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Effectiveness of Gandasil D Fertilizer Concentration on *Indigofera* Seedling Growth in Various Growing Media Compositions

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Abstract

Indigofera sp. is an environmentally friendly source of indigo dye for batik production and a material for livestock industry because this plant potentially serves as a forage protein source. This plant has the potential to be further developed and its cultivation requires quality seeds. Seedling growth is an important factor in achieving maximum productivity. Increasing its growth can be done by providing sufficient nutrients and using appropriate growing media. The results showed that there was an interaction between the concentration of Gandasil D fertilizer and growing media composition, namely at Gandasil D fertilizer concentration of 2 g/1 liter of water and a growing medium consisting of coco peat and compost with the parameters of plant height and stem diameter observed at 10 WAP. The Gandasil D fertilizer concentration of 2 g/1 liter of water affected the growth of *Indigofera seedlings* more effectively than other concentrations. A growing medium consisting of coco peat and compost with a ratio of 1:1 was more effective in boosting the growth of *Indigofera* seedlings than growing media consisting of other compositions.

Keywords: Fertilizer Concentration, Growing Media Composition, Indigofera

INTRODUCTION

Indigofera sp. has a benefit as a natural dye because the leaves of this plant contain indigo pigment, that is a dye with the colour greenish blue, so it can be used as a source of blue dye for batik production as a new and more environmentally friendly innovation. In addition, *Indigofera sp.* is one genus that is beneficial for the livestock industry because it serves as a forage protein source. In terms of nutrient content, it has been reported that *Indigofera sp*. is classified as a legume shrub that can produce high quality forage. This plant has an economic value because using *Indigofera sp.* can lower feed costs by 20-30% (Haryanto and Sasmita, 2020).

Indigofera sp. has the potential to be further developed and its cultivation requires quality seedlings. Good seedling growth can be achieved with good growth supporting factors. In addition to internal or genetic factors, there are also external factors or the environment that affects plant growth. The environment where the plants grow is crucial for the growth of *Indigofera* seedlings, namely providing sufficient nutrients for the plants and providing growing media as needed for the growth of *Indigofera sp*.

Plants require proper care for their growth and development. One of the efforts to optimize plant growth is fertilization. Fertilization is to administer fertilizer to plants, either directly on the plant organs or on media where the plants grow, intended to increase the quality and quantity of plant growth and productivity (Tresia and Saenab, 2020). Fertilization can be done either through the soil or through the leaves. The types of fertilizer needed are those containing NPK chemical elements and other complementary elements. Gandasil D fertilizer is a foliar fertilizer that contains both macro and micro nutrients. The nutrients contained in this

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fertilizer include nitrogen (N) 14%, phosphate (P) 12%, chlorine-free potassium (K:) 14%, magnesium (Mg) 1%, manganese (Mn), zinc (Zn) and various vitamins for plant growth, such as Nicotinic Acid Amide, Aneurine and Lactoflavine. In addition, this fertilizer has an important property that makes it possible to be used simultaneously with pesticides (Panggabean, 2007). Gandasil D fertilizer is administered through the leaves by spraying. The nutrients are absorbed by the leaves by diffusion and osmosis mechanisms through the stomata. Thus, the mechanism of absorbing nutrients through the leaves is directly related to the opening and closing of the stomata. Stomatal opening is a process regulated by turgor pressure and at that time, nutrients enter leaves through stomata by diffusion together with water. Fertilizer that is sprayed on the leaves enters the leaf or plant cells through the leaf stomata that are found on both the lower and upper surface of the leaves, making it possible to be used in biochemical processes that take place in plants.

In foliar fertilization, fertilizer concentration determines its success. If the fertilizer is excessive then the plant will die; if the fertilizer is not adequate, the yield will not be good because the plant will lack the fertilizer that it needs. In relation to this, fertilizer producers have usually included instructions concerning the use of fertilizer on the packaging label, but there has not been a proper concentration for *Indigofera sp*. The commonly used concentration is 2 grams/liter of water (Andalasari et al., 2014).

In addition to the concentration of Gandasil D fertilizer, the use of various materials as the growing media in the nursery also plays an important role, regarding the fact that nursery is the early stage of root development. Growing media is a medium or material used as a place to grow and develop plant roots. An important function of growing media is to support plants, especially for plants that are grown in pots or polybags so they can grow well, provide nutrients and provide water for the plants.

