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Effect of Shade and Thinning on Yield and Chemical Content of Tomato (*Lycopersicum esculentum* Mill.)

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Abstract— *Tomatoes are one of horticultural commodities which have many benefits for the community, including spices, fruits and vegetables. Tomato cultivation techniques using fruit shade and thinning can be done to overcome the constraints of the mismatch between the quality of products produced by farmers and the quality of products desired by community. Shade has a function to create environmental conditions in accordance with plant conditions, while fruit thinning has a function to maximize the results of photosynthesis so that it can improve the quality of tomatoes. This study aimed to determine the effect of shade and thinning on the result and quality of tomatoes. The study was conducted from January to May 2022 in the Malang, East Java. This research used a Completely Randomized Design with Nested Pattern which consisted of 12 treatments with 3 replications, so that from 36 units of combination treatment. The treatment used was a combination of the use of fruit shade (0,25 and 50%) and thinning intensity (0,3,4 and 5). The analysis of the data used was the F level test of 5%. If the 5% F test had a significant effect, then it was followed by a 5% HSD test. The results showed that the use of fruit shade and thinning significantly affectd the parameters of flower emergence, fruit weight per hectare, fruit weight per fruit, fruit volume, fruit diameter, and no significant effect on the parameters of total dissolved solids.*

Keywords— ***Acid–base Titration, Total Dissolved Solids, Light Intensity.***

I. INTRODUCTION

Tomato is one of the plants which classified as a horticultural commodity that has many benefits. It does not only function as a fruit vegetable but is often used as a spice in cooking, food and drinks. Tomato plants are cultivated by farmers to meet the needs of consumers and industry. The need for tomato consumption in 2015 reached 4.18 kg per capita and increased in 2016 to 4.46 kg per capita. To meet the increasing needs of tomatoes, it must be followed by the production of good quality tomatoes in accordance with market needs (Statistics Indonesia 2017).

The obstacles faced by farmers to meet the needs of consumers are in the mismatch between the quality required by consumers and the quality of products produced by farmers. The efforts which can be made to improve the quality of plants are to create environmental conditions in accordance with plant growth and pay attention to plant cultivation techniques.

One of the cultivation techniques which can be used for environmental engineering is the use of shade. The use of shade is done because it provides benefits to regulate the intensity of solar radiation, temperatures, and humidity. Even though tomatoes are quite tolerant, but the intensity Low sunlight can affect photosynthesis. Process disrupted photosynthesis will cause tomatoes to be produced has a lower weight than it should (Haque et al. 2009), but research on low light intensity on quality tomatoes are still not much done. Therefore, it needs more study more about the effect of shade on the production and quality of tomatoes necessary. Plants try to increase light absorption in light deficit conditions by increasing the amount of chlorophyll per unit leaf (Cabuslay et al. 1995). Decreased ratio of chlorophyll a / b in plants shade tolerant aims to improve efficiency capturing light for the plant as a whole (El-Abd et al. 1994).

Another effort which can be done to improve fruit quality is by conducting fruit thinning. Reducing the number of fruits can increase fruit weight per fruit. It is intended to reduce competition for the use of photosynthesis between fruit and flowers, so that photosynthesis can be concentrated for fruit development. Based on the description above, the research which uses the fruit shade and thinning needs to be done to determine the result and quality of tomatoes. The purpose of this study was to determine the effect of shade and thinning on yield and chemical content of tomatoes.

II. MATERIALS AND METHODS

The research had been carried out in Sidorahayu Village, Wagir Sub-District, Malang Regency for 5 months with the implementation period of January-May 2022. The tools used are pot tray, paranet, bamboo, luxmeter, refractometer, calipers, analytic scales, measuring cups, rulers or meters sprayer, stationery, and camera. While the materials used are variety tomato seeds of Tymoty, soil, goat manure, water, poly bag size 35 cm x 35 cm and raffia rope. Fertilizers used include SP36 fertilizer, Urea fertilizer, NaCl fertilizer, and ZA fertilizer.

