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Effect of Nitrogen and Humic Acid on Growth and Yield of Pakcoy (*Brassica rapa subsp. chinensis*)

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Abstract. Decreased soil quality due to reduced nutrient content is one of the causes of decreased quality and yield in plants. The use of humic acid organic matter with N fertilizer is one of the efforts to increase nutrients in the soil while increasing plant growth and yield. This research was conducted in Heuleut Village, Leuwimunding District, Majalengka Regency, from May to June 2024. The research method used was the experimental method with a group-randomized design. The treatment consisted of 16 treatments that were repeated twice. The variables observed were plant height, number of leaves, root volume, plant fresh weight, leaf area, and plant growth rate. The results showed that the use of N fertilizer at a dose of 115 kg/ha (urea 250 kg/ha) and humic acid 3 g/plant had a good effect on all variables observed. The results of soil analysis showed an increase in N-total and C-organic.

Keywords: pakcoy, humic acid, nitrogen, growth, yield

INTRODUCTION

Pakcoy is a favorite vegetable of many people from children to adults because of its high protein content. The concave shape of its leaves like a spoon makes it called spoon mustard. Not only rich in beta-carotene, pakcoy is also a source of vegetable protein, carbohydrates, fiber, and important minerals such as calcium (Ca), magnesium (Mg), iron (Fe), and sodium, this vegetable is also rich in vitamins A and C (Yama & Kartiko, 2020). Based on data from Badan Pusat Statistik (2021), pakcoy production in Indonesia showed an increase from 2018 to 2019. However, the increase in total production was not accompanied by an increase in productivity per unit area of land. There was a decrease in pakcoy productivity from 6.59 tons/ha in 2018 to 5.72 tons/ha in 2019. This indicates a potential decrease in efficiency in pakcoy cultivation.

The decline in pakcoy productivity is significantly influenced by the degradation of soil quality, which is characterized by a decline in essential nutrient content. Macro and micronutrients play a crucial role in various plant physiological processes, including vegetative growth and reproductive organ development (Mpapa, 2016). Crop productivity is highly dependent on the availability of nutrients in the soil. Unsustainable agricultural practices, such as excessive use of chemical fertilizers or poor crop rotation, can lead to nutrient depletion, especially nitrogen, which inhibits plant growth (Nuraini & Zahro, 2020).

One of the nutrients most needed by mustard plants is nitrogen. Nitrogen has a very important role in leaf growth because it functions to increase vegetative growth so that plant leaves become wider, greener in color, and have better quality (Sarif et al., 2015). The absorption of nutrients will take place well if the soil is loose, one of the efforts to loosen the soil is by applying organic materials such as humic acid.

Humic acids are organic compounds that are part of humus consisting of long chains of carbon acids resulting from the decomposition of organic matter such as leaves and other plant residues. Humic acids have an indirect effect on increasing soil fertility through improving the physical, chemical, and biological quality of the soil; on the other hand, they directly improve metabolic processes within the plant, helping to improve its growth and health (Victolika et al., 2014).

Humic acid, a component of humus, helps increase the efficiency of nitrogen (N) fertilizer use in the soil. This happens because humic acids can improve soil structure, enhance water retention, and increase the soil's ability to hold and release nutrients slowly. Humic acids help prevent nitrogen loss through leaching or volatilization, allowing plants to utilize nitrogen fertilizers more effectively (Ismillayli et al., 2019).

There is not much information about the effect of the use of N fertilizer rates and humic acid on the growth and yield of pakcoy plants. This study aims to determine the effect of N fertilizer rate and humic acid on the growth and yield of pakcoy plants.

LITERATURE

Nitrogen is the main nutrient required by plants for the growth and formation of vegetative organs such as stems, leaves, and roots. Thus, an increase in nitrogen dose can be assumed to increase the number of leaves in plants (Suhastyo & Raditya, 2019). The more nitrogen absorbed by the plant, the more active the meristematic tissue at the stem growth point, which results in higher plant growth (Bagus Bima Soekamto et al., 2024).

