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Use of Soil Ameliorant And Inorganic Fertilizer to Increase Soil Fertility Phosphorous Concentrations in Plant Tissue, Growth and Yield of Shallot in Dry Land

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Abstract: Sub-optimal land use including dry land in West Nusa Tenggara (NTB) has not been optimal due to various land biophysical constraints such as low soil fertility, physical conditions with rough soil texture and uncertain water availability, so efforts are needed to improve the land condition. . Shallots (Allium ascalonicum L.) one of the vegetables that have a high enough potential to be developed in the land. The purpose of this study was to determine the interaction of various soil enhancers and doses of inorganic fertilizers on growth, tuber yield, and P content of shallot plants in suboptimal land. The method used in this research is the experimental method. The experimental design used was a Randomized Block Design which was arranged in a factorial design consisting of two factors. The first factor is soil amendment, consisting of 4 types, namely: P0= without soil ameliorant; P1= 20 tons ha^{-1} manure; P2= 5 tons ha^{-1} biochar; P3= 10 tons ha^{-1} mushroom baglog waste. The second factor was the dose of NPK fertilizer, consisting of N1=150 kg ha^{-1}; N2 = 300 kg ha^{-1}; N3=450 kg ha^{-1}. Each treatment combination was repeated 3 times. The results showed that there was an interaction between soil amendments and the dose of NPK fertilizer on organic C and soil CEC. But there was no interaction between the growth and yield of shallot bulbs. Soil ameliorant and dose of NPK fertilizer alone affected growth, namely the height and number of leaves of shallot plants. The best treatment for tuber yield was obtained in a combination of an application of 20 tons ha^{-1} of manure and 450 kg ha^{-1} of NPK fertilizer. Likewise with the P concentration in the onion plant tissue.

Keywords: Soil amendment; NPK fertilizer; Sub optimal land; Shallot

Introduction

The potential for dry land in West Nusa Tenggara (NTB) is quite large with a total area of 1,716,944 ha or 85.19% of the total area of NTB, which is 2,015,358 ha (Ritung et al., 2015). Generally, this suboptimal is dry land. The area of dry land in NTB is recorded at 1,807,463 ha or 84.03% of the total area. Of this area, only about 30% is used for the development of food crops, with relatively low yields, so the use of dry land is not optimal. Therefore, the utilization of dry land. This land needs to be increased to become productive land, and able to support food security support the development of sustainable cash agriculture. However, the development of dry land is not easy due to various constraints from land biophysical factors such as having low soil fertility, and poor nutrients such as nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), and low calcium. The physical properties of the soil are generally coarse-textured, with a sand content of > 70%, a low organic carbon content of <1.0%, low water holding capacity, and low cation exchange capacity (CEC=cation exchange capacity) (Suriadikarta et al. al, 2002). The organic matter content of dry land is generally less than 1% (Samosir, 2000).

A decrease in soil chemical and biological properties is generally inseparable from a decrease in soil organic matter content so the application of organic matter as a resilience agent is one of the efforts to improve land naturally. Efforts to maximize the

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potential of dry land include increasing the levels of organic matter and nutrients through the use of soil amendments derived from various agricultural wastes. such as manure, compost, biochar, and straw mushroom baglog waste can be an alternative to fixing dry land. Meanwhile, to meet the need for nutrients to support the growth of crop yields, it is necessary to add complete inorganic fertilizers, especially macro elements, namely phonska (BBSDLP, 2012). The addition of organic fertilizers and soil amendments generally ranges from 5.0-20 tons ha^{-1} (Mulyati & Lolita, 2006). For inorganic fertilizers, it depends on the type of plant to be cultivated because each type of plant requires a different amount of nutrients.

Manure is a type of organic fertilizer that when applied to the soil can contribute to the addition of nutrients, and increase humus levels, to improve the physical, chemical, and biological properties of the soil (Subekti, 2005). Furthermore, the addition of biochar and baglog mold merang can also act as a soil conditioner that can improve soil properties. Biochar is a natural soil enhancer made from the incomplete combustion of agricultural residues or wastes that are difficult to decompose such as rice husks, wood, coconut shells and others (BBSDLP, 2012). Biochar is a material produced from organic matter in the form of agricultural waste, in the form of rice husks, oil palm bunches, corn cobs, tobacco stalks, coconut shells and others (Mulyati et al., 2014), which is heated through a pyrolysis process. in limited oxygen conditions (Gani, 2009). Biochar can act as a technological component to improve the quality and productivity of agricultural land (Goenadi, 2002), which in turn can increase plant growth and yield. Another soil enhancer, namely baglog mushroom waste which contains quite high lignin and cellulose and consists of a mixture of 80% sawdust, 10% bran, 1.8% lime, 1.8% gypsum and 0.4% TS (Ghazali et al., 2009).

