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Soil Conservation in *Brassica rapa chinensis* L (Pakcoy) Growth

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Abstract: Population increase has an impact on the procurement of food sources. Pakcoy is a vegetable that is in increasing demand. Farmers' response to this condition is to use excessive fertilizer and pesticides, thereby reducing soil fertility. The research aims to obtain a combination of fertilizer and humic acid, which is effective in cultivating *B. rappa chinesis* L., as well as soil conservation efforts. The methodology was experimental with Randomized Block Design (RBD) on four treatments, K, P1, P2, and P3. The dose of K was 150 g/5 m², NPK 16:16:16, 1 kg/5 m² dolomite, and 5 kg/5 m² manure. The P1 treatment is the same as K but without NPK fertilizer. P2 and P3 treatments were reduced by 50% and 70% of NPK fertilizer, respectively, with the addition of humic acid. The research results show that P2 with local environmental conditions provides optimal results in terms of chlorophyll, stomata, and plant height. Soil fertility was shown by increasing pH to 6.6, K 281 ppm and P 509 ppm, Cation Exchange Capacity (CEC) 31.60 $cmol_c$/kg, soil enzymes of 0.12 mg FDA g-1 soil d.w. h-1, an average number of earthworms of 17. The conclusion is that P2 fertilizer formulation can be applied to cultures as an anticipation of food security.

Keywords: Brassica rapa chinensis; Conservation; Pakcoy; Soil

Introduction

Sukanagalih Village, Cianjur Regency, West Java, is one of the villages that supplies vegetables in DKI Jakarta. The horticultural crop commodities produced are grown in Sukanagalih village, namely *Allium fistulosum* (leeks), *Zea mays* (corn), *Solanum lycopersicum* (tomatoes), *B. rapa chinensis* L., *Brassica oleracea* var. Capitata (cabbage), *Cucumis sativus* (cucumber), *Solanum melongena* (eggplant), *Lactuca sativa* (lettuce), *Phaseolus vulgaris* (green beans), *All*ium ascalonicum L (shallot). The demand for several horticultural crops shows an increase, seen from the area for production recorded. Land requirements for *Capsicum annum* (red chilies) are from 6 ha to 34 ha; cayenne pepper is from 17 ha to 49 Ha; and *B. oleracea* var. Capitata from 124 ha to 139 ha.

B. rapa chinensis L. is a type of vegetable that is often grown due to market demand and also has a relatively short lifespan, about 30 days (Zhang et al., 2023). The average land area used for harvesting this crop from 2014 to 2017 was 60,297.25 ha. The 110% increase in demand from 2018 to 2022 increased the area of harvested land to 670,310.75 ha (BPS, 2022). The increase in market demand for *B. rapa chinensis* is due to the favor of the community, ease of processing into food, fast harvest period, and healthy nutritional content. The contents of *B. rapa chinensis* L, are carbohydrate, amino acids, , essential minerals, vitamins A, B9, and K1 and, carotenoids such as violaxanthin, neoxanthin, and glucosinolates. There are necessary for health (Zou et al., 2021). The major bioactive content in components of *B. rapa* L. is flavonoids, phenylpropanoids, isothiocyanates and glucosinolates. The main of flavonoids content as kaempferol, quercetin, , and derivate of isorhamnetin. These substances were observed to play a beneficial role in promoting human health and recommendations for adequate consumption as dietary compounds (Dejanovic et al., 2021). It also contains vitamins C (Domínguez-Perles et al., 2014) and amino acids

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essential, vitamins A, B, C, E, and K1 (Šamec & Salopek-Sondi, 2019). B. rapa leaves also accumulate Calcium (Ca) and Magnesium (Mg), which are essential minerals (Alcock et al., 2021). Dry mass of *B. rapa* L at 100 g, consists of 3.1 g carbohydrate, 1.7 g protein, 0.2 g fat, 0.7 g fiber, 0.8 g ash, 102 mg Calcium, 46 mg phosphorus, 2.6 mg Iron, and energy 86 kJ 2.3 g, beta carotene, 53 mg vitamin C (Fernandez & Agan, 2021).

The increasing need for *B. rapa chinensis* L. is anticipated by farmers with the use of fertilizers and pesticides. The results of observations in the field show that farmers use both manure and inorganic fertilizers in excess of the recommended dose. Chemical fertilizer induce deterioration of healthy soil (Tiwari et al., 2023). The use of pesticides is also excessive because farmers spray before there is a pest attack. Excessive use of fertilizers and pesticides induce negative effect to the environment, including degradation of soil fertility and enhanced greenhouse gas. Chemical synthetic fertilizer application impact is the decreasing of nitrogen-fixing bacteria and also soil biodiversity (Tripathi et al., 2020). Some research has been conducted on the effect of inorganic and organic fertilizers such as Nitrogen, Phosphor and Kalium (NPK) on horticultural crops.

