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## INORGANIC FERTILIZERS COVERED BY ACTIVE RICE HUSK CHARCOAL PROMOTE GROWTH AND YIELD OF SHALLOT IN DRYLAND

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### ABSTRACT

Shallot is one of the seven strategic commodities in Indonesia. The demand for shallot continues to increase every year as the population increases, therefore the expansion of shallot planting areas in dryland is an alternative to increase production. This study aims to investigate the response of growth and yield of shallot (Batu Ijo variety) to various doses of inorganic fertilizers coated with activated charcoal in dryland. This research was conducted at the Sandubaya Experimental Station - West Nusa Tenggara Institute for Assessment of Agricultural Technology from March to June 2019. The research location is at the coordinates of -8°30'47", 116°39'14", 56.4ft at an altitude of 46.0 m above sea level. The study used a randomized block design (RBD) with 1 factor and 5 levels of treatment dose of inorganic fertilizer coated with activated charcoal. Treatment of inorganic fertilizer dosage, namely B1: farmer practices of inorganic fertilizer (100%), B2: inorganic fertilizer 25% + coated with activated charcoal, B3: inorganic fertilizer 50% + coated with activated charcoal, B4: 75% inorganic fertilizer + coated with activated charcoal and B5: 100% inorganic fertilizer + coated with activated charcoal. The results showed that there was a correlation between plant height, number of leaves, number of bulbs and yields. The application of inorganic fertilizer as much as 75% of the standard dose + activated charcoal coating can have the highest effect on plant height, number of leaves, number of bulbs, yield and weight of the shelf life of 30 to 60 days after harvesting.

### KEY WORDS

Activated charcoal coated, dosage, inorganic fertilizer, shallot.

Horticulture is one of the important sub-sectors in agricultural development (Dahlianah, 2018). Shallot (*Allium ascalonicum* L.) is one of the horticultural commodities that belong to the spice vegetable group and is used as food seasonings (Fajar *et al.*, 2019). The extensification of shallot continues to increase from year to year as the market share is always open and the selling price is relatively profitable for farmers (Suriadi, 2018). Considering that shallot is one of the national strategic commodities in Indonesia, it must be developed through various efforts including the use of marginal lands (Firmansyah and Mokhtar, 2014).

One of the factors that determine the success of an agricultural system is land resources, because almost all cultivation businesses are based on land resources, but the current problem is the low level of soil fertility, especially on marginal lands (Gusmailina *et al.*, 2015). One of the efforts to fulfill soil fertility is by means of fertilization. Fertilization is an important factor affecting plant growth in agricultural cultivation systems. The nutrients contained in the soil alone are not sufficient for optimal plant growth, but excessive application of inorganic fertilizers can result in decreased of land productivity.

One way to overcome the further impacts that will arise from the use of inorganic fertilizers is through the application of inorganic fertilizers with the right dose (Anonymous, 2016). In addition to the right dose of fertilization, technological innovation is needed in fertilization activities so that it is hoped that the effect of applying fertilizer can be seen on its effect on growth and increased production of shallot. The use of inorganic fertilizers besides being able to reduce land productivity, the problem faced by farmers is also the nature of fertilizers that are easily soluble so that excessive fertilizer application becomes ineffective.



One way to modify slow availability of fertilizer is to mix materials that are difficult to dissolve in water and coat the fertilizer with certain materials so that the release of fertilizer in the soil becomes slow (Pratomo *et al.*, 2009). Fertilizers in the form of slow release can optimize nitrogen absorption because they can control the release of nitrogen elements according to the time and amount needed and can maintain the presence of nitrogen in the soil (Nainggolan *et al.*, 2009). Activated charcoal is a material that is difficult to dissolve in water so it can be used as a mixture for the slow release of fertilizers.

Based on these thoughts, it is necessary to do research on the application of activated charcoal in the cultivation of shallot crops. Reducing the use of inorganic fertilizers combined with activated charcoal coating on inorganic fertilizers is expected to provide new information on the use of activated charcoal in shallot cultivation, especially in dryland.

