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The effect of NPK fertilizer and planting media on plant growth and saponin content of the medicinal plant *Anchomanes difformis*

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Abstract. *Rivai RR, Wardani FF, Zulkarnaen RN. 2017. The effect of NPK fertilizer and planting media on plant growth and saponin content of the medicinal plant Anchomanes difformis. Nusantara Bioscience 9: 141-145. Anchomanes difformis* (Blume) Engl., belongs to the aroid family (Araceae) and has potential as a medicinal plant. *A. difformis* has not in the past been widely cultivated by farmers in Indonesia, so if it is to be grown as a crop for medicinally active compounds, we must first find how best to cultivate it. The objective of the research described here was to determine an effective planting media and optimum dosage of a standard NPK fertilizer for *A. difformis* plant growth in pots, and saponin content of its rhizomes. The research was conducted at the Treub Laboratory and Garden Nursery, Center for Plant Conservation Botanic Gardens, Indonesian Institute of Sciences (LIPI). A completely randomized design with three replications was used to test a factorial arrangement of two treatment factors, namely: planting media of three types; and dosage of a standard NPK fertilizer (15% N, 15% P_2O_5, 15% K_2O) at four levels. Results showed that for plant growth of *Anchomanes difformis*, a mixed medium of soil/cocopeat (1:1) was the best of the three media evaluated, and the application of the NPK fertilizer at a dosage equivalent to 100 kg/ha was the optimum fertilizer level. There was no statistical interaction between the treatment factors. The rhizomes of *A. difformis* had their highest level of saponin content when planted in the mixed soil/cocopeat (1:1) medium, and with NPK fertilizers at a dose level of 100 kg/ha.

Keywords: *Anchomanes difformis*, medicinal plant, NPK fertilizer, plant growth, saponin

INTRODUCTION

Anchomanes difformis (Blume) Engl. belongs to the family Araceae. It is a perennial, herbaceous plant of the tropics (Mayo et al. 1997). *A. difformis* has significant potential for industrial applications in the food, textile and pharmaceutical industries (Afolayan et al. 2012; Abe and Lajide, 2014). It has long been used in West Africa as a traditional treatment for dysentery, coughs, constipation, trypanosomiasis and peptic ulcer disease (Okpo et al. 2011; Okpo et al. 2012). It has compounds with various beneficial effects such as antimicrobial, antiplasmodial, antitrypanosomal, antileishmanial, antinociceptive and antiinflammatory activity (Bero et al. 2009; Bero et al. 2011; Eneojo at al, 2011; Adebayo et al. 2014). Important information has been documented by Soladoye et al. (2010) that *A. difformis* also contains anti-cancer compounds.

The plant holds real promise for producing secondary metabolites that could be used in treating a range of medical conditions (Aliyu et al. 2008). There are many kinds of secondary metabolites in *A. difformis*, but saponins are of special interest. The most abundant phytochemical component of *A. difformis* are the saponins (5.36-11.76 mg/100g) (Abe and Lajide, 2014). Saponins are a class of natural products constructed of an aglycone (triterpene or steroid) component combined with a saccharide component (of hexoses and/or uronic acids). Saponins are relatively widespread in our foodstuffs and herbal preparations, and have been investigated for the development of new natural medicines and to verify the efficacy of traditional herbal medicinal applications (Tamura et al. 2012). Eneojo et al. (2011) have demonstrated that the vegetative organs including leaves and rhizomes are the main parts of *A. difformis* that could be used as medicinal raw material.

A. difformis has not been widely cultivated by farmers in Indonesia (Wardani et al. 2015). Cultivation techniques need to be developed for producing the plant as a crop. The primary soil nutrients needed for all plant growth are nitrogen, phosphorus and potassium (NPK) (Dwidjoseputro 1983; Ariani, 2009; Pratikta et al. 2013; Sukamto et al. 2014; Sahoo et al. 2015). External application of major nutrients is beneficial for better growth and phytochemical composition including saponin content of various plants (Hosoda and Noguchi 1990; Singh et al. 2004; Osuagwu and Nwosu, 2006; Abdelaziz et al. 2007; Azzaz et al. 2009; Ibrahim et al. 2013; Mary and Nithiya, 2015; Mulyana et al. 2015; Xia et al. 2016). Hence, the immediate focus of the research reported here has been to identify an effective planting medium and to optimize the dosage of a standard NPK fertilizer, to ensure good plant growth and high saponin content of *Anchomanes difformis.*

MATERIALS AND METHODS

A pot experiment was conducted at the Treub Laboratory and Garden Nursery, Center for Plant Conservation Botanic Gardens, Indonesian Institute of

Sciences (LIPI) for more then one year (December 2014-January 2016). Plant materials of *A. difformis* for the experiment were obtained from the Bogor Botanic Gardens collection grown at location Vak XI.B.VIII.125. The qualitative saponin content analyses of rhizomes harvested from the experiment were carried out at the Services Laboratory of Tropical Biopharmaca Research Center, Institut Pertanian Bogor, Bogor, Indonesia.