Organic fertilizers derived such as rabbit urine, guano, cow, husk, and charcoal and soil, gave different effects. The highest growth diameter *Portulaca oleracea* L. (Purslane) effect on rabbit urine , and the highest fresh weight there was in guano (Dewanti et al., 2023). Effectiveness in plant height, leaf, number width and the color of spinach showed in liquid organic fertilizer (LOF) formula from peanut and banana peels treatment. The best composition is 50% peanut and banana LOF (Rusdiyana et al., 2022). Combining an application of 20 tons ha^{-1} of manure and 450 kg ha^{-1} of NPK fertilizer is the best treatment for tuber yield of shallot. It is caused by increase f on organic C and soil CEC and interaction between manure, soil and NPK fertilizer (Mulyati et al., 2022)

Vermicompost treatement in long beans showed significantly increased height plant and number of leaves. However, the NPK fertilizer application fertilizer increase stem length, number of leaves, the leaf length and width. But vermicompost and NPK fertilizerbtreatment does not significantly affect all measured long bean growth (Raksun et al., 2019). Application of NPK 12:6:27 was 206.3 g/pot and 207 g/pot compared to 100 g/pot to main nursery palm oil plant for three months on soil medium pH 4.7 show effectivity dry weight 158.20 g/pot (Purnomo et al., 2022). Organic and inorganic fertilizers for agricultural businesses are generally needed in large quantities. NPK needs in the cultivation of *(*cabbage*)* can reach 250 kg/ton of organic fertilizer 10 tons/ha (Purba et al., 2023).

An effort to increase agricultural productivity without causing lasting damage is to implement a sustainable agricultural model and efficient land use along with improving soil fertility. The use of Plant Based Soil Conditioner (PBCS) can reduce the application inorganic such as NPK and organic fertilizers.

One of the PBCS is humic acid, which includes biostimulant substances (Malik et al., 2020). Humic acid comes from the decomposition of plants and animals through aerobic and anaerobic events. This substance is also a mixture of synthesis products of microorganisms. Humic acid is a coal derivative oxidized with H_2O_2 and capable of nitrogen adsorption. Humic acid can be modified according to agricultural needs (Yan et al., 2021). Based on molecular weight and solubility, it is divided into humus, humic acid and fulvic acid. Humic acid is an material organic that is found in soil. This organic material can bind soil water with a capacity of 80 to 90%, stabilize soil structure and soil microbial activity, and maintain neutral pH and physiology of plant. It also affects on nutrient binding and plant root composition, acquisition phosphorus of phytohormone and strengthens plant adaptability to saline conditions. Humic acid also plays a role, similar to auxin. The bacteria that play this role are from the genus Copromyxella. According to theory, it comes from the decomposition of lignin. The loss of methoxyl forms hydroxyphenyl into a low molecular weight substance, and oxidation of the aliphatic chain forms COOH (Gael et al., 2022).

Humic acid dissolves in an alkaline medium and water. It is amphiphilic in micelle form in neutral and acidic conditions. Has the structure of quinones, phenol and carboxyl acid (de Melo et al., 2016). Research on of humic acid productivity of *B. rapa chinensis* L, which at the same time improves soil fertility, is still limited. Therefore, research is needed to find fertilizer and humic acid formulations that are effective on soil production and fertility.

Method

The research was conducted in Sukanagalih village, Pacet subdistrict, Cianjur district, West Java, in the Biology laboratory of the UAI Biology Study Program and the laboratory of the Bogor Soil Research Institute. Before the research, the land to be used was cleaned, and 12 demonstration plots (demplot) measuring 1 m x 5 m were made. Determination of replicate demonstration plots for the control group in the treatments was carried out randomly.

The research method was an experiment with an RBD. The control group was compared with three treatments, each consisting of 3 replications of demonstration plots distributed randomly. Dependent variables included water content in the soil, enzyme activity, soil chemical, earthworm population density, chlorophyll content, plant height, number of leaves, leaf area, number of stomata, and plant fresh weight. The environmental conditions measured were temperature, humidity, light intensity and soil pH (Figure 1). Humidity was measured using a digital Hygrometer (LM-8000), and light intensity was measured using a digital Lux Meter (LX-101A).

