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The effect of chicken manure tea and vermicompost on some quantitative and qualitative parameters of seedling and mature greenhouse cucumber

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ABSTRACT

Nowadays, to produce healthy foods, application of compost and other organic fertilizers has received more attention as a suitable alternative for utilization of chemical fertilizers. This study was conducted to evaluate the effect of chicken manure tea and vermicompost application on some quantitative and qualitative traits in seedling and mature greenhouse cucumber (*Cucumis sativus* cv. Extreme), in a research greenhouse in Iran's Tehran Province. The experiment was factorial in a randomized completely block design with four replications. Treatments were control (without any fertilizer), control with chemical fertilizer (20-20-20), vermicompost in two levels (20 and 30%), and chicken manure tea (25, 50, and 75%). Results showed that increasing the amount of chicken manure tea (up to 50%) significantly increased shoot length, stem diameter, true leaf length and width, shoot fresh and dry weights, and chlorophyll content, days until flowering, yield (40, 65, and 90 days after culturing), marketable fruit ratio to second degree fruit, and total fruit weight of cucumber. By enhancement in content of chicken manure tea (75%) all traits showed the same result as treatment with chemical fertilizer.

1. INTRODUCTION

Cucumbers, fruit in the *Cucurbitaceae* family, have numerous uses for salad as a food. They contain high levels of lignins, Vitamin K, cucurbitacins, and their derivatives (triterpenoids), flavonoids (apigenin, luteolin, quercetin, and kaempferol), and antioxidants such as beta carotene and Vitamin C, and B Vitamins, among other trace elements and minerals [1]. Important vegetable crops grown in Iran are onion, tomato, cabbage, and cucumber. Since cucumber is used as a fresh product, the chemicals and residual toxins, remains in the organic seedlings are very important. High performance and out-of-season products in greenhouse use up to 95% less water than traditional agriculture, which has led to increasing growers' attention [2].

Cucumber is very sensitive to both abiotic and biotic stresses, and serious problems can occur under unfavorable environmental conditions. There are advanced techniques for retention of soil moisture including vermicompost and chicken manure tea. With the addition of these materials to soil, holding capacity of water increases in the soil and water permeability in heavy soils and the rate of water evaporation decrease in soil. Possible use of organic agricultural wastes and super absorbent is essential in prevention of environmental impacts of agricultural wastes. Compost tea has been introduced as a vermicompost aqueous extract containing many elements of organisms, such as bacteria and fungi. The aqueous vermicompost extract is used to improve better growth and yield of organic culture. Manure compost has been widely applied, as it is highly accessible at low price [3]. In this regard, the use of organic fertilizers is an appropriate approach to increase production and yield per unit area. The use of organic fertilizers such as animal fertilizers or compost in agriculture has given special attention to sustainable agricultural enthusiasts; on the other hand, this process can reduce their concerns about the accumulation of hazards waste in environment [4].

Previous research showed that vermicompost could significantly increase the growth, development, and yield of seedlings of tomato, and cucumber [5]. Some studies have indicated an increased growth and protein content in *Pisum sativum* plants in response to vermicompost application [6]. According to some, vermicompost treatment compared to other treatments was appropriate for optimum plant growth in cucumber [7].

Therefore, the present study was undertaken to investigate the influence of effective compounds on some quantitative and qualitative parameters with appropriate concentration of chicken manure tea and vermicompost in cucumber seedlings. Another arena is the production

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of compounds that help in the absorption of water and increase yield, which leads to keeping the quality of mature greenhouse cucumber.

2. MATERIALS AND METHODS

This experiment was conducted in the commercial greenhouse to cultivate cucumber located in Tehran Province (35.6892° N, 51.3890° E). Seeds were purchased from Kimia Company.

