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Short Communication: Growth analysis of sentang (*Azadirachta excelsa*) in agroforestry system

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Abstract. *Rahmawathi AM, Wijayanto N, Wulandari AS. 2017. Short Communication: Growth analysis of sentang (*Azadirachta excelsa*) in agroforestry system. Biodiversitas 18: 589-592*. Sentang is one of forestry plants which can be planted in agroforestry system. It is one of the important medicinal plants grown in different agroforestry systems and contains an active compound of azadirachtin. It has cone crown and balance branch that makes it suitable to be cultivated in agroforestry system which utilizes lower stratum or ground. This research aimed to analyze growth and nutrient content of sentang in agroforestry and monoculture system. Plantation site was in Conservation Unit Research Center for Biopharmaceutical IPB. The sentang was two years old. The design was complete randomized design with one factor (cropping system) and two treatments (agroforestry and monoculture). The results showed the increase of sentang height was higher in agroforestry system than the monoculture due to additional nutrition obtained by sentang in agroforestry system derived from fertilizing activity at the beginning of soybean planting. Nutrient content of sentang was higher in agroforestry plot than monoculture. Fertilizing activity of soybean led to an increase of sentang in agroforestry system.

Keywords: Agroforestry, *Azadirachta excelsa*, nutrient content, growth analysis, cropping system

INTRODUCTION

Sentang is the common name of *Azadirachta excelsa* (Jack) M. Jacobs that belonging to the family Meliaceae. It is one of the important medicinal plants grown in different agroforestry systems and contains an active compound of azadirachtin ($C_{33}H_{44}O_{16}$). It is one of the triterpenoids compound and sources of good bio-pesticide. This compound of azadirachtin does not kill the insects directly, but it stimulates sterility in the adult stage, inhibit the growth and life cycle process, and act as a repellent, and antifeedant (Morgan 2009; Emerenciano et al. 2015). Sterility occurs because azadirachtin works by inhibiting hormone production. Azadirachtin compound is also effective to control over 195 species of insects such as armyworms and caterpillars (*Trichoplusia ni* and *Pseudaletia unipuncta*) (Akhtar et al. 2008; Mazid et al. 2011). In addition, the concentration of azadirachtin in sentang can be influenced by environment and not merely by genetic substances in the plant itself (Shukor and Seong 2006).

Sentang is fast growing species and is usually harvested after five years of planting which provides an alternative to fulfill wood supply. Due to continuously increasing demand of wood for various needs, the wood supply for market purposes must be fulfilled. In Malaysia, sentang has been preferred as a commercial timber since 1997. Its wood can be utilized as lightweight construction, furniture, panel, and veneer. In Thailand, an average growth rate in girth size is 8-10 cm per year. Various parts of sentang tree (seed, flowers, and edible young shoots) have been used for traditional medicine. This particular tree has been reported for its effective use against human diseases such as heart disease, psoriasis, nerve disorders, diabetes, eczema, and blood pressure (Shukor and Seong 2006; Nordahlia et al. 2014). Besides several utilities, the cone-shaped crown also makes it a suitable for incorporating in agroforestry system.

Agroforestry system is the utilization of components in time and space together (Alao and Shuaibu 2013)). Agroforestry can protect the soil from erosion and reduce the needs for fertilizer or nutrient from outside the plantation. The existence of recycling crop residue derived from the trees during the pruning time is very advantageous. Other common advantages of agroforestry are that it produces higher timber quantity and density (Datta and Singh 2007), increase the abundance and diversity of invertebrates of soil around the ecosystem (Kinasih et al. 2016), and increase wood growth and volume (Tomar et al. 2009). On the other hand, research about sentang in agroforestry system is still a little bit in Indonesia. Based on that reason, the research is to analyze growth and nutrient content of sentang in agroforestry and monoculture system.