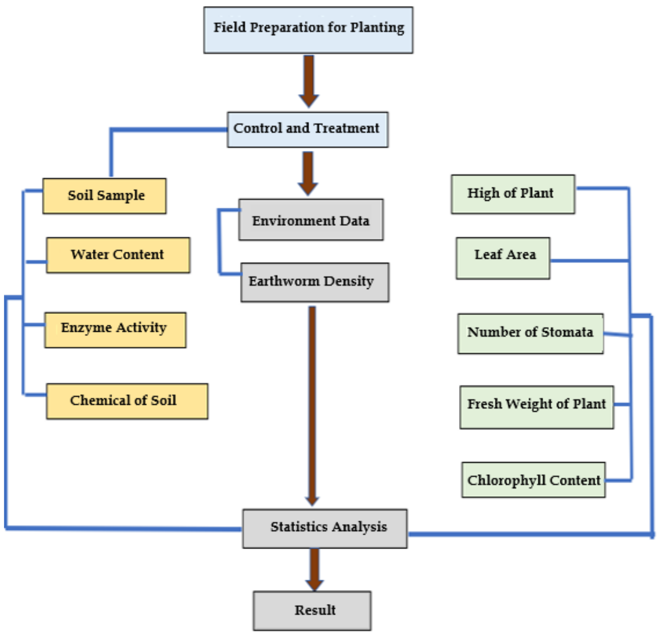

Figure 1. Stages of research

The fertilizer dose in the control group (K) was NPK 16:16:16, 150 gr/plot, 1 kg dolomite/ plot and 5 kg manure/ plot. Treatment dose P1 was humic acid 1 gr/200 ml water/plot, 1 kg dolomite/plot and 5 kg manure/plot, P2 was NPK 16:16:16 as much as 75 gr/ plot, humic acid 1 gr/200 ml water/plot, 1 kg dolomite/plot, 5 kg manure/plot. P3 was NPK 16:16:16 as much as 105 gr/plot, humic acid 1 gr/200 ml water/plot, 1 kg dolomite/plot and 5 kg manure/ plot. Seedling plots were also prepared in different places. The seeds of *B. rapa chinensis* L. were spread evenly on the prepared seedbed media for 1 to 2 weeks. Seedlings that grow are selected to obtain a height of around 10 cm and a number of leaves of 3, and then they are transferred into a hole in the plot. The distance between 1 hole and another is 20 cm. Humic acid was applied on days 0, 10, and 25 after planting; harvesting was done on day 31. Watering was done with sprinkled water in the morning and evening.

Water Content in Soil

Water content was measured using gravimetric and volumetric methods, and soil density using a modified Reynold's gravimetric method. Soil physical measurements were carried out before and after treatment using an analytical balance to determine its wet weight before the soil was dried. Drying was carried out in an oven at 105 °C for 24 hours and cooled. Drying is carried out continuously until the weight obtained is constant. The constant weight at the end is the dry weight of the soil. The obtained weight is used to calculate:

Gravimetric Water Content

$$KAT\ (g/g) = \text{wet weight} - \text{dry weight} \quad (1)$$

Soil Density

$$KT\ (g/cm3) = \text{dry weight}/\text{volume} \quad (2)$$

Volumetric Water Content

$$KAV\ (g/cm^3) = \text{ground water content}\ (g/g)\ x\ \text{soil density}\ (g/cm^3) \quad (3)$$

Enzyme Activity

Test enzyme activity using the method (Adam & Duncan, 2001), which has been modified; this test uses several solutions, namely Solution A, Solution B, Fluorescein Diacetate (FDA) solution, Buffer, and Mother Solution. Solution A is $NaH_2PO_4.H_2O$ 0.827 g dissolved in 100 ml of homogenized distilled water. Solution B is 4.26 g Na_2HPO_4 dissolved in 500 ml distilled water and homogenized. Buffer solution: solution A 65 ml and solution B 435 ml with pH 7.6. Increasing the pH can be done by adding solution B. Decreasing the pH can be done by adding solution A. FDA solution is 30.25 mg FDA, which is dissolved in 50 ml of acetone and homogenized. The mother solution is a 12.5 ml FDA solution mixed homogeneously with a 237.5 ml buffer. Next, 0.30 g of the sieved soil sample was put into a vial with six repetitions for each treatment and six samples as standards. The samples in each treatment were added with 6 ml of buffer and 1 ml of FDA solution, except for the blank, which only had 6 ml of buffer added. The following are the quantities added to make a standard solution (Table 1).

Table 1. The Volume of the Mother Solution and Buffer

Label	Mother Solution (ml)	Buffer (ml)
Blanco	0.0	6.1
Standard 1	0.5	5.6
Standard 2	1.0	5.1
Standard 3	2.0	4.1
Standard 4	3.0	3.1
Standard 5	4.0	2.1
Standard 6	5.0	1.1

The vial, which has been filled with the mother solution/sample, is closed and incubated for 30 minutes at a temperature of 27.5 ^{o}C on a water bath shaker at a speed of 200 rpm. 6 ml of acetone was added to each sample bottle and blank and homogenized. The supernatant obtained was filtered using Whatman 42 filter paper using a funnel with a test tube container. The absorbance value obtained was measured using a spectrophotometer at a wavelength of 490 nm.

