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Growth Response of Cacao (*Theobroma cacao* L.) Clone Iccri 06 H to Various Doses of Humic Acid and NPK Fertilizer

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Abstract

This study seeks to assess the growth response of cocoa seedlings (*Theobroma cacao* L.) clone ICCRI 06 H to various concentrations of humic acid and NPK fertilizer. The study was carried out at the Agroecotechnology Laboratory, Faculty of Agriculture, Sultan Ageng Tirtayasa University, and the Integrated Agricultural System (Sitandu) in Banten Province, Curug District, Serang City, Banten. Two components were used in the study: NPK fertilizer (0, 5, 7, 5, and 10 g/plant) and humic acid (0, 10, 20, and 30 g/plant) using a Randomized Block Design (RBD). Observation parameters included plant height, stem diameter, number of leaves, leaf area, leaf chlorophyll index, fresh plant weight, and dry plant weight. The results showed that applying 20 g/plant of humic acid yielded the best results in increasing the number of leaves at 8 Weeks After Plant (WAP) and fresh plant weight at 12 WAP. Humic acid at 30 g/plant showed the highest effect on leaf chlorophyll index at 12 WAP. NPK fertilizer at 5 g/plant was most effective in increasing plant height at 4 WAP, leaf area, and fresh weight of plants at 12 WAP. Meanwhile, the 7.5 g/plant dose yielded the best results for nearly every growth parameter. Only at 4 WAP did a treatment of 10 g/plant result in an increase in plant height. On the dry weight of plants at 12 WAP, there was an interaction between the application of NPK fertilizer at 7.5 g/plant and humic acid treatment at 20 g/plant.

Keywords: *clone ICCRI 06 H, cocoa, humic acid, NPK fertilizer*

INTRODUCTION

Indonesia is the world's seventh-largest producer of cocoa in 2021–2022. Apart from the expanding export prospects, the domestic cocoa bean market remains sizable. Regretfully, throughout the last five years, Indonesia's cocoa production has continued to fall. About 767.280 tons of cocoa beans were produced in 2018. After then, it kept declining until 2022, when only about 650.612 tons of cocoa beans were produced (BPS, 2023). According to Tyasmoro *et al.* (2021), the productivity of cocoa plants in Indonesia is low, which is only about 1 ton/ha with a target of 2 tons/ha. This low productivity is caused by several things, one of which is a less than optimal nursery process.

One way to improve the quality of cocoa seedlings is to maximize the absorption of nutrients by plant roots. According to Suwardi and Wijaya (2013) in order to maximize plant nutrient absorption, humic acid helps to enhance root activity. Khaled and Fawy (2011) claim that adding humic acid to the soil can improve the uptake of nutrients, including sodium (Na), potassium (K), phosphorus (P), and magnesium (Mg). Additionally, humic acid will help plants absorb micronutrients like copper (Cu) and zinc (Zn) more readily.

The essential macronutrient requirements of cocoa seedlings can be satisfied using NPK compound fertilizer. This fertilizer is also known as a complete fertilizer because it contains three essential elements: potassium (K), phosphorus (P), and nitrogen (N) (Puslitkoka, 2008). According to Widiana *et al.* (2020), the advantage of using compound fertilizer compared to single fertilizer is that its use is more practical.

Clone ICCRI 06 H is a hybrid clone developed by the Indonesian Coffee and Cocoa Research Center. This clone is the result of a cross between TSH 858 x KW 162 clones. ICCRI 06 H clone was developed to overcome VSD (*Vascular streak dieback*) disease which is deadly for cocoa plants with a mortality ratio of up to

50%. ICCRI 06 H clone has high production potential and average dry bean weight of about 2 tons/ha and 1.7 g (quality A according to SNI) (Susilo, 2012).

This study seeks to assess the growth response of cocoa seedlings (*Theobroma cacao* L.) clone ICCRI 06 H to various concentrations of humic acid and NPK fertilizer.

