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Growth and Yield of Tomato (*Lycopersicum esculantum* Mill.) as Influenced by the Combination of Liquid Organic Fertilizer Concentration and Branch Pruning

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ABSTRACT

The research was carried out in Oebelo Village, Kupang Tengah Subdistrict, Kupang Regency. The aim of the study was to determine the effect of the concentration of liquid organic fertilizer combination and branch pruning toward the growth and yield of tomatoes. The research design used was Random Design Single factor group with 3 replications. The combination tried were K0 (without liquid organic fertilizer (LOF) and without pruning); K1 (without LOF by pruning 1 branch); K2 (without LOF by pruning 2 branches); K3 (LOF 50 ml/l of water without pruning); K4 (LOF 50 ml/l of water by pruning 1 branch); K5 (LOF 50 ml/l of water by pruning 2 branches); K6 (LOF 100 ml/l of water without pruning); K7 (LOF 100 ml/l of water followed by pruning 1 branch); K8 (LOF 100 ml/l of water by pruning 2 branches); K9 (LOF 150 ml/l of water without pruning); K10 (LOF 150 ml/l of water by pruning 1 branch); K11 (LOF 150 ml/l of water by pruning 2 branches). The results of the study based on the Duncan test 5% showed that the treatment of liquid organic fertilizer concentration 100 ml/l of water and pruning 1 branch (K7) affected the plants height of 21 Days After Planting (45.25 cm), 28 DAP (68.83 cm), and 35 DAP (88.00 cm); number of leaves (31.00); number of fruits (37.50); fruit weight (393.22 g); and fruit diameter (5.11 cm) which significantly different from other treatments.

Key words : *Tomatoes, Liquid organic fertilizer, Branch pruning*

Introduction

Tomato (*Lycopersicum esculantum* Mill) is one of the commodities of seasonal fruit vegetables in the form of shrubs of the family Solananceae that are mostly demanded by the public. This crop of America has advantages viewed from the aspect of health and economy. In health aspects, tomatoes contain vitamins A and C, minerals, and lycopene for human health. Then, as an economic aspect, tomatoes are a high-value commodity as a source of foreign exchange and income. For Indonesian people, tomato is familiar because it has become part of their daily needs. The tomato can be useful for many purposes, both for cooking and medicine. The yield of tomatoes in Indonesia is still less, therefore import is still needed.

In East Nusa Tenggara, tomato production in 2017 was 6.70 tons/ha, but in 2018 it decreased to 6.42 tons/ha. Whereas, in 2019 the production amounted to 8,70 tons/ha (BPS NTT, 2020). The production is still categorized as low compared to the ideal tomato production of 10-15 tons/ha. The low production is due to the lack of availability of nutrients in the ground, and many people do not practice pruning techniques in cultivation yet. The increase

in production to fulfil the needs cannot be separated from good caring efforts. One of the most important factors in plant care is fertilization and pruning.

The nutrient is one of the supporting factors for optimum growth and development of the tomato plant. The use of fertilizer to increase tomato production is already entrenched and considered by farmers as one of the activities which cannot be separated from their farming activities (Widiyanto, *et al*., 2007). The impact of the use of inorganic fertilizers produces a high increase in crop productivity. However, the use of inorganic fertilizers for a relatively long period generally has a negative impact on soil conditions. The soil becomes hard quickly, less able to store water, and quickly becomes acidic which finally reduces crop productivity (Widiyanto, *et al.,* 2007). Generally, Organic fertilizer is complete because it contains macro and micro elements even in small amounts (Iyamuremya, *et al.,* 1996).

The use of manure or compost is believed to be able to overcome the problems caused by inorganic fertilizers. Manure or compost also has many disadvantages besides advantages. The utilization of natural organic fertilizer that can be used to overcome the constraints of agricultural production is liquid organic fertilizer. This organic fertilizer is produced from raw materials from livestock manure, compost, natural waste, plant hormones, and other natural materials. It can fix the physical characteristic, chemical, and biological properties of the soil, and so it will increase crop production, improve the quality of plant products, reduce the use of inorganic fertilizers, and as an alternative to manure (Made, *et al.,* 2012).