Population Density of Earthworm

Calculation of earthworm population density refers to research conducted by Kalu et al. (2015). Earthworms were obtained from a 25 cm x 25 cm quadrant area and dug to a soil layer depth of 0-30 cm. In the holes that have been dug, the earthworm population is counted using the hand-counting method (hand-sorting). Soil worm population density (WPD) can be calculated using the Formula 4.

$$WPD = \text{Number of earthworms/ sample area} \quad (4)$$

Chlorophyll Determination

Analysis of chlorophyll content refers to research conducted by Yama et al. (2020). From each plot, two freshly harvested *B. rapa chinensis* L leaves were randomly taken. Each leaf is covered with newspaper so that it is always moist when stored in the field. Next, the leaves were cut and weighed with an analytical balance of 1 gram each, and extraction was carried out. Next, the leaves were crushed using a mortar and pestle mixed with 20 ml of ethanol. The fine leaves are filtered using a glass funnel in a measuring flask using Whattman filter paper 42. The filtered filtrate is a chlorophyll extract. The chlorophyll extract was transferred to a cuvette, and then the chlorophyll absorbance was measured using a spectrophotometer at λ 645 nm and 663 nm. Calculation of chlorophyll content (mg/L) is determined using calculations with the Formula 5.

$$\text{Chlorophyll a} = 12.7\ A\ 663 - 2.69\ A\ 645$$
$$\text{Chlorophyll b} = 22.9\ A\ 645 - 4.68\ A\ 663$$
$$\text{Total Chlorophyll} = 20.2\ A\ 645 + 8.02\ A\ 663 \quad (5)$$

Soil Chemical

Soil chemical measurements were carried out by measuring 1 kg from 3 soil sample points before and after treatment. Samples come from treatments that provide the highest results from the variables measured. The samples were put in plastic and stored in a cool box containing ice cubes, with a temperature of around 4 C; then, the next day, the soil samples were tested at the Soil Research Institute Laboratory, Jl. Student Army No. 12, Agricultural Research Campus, Cimanggu, Bogor. The parameters measured were CEC, P_2O_5 Olsen, K_2O Morgan, pH H_2O and pH KCl.

Plant Height

The height of *B. rapa chinensis* L was measured from the base of the stem to the growing point using a ruler. Plant height measurements were conducted at harvest time, namely day 1 after the planting period.

Number of Leaves

Observation of the number of leaves of the *B. rapa chinensis* L plant was carried out by randomly counting the leaves on each demonstration plot. The number of plants per demonstration plot is 10. Counting is done at harvest

Leaf Area

Measuring the leaf area of *B. rapa chinensis* L was carried out using the compu eye application by tracing the largest leaf of one plant on newspaper or HVS paper. The scanned tracing results were colored green using Adobe Photoshop software and then entered into the Compu eye application.

Number of Stomata

B. rapa chinensis L. leaves that have been picked are smeared with clear nail coloring on the upper and lower surfaces of the leaves. The surface of the leaves that have been smeared with polish is covered with clear sellotape and waited until dry. Once dry, the tape is peeled and placed on an object glass that has been labeled. Observations were made on two plant samples per planting plot by counting the number of stomata covering an area of one field of view under a binocular microscope at 40x magnification.

Fresh Weight

The fresh weight of *B. rapa chinensis* L was determined by weighing all parts of the plant, including the roots. Weighing was carried out on the 31st day for all plants according to the control and treatment groups.

Data Processing

The data obtained from the research results were then analyzed statistically. Analysis used Analysis of Variance.

Result and Discussion

The productivity of *B. rapa chinensis* L, which is indicated by fresh weight at harvest, number of leaves, nutritional content, and secondary metabolisms such as flavonoids, hydroxycinnamic acids, carotenoids, and chlorophylls, is influenced by abiotic factors such as light intensity and temperature (Neugart et al., 2018), (Heinze et al., 2018). Environmental conditions at the research location show a soil average pH of 7, sunlight intensity of 761.13 Lux, humidity of 42.75% and temperature of 32.31°C (Table 2).

Research on sunlight in Helsinki, Finland, and Gual, India, recorded 400,000 photon spectra, to which plant photoreceptors responded to red, infrared, blue, green, and ultraviolet light (Kotilainen et al., 2020). Red and blue light is the important light which absorbed by plants in photosynthesis (Nurunisa et al., 2018).

Research showed that the intensity of red-blue LED light at 3000 Lux provides an optimal effect on the growth of *B. rapa chinensis* L with an indication of the fresh weight of the plant without it being 9.05 g/individual (Setiawan et al., 2022). The results of research on the average fresh weight of *B. rapa chinensis* L for treatments, including control with an average sunlight intensity of 761.13 Lux, was 11.05 kg or 88.40 g/individual *B. rapa chinensis* L (Figure 2).

