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Response of Red Chili (*Capsicum anuuum* L.) to Humic Acid Application in Dryland

Respons Cabai Merah (Capsicum annuum L.) terhadap Pemberian Asam Humat di Lahan Kering

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ABSTRAK

Penanaman cabai merah di lahan kering dalam upaya meningkatkan produksi dan produktivitas terkendala oleh ketersediaan air yang terbatas. Pemberian asam humat meningkatkan kemampuan tanah mempertahankan air yang tersedia dan meningkatkan pertumbuhan dan hasil tanaman. Penelitian ini bertujuan untuk mengkaji respons cabai merah yang ditanam di lahan kering dengan pemberian asam humat. Tempat penelitian di *Teaching and Research Farm*, Fakultas Pertanian Universitas Jambi. Rancangan Acak Kelompok dengan 5 ulangan digunakan dalam penelitian ini. Dosis asam humat yang diperlakukan adalah 0 ton/ha, 2,5 ton/ha, 5 ton/ha, 7,5 ton/ha, dan 10 ton/ha. Cabai merah memberikan respons yang positif terhadap pemberian asam humat dengan meningkatkan tinggi tanaman, jumlah cabang, jumlah dan bobot buah. Dosis asam humat yang memberikan hasil tertingi sebesar 6,6 ton/ha adalah 5 ton/ha. Penelitian ini baru mampu memberikan hasil sebesar 44,06% bila dibandingkan dengan potensi hasil cabai merah.

Kata kunci: dosis, hasil, ketersediaan air terbatas, pertumbuhan

ABSTRACT

Red chili cultivation in dry land in an effort to increase production and productivity is constrained by the limited availability of water. The application of humic acid increases the ability of soils to retain restricted water and enhances plant growth and yield. This study aimed to investigate the response of red chili grown in dry land to the application of humic acid. Research place at the Teaching and Research Farm, Faculty of Agriculture, Jambi University. A Randomized Block Design with 5 replications was used in this study. The treated humic acid dose is 0 ton/ha, 2.5 ton/ha, 5 ton/ha, 7.5 ton/ha, and 10 ton/ha. Red chili gave a positive response to the application of humic acid by increasing plant height, number of branches, fruit number, and fruit weight. The dose of humic acid that gave the highest yield of 6.6 ton/ha was 5 ton/ha. This study was only able to provide a yield of 44.06% when compared to the potential yield of red chili.

Keywords: doses, growth, restricted water, yield

INTRODUCTION

Red chili (*Capsicum annuum* L.) is one of the national superior vegetables whose cultivation is widespread in Indonesia. The national red chili production and productivity in 2019 were 1.24 million tons with a productivity of 9.10 tons/ha (BPS and Directorate General of Horticulture, 2019). If it is only used for household consumption of 404,723 tons per year (BPS, 2020), then the red chili production produced is sufficient. It can even meet the demand for industry and restaurants; however, in the same year the imports of red chili increased by 22.26%, meanwhile the red chili exports decreased by 11.90% (BPS, 2019). In order for the red chili production to be evenly distributed throughout the year, it is necessary to expand the cultivation of red chilies on marginal lands.

Most of the marginal land in Indonesia is dominated by dry land which has very low fertility and the availability of water depends on rainfall. Red chili cultivation in dry land and in the dry season will suffer drought stress in part or all of plant life. The drought stress directly or indirectly affects plant physiological processes by inhibiting plant metabolism causing slow plant growth and development and as a result the production decreases (Chutia & Borah, 2012). The drought stress up to 50% of field capacity reduces the growth and yield of red chilies by reducing the plant height, number of branches, number of fruit and fruit weight of plants (Ichwan et al., 2017). An effort that can be made to overcome this problem is to provide soil organic matter such as humic acid.

According to Ismail and Almarshadi (2013) humic acid as a soil amandment can improve soil physical properties, reduce soil specific gravity and saturated hydraulic conductivity, increase soil water holding capacity, and increase soil organic matter and nutrients. The humic acid can reduce drought stress by regulating the osmotic potential of plants by maintaining water absorption and cell swelling thereby minimizing the consequences of drought stress (Moraditochaee, 2012).