RESEARCH METHODOLOGY

A. Tools and Materials

A ruler, bucket, paddle, oven, hoe, machete, vernier, SPAD, meter, and digital scale were among the equipment utilized in this study. While the materials used were cocoa seeds of ICCRI 06 H clone, AH-90 humic acid, NPK (16:16:16), uv plastic, topsoil, polybag 20 cm x 30 cm, plastic rope, 50% paranet, sand sieve size 1 cm x 1 cm, bamboo, paranet, polybag 10 cm x 10 cm, fungicide, and insecticide.

B. Research Design

This study was conducted at the Agroecotechnology Laboratory, Faculty of Agriculture, Sultan Ageng Tirtayasa University, and the Integrated Farming System (Sitandu) of Banten Province, Curug District, Serang City, Banten. The study was carried out between January and May of 2025. A Randomized Block Design (RBD) with two components was employed in this investigation. Humic acid at levels of 0 g/plant (a0), 10 g/plant (a1), 20 g/plant (a2), and 30 g/plant (a3) was the first factor. NPK fertilizer at levels of 0 g/plant (n0), 5 g/plant (n1), 7.5 g/plant (n2), and 10 g/plant (n3) constitutes the second factor. Plant height, stem diameter, number of leaves, leaf area, leaf chlorophyll index, plant wet weight, and plant dry weight were among the parameters measured in this investigation. To ascertain the effect, the acquired data were subsequently subjected to Analysis of Variance (ANOVA) at the 5% level. Additional tests were conducted using the Duncan Multiple Range Test (DMRT) at the 5% level if the variance findings indicated a significant effect.

C. Research Procedure

1. Land Preparation and Shading

After removing weeds and other crop leftovers, the field was measured under the research plan. Bamboo and parnet were used to shade at a 50% intensity. This is consistent with Sukadi's (2018) assertion that for young cocoa plants to thrive as best they can, sunshine intensity should be between 25 and 60% of full sunlight.

2. Cocoa Seed Sowing

Cocoa seeds were germinated in 10 cm x 10 cm polybags containing topsoil and sand in a 1:1 ratio. Cocoa seeds are planted by placing them on the media that has been previously

perforated to a depth of ±2 cm. The radicle faces downward and the plumula faces upward and then immersed with soil.

3. Making Planting Media

Topsoil from the Sitandu region was used as planting media, and it was then sieved using a 1 cm x 1 cm sieve. Following that, the planting medium was placed into 20 cm x 30 cm polybags, each weighing 2 kilogram.

4. Transplanting Cocoa Seedlings

Transplanting cocoa seedlings to polybags is done when the seedlings are 14 days old. The criteria for seedlings that are ready to be transplanted are that the seedlings have seed pieces that have expanded and lifted from the ground and the height of the seedlings is uniform. Transplanting is done very carefully so that the roots of the plants are not damaged.

5. Application of Humic Acid and NPK

At 1 WAP and 5 WAP, the cocoa seedlings received half of the treatment dose from the simultaneous application of humic acid and NPK fertilizer. The soil surrounding the seedlings was submerged in humic acid and NPK fertilizer at a depth of ± 1-2 cm, using the proper dosage in

accordance with the preset treatment combination.

6. Plant Maintenance

Watering and managing plant pest organisms are examples of maintenance. Each plant received 200 milliliters of water twice a day, in the morning and the evening. Weeds that were growing around the experimental plants were pulled by hand in order to control the pests. In the meantime, insecticides and fungicides are used to control any pests that appear as fungus or pests.

RESULTS AND DISCUSSION

A. Plant Height.

Results presented in Table 1 demonstrate that the single application of humic acid had no discernible impact at 4, 8, and 12 weeks after planting. This is thought to be due to several factors, one of which is the use of inappropriate doses of humic acid so that the plant growth response does not grow significantly. Doses that are too small will not meet the nutrient needs of plants, so plant growth does not increase significantly. While too much dose can cause negative effects for plants such as poisoning which causes plants to not be able to grow optimally or even experience death. Based on the results of research by Santi (2016), although humic acid addition can boost nutrient intake and the number of soil microbes, these effects are not necessarily clearly correlated with plant vegetative development. The study found that adding humic acid to cocoa seedlings boosted their dry weight and leaf nutrient content, but had no discernible effect on plant height or stem diameter.