The research method used is a Completely Randomized Design with a Nested Pattern (using nested) using 12 treatments including N0B0 (without shade + without thinning), N0B1 (without shade + maintained 3 fruits), N0B2 (without shade + maintained 4 fruits), N0B3 (without shade + maintained 5 fruits), N1B0 (shade of 25% + without thinning), N1B1 (shade of 25% + maintained 3 fruits), N1B2 (shade of 25% + maintained 4 fruits), N1B3 (shade of 25% + maintained 5 fruits), N2B0 (shade of 50% + without thinning), N2B1 (shade of 50% + maintained 3 fruits), N2B2 (shade of 50% + maintained 4 fruits), N2B3 (shade of 50% + maintained 5 fruits). Each treatment is repeated 3 times, so that 36 units are obtained. Each experimental unit consists of 6 plants, so that a total plant of 216 plants is obtained.

Parameters of observations: The variables observed by using non-destructive methods included the time flowers appeared, while the observed variables include fruit weight per plant , fruit weight per fruit, fruit volume, fruit diameter, total dissolved solids and Acid–base titration.

Statistical analysis: Data obtained from observations are analyzed using ANOVA F test with a level of 5%. If the results of the analysis of variance have a effect, then continued with Significant Difference test (HSD) at the level of 5% (Gomez and Gomez 1984).

III. RESULT AND DISCUSSION

Time of Flowers Appear, Fruit Weight per Plant and Fruit Volume and Diameter

The results of the variety analysis show that the treatment of fruit shade and thinning gave a significant effect on the time of flower appearance on tomato plants. Based on Table 1, it can be seen that in the treatment without shade and shade of 25% with all thinning rates produce the fastest flowering time, while in the shade treatment of 50% with all thinning results has the lowest flowering time.

The results of the analysis of variance show that the treatment of fruit shade and thinning gives a significant effect on the weight of fruit per plant. Table 1 shows that tomato plants without shade are able to produce the highest average fruit weights per plant. The average of fruit weight per plant in the treatment without shade and without thinning are not significantly different from the treatment of shade 25% with all thinning levels.

The results of the analysis of variance show that the treatments of fruit shade and thinning give a significant effect on the fruit weight per fruit. Table 1 shows the condition of plants without shade and shade of 25% shows that tomato plants are able to produce the highest average tomato compared to shade of 50%. The results of the research show that the treatment without tomato thinning gave the highest average fruit weight per plant compared to other treatments.

The results show that the use of fruit shade and thinning has a significant effect on the parameters of fruit volume and diameter. Table 1 shows that the treatment without shade maintained by 3 fruits per bunch gives the highest fruit volume and diameter, whereas at shade of 50% treatment with all fruit thinning levels produced the lowest average fruit volume and diameter. The results also show that the combination of treatments with the treatment maintained 3 fruits per bunch produces the highest fruit weight, while the treatment without thinning produces the lowest fruit weight.

Total Dissolved Solids (TDS) and Acid–base Titration of Tomatoes

The observations showed that total dissolved solids (TDS) of tomatoes in the shade difference and the amount of thinning were 3.72 to 4.04 (Figure 1). Whereas the results of acid-base titration show that the greater the shade, the lower the content of acid-base Titration (Figure 2). In tomatoes without shade, the results of Acid-base Titration 302.2 mg $100g^{-1}$ can be seen while in the shade of 50% it can go down to 229.8 mg $100g^{-1}$.

The data shows that the higher the shade level, the Acid-base Titration will be lower. Figure 3 shows that the R^2 score of 0.9433 besides the equation shows the existence of

a negative correlation.

Table 1. Comparison of SM, pH, TOC, TN, P and K in five different soil types.

Treatment	Time of Flower Appearance (DAP)	Fruit Weight per Plant (g)	Fruit Weight per Fruit (g)	Fruits Volume (cc)	Fruits Diameter (mm)
N0B0	32.33 a	830.72 b	38.25 c	48.89 def	44.10 bc
N0B1	32.33 a	692.55 b	40.67 c	58.30 g	46.84 c
N0B2	32.00 a	786.33 b	36.28 bc	51.55 efg	44.76 c
N0B3	32.33 a	773.44 b	35.19 abc	47.78 cdef	43.26 bc
N1B0	32.33 a	650.66 b	32.38 abc	48.88 def	43.64 bc
N1B1	32.00 a	628.52 b	38.40 c	55.53 fg	45.24 c
N1B2	32.33 a	629.16 b	38.59 c	49.88 defg	44.31 bc
N1B3	32.67 a	688.33 b	36.65 bc	46.11 bcde	43.21 bc
N2B0	37.00 b	188.88 a	23.68 a	41.85 abcd	38.08 a
N2B1	40.33 b	137.36 a	25.98 ab	39.26 abc	40.51 ab
N2B2	37.67 b	220.95 a	25.11 ab	37.03 ab	38.70 a
N2B3	38.67 b	170.67 a	25.58 ab	34.07 a	38.04 a
HSD (5%)	3.92	303.23	11.72	9.19	4.11
CV (%)	3.99	19.32	12.04	6.70	3.28