MATERIALS AND METHODS

Study area

This experiment was performed in the land owned Conservation Unit Research Center for Biopharmaceutical Cikabayan, IPB Dramaga Bogor, West Java, Indonesia

with a size of 300 m^2. It is located between 106° 43' 0.81" E, and 6° 33" 51.95" S (Figure 1). Sentang stands in research location was two years old with a spacing of 2.5 m x 2.5 m. In the first year, this location had been planted with four varieties of soybean under the stands. In the second year, it was replanted with soybean using the three best soybean varieties for the previous study.

Tillage was performed before soybean was planted under sentang stand with a spacing of 0.5 m. In the second year, soybean cultivation was fertilized using goat and poultry manure. Pest and disease control management was additionally done for soybean using bio-pesticide derived from sentang leaves extract. In this agroforestry system, sentang particularly acquired maintenance activity such as weeding for the growth of soybean, as the gap plant.

Data collection

On the field and monthly data was collected for its stem diameter at breast height level (1.30 cm from the ground) using a caliper and the stem was then painted with red line for its next measurement. Height was measured from the base up to the apical shoot. All these data was for all individuals and in every season until the soybean cultivation ended. The parameters measured for the crown were its length and width. Measurement of the root system was conducted for sentang in the depth of 0-20 cm (Wijayanto and Hidayanthi 2012). Root measurement was done upright with soybean mound. Soil digging was stopped if root had been found in 0-20 cm depth but the digging kept continuing if the root had not been found. The measurement was done for every 50 cm to the right and left direction from previous digging point until the root was found. The measurement was done in line with soybean mound (east and west). Observation and data collection was done before planting and after soybean harvested. Observation and data collection was done before planting and after soybean was harvested.

Data analysis

The design was complete randomized design with one factor (cropping system) and two treatments (agroforestry and monoculture). Each treatment was repeated 14 times. Design model was (Mattjik and Sumertajaya 2006):

$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$

Where:

Y_{ij} : observation on treatment-i and replication-j

μ : mean

α_i : effect of treatment -i

β_j : effect of replication -j

ε_{ij} : random effect on treatment-i and replication-j distributes normally

Analysis of variance (ANOVA) was performed with least significant different of 5% to see the difference among treatments. Duncan's Multiple Range Test of alpha 5% was performed if there was significantly different to the observed parameter. Data was processed by SAS 9.0 program.