Growing media can be made from a single material or a combination of several materials, as far as they function as a good growing medium. One of the key success factors for plant cultivation is to determine the proper growing media composition because it is the beginning of plant cultivation. Several organic materials that can be used as growing media include husk charcoal, compost, and coconut coir or cocopeat.

Husk charcoal is a by-product derived from combustion. The nutrients contained in rice husks are relatively quickly available for plants and able to increase soil pH. Husk charcoal is porous and it does not easily harden so plant roots can grow properly. In addition, the price of rice husk charcoal is relatively cheap, the material is easy to obtain, light, and sterile. Compost is an organic growing medium of which the basic ingredients are derived from the fermentation of plants or organic waste, such as rice straw, husks, leaves, grass, and municipal waste. The advantage of using compost as a growing medium is its ability to restore soil fertility by improving the physical, chemical and biological properties of soil. Besides, compost also facilitates the absorption of nitrogen (N) which is highly needed by plants. Coconut coir or coco peat is an alternative organic material that can be used as a growing medium. Coconut coir that is used as a planting medium should be obtained from old coconuts because they have strong fibers. Coco peat has a high ability to absorb water, namely eight times of its dry weight, and it contains several important nutrients such as N, P, K, Ca and Mg (Mariana, 2017).

The growth of *Indigofera* seedlings is crucial to achieve optimum productivity. Thus, both fertilization and growing media play a very important role. Based on the abovementioned description, the researchers were interested in conducting a study entitled "Effectiveness of Gandasil D Fertilizer Concentration on *Indigofera* Seedling Growth in Various Growing Media Compositions". The study aimed to determine the interaction between Gandasil D fertilizer concentration and growing media composition on *Indigofera* seedling growth, to determine the best concentration of Gandasil D fertilizer for the growth of *Indigofera* seedlings, and to

determine the most suitable growing media composition for the growth of *Indigofera* seedlings.

RESEARCH METHOD

The study was conducted in the garden of the Faculty of Agriculture, UPN "Veteran" Yogyakarta in Sempu, Wedomartani, Sleman, Special Region of Yogyakarta with an altitude of ± 115 m above sea level from April to August 2021. The materials used in this study were *Indigofera arrecta* seedlings, Gandasil D fertilizer, husk charcoal, compost, coco peat, NPK fertilizer (15-15-15), insecticides and fungicides. The study also used various tools, including polybags, hoes, buckets, sprayers, caliper, oven, analytical scales and pruning shears.

This was a field experiment using a Randomized Complete Block Design consisting of two factors. The first factor was three concentrations of Gandasil D fertilizer (K), namely K1 = a concentration of 1 g/1 liter of water, K2 = a concentration of 2 g/1 liter of water, and K3 = a concentration of 3 g/1 liter of water. The second factor was three growing media compositions, namely M1 = husk charcoal: compost (1 : 1), M2: coco peat : compost (1 : 1), and M3 = husk charcoal : coco peat : compost (1 : 1 : 1). There were nine treatment combinations in triplicates. Each of the treatment combinations consisted of six plants and there was a total of 162 plants. The parameters observed periodically at 4, 6, 8, and 10 WAP (Week After Planting) were plant height, stem diameter, number of branches. Meanwhile, the number of twigs (smaller branches), plant fresh weight, and plant dry weight were observed at the end of the study (10 WAP). The data obtained were then analysed by analysis of variance at a 5% level.

RESULT AND DISCUSSION

Plant Height

The results of the analysis of variance showed that there was no interaction of the concentration of Gandasil D fertilizer and the growing media composition on plant height at 4 WAP, 8 WAP and 10 WAP. The concentration of Gandasil D fertilizer and the composition of the growing media did not have a significant effect on the plant height of *Indigofera* seedlings at 4 WAP and 8 WAP. The concentration of Gandasil D fertilizer and the growing media composition had a significant effect on plant height at 10 WAP.