The main role of a soil conditioner is to improve soil properties, but cannot replace the role of NPK inorganic fertilizer as a nutrient supplier. Thus nutrient management by combining soil amendments and inorganic fertilizers can be a strategic alternative in suboptimal land management including dry land in North Lombok and East Lombok. In this study, the application of a soil enhancer that is integrated with the use of various doses of NPK fertilizer will be tested on shallots (Allium ascalonicum L.) as an indicator plant.

Shallots are the vegetable plant that has the shape of grass, short stems and fibrous roots, and long and hollow leaves like pipes, with the base of the leaves being able to change its function to become a bulb (Pratiwi, 2021). Shallot bulbs are widely used as seasonings, and ingredients for the food industry, and are often also used as traditional medicine, whose development has increased significantly, with a harvested area of 11,518 ha in 2015 to 17,570 ha in 2020 (BPS, 2020). Red onion is a plant that requires quite a lot of nutrients to obtain certain production. The main nutrients that need to be added to fertilizing shallot plants are N, P, and K fertilizers. The results of Mehran et al (2012) showed that applying NPK fertilizer at 600 kg ha^{-1} produced a wet tuber weight of 8.92 tons ha^{-1}, whereas application of NPK fertilizer at 200 kg ha^{-1} produces a wet tuber weight of 7 tons ha^{-1}. The combination of NPK fertilizer with appropriate soil conditioner on dry land is expected to improve soil properties and reduce the dose of NPK fertilizer in shallot cultivation.

Method

The materials used in this experiment were manure, rice husk charcoal (biochar), straw mushroom baglog, NPK 16-16-16 fertilizer, Tajuk variety of shallot seeds, chemicals and other materials used for soil and plant analysis purposes. laboratory. While the tools used are drums, stakes, funnels, hoes, plastic, paper, plywood, gembor, and raffia rope. measuring tape, sacks, sieves, brown envelopes, analytical scales, ovens, stationery, and laboratory equipment for soil and plant analysis purposes.

The experimental design used was a factorial randomized block design (RBD) consisting of two factors. The first factor is the soil enhancer, consisting of 4 types of enhancer, namely: P0=without soil enhancer; P1=manure 20 tons ha-1; P2 = biochar 5 tons ha-1; P3=baglog mushroom waste 10 tons ha-1. The second factor is the dose of NPK fertilizer, consisting of N1=150 kg ha-1; N2 = 300 kg ha-1; N3=450 kg ha-1. Then the two treatments were combined so that 12 treatment combinations were obtained and each treatment combination was repeated 3 times, so 36 experimental plots were obtained.

The experimental land was processed, and experimental plots were made measuring 1 x 2 m with a bed height of 40 cm. The distance between the plots is 60 cm. The distance between blocks is 1 m. Furthermore, soil conditioner was given according to the treatment on the experimental plot by spreading it evenly over the bed and then letting it sit for a week, and watering it, then the shallot seeds were planted. Scattered seeds (blue labels) were planted by immersing 2/3 of the tubers into the soil, 1 tuber per planting hole with a spacing of 20 x 15 cm (65 plants per plot). Plants are maintained by watering with the laboratory system, weeding weeds, and pests and diseases are controlled mechanically. NPK fertilization treatment was carried out according to the treatment with NPK doses of kg ha^{-1}; 300 kg ha^{-1}; and 450 kg ha-1. NPK fertilizer was given twice, namely at the age of 15 and 35 days after planting, by spreading it evenly in the grooves dug between the rows of shallot plants.

Growth parameters (plant height and number of leaves) were observed 7 times, namely when the plants were 2, 3, 4, 5, 6 and 7 WAP, while the tuber yield which included the number of tubers, tuber fresh weight and yield, was observed after harvest. Data analysis was carried out using analysis of variance (ANOVA) at the 5% level of significance and for significantly different treatments a follow-up test was carried out with the honest significant difference test (BNJ) at the significant level.