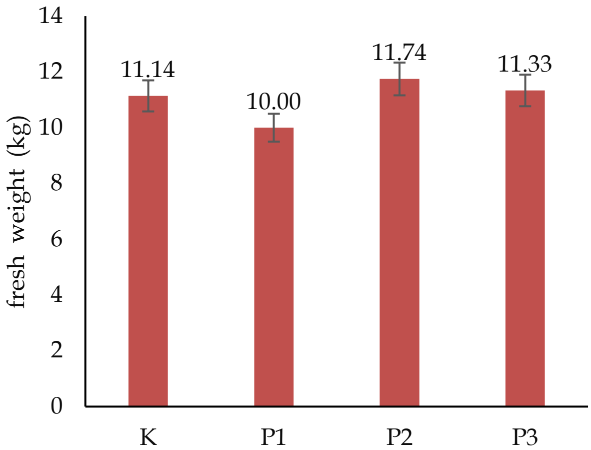

Figure 2. Fresh weight

There was no significant difference in the fresh weight of *B. rapa chinensis* L between the control and treatment groups (P≥0.05). The optimal temperature for the growth of *B. rapa chinensis* L is 21 to 30 C with LED 13. 500 μmol m−2 s−1 without infrared, increasing the temperature increases 22% of the fresh weight, which is 26 grams (Kong et al., 2023).

Table 2. Environment Conditions

Treatment	Parameter			
	pH	Sunlight intensity (Lux)	Humidity (%RH)	Temperature (°C)
K	7	788.25	43.00	31.50
P1	7	832.00	40.75	33.25
P2	7	752.75	44.25	31.75
P3	7	671.5	43.00	33.75

Thus, the intensity of sunlight is more effective than the red-blue LED light intensity of 3000 Lux and 13. 500 μmol m−2 s−1. It also shows that light intensity affects the fresh weight of *B. rapa chinensis* L (Cruz et al., 2022). Based on data results, *B. rapa chinensis* L can still adapt to a humidity average of 42.75%. Humidity suitable for the growth of *B. rapa chinensis* L is 55%, 75%, and 95%. This plant is very sensitive to humidity, especially affecting the root system (Lind et al., 2016).

The results on chlorophyll showed that the highest content was significantly (P≤0.05) in P2 42.75 mg/g (Figure 3). The high chlorophyll content in P2 was caused by the optimal availability of 50% dose NPK 16:16:16 as much as 75 gr/plot, equivalent to 3 kg/ha. The combination of manure and humic acid provides nutrients and increases the absorption of nutrients, especially nitrogen, which plays an important role in chlorophyll synthesis (Ariyanti et al., 2019). A combination of humic acid and NPK 15:15:15 dose increases 65%-82% chlorophyll content and 28% - 71% sugar in *Capsicum annuum* L, increased soil fertility by indicated of pH soil improving as well as N, P and K. The combination of 25% humic acid and 75% NPK fertilizer is the best growth and yield. Therefore, for the sustainability of chili cultivation. Humic acid 5 kg ha-1 needs to be combined by 700 kg ha-1 NPK fertilizer (Ichwan et al., 2022).

Data shows *B. rapa chinensis* L was successfully cultivated in andosol soil with a pH of 7 in both control and treatment. This plant has a 90-gram compost/soil polybag. The resulting fresh weight was 102.50 g (Liana et al., 2023)

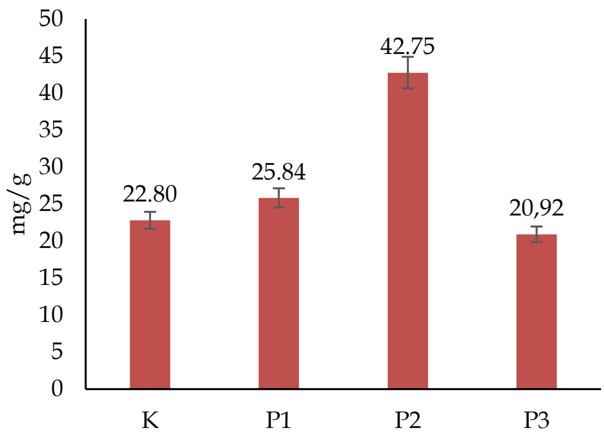

Figure 3. Chlorophyll content

The water content after treatment showed a decrease because the conditions during sampling before the treatment experienced rain were different from those after the treatment. There was no significant difference (P≥0.05) between the control and treatment groups both before and after treatment (Table 3).