The mean plant height of *Indigofera* seedlings at 4 WAP, 8 WAP, and 10 WAP is presented in Table 1 below:

Table 1. Plant height of *Indigofera* seedlings observed at 4 WAP, 8 WAP, and 10 WAP:

Treatment	Plant Height (cm)		
	4 MST	8 MST	10 MST
Gandasil D Fertilizer Concentration (K)			
K1 = 1 g / 1 liter of water	40.81 a	97.70 a	117.63 b
K2 = 2 g / 1 liter of water	45.93 a	100.07 a	125.52 a
K3 = 3 g / 1 liter of water	41.48 a	97.48 a	115.78 b
Growing Media Composition (M)			
M1 = husk charcoal : compost (1:1)	40.74 p	93.37 p	112.37 q
M2 = coco peat : compost (1 : 1)	43.96 p	104.44 p	128.89 p
M3 = husk charcoal : coco peat : compost (1 : 1 : 1)	43.52 P	97.44 p	117.67 p
Interactions	(-)	(-)	(-)

Where: The mean in the column that is followed by the same letter shows no significant differences based on DMRT at a 5% level.

The K2 factor, namely the Gandasil D fertilizer concentration of 2 g/1 liter of water, showed a higher mean plant height compared to the other Gandasil D fertilizer concentrations observed at 10 WAP. This concentration was believed to be the optimum concentration, thus resulting in better plant height. Treatment with a higher fertilizer concentration unexpectedly was counterproductive because it can inhibit growth. In addition, Gandasil D fertilizer which is administered through the leaves has a faster effect on plants than that administered through the roots. Gandasil D fertilizer is also more effective in addressing lack of micro elements. According to Rinsema (1986) cit., Bernantha et al., (2017), an increase in plant height indicates the growth of plant that results in cell elongation and enlargement. As the plant keeps growing, the growth of the plant is determined by the availability of nutrients in the soil.

The M2 factor, i.e., a growing media composition consisting of coco peat and compost with a ratio of 1 : 1, showed a higher mean plant height compared to the other growing media composition observed at 10 WAP. Adding coco peat in compost media is believed to be able to provide more organic matters. Improved soil physical properties, increased water holding capacity, and increased soil porosity will improve soil fertility by improving the life of soil microorganisms (Irawan, 2014).

Stem Diameter

The results of analysis of variance showed that there was no interaction of the Gandasil D fertilizer concentration and the growing media composition on stem diameter at 4 WAP, 8 WAP and 10 WAP. The treatment with the Gandasil D fertilizer concentrations had a significant effect on the stem diameter of *Indigofera* seedlings at 4 WAP, 8 WAP, and 10 WAP. The treatment with the growing media compositions did not have a significant effect on the stem diameter of *Indigofera* seedlings at 4 WAP and 8 WAP, but it had a significant effect on the stem diameter of *Indigofera* seedlings at 10 WAP.

The mean stem diameter of *Indigofera* seedlings at 4 WAP, 8 WAP, and 10 WAP is presented in Table 2 below:

Table 2. Stem diameter of *Indigofera* seedlings observed at 4 WAP, 8 WAP, and 10 WAP

Treatment	Stem Diameter (mm)		
	4 MST	8 MST	10 MST
Gandasil D Fertilizer Concentration (K)			
K1 = 1 g / 1 liter of water	0.51 b	1.12 b	1.22 b
K2 = 2 g / 1 liter of water	0.59 a	1.27 a	1.38 a
K3 = 3 g / 1 liter of water	0.51 b	1.13 b	1.19 b
Growing Media Composition (M)			
M1 = husk charcoal : compost (1: 1)	0.54 p	1.17 p	1.26 q
M2 = coco peat : compost (1 : 1)	0.53 p	1.21 p	1.34 p
M3 = husk charcoal : coco peat : compost (1 : 1 : 1)	0.54 p	1.13 p	1.19 q
Interaction	(-)	(-)	(-)

Where: The mean in the column that is followed by the same letter shows no significant differences based on DMRT at a 5% level.

The K2 factor, i.e., the Gandasil D fertilizer concentration of 2 g/1 liter of water, showed a larger mean stem diameter than other concentrations observed at 4 WAP, 8 WAP, and 10 WAP. It is believed that providing macro and micro nutrients through Gandasil D fertilizer could affect the growth of the stem, making the stem diameter larger than that of the plants treated

with other concentrations. Nutrients play a very important role; inadequate or excess nutrients will affect the photosynthesis process in a plant which disrupts the plant growth and development, including the stem diameter. Sufficient nutrients are crucial for the development of plant organs because plant growth always requires intensive exchange of substances. Growth will properly take place if the nutrients needed are met (Umar et al., 2016).

