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The Effect of Dosage and Time of Application Potassium Fertilizer on Growth of Bidara (*Ziziphus Rotundifolia*)

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Abstract

This research aimed to analyze the effect of dosage and time of application and potassium fertilizer to bidara plants' (*Ziziphus rotundifolia*) growth. This research was arranged by Split Plot design in a Randomized Complete Block Design (RCBD). The Factor of Potassium time of application, that were during planting, 2 weeks after planting; 4 weeks after planting; 6 weeks after planting, was as the main plot, while the potassium fertilizer dosage of (K_2O) 0 kg ha^{-1}, 60 kg ha^{-1}, 120 kg ha^{-1}, 180 kg ha^{-1} as secondary plot. The results showed that the time of application of Potassium fertilizer had an effect on the height of the best Bidara at the age of 2 week after planting. The 60 kg K2O ha-^{1} dosage can increase plant height from 2 week after aplication to 10 week after aplication. The applications of 4 week after planting produced in a higher number of shoots than applications at 2 or 6 week after planting. The fertilizer application at 6 weeks after planting showed the highest fresh leaf weight and dry leaf weight which were 50,631 g and 20,900 g and the lowest in application 2 weeks after planting were 24,263 g and 12,925 g. The fertilizer dosage as much as 60 kg ha^{-1} produced the highest dry weight which 18,069 g. Fertilizing as much as 180 kg ha^{-1}, showed the highest root fresh weight of at 12,757 g, compared to the control (8,900 g). The Potassium application of 6 week after planting produced the longest root growth (20,500 cm) compared to other treatments.

Keywords: bidara, dosage, fertilizer, potassium,

INTRODUCTION

Bidara plant (*Ziziphus* spp). is a Rhamnaceae family that has been known and used as a traditional medicinal plant in Africa, India, Iran, China, Russia, and Europe (Ghout, 2010; Golmohammadi, 2012; Saad *et al*, 2013). This plant has sweet fruit that can be eaten directly as a snack and also useful as a flavor for food, that's why this plant is much needed in food and pharmaceutical industry (Jinwei Li et al. 2011). In each 100 g, it contains 17 g of carbohydrates, 5.4-10.5 g of sugar, 0.07 g of fat, 0.8 g of protein and 81.6-83.0 g of water (Bhatt and Dhyani, 2013). Ziziphus jujuba species is rich in vitamin C, in each 100 g of fruit flesh, it contains 188 to 544 mg of vitamin C, besides, there is vitamin (thiamina) B1 and vitamin B2 (riboflavina) (Shanmugavasan *et al*, 2011). Secondary metabolites compounds such as alkaloids, flavonoids and phenolic components, terpenoids and saponins are widely found in the roots, stems, leaves, fruits and seeds (Mahajan and Chopda, 2009). These compounds play a role in preventing the attacks of human immunodeficiency virus (HIV) which can lead to acquired immunodeficiency syndrome (AIDS) condition, a cancer in human (Mishraet al, 2011; Bhatt, and Dhyani, 2013). Bidara plants are used as herbal medicines to treat diabetes, tumors and cardiovascular diseases (Qing-Han Gaoa *et al*. 2011). Other uses of Bidara plants are as anti-diarrhea / disentry, tuberculosis, insomnia, asthma and it is also used to reduce blood pressure (Sing *et al*, 2002). Bidara are cultivated plants, especially in the Middle East like Iran and other countries such as Africa, India, and China. In Indonesia, Bidara grows as a wild plant, it has not been cultivated but in some areas in Indonesia the fruit is consumed as a snack and the leaves are used to cure stomachache. Bidara plants as high-economic-value plants need to be saved and cultivated in Indonesia. Currently, the largest supplier country of Jujube plants for the Industry needs is China. In the future, Indonesia can also utilize one of the potential wealth of plant resources as its superior commodity to improve the health and welfare of the community. The increasing for high-value plants can be achieved through the activities of plants domestication which begins with an exploration of potential species scattered in several regions to a modification of the micro environment to test its adaptability. Nutritional factors are the the basic needs for plants to encourage their growth and development. One of macro elements that plays an important role in the plant's metabolic system is Potassium (K). If it is associated to the K content of soil on agricultural land, the conditions are quite diverse. Generally, rice fields contain more K than dry land. In addition, soil types and natural processes have an effect on determining K inputs and outputs to and from the land (Subandi, 2013). The K element is most absorbed in food crops so that observation improvement is needed to the potassium management. The goal is that the K status of the land is maintained or not rapidly declining, and it is also intended to prevent waste and provide the necessary nutrients. Potassium is classified as a mobile element in plants; in cells, in plant tissues, and in xylem and phloem. Plants will not be able to use potassium excessively in relation to the effectiveness of absorption of other elements such as nitrogen and phosphorus. The proper potassium giving will increase the absorption efficiency of both elements (Syakir and Gusmain, 2012). The treatment of environmental modification to spur plant growth can be done through improved time of application that is effective in providing fertilizers and the right measure so that efficiency can be achieved.

