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Response of Chili Pepper (*Capsicum frutescens L.*) Yield to Age of Shoot Pruning and Trichotomous Dosage

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Abstract

Background: Increasing the productivity of Chili pepper plants can be done by pruning shoots and using trichotomous biofertilizer as an alternative to chemical fertilizers. This study aims to determine the effect of treating shoot pruning age and adding trichotomous doses on Chili pepper plant yields. **Methods:** This experiment used a Randomized Block Design with two factors. The first factor is the age of shoot pruning, which consists of 4 treatment levels, namely P0 = No pruning, P1 = shoot pruning 14 HST, P2 = shoot pruning 21 HST, P3 = shoot pruning 28 HST and trichotomous dose as the second factor consisting of 4 treatment levels, namely T0 = Without trichotomous, T1 = 600g/plant, T2 = 800 g/plant, and T3 = 1000 g/plant, so that 16 treatment combinations were obtained with three replications. **Results:** The results showed that the combination of pruning age treatment of 28 HST and trichotomous dose of 800g/plant produced the best number of flowers. A pruning age of 28 HST gave the best results on the number of leaves, leaf area, productive branches, total number of fruits per plant, and total fruit weight per plant. A trichotomous dose of 800 g/plant gave the best results on plant height, number of productive branches, total number of fruits per plant, and total fruit weight per plant. **Conclusion:** The pruning age of shoots and trichotomous doses affect the yield of Chili pepper plants.

Keywords: Chili pepper (*Capsicum frutescens L.*); Pruning; Trichotomous Protein

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Introduction

Chili pepper (*Capsicum frutescens L.*) is a unique horticultural plant that other plants cannot substitute. When the supply of Chili pepper is scarce, it will cause a significant increase. The productivity of Chili pepper in 2020 was 8.33 tons/Ha (BPS, 2021). Meanwhile, the average consumption of Chili pepper in households in 2020 was 2,020 kg/capita/year (Pusat Data dan Informasi Pertanian, 2021). The demand and consumption of Chili pepper will increase along with population growth. One strategy that can be used to address this growing need is to carry out extensification and intensification. Intensification efforts are carried out with sound and correct culture, one of which is pruning the top of the stem to increase the productivity of Chili pepper and improve soil structure with trichotomous.

The pruning of stem tips can stop apical dominance and stimulate the growth of shoot eyes below the plant tips to grow many branches that allow for the development of many productive branches for flowers and fruits. The results of the study by Mu'afa et al. (2020) show that the treatment of the age of pruning shoots significantly affects the number of productive branches, the number of flowers, and the number of fruits in chili plants. The best effect was shown in pruning shoots at the age of 21 HST.

The growth of Chili pepper plants requires loose and fertile soil media, so slow-release organic fertilizers must be added. One effort to accelerate the provision of nutrients is by decomposition by Trichoderma sp. Fertiliser made from cow dung can be combined with the biological agent Trichoderma sp. or Trichotomous fertilizer. Trichotomous derived from cow dung contains various nutrients, namely N 0.50%, P 0.28%, K 0.42%, Ca 1.035 ppm, Fe 958 ppm, Mn 147 ppm, Cu 4 ppm, and Zn 25 ppm (BPTP JAMBI, 2009). The results of research by Tigahari et al. (2021) showed that the treatment of a dose of Trichoderma compost of 250 gr had a significant effect on the number of fruits in the second harvest, namely 86 fruits, and the third harvest, namely 146.33 fruits. Chili plant fruit's weight parameters were also significantly different in the second harvest, 121 g, and the third harvest, 196.33 g. Trichoderma sp can maintain soil fertility; if it infects plant roots, it will help the absorption of certain nutrients, especially phosphorus.

The combination of pruning plant shoots and giving trichotomous is expected to significantly increase the productivity of Chili pepper plants due to the addition of nutrients. Based on the description above, this study aims to determine the combination of pruning shoots and adding the correct dose of Trichotomous for Chili pepper.

Method

The research was conducted on agricultural land in Kaligunde Hamlet, Menyono Village, Kuripan District, Probolinggo Regency, East Java, which was carried out from July to October 2023. The study used a factorial Randomized Block Design (RAK) with two treatment factors. The first factor is the age of shoot pruning consisting of 4 levels (without pruning (control), shoot pruning 14 HST, shoot pruning 21 HST, shoot pruning 28 HST), the second factor is the dose of Trichotomous consisting of 4 levels (T0 = Without trichotomous (control), 600 g/plant, 800 g/plant, and 1000 g/plant). Sixteen treatment combinations were repeated 3 times so that 48 experimental units were obtained with 3 sample plants, and 144 plants were observed.