## MATERIALS AND METHODS OF RESEARCH

This research was conducted at the IP2TP Sandubaya Experimental Station – West Nusa Tenggara Institute for Assessment of Agricultural Technology, Indonesia from March to June 2019. The experimental station is located at the coordinates of 8°30'47", 116°39'14", 56.4ft at an altitude of 46,0 m above sea level (m asl). The shallot variety planted was local Indonesian Batu Ijo variety using a 1 factor Randomized Complete Design (RCD) with 5 levels of treatment with doses of inorganic fertilizers coated with activated charcoal and replicated 3 times. Each treatment observed 7 sample plants which were selected randomly following a zig-zag pattern. The treatments studied were as follows:

- B1: 100% Inorganic Fertilizer;
- B2: 25% Inorganic Fertilizer + Activated Charcoal;
- B3: 50% Inorganic Fertilizer + Activated Charcoal;
- B4: 75% Inorganic Fertilizer + Activated Charcoal;
- B5: 100% Inorganic Fertilizer + Activated Charcoal.

The field experiment was includes land clearing, making beds and arranging drainage channels by hoeing. Soil preparation at the experimental site was carried out by first cleaning the remaining weeds or previously planted plants, then the soil was processed by hoeing until loose. After that, an experimental plot was made with a bed size of 5 x 1.20 m with a height of 20-30 cm and a distance between beds of 40 cm. Fertilizer application was done by spreading it over the surface of the bed. The application of SP-36 fertilizer coated with husk charcoal was given at the time of land preparation, while for Urea and NPK fertilizers coated with husk charcoal were applied 3 times at the age of 15, 30 and 45 days after sowing (DAS). Basic fertilizer in the form of SP-36 fertilizer as much as 100 kg/ha coated with activated charcoal was applied 7 days before sowing. NPK plus Zn fertilizer as much as 250 kg/ha and Urea fertilizer as much as 300 kg/ha coated with activated charcoal were given at the age of 15, 30 and 45 DAS. Before the shallot bulbs were planted, the bulbs were treated by cutting off the ends 1/3 of the bulb and coated with fungicide. Fertilization dose treatment on shallot plants is shown in Table 1.

Tabel 1 – Treatment of fertilization dose on shallot in dryland of Eastern Lombok, Indonesia during 2019 growing season

Fertilizer	B1 (Farmers' Existing Application) -----kg/ha-----	B2	B3	B4	B5
Urea	300	75	150	225	300
NPK Plus Zn	250	62.5	125	187.5	250
SP-36	100	25	50	75	100
Activated charcoal	-	√	√	√	√

Sowing activities were conducted by hand with a depth of 3-5 cm and planted one tuber/hole with a spacing of 20 x 15 cm. Plant maintenance includes weeding which was done 2 times, irrigation was done 2 times/7 days by flooding for 1 night (depending on the availability of water in the experimental site which is dryland), fertilization at the age of plants



15, 30 and 45 days after sowing (DAS). Pest and disease control according to the level of attack in the field. Parameters observed included plant height, number of leaves, fresh weight, and weight loss after harvest. Plant height were masured from the base of the stem to the tip of the highest leaf which was straightened vertically upwards. Plant height was measured at the age of 20 and 70 DAS. The number of leaves was measured by counting the number of leaves per plant in each treatment and the number of bulbs was calculated at the age of 20 and 70 DAS. The parameters of fresh weight of sampling plots were measured at 70 DAS (at harvest), the shrinkage weight of shallot bulbs at 30 and 60 days after harvest (DAS) by drying. To find out the differences between treatments in this test, all the data that had been collected were analyzed using ANOVA and followed by an honest real difference test at the 5% level.

## RESULTS AND DISCUSSION

*General Characteristics of Experimental Site.* The experimental site has a flat topography with a height of 46.0 m above sea level (m asl) which is located in Labuhan Haji Village, Pringgabaya District, East Lombok Regency, West Nusa Tenggara Province, Indonesia. The results of soil analysis which was conducted previously before experiment is presented in Table 2. These results indicate that the soil pH is neutral. Neutral soil pH conditions are ideal soil conditions for plant growth. The total NPK nutrient content in the soil is very low, but the P and K nutrients available in the soil are very high. According to Bouajila and Sanaa (2011), the availability of P in the soil is influenced by pH, and the highest P availability is at pH 6.8-7.2.