Result and Discussion

Soil Characteristics for Experiment

The characteristics of the soil used in this experiment can be seen in Table 1.

Table 1 shows that the soil used for the experiment has a sandy loam texture with a composition of 60% sand, 34% silt and 6% clay. Soil texture is one of the most important physical properties of the soil, is the fineness of the soil, affects the number of macro and micro pores in the soil, so that it is closely related to the movement of water and solutes in the soil (Harjowigeno, 2007).

Table 1. Results of chemical characteristics at research locations before the experiment

Parameter	Method	Test result	Criteria
Texture: Sand (%)	Sedimentation	60	Sandy Loam
Dust (%)		34	
Clay (%)		6	
$pH-H_2O$	Electrometric	7.40	Neutral
N-Total (%)	Kjeldahl	0.09	Very low
P-Total (%)	Spectrophotometry	0.22	Low
K-Total (%)	AAS	0.25	Low
C-Organik (%)	Walkley & Black	0.84	Very low
KTK (cmol/kg)	Percolation	15.20	Low

The soil pH is neutral, which means it is suitable for the growth of shallot plants. C-organic is very low, so the addition of soil amendments has the potential to increase soil C-organic content, and low CEC can also be increased because an increase in soil CEC can increase nutrient and water retention in the soil. Furthermore, the N-total soil content is classified as very low with a value of 0.09%. The low N is thought to be due to the soil which is dominated by the sand fraction having high porosity. So that leaching and evaporation will take place quickly and element N can be lost easily, and can also be carried away by irrigation water easily (Sudirja et al., 2017).

The P-Total content of the soil is also low, namely 0.22%, this is presumably because the element phosphorus tends to form insoluble compounds so that it is not available for plants or is fixed by Fe and Mn compounds in acid soils and Ca and Mg in alkaline soils (Priyono & MM, 2020). Based on the results of the soil analysis, it can be concluded that the soil used for this experiment has a low level of fertility, so it is hoped that the provision of soil amendments can increase the level of soil fertility and plant productivity.

Characteristics of Soil Improvers for Experiments

Soil enhancer is a substance whose role is to accelerate the improvement of soil quality in the form of organic polymers that have the ability to improve soil properties, both in the form of physical, chemical and biological soil properties (Suriadikarta et al., 2005; Rahman, 2019; Rachman et al., 2006). Following are the results of the analysis of some of the soil enhancers used in this experiment as presented in Table 2.

Table 2 shows that the pH for all soil conditioners is classified as alkaline, which is why these soil conditioners are often used to increase the pH in acid soils. C-organic ranged from 15.16-45.25%, N-total 0.34-0.81%, P_2O_5 1.38%, K_2O 1.99%, C/N ratio 21.06-136.03 and CEC 13.39-27.61 cmol kg-1 , The application of this soil amendment is useful for improving soil fertility both physically, chemically and biologically (Abdillah & Budi, 2021), contains a number of macro nutrients such as nitrogen (N), phosphate (P) and potassium (K), but also has micro elements such as calcium (Ca), magnesium (Mg) and micro elements such as zinc (Zn), copper (Cu) and manganese (Mn), as essential nutrients for plant growth and maintaining nutrient balance in the soil (Bachtiar et al., 2021). Goenadi & Santi (2017) further revealed that the characteristics of biochar can function on soil health and nutrient availability for plants because of its ability to absorb dissolved compounds, gases and inorganic nutrients, and function as a habitat for soil microbes (Hou et al., 2022) .

Tabel 2. Karakteristik Beberapa sifat kimia pembenah tanah

Paramter	Method	Score		
		Manure	Biochar	Mushroom Baglog
pH-H2O	Electrometry	9.05	9.03	8.44
C-Organik (%)	Gravimetry	15.16	17.31	46.25
N-Total (%)	Kjeldahl	0.72	0.81	0.34
C/N ratio	-	21.06	21.37	136.03
P2O5 (%)	Spectrophotometry	1.38	0.74	0.46
K2O (%)	AAS	1.99	1.39	1.34
KTK (cmol kg^{-1})	Percolation	27.61	13.39	20.17

