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REGULAR ARTICLE

QUALITY OF TOMATO FRUIT (*Lycopersicon esculentum* Mill.) YIELDS UNDER DIFFERENT PERIODS OF WEED CONTROL AND BRANCH PRUNING

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ABSTRACT
The research aims to determine the effect of weeds during the period of weeding and reducing the number of branches on tomato yields. The research was carried out in Mojorejo Village, Junrejo District, Batu City with an altitude of 560 meters above sea level, rainfall of 1600 mm/year, and an average daily temperature of 23°C. The experimental design used was a Randomized Block Design with 2 factors and 3 replications. The first factor is the weeding period (P) which consists of 3 weeding periods, the treatment consists of: without weeding (P0), weeding 2 times at 28 and 56 days after planting (P1), and weeding 4 times at 14, 28, 42 and 56 days after planting (P2). The second factor is pruning the number of tomato plant branches (W) which consists of 3 levels, the treatment consists of without pruning branches (W0), pruning branches leaving 2 branches (W1), pruning branches leaving 4 branches (W2). Observations of harvest results include the number of harvested fruits per plant (number/plant), fruit diameter (cm), fresh fruit weight per fruit (g), and fresh fruit weight per plant (g). The observation data that has been obtained will be analyzed in further tests using the BNJ test with a level of 5% to determine the differences between treatments. The results obtained in this study showed that there was a real influence on the treatment of weeding and pruning branches on tomato yields.

Keywords: *Weeding Periods, Pruning, Tomato, Fruit, Yields*

INTRODUCTION
The land area for tomatoes (*Lycopersicon esculentum* Mill.) in Indonesia in 2014 was 59,008 ha and in 2015 it was 54,544 ha. Tomato production in 2014 was 915,987 tons and in 2015 it was 877,792 tons. Based on this data, there was a decline from 2014 to 2015, namely a decline of around 4.2% **(Hardiman *et al.,* 2014)**. The decrease in production is caused by less optimal plant growth, and disruption of optimal growth due to lack of nutrition, water, light, and growing space, and one of the causes is the presence of weeds in the tomato plant growing area.

Weeds are the plant which presence is undesirable because they can affect the growth of cultivated plants, especially tomato plants. Weeds that grow close to cultivated plants can cause rivalry or competition as an interaction between the two **(Moenandir, 2010).** Competition between weeds and tomato plants can result in competition for nutrients, water, light, and growing space, so there need to be appropriate control efforts by controlling weeds by carrying out optimal weeding periods **(Hardiman *et al.,* 2014)**. Controlling weeds by weeding can suppress the presence of weeds in tomato planting areas which are difficult to predict, so appropriate weeding methods are needed. Tomato cultivation must be weed-free in general throughout its life cycle, especially in the early growth period of tomato plants so that there is an opportunity to get optimal growth space and nutrition as early as possible before weeds start to appear in the tomato plant cultivation area.

Absorption of nutrients from tomato plants in the presence of weeds can result in competition. Apart from that, optimizing nutrient absorption can be done by pruning the number of branches on tomato plants so that the nutrients absorbed are focused on the product produced. One of the important stages in cultivating tomato plants is pruning. Pruning and thinning fruit is an effort to optimize fruit quality. The pruning that farmers usually do is pruning water shoots and pruning branches **(Hapsari *et al.,* 2017)**. The research aims to determine the effect of weeds during the period of weeding and reducing the number of branches on tomato yields.

MATERIAL AND METHODS

Study Area and Source of Plant Material

The research was carried out at the Lowokwaru District, Malang City with andosol soil type, altitude 330 m above sea level, rainfall 1500 mm/year, and average daily temperature 25^{o}C. The seeds used in this research were seeds of the Servo F1 tomato variety.

Experimental Design

This research was carried out using a Randomized Block Design (RAK) factorial experiment with 2 factors and 3 replications. The first factor is the weeding period (P) which consists of 3 weeding periods, the treatments are; P0 (without weeding); P1 (weeding 2 times at 30 and 58 days after planting); and P2 (weeding 3 times at 30, 44 and 58 days after planting). The second factor is pruning the number of tomato plant branches (W) which consists of 3 levels, the treatments are; W0 (no branch pruning); W1 (pruning branches leaving 2 branches); and W2 (pruning branches leaving 4 branches).