Note: The numbers accompanied by the same letter in the same column show that there is no significant difference based on the 5% HSD test, DAP = days after planting

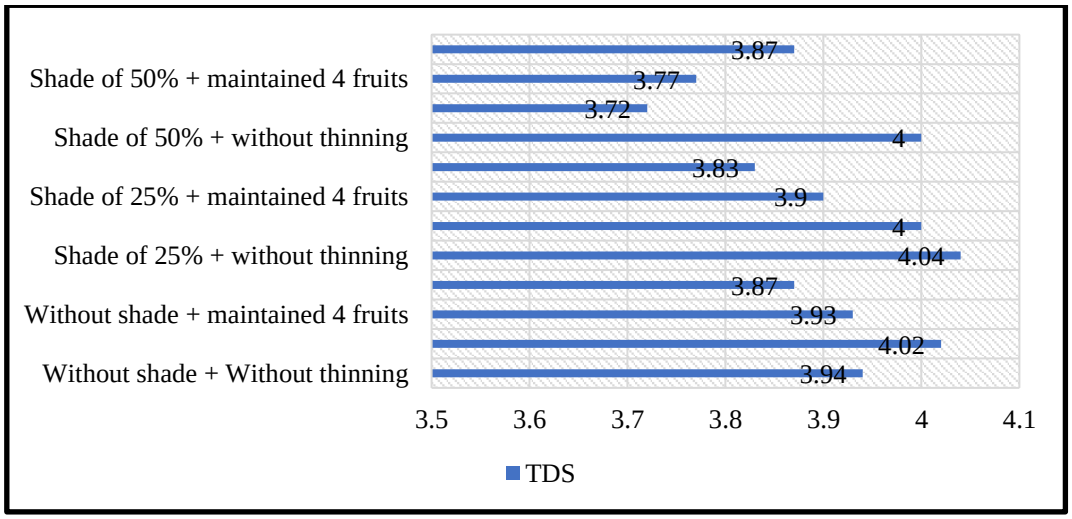

Fig.1. Total Dissolved Solids (TDS) of Tomatoes

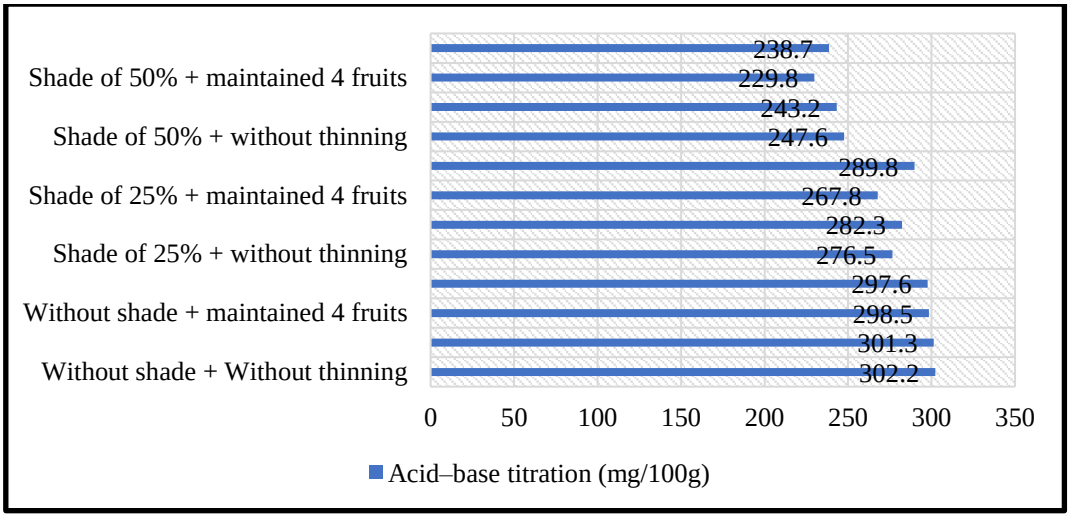

Fig.2. Acid–base Titration of Tomatoes

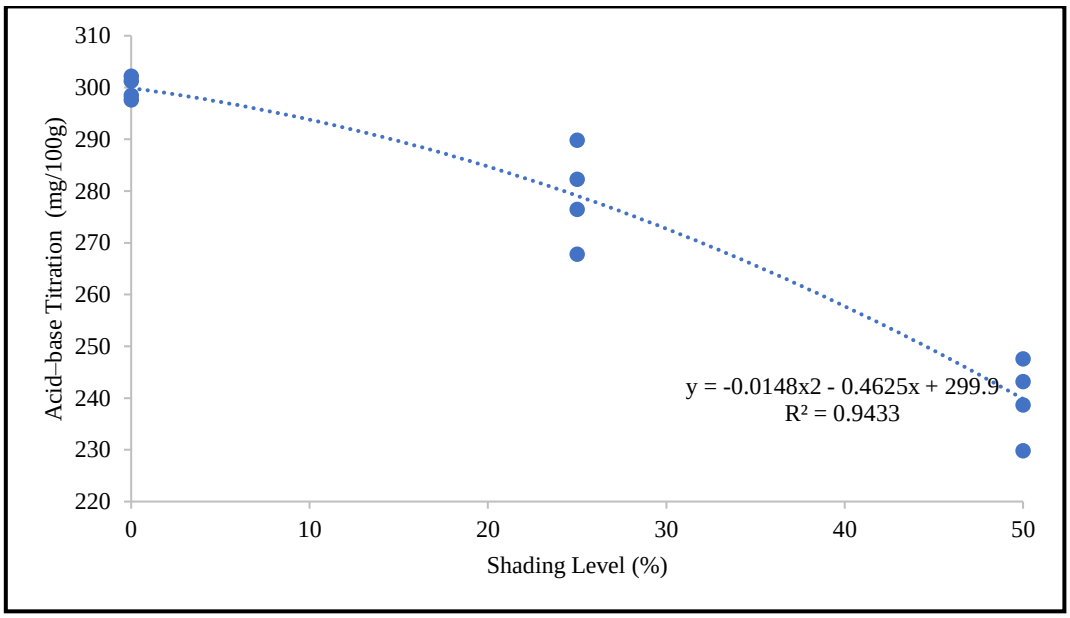

Fig.3. Regression Between the Percentage of Shade and Content of Acid-base Titration on Tomatoes

IV. DISCUSSIONS

Time of Flowers Appear, Fruit Weight per Plant and Fruit Volume and Diameter

The results show that the higher the shade level can slow down the time of flower appearance. This happens because the shade can cause low light intensity, so it can cause tomato plants to have flowers more slowly. According to Kittas et al. (2009) the quality of solar radiation at a higher level of shade was not suitable for the flowering induction process, so that the appearance of flowers on tomato plants under shade was longer. This relates to the presence of phytochromes in plants which become the pigments and responsive to flowering. Sirait (2008) added that sunlight had a very important function in the process of photosynthesis in plants which affected growth

The results showed that the treatment without shade and 25% shade resulted in fruit weights that were not significantly different. This makes it possible that tomato plants are able to survive and are able to produce optimally even in shade treatment. This is supported by the research of Kartika et al. (2015), who state that tomato plants can grow well in the shade below 30%, where the shade under 30% is the optimal condition because it gets low sun intensity and low temperatures accordingly, so that photosynthetic activity runs optimally and causes assimilation which is needed by plants to meet maximum growth. Besides, fruit thinning also affects the weight of fruit per plant.