Response of Soil Improver and Dosage of N Fertilizer to the Growth of Shallot Plants

The results of the analysis of diversity showed that the treatment of soil enhancers had a significant effect on plant height at 7 WAP and the number of leaves at 7 HST, while the doses of inorganic fertilizers had a significant effect on plant height and number of leaves at 7 and 8 WAP, but there was no interaction between soil conditioners. and the dose of NPK fertilizer on plant height and number of leaves of shallot plants (Table 3). Plant height as a plant size is often observed as an indicator of growth and a parameter used to measure the effect of treatments such as bacteria, actinomycetes and mycorrhizal fungi (Goenadi & Santi, 2017). Thus the quality of this soil enhancer is greatly influenced by the source of origin of the raw materials used. Plant height in the treatment of soil amendments and inorganic fertilizers is listed in Table 3.

Table 3. The Effect of Applying Soil Improver and NPK Fertilizer Doses on the Average Number of Leaves of Shallot Plants Age 2 to 8 MST

Treatment	Plant Height (cm) at Age (MST))						
Land Builder	2	3	4	5	6	7	8
P0	11.06	19.53	22.97	24.59	25.40	25.74	25.78 b
P1	11.86	19.58	22.93	24.41	25.42	26.63	28.08 a
P2	12.13	19.66	22.41	23.83	25.09	26.12	2802 a
P3	10.71	17.72	20.53	21.91	22.61	23.37	23.94 b
BNJ	-	-	-	-	-	-	2.11
NPK Fertilizer Dosage							
N1	11.13	19.09	22.00	23.37	23.74	24.15 b	24.28 b
N2	11.88	19.03	22.26	23.70	24.99	26.67 ab	26.51 a
N3	11.31	19.25	22.38	24.09	25.91	27.38 a	27.82 a
BNJ	-	-	-	-	-	3.01	2,15

Note: Numbers followed by the same letter in the same column are not significantly different based on the BNJ test at the 5% level.

Table 4. The Effect of Applying Soil Improver and Dosage of NPK Fertilizer on the Average Number of Leaves of Shallot Plants Age 2 to 8 MST

Treatment	Number of Leaves (strands) at Age (MST))						
Land Builder	2	3	4	5	6	7	8
P0	9.19	13.69	20.39	22.88	24.65	25.09 a	25.31 a
P1	9.66	14.79	20.31	22.19	23.57	24.14 ab	24.31 ab
P2	9.96	14.46	20.11	22.63	23.91	24.98 a	25.11 a
P3	9.19	13.38	16.84	17.68	18.52	18.81 b	18.95 b
BNJ	-	-	-	-	-	6.01	6.02
NPK Fertilizer Dosage							
N1	8.94	13.43	18.24	19.83	20.12	20.12 b	20.23 b
N2	10.07	14.28	19.44	21.88	23.33	24.65 ab	24.86 ab
N3	9.49	14.52	20.56	22.33	24.54	25.00 a	25.16 a
BNJ	-	-	-	-	-	4.71	4.72

Note: Numbers followed by the same letter in the same column are not significantly different based on the BNJ test at the 5% level.

Table 3 shows that there was a significant difference in shallot plant height only at 8 WAP, while at the beginning of growth from 2 – 7 WAP there was no significant difference. Meanwhile, the dose of NPK fertilizer had a significant effect on plant height at 7 MST and 8 MST, which had shown a significant difference in plant height growth. The highest plant was obtained at a fertilizer dose of 450 ka ha^{-1}, namely 27.38 cm and the lowest was obtained at N1 by applying a dose of 150 kg ha^{-1} NKP fertilizer. However, the dose of NPK fertilizer 300 kg ha^{-1} was not significantly different from N1 and N2. This is caused by the application of supplementary fertilizer when the plants are 5 WAP after planting so that the impact of supplementary fertilizer application has not been evident. high so that the availability of nutrients is released slowly so that there is no visible response from the plant. Treatment of soil conditioner and dosage of inorganic fertilizers did not significantly affect the number of tubers and fresh weight of tubers. Likewise, there was no interaction between the soil enhancer and the dose of inorganic fertilizer on shallot crop yields. However, the dosage of inorganic fertilizers affected the yield (kg per plot).

