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Production Response of Chilli (*Capsicum annuum* L.) to Shoot Pruning and Application of Different Mulch Types

Respon Produksi Cabai (Capsicum annuum L.) terhadap Pemangkasan Pucuk dan Pemberian Berbagai Jenis Mulsa

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui respon produksi cabai (*Capsicum annuum* L.) terhadap pemangkasan pucuk dan aplikasi berbagai jenis mulsa. Penelitian ini dilakukan di Desa Ladang Bambu, Kabupaten Medan Tuntungan, Provinsi Sumatera Utara, pada ketinggian 30 meter di atas permukaan laut, mulai September 2017 sampai Februari 2018. Penelitian ini menggunakan rancangan acak kelompok dengan dua faktor perlakuan. Faktor I yaitu pemangkasan pucuk diberi kode "P" dengan empat umur pemangkasan, yaitu P0: tanpa pemangkasan sebagai kontrol, P1: saat tanam, P2: dua minggu setelah tanam (WAT), P3: empat minggu setelah tanam (WAT). Faktor II yaitu penggunaan mulsa diberi kode "M" dengan empat jenis, yaitu M0: tanpa mulsa sebagai kontrol, M1: mulsa plastik hitam perak, M2: mulsa jerami padi, M3: mulsa batang jagung. Hasil penelitian menunjukkan bahwa, tidak ada interaksi yang nyata antara pemangkasan pucuk dan aplikasi berbagai jenis mulsa terhadap produksi tanaman cabai di akhir penelitian. Pemangkasan tunas pada saat penanaman meningkatkan diameter batang, jumlah bunga, jumlah buah, dan produksi total. Perlakuan dengan mulsa plastik hitam perak meningkatkan diameter batang, jumlah bunga, jumlah buah, dan produksi total.

Kata kunci: Cabai, Mulsa, Umur pemangkasan.

ABSTRACT

This study aims to determine the response of chilli (Capsicum annuum L.) production to shoot pruning and application of different types of mulch. This study was conducted in Ladang Bambu village, Medan Tuntungan district, North Sumatra province, at an altitude of 30 metres above sea level, from September 2017 to February 2018. The study used a randomised block design with two treatment factors. Factor I: shoot pruning was coded "P" with four pruning ages, namely P0: without pruning as control, P1: at transplanting, P2: two weeks after transplanting (WAT), P3: four weeks after transplanting (WAT). Factor II: the use of mulch was coded "M" with four types, namely M0: without mulch as control, M1: black silver plastic mulch, M2: rice straw mulch, M3: maize stalk mulch. The results showed that, no significant interaction between pruning the shoots and the application of various types of mulch on chili plant production at the end of the study. Pruning the shoots at transplanting increased stem diameter, total number of flowers, number of fruits and total production. Treatment with black silver plastic mulch increased stem diameter, total number of flowers, number of fruits and total production.

Keywords: *Age of prunning, Chili, Mulch.*

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INTRODUCTION

Red chilli plants have a fairly wide range of adaptability, so they can be grown in both lowland and highland areas. However, the average productivity of red chili in Indonesia is relatively low, only around 5.61 tonnes.ha^{-1} (Badan Pusat statistik, 2016). The production potential ranges from 12-20 tonnes.ha^{-1}. There are many constraints that need to be addressed to increase red chili production (Hasyim et al., 2015).

The requirement of red chilli for one million people is approximately 800,000 tonnes/year or 66,000 tonnes/month. Demand for chilli usually increases by about 10-20% of normal demand during religious holidays (Kementerian Pertanian, 2016). National production of fresh red chilli was 1,074,602 tonnes in 2014, 1,045,182 tonnes in 2015 and 1,042,949 tonnes in 2016. From 2014 to 2016, there was a decrease in production of more than 20,000 tonnes (FAO, 2018).

The barriers that need to be addressed are the quality and quantity of the fruit, which are not optimal. Technological innovation is needed to support the increase in red chilli production through pruning and mulching (Salli et al., 2016; Yulia et al., 2015). Pruning can speed up flowering, increase the number of productive branches, the number of fruits and the weight of the fruits. Increasing the number of branches increases the diameter of the stem, the number of productive branches, the number of flowers and the number of fruits (Wijaya et al., 2015).

Pruning aims to strengthen and reduce the growth of the main stem, to reduce the volume of the plant canopy and to open up the light channel to all parts of the plant. Pruning also promotes a cleaner environment so that plants are free from pests and diseases. All of these benefits will increase fruit production (Salli et al., 2016). In addition to pruning, pest and disease control can be done by using automatic insect traps using yellow LED traps (Telaumbanua et al, 2022).