Procedure

The implementation of this research began with the identification of Trichoderma isolates using a microscope with the characteristics of branched, septate hyphae, spores that are round and green in color, propagation of Trichoderma isolates carried out by selecting Trichoderma sp that have active growth which was observed after 14 days of incubation, propagation of Trichoderma sp on cooked and sterilized corn media by inserting Trichoderma Isolates into corn media and incubating for 14 days, making Trichotomous which was carried out by mixing ingredients consisting of 200 kg of cow dung, 20 kg of bran, 1L of EM4, 500 mL of molasses, and 250 grams of Trichoderma culture fermented for 21 days, seed preparation by selecting seeds that sink in water, seed sowing using a planting medium of a mixture of soil and manure with a ratio of 2: 1 which was carried out until 21 HSS or the seedlings had at least 3 true leaves, preparation of planting media using top soil, application of trichotomous doses according to the treatment doses that has been determined, namely 600g/plant, 800g/plant, and 1000g/plant given 7 days before planting Chili pepper seedlings, transplanting is carried out when the seedlings reach 21 days old with the criteria of having at least 3 true leaves, pruning of shoots along 0.5 cm which is carried out according to the predetermined treatment, namely 14 HST, 21 HST and 28 HST, maintenance (watering, fertilizing, weeding, weeding, and controlling OPT). The parameters observed were the number of branches, number of flowers, number of fruits per harvest period, total number of fruits, and total fruit weight.

Data analysis

Data were analyzed using analysis of variance (ANOVA). If there are significantly different treatment results, it is continued with an honest significant difference test (HSD) with a level of 5%.

Result

Nutrient Content in Trichotomous

Table 1. Results of Analysis of Nutrient Content in Trichotomous

Test Parameters	Analysis Results
C-Organic	10,20 %
N	0.34 %
P	0.30 %
K	0.36 %

Table 1. shows, based on the results of the analysis of the nutrient content of trichotomous, C-organic (10.20%) is included in the very high category, N (0.34%) is included in the medium category, P (0.30%) is included in the low category, and K (0.36%) is included in the low category.

Number of Productive Branches

Table 2. Number of Productive Branches of Chili Plants in the Treatment of Pruning Age and Trichotomous Dosage

Treatment	Average Number of Productive Branches of Chili Plants
Pruning Age	
Control	13.11 a
14 HST	26.33 b
21 HST	32.69 c
28 HST	36.42 d
BNJ 5%	**4.02**
Trichotomous Dosage	
Control	23.50 a
600 g/plant	25.39 a
800 g/plant	29.53 b
1000 g/plant	30.14 b
BNJ 5%	**4.02**

Description: Numbers followed by the same letter in the same treatment show no significant difference in the 5% BNJ test.

Table 2. Treatment of shoot pruning age and addition of Trichotomous dose individually gave a significant effect on the parameter of the number of productive branches of Chili pepper plants pruned at the age of 28 HST, producing the most crucial number of productive branches and significantly different from the control (without pruning) and other shoot pruning age treatments. There was an increase in the number of productive branches of Chili pepper plants by 177% by the 28 HST pruning age treatment compared to the control (without pruning). Table 2. also shows that the trichotomous dose of 800 g/plant gave the best number of productive branches and was significantly different from the control and the trichotomous dose of 600 g/plant but was not substantially different from the additional Trichotomous dose treatment of 1000 g/plant. There was an increase in the number of productive branches by 25.6% by the effect of the trichotomous dose treatment of 800 g/plant compared to the control.

Total Number of Flowers

Table 3. Average Total Number of Flowers of Chili Plants in Combination of Pruning Age and Trichotomous Dosage Treatments

Age Treatment Pruning Plant Shoots	Average Total Number of Flowers per Plant Trichotomous Addition Dosage (flowers)			
	Control	600 g/plant	800 g/plant	1000 g/plant
Control	138.78 a	141.56 a	149.44 ab	144.89 b
14 HST	162.56 bc	164.78 cd	171.89 cdef	169.78 cde
21 HST	164.67 cd	177.00 def	179.44 ef	183.11 ef
28 HST	178.22 def	176.44 cdef	184.11 ef	199.67 g
BNJ 5%	**14.18**			

Description: Numbers followed by the same letter show no significant difference in the 5% BNJ test.

