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Application of Weed Compost Product (WCP) to Improve Quality Ultisol and Increase for NPK Efficiency in Cultivation of Soybean (*Glycine max* L) in North Sumatra

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ABSTRACT

An experiment aimed at studying the effect of weed compost products (WCP) produced from several weed plants and NPK fertilizer on the growth and yield of soybean plants on Ultisol soil was carried out. The experiment used a factorial Randomized Block Design (RBD) with two factors, namely the application of WCP and NPK fertilizer. The WCP treatment consisted of 4 levels, namely 0, 25, 50 and 75 g/polybag) and the NPK fertilizer treatment consisted of 4 levels, namely: 0, 1.25, 2.50, and 3.75 g/polybag, resulting in 16 treatment combinations. Each treatment was replicated three times so there were 48 experimental units. Variables observed included: height of plants aged 2 – 5 weeks, number of branches, number of pods, weight of pods and weight of 100 seeds.Results obtained showed that the WCP application had a significant effect on increasing growth (height of plants aged 5 weeks) and yield (number of pods, weight of pods, and weight of 100 grains). Application of NPK fertilizer also had a significant effect on increasing growth (5 week old plant height and number of branches) and yield (number of pods, pod weight and 100 seed weight). The WCP x NPK interaction had a real positive effect as shown by the addition of WCP increasing the effect of NPK based on the number and weight of pods. Based on the equation obtained $\hat{Y} = 233.60 + 2.46X - 0.034X^2$, the relationship between pod weight with WCP and NPK, it was found that X_{max} (WCP_{max}) was 36.22 g/polybag and Y_{max} (NPK_{max}) was 278.21 g/polybag . The WCP containing N, P, K and other elements can play a role in adding, increasing the effect, and reducing the amount of NPK fertilizer used from 3.75 to 2.39-2.75 g/polybag so that it can save the use of NPK fertilizer by around 1.25-1.36 g/polybag (33.33-36.27%). This phenomenon also confirms that WCP can improve the quality of Ultisol soil and save on the use of NPK fertilizer in soybean cultivation, so it has the potential to be an alternative technology.

INTRODUCTION

Ultisol soil is the largest type of soil reaching 103 348 000 ha spread across various islands in Indonesia [18]. This land is widely used as an area for cultivating food, including soybeans. Ultisols are old soils and develop from acidic parent materials, such as liparite, so genetically these soils are poor soils because minerals containing nutrients, such as K, Mg, Ca, are generally low [2]. In addition, soil in this tropical region generally experiences advanced weathering and very intensive leaching due to the influence of high temperature and rainfall so that it has relatively poor chemical-physical properties which are always characterized by pH (4.1-5.5), NPK nutrient content, soil organic matter is relatively low, and relatively high exchangeable Al has the potential to lower pH and be toxic to plants [3, 4]. This condition has always been an obstacle in the cultivation of food crops, especially soybeans. To overcome plant nutrient needs, especially N, P and K, farmers must add NPK fertilizer, either in single or mixed form. Problems related to NPK fertilizer, farmers always face problems, including: the price of fertilizer is expensive and it is always difficult to obtain in the market so that food farming cultivation is less profitable for farmers. For this reason, it is necessary to look for alternative technology that can help save, be effective and efficient in the use of NPK fertilizer. Weeds are considered unwanted plants but many grow in or around agricultural areas. This plant is seen as a problem because it is a competitor to the main crops in food cultivation so it needs to be controlled. However, weeds are also plants that absorb CO_2 (C capture) from the air and a number of elements from the soil. So weeds can act as C-storage, a source of soil organic matter and a contributor to a number of nutrients needed by plants. The potential of these weeds, if processed into weed compost product, can be an alternative technology to be used to improve the quality of agricultural cultivation soil. As an alternative agricultural technology, the potential of weed compost product is believed to have advantages in improving soil quality through its role, including: (1) as a source of soil organic matter which can play a role in increasing soil water holding capacity, cation exchange capacity, soil structure and aeration [5] , (2) as a source of N, P and K, and other elements that can possibly add nutrients and replace some NPK fertilizers, thereby potentially reducing the use of NPK fertilizers. (3) as an energy source to encourage soil biological activity which can increase soil fertility, (4) weeds as raw materials are available in sufficient quantities naturally on the site or around agricultural land, (5) their use without causing side risks to soil and water bodies, and (6) management and use of weeds without burning can contribute to controlling CO_2 as a contributor to greenhouse gases (GHG) through the mechanism of C-capture by weed plants and C-storage in the soil so that it can be an alternative effort to control the effects of climate change on land, air, water and aesthetics and environmental impacts. Several research results prove that organic fertilizer can increase crop yields for up to two growing seasons [7] and the provision of weed compost as much as 30 tonnes/ha has the effect of increasing plant growth and yield [6].