Chicken manure and vermicompost were mixed with tap water in a ratio of 1:4 (v/v) in polyethylene non-degradable 25 L containers at room temperature for a brewing period lasting 2 days. Next, the liquid was filtered through double-layered cheesecloth to obtain the aerated compost tea and the vermicompost teas (VT) which were both stored in dark polyethylene containers at room temperature for 15 days before use. The pH and electrical conductivity (EC) were determined using a CRISON pH-meter and a CRISON EC-meter (dS m^{-1}), respectively. Total N was determined by a LECO-device analyzer. NO_3^-, NH_4^+, and SO_4^{2-} were analyzed by a HANNA HI 993310 photometer. Phosphorus (P_2O_5) was determined by the Bray method and potassium (K_2O) by the ammonium acetate method. Total magnesium (Mg), calcium (Ca), iron (Fe), copper (Cu), zinc (Zn), boron (B), manganese (Mn), chromium (Cr), lead (Pb), mercury (Hg), nickel (Ni), and cadmium (Cd) were determined using inductively coupled plasma atomic emission spectroscopy.

The culture medium was prepared based on 75% coco-peat and 25% perlite and was poured into pots of seedling size. Pot size having a height × width (7.5 × 10 cm; 1500 vol.) was used. Bottoms were made of PVC plates and drilled with five equidistant holes (0.5 cm diameter) to allow for drainage. Pots were filled with 7 or 8 cm of substrate.

In each pot, two seeds were sown. Irrigation was carried out daily. From the 4th day, the seeds began to germinate. Before opening the cotyledon leaves, manual tinting was done. On the 5th day, almost all true leaves appeared in all pots. Then, the desired composition was applied through soil application.

The experiment was arranged in a randomized complete factorial block design with two factors including (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, T3): Vermicompost (20 and 30% [V/V]), and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% (V/V).

Nine days after germination, the seedling was harvested and transferred to the lab to measurement. Some factors such as shoot length, stem diameter, true leaf length and width, shoot fresh and dry weights, and chlorophyll content were recorded in seedling. Fresh weight of shoot and root was recorded by digital balance accuracy of 0.1 g. Shoot and root were weighed and placed in the oven at 60°C for 72 h and were re-weighed by a digital scale. The longest root length was measured using ruler. Chlorophyll content was measured as explained. 0.5 g leaf was calculated. The material was homogenized in a homogenizer by addition of 10 ml of 80% acetone. The acetone extract containing all chloroplast was centrifuged at 2500 rpm for 5 min. This obtained extract was diluted by adding 9 ml of 80% acetone per ml of the extract. It was read on a spectrophotometer at 645 nm and 663 nm [8].

Treatment was applied for other pots for the next step. The plants from this stage were the same as the first test plants. At the end of the grown season, marketable cucumbers factors such as shoot length, days until flowering, yield (40, 65, and 90 days after culturing), and marketable fruit ratio to second degree fruit and total fruit weight were noted.

The analysis was performed on data using SPSS 16. Comparisons were made using one-way analysis of variance (ANOVA) and Duncan's multiple range tests. Differences were considered to be significant at $P \leq 0.05$.

3. RESULTS AND DISCUSSION

Previous studies concluded that the highly fertile soil, high water capacity, and avoiding salt accumulation are requirements for achieving maximum growth of cucumber seedlings in greenhouse. In this study, we found that the fertile, well-drained, deep, coco-peat, and perlite rich with organic matter were essential for the development of cucumber roots [9].

3.1. Evaluation of Treatments on Seedling Cucumber

Shoot length, stem diameter, true leaf length and width (all of the leaves that emerge after the true leaves have appeared will look the same as the true leaves), shoot fresh and dry weights, and chlorophyll content tested in this study. The characteristic of the treatment is shown in Table 1.

According to Table 1, the effect of treatment of chicken manure tea and vermicompost was significant on shoot length and stem diameter at 1% level. The control group showed a statistically significant difference with other treatments. Control treatment with 3.03 cm, the lowest and chicken manure tea 50% (v/v) have the highest length of shoot seedling. Data showed that stem diameter increased significantly during the time due to treatment. The highest shoot diameter was observed in the treatment with chicken manure tea 50% (v/v) [Figure 1]. Vegetative growth in plants is affected by several factors, which water availability is one of the most important. The effects of vermicompost and its extract on vegetative growth of plants, humic, fulvic, and other organic acids also have a positive effect on vegetative growth, stimulating shoot length, and stem diameter [10]. The stem also may represent a huge volume for storage of photosynthetic materials and then the remobilization of photosynthetic materials into fruits. Some growth regulators such as indole-3-acetic acid (auxin) have increased plant height using organic fertilizers [10,11]. The results of this study agree with those observed in *Crossandra undulaefolia* [12], radish [10], *Calendula officinalis,* and strawberries [11].