The humic acid spray from vermicompost 50 mL/L induces a marked increase in total leaf area, yield and total dissolved solids of grapevines (Popescu & Popescu, 2016). The provision of 1200 ppm humic acid is the best concentration that can increase K uptake and soybean plant growth in Ultisols (Wahyuningsih et al., 2016). Furthermore, Al-Fraihat et al. (2018) state that humic acid with a concentration of 1000 mg/L causes the highest growth and yield on onion plants.

The results of the above research indicate that in order to increase the plant growth and yield, different concentrations or doses of humic acid are required. Information about the need for humic acid for red chilies grown in dry land is still limited. Therefore, this study aimed to examine the role of humic acid in increasing the growth and yield of red chili grown in dry land, and to obtain the right dose of humic acid providing the best growth and yield of red chili.

MATERIALS AND METHODS

The research was carried out at the Teaching and Research Farm of Faculty of Agriculture, Jambi University, at an altitude of 35 m above sea level. The study started from June 2020 to November 2020. The study used a Randomized Block Design (RAK) with 5 (five) replications. The treatments tested were humic acid doses consisting of 0 kg/ha; 2.5 kg/ha; 5 kg/ha; 7.5 kg/ha; and 10 kg/ha.

The red chili seeds of Lado variety were sown using polybags measuring 24 x 40 cm containing a mixture of soil, sand, and cow manure (2:1:1). After the seedlings are 10 days old (3-4 leaves), the chili seedlings were transferred into small polybags with a mixture of soil, sand and cow manure (2:1:1), and left in the nursery for 35 days, after that the seedlings were transferred to the field. Before being moved, the planting site was given silver black plastic mulch.

The humic acid used commercial humic acid (AH 90, with 90% humic acid content The humic acid was given 1 (one) week before planting, mixed with NPK fertilizer and mixed with soil between rows of plants. The NPK used was NPK 16:16:16 with a dose of 700 kg/ha. The dose of humic acid was given according to the pre-determined treatment.

The follow-up fertilization in the form of 16:16:16 NPK fertilizer was given in the 4, 6 and 8 weeks after planting (WAP). The fertilizer was given by pouring with a dose of 2 g/L, and the volume of flushing was 100 mL per plant. Observations were made on the plant height, number of branches, number and weight of fruit. The observations of plant height and number of branches were carried out at the time of the first harvest of the first flowering period. In addition, the observations were made on the flowering time of plants. The data were analyzed by Anova and continued with the DMRT test at level = 5%.

RESULTS

The results showed that the application of humic acid to red chili plants affected the plant height and number of branches. Increasing the dose of humic acid augmented the plant height and number of branches of red chili. The average height and the highest number of branches of red chili were found in the provision of humic acid at a dose of 7.5 kg/ha and 5.0 kg/ha. However, based on the DMRT further test on the red chili plant height, the humic acid doses of 5.0 kg/ha and 7.5 kg/ha were not significantly different (Figure 1).

The results also showed that the provision of humic acid gave better growth of red chili than without humic acid. The greatest increase was found at a dose of 7.5 kg/ha for plant height and 5.0 kg/ha forthe number of branches (Table 1). The flowering age of red chili was not affected by the application of humic acid. The flowering red chilies ranged from 28 days after planting (DAP) to 33 DAP, both with umic acid and without humic acid (Table 2).

The number and weight of red chilies were influenced by various doses of humic acid. The highest number and weight of fruit was obtained in the application of humic acid of 5 kg/ha. When compared with the treatment without humic acid provision, the largest increase in the number and weight of fruit was found in the humic acid with a dose of 5 kg/ha. The addition of humic acid increased the number of fruits by 13.22% to 118.60%, and fruit weight by 27.89% to 127.88% (Table 3). The performance of red chili plant due to the application of humic acid is presented in Figure 2.