Therefore, even though weeds are considered as unwanted plants, if they are processed into compost product, it was estimated that they can become a useful and environmentally friendly alternative technology. Apart from improving the quality of Ultisol soil, adding nutrients, reducing the amount of NPK fertilizer, WCP can also play a role in making the effect more effective and efficient and saving on the use of NPK fertilizer.

Based on the description above, the aim of the research was to study the application of weed compost product (WCP) and its effect in improving the quality of *Ultisol* soil and the efficiency of using NPK in soybean cultivation.

EXPERIMENTAL

This experiment was carried out at the Experimental Garden of the Faculty of Agriculture, Islamic University of North Sumatra. The experimental location is located at an altitude of ± 44 m above sea level (masl), with flat topography.

The materials used consist of: Dega1 variety soybean seeds, Weed Compost Product (WCP) produced from several types of weeds (*Asytasiaintrusa*, *Imperata cylindrica*, and *Mikania micrata*), 46% Urea fertilizer, 46% TSP, 60% KCl; dolomite, manure; Ultisol soil was collected to a depth of 0-30 cm in Tanjung Morawa Village. Several chemical properties of WCP and several physico-chemical properties of Ultisol soil were analyzed in the laboratory.

The experiment used a factorial Randomized Block Design (RBD). The factors tested consisted of two factors, namely weed compost product (WCP) and NPK fertilizer. The WCP doses tested consisted of: 0, 25, 50, and 75 g/polybag, while the NPK consisted of 4 doses: 0, 1.25 (mixed from: 0.75Urea + 0.25 TSP +0, 25 KCl) g/polybag, 2.50 ((mixed from:1.5Urea + 0.5 TSP +0.5

KCl) g/polybag, and 3.75 (mixed from:2.25Urea + 0.75 TSP +0.75 KCl) g/polybag. Each treatment was replicated 3 times so that there were 48 (4 x 4 x 3) experimental unit.

1.Weed Composting Techniques

Weed Compost Product (WCP) was produced from weed materials consisting of *Mikania micrantha* (sembung vines), *Imperata cylindrical* (weeds), and *Asystasia intrusa species*. The three types of weeds were collected from agricultural areas in the experimental environment. The consideration for choosing this weed was because it grows a lot and is easy to find in various agricultural lands in general.

The manufacture of WCP has been carried out using the following procedure: A box-shaped container made from boards measuring 1.5 x 1.5 x 1.5 m was prepared first. The weed grass was cut into pieces about 1 cm in size. The weed pieces were placed in the container as the first layer. In the next layer, manure (cow dung), topsoil and dolomite were added sequentially. The compost material in the box was watered with water mixed with EM_4 (effective microbial) to regulate humidity, adding biodecomposer starter to speed up the decomposition process. After that, the composting container was covered with plastic. The composting process was monitored by measuring the temperature using a thermometer. Temperature measurements are carried out every 2 days. The way to maintain the composting temperature was conducted by turning the compost. The compost turning process was carried out every 3 days until the process is complete and the compost product is mature. The maturity of the compost product was characterized by the color of the compost being brownish black, the volume shrinking by 50%, and the C/N of the compost product being around 20. The resulting compost product was analyzed for N (Kjaldahl), total P (Spectrophotometer), K (AAS) and C-organic content (Walkley and Black), pH (pH meter), and C/N (by calculation). This product is named Weed Compost Product (WCP) that will be tested for its effects.

2.WCP and NPK Treatment

A total of 10 kg of Ultisol soil was filled into polybags as a plant medium. WCP and NPK fertilizer were added to each polybag according to the designed treatment as shown in Table 1. WCP was given by mixing the WCP material with soil in a polybag according to the treatment.