Humic acid can increase pH, organic C content, and microorganism populations in humic dystrudept soils (Santi, 2016). Humic acid application in soil conditions that have optimal nitrogen (N) levels does not show a significant effect; in nitrogen-deficient soils, humic acid can increase nitrogen use efficiency (Restida et al., 2014).

Humic acid application to nutrient-deficient soil is more effective in increasing the ability of plants to absorb nitrogen compared to fertile soil (Susilo et al., 2023). The use of humic acids at excessive concentrations can cause damage to soil chemical properties. Excess humic acid can disrupt the chemical balance of the soil, which can reduce the availability of nutrients to plants or even damage the overall soil structure (Fauziah et al., 2019).

The increase in nitrogen absorption by plants is related to the role of humic acid in increasing nitrogen fertilization efficiency and nitrogen availability by slowing down the release of nitrogen into nitrate through the nitrification process (Nuraini & Zahro, 2020).

METHODS

The research was conducted on experimental land in Heuleut Village, Leuwimunding District, Majalengka Regency. The land is located at an altitude of 70-80 meters above sea level with an air temperature of 29 - 30 °C. The experimental design used was group randomization, with the treatments given being doses of N fertilizer and humic acid. There were 16 treatments, and each treatment was repeated twice. The plot size is 1.2 m x 1.2 m, the distance between plots is 40 cm, and the distance between plants is 20 cm. Each experimental plot consisted of 36 plants.

Observations were made on plants aged 14, 21, and 28 DAP (Days After Planting), including plant height, number of leaves, root volume, fresh weight, leaf area, relative growth rate, and net assimilation rate. Observations were made by taking one plant in each treatment. The observed plants were brought to the Plant Physiology Laboratory, Faculty of Agriculture, Universitas Swadaya Gunung Jati, Cirebon, for further observation.

Observations on plant height were measured using a ruler. The number of leaves was counted manually per blade. Root volume was observed using a measuring cup that has been given water, and then the addition of water volume after inserting the roots is the root volume. Fresh weight was weighed using a digital scale with two zeros behind the comma to increase the scale's accuracy. Leaf area was measured using the Easy Leaf Area application by cutting all fully bloomed leaves from the stump and then arranging them neatly to be photographed, and the application will display the results. As for the observation of relative growth rate and net assimilation rate, dry weight variables were needed, so the sample plants taken for each observation were dried using an oven at 105 °C for one day. Observation data were processed using analysis of variance (F test) based on the linear model of randomized group design. If the results of the variance showed a significant effect of the treatment tested

(F value > $F_{5\%}$), then the test was continued using the Scott-Knott Cluster Test at a real level of 5%.

DISCUSSION

The application of nitrogen fertilizer and humic acid significantly increases the levels of total nitrogen and organic carbon in the soil. This is evidenced by laboratory results showing that the application of nitrogen fertilizer and humic acid raises total nitrogen in the soil by 0.3 and increases organic carbon in the soil by 0.95 from the initial condition of the soil before treatment.

Plant Height

Based on the research that has been carried out, it can be seen in (Table 1) that the plant height in the treatment of N 115 kg/ha (urea 250 kg/ha) and humic acid 3.0 g/ha is the highest variable when compared to the control treatment. This is in accordance with the statement of Lakitan, (2010) in Sarif et al., (2015) which states that applying the right dose of nitrogen fertilizer can affect growth and increase plant productivity. The treatment with a dose of N 57.5 kg/ha (urea 125 kg/ha) and humic acid 4.5 g/plant had the lowest average plant height of all treatments.

Humic acid dose of 3 g/plant, which is the dose with the results that have the highest effect on pakcoy plant height, is in accordance with research conducted by Rahhutami et al., (2021) namely, the provision of humic acid at a dose of 3 g/plant can have a significant effect on the growth of pakcoy plants. The growth and development of pakcoy can be influenced by several external and internal factors. The internal factors are the pakcoy seeds themselves, such as the level of seed purity and the percentage of seed growth.

