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Research article

Growth and Yields of Three Tomato Strains of Lycopersicum Esculentum Mill With Various Dosages of Trichoderma Sp

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Abstract.
By testing several F1 tomato lines, the genetic diversity of tomatoes can be observed for their agronomic characters and product. To increase fruit production, *Trichoderma* sp, a biological microbial material and plant growth stimulator, can be applied to tomatoes. The goal of this study was to track the growth and development of three tomato strains along with their interactions with *Trichoderma* sp. A completely randomized design was used in this study, with two factors and three responses, and the two treatments were repeated three times. The tomato strains were Servo F1, F2, and F3, and the *Trichoderma* sp dosages were 30 g/plant, 40 g/plant, and 50 g/plant. ANOVA was used to analyze the data, followed by a DMRT test at a 5% level. This study found that the F1 tomato strain was significantly taller, while the F3 tomato strain had a sweeter taste. *Trichoderma* sp at a dose of 40 g/plant accelerated the appearance of flowers and fruit diameter. The addition of *Trichoderma* sp at a dose of 40 g/plant in Servo F1 tomatoes increased the total number of leaves and the total weight per plant. Tomato vitamin C content was increased in the F1, F2, and F3 tomato strains with 30 g/plant *Trichoderma* sp.

Keywords: Tomato, *Trichoderma* sp, strain

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1. Introduction.

Tomato is a perennial plant of the Solanacea family that grows in the tropics, has economic value, and is liked by many people, it tastes sweet, slightly sour and durable in storage.[1]. Fresh tomatoes contain protein, fat, vitamin A, vitamin C, as antioxidants, increase immunity, [1] This plant can grow in the lowlands to the highlands can be planted throughout the season.

Based on plant production data released by the Indonesian Horticultural Statistics Central Office in 2018 to 2020, it has increased. The tomato production in Yogyakarta was 821 tons during three years from 2018 until 2020, in 2019 it was 1372 tons and in

2020 it was 1372 tons and in 2020 it was 1531 tons[2]. Consumer demand for tomatoes is getting bigger along with the need.

The problem in decreasing tomato productivity is the attack of the tomato yellow curl virus (TYLCV) [3] , small fruit size, limited superior seeds and the need for organic fertilizer rich in macro and micro nutrients. Assembling superior varieties with high yields and disease resistance is the right solution, supported by the availability of tomato genetic diversity. It is necessary to test several genotypes of tomato plants from several derivatives to observe the growth and yield characteristics of plants and disease resistance with the addition of *Trichoderma* sp. The *Trichoderma* sp., apart from being a decomposing organism, can also function as a biological agent and plant growth stimulator that is inexpensive, easy to obtain and environmentally safe [4].

Several studies were carried out by giving *Trichoderma* sp at a dose of 250 gram on chili plants [5], a dose of 30 gram of Chung tomatoes [6], a dose of 40 gram of tomatoes of the Lentana, Permata, and Ratna varieties [7], using the seeds of the F1 strain to produce growth and yields. the best tomatoes. The uses seeds from the F1 line. A study showed that in chili nurseries on soil media given *Trichoderma* sp showed the same good growth without *Trichodema* sp, but when applied to land with soil media showed superior chili yields [8].

In this study *Trichoderma* sp was applied in compost with various doses and seed origin of Servo Variety Tomato from F1, F2 and F3 lines. Planting from F1 seeds will be better than the next generation, but if you add compost containing *Trichoderma* sp, it is suspected that it will produce optimal growth and yields. Plants that come from the first derivative (F1) of a cross between two parents will have better traits or a mixture genetic of the two parents. The seed if we replant from the next generation, namely F2 and F3, they will show genetic diversity [9]. *Trichoderma* sp on tomatoes infected with TYLCV. The research hypothesis is that F3 Tomatoes grown with *Trichoderma* sp. 40 gram per plant can increase the phenotypic diversity and quality of crop yields.

2. Methodology

The research was carried out from April to August 2020 at the Wedomartani research garden, Faculty of Agriculture, UPN “Veteran” Yogyakarta on height 110 mdpl. The study used a 2-factor Completely Randomized Design. namely the generation of tomatoes and doses of *Trichoderma* sp, with 3 replications. Tomato generation treatments included F1, F2 and F3, while the treatment doses of *Trichoderma* sp were 30, 40 and 50 g/tnm.

The research materials were tomato plants of Servo variety, soil media, *Trichoderma* sp. Tools, namely plantera bag 25 kg, digital scales, stationery, caliper, and hose.