METHOD

This research was conducted at Green House of Agriculture Faculty, Bambu Kuning Universitas Nasional, South Jakarta. The plant material used was one-year-old Bidara (*Ziziphus rotundifolia*) seedling cuttings. The length of cuttings was 25 cm, the average stem diameter was 0.7 cm. Other ingredients used were KCl fertilizer, the planting media were in the form of fuel husk, soil (that were dried by wind then sieved) and cow manure, and the composition of husk planting media: soil: fertilizer was 1: 1: 1 v / v. The equipment used for laboratory analysis included scales, ovens, laboratory equipment (such as pipettes, measuring cups, measuring flasks), shaker machines, filter paper, thermometers, analytical scales, digestion tubes, pipettes, shakers, heating devices, purifying paper water used to analyze soil content. Other equipment in the form of stationery, cameras, poly bags with a 30 cm diameter, measuring cups for watering plants, Thermo hygrometer (as a measuring temperature and humidity), calipers, meters, mattress threads, bamboo stands, scissors cuttings. The study was arranged in a Randomized Block Design (RBD) with Split Plot. The main plot was time of application which was during planting, 2 weeks after planting; 4 weeks after planting; 6 weeks after planting, while the secondary plot was a measure of potassium fertilizer (K_2O) 0 kg ha^{-1}, 60 kg ha^{-1}, 120 kg ha^{-1}, 180 kg ha^{-1}. The application of Potassium fertilizer was done after the seeds were one month old after the transferring from the nursery to a new media. The aim was to provide conditions for plants to adapt first to a new media. The potassium fertilizer distribution was done by giving it with circular motion in the root area, the distance from the upper root was 15 cm. Watering was done every three days with the addition of 500 ml of water per poly bag pot. The growth observation begins at 2 weeks after the application was completed every two weeks. The variables measured included the number of shoots, shoot length, mean while root length, dry and wet root weight, and dry and wet leaf weight. The data were analyzed by Variance Investigation and further testing with Duncan Multiple Range Test α 5%.

RESULT

Bidara plants grow and develop in shade houses that are given UV plastic roofs and covered with shading net. The microclimate conditions in the shade house were the average daily temperature ranging from 27 °C to 33 °C and the average humidity was 67%.