Thinning tomatoes is an action taken to reduce the number of fruits per bunch of tomatoes. It is intended that the rate of assimilation of photosynthesis results can be focused on several fruits so as to improve the quality of tomatoes. However, fruit thinning can reduce the average fruit weight per plant. The more fruit that is maintained per fruit bunch, the more fruit weight produced per plant, otherwise the less fruit that is maintained per fruit bunch, the less fruit weight produced per plant. This is in accordance with the research conducted by Rahayu et al. (2011) who state that the smaller number of melons maintained, it can increase the weight per fruit but reduce the production of weights per plant. According to Sugihartiningsih and Wartapa (2008), explain that one of the activities carried out at the main branch aims to give higher result of photosynthesis for the establishment and development of tomato fruit.

The result show that the 50% shade condition on tomato indicate that the plants do not carry out photosynthesis optimally, so they are not able to form the optimal volume and diameter of the fruit. Treatment without shade and shade of 25% of tomato plants are able to form the optimal fruit weight. This happens because each plant requires optimal conditions to form tomatoes. This is in accordance with the research of Sanura (2013), which resulted that the shade of 25% treatment gave the highest results of weight per tomato. Besides, thinning fruit also affects the weight of fruit per fruit. The results show that the combination of treatments with the treatment maintained 3 fruits per bunch produces the highest fruit weight, while the treatment without thinning produces the lowest fruit weight. This happens because in the treatment without thinning, the number of tomatoes kept per plant will increase, so that the assimilation results of photosynthesis can not focus on enlargement of several fruits but split into many tomatoes, so as to reduce the weight of fruit per tomato. This is consistent with the results of research by Hapsari et al. (2017), who stated that the less fruit exists, the greater the volume and weight of fruit per fruit unit. Shehata et al. (2013), too states that tomatoes are planted on condition the shade of 35% and 65% shows an increase plant height, stem diameter, number of branches and interest, and total crop yields.

The treatment combination without shade and maintained 3 per bunch are able to provide conditions optimally for fruit development. The condition without shade plant gets full sunlight intensity, causing the plants to perform photosynthesis optimally. Syakur (2012), added that during the day the sun's rays are blocked by shade, this can result to reduce solar radiation in reaching the ground. Photosynthesis can optimally improve the quality of tomatoes through enlargement of the volume and diameter of the fruit. Suparwata (2018), added that in the cultivation of agricultural crops, the presence of shade greatly affects the intensity of radiation. So that besides directly affecting plants, it also has an indirect effect through changes in the microclimate around plants. Formation of fruit volume and diameter can be affected by thinning tomatoes.

Thinning fruit can increase the volume and diameter of the fruit, because with the reduction in the number of fruit kept the allocation of photosynthesis can focus only on the fruit maintained. Research conducted by Angelia (2017) states that the number of fruits per plant maintained can affect the fruit circumference and fruit volume. The more fruit kept, the smaller the weight, circumference and volume of the fruit.

Total Dissolved Solids (TDS) and Acid–base Titration of Tomatoes

TDS shows that the shade treatment and fruit thinning do not affect the formation of total dissolved solids. This is not in accordance with the opinion of Sandri et al. (2013) who stated that the total value of dissolved solids will decrease with increasing shade levels. This is presumably because light is an energy source for photosynthesis so that it can increase the total dissolved solids of the fruit. The higher the fruit acid, the less brix is contained therein. The increasing of brix value shows that the sugar content in the fruit is increasing. Callejón-Ferre et al. (2009) stated that the total dissolved content of tomatoes is reduced by the shade increased, a significant difference was seen in the shade of 60% which decreased from the minimum shade limit of 50%.

Yue et al. (2008) states that titrated acidity is negatively correlated with relative light intensity. This means that fruit acid content increases as light intensity decreases. The study is different from the results which is obtained. This is thought to be due to the effect of high temperatures on 75% shade. According to Gent (2007) a decrease in the content of fruit acid titrated tomatoes occur with increasing temperature.

V. CONCLUSIONS

Based on the results of the research, it can be concluded that the quality of tomatoes which can be affected by the shade treatment and thinning of fruit is fruit weight, fruit volume, and fruit diameter. The higher the intensity of the shade and the more fruits retained per fruit bunch can reduce the average fruit weight per plant, fruit weight per fruit, fruit diameter and fruit volume. High quality tomatoes can be seen from tomatoes which have fruit weight and chemical content.