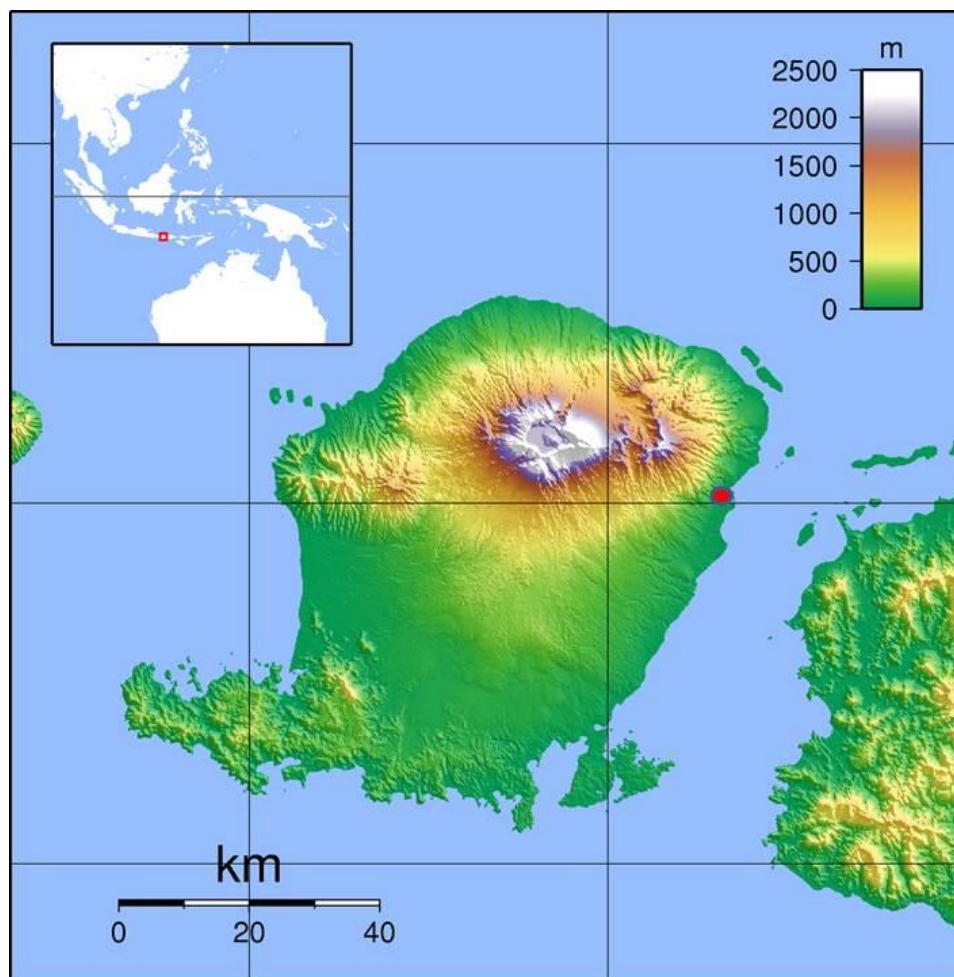


Figure 1 - Map of Lombok Island where the experimental site is in Labuhan Haji Village, East Lombok Regency, West Nusa Tenggara Province, Indonesia with red dot sign in the eastern part of the map

Table 2 – Results of preliminary soil analysis at the experimental site in 2019<sup>\*)</sup>

Parameter Analysis	Unit	Value	Status	Method
pH-H <sub>2</sub> O	-	8.14	Slightly alkaline	Electrode pH-Meter
N Total	%	0.11	Very low	Kjeldahl
P Total	%	0.05	Very low	Spectrophotometer
K Total	%	0.45	Very low	AAS
P available	ppm	23.97	Very high	Spectrophotometer
K available	ppm	101.31	Very high	AAS
CEC	cmol/kg	16.26	Low	Percolation

<sup>\*)</sup> Based on the *Soil, Fertilizer and Plant Analysis Manual, Indonesian Soil Research Institute, 2009*.

Cation Exchange Capacity (CEC) at the experimental site is low with a value of 16.26 cmol/kg but still above the average CEC for sandy soils, which is generally 2-4 cmol/kg (Ashari, 1995). Factors that can increase CEC are based on the amount of clay and organic matter (Darlita *et al.*, 2017). The very low C-organic content of the soil affects the CEC value of the soil. Sulastri (2006) stated that CEC in general can provide an overview of the amount of soil cations in available form that can be utilized by plants.