Besides fertilization, pruning also needs to be considered in plant cultivation techniques. The pruning for plants is an activity of plant cultivation to set and control the vegetative growth, flowering, and fertilization. The pruning for a shoot can affect better growth and production if it is done at the right part of the plant and at the right time. Conversely, pruning the parts of plants at an improper time will actually inhibit the growth and yield of crops (Setiyowati, *et al.,* 2010).

The objective of pruning is to improve the quantity and quality of the crops. This activity is a step that needs to be concerned to increase the quantity and quality of fruits. Therefore, it is necessary to prune the weak and unproductive branches. This pruning will contribute carbohydrates for blossoms formation and fruit growth. In addition, the quality of the blossom and fruit is strongly influenced by the branch vigor where the blossom and fruit are located and the location of the branch on the tree (Zulkarnain, 2010).

Some research results show that pruning can provide benefits such as a) reducing competition between leaves and fruits per plant or other plants. According to Sowley *et al.* (2013), pruning tomato increases the quality (size) by 55%. b) reducing the incidence of disease. According to Sowley *et al.* (2013), if the excessive leaf growth is pruned, air circulation around the canopy improves. This situation will reduce the humidity of the microclimate around the plants which will also reduce the incidence of disease. c) increasing marketable yield. By pruning, the number of fruits can be reduced at the most appropriate stage so that the fruits will become larger and easier to prune (Sowley *et al*., 2013).

Based on the above description, it was necessary to conduct a study that aimed to determine the effect of the combination of liquid organic fertilizer concentration and branch pruning on the growth and the yield of tomato plant.

Materials and Methods

This research was conducted in the farmers' land in Oebelo Village, Kupang Tengah Subdistrict, Kupang District. It was conducted from April to July 2014. The material used was the variety of lentana tomato seeds. The equipments used were cow dung, leaves, sugar, EM4, water, hoes, meters, machetes, shovels, tugal, ravian ropes, buckets, kater, scissors, hoses, and stationery.

This study used a randomized block design (RBD), the factor experimented was the combination of liquid organic fertilizer (LOF) concentration and pruning (K) consisting of 12 levels. They are K0 = Without LOF + without pruning, K1 = Without LOF + pruning 1 branch, K2 = Without LOF + pruning 2 branches, K3 = LOF 50 ml/l of water + without pruning, K4 = LOF 50 ml/l of water + pruning 1 branch, K5 = LOF 50 ml/l of water + pruning 2 branches, K6 = LOF 100 ml/l of water + without pruning, K7 = LOF 100 ml/l of water + pruning 1 branch, K8 = LOF 100 ml/l of water + pruning 2 branches, K9 = LOF 150 ml/l of water + without pruning, K10 = LOF 150 ml/l of water + pruning 1 branch, K11 = LOF 150 ml/l of water + pruning 2 branches. Each treatment was repeated 3 times so there were (12 × 3) 36 experimental units. The

determination of an experiment was done randomly.

Research Activities

The implementation of the research includes the manufacture of liquid organic fertilizer, land preparation, nursery, planting, application of liquid organic fertilizer, tomato branch pruning treatment, crop care, and harvesting.

a. Making liquid fertilizer

Liquid organic fertilizer was made from 30 kg of cow manure and 5 kg of green leaves that were taken from market waste, 3 kg of coconut husk, 5 kg of banana stems, and remaining vegetables which are then put into a bucket. 100 g sugar + shrimp paste 100 g + EM-4 50 ml were dissolved in sufficient water then put into a bucket that had been excreted by animal feces and green leaves. Then, adding clean water until the volume reaches 50 l, then tightly closed. It is opened and stirred for 15 minutes every day. Finally, after 12-14 days, the proliferation of the bacteria finished, and it can be filtered for inclusion in a clean container (bottle) then it can be utilized.

b. Land preparation and nursery

The land was cleaned by removing unnecessary substances or grass using cutting tools, then the land was cultivated by hoeing; after that the land was leveled. The next stage was making 1.4 x 2.0 m of garden beds. The garden beds distance between treatments was 0.5 m and between replications was 1 m. Then, Nursery was carried out in aqua cup which had been filled with a mixture of soil and bokashi in a ratio of 2:1. During the initial growth, the care of plant seeds in the nursery must be intensively watered by continuous supervision. While, Watering was carried out since the seedlings planted into nursery containers until the plants were ready to be moved to available planting spot. The watering was done twice a day, in the morning and evening. By using a paddle with smooth hole which aims not to damage the seeds of plants that have or just grown.