The increase in temperature during the dry season causes the soil temperature to rise, the soil moisture to decrease and the groundwater to decrease excessively through the evaporation process. These conditions provide sub-optimal growth conditions for red chilli plants. Efforts to modify the microclimate around the plants through the use of mulch can maintain and increase red chilli production (Anggorowati et al., 2016). Chili plant productivity can also be increased through an automatic control and monitoring system using high-tech sensors (Triyono et al., 2018; Telaumbanua et al., 2024).

The use of mulch can prevent water loss from the soil and maintain soil temperature and moisture. The use of mulch can also suppress weed growth, increase the activity of beneficial microbes and thus create suitable conditions for plants. The use of mulch can increase plant growth (Dila et al., 2015; Fauzi et al., 2016; Zuliati et al., 2020).

This study aims to determine the best pruning age and type of mulch for red chilli production. Pruning techniques and mulch use are expected to reduce the constraints of pest and disease attack, lack of water and reduced fruit quality or quantity.

METHODS

This study was conducted in Ladang Bambu subdistrict, Medan Tuntungan district, Sumatra Utara province, at an altitude of 30 m above sea level, from September 2017 to February 2018.

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The materials used are Lado red chilli seeds, a mixture of topsoil and compost, dry maize plant material, dry rice straw material and black silver plastic mulch, NPK 15-15-15 fertiliser, fungicide, insecticide and water. The tools used are hoes, knives, watering cans, meters, scales, calculators, stationery and cameras.

The study used a randomised block design with two treatment factors. Factor I: shoot pruning was coded "P" with four pruning ages, namely P0: without pruning as control, P1: at transplanting, P2: two weeks after transplanting (WAT), P3: four weeks after transplanting (WAT). Factor II: the use of mulch was coded "M" with four types, namely M0: without mulch as control, M1: black silver plastic mulch, M2: rice straw mulch, M3: maize stalk mulch.

The planting distance is 50 x 50 cm in a 150 x 100 cm plot, resulting in 6 plants per plot. A total of 16 treatment combinations were replicated 3 times to obtain 48 plots with a total of 288 plants as destruction plants.

The research data were analysed using analysis of variance with the following linear model:

$$Y_{ijk} = \mu + \rho_i + \alpha_j + \beta_k + (\alpha\beta)_{jk} + \varepsilon_{ijk}$$
$$i = 1,2,3 \; ; \; j = 1,2,3,4; \; k = 1,2,3,4$$

If the results of the analysis of variance show a significant effect, the Duncan Multiple Range Test (DMRT) is performed at the α level = 5% (Steel & Torrie, 1995).

Land preparation begins with weed and litter control. A 150 x 100 cm plot is created with a 30 cm spacing between plots. Each plot is covered with mulch according to the type of treatment. The seeds are sown for 4 weeks. Healthy chilli seedlings are selected and transplanted to plots in the field. The shoot pruning treatment is carried out depending on the treatment time, namely 0 WAT or at transplanting, 2 WAT and 4 WAT. The method consists of cutting the shoot of the plant at the growing point of the main stem of the plant with a sharp and sterile knife.

Care includes irrigation, NPK 16-16-16 fertiliser, replanting, weeding, staking, pest and disease control. Fruit harvest begins at 70 days or 10 WAT and meets harvest criteria. The variables observed are stem diameter, total number of flowers, number of fruits and total production.

RESULTS AND DISCUSSION

Stem Diameter (mm)

Observational data on plant stem diameter at 15 WAT showed that the treatment of application different types of mulch had a significant effect on stem diameter, while the treatment of shoots pruning and the interaction of the two treatments had no significant effect on stem diameter. Table 1 shows that the stem diameter of 15 WAT plants in the shoot pruning at transplanting treatment (P1) was 13.49 mm. The stem diameter in the black silver mulch treatment (M1) was 14.78 mm. For each factor, these two treatments were the highest. Pruning increases plant growth. Early pruning can increase plant growth. Plant growth in this case is inhibited by the diameter of the stem because it overlaps with the flowering period of the plant. Half of the physiological activity is directed towards the growth and development of the plant's reproductive organs (Habiba et al., 2018).

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Table 1. Stem diameter (mm) at 15 WAT on pruning of shoots and application of different types of mulch

Types of mulch	Pruning				Means
	P0 (without pruning)	P1 (0 WAT)	P2 (2 WAT)	P3 (4 WAT)	
M0 (without mulch)	11.10	12.89	12.30	12.82	12.28b
M1 (black silver plastic)	14.51	15.22	14.64	14.76	14.78a
M2 (rice straw)	12.71	13.42	12.33	11.26	12.43b
M3 (maize stalk)	12.33	12.42	12.48	13.48	12.68b
Means	12.66b	13.49a	12.94b	13.08b	

Description: Numbers followed by different letters in the same column or row indicate significant differences in Duncan's Multiple Range Test at the α = 5% level.