Table 1. Pakcoy Plant Height

No.	Treatment	Plant Height (cm)					
		14 DAP		21 DAP		28 DAP	
1	A (N 0,0 kg/ha + HA 0,0 g/plant)	8.92	a	12.42	a	20.81	a
2	B (N 0,0 kg/ha + HA 1,5 g/plant)	11.08	a	15.92	b	25.20	b
3	C (N 0,0 kg/ha + HA 3,0 g/plant)	9.42	a	13.04	a	21.54	a
4	D (N 0,0 kg/ha + HA 4,5 g/plant)	6.00	a	9.00	a	15.53	a
5	E (N 57,5 kg/ha + HA 0,0 g/plant)	10.42	a	14.96	b	24.81	b
6	F (N 57,5 kg/ha + HA 1,5 g/plant)	8.50	a	11.17	a	19.86	a
7	G (N 57,5 kg/ha + HA 3,0 g/plant)	7.42	a	9.88	a	16.26	a
8	H (N 57,5 kg/ha + HA 4,5 g/plant)	5.58	a	7.92	a	13.61	a
9	I (N 115 kg/ha + HA 0,0 g/plant)	9.92	a	13.79	b	25.48	b
10	J (N 115 kg/ha + HA 1,5 g/plant)	6.75	a	10.33	a	19.80	a
11	K (N 115 kg/ha + HA 3,0 g/plant)	11.75	a	**19.42**	**c**	**31.99**	**c**

12	L (N 115 kg/ha + HA 4,5 g/plant)	6.50	a	10.00	a	18.11	a
13	M (N 172,5 kg/ha + HA 0,0 g/plant)	8.83	a	14.17	b	25.43	b
14	N (N 172,5 kg/ha + HA 1,5 g/plant)	6.00	a	10.58	a	21.09	a
15	O (N 172,5 kg/ha + HA 3,0 g/plant)	9.50	a	**18.46**	**c**	**30.23**	**c**
16	P (N 172,5 kg/ha + HA 4,5 g/plant)	8.58	a	12.13	a	22.78	a

Notes: Numbers with the same lowercase letter in a column are not significantly different according to the Scott-Knott cluster test at the 5% level.

Number of leaves

Different doses of N fertilizer and humic acid produce different numbers of leaves (Table 2). This shows that the dose of N fertilizer and humic acid is able to supply the nitrogen element needed by pakcoy plants during the process of growth and development of pakcoy plants because the vegetative growth of plants is closely related to nitrogen nutrients this is in line with the opinion of Sitio et al., (2015) that vegetative growth is always related to nitrogen nutrients supplied to plants.

The increase in the number of leaves in pakcoy plants with increasing amounts of humic acid given is one of the roles of humic acid to maintain the availability of N nutrients in the soil so that plants can absorb more nutrients in the soil. This is in line with the opinion of Nainggolan, (2009) in Radite & Hasiholan Simanjuntak, (2020) N nutrients play an important role in plant vegetative growth N nutrients are absorbed by plants in the form of NH_4+ and NO_3-.

Table 2. Number of Leaves of Pakcoy Plants

No.	Treatment	Number of Leaves per Plant (leaves)					
		14 DAP		21 DAP		28 DAP	
1	A (N 0,0 kg/ha + HA 0,0 g/plant)	5,33	b	6,25	b	7,25	a
2	B (N 0,0 kg/ha + HA 1,5 g/plant)	5,67	b	6,00	a	9,17	b
3	C (N 0,0 kg/ha + HA 3,0 g/plant)	5,84	b	6,58	b	8,08	b
4	D (N 0,0 kg/ha + HA 4,5 g/plant)	4,42	a	4,83	a	5,92	a
5	E (N 57,5 kg/ha + HA 0,0 g/plant)	5,00	b	7,17	b	9,33	b
6	F (N 57,5 kg/ha + HA 1,5 g/plant)	4,50	a	5,33	a	6,83	a
7	G (N 57,5 kg/ha + HA 3,0 g/plant)	5,00	b	5,17	a	6,75	a
8	H (N 57,5 kg/ha + HA 4,5 g/plant)	4,00	a	4,58	a	5,92	a
9	I (N 115 kg/ha + HA 0,0 g/plant)	5,25	b	7,09	b	10,00	b
10	J (N 115 kg/ha + HA 1,5 g/plant)	3,92	a	6,00	a	7,42	a
11	K (N 115 kg/ha + HA 3,0 g/plant)	5,58	b	7,33	b	9,92	b
12	L (N 115 kg/ha + HA 4,5 g/plant)	4,08	a	5,87	a	8,17	b
13	M (N 172,5 kg/ha + HA 0,0 g/plant)	5,08	b	6,42	b	8,92	b
14	N (N 172,5 kg/ha + HA 1,5 g/plant)	4,67	a	5,92	a	7,42	a
15	O (N 172,5 kg/ha + HA 3,0 g/plant)	5,67	b	7,42	b	9,42	b
16	P (N 172,5 kg/ha + HA 4,5 g/plant)	4,83	b	6,42	b	8,92	b