The stages of carrying out the research include: (1) Tomato plants are sown in soil nursery media and manure with a balanced composition in a tray, then placed in a green house. (2). Preparation of planting media by filling a 25 kg plantera bag with soil, compost and cocopeat media (1:1:1) placed on the green house; (3) Transplanting is done when the tomato seedlings are 2 weeks old from the nursery media marked by the emergence of roots, leaves and plant height of 15 cm; (4). The treatment of giving *Trichoderma* sp was carried out at the age of 14 days in plantera bag with a dose according to the treatment sown and backfilled with media; (5). Maintenance includes watering, installation of bamboo supports, cutting side shoots and biological pest control; (6). Harvesting is done at the age of 60 DAP or the fruit has shown ¼ of the red color, and the next harvest is done every 3 days until 3 harvests. Observation parameters include: high of plant, total of leaves, flower appearance,diameter of fruit, weight of fruit per plant, fruit sweetness and vitamin C. The Duncan Multiple Range Test (DMRT) level 5% will be carried out if there is a significant difference in treatment from the analysis of variance.

3. Result and Discussion

The observation of plant height parameters at the age of 5 and 7 weeks after genetic diversity analysis showed that the treatment of F1 tomato offspring had significant impact, but the *Trichoderma* sp treatment had no significant impact.There was not interaction between the treatments of Filial and dose of *Trichoderma* sp. The data average and influence of Filial and dose of *Trichoderma* sp on high of plant at 5 and 7 wap showed Table 1.

Table 1: The influence of Filial and dose of *Trichoderma* sp on high of plant at 5 and 7 wap (cm).

Filial (F)	High of plant 5 wap	High of plant 7 wap
F1	47,111 a	71,722 a
F2	40,500 b	58,889 b
F3	37,222 b	56,944 b
Trichoderma sp		
30 g/plant (K1)	39,556 p	58,944 p
40 g/pant (K2)	42,444 p	62,778 p
50 g/plant (K3)	42,833 p	65,833 p

Note: The letter notation behind the number in the same row and column indicated no significant disparate in the 5% DMRT test.

Table 1 shows that the Filial 1 were significantly higher and stronger than the Filial 2 and 3 treatments at the life of 5 wap and 7 wap. Nazirwan *et al*. (2014) present that distinction in high of plant each tested genotype was due to the genetic distinction of each genotype, which had different special characteristics and traits. The abiotic and biotic environment will affect the vegetative growth of plants such as the intensity of sunlight, macro and micro nutrients, humidity, soil microbial and climate. [10]. Servo F1 tomato plants are determinate tomatoes that are very suitable to be planted in low to medium lands, with plant heights reaching 95-140 cm at the age of 65 days after transplanting [11]. Tomato F1 plants have of genotypic characteristics from both parents, where each parent will contribute half of the genome, while agronomically it has a special and similar appearance (Syukur, 2018) [12]. The tomato of Filial 1 will reproduce generatively by selfing to produce F2 derivatives. Furthermore, the Filial 2 tomatoes were self-drilled to produce F3 derived tomatoes.

The Giving of *Trichoderm*a sp with various doses has not been able to stimulate the formation of plant height, because the soil media only adds microorganisms to grow. The process of microbial decomposition in the soil takes a long time, meaning that it is still on going and has not been able to encourage plant of vegetative growth, including plant heights of 5 and 7 mst. (Setyadi *et al*., 2017).[8]. *Trichoderma* sp is known as cellulosic bacteria which is capable of producing cellulase enzymes. Cellulolytic bacteria function to hydrolyze cellulose from plant residues and other organisms to be broken down into glucose, CO2 and hydrogen compounds as nutrients for plants and soil organisms.[13]. The average value of the total of leaves 7 weeks showed in table 2.

Table 2: The influence of Filial and dose of *Trichoderma* sp on total of leaves aged 7 wap (cm).

Treatment Filial	*Trichoderma* sp 30 g/plant (K1)	*Trichoderma* sp 40 g/plant (K2)	*Trichoderma* sp 50 / plant (K3)	Average
F1	63,000 b	84,167 a	78,667 ab	75,278
F2	68,000 b	68,000 b	80,167 ab	72,056
F3	67,500 b	63,000 b	73,833 ab	68,111
Average	66,167	71,722	77,556	

Note: The letter notation behind the number in the same row and column indicated no significant disparate in the 5% DMRT test.