The NPK treatment was given in 2 stages, namely 2/3 of the treatment dose when the plants were 4 days old and 1/3 of the treatment dose when the plants were 30 days old. NPK fertilizer was applicated by sowing it on the surface and covering it with soil in each treatment polybag. In each polybag, 2 soybean seeds were planted 3-4 cm deep and covered with soil. Variables in plant growth and yield that were observed included: height of plants aged 2 – 5 weeks, number of branches, number of pods, weight of pods and weight of 100 grains. The collected data were analyzed according to statistical procedures published. [13]

Table 1. Application of WCP and NPK Fertilizer Treatment

Treatment Number	Treatment Symbol	WCP (g/polybag)	NPK Fertilizer Treatments (g/polybag)					
			2/3 dose at 4 days of plant age			1/3 dose at 30 days of plant age		
			Urea	TSP	KCl	Urea	TSP	KCl
1	K_0A_0	0	0	0	0	0	0	0
2	K_1A_0	25	0	0	0	0	0	0
3	K_2A_0	50	0	0	0	0	0	0
4	K_3A_0	75	0	0	0	0	0	0
5	K_0A_1	0	0,5	0,166	0,166	0,25	0,083	0,083
6	K_1A_1	25	0,5	0,166	0,166	0,25	0,083	0,083
7	K_2A_1	50	0,5	0,166	0,166	0,25	0,083	0,083
8	K_3A_1	75	0,5	0,166	0,166	0,25	0,083	0,083
9	K_0A_2	0	1	0,333	0,333	0,5	0,166	0,166
10	K_1A_2	25	1	0,333	0,333	0,5	0,166	0,166
11	K_2A_2	50	1	0,333	0,333	0,5	0,166	0,166
12	K_3A_2	75	1	0,333	0,333	0,5	0,166	0,166
13	K_0A_3	0	1,5	0,5	0,5	0,75	0,25	0,25
14	K_1A_3	25	1,5	0,5	0,5	0,75	0,25	0,25
15	K_2A_3	50	1,5	0,5	0,5	0,75	0,25	0,25
16	K_3A_3	75	1,5	0,5	0,5	0,75	0,25	0,25

K= WCP dosage *A= NPK dosage*RESULTS AND DISCUSSION

1. Chemical Characteristics of Weed Compost (WCP) and Ultisol Soil

The results of WCP analysis are presented in Table 2 and soil analysis in Table 3. Table 2 showed that WCP contains 13.12% organic C and 0.73% total N and a C/N ratio of 19.97.

Table 2. Weed Compost (WCP) Analysis Results

No.	WCP Properties	Value	Method
1.	Organic-C (%)	13.12	Gravimetric
2.	Total-N (%)	0.73	Kjeldahl
3.	C/N rasio	19.97	Calculation
4	P_2O_5 (%)	0,31	Spectrophotometry
5	K_2O (%)	0,24	AAS

The C/N WCP ratio value indicates that the WCP produced has reached maturity based on the criteria where the C/N ratio value for organic materials was around 10-20 and can release available nutrients through the mineralization process [1]. This situation allows WCP to be able to release the nutrients contained in it into a form available to plants.

Table 3. Results of Analysis of Several Physical And Chemical Properties of *Ultisol*

No.	Soil Properties	Value	Criteria	Method
1.	Texture Sand (%) Dust (%) Clay (%)	 56,98 6,45 36,57	Sandy Clay	Hydrometer
2.	Organic-C (%)	0,25	Low	Walkley & Black
3.	Total-N(%)	0,04	Low	Kjeldahl
4.	Available P (ppm)	3,20	Low	Bray I/Spectrophotometry
5.	Total- P (me/100g)	7,44	Low	Spectrofotometry
6.	Exchangeable-K (me/100g)	0,76	-	AAS
7.	pH_{H2O} 10:1	5,93	Medium	Elektrometry
8.	Cu (ppm)	0,3		AAS
9	Mn (ppm)	46		AAS

Table 3 showed that the results of the *Ultisol* soil analysis which has the following properties: contains organic C, total N, available P, exchangeable K was relatively low. The soil pH (5.93) is moderate and the soil texture is sandy clay. Low organic C (0.25%) and dominant in sand content (56.98%) have consequences for low soil physico-chemical quality such as soil water holding capacity, structure, aeration and soil CEC. This condition has a negative impact on plant growth. Therefore, the addition of organic matter in the form of weed compost product (WCP) is very important to improve the quality, both physics and chemistry of the soil in supporting agricultural cultivation in general, and soybeans in particular.