Table 3. explains that the treatment of pruning shoots and the addition of Trichotomous dose interacted. The combination of the treatment of the age of pruning shoots at 28 HST and the dose of Trichotomous 1000 g/plant produced the highest number of total flowers (199.67 flowers). It was significantly different from other treatment combinations. The combination of the treatment of pruning shoots at 28 HST with the dose of Trichotomous 1000 g/plant increased the number of total flowers of the plant by 38% compared to the combination of control treatments.

Total Fruit Number and Total Fruit Weight Per Plant

Table 4. Average Total Fruit Number and Total Weight of Chili Pepper Plants in Pruning Age and Trichotomous Dosage Treatments

Treatment	Total Number of Fruits (fruits)	Total Fruit Weight (grams)
	Pruning Age	
Kontrol	72.33 a	86.50 a
14 HST	82.20 b	96.98 b
21 HST	87.75 c	103.11 c
28 HST	93.26 d	109.13 d
BNJ 5%	**2.59**	**4.29**
	Trichotomous Dosage	
Control	79.65 a	94.11 a
600 g/plant	83.65 b	98.2 ab
800 g/plant	86.34 c	102.25 b
1000 g/plant	85.80 bc	101.15 b
BNJ 5%	**2.59**	**4.29**

Description: Numbers followed by the same letter in the same column and treatment show no significant difference in the 5% BNJ test.

Table 4. shows that the treatment of shoot pruning age and the addition of trichotomous dose individually significantly affect the total number of fruits per plant. The treatment of shoot pruning age at 28 HST produced the highest total number of fruits per plant and was significantly different from the control treatment and other pruning age treatments. There was an increase in the total number of fruits per plant by the 28 HST shoot pruning age treatment by 29% compared to the control. Table 4. also shows that the 800 g/plant dose treatment produced the total number of fruits per plant, significantly different from the control and 600 g/plant trichotomous doses but not substantially different from the 1000 g/plant trichotomous dose treatment. There was an increase in the total number of fruits per plant by the 1000 g/plant trichotomous dose treatment by 7% compared to the control. Table 4 shows that the treatment of shoot pruning age at 28 HST produced the highest total fruit weight per plant and significantly differed from the control and other pruning age treatments. There was an increase in total fruit weight per plant by the 28 HST shoot pruning age treatment of 27% compared to the control. Table 4. also shows that the 800 g/plant dose treatment produced the highest total fruit weight per plant and was significantly different from the control treatment but not substantially different from other trichotomous dose treatments. There was an increase in total fruit weight per plant by the 1000 g/plant trichotomous dose treatment of 7% compared to the control.

The quadratic regression analysis test of the relationship between trichotomous dose and total fruit number (Figure 1) and total fruit weight (Figure 2) of Chili pepper showed that.

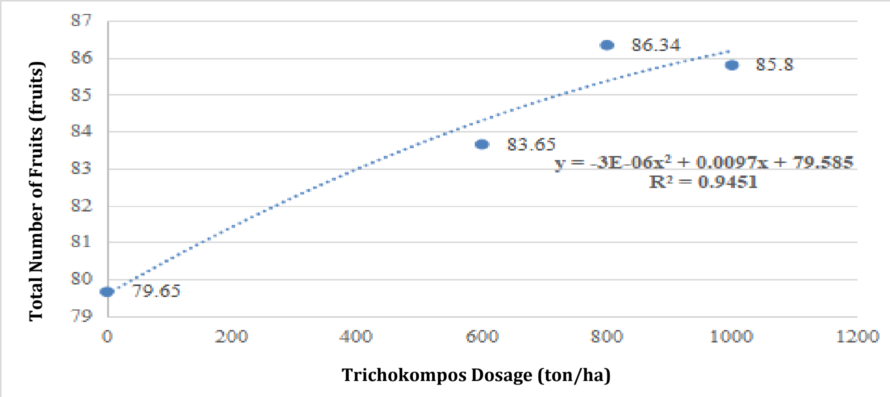

Figure 1. Quadratic Regression Analysis Graph of the Relationship between Trichotomous Dosage and Total Number of Fruits in Chili Plants

Figure 1. explains that the dose of trichotomous and the total number of fruits form the equation Y = -3E-06x2 + 0.0097x + 79.585 with an R2 value of 0.9451. This shows that the dose of trichotomous affects 94.51% of the total number of fruits per Chili pepper plant. The derivative equation Y (Y`=0) results show that the highest dose of trichotomous to increase the total number of fruits is 1.616 g/plant.