The experiment focused on two factors: plant growth media; and dosage level of a standard NPK fertilizer. The three plant growth media were as follows: soil, soil+cocopeat (1:1) and cocopeat. The four dosage levels of the NPK fertilizer (containing 15% N, 15% P_2O_5, 15% K_2O) were equivalent to 0, 50, 100, and 150 kg/ha with once applied in the beginning. The plants were grown in the pots with a 3 x 4 factorial arrangement of treatments. There were 12 combinations of treatment with three replications equivalent to 36 experimental units. Each experimental unit consisted of 3 seedlings of *A. difformis*, in total 108 units of observation.

Plant growth was evaluated in terms of the following variables: plant height, total number of shoots per plant, leaf width, leaf length and diameter of petiole. The observations were carried out every month from 1-8 months after planting for 108 units of observation. Plants were eventually harvested on 12 months after planting and their freshly harvested rhizomes were measured and weighed, and then the rhizomes from each treatment were analyzed for the presence of saponin qualitatively at the above laboratory.

Data were subject to analysis of variance, and treatment effects were assessed by F test at 5% significance level. Differences between treatments means were tested for significance using Duncan's Multiple Range Test (DMRT) with a 5% probability level. The analysis software used were Microsoft Excel 2013 and Statistical Tool for Agricultural Research (STAR).

RESULTS AND DISCUSSION

Anchomanes difformis plants exhibited differences in some parameters of growth, and in saponin content of their harvested rhizomes, in response to differences in the medium in which they were planted and the level of application of a standard NPK fertilizer.

Plant growth

As shown in Table 1, the number of shoots per plant responded significantly to NPK fertilizer application but not to difference between the planting media. There was no statistical interaction between fertilizer rate and difference in media, for shoot number. On the other hand, petiole diameter was significantly affected by difference in medium but not by rate of fertilizer application. Again, there was no statistical interaction between the two treatment factors for petiole diameter.

None of the other measured variables-plant height, leaf width and leaf length-were significantly affected by difference in media, NPK fertilizer application, or by their interaction (Table 1).

External application of NPK fertilizer benefited *A. difformis* plant growth, as observed in the parameter number of shoots per plant. Table 2 shows that the optimum application rate for shoot number was equivalent to 100 kg/ha. Similar results of increasing plant growth parameters by the application of NPK fertilizers in the Araceae family (*Amorphophallus paeoniifolius*, for example) have been obtained by Sahoo et al. (2015). Effects of NPK fertilizer on plant growth have been documented for a broad range of species, such as *Xanthosoma sagittifolium* and *Colocasia esculenta* var. *antiquorum* by Caesar (1980), *Ocimum basilicum* by Singh et al. (2004), *Rosmarinus officinalis* by Abdelaziz et al. (2007), *Capsicum annum* by Ariani (2009), *Zea mays* by Pratikta et al. (2013), and *Persea americana* by Sukamto et al. (2014).

Table 1. Parameters of vegetative growth of *Anchomanes difformis* in response to different media and dosage level of a standard NPK fertilizer (15% N, 15% P_2O_5, 15% K_2O) on 8 MAP

Media	NPK (kg/ha)	Height (cm)	No. of shoots/ plant	Leaf width (cm)	Leaf length (cm)	Petiole diameter (cm)
Soil	0	31.0	1.9	21.3	31.0	4.44
	50	24.7	2.0	18.3	25.0	4.93
	100	31.9	2.5	12.7	20.1	4.64
	150	18.1	0.9	15.1	20.4	3.04
Soil: Cocopeat	0	42.7	1.7	28.0	42.2	5.34
	50	42.2	3.1	29.1	41.1	8.02
	100	30.4	1.3	20.4	26.6	4.96
	150	33.7	1.4	16.9	29.0	6.07
Cocopeat	0	32.3	1.3	21.9	31.9	5.81
	50	43.7	2.1	26.2	33.9	6.01
	100	33.0	2.7	18.1	27.9	5.73
	150	39.8	1.9	22.3	31.2	5.67
Media (M)		ns	ns	ns	ns	*
Fertilizer (F)		ns	*	ns	ns	ns
M x F		ns	ns	ns	ns	ns
CV%		39.9	40.7	41.8	41.5	23.6