Table 1. Bidara Plant Height Observation at 2-10 weeks after Planting

Time of Application and/ fertilizer dosage	Bidara Plant Height (cm)				
	2	4	6	8	10
F0: at planting time	82.813 a	89.875 ab	90.375 a	91.838 a	88.931 b
F1:2 week after planting	80.563 b	90.675 ab	91.931 a	91.931 a	73.919 c
F2:4 week after planting	70.273 b	102.721 a	73.914 a	83.700 a	91.800 b
F3:6 week after planting	81.333 b	83.533 b	86.533 a	86.533 a	112.180 a
D1: 0 kg ha^{-1}	72.667 b	92.219 a	89.406 ab	83.281 ab	83. 190 b
D2: 60 kg ha^{-1}	86.467 a	90.493 a	92.140 a	92.707 a	93.990 ab
D3: 120 kg ha^{-1}	81.214 ab	95.119 a	75.313 b	80.819 b	102.360 a
D4: 180 kg ha^{-1}	88.786 a	87.507 a	88.007 ab	88.136 ab	96.100 a

Note: Numbers followed by the same letter in the same column are not significantly different in the 5% Duncan α test.

Description: F0: Application at Planting Time; F1: Application at 2 weeks after planting;
F2: Application at 4 weeks after planting; F3; Application at 6 weeks after planting.
D1; Dosage of 0 kg ha^{-1}; D2: 60 kg ha^{-1}: 120 kg ha^{-1}; 180 kg ha^{-1}

Effect of application time of potassium fertilizer on plant height and morphological form of bidara is presented in Figure 1 and Figure 2

(a) (b)

Figure 1. Effect of application time at planting (a) and 2 weeks after planting (b) on height
Plant

Description: F0: Application at Planting Time; F1: Application at 2 weeks after planting;
F2: Application at 4 weeks after planting; F3; Application at 6 weeks after planting.
D1; Dosage of 0 kg ha^{-1}; D2: 60 kg ha^{-1}: 120 kg ha^{-1}; 180 kg ha^{-1}

(c) (d)

Figure 2. Effect of application time 4 MSA (c) and 6 weeks after planting (d) on plant height

Description: F0: Application at Planting Time; F1: Application at 2 weeks after planting;
F2: Application at 4 weeks after planting; F3; Application at 6 weeks after planting.
D1; Dosage of 0 kg ha^{-1}; D2: 60 kg ha^{-1}: 120 kg ha^{-1}; 180 kg ha^{-1}

The growth of plant height at various fertilizer dosages is presented in Figure 3 and Figure 4 below:

 

F0 F1

Figure 3. Effect of Fertilizer dosage on Bidara Plant Height From left to right F0 on D1, D2, D3, D4 and F1 on D1, D2, D3, D4

Description: F0: Application at Planting Time; F1: Application at 2 weeks after planting;
F2: Application at 4 weeks after planting; F3; Application at 6 weeks after planting.
D1; Dosage of 0 kg ha^{-1}; D2: 60 kg ha^{-1}: 120 kg ha^{-1}; 180 kg ha^{-1}

 

F2 F3

Figure 4. The Effect of Potassium Fertilizer dosage on Plant Height from the left go right F2 on D1, D2, D3, D4 and F3 on D1, D2, D3,, D4

Description: F0: Application at Planting Time; F1: Application at 2 weeks after planting;
F2: Application at 4 weeks after planting; F3; Application at 6 weeks after planting.
D1; Dosage of 0 kg ha^{-1}; D2: 60 kg ha^{-1}: 120 kg ha^{-1}; 180 kg ha^{-1}

The results of observing the number of shoots are shown in Table 2 below:

Table 2. Number of Bidara Shoots at the 2-10 after Planting

Time of Application and fertilizer dosage	Number of Bidara Shoots				
	2	4	6	8	10
F0: at planting time	31.688 bc	34.313 bc	39.438 c	46.438 c	60.500 b
F1:2 week after planting	29.375 c	28.563 c	33.625 c	40.625 c	52.216 c
F2:4 week after planting	58.538 a	60.846 a	60.769 a	67.769 a	82.154 a
F3:6 week after planting	39.188 c	41.750 b	46.125 b	53.313 b	67.563 b
D1: 0 kg ha^{-1}	38.067 a	40.667 ab	45.400 a	52.400 a	66.763 a
D2: 60 kg ha^{-1}	43.938 a	44.813 a	47.750 a	54.688 a	69.063 a
D3: 120 kg ha^{-1}	36. 143 a	40.143 ab	44.429ab	51.463 ab	65.929 a
D4: 180 kg ha^{-1}	38.067 a	36.000 b	39.375 b	46.438 b	57.688 b