The black silver mulch treatment (M1) produced the highest average stem diameter compared to the treatment without mulch (M0), rice straw mulch (M2) and maize stalk mulch (M3). This is due to the dual effect of the plastic sheets in modifying the rhizosphere and the above ground environment in supporting plant growth. Black silver mulch suppresses weed growth, reflects light, maintains soil aeration, prevents leaching of soil nutrients, prevents evaporation and increases the activity of beneficial micro-organisms. Black silver plastic mulch reflects light from the silver colour. This reflection optimises the process of photosynthesis to the leaves. On the other hand, the reflection of light from below repels pests and keeps them away from the plants. Plastic mulch covers the top of the soil, suppressing growth and reducing competition for resources with weeds. Plastic mulch has a similar effect to ground cover in that it can reduce soil compaction and nutrient leaching from rain events. Plastic mulch also reduces the loss of groundwater to the atmosphere through evaporation (Muslim & Soelistyono, 2018; Zuliati et al., 2020).

Total number of flowers (flowers)

The pruning of shoot and the application of different types of mulch had a significant effect on the total number of flowers. The interaction between the two treatments was not significant for total number of flowers. Data on the total number of flowers on chilli plants at 15 WAT are presented in Table 2. The highest total number of flowers was obtained in the no pruning treatment (P0), namely 32.33 flowers, and the lowest in the 4 WAT pruning treatment (P3), namely 15.00 flowers. The highest total number of flowers was obtained in the black silver plastic mulch treatment (M1), namely 33.63 flowers, and the lowest in the maize stalk mulch treatment (M3), namely 21.37 flowers.

Table 2. Total number of flowers (flowers) on pruning of shoots and application of different types of mulch

Types of mulch	Pruning				Means
	P0 (without pruning)	P1 (0 WAT)	P2 (2 WAT)	P3 (4 WAT)	
M0 (without mulch)	25.73	29.33	28.13	15.73	24.73 b
M1 (black silver	46.13	42.27	26.67	19.47	33.63 a

plastic)					
M2 (rice straw)	32.93	33.60	29.87	10.93	26.83ab
M3 (maize stalk)	24.53	21.73	25.33	13.87	21.37 b
Means	32.33a	31.73a	27.50a	15.00b	

Description: Numbers followed by different letters in the same column or row indicate significant differences in Duncan's Multiple Range Test at the α = 5% level.

Treatment without pruning (P0), pruning at 0 WAT (P1) and pruning at 2 WAT (P2) were equal, but pruning at 4 WAT (P3) significantly increased the number of flowers. Pruning or wounding can cause stress to plants. The effect is an increase in the generative rate as a sign for plants to accelerate their reproduction. Plant stress also increases the incidence of inhibition of the plant's carbohydrate synthesis rate. Carbohydrates are a component that triggers flower initiation in plants. Setiawan (2015) noted that young plants store more food reserves in the form of carbohydrates. Carbohydrates are also used as the main component for flowering. The form of injury causes stress to plants, thereby inhibiting the rate of carbohydrate and flower formation. Pruning too long will reduce the number of flowers on the plant. The flowering period is actually used by the plant to repair damaged cells and increase branch growth. This is the reason why the plant does not increase the number of flowers.

The black silver plastic mulch treatment (M1) was significantly different from the rice straw mulch treatment (M2), the control (M0) and the maize stalk mulch treatment (M3). Black silver plastic mulch form conditions that meet the needs of plant flowering. Nutrient uptake to full light is one of the factors that supports flowering. Muslim & Soelistyono (2018) stated that flowering is supported by sunlight and adequate nutrients. The radiation of sunlight and its reflection from silver mulch are related to increased efficiency of photosynthesis carried out by plant chlorophyll cells. Increased photosynthesis is associated with increased energy for growth and development of plant organs, including flowering. Plastic mulch prevents nutrients in the soil from being washed away by rainwater, making them available to plants. Bahtiar et al., (2018) found that soil temperature is related to the uptake of phosphorus and nitrogen nutrients. Phosphorus and nitrogen are key factors in increasing flowering and plant growth. Plastic mulch increases soil temperature and remains in the soil longer than without plastic mulch.