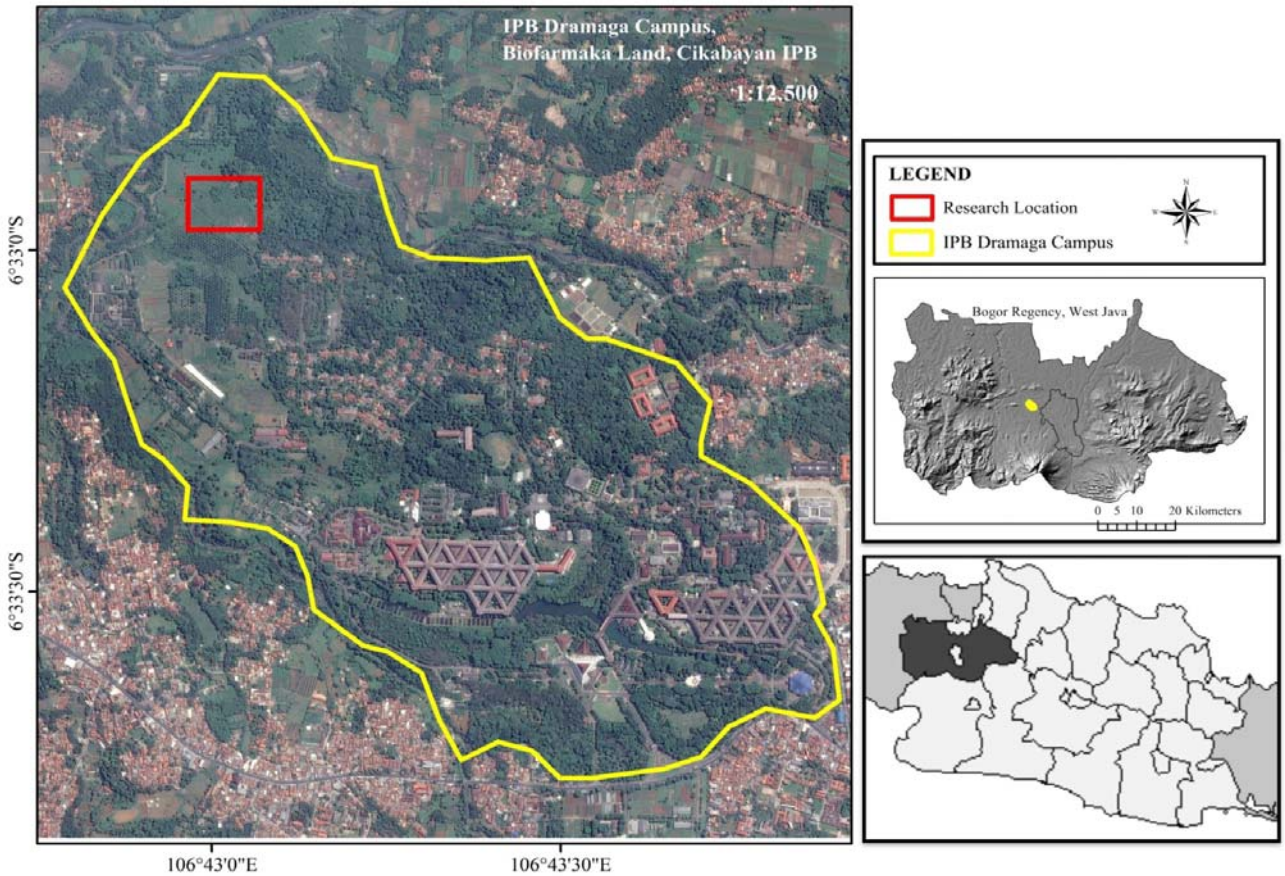

Figure 1. Location of Conservation Unit Research Center for Biopharmaceutical Cikabayan IPB, Bogor, West Java, Indonesia

Analysis of nutrient content in sentang leaf

Analysis of nutrient content was performed before planting and after soybean harvesting. Leaf sample was from agroforestry and monoculture which was randomly taken then composited. The weight was 100 g of the dry leaf. Analysis of nutrient content was performed in Testing Laboratory, Department of Agronomy and Horticulture, Institut Pertanian Bogor, Indonesia.

RESULTS AND DISCUSSION

Growth of sentang

The increase of diameter and height of sentang in agroforestry was greater than monoculture (Table 1). Tillage in agroforestry also contributed to higher nutrient and water uptake in the sentang root. The increase of diameter and height in agroforestry system significantly occurred during the first month after soybean planting. Height gain was still significant in the second month after soybean planting. Study of Shukor et al. (2015) indicated that initial growth of sentang seedlings showed better results in the very beginning when the treatment. The process of diameter increasing was slower than height increasing.

The increase of sentang crown diameter in monoculture and agroforestry system gave the same result. In agroforestry system, sentang crown directly covered the mound of soybean. It caused the exposure of light to lower surface were reduced. Narrow sentang spacing was also the factor of bigger crown density in the stand. Study of Sabarnudin et al. (2004) confirmed that mahogany crown density in alley cropping affected the canopy density in that area. This canopy density was associated with the light received by crops under the stand. In agroforestry system, tree component and crop under its shade will cause interactions on the top and below the soil surface.

According to Suryanto et al. (2005), tree canopy provides interaction above soil surface that affects the width cover of crops. Interaction below the surface is determined by the root system of each species. It also affects indirectly to the tree crown and root development. The result of the observation of sentang root showed that root length and depth in monoculture system gave the same result. The length and depth of the root showed no difference in the treatments given because fertilized of soybean plant in agroforestry used organic manure. Organic fertilizer is given to the soybean plants through the decomposition process. While fertilized use of chemical fertilizer, the availability of nutrients plant can be directly absorbed by the roots. Sentang roots intersected each other, so there would be competition in nutrient and water uptake around the plant. There is a potential tool for managing below-ground competition in agroforestry, such as tree root pruning. Agroforestry applies cultivation concept in the form of combination between a plant with a shallow root and a plant with deep root. The trees are having deep and vertical root is able to absorb nutrient higher than the tree with a shallow root and can also function as soil and water holder (Suprayoga et al. 2002, Masukwe et al. 2008).