Note: Numbers followed by the same letter in the same column are not significantly different in the 5% Duncan α test

Table 3. Results of Bidara plant growth (fresh weight, dry weight leaft, fresh root weight, root dry weight, root length) at the 10 weeks after planting

Time of Application and fertilizer dosage	Variable of Bidara Growth				
	Fresh weight plant (g)	Dry weight of leaf (g)	Fresh root Weight (g)	Root Dray weight (g)	Root Leng (cm)
F0: at planting time	31.388 b	14.956 b	11.194 a	5.2313 a	20.294 a
F1:2 week after planting	24.263 b	12.925 b	9.219 a	3.8313 a	14.863 b
F2:4 week after planting	33.257 b	15.144 b	11.767 a	5.0563 a	14.807 b
F3:6 week after planting	50.631 a	20.900 a	11.000 a	4.9687 a	20.500 a
D1: 0 kg ha^{-1}	29.969 a	13.769 b	8.900 b	3.8125 a	17.663 a
D2: 60 kg ha^{-1}	40.506 a	18.069 a	10.338 ab	4.7062 a	18.975 a
D3: 120 kg ha^{-1}	32.694 a	15.063 ab	11.186 ab	5.1250 a	18.050 a
D4: 180 kg ha^{-1}	36.814 a	17.025 ab	12.757 a	5.4438 a	15.914 a

Note: Numbers followed by the same letter in the same column are not significantly different in the 5% Duncan α test