The M2 factor, namely a growing media composition consisting of coco peat and compost with a ratio of 1 : 1, showed a larger mean stem diameter compared to the other growing media compositions observed at 10 WAP. This is because a growing medium that combines coco peat and compost is a balanced and proper composition that can improve the physical properties of soil, hold water and nutrients as needed by the plant. The combination of coco peat and compost contains various organic nutrients. The application of the growing media composition along with the administration of Gandasil D fertilizer which is a hormone or growth regulator optimizes the nutrient decomposition process, eventually affecting plant growth and development, including the stem diameter.

Plant Height and Stem Diameter at 6 WAP

The results of the analysis of variance showed that the Gandasil D fertilizer concentration and the growing media composition had an interaction on plant height and stem diameter at 6 WAP. The mean plant height and stem diameter of *Indigofera* seedlings at 6 WAP are presented in Table 3.

Table 3 below shows that there was an interaction between the Gandasil D fertilizer concentration and the growing media compositions. This means that these two factors simultaneously influenced the growth of *Indigofera* seedlings. Giving treatment that combined the K and M factors at the K2M2 level, i.e., the Gandasil D fertilizer concentration of 2 g/1 liter of water and a growing media consisting of coco peat and compost showed higher plant height and larger stem diameter than the other treatments.

Table 3. Plant height and stem diameter of *Indigofera* seedlings observed at 6 WAP

Treatment Combination	Plant Height (cm)	Stem Diameter
K1M1	71.00 a	0.57 bc
K1M2	72.00 a	0.60 b
K1M3	61.22 b	0.47 c
K2M1	65.33 ab	0.62 b
K2M2	74.67 a	0.71 a
K2M3	73.89 a	0.63 b
K3M1	52.67 c	0.49 c
K3M2	72.00 a	0.56 bc
K3M3	71.22 a	0.55 bc

Where: The mean in the column that is followed by the same letter shows no significant differences based on DMRT at a 5% level.

Number of Branches

The results of the analysis of variance showed that there was no interaction between the Gandasil D fertilizer concentration and the growing media composition and that each treatment had a significant effect on the number of branches of *Indigofera* seedlings at 4 WAP, 6 WAP, 8 WAP, and 10 WAP.

The mean number of branches of *Indigofera* seedlings at 4 WAP, 6 WAP, 8 WAP, and 10 WAP is presented in Table 4 below.

The K3 factor, i.e. the Gandasil D fertilizer concentration of 3 g/1 liter of water, showed a lower mean number of branches than the concentration of 1 g/1 liter of water and 2 g/1 liter of water observed at 4 WAP, 6 WAP, 8 WAP, and 10 WAP. It is assumed that the plants could not grow and develop optimally at this concentration because Gandasil D fertilizer already contains quite high macro and micro elements. According to Hochmuth et al., 2009, excess N, P, and K nutrients received by plants will lower the absorption of other nutrients such as Zn, Fe, and Cu, resulting in a deficiency of these three elements. It is necessary to administer the right concentration of fertilizer in every growth stage, especially in the vegetative phase.

The M2 factor, namely a growing media composition consisting of coco peat and compost with a ratio of 1: 1, showed a higher mean number of branches than the M1 and M3 factors observed at 4 WAP, 6 WAP, 8 WAP and 10 WAP. Adding coco peat into compost media is able to increase its water-holding capacity, allowing the growing media to hold water longer for nutrient absorption by plant roots.

Table 4. Number of Branches of *Indigofera* seedlings observed at 4 WAP, 6 WAP, 8 WAP, and 10 WAP

Treatment	Number of Branches			
	4 MST	6 MST	8 MST	10 MST
Gandasil D Fertilizer Concentration (K)				
K1 = 1 g / 1 liter air	8.07 a	8.07 a	14.93 a	17.81 a
K2 = 2 g / 1 liter air	8.19 a	8.19 a	15.44 a	18.37 a
K3 = 3 g / 1 liter air	6.96 b	6.96 b	14.00 b	15.81 b
Growing Media Composition (M)				
M1=husk charcoal : compost(1:1)	7.78 q	7.78 q	14.48 q	16.48 q
M2=coco peat : compost (1 : 1)	8.07 p	8.07 p	15.70 p	18.85 p
M3=husk charcoal : coco peat : compost (1 : 1 : 1)	7.37 q	7.37 q	14.63 q	16.67 q
Interaction	(-)	(-)	(-)	(-)

Where: The mean in the column that is followed by the same letter shows no significant differences based on DMRT at a 5% level.