Notes: Numbers with the same lowercase letter in a column are not significantly different according to the Scott-Knott cluster test at the 5% level.

Root Volume

Dosing of N fertilizer and humic acid showed the highest results when compared to root volume data in other treatments. The smallest result was shown by the control treatment. Plant vegetative growth is influenced by the availability of nitrogen in the soil; the provision of N fertilizer at the right dose can increase the ability of plants in vegetative growth such as leaves, roots, and stems. This is in line with what was conveyed in the research by Suhastyo & Raditya (2019) the increase in root volume indicates that pakcoy plants respond positively to nutrient absorption and is one sign of good vegetative growth.

The increase in root volume is also a form of the role of humic acid, which can change the physical properties of the soil, which will make it easier for plants to absorb nutrients in the soil. This is in line with Selladurai & Purakayastha, (2016) the role of humic acid can also increase plant absorption in absorbing available nutrients in the soil so as to increase plant productivity and yield. The increase in plant absorption is always related to the volume of roots that also increases.

Table 3. Root Volume of Pakcoy Plants

No.	Treatment	Root Volume (ml)		
		14 DAP	21 DAP	28 DAP
1	A (N 0,0 kg/ha + HA 0,0 g/plant)	0,21 a	0,42 a	1,05 a
2	B (N 0,0 kg/ha + HA 1,5 g/plant)	0,32 a	0,53 a	1,26 a
3	C (N 0,0 kg/ha + HA 3,0 g/plant)	0,42 b	0,74 a	1,89 a
4	D (N 0,0 kg/ha + HA 4,5 g/plant)	0,42 b	0,74 a	1,26 a
5	E (N 57,5 kg/ha + HA 0,0 g/plant)	0,74 c	1,16 b	3,26 b
6	F (N 57,5 kg/ha + HA 1,5 g/plant)	0,21 a	0,53 a	1,79 a
7	G (N 57,5 kg/ha + HA 3,0 g/plant)	0,42 b	0,74 a	1,79 a
8	H (N 57,5 kg/ha + HA 4,5 g/plant)	0,63 c	0,95 a	2,42 a
9	I (N 115 kg/ha + HA 0,0 g/plant)	0,74 c	1,23 b	3,73 b
10	J (N 115 kg/ha + HA 1,5 g/plant)	0,74 c	1,47 b	2,10 a
11	K (N 115 kg/ha + HA 3,0 g/plant)	**1,42 d**	**2,24 c**	**8,19 c**
12	L (N 115 kg/ha + HA 4,5 g/plant)	0,21 a	0,74 a	1,05 a
13	M (N 172,5 kg/ha + HA 0,0 g/plant)	0,74 c	1,16 b	3,89 b
14	N (N 172,5 kg/ha + HA 1,5 g/plant)	0,21 a	0,74 a	2,10 a
15	O (N 172,5 kg/ha + HA 3,0 g/plant)	0,95 c	1,37 b	**6,20** c
16	P (N 172,5 kg/ha + HA 4,5 g/plant)	0,53 b	0,95 a	3,47 b

Notes: Numbers with the same lowercase letter in a column are not significantly different according to the Scott-Knott Group test at the 5% level.