c. Planting

Tomato seeds can be removed to the prepared land after 21 days in the nursery. When planting into the experimental plot, sorting of the seeds was done before to obtain good plant growth. The criteria for the selected seedlings should be attractive with fresh appearance and the leaves are not damaged. A day before planting, bokashi fertilizer was done into the planting holes with a dose of 250 g/hole. Planting seeds according to the standard planting distance of 40 × 60 cm with one seed per planting hole. During planting, Furadan 3G was treated to prevent the disturbance of ant pests or other root-destroying pests.

d. Liquid organic fertilizer application

The application of liquid organic fertilizer appropriates with concentration, without concentration, concentration of 50 ml/l of water, 100 ml/l of water, and 150 ml/l of water. Provision of liquid organic fertilizer is carried out a week after transplanting until harvest with an interval of three days. The volume of liquid organic fertilizer for each treatment was 200 ml of solution/plant.

e. Treatment of tomatoes pruning branches

Treatment was done to prune the buds or apical branches by leaving the main branch according to treatment. The treatment was conducted when 50% of plants have been in the flowering phase. When pruning done, bokashi was also added with a dose of 250 g/plant. It was done by digging the ground around the plant (± 5 cm from the plant), then mixing it with the bokashi.

f. Plant care and harvest

Plant care includes watering, caring, weeding, pest and disease control. Watering was done sufficiently by utilizing available water sources and was done twice in a day with volume 250 ml/plant. Stake installment was carried about 2 weeks after planting by tying the plants at the stake with distance of 10 cm. Weeding was done if weeds found in the experimental plot. Pests caterpillar control was done by spraying vegetable pesticides (concoction of tobacco and detergent). Harvesting was done when the plants are at the age of 58-68 days after planting (DAP) or their fruits are reddish and green.

Observation Variables

Observations on the variables of plant height and number of leaves conducted when the plants were in the generative phase marked by the appearance of the first blossom. While for the variable amount, weight and diameter of the fruits were done when harvesting the sample plants.

Model and Data Analysis

Data analysis model is randomized block design (RBD) with single factor experimental method. The experimental data obtained were then analyzed using variance. To know the differences between treatments, the analysis was done using Duncan test 5%.

Results and Discussion

Plants Grow

The plants grow observed were height and number of leaves. The height of the plant was obtained by measuring the height of the plant from the surface of the ground to the top of the highest leaf using ruler. The measurements were done at the age of 21, 28 and 35 DAP. The amount of leaves was identified by calculating all leaves that have been perfectly opened on sampling plants. Measurements were conducted at the age of 35 DAP. The results of the 5% duncan test for the average height and number leaves of tomato plants as influenced by the combination of the liquid organic fertilizer concentration and pruning are presented in Table 1.

Plants height (cm)

The results of 5% DMRT test (Table 1) showed that the combination of treatment between LOF and pruning had not affected to a difference height of the plants, but the difference found in the effect of the LOF concentration applied. It was caused by no pruning at the time of observation to the height of the crop. At the age of 21 DAP, the height of tomato was higher in the treatment of liquid fertilizer 100 ml/l of water + pruning 1 branch (K7) and significantly different in other treatments, but not significantly different from the treatment of K6 and K8. At the age of 28 and 35 DAP, tomato was higher in the treatment of liquid fertilizer 100 ml/l of water + pruning 1 branch (K7) and significantly different in other treatments, but not significantly different from the treatment of K6, K8, K9, K10 and K11. The higher of tomato was caused by the nutrients supplied was sufficient so that it can be used for apical meristem cell division, consequently the plant height can increase. The increase of the plant was also estimated that the provision of liquid organic fertilizer containing nutrient N (10.02%). It was able to increase the nutrient N in the soil which originally at 0.17% so that it can cause the triggering of cells at the end of the stem which affect cell division and enlargement immediately in the meristematic area. This explanation is in line with Sowley, *et al.* (2013) who states that the division and enlargement of meristematic cells at the tip of the stem, even though the speed is not equal. Setiyowati, *et al.* (2010) states that supplying liquid organic fertilizer containing elements of N, P, K, Mg and Ca would cause the synthesis of the dam and cell walls division anticlinally, so that it would accelerate the increase of the plant height.