DISCUSSION

The results of observations and analyzes to the number of shoots showed that the time of application of potassium fertilizer had a significant effect to the growth of the Bidara's shoot, as well as the dosage of fertilizer. The interaction between the time of application and fertilizer dosage to the number of shoots formed was not significant. Bidara plants grow and develop in shade houses that are given UV plastic roofs and covered with shading net. The microclimate conditions in the shade house were the average daily temperature ranging from 27 ^{o}C to 33 ^{o}C and the average humidity was 67%. The pH analysis of planting media after the plants were harvested was between 7-8. There was no attack of pests on plants, but only in a few plants seen that there were whitish parts on the leaves. Bidara's stem looked to grow quickly but had a weak condition so it easily fell. To help the stem grow upright, it was supported by a bamboo wood so as not to fall down and to arrange the plants so that they did not cover one another. An observation of the development of Bidara plants' height was carried out at the age of 2 weeks after the completion of potassium fertilizer application. The growth of its height increased until the observation at week 10 after aplication. The results of the analysis showed that there was no real interaction between time of application and the Potassium measure to the height of Bidara plants. However, the time of application and Potassium fertilizer measure were significantly influence the height of Bidara plants. Potassium application at planting time showed a higher growth of Bidara plants at the second week observation as well as 10 weeks observation after the planting. It is assumed that the potassium applied at the time of planting can be immediately utilized by plants because the plants that were in the stadia would actively grow. The Potassium giving in the active stage phase will also help in the process of absorption of other elements such as Nitrogen and phosphorus. These three elements are essential elements and are needed in large quantities for plant growth and development. Plants absorbed potassium during the active stadia and increased along with the plant growth improvement, if in these phases the availability of potassium in the soil was lacking, potassium would undergo mobilization from the old leaf parts. The Potassium giving in the early phases of plant growth allowed plants to use it more quickly because the plants were actively doing metabolism for the growth of shoots so they could grow faster. The Potassium application at the age of 6 weeks after the planting showed better growth in 10 week after aplication observations. This was presumably because the amount of fertilizer to plants was sufficient for the needs of plants so that they could be optimally utilized by plants for the growth and elongation of their cells. The Potassium fertilizer measure significantly affected the height of Bidara plants. The giving of Potassium fertilizer as much as 60 kg K_2O ha-^{1} consistently was able to increase plant height from the age of 2 week after aplication to the age of 10 week after aplication. At the age of 10 week after aplication, the plant height was significantly different from K giving at 120 kg K2O ha-1 compared to the control. This was presumably because the role of Potassium, as an essential nutrient used in all metabolic processes, could support cell metabolism in plants. Potassium (K) is the third main nutrient after N and P which plays a role in the opening and closing of the stoma which strongly supports photosynthetic activity. Besides, the nutrient absorption of N, P and K was getting better with K fertilization. This is in line with Sahari's (2007) statement that high absorption of N influences leaf width and greener leaf color so photosynthesis works better. Photosynthesis results are used for plants' growth and improvement , plants' length or height growth, new branch and leaf formation. The addition of Potassium to a dose of 180 kg ha -1 was not followed by the increase of Bidara plants' height. The results of observations and analyzes to the number of shoots showed that the time of application of potassium fertilizer had a significant effect to the growth of the Bidara's shoot, as well as the dosage of fertilizer. The interaction between the time of application and fertilizer dosage to the number of shoots formed was not significant. The results of observing the number of shoots are shown in Table 2 above, the treatment of potassium fertilizer at the age of 4 weeks after planting tended to produce a higher number of shoots compared to the potassium fertilizer giving at the age of 2 and 6 week after planting. Consistently, the treatment showed differences until week 10 of the week after application observation. The increasing number of shoots was assumed that in the early stages of growth, plants would encourage growth in the apical part of the shoots so that the concentration of nutrient use was preferred for cells multiplication in the shoots to increase plant height. The next phase of nutrition would be used for the formation of side shoots so that the application of Potassium fertilizer at the age of 4 week after planting was then used to multiply shoots or branches. Fertilizer doses significantly influence the number of shoots in Bidara plants. The addition of 60 kg of fertilizer ha-1 was consistently able to increase the number of shoots of Bidara plants from the ages of 2 to 10 week after aplication. The increasing amount of the Potassium fertilizer given up to 180 kg ha-1 actually did not increase the number of formed shoots. This was presumably because plants would use nutrients in sufficient quantities according to the growth phase. The K element plays a role in maintaining plasma cells in order to be in 100 to 200 µM, to keep turgor cells stability in opening and closing event of stomata. In addition, K element also strengthens the cell wall and is involved in the *Lignification* process of the *Sclerenchym* tissue so that the tissue becomes stronger and is able to protect plants from external disturbances (Fageria et al, 2009). The results