Leaf Area

Based on the research data in (Table 5), the application of N fertilizer and humic acid had a significant effect on the fresh weight of pakcoy plants. The treatment of N 115 kg/ha (urea 250 kg/ha) and humic acid 3 g/plant gave the highest effect on the leaf area of pakcoy plants. The fresh weight of plants is always directly proportional to the number of leaves and leaf area. This is because the increasing number of leaves indicates that the plant gets N nutrients optimally from the soil so that the vegetative growth of plants can run smoothly (Radite & Hasiholan Simanjuntak, 2020).

According to Bella Puspita et al., (2015), nitrogen fertilization significantly affects leaf expansion, especially in terms of leaf width and area. The increase in leaf area also increases the value of the Leaf Area Index (LAI) of the plant. Plants will accelerate the growth rate of their leaves to maximize light capture, so that the photosynthesis process in the leaves can take place properly.

Humic acid has a role to increase leaf area caused by the fulfillment of N nutrients absorbed by plants. This is in line with the opinion Erawan & Bahrun, (2013) in Radite & Hasiholan Simanjuntak, 2020), meeting the nitrogen needs of urea fertilizer applied with humic acid coating helps prevent N nutrients from being lost due to leaching or evaporation.

Table 4. Leaf Area of Pakcoy Plants

No.	Treatment	Leaf Area per Plant (cm^2)					
		14 DAP		21 DAP		28 DAP	
1	A (N 0,0 kg/ha + HA 0,0 g/plant)	144,96	a	209,73	a	464,41	a
2	B (N 0,0 kg/ha + HA 1,5 g/plant)	307,41	b	356,00	b	647,34	a
3	C (N 0,0 kg/ha + HA 3,0 g/plant)	325,67	b	368,49	b	472,63	a
4	D (N 0,0 kg/ha + HA 4,5 g/plant)	89,58	a	108,78	a	390,44	a
5	E (N 57,5 kg/ha + HA 0,0 g/plant)	325,74	b	501,61	b	720,61	a
6	F (N 57,5 kg/ha + HA 1,5 g/plant)	87,97	a	123,76	a	388,79	a
7	G (N 57,5 kg/ha + HA 3,0 g/plant)	191,40	a	215,70	a	322,57	a
8	H (N 57,5 kg/ha + HA 4,5 g/plant)	108,23	a	137,01	a	175,64	a
9	I (N 115 kg/ha + HA 0,0 g/plant)	329,05	b	473,45	b	649,53	a
10	J (N 115 kg/ha + HA 1,5 g/plant)	133,40	a	252,75	a	422,18	a
11	K (N 115 kg/ha + HA 3,0 g/plant)	496,87	c	755,29	c	1.269,03	b
12	L (N 115 kg/ha + HA 4,5 g/plant)	215,31	a	275,65	a	483,97	a
13	M (N 172,5 kg/ha + HA 0,0 g/plant)	220,98	a	301,80	a	663,43	a
14	N (N 172,5 kg/ha + HA 1,5 g/plant)	140,14	a	199,52	a	298,37	a
15	O (N 172,5 kg/ha + HA 3,0 g/plant)	306,49	b	434,36	b	923,68	b
16	P (N 172,5 kg/ha + HA 4,5 g/plant)	276,69	b	436,54	b	644,07	a

Notes: Numbers with the same lowercase letter in a column are not significantly different according to the Scott-Knott cluster test at the 5% level

Relative Growth Rate

The application of N fertilizer and humic acid had a significant effect when the plants were 14 HST to 21 HST, this was evidenced by a significant increase in (Table 6). Increased growth of vegetative organs such as increasing the number of leaves, increasing plant height, root elongation, and the efficiency of assimilate distribution to various parts of the plant will affect the dry weight produced (Anjarwati et al., 2017). The growth of vegetative organs is a benchmark for plant growth rate, where the role of N nutrients is a macro source of plants for continued growth.

Humic acid can affect plant growth both directly and indirectly. Humic acid can significantly affect the growth and yield of pakcoy plants, this can be seen from the calculated parameters such as plant height, number of leaves, root volume, leaf area, and plant fresh weight. In this context, humic acid plays a role in increasing plant cell energy by increasing ion exchange ability. This increase is caused by the humic fraction, which has a negative charge due to the dissociation of hydrogen ions (H) from various groups, which causes an increase in cation exchange capacity (CEC) (Hermanto et al., 2013 on Shaila et al., 2019).