2. Recapitulation of The Results of The Variance Analysis

A recapitulation of the results of the variance analysis of the application of WCP, NPK and their interactions in Ultisol soil on the growth and yield of soybeans is presented in Table 4.

Table 4. Recapitulation of Results of Variance Analysis of The Effects of WCP, NPK and Their Interactions on The Growth and Yield of Soybeans on Ultisol Soil.

No.	Variables	WCP	NPK	WCP x NPK Interaction
1	Plant height 2 weeks	ns	*	ns
2	Plant height 3 weeks	ns	*	ns
3	Plant height 4 weeks	ns	*	ns
4	Plant height 5 weeks	*	*	ns
6	Number of Branches 4 weeks	ns	*	ns
7	Number of Branches 5 weeks	ns	*	ns
8	Number of Pods	*	*	*
10	Pod Weight	*	*	*
11	Weight of 100 grains	*	*	ns

ns = no significant effect. ** = significant effect*

Table 4 shows that WCP application has a significant effect as shown by differences in height of 5 week old plants, number of pods, pod weight and weight of 100 grains. However, there was no significant difference in the height of 2-4 week old plants and the number of branches. NPK application had a significant effect on all variables and was faster than the effect of WCP as shown by the difference in plant height from 2 to 5 weeks (Figure 1). The WCP x NPK interaction had a significant effect as shown by differences in the number and weight of plant pods.

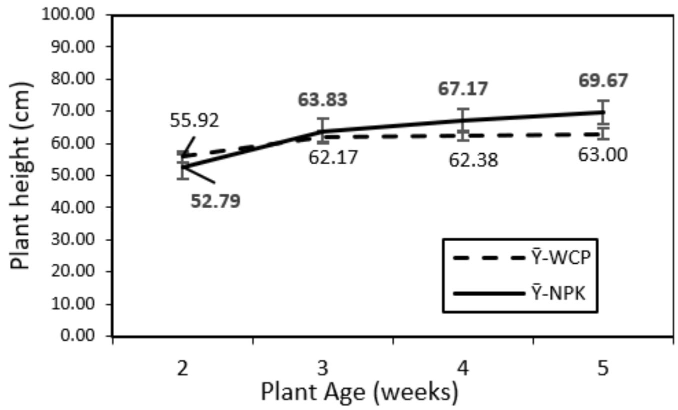

Figure 1. Effect of WCP and NPK on the Growth Rate of Soybean Plant Height at 2-5 Weeks.

Figure 1 showed that WCP has no effect at 2-4 weeks of age, but begins to have an effect at 5 weeks of age; while NPK has an effect from 2 to 5 weeks of age. So WCP has a slower effect compared to NPK. This phenomenon can occur in connection with the provision of nutrients. In this case, WCP in organic form was relatively slow in providing nutrients so that it has a slow effect; Meanwhile, NPK is in inorganic form which can dissolve relatively quickly so that it quickly provides nutrients for plants.

3. Effect of WCP on Soybean Growth and Yield

The effect of WCP on soybean growth and yield was presented in Table 5. Table 5 showed that application of WCP significantly increases plant growth and yield as shown by an increase in plant height at 5 weeks of age, number of pods, weight of pods and weight of 100 grains.

Table 5. Effect of WCP on Plant Growth and Yield of Soybeans

WCP dosage (g/polybag)	Plant height 5 weeks (cm)	Branch/plant	Number of Pods/Plant	Pod Weight (g/polybag)	Weight of 100 grains (g/polybag)
0	52,79c	5,29	33.88b	67,75b	23,13b
25	63,83ab	5,71	39,75a	79,60a	25,54a
50	67,17a	5,58	42,46a	85,17a	25,63a
75	59,67b	5,75	42,79a	85,75a	25,79a

Numbers in columns followed by the same letter are not significantly different at the P= 5% level based on the DMRT test.