Table 1. Average plant height (cm) of cocoa seedlings after applying different amounts of humic acid and NPK fertilizer

Plant Age (WAP)	Humic Acid Doses (a)/Plant	NPK Fertilizer Doses (n)/Plant				Average
		n0 (0 g/plant)	n1 (5 g/plant)	n2 (7.5 g/plant)	n3 (10 g/plant)	
		…..cm…..				
4	0 g (a0)	20.88	22.22	25.05	24.48	23.16
	10 g (a1)	21.18	22.63	22.15	23.62	22.40
	20 g (a2)	22.77	22.28	24.27	24.78	23.53
	30 g (a3)	22.55	23.97	23.88	24.47	23.72
	Average	21.85b	22.78ab	23.84a	24.34a	23.20
8	0 g (a0)	25.92	32.08	34.63	34.00	31.66
	10 g (a1)	27.50	32.52	31.77	33.62	31.35
	20 g (a2)	28.83	32.95	39.57	36.87	34.55
	30 g (a3)	30.97	37.20	37.05	32.73	34.49
	Average	28.30b	33.69a	35.75a	34.30a	33.01
12	0 g (a0)	36.92	47.88	50.85	50.22	46.47
	10 g (a1)	36.90	47.18	46.25	42.72	43.26
	20 g (a2)	38.97	48.62	52.05	47.75	46.85
	30 g (a3)	37.47	53.47	49.05	44.48	46.12
	Average	37.56b	49.29a	49.55a	46.29a	45.67

Notes: According to the 5% DMRT test, numbers that are followed by the same letter in the same row do not differ significantly.

According to Table 1's results, NPK fertilizer treatment has a significant impact on plant height at 4, 8, and 12 weeks after planting. At 4 weeks, the treatment with 10 g/plant (n3) had the highest average plant height value, measuring 24.34 cm; at 8 weeks, the treatment with 7.5 g/plant (n2) had the highest average plant height value, measuring 35.75 cm; and at 12 weeks, the treatment with 7.5 g/plant (n2) had the highest average plant height value, measuring 49.55 cm. These findings are

consistent with a study by Laia *et al*. (2021) that found that the 10 g/plant NPK fertilizer treatment produced the best plant height growth results. Then, Sitio *et al.* (2015) stated that nitrogen (N) is an essential nutrient element needed in the preparation of protein compounds, chlorophyll, and alkoloids. Protein compounds are used by plants to regulate plant growth, then increased synthesis of proteins encourages cell division and elongation which causes maximum plant height growth.

B. Stem Diameter

Based on Table 2, at the age of 4, 8, and 12 weeks after planting, the single treatment of humic acid did not have a significant effect on stem diameter parameters. These results may be due to various reasons, one of which is the poor response of the clones used to humic acid. Clone ICCRI 06 H is a clone resulting from a cross between clones TSH 858 and KW 162, this clone is a clone that has not been widely studied, especially regarding its response to humic acid. The response of ICCRI 06 H clone to humic acid application is thought to be not as good as other clones. Khair *et al.* (2017) demonstrated that while not all cocoa clones responded in the same way, the development of numerous clones was significantly impacted by the application of organic fertilizer.

Table 2. Average stem diameter (mm) of cocoa seedlings after applying different amounts of humic acid and NPK fertilizer

Plant Age (WAP)	Humic Acid Doses (a)/Plant	NPK Fertilizer Doses (n)/Plant				Average
		0 g (n0)	5 g (n1)	7.5 g (n2)	10 g (n3)	
		.....mm.....				
4	0 g (a0)	3.23	3.67	3.83	3.88	3.65
	10 g (a1)	3.30	3.77	3.85	3.62	3.63
	20 g (a2)	3.67	3.75	4.05	3.85	3.83
	30 g (a3)	3.68	3.75	3.88	3.95	3.82
	Average	3.47b	3.73a	3.90a	3.83a	3.73
8	0 g (a0)	4.42	5.53	6.05	5.63	5.41
	10 g (a1)	4.60	5.30	5.65	5.15	5.18
	20 g (a2)	5.20	5.57	5.93	5.73	5.61
	30 g (a3)	5.60	5.23	5.40	5.20	5.36
	Average	4.95b	5.41ab	5.76a	5.43a	5.39
12	0 g (a0)	6.03	7.70	8.03	8.50	7.57
	10 g (a1)	6.13	8.02	7.70	7.08	7.23
	20 g (a2)	6.97	8.00	8.32	7.72	7.75
	30 g (a3)	7.02	7.68	7.33	7.13	7.29
	Average	6.54b	7.85a	7.85a	7.61a	7.46