Table 1: Analysis of variance of traits in seedling cucumber.

SOV	DF	Shoot length	Shoot diameter	Shoot dry weight	shoot fresh weight	Length of true leaf	Width of true leaf	Chlorophyll content
Vermicompost	1	0.43^{ns}		0.09^{ns}	0.14^{ns}	0.07^{ns}	0.18^{ns}	0.29^{ns}
Chicken manure tea	2	28.08**	1.87**	10.25**	23.20**	0.99**	16.45**	12.30*
Chicken manure tea×Vermicompost	2	0.45*	1.13*	2.42*	1.48*	1.67*	12.13*	1.27*
Error	12	0.08	0.13	1.24	1.76	2.65	1.25	6.23
CV	-	11.13	18.8	32.6	2.54	7.87	11.23	9.23

* and **: Significant at the 5% and 1% probability levels, respectively; "ns" is not significant. SOV: Source of variance, DF: Degree of freedom, CV: Coefficient of variation

ANOVA for different traits as influenced by chicken manure tea and vermicompost level is given in Table 1. The Chicken manure tea showed a statistically significant difference with control.

Chicken manure tea treatment (T5) with 2.75 g, the highest and control treatment without any fertilizer (T0) has the lowest shoot fresh weight. The same result with shoot dry weights was obtained (1.02 g) in treatment with chicken manure tea 50% (v/v) [Figure 2]. In the study, on the effects of vermicompost organic fertilizer on tomato growth, it was observed that the fresh and dry weight of this plant increased with increasing levels of vermicompost due to changes physical and chemical properties microbial [13]. Several studies have shown that photosynthetic rate does affect on dry matter of the plant [14]. Other studies have mentioned that vermicompost is excellent source of plant-available nutrients and enhanced shoot and dry fresh weight in cucumber [15], strawberry [16], and oat [13].

Various levels of fertilizer have a significant effect on the growth of leaf length and width and chlorophyll content [Table 1]. Longest leaves belonged to plants sprayed by chicken manure tea 50% (v/v) and lowest in control without any fertilizer (3.14 cm). This treatment will give the same result for seedling leaf width. The rate of width leaves was affected by chicken manure tea 50% (v/v) [Figure 3]. Final chlorophyll content was achieved through same treatment (20.96 Soil-Plant Analyses Development units) [Figure 4]. Application of compost-tea can keep moisture content in the leaves; photosynthesis rate and extent by the rate of carbon dioxide uptake can enhance photosynthesis in treated cucumber [17]. Vermicompost fertilization through soil capacity will increase higher nutrient uptake in German chamomile that leads to increased chlorophyll content [18].

3.2. Evaluation of Treatments on Mature Cucumber

The effect of treatment on the shoot length, days until flowering, yield (40, 65, and 90 days after culturing), marketable fruit ratio to second degree fruit and total fruit weight was significant [Table 2].

Similarly, shoot length in mature cucumber treated with chicken manure tea 50% (v/v) (161.2 cm) was lower than other treatment; this was significantly different from the control, which averaged (137.5 cm) [Figure 5]. The same result was observed in days until flowering, which was (28.7 days) in control [Figure 6]. The researchers found that application of vermicompost at low concentrations (up to 20%), increased the growth of cucumber plants, but concentrations more

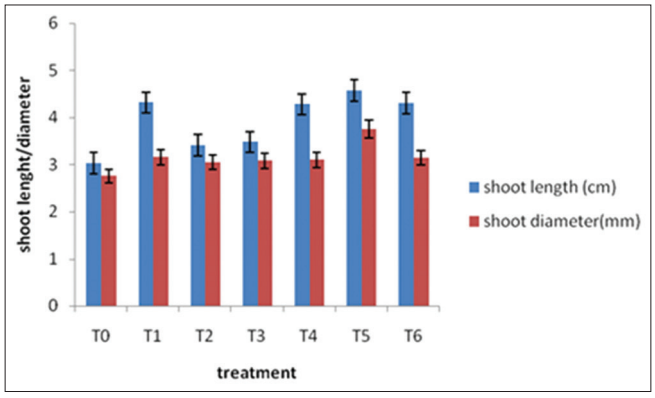

Figure 1: Changes in shoot length/stem diameter in cucumber seedling treated with chicken manure tea and vermicompost; (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, and T3): Vermicompost (20 and 30% [V/V]) and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% [V/V]); (error bar indicate standard deviation)