Based on plant growth and yield (Table 5), it also confirms that WCP can improve the quality of Ultisol soil. This situation can be related to the characteristics of WCP as shown in Table 2 which are believed to play a role: (1) increasing *Ultisol* soil organic matter (0.25%) which is relatively low which comes from 13.12% C-organic WCP. This condition can improve the physical properties of the soil, including: increasing the water holding capacity of the soil, improving soil structure and soil porosity. This atmosphere can facilitate the movement of nutrients and the absorption process thereby supporting the growth and development of plant roots [5,11], (2) the N, P and K content in WCP material can increase the amount of nutrients in the soil. This role was believed to be able to fulfill sufficient plant N, P, and K elements so that it can support growth and increase yields.

The results of this research are in line with several reported research results, including: that compost fertilizer has the effect of increasing the growth and yield of several soybean varieties (*Glycine max* (L.) [9]; manure and *Crotalaria juncea L* have the effect of increasing the growth and yield of soybean plants (Glycine max).

The relationship between application of WCP and a number of variables ware presented in Figure 2. The figure showed the relationship between WCP and 5 week old plant height (a), number of pods (b), pod weight (c), and weight of 100 grains (d). In all these figures, it can be seen that the WCP application increases all variables in a positive linear manner. This phenomenon showed that it is still possible to increase the WCP dose.

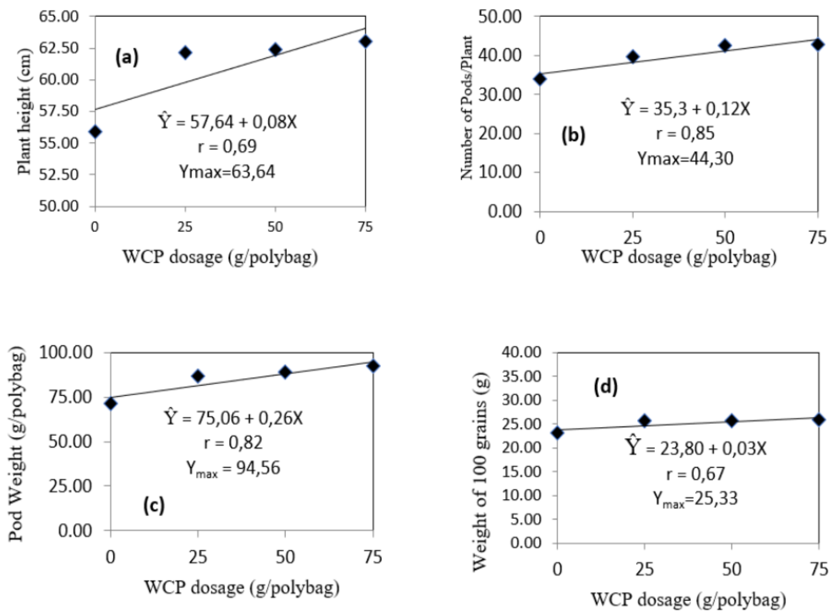

Figure 2. Relationship between WCP Application and 5 week old plant height (a), pods number (b), pod weight (c), and 100 grain weight (d).

4. Effect of NPK on Growth, Yield and Quality of Soybeans

The effect of NPK on the growth, yield and quality of soybeans was presented in Table 6. Table 6 showed that NPK increases growth and yield as shown by increasing plant height, number of 5 week old plant branches, number of pods, weight of pods, and weight of 100 grains. As with the effect of WCP (Table 5), the effect of NPK also increases the quality of the results shown by increasing the weight of 100 grains. The growth of plant height and number of branches increased with the application of NPK 1.25-3.75 g/polybag compared to without NPK. Yield (number and weight of pods) increased and was maximum at the highest NPK dose (3.75 g/polybag), while yield quality (weight of 100 grains) began to increase at an NPK dose of 2.5 g NPK/polybag and did not differ from dose 3 .75 g NPK/polybag.

Table 6. Effect of NPK on Growth, Yield and Quality of Soybean Grain

NPK dosage (g/polybag)	Plant height 5 weeks (cm)	Branch/plant	Number of Pods/Plant	Pod Weight (g/polybag)	Weight of 100 grains (g/polybag)
0	55,92 b	4,13b	27,92c	56,08c	24,13 b
1,25	62,17 a	6,17a	34,13b	68,42b	24,63 b
2,50	62,38 a	6,38a	38,58b	77,17b	25,79 a
3,75	63,00 a	5,67a	58,25a	116,60a	25,54 a

Numbers in columns followed by the same letter are not significantly different at the P= 5% level based on the DMRT test.