Land Preparation, Seedling and Transplanting

Minimum tillage is carried out to loosen the soil, then beds are made with a height of 30 cm, and a width of 1 m and displayed following the shape of the land. The distance between beds is 30-40 cm wide. Then the soil is left for one week. Providing basic fertilizer in the form of compost as much as 10 tons ha^{-1}. Tomato seeds of the Servo F1 variety are sown by making rows (lines) on the seedling medium with a distance between rows of 5 cm and a depth of 1 cm. Seeds are sown with a distance of 2-3 cm between seeds. The escape is covered with soil and watered sufficiently. Sprouts that grow approximately 5 cm or around 10 days after planting can be transplanted by making a planting hole 5-7 cm in diameter. One bed has two rows of planting holes, the distance between rows is 40 cm and the distance between holes in one row is 50 cm, the depth of the planting holes is approximately 5-7 cm.

Maintenance of Tomato Plants

Tomato plants are quite sensitive and need intensive care. This plant is very susceptible to pests and disease, especially those planted in the lowlands. After harvesting, the risk of tomato fruit damage is still high, around 20 - 50%.

Embroidery. Replanting functions to replace plants that fail to grow, whether they are sick or fall due to the weather. Plants that look unhealthy (yellow/wilted) or are dead are removed by pulling them out. Replanting on dead seeds is carried out 7 days after planting, by replacing the seeds that have been prepared.

Watering. Watering should be adjusted to weather conditions. In high rainfall, drainage channels are created for rain absorption. In the dry season, watering can be done in the morning to prevent the soil from cracking and drying out.

Fertilization. The fertilizer used in this research was urea, SP-36 and KCl with a fertilizer dose of N Urea: 180 kg ha^{-1}, P_2O_5: 150 kg ha^{-1}, and K_2O: 100 kg ha^{-1}. Fertilizer requirements/plant can be given as much as 6.3 g of urea/plant, SP-36: 6.7 g/plant and KCl: 2.7 g/plant.

Weed Control and Pruning

Weeding aims to remove weeds in the planting area. Weeding is carried out according to the treatment, P0 (No weeding), P1 (Weeding 2 times at 30 and 58 days after planting), P2 (Weeding 3 times at 30, 44 and 58 days after planting). Branch pruning is carried out at 30 days after leaving 2 productive branches (W1), leaving 4 productive branches (W2) and no pruning (W0). Pruning is carried out using scissors or a knife.

Data Collection

Observation of results was carried out at harvest time with plants aged 62 until the end of the harvest period with a harvest time interval of 3 - 4 days. Observation of results includes; (1) Number of Harvested Fruit/Plant (amount/plant). The number of harvested fruit/plants is obtained from the total number of harvested fruit/sample plants; (2) Fruit Diameter (cm). Observations were made by measuring the transverse length of the fruit using a vernier caliper by taking the average of 2 fruit/plant observations; (3) Fruit/Fruit Weight (g). The weight of fresh fruit/fruit is obtained from the average weight of fruit/fruit by taking samples of 2 pieces/plant/plot and weighing them using an analytical balance; (4) Fruit/Plant Weight (g). Obtained by weighing the fresh weight of the fruit at each harvest/sample plant and weighing it using an analytical balance.

Data Analysis

The observation data was then analyzed using analysis of variance, Analysis of Variance (ANOVA), and carried out with the F test at an error rate of 5%, to determine the effect of the treatment applied. If there is a real difference between the treatments, a further BNJ test is carried out at an error rate of 5%.

RESULTS

Number of Tomato Fruits per Plant

The results of the analysis of variance on the number of fruit/plant parameters showed that there was no interaction between weeding and pruning tomato branches. Weeding and pruning branches of tomato plants separately had a significant effect on the number of fruit/plants. The average number of fruits/plants is presented in Table 1.

Table 1. The table title is centered in Arial 10 font and placed above the table

Treatment	Number of Tomato Fruits per Plant (fruit)
P0	16,31 a
P1	21,75 b
P2	22,97 b
BNJ 5%	2,35
W0	22,25 b
W1	16,83 a
W2	21,94 b
BNJ 5%	2,35
KK%	9,48

Legend: Numbers accompanied by the same letter in the same column are not significantly different based on the 5% BNJ test, P0: no weeding, P1: weeding 2 times, P2: weeding 3 times, W0: no pruning, W1: pruning leaves 2 branches, W2: pruning leaving 4 branches.