Table 2 indicated that the combination of tomato F1 and *Trichoderma* sp 40 g/tnm handling had more total of leaves than the other handling at 7 wap aged. There is F1K2 treatment combination was not significantly different from the F2K3, F1K3 and F3K3

treatments. This is because *Trichoderma* sp plays a role in accelerating the overhaul of microbes in the soil, making it easier for roots to absorb macro (N, P, K) and micro nutrients (Cu, Ca, Mg, Fe, Zn etc) in the soil which are needed for plant growth and development. The macro and micro nutrients are then transported by the xylem vessels to the leaves where photosynthesis takes place. This photosynthesis will be effective if it occurs during the day with the help of sunlight which will remodel CO2 and water into carbohydrates and oxygen. The oxygen produced by plants is then released through the stomata, so that Carbohydrates are circulated throughout the all of organ plant.(Salisbury and C.W.Ross, 2017) [14].

The observation of flower appearance was carried out when the sample plants showed more than 50% of flowering plants. Tomato plant flowers are star-shaped, yellow and have a stalk. The Flowers are collected in a series. In terms of plant flower appearance, the results of the analysis of variance indicated that the handling line (F) and the dose of *Trichoderma* sp had a significant impact. There was no interaction among handling of Filial and dose *Trichoderma* sp. The data average value of tomato flowering and influence two treatmen showed Table 3.

Table 3: The influence of Filial and dose of *Trichoderma* sp on time of tomato flowering (days).

Treatment Filial	Trichoderma sp 30 g/tnm (K1)	Trichoderma sp 40 g/tnm (K2)	Trichoderma sp 50 g/tnm (K3)	Average
F1	30,667	30,333	34,333	31,778 a
F2	33,333	31,833	33,333	32,833 ab
F3	33,833	33,500	35,167	34,167 b
Average	32,611 p	31,889 p	34,278 q	

Note: The letter notation behind the number in the same row and column indicated no significant disparate in the 5% DMRT test.

Tomat F1 and F2 on time of flower significantly faster than F3 (Table 3). The administration of *Trichoderma* sp 30 g/plant and 40 g/plant was significantly faster in flowering than 50 g/plant.This is because they are genotypically the same but in different generations and because environmental influences will affect flower growth. Servo tomato genotypes tested showed different phenotypes in the observed characters, including their ability to flower. The phenotypic character of Servo tomato flower appearance at the age of 30-33 days [11].

The results of the analysis of the various diameters of tomatoes at the age of 11 weeks indicated that the Filial handling had no significant impact but the dose of *Trichoderma* sp had a significant impact There was not interaction among handling Filial and dose of

Trichoderma sp. The data average diameter of fruits and the influence two treatments showed Table 4. (cm)

Table 4: The influence of Filial and dose of *Trichoderma* sp on diameter of fruit at 11 wap (cm).

Treatment Filial	*Trichoderma* sp 30 g/tnm (K1)	*Trichoderma* sp 40 g/tnm (K2)	*Trichoderma* sp 50 g/tnm (K3)	Average
F1	3,717	4,278	3,858	3,951 a
F2	3,862	3,917	3,927	3,902 a
F3	3,543	4,320	4,282	4,048 a
Average	3,707 q	4,172 p	4,022 q	

Note: The letter notation behind the number in the same row and column indicated no significant disparate in the 5% DMRT test.

The parameter diameter of fruits indicated that the treatment line (F) had no significant effect between treatments on stem diameter (Table 4). The handling of *Trichoderma* sp 40 g/plant was significantly wide on diameter of fruits than the other handling. This is because the administration of *Trichoderma* sp is able to control *Fusarium oxysporum* wilt disease and increase the productivity of tomato plants. The Giving *Trichoderma* sp 40 g/tnm which causes plants to survive, so that plant growth and development takes place optimally and produces fruit with a larger diameter than other treatments. The process of photosynthesis in the leaves produces photosynthate which improves fruit quality, this is indicated by an increase in fruit diameter. [15]. The wide diameter of fruit, greater the weight of fruit.

In the observation of the level of sweetness of tomatoes was measured using a refractometer brix DBR 85. The analysis of variance sweetness of fruit at the age of 11 indicated that the Filial handling had a significant impact but the giving of dose *Trichoderma* sp had no significant impact. There was not interaction among the handling Filial and dose of *Trichoderma* sp . The data average value of fruit sweetness and the influence two treatments showed Table 5.

Table 5: The influence of Filial and dose of *Trichoderma* sp on sweetness of fruit (brix) at 11 wap.

Treatment Filial	*Trichoderma* sp 30 g/tnm (K1)	*Trichoderma* sp 40 g/tnm (K2)	*Trichoderma* sp 50 g/tnm (K3)	Average
F1	7,667	7,667	7,333	7,556 b
F2	7,667	7,667	7,333	7,556 b
F3	8,500	7,833	7,833	8,056 a
Average	7,944 p	7,722 p	7,500 p	

Note: The letter notation behind the number in the same row and column indicated no significant disparate in the 5% DMRT test.