Figure 2 – Shallot sowing activities in the experimental site on 3<sup>rd</sup> April 2019



Figure 3 – Growth performance of shallot in the experimental site during the growing season in 2019



Figure 4 – Harvesting activities of shallot in the experimental site 70 days after sowing



Figure 5 – Bulbs of shallot harvested from the experimental site during the growing season in 2019

**Plant Height and Number of Leaves.** Parameter of plant height was measured in cm from the soil surface to the tip of the highest leaf as many as 7 plants in each experimental plot at the age of 20 and 70 DAS. Based on the results of ANOVA analysis, treatment B4



with a dose of 75% inorganic fertilizer coated with activated charcoal showed the highest plant and had the highest number of leaves. This shows that the application of 75% dose of inorganic fertilizer coated with activated charcoal has been able to meet the needs of plants to grow the highest and produce the highest number of leaves (Table 3). According to Foth (1994) in Olvie *et al.* (2015) that the determination of concentration and dose in fertilization is very important because it will have an adverse effect on growth if it is not in accordance with plant needs.

Table 3 – The results of ANOVA parameters of plant height and number of leaves during field experiment in 2019

Treatment	Plant Height 20 DAS	Stdev	Plant Height 70 DAS	Stdev	Number of Leaves 20 DAS	Stdev	Number of Leaves 70 DAS	Stdev
B1	46,86 a	6,031	48,43 a	6,925	25,14 a	12,59	22,57 a	5,86
B2	46,43 a	6,768	46,14 a	6,149	25,00 a	6,78	15,14 a	2,67
B3	48,14 a	3,671	48,29 a	9,482	27,14 a	5,52	16,43 a	5,38
B4	50,07 a	6,354	53,00 a	3,000	35,43 a	10,97	26,43 a	16,81
B5	49,71 a	4,821	50,71 a	6,651	31,29 a	7,97	22,57 a	7,85

Note: The average value followed by the same letter in the same column means that it is not significantly different in the Tukey's Test 5%.

Based on the data in Table 3, the application of activated charcoal coated rice husks in reducing the dose of inorganic fertilizer use can offset the 100% dose of inorganic fertilizer use. According to Wijayanti (2009) that mashed rice husk charcoal is recommended to be used because it has absorption speed. In a research report, Gusmailina *et al.* (2000) argued that the application of activated charcoal in the growing media could increase the growth of *Eucalyptus urophylla* better than fertilizer, but the growth would be better when the activated charcoal was mixed with compost. Lempang and Tikupadang research report (2013) stated that the growing medium for seedlings of *Gmelina arborea* Roxb added with activated charcoal at a level of 15% could increase the growth of 8.20% in height, 45.95% in stem diameter and 58.82% in biomass weight.

In addition to functioning as absorption, husk charcoal can increase soil pH, thereby increasing the availability of phosphorus (P). It is known that P fertilizer is a macronutrient fertilizer needed by plants, including for the formation of ethriphosphate fertilizer (ATP). ATP is a fertilizer that plants need in every cell activity which includes cell division, enlargement and elongation so that the availability of P affects the growth of plant height. Gardner *et al.* (1991) stated that the increase in plant height occurred due to cell division and an increase in the number of cells that needed fertilizer in the form of ATP. Lingga and Marsono (2007) added 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 the formation of forage leaves which are very useful in the process of photosynthesis.

Table 4 – The results of ANOVA parameter for number of shallot bulbs during field experiment in 2019

Treatment	Number of Bulb 20 DAS	Stdev	Number of Bulb 70 DAS	Stdev
B1	3,71 a	1,799	4,71 a	1,704
B2	4,14 a	1,952	3,29 a	0,756
B3	4,30 a	1,813	4,86 a	1,676
B4	5,57 a	1,512	6,14 a	3,132
B5	5,00 a	1,826	5,86 a	2,116

Note: The average value followed by the same letter in the same column means that it is not significantly different in Tukey's Test 5%.