Table 4 shows the number of shallot leaves at the age of 2 to 6 MST has increased, with the number of leaves not significantly different until 6 MST. The impact of the soil conditioner treatment and the dose of NPK fertilizer was seen after the plants were 7 MST. At the age of 7 and 8 WAP, the number of leaves was higher on plants without soil amendments (P0), namely 25.09 leaves but not significantly different from 20 tons ha^{-1} manure and 5 tonsha biochar (P2), while the lowest was in mushroom baglog waste. The application of different doses of NPK fertilizer resulted in plants with different number of leaves at the age of 7 and 8 WAP. The highest number of leaves in the 450 kg ha^{-1} NPK fertilizer dose was significantly different from the 150 kg ha^{-1} (N1) NPK fertilizer dose, namely 20.12 leaves, but not significantly different from the 300 kg ha^{-1} (N2 NPK) fertilizer dose.

Along with increasing age of the plants, plant height and number of shallot leaves continued to increase from 2 – 8 WAP. Plant height and number of plant leaves are indicators of plant growth parameters (Gentili et al., 2018). The formation of leaves is influenced by the genetic nature of plants and their growth environment. In this study, the number of leaves was influenced by the soil conditioner and the dose of NPK fertilizer applied. Plant growth is inhibited by applying soil conditioner in the form of mushroom baglog waste, possibly caused by the level of maturity or the source of raw materials that are not uniform. The nutrients contained in NPK 16: 16: 16 fertilizer as a source of nutrients that contain nutrients that can increase plant growth and productivity, furthermore and Marchner (2002) state that the main role of N for plants is to stimulate overall growth, especially stems, branches and leaves. In addition, N plays an important role in vegetative processes, especially for the formation of chlorophyll a and b which are very useful in the process of photosynthesis.

Effect of Soil Improvement and Dosage of N Fertilizer on Shallot Bulbs Yield

Treatment of soil conditioner and dosage of inorganic fertilizers did not significantly affect the number of tubers and fresh weight of tubers. Likewise, there was no interaction between the soil enhancer and the dose of inorganic fertilizer on shallot crop yields. However, the dosage of inorganic fertilizers affected the yield (kg per plot). The number of tubers produced was relatively the same, which ranged from 8.33 – 9.33 tubers per clump, but tuber weight and yield per plot showed a significant effect between treatments, especially in the treatment of NPK fertilizer doses, while the addition of soil conditioner had no effect on the tuber fresh weight component. and yield per plot. (Table 5). Shallot bulbs come from the lateral shoots of the bulbs on the bulbs. Gunawan (2010) states that the number of plant tubers depends on the ability of the mother tuber and lateral tubers to form new tubers.

Table 5. The effect of applying soil amendments and NPK fertilizer doses to the average yield of shallot bulbs at Harvest

Treatment	Number of Tubers (clump)	Fresh Weight of Tuber (g)	Yield (kg per plot)
Land Builder			
P0	9.17	32.27	1.65
P1	8.92	31.25	1.53
P2	9.22	29.32	1.42
P3	8.63	22.88	1.34
BNJ	-	-	-
NPK Fertilizer Dosage			
N1	8.34	24.85	1.31 b
N2	9.33	29.94	1.48 ab
N3	9.28	31.99	1.67 a
BNJ	-	-	0.31

Note: Numbers followed by the same letter in the same column are not significantly different based on the BNJ test at the 5% level.

Table 5 also shows that the fresh weight of the tubers tends to decrease with the treatment of soil conditioner, and the lowest tends to be the treatment with baglog mushroom waste. In the treatment without soil enhancer, the fresh weight of the tubers was 32.27 g followed by the manure treatment 31.25 g, the biochar treatment 29.32 g and the baglog mushroom waste treatment 22.88 g, although statistically this was not significantly different from the other enhancers. Treatment of inorganic fertilizer doses, NPK fertilizer dose treatment of 150 kg/ha) showed lower fresh weight than the application of NPK inorganic fertilizer treatment of 450 kg ha-1. This shows that the tuber fresh weight without soil enhancer (P0) 32.27 g combined with 450 kg ha-1 31.99 g NPK inorganic fertilizer produced a higher fresh tuber weight than plants treated with mushroom baglog waste weighing 22.88 g. The fresh weight of the tubers in the P0 treatment was higher compared to the other soil improver treatments indicating that the plant's response to the dose of NPK fertilizer given. This is because the nutrients in NPK can increase plant growth and yield.