Table 1. Characteristic of sentang growth in monoculture and agroforestry system

Parameters	F test	Cropping system	
		Mono-culture	Agro-forestry
Increased of diameter (cm)			
1st month	*	1.01[b]	1.25[a]
2nd month	ns	0.39[a]	0.37[a]
3rd month	ns	0.19[a]	0.24[a]
Increased of height (m)			
1st month	*	0.76[b]	1.23[a]
2nd month	*	0.34[b]	0.56[a]
3rd month	ns	0.47[a]	0.36[a]
Increased of crown diameter (m)	ns	0.40[a]	0.37[a]
Increased of root length (m)	ns	0.38[a]	0.37[a]
Increased of root depth (cm)	ns	2.54[b]	3.70[a]

Note: (ns): Not significantly different; (*): significantly different on alpha 5%; Numbers followed by the same letter are not significantly different on alpha 5% (Duncan's Multiple Range Test)

Table 2. Comparison of sentang nutrient content before planting and after soybean harvesting

	Before soybean planting	After soybean harvesting	
		Monoculture	Agroforestry
N (g/plant)	2.22	2.67	2.81
P (g/plant)	0.11	0.15	0.15
K (g/plant)	0.81	1.11	1.40

Nutrient content

Nutrient content of sentang increased in monoculture and agroforestry system (Table 2). The increase of nutrient (N, P, and K) content planted in monoculture were 0.45 g/plant, 0.04 g/plant, and 0.30 g/plant, respectively. Whereas the increase of sentang nutrient content planted in agroforestry for N, P, and K was 0.59 g/plant, 0.04 g/plant, 0.59 g/plant, respectively. The difference of nutrient content of the two locations was not significant except for K nutrient. High nutrient content on sentang planted in agroforestry is also indicated by the bigger diameter and height increment compared to the plant in monoculture. Availability and amount of nutrient content in this research shows that N was absorbed highest followed by K and P. The effect of N fertilizer to 39 years old sentang also increased the content of N, P, and K in the leaf. The nutrient increase was also followed by the increase of diameter and total stem volume (Ong et al. 2012).

The increase of nutrient content on sentang planted in agroforestry was due to the fertilizer which was given to soybean, which affected sentang as well. The availability of added nutrient from organic fertilizer in the first year was predicted to cause the differences in nutrient content which was not too big. The existence of soybean also helped to provide several nutrients indirectly. The larger amount of

nitrogen was because of the ability of soybean root nodule in N_2 fixation from the atmosphere. Nutrient content could derive from leaf or another plant part which falls to the ground. Leaf of soybean which falls also contributes to the soil nutrient. Re-absorption of nutrient from decomposed leaf could be one of the key ways to prevent the lost of soil nutrient. The absorbed nutrient will be transported and distributed to the new tissues or stored as food stock. The result of the process of leaf decomposition into litter and partially into organic materials will be re-used as a nutrient source by the plant (Singh et al. 2005; Hasanuzzaman and Hossain 2014).

Two years old sentang planted in agroforestry along with soybean had a bigger increase in height and diameter than in monoculture. Nutrient content of sentang planted in agroforestry was higher than in monoculture. Agroforestry of sentang and soybean planted organically can be done again on the next planting period to identify its effectiveness for sentang growth.

REFERENCES

Akhtar Y, Yeoung YR, Isman MB. 2008. Comparative bioactivity of selected extracts from Meliaceae and some commercial botanical insecticides against two noctuid caterpillars, *Trichoplusia ni* and *Pseudaletia unipuncta*. Phytochem Rev. 7: 77-88.