Number of fruits (fruits) and Total production (g)

The shoot pruning treatment and the application of different types of mulch significantly affected the number of fruits and total production. The interaction between the two treatments was not significant on the number of fruits and total production. Table 3 shows the highest number of fruits obtained from pruning at planting time (P1) and the lowest number of fruits from pruning 4 WAT (P3). The black silver plastic mulch treatment (M1) gave the highest number of fruits, while the maize stalk mulch treatment (M3) gave the lowest number of fruits. Table 4 shows that the pruning of shoot at transplanting treatment (P1) gave the highest total production, but the 4 WAT pruning treatment (P3) gave the lowest total production. The black silver plastic mulch treatment (M1) gave the highest total production, while the maize stalk mulch treatment (M3) gave the lowest total production.

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Table 3. Number of fruits (fruits) on pruning of shoots and application of different types of mulch

Types of mulch	Pruning				Means
	P0 (without pruning)	P1 (0 WAT)	P2 (2 WAT)	P3 (4 WAT)	
M0 (without mulch)	10.53	10.93	7.87	4.40	8.43a
M1 (black silver plastic)	17.20	14.40	8.80	6.13	11.63a
M2 (rice straw)	8.80	14.40	10.67	3.47	9.33a
M3 (maize stalk)	4.27	3.33	3.73	2.93	3.57b
Means	10.20a	10.77a	7.77a	4.23b	

Description: Numbers followed by different letters in the same column or row indicate significant differences in Duncan's Multiple Range Test at the α = 5% level.

Table 4. Total production (g) on pruning of shoots and application of different types of mulch

Types of mulch	Pruning				Means
	P0 (without pruning)	P1 (0 WAT)	P2 (2 WAT)	P3 (4 WAT)	
M0 (without mulch)	47.13	54.57	39.23	23.56	41.12a
M1 (black silver plastic)	93.54	76.70	46.49	34.94	62.91a
M2 (rice straw)	42.12	66.14	53.37	16.67	44.58a
M3 (maize stalk)	22.93	16.71	21.34	16.18	19.29b
Means	51.43a	53.53a	40.11a	22.84b	

Description: Numbers followed by different letters in the same column or row indicate significant differences in Duncan's Multiple Range Test at the α = 5% level.

The treatments without pruning (P0), pruning 0 WAT (P1) and 2 WAT (P2) were not significantly different, but significantly different from the 4 WAT pruning treatment (P3) in terms of number of fruits and total production. This difference is due to the fact that in the 4 WAT pruning, the pruning period approaches the generative phase. Pruning too late shortens the period of increased plant growth and therefore has little effect on plant size. Plants in the earlier pruning period have a larger size than plants pruned later.

Chilli is a plant that has a vegetative and a generative phase that do not run simultaneously. Plants that are pruned during the vegetative period can focus their physiology on the growth of vegetative organs such as leaves, stems or roots. Pruning during the vegetative period reduces the growth of the main stem, allowing more sunlight to reach the branches of the plant. Increasing the number of leaves increases the photosynthetic activity of the plant. Photosynthate increases optimal growth and production (Habiba et al., 2018; Ikhza, 2018). The maximum development of vegetative organs supports the development of more optimal generative organs, such as flower formation and fruit filling. In indeterminate plants, vegetative organs tend to be prioritised before productive organs. Plants that are pruned too late reduce the number of flowers and fruit production (Zamzami et al., 2015).

The treatments with no mulch (M0), black silver plastic mulch (M1) and rice straw (M2) differed significantly from the treatment with maize stalk mulch (M3). Light maize stalk mulch can cause growth disturbances. Growth disturbance from maize stalk mulch is similar to that from mulch on weed growth. Dry corn stover will not completely cover the soil. Corn stover that is exposed to wind or rainwater pressure will cause the mulch stalks to shift and hit young plants. Plants that are disturbed do not grow optimally and experience reduced production (Yalang et al., 2016).

The advantage of organic mulch is that the by-products of the decomposition of the organic material as mulch can be useful as additional nutrients in the soil. Although not organic, the use of plastic mulch on horticultural crops can provide good air and water management in the soil. The treatment of black silver plastic mulch helps to improve plant physiology. Optimal physiological processes increase the vegetative growth of plants and improve the quality of plant yields (Muslim & Soelistyono, 2018; Amir, 2018).

CONCLUSION

The results showed that there was no significant interaction between shoot pruning and different types of mulch. Soil conditions, nutrients, climate, and plant management were optimal so that pruning and mulching treatments on plants did not have a significant effect. Shoot pruning at planting increased the number of flowers, the number of fruits, and total production. Black silver plastic mulch treatment increased stem diameter, the number of flowers, the number of fruits, and total production. Pruning and mulching can provide benefits in certain aspects, such as disease control or water use efficiency, but are not strong enough to directly affect crop yields.

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