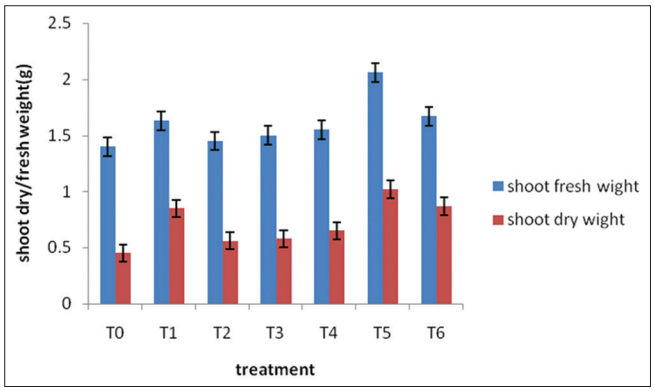

Figure 2: Changes in shoot dry/fresh weights in cucumber seedling treated with chicken manure tea and vermicompost; (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, T3): Vermicompost (20 and 30% [V/V]) and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% [V/V]); (error bar indicate standard deviation)

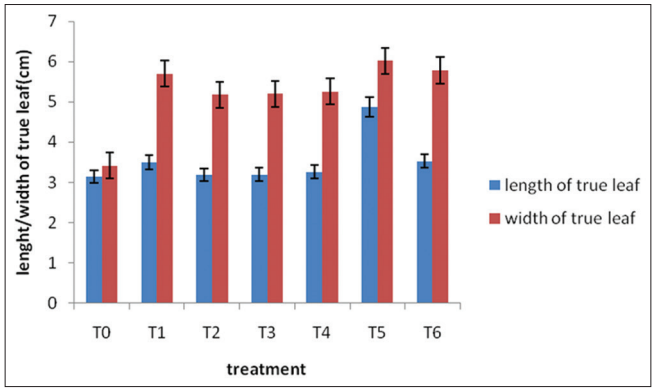

Figure 3: Changes in length/width of true leaf in cucumber seedling treated with chicken manure tea and vermicompost; (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, and T3): Vermicompost (20 and 30% [V/V]) and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% [V/V]); (error bar indicate standard deviation)

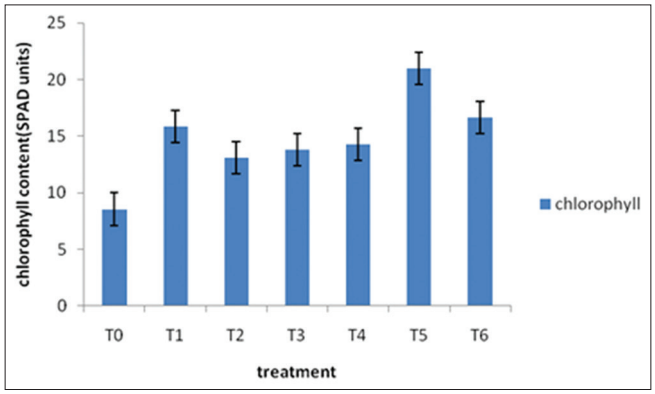

Figure 4: Changes in chlorophyll content in cucumber seedling treated with chicken manure tea and vermicompost; (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, and T3): vermicompost (20 and 30% [V/V]) and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% [V/V]); (error bar indicate standard deviation)

Table 2: Analysis of variance of traits in mature cucumber.