Notes: According to the 5% DMRT test, numbers that are followed by the same letter in the same row do not differ significantly

Based on Table 2, at the age of 4, 8, and 12 weeks after planting, the single treatment of humic acid did not have a significant effect on stem diameter parameters. These results may be due to various reasons, one of which is the poor response of the clones used to humic acid. Clone ICCRI 06 H is a clone resulting from a cross between clones TSH 858 and KW 162, this clone is a clone that has not been widely studied, especially regarding its response to humic acid. The response of ICCRI 06 H clone to humic acid application is thought to be not as good as other clones. Khair *et al.* (2017) demonstrated that while not all cocoa clones responded in the same

way, the development of numerous clones was significantly impacted by the application of organic fertilizer.

Table 2 demonstrates that the NPK fertilizer application has a noticeable impact on the stem's diameter four, eight, and twelve weeks after planting. The NPK fertilizer treatment of 7.5 g/plant (n2) had the largest average stem diameter at 4 weeks after planting, with an average measurement of 3.9 mm. In contrast, the treatment of 7.5 g/plant (n2) had the largest average stem diameter at 8 weeks after planting, with an average measurement of 5.76 mm. The 7.5 g/plant (n2) treatment had the largest average stem diameter at 12 weeks after planting, with an average measurement of 7.85 mm. Elkas *et al.* (2017) state that nutrients such as potassium (K) and phosphorus (P) are crucial for enlarging the stem diameter. Plant stems serve as a conduit between roots and leaves, among other purposes. P and K element availability influences the best way for carbohydrates to develop and makes it easier for nutrients to go smoothly to the stem, which eventually leads to the best possible stem growth. Furthermore, P and K are involved in the development of other plant organs.

C. Number of Leaves

Based on Table 3, at the age of 4 and 12 weeks after planting, humic acid treatment did not have a significant effect on the number of leaves. Meanwhile, at the age of 8 weeks after planting, the humic acid treatment had a significant effect on the number of leaves. At the age of 8 weeks after planting, the highest average number of leaves was found in the humic acid treatment of 20 g/plant (a2) with an average value of 12. Ashari et al. (2017), found that the best growth response to the growth of castor bean seedlings was provided by humic acid (20 g/plant) for the parameters of plant height, crown diameter, and leaf area.

Table 3. Average number of leaves of cocoa seedlings after applying different amounts of humic acid and NPK fertilizer

Plant Age (WAP)	Humic Acid Doses (a)/Plant	NPK Fertilizer Doses (n)/Plant				Average
		0 g (n0)	5 g (n1)	7.5 g (n2)	10 g (n3)	
		.....				
4	0 g (a0)	6.67	7.00	7.17	7.33	7.04
	10 g (a1)	6.83	7.33	7.00	7.33	7.13
	20 g (a2)	6.67	7.00	7.50	7.50	7.17
	30 g (a3)	6.17	7.50	7.83	7.33	7.21
	Average	6.58	7.21	7.38	7.38	7.14
8	0 g (a0)	9.17	10.17	10.33	11.50	10.29b
	10 g (a1)	9.50	12.33	10.83	11.00	10.92ab
	20 g (a2)	9.50	12.17	13.67	12.67	12.00a
	30 g (a3)	9.17	12.50	13.33	11.33	11.58a
	Average	9.33b	11.79a	12.04a	11.63a	11.20
12	0 g (a0)	14.83	19.17	18.50	19.83	18.08
	10 g (a1)	15.00	19.83	18.00	18.33	17.79
	20 g (a2)	14.50	19.50	22.00	19.50	18.88
	30 g (a3)	14.00	19.00	21.17	20.33	18.63
	Average	14.58b	19.38a	19.92a	19.50a	18.34

Notes: According to the 5% DMRT test, numbers that are followed by the same letter in the same row do not differ significantly.