Table 3. Soil Physical

Variable	Treatment	Before	After
Water content Gravimetry *(g/g)*	K	161	76.00
	P1	151	80.0
	P2	166	79.13
	P3	150	81.43
Water content Volumetric *(g/g)*	K	144.32	54.91
	P1	124.36	60.76
	P2	138.29	64.75
	P3	113.08	54.40
Soil compaction *(g/cm³)*	K	0.90	0.71
	P1	0.80	0.76
	P2	0.80	0.81
	P3	0.75	0.65

The rain in the research area is evenly distributed. Soil density after treatment showed a decrease. Based on the results of soil density analysis, there were no significant differences between the control and treatment groups ($P \geq 0.05$). The decrease in soil density after treatment was compared to the time before the soil was processed, whereas a month later, the soil experienced a compaction process. Reducing water content and compaction still supported the growth of *B. rapa chinensis* L in both the control and treatment groups.

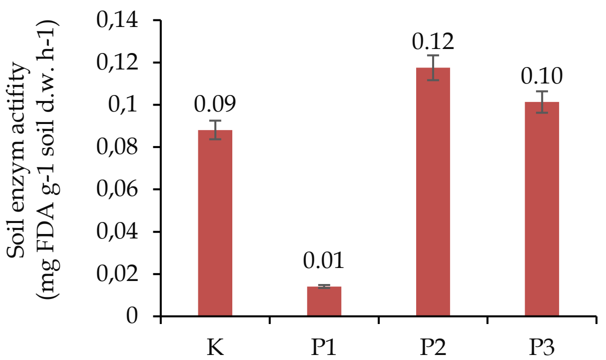

Figure 4. Soil enzyme activity

Soil enzyme activity showed that there was a significant difference ($P \leq 0.05$) between K and P1. P2 and P3. Based on the average enzyme activity obtained, the treatment with the highest enzyme activity value is P2, and the lowest is P1. These results indicate that to increase soil enzyme activity, NPK is needed in addition to dolomite and manure (Sofatin et al., 2016). Soil enzyme activity is an indicator of the presence of soil microbes and function (Wang et al., 2023).

P2 showed the highest soil enzyme activity significantly. The same thing was also shown by the highest yield significantly ($P \leq 0.05$) found in P2. Chemical soil for P2 shows an increase in pH, P_2O_5, and K_2O, as well as Cation Exchange Capacity (CEC) (shown in Table 4). Humic acid can strengthen the ability of soil to provide plant nutrients and plant ability to bind CO_2 in the photosynthesis process (Tiwari et al., 2023).

Increasing the dose of humic acid application can significantly increase the content of macroelements and microelements in the soil except for P and Mg. The doses used are 1 st 0 ppm m^{-2}, the 2nd dose: 60 ppm m^{-2}, the 3rd dose: 120 ppm $m^{-2}$and the4th dose: 150 ppm m^{-2}. Based on research results, the total N content of the plant for four doses samples was determined at 5.43 %, 5.58 %, 5.69 %, and 5.73 %. Phosphor contents were detected 0.40 %, 0.42 %, 0.41 %, 0.41 %); Kalium were 5.49 %, 5.73 %, 5.83 %, 6.01 %, Calcium were 1.85 %, 1.91 %, 2.06 %, 2.29 %, Magnesium were 0.12 %, 0.13 %, 0.13 %, 0.14 %, and Sulphur were 3.39 %, 4.65 %, 4.83 %, 4.84 % and several microelements contents were founded as Ferum 96, 110, 112, 120 mg kg^{-1}, Cuprum (5, 8, 18, 24 mg kg^{-1}, Mangan 12, 16, 22, 94 mg kg^{-1} and Zinc 32,34, 36, 37 mg kg^{-1}) (Adiloglu et al., 2018).

The increase in soil chemistry at P2 was also accompanied by earthworm density (Figure 2). A significant increase in earthworm density after treatment on day 31 ($P \leq 0.05$) occurred in P2, namely from 69 to 170 individuals. The increase in worm density on day 31 of P2 was due to the optimal availability of manure, humic acid and NPK. Humic acid combined with NPK effectively alters colony structure and soil microbial activity, enzymes, and soil fertility.

Table 4. Chemical Soil

Variable	Before treatment	After treatment
pH		
H_2O (1:5)	6.2	6.6
KCl (1:5)	5.7	6.3
P (ppm P_2O_5) (Olsen)	325	509
K (ppm K_2O) (Morgan)	256	281
CEC ($cmol_c$/kg)	30.53	31.60

The decrease in worm density in the control group after day 31, namely from 83 to 53, was due to a lack of availability of organic material. In contrast, in P1, the decrease occurred due to control, and an increase did not follow P1 in worm abundance because it was not combined with humic acid, while in P3, due to high NPK levels of 70%. Inappropriate application of inorganic fertilizer will reduce soil quality, which can affect the presence of earthworms (Yulia et al., 2022).