Note: * = significantly different, and NS = not significantly different (P <0.05); MAP = Months After Planting

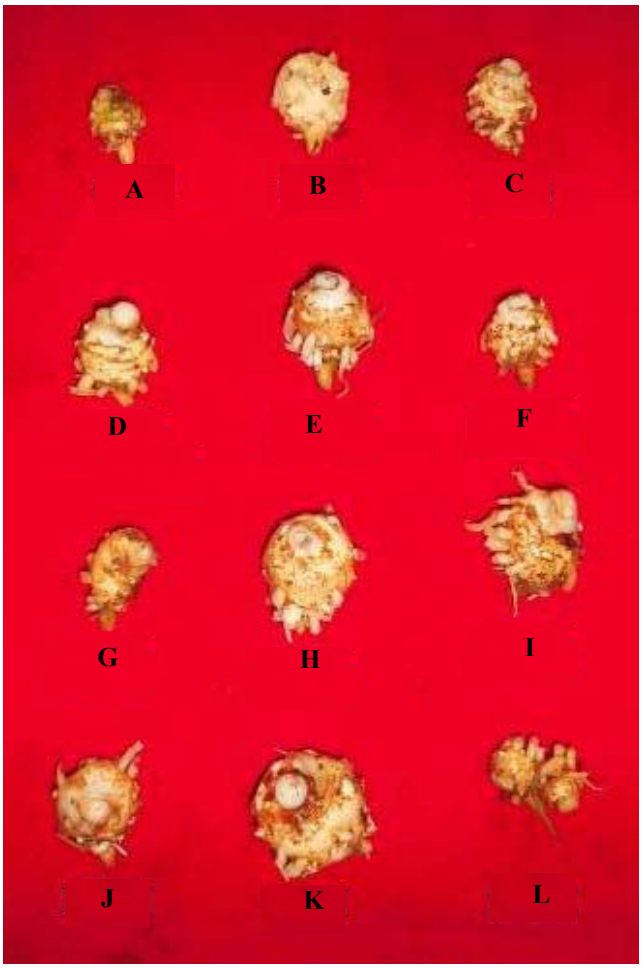

Figure 1. Rhizomes of *Anchomanes difformis*. A. 0 kg/ha NPK; soil, B. 0 kg/ha NPK; soil+cocopeat, C. 0 kg/ha NPK; cocopeat, D. 50 kg/ha NPK; soil, E. 50 kg/ha NPK; soil+cocopeat, F. 50 kg/ha NPK; cocopeat, G. 100 kg/ha NPK; soil, H. 100 kg/ha NPK; soil+cocopeat, I. 100 kg/ha NPK; cocopeat, J. 150 kg/ha NPK; soil, K. 150 kg/ha NPK; soil+cocopeat, L. 150 kg/ha NPK; cocopeat

The response of plant growth in the Araceae family to soil conditions has also been observed for other parameters such as petiole size (Caesar 1980). In our experiment, petiole diameter was higher in the media that contained cocopeat and lowest in the pure soil medium (Table 3). Similar research showed that cocopeat was the optimal medium for germination of *Alpinia malaccensis* (Rivai et al. 2015). Cocopeat is a highly porous medium. It is obtained by extracting fibre from coconut shells, and has a high water holding capacity and C/N ratio, which makes it suitable for tropical plants. Planting medium also influences nutrient absorption for plant growth (Meyer and Anderson 1954).

Rhizome production

Rhizomes are the main organs of *A. difformis* used as a medicinal raw material. Table 4 shows the effect of the different planting media and NPK dosage levels on rhizome diameter and weight. Both parameters were affected only by planting media but not by NPK application.

The results presented in Table 5 show that the mixed medium of soil and cocopeat (1:1) was the best of the three media for increasing rhizome diameter and weight of *A. difformis* (Picture 1. b, e, h and k). In contrast, Sahoo et al. (2015) found that NPK fertilizer, in addition to difference in soil media, significantly affected the corm yield of *Amorphophallus paeoniifolius* (Araceae).