The NPK fertilizer treatment has a significant impact on the number of leaves at 4, 8, and 12 weeks after planting, according to data on the average number of leaves shown in Table 3. The NPK fertilizer treatments of 7.5 g/plant (n2) and 10 g/plant, with the same average value of 7.38, had the highest average number of leaves at 4 weeks after planting. In contrast, the 7.5 g/plant (n2) treatment had the highest average number of leaves at 8 weeks after planting, with an average value of 12.04. Within 12 weeks after planting, the 7.5 g/plant (n2) treatment had the highest average number of leaves, with an average of 19.92. These findings are consistent with those of a study conducted by Triastuti *et al.* (2016), which found that the parameters of plant height, number of leaves, stem diameter, root volume, root crown ratio, and plant dry weight were all positively impacted by the application of 7.5 g/plant of NPK fertilizer.

D. Leaf Area.

Table 4 shows that the single humic acid treatment had no discernible impact on leaf area measurements 12 weeks after planting. One of the many possible causes of this is the improper frequency of application. When humic acid is applied too frequently between the first and second applications, it builds up in polybags and eventually slows down its pace of growth. On the other hand, humic acid will be washed away and have no effect on plants if it is applied too far away. According to research by Aurora (2017), the amount of humic acid applied can have an impact on the leaf area of cocoa trees, although the effect varies depending on when and how often it is applied.

Table 4. Average leaf area (cm^2) of cocoa seedlings after applying different amounts of humic acid and NPK fertilizer

Plant Age (WAP)	Humic Acid Doses (a)/Plant	NPK Fertilizer Doses (n)/Plant				Average
		0 g (n0)	5 g (n1)	7.5 g (n2)	10 g (n3)	
		.....cm^2.....				
12	0 g (a0)	53.43	105.53	86.17	102.74	86.97
	10 g (a1)	60.82	94.94	95.83	64.64	79.06
	20 g (a2)	69.73	108.83	120.77	90.84	97.54
	30 g (a3)	82.22	144.82	104.12	75.15	101.58
	Average	66.55c	113.53a	101.72ab	83.34bc	91.29

Table 4 demonstrates that the NPK fertilizer application has a significant impact on the leaf area characteristics 12 weeks after planting. With an average value of 113,53 cm2, the results of the NPK fertilizer treatment at a dose of 5 g/plant (n1) tended to be greater than those of the other treatments. Nasrullah *et al.* (2015) stated that the NPK fertilizer treatment of 5 g/plant had a very significant effect on the height of seedlings aged 60 and 90 HST, the diameter of the base of the stem aged 60 and 90 HST, leaf area, root length, wet weight of roots, wet weight of upper berth, dry weight of upper berth. The increased growth of cocoa seedlings in the NPK fertilizer treatment (16:16:16) of 5 grams per plant is because the dose can meet the needs of essential nutrients, particularly macroelements required during the growth period, such as potassium (K), phosphorus (P), and nitrogen (N).

E. Leaf Chlorophyll Indeks

Table 5 shows that the humic acid treatment had a substantial impact on the leaves' chlorophyll index parameter 12

weeks after planting. Results from a 30 g/plant (a3) humic acid treatment tended to be greater than those from the other treatments, with an average value of 31.93. This is because humic acid improves the soil's physical, chemical, and biological characteristics, acting as a soil dissector. The presence of nearby microorganisms has an impact on plant growth in addition to the availability of nutrients. Certain kinds of microbes aid in the growth of plants and aid in the plants' uptake of nutrients. By encouraging the growth of soil beneficial microorganisms, humic acids enhance soil biology. Humic acid plays a crucial role in the soil as a source of carbon components and helps to increase the availability of nutrients that soil microbes require. According to Tikhonov *et al.* (2010), furthermore, the structure of the microbial population that inhabits the soil is also determined by its pH level..