The results of height measurements showed that *B. rapa chinensis* L was significantly highest ($P < 0.05$) in P3 and P2 compared to K 22.83 cm and P1 23.04. In comparison, between P2 and P3, it was 23.88 cm and 24.42 cm. There were no significant differences (Figure 6). These results show the significant role of the combination of humic acid and fertilizer in determining the effect on the increase in height of *B. rapa chinensis* L.

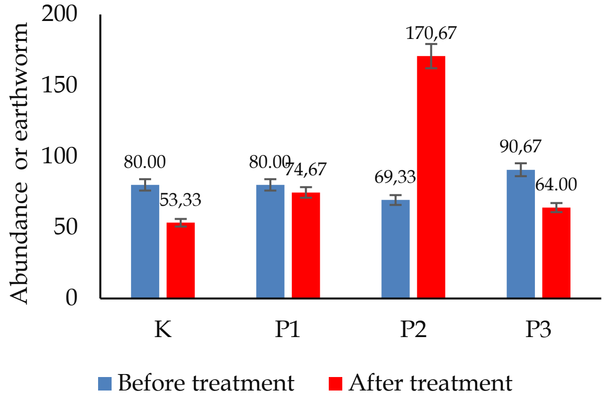

Figure 5. Density of earthworm

Reducing NPK fertilizer in P2 and P3 by 30-50% combined with manure and humic acid encouraged a faster height increase compared to control and P1. N is a building block for proteins and nucleic acids. P plays a role in carbohydrate metabolism, is a constituent of ADP and ATP, and plays a role in plant cell division. Element K can stimulate meristem growth (Fiolita et al., 2017). Application NPK 2, 4 and 6 gr/plant in *Zea mays* saccharate Sturt does not affect plant height and number of leaves (Waworuntu et al., 2023).

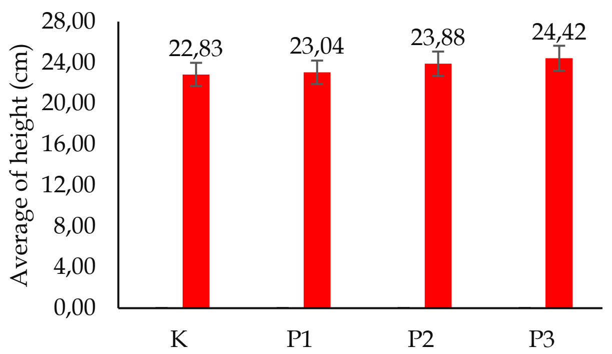

Figure 6. Height of *B. rapa chinensis* L

Nitrogen (N) and carbon (C) in humic acid increase the KTK value (Pranata & Simanjuntak, 2020). The N element obtained from humic acid also plays a role in the cell elongation process so that it can accelerate plant height growth (Pramitasari et al., 2016).

The direct impact of giving humic acid to plants is that it improves plant metabolic processes because humic acid contains amino acids and auxin (Faizal Anam et al., 2022). Auxin is a growth hormone substance that can be found at the tips of roots, stems, and flower formations, which plays a role in regulating cell enlargement and triggering cell elongation in the tip meristem area (Andianingsih et al., 2021).

The average number of stomata on P2 was significantly highest ($P < 0.05$), namely 29, compared to K, P1, P3, and P4, respectively 22.23 and 24 (Figure 7).

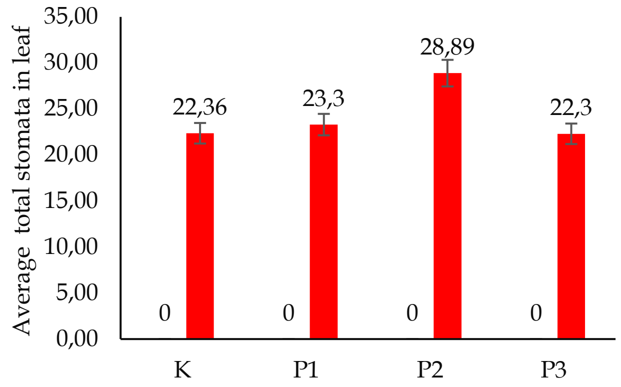

Figure 7. Average total stomata

Humic acid given at P2 increases the utilization of NPK, which functions to stimulate the process of opening and closing stomata by increasing cell turgor activity. Element K also plays a role in stimulating the translocation of assimilate from the source (leaves) to the storage organ (sink). Increasing the number of stomata is related directly proportional to the CO_2 that can be fixed. Based on differences in carbon dioxide fixation, *B rapa chinensis* L plants are included in C3 plants (Perkasa et al., 2017).

The number of leaves in groups K, P1, P2, P3, and P4 did not show significant differences ($P \geq 0.05$). The following is a picture of the number and area of leaves (Figure 8). The application of liquid organic fertilizer derived from composting tea plants also showed no difference in the leaves number of sweet corn (Pane et al., 2023).