In treatments of K9, K10 and K11, the concentration applied was equal to 150 ml/l of water, but the height of the plant phisically through observation

Table 1. Average Plant Height (cm) of Tomatoes as Influenced by Liquid Organic Fertilizer Concentration and Pruning

Combination of Liquid Organic Fertilizer Concentration	Average Plant Height (cm)			Average Amount of Leaves (leaf)
	21 DAP	28 DAP	35 DAP	
Without LOF + without pruning (K0)	24.08 d	44.08 b	59.67 b	19.33 c
Without LOF + pruning 1 branch (K1)	27.75 cd	45.33 b	61.50 b	20.00 c
Without LOF + pruning 2 branches (K2)	28.42 cd	45.58 b	62.33 b	20.00 c
LOF 50 ml / l water + without pruning (K3)	30.17 c	47.50 b	62.50 b	20.50 c
LOF 50 ml / l water + pruning 1 branch (K4)	30.92 c	50.00 b	63.83 b	20.83 c
LOF 50 ml / l water + pruning 2 branches (K5)	30.60 c	49.83 b	63.67 b	20.83 a
LOF 100 ml / l water + without pruning (K6)	41.42 ab	63.58 a	81.83 a	30.33 a
LOF 100 ml / l water + pruning 1 branch (K7)	45.25 a	68.83 a	88.00 a	31.00 a
LOF 100 ml / l water + pruning 2 branches (K8)	41.50 ab	66.00 a	83.17 a	30.67 a
LOF 150 ml / l water + without pruning (K9)	38.50 b	60.08 a	77.33 a	25.00 b
LOF 150 ml / l water + pruning 1 branch (K10)	40.08 b	60.83 a	80.00 a	26.33 6
LOF 150 ml / l water + pruning 2 branch (K11)	39.75 b	60.67 a	79.50 a	25.83 b

Note: The numbers followed by the same letter in each column are not significantly different according to the duncan multiple distance test (DMRT) at the 5% level.

contributed to the shorter size of 100 ml / l of water (K6, K7, and K8). It was affected by concentration of 150 ml/l of water categorized as lot of concentrations. It can make some nutrients not absorbed by plants because the nutrients absorbed already included for their growth and development.

The above result is dealt with Sowley, *et al.* (2013) who state that by the availability of nutrients in sufficiently balanced amount for the process of plant growth, cell division, photosynthesis and cell elongation will occur rapidly which affect some plant organs grow fast especially in the vegetative phase. Setiyowati, *et al.* (2010) states that if organic fertilizer is supplied in large quantities, the nutrients are not taken by the roots of plants, but it can function to improve the physical, chemical and biological properties of the soil. Conversely, if fertilizer is supplied in small amounts, it will inhibit the plant growth because the soil becomes solid and nutrients are less.

Table 1 also shows that plant height is lower in treatments of without liquid fertilizer + without pruning (K0) and is not significantly different from K1 and K2 treatments, but has significantly different from other treatments. This lower appearance was caused by no fertilizer and the concentration of fertilizer supplied still low so that the nutrients absorbed by plant are also reduced. As a result, apical meristem cell division activity is inhibited and then physic of the plant is shorter. Darman (2006) states that low levels of nutrients in the soil will disrupt the metabolic processes in the soil. It will cause plant stunted.

Amount of leaves

Table 1 showed that the amount of tomato leaves is more in the treatment of LOF 100 ml/l of water and pruning 1 branch (K7) and significantly different from other treatments, but is not significantly different with LOF in the treatment 100 ml/l of water without pruning and pruning 2 branches (K6 and K8). It was affected by the supply of LOF containing nutrients P (103.47 ppm) which can contribute to release and to increase nutrient P which initially 74.20 ppm becomes available in the soil and then can be absorbed by the plant roots. The stock of sufficient nutrient P cause translocations to all parts of the plant can be fulfilled properly. Adequate nutrient P in the body of the plant can stimulate meristem tissue division, root growth and leaf development which affect the level of nutrients and water absorption to optimum level. It will be used for cell division, extension and differentiation.

The above description is in line with Darman (2006) who states that one of the functions of organic substances is that can release bound nutrient in the soil to be available so that the root of the plant can easily absorb it. Furthermore, Kanyomeka and Shivute (2005) states that pruning can change the balance between the roots and shoots of the plants in terms of water removal, nutrients, and starch reserves from the undisturbed root system to pruned shoots cause the increase of vegetative growth.