Table 5. Average chlorophyll index of cocoa seedlings after applying different amounts of humic acid and NPK fertilizer

Plant Age (WAP)	Humic Acid Doses (a)/Plant	NPK Fertilizer Doses (n)/Plant				Average
		0 g (n0)	5 g (n1)	7.5 g (n2)	10 g (n3)	
		.....				
12	0 g (a0)	20.11	30.80	31.83	26.72	27.37b
	10 g (a1)	24.37	31.87	31.09	30.09	29.36ab
	20 g (a2)	22.26	33.20	35.09	31.36	30.48a
	30 g (a3)	22.22	34.05	34.82	36.61	31.93a
	Average	22.24b	32.48a	33.21a	31.20a	29.78

Notes: According to the 5% DMRT test, numbers that are followed by the same letter in the same row do not differ significantly.

Table 5 demonstrates how the NPK fertilizer application has a noticeable impact on the leaf chlorophyll index characteristics 12 weeks after planting. With an average value of 33.21, the NPK fertilizer treatment with a dose of 7.5 g/plant (n2) produced better outcomes than the other treatments. The 7.5 g/plant treatment was significantly different from the 0 g/plant (n0) treatment (control) with an average value of 22.24, but not significantly different from the 5 g/plant (n1) and 10 g/plant (n3) treatments with an average value of 32.48 and 31.2, respectively. These results indicate that the dose of NPK fertilizer of 7.5 g/plant is sufficient for plant nutrient needs, especially nitrogen (N) as the main constituent of chlorophyll. According to Taisa *et al.* (2021), plants need various essential nutrients and one of them is nitrogen (N) as one of the constituent elements of chlorophyll which is the main agent of chloroplasts.

F. Plant Wet Weight

Based on Table 6, at the age of 12 weeks after planting, the humic acid treatment gave a significant effect on the wet weight parameter of the plants. Humic acid treatment of 20 g/plant (a2) with an average value of 39.04 g gave results that tended to be higher than the other treatments. The increase in plant wet weight was caused by the increase in the volume of plant organs such as stems, leaves, and roots. Humic acid has the ability to stimulate root growth. This is because humic acid contains the hormone auxin which can stimulate root growth. These results are supported by the statement of Suwardi and Wijaya (2017) which states that humic acid contains the hormone auxin which is able to stimulate root growth so as to accelerate root development, and increase root wet weight. Hermanto (2013) because it can increase the effectiveness of nutrient and water absorption, humic acid plays a significant role in promoting plant

growth. This, in turn, stimulates enzyme activity and the proper formation of plant tissues. Humic acid has functions in plant growth, one of which is to stimulate root growth (Sari and Soetanto, 2017).

Table 6. Average wet weight (g) of cocoa seedlings after applying different amounts of humic acid and NPK fertilizer

Plant Age (WAP)	Humic Acid Doses (a)/Plant	NPK Fertilizer Doses (n)/Plant				Average
		0 g (n0)	5 g (n1)	7.5 g (n2)	10 g (n3)	
		.....g.....				
12	0 g (a0)	21.00	40.33	39.33	44.00	36.17ab
	10 g (a1)	20.83	42.50	33.50	29.67	31.63b
	20 g (a2)	21.00	44.00	53.83	37.33	39.04a
	30 g (a3)	20.50	45.33	38.50	30.50	33.71ab
	Average	20.83c	43.04a	41.29a	35.38b	35.14

Notes: According to the 5% DMRT test, numbers that are followed by the same letter in the same row do not differ significantly

Table 6 demonstrates that the NPK fertilizer treatment has a noteworthy impact on the plant wet weight characteristics 12 weeks after planting. With an average value of 43.04g, the NPK fertilizer treatment with a dose of 5 g/plant (n1) produced better results than the other treatments. With an average value of 20.38 g and 35.38 g, respectively, the 5 g/plant treatment differed significantly from the 0 g/plant (n0) (control) and the 10 g/plant (n3) treatments, but not significantly from the 7.5 g/plant (n2) treatment, which had an average value of 41.29 g. According to these findings, the NPK fertilizer treatment with a dose of 5 g/plant (n1) produced better results than the other treatments. These findings suggest that 5 g/plant (n1) of NPK fertilizer treatment is adequate to satisfy the nutrient requirements of cocoa seedlings. The growth of cocoa plants will be optimized with the necessary nutrients, which will ultimately result in an increase in the plants' moist weight. These findings are consistent with research by Nasrullah *et al.* (2015), which demonstrated that the best results were obtained when cocoa seedlings were fertilized with NPK fertilizer at a rate of 5 g/plant using the following parameters: seedling height, stem base diameter, leaf area, root wet weight, root length, top wet weight of stems, and dry weight of stems.