The average number of leaves in groups K, P1, P2, P3, and P4 were 18, 17, 18, and 18, respectively. The number of leaves was stimulated by the availability of the Nitrogen , Phosphor , and Kalium. Thus, in groups that did not give NPK (P1), the availability of NPK is related to the existence of humic acid, which is able to increase the KTK of the land.

The average leaf area in groups K, P1, P2 and P3 was 144.89 cm^2, 139.30 cm^2, 147, 51 cm^2 and 142.07 cm^2. There were no significant differences ($P \geq 0.05$) in these groups (Figure 9). Thus, the existence of humic acid without the addition of NPK still supports the need for NPK to influence leaf area. Humic acid can increase KTK and bind Nitrogen and Phosphor , which affect leaf formation so that they are not leached (Radite & Simanjuntak, 2020).

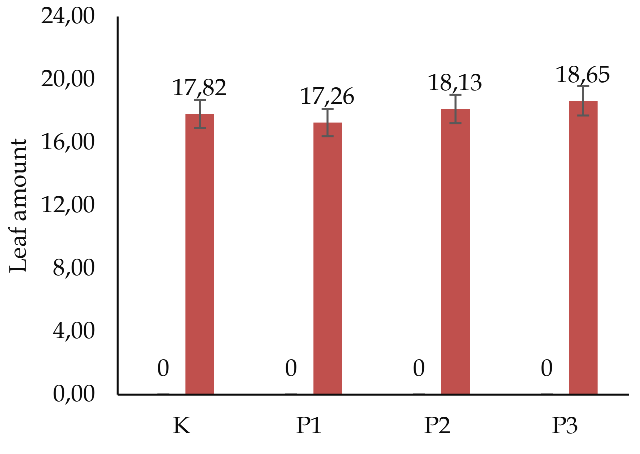

Figure 8. Average leaf amount

Data on *Zea mays* plants indicated that the treatment of organic fertilizer from horse manure of 12 tons/ha, 18 tons/ha and 24 tons/ha, respectively, combined with NPK 40 kg/ha, 80 kg/ha and 120 kg/ha, did not have an impact on growth on leaf length, height, number of leaves, stem diameter on day 15, 30 and 45. Will is still single, having a significant impact on growth (Raksun et al., 2021).

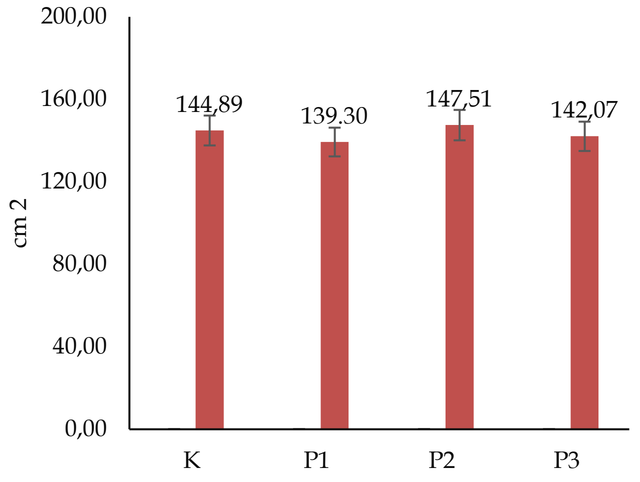

Figure 9. The average leaf area

Research on green eggplant with factorial design also shows that the combination of organic fertilizer 0.5 kg/m², 1 kg/m², 1.5 kg/m², NPK 5 g/plant, 10 g/plant, 15 g / plant, 20 g / plant and organic fertilizer and does not affect growth (Raksun et al., 2019). This data shows the effectiveness and efficiency of humic acid and NPK applications.

Conclusion

Combination Fertilizer and humic acid formulations are NPK 16:16:16 as much as 75 gr/5 m², humic acid 1 gr/200 ml water/5 m², 1 kg dolomite/5 m² and 5 kg manure/5 m². can be applied to meet the needs of *B. rappa chinensis* L in anticipation of food security. Optimal results are found in chlorophyll content plants, heights of plants, and numbers of stomata. Improvements in soil fertility were shown by increasing pH to 6.6, KTK 31.60 cmolc/kg, K 281 ppm K_2O and P 209 ppm P_2O_5, an average number of worms of 171 and soil enzymes of 0.12 mg FDA g-1 soil d.w. h-1).

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Nita Noriko's contribution in idea, conceptualization and writing; Rachmad Agustono as fertilized expert and methodology; Risa Swandari Wijihastuti and Arief Pambudi for data analysis and validation; Elya Novani and Nadya Isna Choirunnisa collecting data

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Conflicts of Interest
The results of this research are objective, and there is no conflict of interest with various parties.

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