At least, amount of leaves per plant in treatment without liquid organic fertilizer and without pruning (K0) was significantly different from other treatments, but not significantly different from the treatment without LOF and LOF with 50 ml/l of water for all pruning treatments (Table 1). It is a cause of the absence or less of the addition of organic substances from the outside so that the nutrients inside the soil are difficult to be absorbed by the roots of the plant because they are in a bound state. On the other hand, by the fewer nutrients available in the soil, they must be translocated to all parts of the plant so that there are some parts which have not obtained nutrients or just got less. This situation cause the need of nutrients by plants becomes less so that vegetative growth of plants concerning the amount of leaves also becomes less.

According to Darman (2006), the soil with lack of organic fertilizer can cause soil textures become bad and there are bound nutrients, like P not easily available for plants. Furthermore, Isrun (2006) states that too dense plants or not pruned which has lack of nutrients in the soil can cause their vegetative growth decrease.

Yield of Crops

The yield of crops observed were amount, weigh, and diameter of the fruits. The number of fruits is identified by calculating the number of fruits found in a sample plant. Fruit weight is obtained by weighing all fruits obtained from each sample plant. The diameter of the fruit is obtained by measuring the diameter using calliper during harvesting. The results of the 5% duncan test on the average number, weigh, and diameter of fruit tomato as influenced by the combination between liquid organic fertilizer concentration and pruning are presented in Table 2.

Amount of fruit

Data in Table 2 shows that LOF treatment of

Table 2. Average Amount, Fruit and Diameter of Fruits of Tomatoes as influenced by Liquid Organic Fertilizer Concentration and Pruning

Combination of Liquid Organic Fertilizer Concentration	Average Number of Fruits (fruit)	Fruit Weigh (g)	Diameter Fruit (cm)
Without LOF + without pruning (K0)	13.83 f	75.62 f	1.39 g
Without LOF + pruning 1 branch (K1)	18.83 e	146.60 e	2.09 f
Without LOF + pruning 2 branches (K2)	19.17 e	154.91 de	2.15 f
LOF 50 ml / l water + without pruning (K3)	20.00 de	201.70 cd	2.58 def
LOF 50 ml / l water + pruning 1 branch (K4)	19.83 de	197.39 cd	2.52 ef
LOF 50 ml / l water + pruning 2 branches (K5)	21.67 de	202.73 cd	2.77 cdef
LOF 100 ml / l water + without pruning (K6)	29.67 b	271.71 b	3.64 b
LOF 100 ml / l water + pruning 1 branch (K7)	37.50 a	393.22 a	5.11 a
LOF 100 ml / l water + pruning 2 branches (K8)	27.83 bc	271.05 b	3.59 b
LOF 150 ml / l water + without pruning (K9)	25.00 bcd	223.69 bc	3.38 bc
LOF 150 ml / l water + pruning 1 branches (K10)	22.33 de	220.02 c	3.13 cde
LOF 150 ml / l water + pruning 2 branches (K11)	23.00 cde	220.05 c	3.19 bcd

Note: The numbers followed by the same letters in each column are not significantly different according to the duncan multiple distance test (DMRT) at the 5% level.

100 ml/l of water and pruning of 1 branch (K7) influences more fruit amount and is significantly different from other treatments. It is affected by number of leaves variable in the same treatment also contributes better yields. Leaves are the main component of plants for photosynthesis. The more leaves formed, the higher the photosynthesis is. The high photosynthetic activity is characterized by the increase of photosynthetic results, such as the amount of fruits. Besides that, the increasing amount of fruits was affected by liquid organic fertilizer supply which can improve soil structure to become loose and crumb. It is characterized by a fairly good soil C-organic content, from 2.38% to 4.23%, so that the growth of plant roots becomes better. Thus, the roots can absorb the available nutrients, water and other substances; then transferred to the part of the photosynthetic plants, such as leaves. The photosynthesis process can produce fruits.