G. Plant Dry Weight

Table 7 shows the relationship between humic acid treatment and NPK fertilizer in cocoa seedlings 12 weeks after planting. With an average value of 19.02 g, the optimal combination was achieved when 20 g/plant (a2) of humic acid treatment and 7.5 g/plant (n2) of NPK fertilizer were combined. This can occur because humic acid can reduce the need for NPK fertilizer. This can occur because humic acid has the ability to reduce the need for NPK fertilizer by facilitating the absorption of nutrients contained in NPK fertilizer. With the increased absorption of fertilizer nutrients, the plant's need for nutrients to carry out metabolic processes will be fulfilled more quickly and ultimately plant growth will accelerate as well. Nuraini and Zahro (2020), applying humic acid with NPK fertilizer has been shown to improve rice plants' absorption of nutrients, particularly nitrogen (N). The dissociation of H ions from different functional groups gives humic acid its negative charge, which gives the humic fraction a high cation exchange capacity (CEC) Hermanto *et al.* (2013). Humic acid's high CEC can improve the soil's capacity to exchange, bind, and absorb cations. According to Rahman (2014), the reason for the rise in biomass is that plants can absorb water and

nutrients efficiently, which promotes the growth of their organs, like roots. They can also increase the activity of the photosynthesis process in their leaves, which can have an impact on the dry weight of the plants.

Table 7. Average dry weight (g) of cocoa seedlings after applying different amounts of humic acid and NPK fertilizer

Plant Age (WAP)	Humic Acid Doses (a)/Plant	NPK Fertilizer Doses (n)/Plant				Average
		0 g (n0)	5 g (n1)	7.5 g (n2)	10 g (n3)	
		.....g.....				
12	0 g (a0)	7,17 d	13.39 bc	12.52 bc	15.31 ab	12,10
	10 g (a1)	7,22 d	14.80 abc	11.44 bcd	10.32 cd	10,94
	20 g (a2)	7,13 d	15.39 ab	19,02 a	12.49b c	13,51
	30 g (a3)	7,45 d	15.58 ab	13.28 bc	10.56 cd	11,71
	Average	7,24	14,79	14,06	12,17	12,07

Notes: According to the 5% DMRT test, numbers that are followed by the same letter in the same row do not differ significantly.

CONCLUSIONS AND RECOMMENDATIONS

In terms of increasing the number of leaves at 8 weeks after planting and the moist weight of plants at 12 weeks after planting, a dosage of 20 g of humic acid per plant (a2) produced the best results. At 12 weeks following planting, the humic acid dose of 30 g/plant (a3) had the greatest impact on the leaves' chlorophyll index. Plant height at 4 weeks post-planting, leaf area, and plant wet weight at 12 weeks post-planting were all most effectively increased by applying NPK fertilizer at a dose of 5 g/plant (n1). When it came to stem diameter parameters at 4, 8, and 12 weeks after planting, leaf number parameters at 8 and 12 weeks after planting, leaf area parameters at 12 weeks after planting, chlorophyll index parameters at 12 weeks after planting, wet weight parameters at 12 weeks after planting, and dry weight parameters at 12 weeks after planting, the dose of 7.5 g/plant (n2) produced the best results. Only 4 weeks after planting did the 10 g/plant (n3) dose have the best results on plant height. The dry weight metric of plants 12 weeks after planting showed an interaction between the humic acid treatment and NPK fertilizer a2n2 (20 g/plant of humic acid + 7.5 g/plant of NPK fertilizer). It is necessary to conduct additional research on several clones and with varying dosages of humic acid and NPK fertilizer..

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