Saponin content

There are many kinds of secondary metabolites in *A. difformis* plant material, including saponins. The rhizomes are relatively high in their saponin content (Eneojo et al. 2011). Table 6 presents the effect of planting media and dosage level of the NPK fertilizer on qualitative analyses of saponin from fresh rhizomes of *A. difformis*. Based on the analysis, the treatment combinations of the mixed soil+cocopeat (1:1) planting medium together with 100 kg/ha NPK fertilizer, and of the soil alone together with 50 kg/ha NPK fertilizer were the best of the tested treatments for increasing the presence of saponin in the rhizomes of *A. difformis*.

Similar studies have been conducted by other workers evaluating the effect of cultivation conditions, including application of fertilizer, on saponin content of a range of plant species: for example, Hosoda and Noguchi (1990) working on *Bupleurum falcatum*; Osuagwu and Nwosu (2006) on *Ocimum gratissimum*; Azzaz et al. (2009) on *Foeniculum vulgare*; Ibrahim et al. (2013) on *Labisia pumila*; Mary and Nithiya (2015) on *Solanum nigrum*, Mulyana et al. (2015) on *Coleus amboinicus* and Xia et al. (2016) on *Panax notoginseng*.

Table 2. Shoot number /plant of *Anchomanes difformis* in response to variation in rate of application of a standard NPK fertilizer (15% N, 15% P_2O_5, 15% K_2O)

NPK (kg/ha)	Number of shoots/plant
0	1.63 b
50	2.15 ab
100	2.41 a
150	1.41 b

Note: Figures followed by the same superscript letters in the same column are not significantly different (P> 0.05) [DMRT].

Table 3. Petiole diameter of *Anchomanes difformis* in response to different planting media

Media	Petiole diameter (cm)
Soil	4.27 b
Soil : Cocopeat	6.10 a
Cocopeat	5.82 a

Note: Figures followed by the same superscript letters in the same column are not significantly different (P> 0.05) [DMRT]

Table 4. Rhizome production of *Anchomanes differmis* in response to different planting media and dosage levels of a standard NPK fertilizer (15% N, 15% P_2O_5, 15% K_2O) on 12 MAP

Media	NPK (kg/ha)	Rhizome diameter (cm)	Rhizome weight (g)
Soil	0	21.2	10.00
	50	20.7	8.33
	100	18.0	9.66
	150	17.8	6.11
Soil : Cocopeat	0	30.9	20.55
	50	36.6	23.33
	100	27.0	23.33
	150	27.3	13.33
Cocopeat	0	23.0	8.33
	50	25.1	18.33
	100	23.9	10.55
	150	24.0	9.77
Media (M)		*	*
Fertilizer (F)		ns	ns
M xF		ns	ns
CV%		21.2	64.5

Note: * = significantly different, and NS = not significantly ($P < 0.05$) MAP = Months After Planting

Table 5. *Anchomanes differmis* rhizome diameter and weight grown in different planting media

Media	Rhizome diameter (cm)	Rhizome weight (g)
Soil	19.4 c	8.53 b
Soil : Cocopeat	30.5 a	20.14 a
Cocopeat	24.0 b	11.75 b

Note: Figures followed by the same superscript letters in the same column are not significantly different (P> 0.05) [DMRT].

Table 6. Qualitative analyses of saponin in the rhizomes of *Anchomanes differmis* in response to different planting media and dosage level of NPK fertilizer (15% N, 15% P_2O_5, 15% K_2O)

Media	Urea (kg/ha)	Presence of saponin	Criteria
Soil	0	-	Absence
	50	+++	Strong
	100	++	Medium
	150	-	None
Soil : Cocopeat	0	++	Medium
	50	++	Medium
	100	+++	Strong
	150	+	Low
Cocopeat	0	+	Low
	50	+	Low
	100	-	Absence
	150	+	Low

Results of a pot experiment evaluating the effect of three different planting media and four different rates of application of a standard NPK fertilizer on the aroid species *Anchomanes differmis* showed that a mixed medium of soil and cocopeat (1:1) together with a fertilizer application equivalent to 100 kg/ha NPK (15% N, 15% P_2O_5, 15% K_2O) was the best of the tested treatments not only for plant growth and rhizome yield but also for increasing saponin content of the rhizomes.

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