According to Mooy and Hasan (2014), the addition of organic substances increase the life of soil microorganisms, and release various kinds of micro nutrients and microorganisms gradually so that it is appropriate with the needs for plant growth and development. Furthermore, Ara, *et al.* (2007) state that pruned plants that will influence higher yields. The increase of yields is influenced by nutrients absorbed by the roots of plants, which then transferred to all parts of plant so that the plant grows and develops well.

Table 1 also shows that the treatment without LOF and without pruning produce fewer fruits than other treatments. It is caused by the absence of LOF and pruning so that the soil harsh (C-organic 1.76%), and it is difficult for the roots to absorb nutrients and water. By the reducing of absorbed nutrients, the plant becomes infertile which is characterized by leaves formed were too less.

According to Darman (2006), plants which lack nutrients become infertile. The infertile growth causes the small number of leaves which consequently reduces the fruit weigh, fresh fruit weight, and dry weight of plants.

Fruit weight (g)

Table 2 shows that LOF treatment of 100 ml/l of water and pruning 1 branch (K7) influences higher fruit weight and is significantly different from other treatments. The increase of fruit boot is affected by the number of fruits variable which contribute to higher yields so that the fruit weight also increases. On the other hand, the increase of fruit weight is affected by the presence of nutrient K in the LOF which is 2.36 me/100 g. It can increase the availability of the nutrient K in the initial soil (1.04 me/100 g) which then contributes in forming and transporting carbohydrates to be stored in fruit marked by the increasing of fruit weight.

The above discussion is in line with Anggiat (2009) stating that macro and micro nutrients contained in liquid organic fertilizers produce complex effects on the formation and production of carbohydrates. Phosphorus is as ATP structure which needed to reduce CO2 into a solid organic com-

pound to produce the fruit weight. Furthermore, Abdel, *et al.* (2013) states that the effect of pruning, all leaves get sunlight so that the leaf area increases and the photosynthesis and photosynthetic increase.

The treatment without LOF and pruning affect the lower fruit weight and significantly different from other treatments (K0). The low weight of fruit is due to competition in the soil as a result of limited nutrients and competition on the ground as a result of some leaves are shaded and do not get sunlight. Lack of nutrients, water and sunlight cause photosynthesis process low and then photosynthesis results are decreasing. Sowley, *et al.* (2013) have similar statement on this that there are two parts of competition in plants, namely; inside and on the ground. The competition in the soil includes nutrients and water, while on the ground includes sunlight. If this competition occurs, it will reduce crop yields.

Diameter of fruit

The result of Duncan test 5% (Table 2) shows that LOF treatment of 100 ml/l of water and pruning 1 branch (K7) produce wider fruit diameter and significantly different from other treatments. The width of the fruit's diameter is affected by photosynthetic activity that normally operates so that most of the results of photosynthesis are stored into the fruit. By the accumulation of photosynthesis results to the fruit, the fruit of the tomato becomes more enlarged and this is related to the diameter of the fruit. On the other hand, the widening of the fruit diameter is because of the division that occurs in all fruit cells. Rizqiani, *et al.* (2007) explains that the internal factors that influence fruit growth are the rate and quantity of photosynthesis results supplied from the plant canopy.

Table 2 also shows that treatment without LOF and without pruning affect narrower fruit diameter and significantly different from other treatments (K0). The narrow diameter of the fruit is because of the disruption of photosynthetic activity as a result of the deprivation of nutrients, water and sunlight. In this case, the availability of nutrients is in limited amount but utilized by many parts of the plant. By the inhibition of the photosynthesis, photosynthate translocation process to the fruit decreases, further cell division and enlargement of the fruit also becomes slow. All of these cause the diameter of the fruit narrowing. According to Surtinah (2007), plants which lack of macro and micro nutrients can inhibit chlorophyll creation so that photosynthetic activity also becomes inhibited, then will produce fewer or low photosynthate.

Conclusion

The study revealed that there is an effect between the combination of liquid organic fertilizer concentration and pruning toward the variables of plant height, number of leaves, number of fruit, fruit weight, and fruit diameter of tomato; and Treatment concentration of 100 ml/l of liquid organic fertilizer and pruning 1 branch (K7) influence the plant height at 21 DAP (45.25 cm), 28 DAP (68.83 cm), and 35 DAP (88.00 cm); amount of leaves (31.00); amount of fruits (37.50); fruit weight (393.22 g); and fruit diameter (5.11 cm) which is significantly different from other treatments.

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