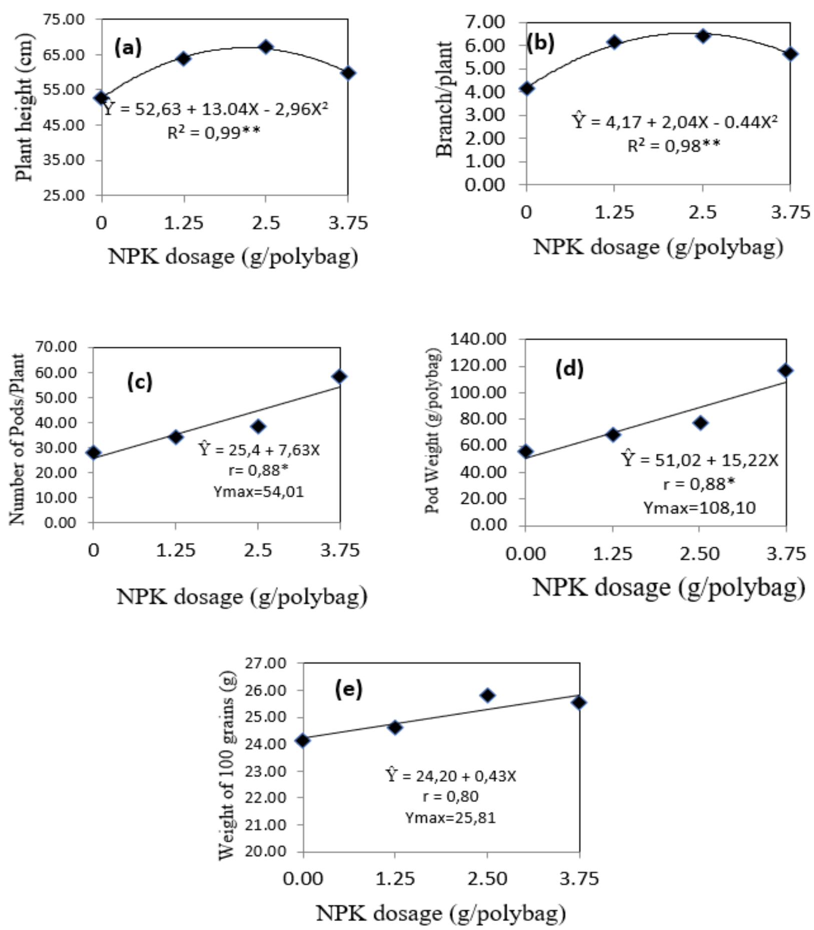

Figure 3. Relationship between WCP application and 5 week old plant height (a), number of branches (b), pods (number/plant (c), pod weight (g/treatment) (d), and weight of 100 grains (e).

The relationship between NPK application and 5 week old plant height, number of branches, number of pods, pod weight and 100 grain weight was presented in Figure 3. The relationship was in the form of a non-linear (quadratic) regression (Figures 3a and 3b), while yield and product quality are linear (Figures 3c, 3d and 3e). Maximum NPK requirements can be calculated based on the equation of the relationship between NPK and plant height and number of plant branches .

Figure 3 also showed that the NPK dose increased the growth (plant and branch height), yield (number and weight of pods), and yield quality (weight of 100 grains). Increased plant response to NPK can be related to low soil N,P and K content (Table 2). This condition can cause: (1) low levels of N, P and K element content, encouraging plants to respond more effectively to the added elements to meet the nutritional requirements of the plants concerned, and (2) the addition of these three elements and other elements allows for adequate and balanced nutrient elements in the soil to be met so that it can facilitate metabolic processes and support plant growth and yields. This phenomenon was in line with study results [8] that all plants will grow well and produce high production if all the nutrients provided are available in appropriate amounts. Sufficient amounts of P elements for plants will have a positive influence on fruit weight because plants that receive enough P elements will encourage the formation of more flowers and higher quality fruit.