Table 5. Relative Growth Rate

No.	Treatment	Growth Rate (g/day)	
		14-21 DAP	21-28 DAP
1	A (N 0,0 kg/ha + HA 0,0 g/plant)	0.041 a	0.130 a
2	B (N 0,0 kg/ha + HA 1,5 g/plant)	0.144 b	0.121 a
3	C (N 0,0 kg/ha + HA 3,0 g/plant)	0.091 a	0.149 a
4	D (N 0,0 kg/ha + HA 4,5 g/plant)	0.039 a	0.214 b
5	E (N 57,5 kg/ha + HA 0,0 g/plant)	0.119 b	0.135 a
6	F (N 57,5 kg/ha + HA 1,5 g/plant)	0.059 a	0.158 b
7	G (N 57,5 kg/ha + HA 3,0 g/plant)	0.070 a	0.105 a
8	H (N 57,5 kg/ha + HA 4,5 g/plant)	0.091 a	0.057 a
9	I (N 115 kg/ha + HA 0,0 g/plant)	0.083 a	0.125 a
10	J (N 115 kg/ha + HA 1,5 g/plant)	0.042 a	0.165 b
11	K (N 115 kg/ha + HA 3,0 g/plant)	0.193 b	0.231 b
12	L (N 115 kg/ha + HA 4,5 g/plant)	0.124 b	0.168 b
13	M (N 172,5 kg/ha + HA 0,0 g/plant)	0.093 a	0.216 b
14	N (N 172,5 kg/ha + HA 1,5 g/plant)	0.124 b	0.155 b
15	O (N 172,5 kg/ha + HA 3,0 g/plant)	0.181 b	0.202 b
16	P (N 172,5 kg/ha + HA 4,5 g/plant)	0.111 b	0.174 b

Notes: Numbers with the same lowercase letter in a column are not significantly different according to the Scott-Knott cluster test at the 5% level.

Net Assimilation Rate

Based on the results in (Table 7), the application of N fertilizer and humic acid had no significant effect at the age of 14 HST to 21 HST or 21 HST to 28 HST on the net assimilation rate of pakcoy plants. The treatment of N 172.5 kg/ha (urea 375 kg/ha) and humic acid 1.5 g/plant had the highest net assimilation rate compared to other treatments.

The absence of an increase in the net assimilation rate in each treatment is thought to be due to the absence of an increase in plant cell energy. This is supported by the opinion of Shaila et al., (2019) an increase in plant cell energy encourages more optimal photosynthesis so that the net assimilation rate is even higher.

Table 7. Net Assimilation Rate

No.	Treatment	Net Assimilation Rate (g/day))	
		14-21 DAP	21-28 DAP
1	A (N 0,0 kg/ha + HA 0,0 g/plant)	0.0032 a	0.0021 a
2	B (N 0,0 kg/ha + HA 1,5 g/plant)	0.0086 a	0.0019 a
3	C (N 0,0 kg/ha + HA 3,0 g/plant)	0.0070 a	0.0086 a
4	D (N 0,0 kg/ha + HA 4,5 g/plant)	0.0022 a	0.0020 a
5	E (N 57,5 kg/ha + HA 0,0 g/plant)	0.0013 a	0.0034 a
6	F (N 57,5 kg/ha + HA 1,5 g/plant)	0.0025 a	0.0015 a
7	G (N 57,5 kg/ha + HA 3,0 g/plant)	0.0029 a	0.0020 a
8	H (N 57,5 kg/ha + HA 4,5 g/plant)	0.0037 a	0.0027 a
9	I (N 115 kg/ha + HA 0,0 g/plant)	0.0013 a	0.0075 a
10	J (N 115 kg/ha + HA 1,5 g/plant)	0.0006 a	0.0027 a
11	K (N 115 kg/ha + HA 3,0 g/plant)	0.0025 a	0.0015 a
12	L (N 115 kg/ha + HA 4,5 g/plant)	0.0034 a	0.0033 a
13	M (N 172,5 kg/ha + HA 0,0 g/plant)	0.0016 a	0.0033 a
14	N (N 172,5 kg/ha + HA 1,5 g/plant)	0.0042 a	0.0121 a
15	O (N 172,5 kg/ha + HA 3,0 g/plant)	0.0027 a	0.0014 a
16	P (N 172,5 kg/ha + HA 4,5 g/plant)	0.0011 a	0.0030 a

Notes: Numbers with the same lowercase letter in a column are not significantly different according to the Scott-Knott Group test at the 5% level.