of the analysis showed that the Potassium fertilizer time of application showed a significant effect on the fresh leaves weight and dry leaves weight. Fertilizer application at 6 weeks after planting, showed the highest fresh Bidara leaf weight and highest weight of dry leaf compared to other treatments which were 50.631 g and 20,900 g then the lowest in application of 2 weeks after planting with a weight of 24.263 g respectively and 12,925 g. Leaf weight is a parameter that reflects the water content and accumulation of photosynthetic results stored in plant tissues, especially leaves. Applications at the age of 6 weeks after planting allowed nutrients available in the media to be utilized by plants to stimulate photosynthetic activity so that the weight of plant leaves was higher. Potassium deficiency and water stress for 21 days decreased the canopy growth but it coud increase root growth also root and canopy ratio. The amount of Potassium fertilizer given to plants had no significant effect on the weight of fresh leaves but has a significant effect on the weight of oven dried leaves. The addition of fertilizer as much as 60 kg ha^{-1}, could increase the dry weight of Bidara leaves. However, the addition of K fertilizer to a dose of 180 kg ha^{-1} did not increase the dry leaf weight of Bidara plants. Fertilizer provision as much as 60 kg ha^{-1} produced the highest dry leaf weight (18,069 g). It is assumed that plants have experienced saturation during absorption of Potassium so that the addition of the given dose of Potassium did not show an increase in dry leaf weight. This opinion is supported by Syakir and Gusmain (2012), reporting that administration of potassium to 60 kg ha-1 has been able to increase patchouli growth in the fresh and dry weight variables compared to controls. Furthermore (Tisdale, et al 1985) which stated that the availability of nutrient K needs to be observed because the phenomenon of "luxury consumption ", namely plants absorbing K exceeds the need for optimum growth, and excess K absorbed by plants is less useful for increasing growth / results so that waste occurs. This is consistent with the results reported by La Ode *et al*. (2011), that the potassium fertilizer giving to 600 kg K_2O ha-1 was able to increase pineapple production but at higher doses of 800 kg ha^{-1} tended to reduce production. Harahap (1992) stated that higher K giving can reduce absorption of Ca and Mg which ultimately disrupts plant growth and production. Giving Potassium can improve the condition of plants more resistant to drought stress because of cell wall thickening. The increasing of enzyme activity, the increasing of the intensity of photosynthesis accelerated the transfer of materials made during photosynthesis and also, plays a positive role in nitrogen transfer and protein synthesis (Gholizadeh *et al*., 2012). In conditions of potassium deficiency, the potassium content and elements of Fe, Mn, Zn, B, Mo and Al in the leaves are also low (Egilla *et al*, 2001). This will affect the formation of chlorophyll and the rate of photosynthesis. This is supported by the opinion of Edy (2012) that the potassium giving at a rate of 37.5 kg KCl-ha^{-1} to 75 kg KCl ha-1 increases stomatal width, chlorophyll content and water use efficiency. Root weight as shown in Table 3 above showed that, the time of application did not significantly affect fresh root weight, oven dry root weight. The dosage of Potassium fertilizer significantly affects the fresh weight of the roots, the higher the amount of potassium fertilizer given, the higher the weight of Bidara root. Giving fertilizer as much as 180 kg ha-1 yielded the highest fresh root weights of 12,757 g, compared without being given Potassium as a result of the weight of 8,900 fresh Bidara roots g. Giving a higher K will increase the absorption of water by plants, causing the root fresh weight to increase. This is consistent with the opinion of Sudarma et al (1998) which stated that the application of K when planting under water stress significantly increases diffusive stomata resistance thereby decreasing transpiration and increasing water potential. The time of application of Potassium fertilizer significantly affected the length of Bidara root. Potassium fertilizer application when planting provides a better influence on root development, as well as application at 6 weeks after planting the development of root length was higher than the application at 2 and 4 week after planting. Allegedly the active phase of the growth of Bidara plants tends to cause the roots to try to develop faster to find food in the medium of growth. Fertilizer dosage had no significant effect on root length, so there was no interaction between time of application and fertilizer dosage on fresh root weight and dry root weight as well as Bidara root length.

CONCLUSION

The effect of high potassium fertilizer application bidara plant seeds are best obtained at the age of 2 weeks after planting. The potassium fertilizer giving as much as 60 kg k2o ha-1, could increase plant height from the age of 2 week after application to the age of 10 week after application. The treatment of potassium fertilizer at the age of 4 weeks after planting resulted in a higher number of shoots compared to potassium fertilizer at the age of 2 and 6 week after planting. Potassium fertilizer application at the age of 4 weeks after planting resulted in the highest number of shoots compared to the other treatments. Fertilizer application at 6 weeks after planting yielded the highest fresh leaf weight and oven dry leaf weight respectively 50,631 g and 20,900 g and the lowest weight in the application 2 weeks after planting was 24,263 g and 12,925 g, respectively. 60 kg ha-1 of fertilizer produced the highest dry weight of Bidara leaves (18,069 g).

Giving fertilizer as much as 180 kg ha-1 resulted in the highest fresh root weights of 12,757 g, compared to the control results of the weight of fresh Bidara roots weighing 8,900 g. Potassium application in 6 week after aplication produced the longest root growth that was (20,500 cm) different from other treatments.

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