SOV	DF	Shoot length	Days until flowering	Yield	Total fruit weight	Remarkable fruit/second degree fruit
Vermicompost	1	4.04^{ns}	1.17^{ns}	2.38^{ns}	1.04^{ns}	1.19^{ns}
Chicken manure tea	2	32.28**	4.05**	12.20**	10.18**	1.76**
Chicken manure tea×Vermicompost	2	1.47*	2.64*	8.21*	1.60*	1.74*
Error	12	1.87	1.61	1.6	0.65	0.87
CV	-	12.14	9.45	9.14	10.14	18.45

* and **: Significant at the 5% and 1% probability levels, respectively; "ns" is not significant. SOV: Source of variance, DF: Degree of freedom, CV: Coefficient of variation

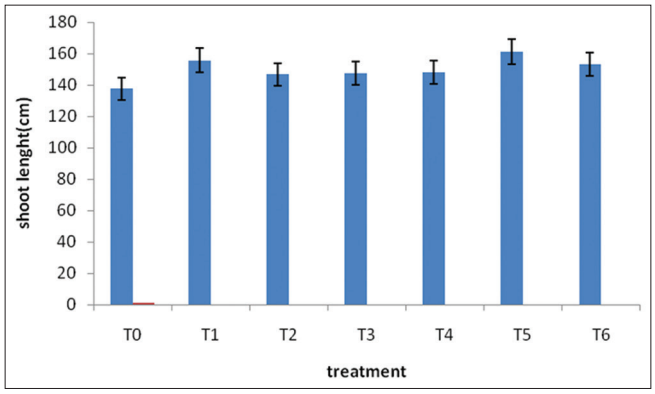

Figure 5: Changes in shoot length in mature cucumber treated with chicken manure tea and vermicompost; (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, and T3): Vermicompost (20 and 30% [V/V]) and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% [V/V]); (error bar indicate standard deviation)

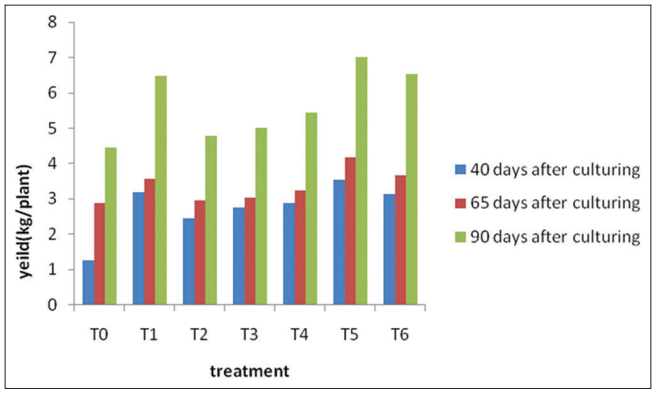

Figure 7: Changes in yield in mature cucumber treated with chicken manure tea and vermicompost; (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, and T3): Vermicompost (20 and 30% [V/V]) and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% [V/V]); (error bar indicate standard deviation)

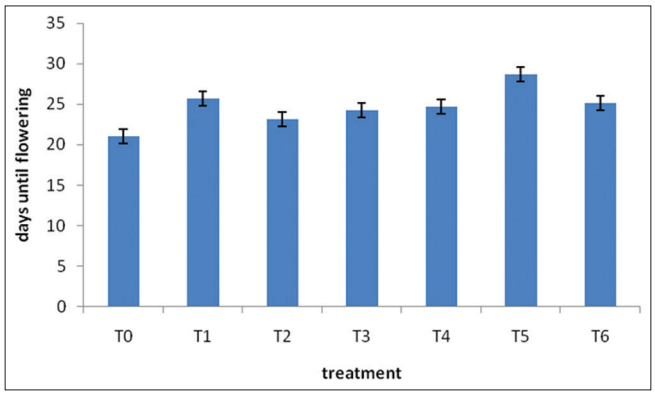

Figure 6: Changes in days until flowering in mature cucumber seedling treated with chicken manure tea and vermicompost; (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, and T3): Vermicompost (20 and 30% [V/V]) and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% [V/V]); (error bar indicate standard deviation)