Plant Fresh Weight

Application of N fertilizer at a dose of 115 kg/ha (urea 250 kg/ha) and humic acid 3g/plant showed the highest response on plant fresh weight both per plant and per plot. The provision of N fertilizer at a dose of 115 kg/ha showed a significant effect, this is in line with the results of research by Kurniawan et al., (2017) which the increase in fresh weight is always directly proportional to the number and area of leaves on the plant. This indicates that plants can absorb the N nutrients available in the soil optimally so that plants can grow healthily.

N fertilizer is a macronutrient that must be available in sufficient quantities for plants to thrive. In the absorption process carried out by plants, humic acid plays a role in increasing the efficiency of the absorption of nitrogen elements in the soil. This is in accordance with Istiqomah et al., (2017) which humic acid is able to retain nutrients in the soil so that their availability in the soil is maintained.

Humic acid used in conjunction with urea fertilizer can trigger a slowdown in the release of nitrogen nutrients so that plants can absorb nitrogen optimally (Ismillayli et al., 2019).

Table 8. Fresh Weight per Plant and Per Plot of Pakcoy Plants

No.	Treatment	Fresh Weight			
		Plant (g)		Plot (kg)	
1	A (N 0,0 kg/ha + HA 0,0 g/plant)	49,15	a	1,720	a
2	B (N 0,0 kg/ha + HA 1,5 g/plant)	98,37	b	3,487	b
3	C (N 0,0 kg/ha + HA 3,0 g/plant)	85,87	b	3,058	b
4	D (N 0,0 kg/ha + HA 4,5 g/plant)	31,79	a	1,112	a
5	E (N 57,5 kg/ha + HA 0,0 g/plant)	96,33	b	3,372	b
6	F (N 57,5 kg/ha + HA 1,5 g/plant)	45,49	a	1,624	a
7	G (N 57,5 kg/ha + HA 3,0 g/plant)	41,64	a	1,482	a
8	H (N 57,5 kg/ha + HA 4,5 g/plant)	28,78	a	1,007	a
9	I (N 115 kg/ha + HA 0,0 g/plant)	130,96	b	4,642	b
10	J (N 115 kg/ha + HA 1,5 g/plant)	46,80	a	1,673	a
11	K (N 115 kg/ha + HA 3,0 g/plant)	**259,73**	**c**	**9,275**	**c**
12	L (N 115 kg/ha + HA 4,5 g/plant)	68,48	a	2,445	a
13	M (N 172,5 kg/ha + HA 0,0 g/plant)	117,41	b	4,109	b
14	N (N 172,5 kg/ha + HA 1,5 g/plant)	64,27	a	2,249	a
15	O (N 172,5 kg/ha + HA 3,0 g/plant)	**204,84**	**c**	**7,169**	**c**
16	P (N 172,5 kg/ha + HA 4,5 g/plant)	139,77	b	4,945	b

Notes: Numbers with the same lowercase letter in the column indicate that they are not significantly different according to the Scott-Knott cluster test at the 5% level.

CONCLUSIONS

The application of N fertilizer and humic acid with a dose of 115 kg/ha N rate (urea 250 kg/ha) and 3 g/plant humic acid showed good results in the variables of plant height, number of leaves, root volume, leaf area, growth rate, and fresh weight. The application of N fertilizer and humic acid also increased N-total and C-organic in the soil. Therefore, it is recommended to use N fertilizer and humic acid according to the N rate of 115 kg/ha (urea 250 kg/ha) and humic acid 3 g/plant.

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