Table 14 shows that the number of fruit/plant parameters with the treatment of weeding 2 times (P1) and weeding 3 times (P2) had a significant effect compared to the treatment without weeding (P0), while the treatment of weeding 2 times (P1) was not significantly different compared to the treatment weeding 3 times (P2). The treatment of weeding 3 times (P2) on the number of fruit/plant parameters had a higher value than the treatment without weeding (P0) and weeding 2 times (P1). In the branch pruning treatment, the number of fruit/plant parameters in the branch pruning treatment which retained 4 branches (W2) was significantly different compared to the branch pruning treatment which retained 2 branches (W1), while the treatment without branch pruning (W0) was not significantly different compared to the branch pruning treatment. by maintaining 2 branches (W1). The treatment without branch pruning (W0) on the number of fruit/plant parameters had a higher value than branch pruning while maintaining 2 branches (W1) and branch pruning while maintaining 4 branches (W2).

The parameter for the number of harvested fruit/plants shows that the 3 times weeding treatment had an average number of harvested fruit/plants that was greater at 22.97 pieces/plant, which was significantly different from without weeding which resulted in a lower number of harvested fruit/plants of 16.31. fruit/plant. The treatment without weeding had a lower average number of harvested fruit/plants compared to the weeding treatment. This is due to competition for nutrients in the soil between tomato plants and weeds. Macro nutrients in the soil are available in high quantities, which will affect the production of tomato plants. The condition of nutrients is also influenced by the availability of water in the soil which will prevent plants from wilting easily. The condition of nutrients and sufficient humidity levels for plants will affect harvest yields. Better soil moisture and nutrient conditions are available and can be utilized optimally by plants. The results of this research are in accordance with the research results of **Afifi (2017).**

Tomato Fruit Weight per Plant

The results of the analysis of variance on the parameters of fruit/plant weight of tomato plants showed that there was an interaction between weeding treatments and pruning tomato branches. The average fruit/plant weight of tomato plants is presented in Table 2.

Table 2. Average fruit/plant weight

Treatment	Tomato Fruit Weight per Plant (g)		
	W0	W1	W2
P0	553,67 a	944,67 b	1427,75 c
P1	618,00 a	1149,92 bc	1040,42 bc
P2	811,42 ab	1259,42 bc	1509,83 c
BNJ%	285,34		
KK%	9,49		

Legend: Numbers accompanied by the same letter in the same column are not significantly different based on the 5% BNJ test, P0: no weeding, P1: weeding 2 times, P2: weeding 3 times, W0: no pruning, W1: pruning leaves 2 branches, W2: pruning leaving 4 branches.

Table 2 in the treatment of weeding 3 times and pruning branches leaving 4 branches (P2W2) had a higher fruit/plant weight compared to the other treatments. The treatment of weeding 3 times and pruning branches leaving 4 branches (P2W2) was not significantly different compared to the treatment of weeding 2

times and pruning branches leaving 2 branches (P1W1), the treatment of weeding 3 times and pruning branches leaving 2 branches (P2W1), the treatment without weeding and pruning branches leaving 4 branches (P0W2), as well as the treatment of weeding twice and pruning branches leaving 4 branches (P1W2), but were significantly different compared to the other treatments.

Weight of Individual Tomato Fruit

The results of the analysis of variance on the fruit/fruit weight parameters of tomato plants showed that there was an interaction between weeding treatments and pruning tomato branches. The average fruit/fruit weight of tomato plants is presented in Table 3.

Table 3. Average fruit/fruit weight

Treatment	Tomato Fruit Weight per Fruit (g)		
	W0	W1	W2
P0	35,04 a	43,79 b	44,33 b
P1	39,29 ab	64,21 d	55,67 cd
P2	53,33 c	58,88 cd	62,96 d
BNJ%	7,67		
KK%	5,19		

Legend: Numbers accompanied by the same letter in the same column are not significantly different based on the 5% BNJ test, P0: no weeding, P1: weeding 2 times, P2: weeding 3 times, W0: no pruning, W1: pruning leaves 2 branches, W2: pruning leaving 4 branches.

Table 3 in the treatment of weeding twice and pruning branches leaving 2 branches (P1W1) had the highest fruit weight compared to the other treatments. The treatment of weeding 2 times and pruning branches leaving 2 branches (P1W1) was not significantly different compared to the treatment of weeding 3 times and pruning branches leaving 2 branches (P2W1), weeding 2 times and pruning branches leaving 4 branches (P1W2). and the treatment of weeding 3 times and pruning branches leaving 4 branches (P2W2), but significantly different compared to the other treatments.