Table 5 shows that the Tomato F3 produces significantly higher fruit sweetness than the Servo Tomato F1 and F2. In the treatment dose of *Trichodema* sp there was no significant disparate among handling, the giving of dose *Trichoderma* sp did not affect the formation of fruit sweetness. Tomato F3 produced fruit with a sweeter taste than other treatments.

The results of the analysis of total fruit weight variance per plant at 11 wap showed that the Filial treatment and the dose of *Trichoderma* sp had significant impact. There was interaction among handling Filial and dose of *Trichoderma* sp. The data average value of total fruit weight per plant and the influence two treatments showed Table 6.

TABLE 6: The influence of Filial and dose of *Trichoderma* sp on total fruit weight per plant at 11 wap (g).

Treatment Filial	*Trichoderma* sp 30 g/tnm (K1)	*Trichoderma* sp 40 g/tnm (K2)	*Trichoderma sp* 50 g/tnm (K3)	Average
F1	403,667 c	651,167 ab	722,500 a	592,444
F2	471,500 c	755,833 a	510,000 bc	579,111
F3	460,000 c	466,167 c	502,500 c	476,222
Average	445,056	624,389	578,333	

Note: The letter notation behind the number in the same row and column indicated no significant disparate in the 5% DMRT test.

Table 6 shows that the combination of F2K2, F1K2 and F1K3 treatments significantly resulted in a total fruit weight per plant that was heavier than the other treatments. The combination of tomato derivative F1 and F2 with *Trichoderma* sp 40 g/plant and 50 g/plant was able to increase total fruit weight per plant. According to Syarief (1985) *cit* Sopilena (2018). [7], that the weight of the fruit depends on the number of fruit so that if the required nutrients increase, the number of fruits will increase and the weight of the fruit will increase, thus affecting the fruit yield per hectare. According to Gardner (1991) [16] that differences in plant growth after entering the production period are strongly influenced by the environment both directly such as soil moisture, temperature, and nutrient content. In the ninth to tenth harvest the number of tomatoes obtained decreased, this was presumably because the absorbed nutrients were not completely stored in the storage tissue (fruit) but were more stored in the tissue of plant (Harjadi, 1996) [17]. In addition, the administration of *Trichoderma* sp produces mitotoxins giving an ammonia-like odor and as a biological agent that can suppress *the* development of Foxysporum (Sopialena, 2018). [7], so that plant development increases, and the fruit of size increases.

The analysis of variance vitamin C of fruit at 11 wap indicated the Filial handling and dose of *Trichoderma* sp had a real impact. There is an interaction among Filial and dose *Trichoderma* sp. The data average value of vitamin C of fruit indicated Table 7.

TABLE 7: The influence of Filial and dose of *Trichoderma* sp on vitamin C of fruit at 11 wap (mg/100 g).

Treatment	*Trichoderma* sp 30 g/tnm (K1)	*Trichoderma* sp 40 g/tnm (K2)	*Trichoderma* sp 50 g/tnm (K3)	Average
Servo F1	28,767 a	25,518 bc	29,570 a	27,952
Servo F2	29,892 a	29,892 a	25,863 bc	28,549
Servo F3	27,800 ab	28,133 a	24,887 c	26,940
Average	28,819	27,848	26,773	

Note: The letter notation behind the number in the same row and column indicated no significant disparate in the 5% DMRT test.

The combination of treatments F1K1, F2K1, F3K1, F2K2, F3K2, and F1K3 actually produced greater vitamin C than the other treatments (Tabel 7). This means that Servo F1 F2 with *Trichoderma* sp 40 g/plant and 50 g/plant can increase assimilate yield accumulation.

Chemical changes in fresh fruit that commonly occur during ripening are changes in sugar content, acid content and vitamin C levels. Raw fruits contain higher levels of vitamin C than ripe fruits. Vitamin C levels in fruit will increase until the fruit is ripe, and will decrease when the level of maturity has been exceeded. Therefore, the content of vitamin C in fresh fruit can be used as an indicator of fruit maturity. Vitamin C content in fresh fruit is influenced by the type of fruit, growing conditions, maturity level at harvest and post-harvest handling. The level of ripeness of old tomatoes so that it lasts a long time in storage (Winarno, 1981) [18]. The content of vitamin C in fresh tomatoes is dynamically influenced by of physiological factors, the level of fruit maturity and other factors such as climate and environmental conditions during the fruit growth period (Sari *et al*, 2021). [19]. The shape and size of the fruit of several treatments can be seen in Figure 1. The shape and size of the fruit varies, some are round, oval, heart and small, the size of medium to large