Table 1. Increase in plant height and number of branches of red chili at various doses of humic acid compared to without humic acid at 10 WAP

Dose of Humic Acid (kg/ha)	Increase in Plant Growth (%)	
	Plant Height	Number of Branches
2.5	12.93	18.39
5.0	21.83	82.79
7.5	22.16	47.83
10.0	6.57	67.52

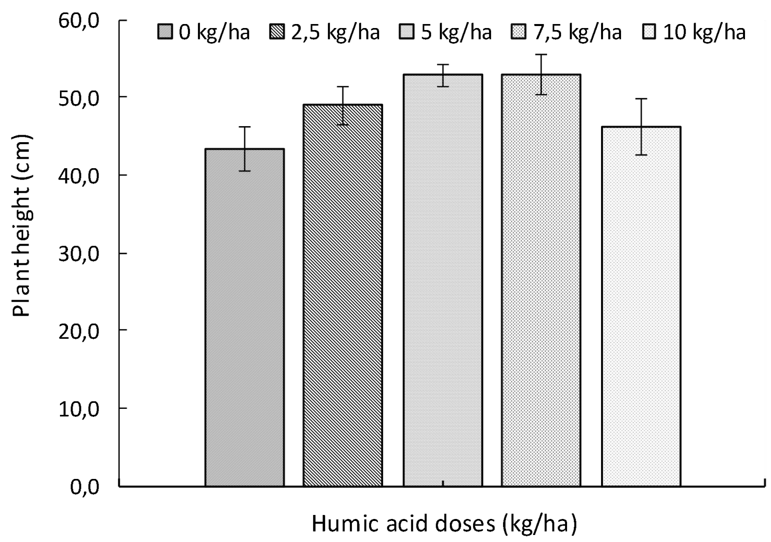
Table 2. Flowering age of red chili at various doses of humic acid

Dose of Humic Acid (kg/ha)	Flowering Age (Day After Planting)
0	33.13
2.5	28.47
5.0	28.00
7.5	29.40
10.0	33.13

Table 3. The number and weight of red chilies fruit on various doses of humic acid and increase of the number and weight of red chili fruits on various doses of humic acid compared to those of without humic acid

Dose of Humic Acid (kg/ha)	Fruit Number	Fruit Weight (g)	Increase (%)	
			Fruit Number	Fruit Weight
0	24.20[c]	72.50[b]	-	-
2.5	27.40[c]	92.72[b]	13.22	27.89
5.0	52.90[a]	165.22[a]	118.60	127.88
7.5	40.73[b]	129.89[ab]	68.32	79.15
10.0	34.37[bc]	113.97[b]	42.02	57.19

Note: Numbers followed by the same letter are not significantly different according to DMRT level α = 5%



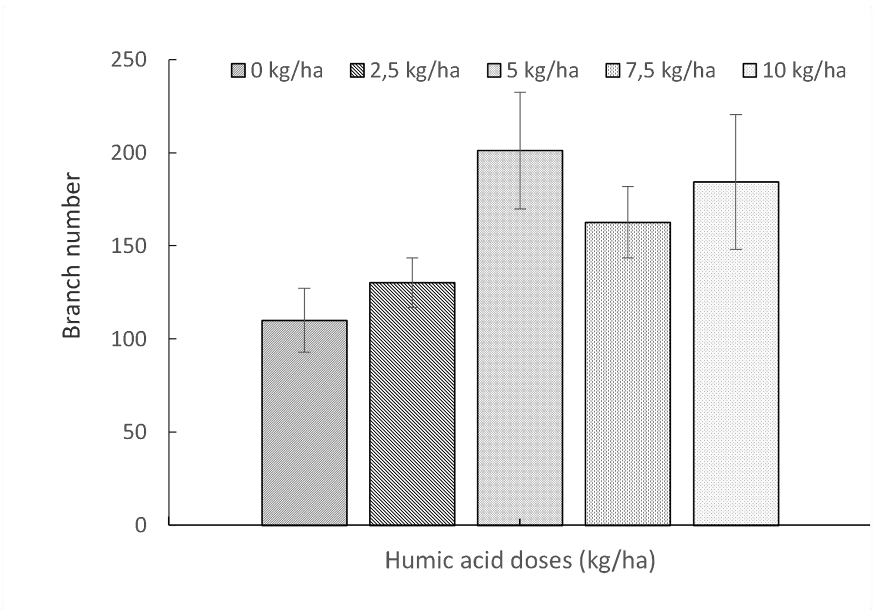


Figure 1. Plant height and number of branches of red chili at various doses of humic acid at 10 WAP (Week After Planting). Error bars indicate standard error (n = 5)

(a) (b)

Figure 2. The performance of red chilli plant due to the application of humic acid at 4 WAP (a) and 11 WAP (b)

DISCUSSION

The provision of humic acid in red chili plants planted in dry land can increase plant growth and yield. The plant height, number of branches, number of fruits, and fruit weight of red chilies increased with increasing doses of humic acid given. The greatest increase was obtained at the humic acid dose of 5 kg/ha except for the plant height, where the greatest increase was found at a dose of 7.5 kg/ha.