Fruit formation on tomato plants is influenced by the plant's growing environment. The factor that influences the percentage of fruit formation is the number of flowers that become fruit. Treatment without weeding proves that the nutritional competition of tomato plants with weeds influences the formation of flowers into fruit, the number of fruit formed is influenced by the content of P and K elements, the P element helps the formation of flowers and fruit and the K element helps in the development of reinforcing tissue on the fruit stalk thereby reducing fruit falling **(Pasaribu *et al.*, 2015).** The availability of nutrients, especially P and K, is very important in influencing the generative growth of plants, including flowering and fruit formation **(Sumpena, 2014).**

Tomato Fruit Diameter

The results of the analysis of variance on the parameters of fruit diameter of tomato plants showed that there was an interaction between weeding treatments and pruning tomato branches. Table X in the treatment of weeding twice and pruning branches leaving 4 branches (P1W2) has the highest fruit diameter compared to other treatments and is significantly different compared to other treatments. The average fruit diameter of tomato plants is presented in Table 4 and Figure 1.

Table 4. Average fruit diameter

Treatment	Fruit Diameter (mm)		
	W0	W1	W2
P0		43,79 b	44,33 b
P1	39,29 ab	64,21 d	55,67 cd
P2	53,33 c	58,88 cd	62,96 d
BNJ%	7,67		
KK%	5,19		

Legend: Numbers accompanied by the same letter in the same column are not significantly different based on the 5% BNJ test, P0: no weeding, P1: weeding 2 times, P2: weeding 3 times, W0: no pruning, W1: pruning leaves 2 branches, W2: pruning leaving 4 branches.

The branch pruning treatment leaving 4 branches had a higher average percentage of fruit set compared to the treatment without pruning. The percentage of fruit formation or fruit set on tomato plants is influenced by the plant's growing environment. By pruning to leave 2 branches, the intensity of light received will increase, so that the surface temperature will also increase. Relatively high temperatures and relatively low humidity cause flowers to fall easily. The process of successful flowering and fruiting is also influenced by abiotic factors, especially air temperature. Tomato plants require day and night temperatures of ±24°C and ±18°C respectively for growth, especially flowering and fruiting. This is in accordance with the research results of **Kusumayanti *et al.* (2015)** and **Simbolon (2017)**.

Figure 1. Shape of tomato fruit size in each treatment

The results of the research showed that in the fruit weight parameters per plant, the treatment of weeding 3 times and pruning branches leaving 4 branches produced a higher fruit/plant weight than the other treatments, whereas the treatment without weeding and without pruning branches produced the lowest fruit/plant weight among the other treatments. , as well as the fruit weight parameter, shows that the treatment of weeding twice and pruning branches leaving 2 branches resulted in a higher weight than the other treatments. The treatment without weeding and without pruning branches produced the lowest fruit/fruit weight. This is because weeding helps optimal absorption of nutrients, water, light, and space for tomato plants. Pruning treatment can inhibit plant vegetative growth because the assimilate formed is used optimally for the plant in fruit formation **(Richardson, 2012)**.

Tomato plants that are pruned produce higher fruit weights compared to those that are not pruned because the results of photosynthesis are used more for fruit formation. The fruit diameter parameter shows that the treatment of weeding and pruning branches produced a fruit diameter that was greater than the treatment without weeding and without pruning branches, while the treatment without weeding and without pruning branches produced the lowest fruit diameter among the other treatments **(Zamzami, 2014)**. Weeding has proven to be effective in preventing competition for weeds' nutrients with tomato plants and by pruning branches, the nutrients absorbed produce photosynthate which improves fruit quality, the larger the fruit size, the greater the weight of the fruit, because the photosynthate produced by the leaves is translocated to the other parts. fruit so that the unit weight of the fruit also increases, in contrast to plants that have more fruit which can reduce the unit weight of the fruit because the photosynthate produced is not sufficient to increase the size of the fruit, such as in the treatment without weeding and without pruning **(Pasaribu *et al.,* 2015)**.

CONCLUSION

Weed controlling three times and pruning branches to retain four branches per plant yielded the highest fruit weight per plant, while the absence of these practices resulted in the lowest fruit weight. Weeding twice and pruning to maintain two branches also proved to be beneficial, enhancing fruit weight compared to untreated plants. These results can be attributed to the positive impact of weeding on nutrient, water, light, and space uptake, optimizing conditions for tomato growth.

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