in mungbean. The height and number of branches per plant also affects the results. It was reported that plant yield is significantly correlated with the number of grains per pod, pods per plant and main branches per plant and plant height [15]. This result is in consonance with the findings which reported an increased weight of seeds on plants with microbial inoculant [16].

3.3 Comparison of Yield Performance

The tests for difference using the Analysis of Variance (ANOVA) with Duncan Multiple Range Test (DMRT) as the post hoc test used to compare the yield performance of mungbeans between treatments are presented in tables 3, 4, 5 and 6 for number of pods per plant, number of seeds per pod and weight of 1000-seed. Table 4 displays the DMRT post hoc test result of the number of pods per plant between treatments indicating that the ANOVA test showed significance difference as shown in Table 3. It shows that the F-value is 10.23 ($p<0.000$) which indicates significant difference in the number of pods per plant in the different treatments.

Table 3: *ANOVA table of Number of pods per plant in the Different Treatments*

Groups	N	Mean	SD
T0 (100% Garden Soil)	30	10.70	2.628
T1 (25% OF + 75% GS)	30	13.10	3.845
T2 (50% OF + 50% GS)	30	15.90	2.893
T3 (75% OF + 25% GS)	30	13.57	4.819
Total	120	13.32	4.052

Number of seeds per pod	Sum of Squares	df	Mean Square	F	p-value
Between Groups	408.900	3	136.300	10.233	.000
Within Groups	1545.067	116	13.320		
Total	1953.967	119			

Table 4: Post Host Test of the Number of pods per plant in Different Treatments

Duncan(a)/Treatment	N	Subset for alpha = .05		
		1	2	3
Treatment 0 (100% Garden Soil)	30	10.70		
Treatment 1 (25% OF + 75% GS)	30		13.10	
Treatment 3 (75% OF + 25% GS)	30		13.57	
Treatment 2 (50% OF + 50% GS)	30			15.90
Sig.		1.000	.621	1.000

Table 4 shows that the largest mean favors Treatment 2 being at the lead for having 15.90 and followed by Treatment 3, Treatment 1 and Control Group, the results were 13.57, 13.10, and 10.70, respectively. It further implies that Treatment 2 having mean of 15.90 pods per plant is significant higher than the rest of the treatment groups. Treatment 1 and Treatment 2 indicates comparable results in the yield performance in terms of number of pods per plant, having the control group as the lowest. This finding is in consonance with the study having the highest number of pods per plant of 24 [16]. The findings reveal that having an equal portion of added nutrients to the soil could increase the yield performance of the mungbeans. Comparing the result from the Control group, the Treatment 2 is 5.2 higher and a 2.33 gap between Treatment 2 and Treatment 3, while 2.80 gap in Treatment 1. As for the number of seeds per pod, ANOVA test shows that there is no significant difference in the mean value of the number of seed per pod indicating that all treatment groups produce similar results as shown in Table 5. It also implies that the data that has been gathered was not enough to generate a significant difference among treatments. However, putting it in a bigger scenario of having a lot of sample size the result would be greatly significant. As for the highest in number of seeds per pods, Treatment 2 produces the highest mean of 10.20 and followed by Treatment 3, Treatment 1 and lastly the Control Group, having a mean of 9.83, 9.80, and 9.47, respectively. Similar results of number of seeds per pods were found indicating that the number of seeds per pod had considerable variations. Though the variations in this study do not produce significant difference [16].

Table 5: ANOVA Table of Number of seeds per pod

Groups	N	Mean	SD
T0 (100% Garden Soil)	30	9.47	2.063
T1 (25% OF + 75% GS)	30	9.80	1.827
T2 (50% OF + 50% GS)	30	10.20	1.750
T3 (75% OF + 25% GS)	30	9.83	2.086
Total	120	9.83	1.930

Number of seeds per pod	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.092	3	2.697	.719	.543
Within Groups	435.233	116	3.752		
Total	443.325	119			

The table 6 below displays the test of difference on the yield performance of mungbean in the different treatments groups in terms of the weight of 1000-seeds. ANOVA tables shows homogenous subset indicating a no significance difference in the weight of 1000-seed among the treatment groups. This finding implies that regardless of the treatment, the weight of the 1000-seed is comparable.

Table 6: ANOVA Table of the 1000-seed weight in Different Treatments

Groups	N	Mean	SD
T0 (100% Garden Soil)	3	0.6750	.03536
T1 (25% OF + 75% GS)	3	0.6333	.07638
T2 (50% OF + 50% GS)	3	0.7500	.08660
T3 (75% OF + 25% GS)	3	0.6833	.10408
Total	12	0.6864	.083994

Number of seeds per pod	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.021	3	.007	.982	.454
Within Groups	.050	7	.007		
Total	.070	10			

However, it is noteworthy to compare the mean of each group having Treatment 2 with the highest mean, followed by Treatment 1 and 3, and the control group as the last, with 0.75 g, 0.6833 g, 0.6833 g and 0.6333 g, respectively. Macroscopically speaking, this little difference would significant result to the bigger yield in favor to Treatment 2 with 50% OF and 50% GS. This finding contradicts the results of a study when they found that the maximum 1000-seed has improved by 30% compared to their control treatment [17]. This may be attributed to the pests' attacks during the conduct of the study. The results of the study further indicate that the growth and the yield performance of mungbeans in the different treatment groups indeed vary.