Number of Twigs, Fresh Weight, and Dry Weight

The results of the analysis of variance showed that there was no interaction between the Gandasil D fertilizer concentration and the growing media composition on the number of twigs, plant fresh weight, and plant dry weight at the end of the study period (10 WAP). The treatment with the Gandasil D fertilizer concentration and the growing media compositions had a significant effect on the number of twigs, fresh weight, and dry weight of *Indigofera* seedlings. The mean number of twigs, fresh weight, and dry weight of *Indigofera* seedlings at 10 WAP are presented in Table 5.

Table 5. Number of twigs, fresh weight, and dry weight of *Indigofera* seedlings observed at 10 WAP

Treatment	Number of Twigs	Fresh Weight (g)	Dry Weight (g)
Gandasil D Fertilizer Concentration			
K1 = 1 g / 1 liter of water	10.07 b	388.33 b	164.12 b
K2 = 2 g / 1 liter of water	12.63 a	481.40 a	183.70 a
K3 = 3 g / 1 liter of water	8.81 c	383.30 b	153.03 c
Growing Media Composition			

(M)							
M1= husk charcoal : compost (1: 1)	11.26	q		413.67	q	165.51	q
M2 = coco peat : compost (1 : 1)	12.52	p		477.97	p	199.67	p
M3 = husk charcoal : coco peat : compost (1 : 1 : 1)	7.74	r		361.40	r	135.68	q
Interaction	(-)			(-)		(-)	

Where: The mean in the column that is followed by the same letter shows no significant differences based on DMRT at a 5% level.

The K2 factor, namely the Gandasil D fertilizer concentration of 2 g/1 liter of water, showed a higher mean number of twigs and fresh weight than the other factors. It is assumed that this concentration was effective for more optimal development of leaves. The higher the number of leaves, the higher the photosynthetic capacity, which then increases the results of the photosynthesis in the form of carbohydrates and proteins to be distributed to all the plant organs, thus increasing the plant dry weight. It has been known that carbohydrates and protein contribute to plant dry weight. According to the opinion of Budiana (1993) cit., Roni and Lindawati (2018), the higher the carbohydrates and protein content in plants, the higher the dry weight of plants.

The Gandasil D fertilizer concentration of 2 g/1 liter of water had better contribution to the plant height at 10 WAP (Table 1), the number of twigs and plant fresh weight compared to the other concentrations, thus producing the highest plant dry weight. The total plant dry weight is the result of the balance between the uptake of carbon dioxide and the actual release of oxygen as shown in the plant fresh weight. Photosynthesis rate affects plant dry weight; the higher the photosynthesis rate, the higher the plant dry weight (Bernantha et al., 2017).

The M2 factor, i.e., a growing media composition that consisted of coconut coir or coco peat and compost with a ratio of 1 : 1, showed higher mean dry weight, fresh weight, and number of twigs than the other factors. This is because coco peat and compost media are able to improve the physical properties of soil as well as retain water and nutrients, allowing them to be absorbed by roots for photosynthesis. Each of the growing media compositions has a different ability to provide organic matter and water for plant growth. Coconut coir or coco peat is an alternative organic material that can be used as a growing medium. Coconut coir as a growing medium has a benefit due to its characteristics of having a high water-holding capacity, being suitable to be used in areas with high temperatures, and containing essential nutrients such as calcium (Ca), magnesium (Mg), potassium (K), sodium (N), and phosphorus (P) (Dalimoenthe, 2013).

CONCLUSIONS

Based on the results of the study on the effectiveness of Gandasil D fertilizer concentration on the growth of *Indigofera* seedlings on various growing media compositions, some conclusions can be drawn as follows:

1. There was an interaction of treatment with K and M factors at the K2M2 level, i.e., the Gandasil D fertilizer concentration of 2 g/1 liter of water and a growing media composition consisting of coco peat and compost, on plant height and stem diameter at 10 WAP.
2. The Gandasil D fertilizer concentration of 2 g/1 liter of water had a more effective effect on the growth of *Indigofera* seedlings compared to other concentrations.
3. A growing media composition consisting of coconut coir (coco peat) and compost with a ratio of 1 : 1 had a more effective effect on the growth of *Indigofera* seedlings than other growing media compositions.

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