Humic acid can improve soil structure, increase soil cation exchange capacity and soil buffering capacity, and increase soil microbial population including beneficial micro-organisms (Ampong et al., 2022). Improvement of soil properties by giving humic acid changes the architecture and dynamics of plant root growth, there is an increase in root size, branching and/or more root hair density, with a larger surface area (Canelass & Olivares, 2014). The results of this study were in line with those conducted by Sani (2014) and Abourayya et al. (2020) that there was an increase in the plant height and number of plant branches due to the provision of humic acid. The increase in height and number of branches was due to an improvement in plant root growth which indirectly improved the ability of the roots to absorb soil mineral nutrients needed by the plants for growth, which increased the efficiency of photosynthesis, cell division and development. The results of research conducted by Noroozisharaf and Kaviani (2018) on *Thyme vulgaris* L. plants, also showed that the application of humic acid increased the uptake of, N, P, K, Mg and Fe plants. Furthermore, the application of humic acid could increase the growth, yield and quality of potato yields caused by the increased nutrient content of P, K, Ca, Mg, Fe, Zn, and Mn, except for Cu (Ekin, 2019). The research results on corn plants conducted by Hassan et al. (2019) also showed that the application of humic acid significantly increased the plant height, leaf area, and length of the ear by 11.69, 24.89 and 3.49% compared to those without humic acid.

The increase in plant growth in the form of height and number of branches of red chili due to the application of humic acid was also due to the direct role of humic acid in the plants. The application of humic acid was able to increase the nitrogen content and chlorophyll content of perennial ryegrass (Daneshvar et al., 2015). Hameed et al. (2018) reported that the provision of a combination of humic acid and foliar fertilizer could increase citrus growth by 32.5% of the plant height, 22.2% of the number of branch sets, reducing the fruit fall by 5.25%, and increasing the fruit yield by 89.8% compared to the that of humic acid or foliar fertilizer only. In addition, there was an increase in plant leaf nutrients, an increase in the total chlorophyll content of the leaves, an increase in ascorbid acid and total sugar of citrus fruits.

The increase in plant height and number of branches due to the application of humic acid in this study was followed by an increase in the number of fruits and fruit weight of red chilies. The results of this study are in line with the results of research conducted by Ichwan et al. (2017) on red chili plants under the drought conditions showing that there was a fairly close correlation between the number of branches and the number of fruit ($r = 0.642$), and between the number of branches and the weight of plant fruit ($r = 0.554$), as well as between the number of fruits and the weight of the fruit. fruit ($r = 0.998$). The increase in the number and weight of red chilies planted on dry land with humic acid application was caused by the increased ability of the soil to hold water (Ismail & Almarshadi, 2013), thereby increasing the availability of water for plants.

Ampong et al. (2022) state that humic acid can affect the photosynthetic process of plants, so that the plants that are given humic acid are better able to carry out the photosynthesis process. The increase in photosynthesis increases the photosynthate produced by the plants which is needed for the formation and enlargement of fruit.

The application of humic acid also increased the plant tolerance to drought, by increasing the activity of antioxidant enzymes, a condition required for plants grown in dry land. The study results of El-Sarkassy et al. (2017) show that the application of humic acid in red chili increases the plant's ability to withstand the conditions of limited water availability by increasing the plant's proline content, and the activity of peroxidase and catalase enzymes. However, the yield of this study is much lower than the potential yield of red chili of 15 tons/ha. This is due to high rainfall and relative humidity, especially during fertilization and fruit enlargement (280−287 mm/month and is around 85−86%) (BMKG Jambi, 2020). This condition cannot support plant development properly so that the results obtained are not optimal.

CONCLUSION

Red chili grown in dry land with limited water availability caused a positive response to the application of various doses of humic acid. The dose of humic acid providing the best growth and yield of red chili was 5 tons/ha with a yield of 165.22 g per plant (6.61 tons/ha) or only 44.06% of the potential yield of red chili. The increased growth and yield of red chili grown in dry land needs to be studied further, for example by combining humic acid with Plant Growth Promoting Rhizobacteria.

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