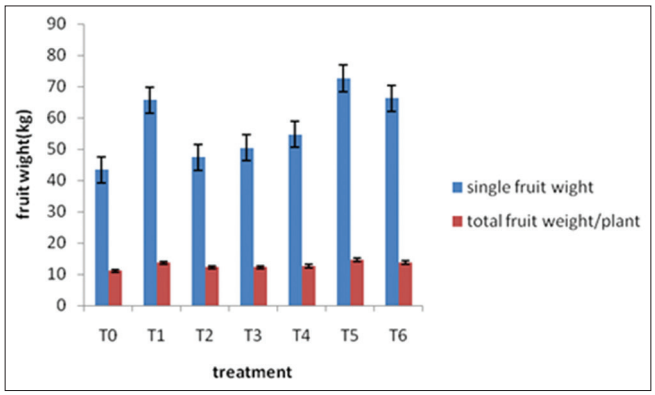

Figure 8: Changes in total fruit weight in mature cucumber seedling treated with chicken manure tea and vermicompost; (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, and T3): Vermicompost (20 and 30% [V/V]) and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% [V/V]); (error bar indicate standard deviation)

than 30% have remarkable decrease in plant growth so that the lowest growth rate was observed in 60% vermicompost treatment [19]. In more than 20%, vermicompost leaves in the carnation being up to 10 times greater than those treated with 60% [20]. The results confirm that the use of organic fertilizers such as vermicompost has an effective in shoot length in Petunia, which is consistent with our finding [21]. It has been noted that the high utilization of compost organic matter due to increased nitrogen uptake by microorganisms, high carbon to nitrogen ratio, high salinity and phenolic substances, and leading to decrease in plant growth [22].

In this study organic matter application, leads to the stimulation of yields, in chicken manure tea 50% (v/v) after 40 (3.55 kg/plant), 65 (4.18 kg/plant), and 90 (7.05 kg/plant) days of culturing; [Figure 7]. Cucumber needs plenty water for growth due to its rapid growth and large leaves especially in the early stages of seedling development. These factors have led to the fact that cucumber is considered drought-sensitive plant and drought decrease the level of humidity in the soil and reduces the yield [23]. Soil management with organic matter can improve the soil structure, as it plays a role in connecting soil particles,

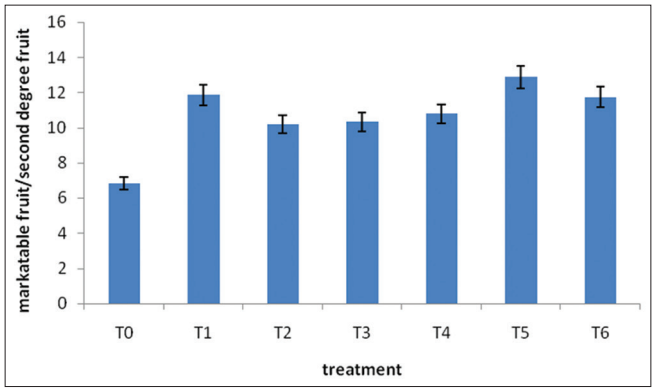

Figure 9: Changes marketable fruit/second degree fruit in mature cucumber treated with chicken manure tea and vermicompost; (T0): Without any fertilizer, (T1): Chemical fertilizer (20-20-20), (T2, and T3): Vermicompost (20 and 30% (V/V)) and (T4, T5, and T6): Chicken manure tea (25, 50, and 75% (V/V)); (error bar indicate standard deviation)

prepares the soil for plant growth. Therefore, the root expansion, as well as, increases water storage capacity leads to more water absorption by plants [24]. Humification rates are increased significantly when plant growth regulators such as gibberellins, auxins, and cytokinin are applied. This has a significant role in enhancing the yield in some plant species such as corn, rice, and tomato [25]. Application of chicken manure tea increased the single fruit weight by 72.6 g, compared to control. Based on result of mean comparison, the highest total fruit weight was related to the same treatment, which there was significantly different at all levels (14.65 g). Marketable fruit ratio to second-grade fruit was 12.8% more than others [Figures 8 and 9]. It seems that cucumber production was improved using chicken manure tea. It can improve the soil physical conditions leading to dry matter and fruit production. Earlier studies showed that the increases in fruit productivity have been attributed to microorganism biological activity [26,27].

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