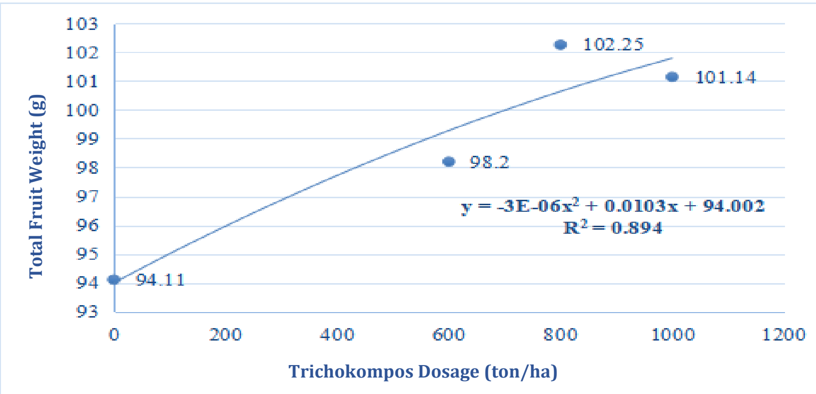

Figure 2. Regression Analysis Graph of the Relationship between Trichotomous Dosage and Total Fruit Weight of Chili Pepper Plants

Figure 2. explains that the trichotomous dose and total fruit weight form the equation Y = -3E-06x2 + 0.0103x + 94.002 with an R2 value of 0.894. This shows that the trichotomous dose has an effect of 89.40% on the total fruit weight per chili pepper plant from the regression derivative. The results of the Y derivative equation (Y`=0) show that the highest trichotomous dose to increase total fruit weight is 1.716 g/plant

Discussion

Pruning on plants reduces the influence of shoot dominance and triggers the growth of side shoots or branches that will become productive branches. This aligns with Mu'afa's theory (2021), which states that auxin is a plant growth hormone concentrated in the shoots. Auxin will move to other parts of the stem when the shoots are cut and stimulate the growth of side branches. Plants that have sufficient food resources can produce new branches. In addition to getting nutrients from the roots, plant shoots can also absorb nutrients from the leaves below. Therefore, by pruning, food resources previously used for vertical growth will be diverted to the growth of lateral branches. The number of branches on plants that are given shoot pruning treatment is higher than on plants that are not pruned because pruning changes the original shape of the plant (morphology) and its physiology. As a result, plants experience changes that also affect the fruit production produced by the plant itself (Prayudi et al., 2019). Pruning of shoots carried out according to the age of the plant will result in vegetative growth stopping and the continuation of generative organ growth, as well as reducing competition for the use of photosynthates between vegetative organs and generative organs so that the number of branches formed will also affect the quality of the fruit itself (Kurniawati & Guritno, 2018).

Another factor that can trigger the growth of plant branches is the availability of nutrients. The addition of trichotomy can meet the nutrient needs of Chili pepper. According to the analysis carried out, the content of organic matter and nutrients such as N, P, and K is C-organic of 10.20%, N-total of 0.34%, P-total of 0.30%, and K-total of 0.36%. The availability of nutrients causes plant growth to be better and makes it easier to absorb nutrients so that chili plants will form new branches well. Furthermore, improvements in nutrient absorption will support the metabolic process so that plants will actively create new branches in their development. Productive branches produce flowers and fruit (Polii et al., 2022). Providing organic fertilizers such as cow dung can significantly affect the number of productive plant branches. Animal waste can increase soil fertility, ultimately increasing growth and yields through increased productive branches. In addition, the use of cow manure also has a real impact on increasing the number of productive plant branches (Nofiyanto et al., 2018). The N element in fertilizer can support branch growth, while the P element affects flowering so that it can form productive branches. Adding ameliorants in organic fertilizers derived from organic materials in the form of livestock manure made into compost can contribute to the availability of N, P, and K nutrients. Planting media given cow manure compost fertilizer can provide nutrients, especially the primary macronutrients such as N, P, and K, which are very much needed during plant growth, such as the number of plant branches. Cow manure compost fertilizer added to the soil can contribute N, P, and K elements, thereby increasing the availability of elements (Hariyadi et al., 2021).

The provision of Trichoderma sp. compost can provide nutrients for plants and also improve soil structure. This makes soil particles larger and can retain water, increase air circulation, and support the photosynthesis process that runs more efficiently, which in turn will stimulate plant growth (Lisa et al., 2018). The provision of Trichotomous significantly impacts the number of plant branches because it contains elements such as nitrogen, phosphorus, and others that can affect the plant's metabolic process. This metabolic process involves the formation and decomposition of nutrients and organic compounds in plants needed to grow new branches on the main stem (Umbola et al., 2020).