REFERENCES

[1] Statistics Indonesia 2017. Five-year data on the horticulture subsector. [online] Available at: http://www.bps.go.id. [in Indonesian]

[2] Haque AA, Hasanuzzaman M & Rahman ML 2009. Morpho-physiology and yield of cucumber (*Cucumis sativa*) under varying light intensity. Academic Journal of Plant Sciences 2(3), 154-157.

[3] Cabuslay GS, Velgara BS & Quintana RU 1995. Low light stress: Mechanism of tolerance and screening method. Philippine Journal of Crop Science 16(1), 39-47.

[4] El-Abd MTG., Shanan SA, Abou-Hadi AF & Saleh MM 1994. Effect of different shading densities on growth and yield of tomato and cucumber. Egypt Journal Horticulure 21(1), 64-72.

[5] Gomez KA & Gomez AA 1984. Statistical procedures for agricultural research (2 ed.). John Wiley and Sons, NewYork, 680 p.

[6] Kittas C, Rigakis N, Katsoulas N & Bartzanas T 2009. Influence of shading screens on microclimate, growth and productivity of tomato. Acta Horticulturae 807, 97-102.

[7] Sirait J 2008. Luas Daun, Kandungan Klorofil dan Laju Pertumbuhan Rumput pada Naungan dan Pemupukan yang Berbeda. Jurnal ITV 13(2), 109-116. [in Indonesian].

[8] Kartika E, Yusuf R & Syakur A 2015. Growth and yield of tomato *(Lycopersicum esculentum* Mill.) In various shading percentage. Journal Agrotekbis, 3(6), 717-724.

[9] Rahayu A, Serhalawan RJPJ & Munandar E 2011. Produksi dan kualitas buah melon (*Cucumis melo* L.) pada jumlah buah per tanaman yang berbeda. Jurnal Pertanian 2(2), 139-144. [in Indonesian]

[10] Sugihartiningsih S & Wartapa A 2008. Pengaturan jumlah cabang utama dan penjarangan buah terhadap mutu benih tomat varietas kaliurang (*Lycopersicum esculentum* Mill.). Jurnal Caraka Tani, 23(1), 39-42. [in Indonesian]

[11] Sanura CPEl 2013. Effect of shading on production and fruit quality six varieties of tomatoes (*Lycopersicon esculentum* Mill.). [Thesis]. Institut Pertanian Bogor. Bogor.

[12] Hapsari R, Indradewa D & Ambarwati E 2017. The effect of pruning and thinning on the growth and yield of tomato (*Solanum lycopersicum* L.). Jurnal Vegetalika 6(3), 37-49. DOI: https://doi.org/10.22146/veg.28016

[13] Shehata S, Elsagheer AA, El-Helaly MA, Saleh SA & Abdallah, 2013. Shading effect on vegetative and fruit characters of tomato plant. Journal of Applied Science Research 9(3), 1434-1440.

[14] Syakur A 2012. Heat unit approach for determining growth and development phases of tomato plants in greenhouse. Journal Agroland 19(2), 96-101.

[15] Suparwata DO 2018. Respon pertumbuhan dan produksi kacang hijau (*Vigna radiata* L.) terhadap perlakuan perbedaan naungan. Jurnal Ilmiah UMG 7(1), 10-21. [in Indonesian]

[16] Angelia OI 2017. pH content, total acidified acid, dissolved solids and vitamin c in some horticultural commodities. Journal of Agritech Science 1(2), 68-74. [in Indonesian]

[17] Sandri MA, Andriolo JL, Witter M & Ross TD, 2003. Effect of shading on tomato plants grown under greenhouse. Horticulture Brasilia 21, 642-645.

[18] Callejón-Ferre AJ, Manzano-Agugliaro F, Díaz-Pérez M, Carreño-Ortega A & Pérez-Alonso J 2009. Effect of shading with aluminised screens on fruit production and quality in tomato (*Solanum lycopersicum* L.) under greenhouse conditions. Spanish Journal of Agriculture Research 7(1), 41-49.

[19] Yue Y, Wei Q, Zhang J, Wang X, Liu-jun & Zhang Q 2008. Relationships between distribution of relative light intensity and fruit quality for trellis trained 'Hwangkumbae'. Acta Horticulture Sinica 35, 625-630.

[20] Gent MPN 2007. Effect of degree and duration of shade on quality of greenhouse tomato. Horticulture Science 42(3), 514–520.