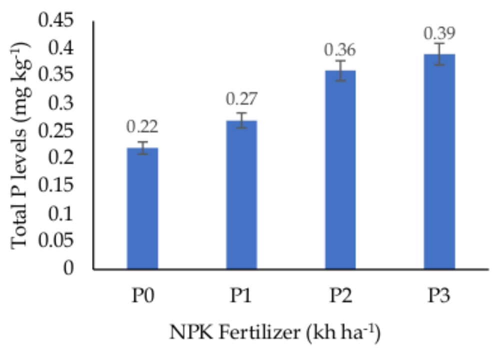

Figure 1. Effect of total P soil conditioner on shallot plant tissue

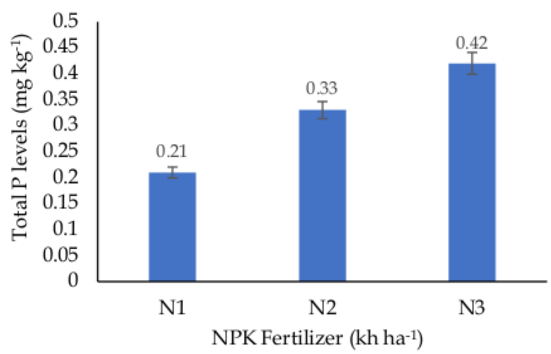

Figure 2. Effect of NPK fertilizer dose on total P levels of shallot plant tissue

Treatment without soil enhancer 20 tons ha^{-1} of manure and 5 tons of biochar/ha has a better yield potential than 10 tons ha^{-1} of mushroom baglog waste. The application of 450 kg ha^{-1} NPK fertilizer was significantly different from the 150 kg ha^{-1} NPK treatment but not significantly different from the 300 kg ha^{-1} NPK treatment resulting in lower yields. These data show that fertilization with the recommended NPK dose of 450 kg ha^{-1} has been able to increase shallot yields (Widiana et al., 2020) but these results are still lower than the yield potential of crown varieties of shallots. The results of Abdulrachman and Susanti's research (2004) said that the application of sufficient K fertilizer in the soil led to more optimal shallot growth. The addition of high doses of potassium shows good results because potassium plays a role in helping the process of photosynthesis (Saravanan et al., 2021), namely the formation of new organic compounds which are transported to the organs where they are stored, namely tubers. Another effect of potassium fertilization is to produce quality tubers (Habib, 2012).

The Effect of Soil Improver and NPK Fertilizer Dosage on Nutrient P Levels in Shallot Plant Tissue

The total P content of shallot plant tissue was highest given soil amendments as can be seen in Figure 1 and those given NPK fertilizer in Figure 2.

The average growth rate for the number of leaves and plant height was the highest in shallot plants that were given the highest manure soil conditioner and showed a significant difference from those that were given biochar and baglog straw mushroom waste (Figure 1), and those that were given NPK fertilizer had total P levels in the tissue plants showed significant differences with increasing doses of NPK fertilizer. This shows that there is a transfer of nutrients, especially P in the plant body and the rate of transfer of these nutrients increases with increasing doses of NPK fertilizer. The highest total plant tissue P nutrient content was obtained at the highest dose of NPK fertilizer, meaning that the higher the dose of NPk fertilizer, the higher the contribution of NPK fertilizer to the total P present in plant tissue. The high levels of P nutrients in plant tissues were also supported by the growth in height and number of leaves of the shallot plants from 2-8 WAP, and this phenomenon was also one of the factors in increasing the weight of the bulbs and yields of the shallot plants.

Conclusion

There is an interaction between the application of soil conditioner and the dose of NPK fertilizer on increasing soil chemical fertility, namely C-organic and soil CEC. But there was no interaction in the growth and yield of shallot bulbs. Soil enhancer and doses of NPK fertilizer alone affect growth, namely the height and number of leaves of shallot plants. The best treatment for tuber yields was obtained from a combination of 20 tons ha^{-1} of manure and 450 kg ha^{-1} of NPK fertilizer. Likewise with the levels of P in the shallot plant tissue.

The highest total P concentration in plant tissue was also obtained by applying 20 tons ha^{-1} of manure and 450 kg ha^{-1} of NPK fertilizer.

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