4. Conclusion

Tomato Servo F1 produced a plant high growth of 5 weeks after planting, plant height 7 weeks after planting, and a sweeter taste. The give of *Trichoderma* sp 40 g/plant can accelerate flower appearance and diameter of fruit. The combination Tomat Filial 1 and *Trichoderma* sp 40 g/plant can be increased the total of leaves and weight of

Figure 1: Tomatoes F1K3, F2K3, F3K3, F2K1, F2K2, F2K3, F3K1, F3K2 dan F3K3.

fruit per plant. The Tomatoes F1, F2 and F3 with the addition 30 g/plant *Trichoderma* sp increased the vitamin C content of the fruit.

References

[1] Fahmil U. Tomato for heart disease prevention. Jurnal Kesehatan. http://ejournal.poltekkesternate.ac.id/ojs 2020;13(1):21-27.

[2] Badan Pusat Statistika. Seasonal vegetables and fruits (tons) for the year 2019-2020. BPS Indonesia. 2020; Available at: https://www.bps.go.id/subject/55/hortikultura.html#subjekViewTab3

[3] Moriones E and Catillo JN. Tomato yellow leaf curl virus, and emerging virus complex causing epidemics worldwide. Virus Research. Elsevier. 2000;71:123-134.

[4] Wahyuni SH. The potential of *Trichoderma* in suppressing attacks *Sclerotium rolfsii* on soybean plants. Jurnal Agrotek Lestari. 2018;15(1):51-57.

[5] Herlina L and Pramestri D. The use of *Trichoderma harzianum* active compost in improving chili plant growth. Jurnal Saians dan Teknologi. Universitas Negeri Semarang. Semarang; 2017.

[6] Berliance ASS, Bambang P, and Bambang S. *Trichoderma* sp. application. to control the attack of *Fusarium oxysporum* f.sp. lycopercii on cung tomato plants (*Lycopersicum esculentum* mill). Bengkulu State University. Bengkulu. Indonesia; 2017. http://repository.unib.ac.id/id/eprint/12696

[7] Sopialena S. The effect of giving *Trichoderma* sp. in tomato plants on production factors. AGRIFOR: Jurnal Ilmu Pertanian dan Kehutanan. 2018;12(2):345-354.

[8] I Made Setyadi D, I Nengah Artha, and Gusti Ngurah Alit SW. The effectiveness of composting *Trichoderma* sp. on the growth of chili plants (*Capsicum annum* L.). E-Journal of Tropical Agroecotechnology. 2017;6(1):21-30.

[9] Qosim WA. Plant breeding method. Bandung: Plantaxia; 2018.

[10] Nazirwan I, Wahyudi A, and Dulbari D. Characterization of germplasma collection in local and introduction of tomato. Jurnal Penelitian Pertanian Terapan. 2014;14(1):70-75.

[11] Panah Merah. Servo variety tomato description. Research report. PT East West Seed Indonesia. Purwakarta. West Java. Indonesia; 2020.

[12] Syukur M, Sriani S, and Yunianti R. Plant breeding techniques. Jakarta: Self-Help Spreader; 2014.

[13] Nufrifaldi N, Hariyadi H, and Widyastuti R. Identifikasi and potential of indigenous fungi for weathering oil palm trunks. Jurnal Agronomi Indonesia. 2019; 47(3):312-317.

[14] Salisbury FB and Ross CW. Plant physiology. 3rd ed. Bandung: Institut Teknologi Bandung; 2017.

[15] Santi KP, Rustikawati R, and Dotti S. Growth performance and yield of sixteen genotypes of tomato (*Solanum lycopersicum* L.) in the lowlands. Journal Akta Agrosia. 2016;19(2):118–128.

[16] Achmad B, Nawawi M, and Abadi AL. Application techniques of *Trichoderma* sp on growth and yield of potato (*Solanum tuberosum* LJ). Journal of Plant Production. 2013;1(3):21–30.

[17] Harjadi H. Introduction of agronomi. Jakarta: PT Gramedia Main Library; 1996.

[18] Winarno W. Post-harvest physiology. Jakarta: Sastra Hudaya; 1981.

[19] Sari LD, Ningrum KRS, Ramadani AH. Vitamin C content of tomato fruit (*Lycopersicum esculentum* mill) each maturity phase based on days after planting. Journal Indonesian Pharmacy and Pharmacy. 2021;8(1):74-82.