4 CONCLUSION AND RECOMMENDATIONS

Organic fertilizer with microbial inoculant increases the plant height, number of leaves, number of branches, number of pods per plant, number of seeds per pods, and weight of 1000-seed. The number of branches in the mungbean plant is associated with its yield performance. There is a comparable effect of the mixture of organic fertilizer with microbial inoculants in the number of seeds per pod and the weight of 1000-seeds. The treatment that produces maximum results in the growth and yield performance of mungbeans in terms of mean value in the number of pods per plant is Treatment 2 having a mixture of 50% organic fertilizer with MI and 50% garden soil. Based on the results of the investigation, the researcher would like to recommend that: organic fertilizer with microbial inoculants may be utilized using 50%-50% mixture with garden soil; further studies may be conducted using another plant and incorporating organic pests control to improve yields; conduct soil analysis of the 50%-50% mixture and consider conducting the same study in a macro scale to possibly gather a significantly better results.

5 REFERENCES

[1]. Benguar, A.N.D, Casiano, P.G.T., Valdehueza, T.L., & Tan, D.A., Golden Ratio Applied in the Orientation of Solar Cells in a Golden Spiral Solar Panel, International Journal of Development Research, Volume 8, Issue 5, 20416-20420, May 2018.

[2]. Aguinsatan, R.R.G., Remedio, V.C., Sarausa, I.R.J.V., Talibong, C.A.D., & Tan, D.A. (2019). Comparative Study on the Energy Efficiency of Angle-oriented and Golden Spiral Solar Panels, International Journal of Development Research, 9(4), 27142-27146.

[3]. Niles, M.T., Ahuja, R., Barker, T., Esquivel, J. Gutterman, S., Heller, M.C., Mango, N., Portner, D., Raimond, R., Tirado, C., & Vermeulen, S. (2018). Climate change mitigation beyond agriculture: a review of food system opportunities and implications. Renewable Agriculture and Food Systems. 33(3), 297-308. Doi: 10.1017/S1742170518000029

[4]. Hussain, F., Huma, Z., Mahmooda, Buriro, M., & Nizamani, R.M. (2016). Growth and Yield Response of Mungbean to Different Levels of Potassium. International Journal of Agricultural and Environmental Research. 2(1), 67-76.

[5]. Hussain, F., Malghani, A.U., Haji, M.A., & Malghani, A.L. (2014). Growth and yield response of two cultivars of mungbean (Vigna radiate L.) to different potassium levels. The Journal of Animal and Plant Sciences. 21(3). 622-625.

[6]. Tan, R.J., Escuadra, G.E., Faderugao, I.L., et al. (2015). Evaluation of New Compost Formulations. Unpublished Research. Kibangan, NSKY Zone.

[7]. Lohmiller, S., Valdebenito, M., & Seisenbeis, S. (2008). NagA-dependent uptake of N-acetyl-glucosamine and N-acetyl-chitin oligosaccharides across the outer membrane of Caulobacter crescentus. J. Bacteriol. National Center for Biotechnology Information. doi: 190:5230-5238.

[8]. Putman, D. H., Oplinger, E. S., Teynor, T. M., et al. (1991). Peanut. Department of Agronomy and Plant Genetics, Minnesota Extenion Service, University of Minnesota, St. Paul, MN 55108.

[9]. UPLB-NFAC guidebook for Upland Crops Testing and Evaluating. (1999).

[10]. Rahman, A. (2017). Growth and Yield Performance of Mungbean (Vigna radiate L. Wilczek) under the Application of Differeent Herbicides. Department of Agronomy, Cher-Bangla Agricultural University. Master's Thesis.

[11]. Alori, E., Babalola, O., & Prigent-Combaret, C. (2019). Impacts of Microbial Inoculants on the Growth and Yield of Maize Plant. The Open Agriculture Journal, 13 (1), pp.1-8.

[12]. Bargaz, A., Lyamlouli, K., Chtouki, M., Zeroual, Y., & Dhiba, D. (2018). Soil Microbial Resources for Improving Fertilizers Efficiency in an Integrated Plant Nutrient Management System. Frontiers in microbiology, 9, 1606. https://doi.org/10.3389/fmicb.2018.01606

[13]. Vetrano F, Miceli C, Angileri V, Frangipane B, Moncada A, Miceli A. Effect of Bacterial Inoculum and Fertigation Management on Nursery and Field Production of Lettuce Plants. Agronomy. 2020; 10(10):1477. https://doi.org/10.3390/agronomy10101477

[14]. Ahamed, K.U., Hasanuzzaman, M., Nahar, K., et al. (2011). Growth Pattern of Mungbean at Different Planting Distance. Academic Journal of Plant Sciences. 4(1). 6-11.

[15]. Canci, H., & Toker, C., (2014) . Yield Components in Mungbean [Vigna radiate (L.) Wilczek]. Turkish Journal of Field Crops. 19(2). 258-261.

[16]. Ahmad, A., Ali, A., Aslam, Z., et al. (2014). Growthm nodulation and yield components of mungbean (Vigna Radiata) as affected by phosphorus in combination with

rhizobium inoculation.African Journal of Agricultural Research. 9(30) 2319-2323.

[17]. Matkarimov, F., Jabborova, D., & Saidmurot, B. (2019). Enhancement of Plant Growth, Nodulation and Yield of Mungbean (Vigna radiate L.) by Microbial Preparations.

Appendix Table 1: *Chemical and Biological Composition of the Organic fertilizer used in this study.*

Chemical Properties	
C:N Ratio	17.9
OM(%)	41.9
CEC(me/100g)	68.2
EC(ms/cm)	3
N(%)	2.1
P2O5(%)	0.6
K2O(%)	1.2
Ca	4.8
Mg	0.9
SiO2	4.6
Microbial Composition	
Actinomycetes	1x10^5
Fungi	1.3x10^4
Bacteria	1.6x10^4