The availability of nutrient fertilizers in the soil that affects plant growth in this case the number of leaves, plants that do not get additional N fertilizer will grow stunted and the leaves are formed smaller, thinner and less in number, while plants that receive N fertilizer grow taller and leaves are formed more and extensive (Poerwowidodo, 1992). Charcoal has



a lot of pores, therefore, even though it is large, it is light, and husk charcoal is no exception. These pores function to bind by absorbing nutrient fertilizers, and if nutrient fertilizers have been absorbed then when watered, nutrient fertilizers do not dissolve in water (Rudy, 2019). The nitrogen given is soluble, it is hoped that the application of activated charcoal can make the nitrogen available slowly release for plants.

Based on the results of data analysis in Table 4, it is known that the highest number of shallot bulbs was in treatment B4 with a dose of 75% inorganic fertilizer coated with activated charcoal. This shows that the addition of activated charcoal coating on inorganic fertilizers can reduce the amount of fertilizer used with yields exceeding the B1 treatment which use of full dose of inorganic fertilizers. According to Engelstad (1997) in Olvie *et al.* (2015), optimal application of N can increase plant growth, increase protein synthesis, chlorophyll formation which causes leaf color to become greener, and increase root ratio. The number of tillers greatly affects the number of bulbs in the plant. The more the number of tillers, the more the number of bulbs produced. The availability of nutrients in plants can affect the number of bulbs in plants. Pohan *et al.* (2002) stated that charcoal has the potential to be developed as a nutrient absorber and releaser (in fertilizers) in the field of soil fertility because it has a large surface area and is approximately the same as soil colloid. With the application of husk charcoal, it can make slowly absorbed fertilizer available to plants and make fertilizer not easily soluble in water. The high pH of husk charcoal increases the availability of P element, which is known to function as P to form flowers, fruit and seeds.

Table 5 – The results of ANOVA parameters of weight and weight after a shelf life of 30 and 60 Days After Harvest (DAH)

Treatment	Weight (kg/ha)	Stdev	30 DAH (kg)	Stdev	60 DAH (kg)	Stdev
B1	2271,3 a	311,1	1303,3 b	292,9	1146,7 b	290,4
B2	2475 a	677,7	1826,7 a	210,8	1700 a	191,1
B3	2855 a	271,2	1838,3 a	162,6	1723,3 a	213,9
B4	2927,7 a	282,7	1955 a	39,1	1815 a	35
B5	2416,7 a	4,575	1876,7 a	157,5	1758,3 a	151,8

Note: The average value followed by the same letter in the same column means that it is not significantly different in Tukey's 5% Test.

With a high pH value of activated charcoal that increases the availability of P. Rinsema (1986) states that phosphorus is very influential in growth and yield formation, where phosphorus functions in energy transfer and the photosynthesis process. The availability of phosphorus in sufficient quantities at the beginning of growth will affect the productive parts of the plant, especially in fruit formation, because at this phase, an adequate supply of P nutrients is needed.

Table 5 shows that the storage weight of shallot bulbs at 30 and 60 DAH was highest in the B4 treatment, i.e. the dose of inorganic fertilizer was 75% coated with activated charcoal. Pangaribuan (2008) in Zulyana (2011) states that the dry weight of plants will increase if photosynthesis increases, so that biomass will be absorbed along with the photosynthesis process. The amount of biomass absorbed will affect the high and low dry weight of the plant. Sudrajad (2015) stated that the total dry weight of plants is a reflection of the accumulation of organic compounds that have been successfully synthesized by plants from inorganic compounds (nutrients, water, and carbon dioxide). Pahan (2008) argued that a good crop fertilization strategy must refer to the concept of maximum effectiveness and efficiency including: the type of fertilizer, the time and frequency of fertilization and the method of applying fertilizer. The addition of husk charcoal coating has an effect on the vegetative and generative growth of plants. The correlation of plant growth is influenced by the availability and distribution of food in other parts of the plant, the use of more water or nutrients in a part of the plant, the presence of growth regulators, or the formation of certain substances in plants (Darmawan and Baharsjah, 2010).



## CONCLUSION

Based on the results of the field experiment, it can be concluded that the application of inorganic fertilizers as much as 75% of the standard dose plus activated charcoal coated can give the highest effect on plant height, number of leaves, number of bulbs, yields and weight of shelf life 30 to 60 days after harvesting.

## CONFLICT OF INTERESTS

Authors clearly declare that they have no competing interests.

## CONTRIBUTORSHIP

Both authors, Titin Sugianti and Baiq Nurul Hidayah, contributed equally during the field experiment and in the process of preparing and publishing this paper.

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