5. Effect of WCP x NPK Interaction on Soybean Growth and Yield

The analysis results of the mean difference test for the effect of WCP, NPK and their interaction on soybean pod weight are presented in Table 7. Table 7 showed that the application of WCP and NPK and their interaction each increased the weight of soybean pods.

Table 7. Effect of WCP x NPK Interaction on Average Soybean Pod Weight

NPK Fertilizer (g/polybag)	WCP (g/polybag)				Average
	0	25	50	75	
0	34,75 n	58,35 m	68,10 j	77,45 h	59,66 d
1,25	68,31 j	75,43 i	62,30 l	81,08 g	71,78 c
2,50	69,32 j	65,21 k	99,73 e	94,05 f	82,08 b
3,75	113,25 d	147,60 a	124,88 b	116,40 c	125,53 a
Average	71,41 c	86,65 b	88,75 b	92,25 a	

Numbers in columns and rows followed by the same letter are not significantly different at the P=5% level based on the DMRT test

The control treatment (no WCP and no NPK) produced the lowest pod weight (34.75 g/polybag). The addition of WCP in the NPK=0 treatment significantly increased the weight of soybean pods from 34.75 g/polybag to 58.35, 68.10, and 77.45, respectively increasing by 40.45%, 48.97% and 55.13 % corresponds to sequentially increasing WCP dose. This increase also occurred in the NPK application. The influence of WCP and NPK has similarities. This condition confirms the evidence that the application of WCP and/or NPK can improve the quality of Ultisol soil.

The relationship between application WCP x NPK and pod weight per treatment is shown in Figure 4.

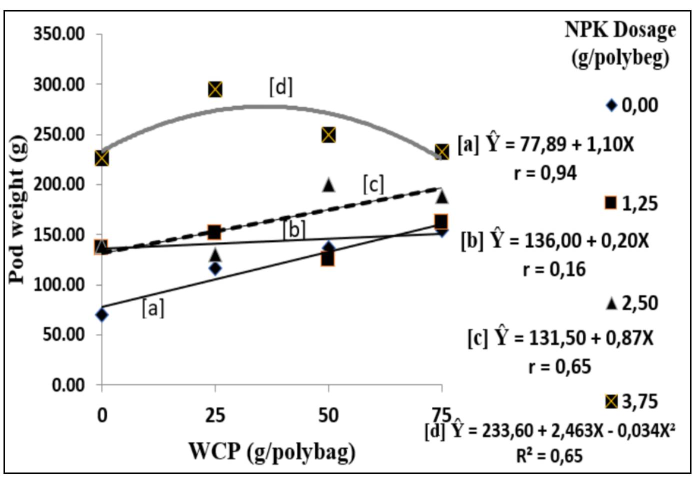

Figure 4. Effect of WCP x NPK interaction on pod weight: WCP at NPK dose=0 (a), WCP at NPK=1.25 (b), WCP at NPK=2.5 (c), and WCP at NPK =3.5 (d)

Figure 4 showed that there was a positive interaction effect of WCP x NPK on soybean pod weight. The effect of WCP increases the effect of NPK in various ways as shown by the differences in the position of the regression line for the effect of WCP at each dose of NPK. This phenomenon was demonstrated by the various regression equations for the relationship between WCP and pod weight at each NPK dose. The results of calculating Minimum (Ymin) and Maximum (Ymax) pod weights at doses WCP=0 and WCP=75 g/polybag based on the regression equation at 4 NPK levels are presented in Table 8. Table 8 showed that the Ymin (coefficient a) and Ymax values are NPK=0 respectively was 77.89 at WCP=0 increasing to 153.64 g/polybag at WCP=75 g/polybag. The increase in Y_{min} and Y_{max} increases, both at WCP=75 g/polybag and at higher NPK levels.