Pruning plant shoots can increase the number of flowers because they stimulate productive branches' growth. Increasing productive branches will increase the number of flowers and fruits in Chili pepper plants. If the lateral shoots are more numerous, then maximum production results will be obtained (Yolanda et al., 2021). The growth of lateral shoots can cause the formation of many stem branches in the axils of the main stem. Pruning shoots also cause plants to have many branches, so there is more formation of flowers and fruits.

The phosphorus and potassium content in Trichotomous plays an essential role in the flowering and fruiting of plants. Meanwhile, nitrogen also plays a crucial role in the flowering process. Flowering is closely related to the number of fruits produced. The more flowers that form and develop into fruit ovaries, the more fruit will be made. Lack of nitrogen in plants' flowering process can negatively impact the number of fruits produced (Sari et al., 2023). According to Christy & Suprihati (2023), Plants need H2PO4 phosphorus to stimulate root growth and influence the flowering process because phosphorus regulates carbohydrate metabolism.

On the other hand, Potassium is needed as an enzyme activator to trigger the translocation of nutrients and water from the soil. This accelerates the process of photosynthesis, which contributes to assimilation and ultimately helps increase the number of flowers in plants. As a result, the plant will produce more flower stalks, producing a more significant number and weight of fruits. This is likely due to the accumulation of assimilates produced from the photosynthesis process, which is later used in the generative stages of the plant, such as fruit formation and filling.

The number of productive branches on a plant is a key factor in determining fruit production. These branches are where flowers grow and then develop into fruit (Salli et al., 2016). The more shoots of all pruned lateral branches, the more sunlight the plant absorbs for photosynthesis, which affects fruit formation (Aeni & Pasetriyani, 2019). Hamdani et al. (2021) stated that pruned plants have a higher weight because the flowering process runs optimally, so the fruit produced also has an optimal weight. In addition, pruning also increases the carbon and nitrogen ratio, which results in the accumulation of carbohydrates that encourage the process of flower and fruit formation (Rasilatu et al., 2016).

The treatment of adding trichotomous doses has a significant effect on the production of Chili pepper plants, including the number of fruits per plant per harvest period, the total number of fruits per plant, the weight of the fruit per harvest period, and the total weight of the fruit per plant. One of the factors that influence plant production is the nutrient content in the planting medium, especially the macronutrients P and K. Both phosphorus and Potassium have a significant influence on Chili pepper plants in the generative phase of the plant, namely stimulating the flowering process, fruit formation, and fruit ripening. According to Ege & Julung (2019), Potassium is essential in the growth of chili fruit, significantly when the fruit is growing large, while phosphorus has a significant role in transporting water to plant cells to ensure optimal development. Furthermore, Lingga in Aziez et al. (2021) Phosphorus helps stimulate root growth and young plants, assisting in assimilation, accelerating flower formation, and seed ripening. Norliyani et al. (2023) explained that Potassium has a vital role in controlling physiological processes in plants, including photosynthesis, accumulation of substances, nutrient transfer, carbohydrate transport, regulation of stomata opening and closing, and water distribution in plant cells and tissues.

Trichotomous has a very high C-organic content, so it is sufficient to meet the organic matter needs of Chili pepper plants. Organic matter added to the soil has many benefits because it can improve soil conditions. Organic matter can improve the soil's physical, chemical, and biological properties. According to Karim et al. (2019), Organic matter can enhance the soil's physical, chemical, and biological properties. In terms of physical properties, this includes increasing soil density, improving air circulation and drainage, increasing binding power between particles, increasing water retention capacity, preventing erosion and landslides, and reviving soil quality. Regarding chemical properties, organic matter can increase cation exchange capacity, increase nutrient availability, and accelerate the process of mineral weathering. Meanwhile, in terms of biology, organic matter acts as a food source for soil microorganisms such as fungi, bacteria, and other beneficial microorganisms, accelerating the development of these organisms.

Conclusion

The combination of treating the age of pruning shoots 28 HST and the dose of trichotomous 800 g/plant produced the best number of flowers. It significantly differed from the combination of other treatments, increasing the total number of flowers by 38% compared to the control. The age of pruning shoots at 28 HST gave the best results on the number of productive branches, the total number of fruits per plant, and the total weight per plant. The trichotomous 800 g/plant dose gave the best results regarding the number of productive branches. The results of the quadratic regression analysis showed that the highest dose of trichotomous to increase the total number of fruits and total fruit weight was between 1.616 to 1.716 g/plant

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Declaration statement

The authors report no potential conflict of interest.

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