Alao JS, Shuaibu RB. 2013. Agroforestry practices and concepts in sustainable land use system in Nigeria. J Hortic For. 5 (10): 156-159.

Datta M, Singh NP. 2007. Growth characteristic of multipurpose tree species, crop productivity and soil properties in agroforestry system under subtropical humid climate in India. J For Res. 18: 261-270.

Emerenciano DP, Maciel MAM, Junior FHX, de Moura. 2015. Phytochemical and pharmacological aspects of Meliaceae and *Azadirachta indica* A. Juss. Intl J Latest Res Sci Technol. 4: 128-135.

Hasanuzzaman M, Hossain M. 2014. Nutrient return through leaf litter decomposition of common cropland agroforest tree species of Bangladesh. Intl Res J Biol Sci. 3: 82-88.

Kinasih I, Cahyanto T, Widiana A, Kurnia DNI, Julita U, Putra RE. 2016. Soil invertebrate diversity in coffee-pine agroforestry system at Sumedang, West Java. Biodiversitas 17: 473-478.

Masukwe TNW, Wilson J, Sprent JI, Ong CK, Deans JD, Okorio J. 2008. Tree growth and management in Ugandan agroforestry systems: effects of root pruning on tree growth and crop yield. Tree Physiol. 28: 233-242.

Mattjik AA, Sumertajaya IM. 2006. Design of Experiments with SAS and Minitab Apps. IPB Press, Bogor. [Indonesian]

Mazid S, Rajkowa RC, Kalita JC. 2011. Biopesticides-a safe to chemical control of pests [review]. Int Sci Adv Technol. 1: 169-178.

Morgan ED. 2009. Azadirachtin, a scientific gold mine. Bioorg. Med. Chem. 17: 4096-4105.

Nordahlia AS, Anwar UMK, Hamdan H, Zaidon A, Omar MKM. 2014. Mechanical properties of 10 year old sentang (*Azadirachta excelsa*) grown from vegetative propagation. J Trop For Sci. 26: 240-248.

Ong KH, King PJH, Lim MT, Awang K. 2012. Influence of nitrogen on growth of *Azadirachta excelsa*. Res J For. 6: 16-23.

Sabarnurdin MS, Suryanto P, Aryono WB. 2004. Mahony (*Swietenia macrophylla* King) trees dynamics in alley cropping agroforestry. Ilmu Pertanian 11: 63-73. [Indonesian]

Schmutterer H, Doll M. 1993. The marrango or Philippine neem tree, *Azadirachta excelsa* (= A. *integrifolia*): a new source of insecticides with growth-regulating properties (minireview). Phytoparastica 21: 79-86.

Shukor NAA, Seong LK. 2006. Azadirachtin variation of six provenances of *Azadirachta excelsa* (Jack) Jacob. Pak J Biol Sci 9: 833-836.

Shukor NN, Hamid HA, Abdu A, Ismail MK. 2015. Growth and physiological response of *Azadirachta excelsa* (Jack) Jacobs seedlings to over top filling treatment. Am J Plant Physiol 10: 1-24.

Singh SP, Bargali K, Joshi A, Chaudhry S. 2005. Nitrogen resorption in leaves of tree and shrub seedlings in response to increasing soil fertility. Curr Sci. 89: 389-396.

Suprayoga D, Van Noordwijk M, Hairiah K, Cadisch G. 2002. The inherent 'safety-net' of an acrisol: measuring and modeling retarded leaching of mineral nitrogen. Eur J Soil Sci. 53: 185-194.

Suryanto P, Tohari, Sabarnurdin MS. 2005. Dynamic resources sharing system in agroforestry: base on of preparation of strategy consideration silviculture. Ilmu Pertanian 12 (2): 165-178. [Indonesian]

Tomar JMS, Pandey HN, Bhatt BP. 2009. Growth behavior of selected agroforestry tree species under the hilly ecosystem of Northeast India-an expanding role for agroforestry. J Sustain Agric 33: 903-916.