Table 8. Calculation of Minimum (Ymin) and Maximum (Ymax) Pod Weight at doses WCP=0 and WCP=75 g/polybag based on the regression equation at 4 NPK levels

Regression Equations	NPK Dosage (g/polybag)	Pod weight (g/polybag)		Correlation Coefficient, r
		Y*min* (WCP=0 g/polybag)	Y*max* (WCP=75 g/polybag)	
$\hat{Y} = 77{,}89 + 1{,}10X$	0	77,89	153,64	0,94
$\hat{Y} = 136{,}00 + 0{,}20X$	1,25	136,00	151,00	0,16
$\hat{Y} = 131{,}50 + 0{,}87X$	2,5	131,50	196,75	0,65
$\hat{Y} = 233{,}60 + 2{,}463X - 0{,}034X^2$	3,5	233,60	278,21	0,65

The relationship between the dose of 0-2.5 g NPK/polybag and pod weight was linear, while the dose of 3.75 g/polybag was quadratic (nonlinear). When giving NPK 3.75 g/polybag, the relationship between WCP and pod weight was $\hat{Y} = 233.6 + 2.463X - 0.034X^2$. Based on this equation, Xmax (WCP) is 36.22 g /polybag and Ymax (pods) is 278.21g/polybag.

Figure 4 also showed that a positive WCP x NPK interaction was found. Giving WCP increases the effect of NPK as shown by the positive regression equation. Pod weight increases as WCP and NPK increase. The interaction that occurs can be caused by several possibilities, including: (1) WCP as a source of organic material can improve the physical and chemical properties of the soil which can support and facilitate increasing the availability of NPK more quickly in the soil, (2) WCP adds a number of NPK nutrients and maybe others that increase the supply of NPK influence, (3) WCP can increase the water holding capacity of soil so that it supports the process of nutrient defusion and absorption of NPK nutrients, etc.

6. Effect of WCP on NPK Efficiency

The equations presented in Figures 3a and 3b are used to calculate the NPK_{max} and Y_{max} values. This value can be used to estimate the efficiency of the NPK application.

Based on the NPK-plant height relationship, $\hat{Y} = 52.63 + 13.04X - 2.96X^2$ obtained X_{max} (NPK_{max}) of 2.47 g NPK/polybag and Y_{max} (plant height) of 66.78 cm.

Based on the NPK-number of branches relationship, $\hat{Y} = 4.17 + 2.036X - 0.44X^2$, X_{max} (NPK_{max}) was 2.31 g NPK/polybag and Y_{max} (number of branches) was 6.53 branches/plant.

From these two variables, an average NPK_{max} value of 2.39 g/polybag was obtained. If we look at the maximum treatment dose (3.75 g NPK/polybag) tested, there was a reduction and savings in the use of NPK of 1.36 g (36.27% NPK) so that the application of NPK was sufficient at only 2.39 g. This dose was not significantly different in the treatment range of 2.5 - 3.75 g NPK which was tested based on the variables plant height, number of branches and weight of 100 grains (Table 6).

The application of WCP increased the effect of NPK as shown by the increase in average pod weight from 71.41 at WCP 0 to 92.25 g at WCP 75 g (Tabel 7). The application of WCP can reduce the need for NPK by 3.75-2.5 = 1.25 (33,33%) g/polybag based on the results shown by 99.73 pod weights achieved at an NPK dose of 2.75 g/polybag. This indicate that it was enough to applicate 2.5 g of NPK combined with 50 g of WCP/polybag.

Based on the results of the calculations above, it is obtained that the reduction and savings in NPK use was 1.25 - 1.39 g/polybag (33.33-36.27%).

CONCLUSIONS AND RECOMMENDATIONS

The results of this research found that WCP is a potential alternative agricultural technology product as proven by the application of WCP and NPK can significantly increase the growth and yield of soybean plants. The WCP x NPK interaction has a positive effect where the WCP application increases the effect of NPK. Based on the relationship $\hat{Y} = 233.6 + 2.463X - 0.034X^2$, the interaction of pod weight on WCP and NPK, the WCP_{max} value was 36.22 g/polybag and NPK_{max} was 278.21 g/treatment. WCP can play a role in reducing and saving in NPK use was 1.25 - 1.39 g/polybag (33.33-36.27%), or adding some NPK elements so that WCP can make NPK usage more efficient. Based on the growth response and plant yields, it confirms that WCP and NPK can be used to improve the quality of Ultisol soil.

WCP needs to be researched further because it has the potential to be an alternative technology, both for improving the properties of Ultisol soil, making efficient use of NPK, increasing the growth and yield of soybean plants, and its role as a C storage which can contribute to CO_2 control to reduce the influence of greenhouse gases (GHG).

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