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Short Communication

Evaluation of *Asystasia gangetica* as a potential forage in terms of growth, yield and nutrient concentration at different harvest ages

Evaluación del potencial forrajero de Asystasia gangetica *a diferentes edades de cosecha*

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Abstract

The objective of this experiment was to analyze growth dynamics, yield and nutrient concentration of *Asystasia gangetica* (L.) T. Anderson at different harvest ages. A pot experiment was conducted at Green House Laboratory of Agrostology, Faculty of Animal Science, Bogor Agricultural University, Indonesia, during the growing season of 2018. Seedlings were transplanted into 115 polybags arranged in a completely randomized design with 23 replications. Plant height, number of leaves, number of branches, dry matter (DM) yields and nutrient concentrations at 30, 40, 50, 70 and 90 days after transplanting (DAT) were determined. Whereas plant height, number of leaves, number of branches and DM yields increased with age, nutrient concentrations followed different patterns. Crude protein % in leaf peaked at 24.2% at 40 DAT then decreased progressively to 8.4% at 90 DAT, while corresponding figures for stem were 10.6 and 2.8%, respectively. Crude fiber concentrations in leaf increased from 10.6% at 30 days to 17.3% at 90 days; corresponding figures for stem were 23.2 and 39.2%. From this pot study, cutting between 40 and 50 days after planting seemed to represent a suitable compromise between DM yield and protein percentage. Studies are needed to determine the repeatability of these results under field conditions and the regrowth potential of plants following harvesting.

Keywords: Growth dynamics, nutritive value, forage production.

Resumen

En condiciones de invernadero, en el Green House Laboratory of Agrostology, Faculty of Animal Science, Bogor Agricultural University, Indonesia, se analizaron la dinámica de crecimiento, el rendimiento y la concentración de nutrientes de *Asystasia gangetica* (L.) T. Anderson a diferentes edades de las plantas. Las plantas crecieron en 115 bolsas de plástico que fueron dispuestas en un diseño completamente al azar con 23 repeticiones. Se evaluaron la altura de la planta, el número de hojas y de ramas, el rendimiento de materia seca (MS) y las concentraciones de nutrientes a los 30, 40, 50, 70 y 90 días después de la siembra. Mientras que la altura de planta, el número de hojas y de ramas, y el rendimiento de MS aumentaron con la edad de las plantas, las concentraciones de nutrientes mostraron tendencias diferentes. El porcentaje de proteína cruda en la hoja alcanzó un valor máximo (24.3%) a los 40 días y luego disminuyó progresivamente a 8.4% (90 días), mientras que los valores correspondientes para el tallo fueron 10.6 y 2.8%, respectivamente. La concentración de fibra cruda en la hoja aumentó de 10.6% (30 días) a 17.3% (90 días), mientras que la del tallo fue de 23.2 y 39.2%, respectivamente. De este estudio a nivel de invernadero se puede concluir que una cosecha entre 40 y 50 días después de la siembra representa un compromiso aceptable entre el rendimiento de MS y el valor nutritivo. Se sugieren estudios complementarios para determinar la repetibilidad de estos resultados en condiciones de campo y el potential de rebrote de las plantas después de un corte o pastoreo.

Palabras clave: Dinámica de crecimiento, valor nutritivo, producción.

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Introduction

Asystasia gangetica (L.) T. Anderson (Acanthaceae) is an attractive herbaceous ground cover that grows from 30 to 60 cm in height. It is widely distributed from tropical Asia to Africa including Nigeria (Lithudzha 2004; GRIN 2007) and in Indonesia is commonly known as 'ara sungsang' in Sumatra Island or 'bayaman' in Java. It is a fast-growing, spreading, perennial herb, with usually erect, branched, square stems up to 2 m long, often rooting at the lower nodes (Shu et al. 2011). It is a soft weed species that is widely grown as ground cover in Indonesian palm plantations (Ramdani et al. 2017).

This plant can dominate over huge areas because it is highly tolerant of low soil fertility and shade (Samedani et al. 2013). It has potential for use as a commercial forage plant due to its ability to reliably grow from seed (Kumalasari et al. 2018). The plant can grow rapidly as cover crop (Asbur et al. 2018a) and minimize erosion (Asbur et al. 2018b).

It has many medicinal, nutritional and local values including its use as forage (Adetula 2004). Norlindawati et al. (2019) reported it has high production and crude protein concentration, which can reach 23.5% and can be higher in the dry season than in the rainy season (Adjorlolo et al. 2014). High mineral concentrations (Khalil et al. 2018) and high palatability for animals (Sobayo et al. 2012) are other desirable attributes. Considerable research has been conducted on its benefit as feed for animals, e.g. broilers (Sobayo et al. 2012) and ruminants (Wigati et al. 2016). However, there is a lack of information on its morphological characteristics and quality as forage at different growth stages.

Research was carried out with *A. gangetica* to assess plant growth dynamics, dry matter (DM) yields and nutrient concentrations at different ages as a guide to identifying optimal times for harvesting.

Materials and Methods

The research was conducted at Green House Laboratory of Agrostology, Faculty of Animal Science, Bogor Agricultural University, during the growing season of 2018. Forage quality was analyzed at Laboratory of University Center (PAU).

Seedlings were prepared in trays for 21 days in a nursery until they reached the 4-leaf stage, before being transplanted into 115 polybags with capacity of 5 kg filled with latosol. The basal fertilizer was fresh cattle manure (with 11.2% organic C, 0.46% total N, 0.24% P_2O_5 and 0.29% K_2O), at the rate of 250 g/polybag, and inorganic fertilizer (Mutiara - 16% N, 16% P_2O_5, 16% K_2O, 0.5% MgO and 6% CaO) at the rate of 2.5 g/polybag, which was mixed with soil 2 weeks before transplanting. The polybags were arranged in a completely randomized design with 23 replications. Treatments consisted of 5 different harvesting ages, i.e. 30, 40, 50, 70 and 90 days after transplanting (DAT).

Growth attributes were measured on all plants during the growth period as follows: plant height (cm) from the base of the plant to the tip of the central spike tassel; and numbers of leaves and branches. Branches were categorized into 3 types, i.e. primary, secondary and tertiary branches. At the predetermined ages, plants were cut approximately 5 cm from the ground and weighed to determine fresh yields. Plants were then separated into branches (stems) and leaves, and weighed to obtain the relevant contributions to total yield. Samples were selected, air dried and weighed to calculate DM yields.

Fresh herbage samples from each treatment were selected, air dried under sunlight for 2 × 12 h, before drying in an air-forced oven at 60 °C for 48 h, and ground to pass through a 1 mm sieve for chemical analyses. Dry matter, crude protein, crude fat, crude fiber and ash concentrations were determined according to AOAC International (2005) procedures.

Data were analyzed statistically as a completely randomized design with R i386 3.6.1 using Analysis of Variance Test (ANOVA); if there was a significant difference, the analyses were continued with the Tukey Honest Significant Difference Test (HSD).

Results

Plant height

Plant height of *A. gangetica* increased progressively with age according to a quadratic relationship ($P<0.001$; Table 1), reaching a mean of 131 cm at 90 DAT.

Number of leaves per plant

Number of leaves per plant of *A. gangetica* increased progressively with age ($P<0.001$; Table 1) reaching a mean of 635 leaves at 90 DAT.

Number of branches per plant

Total number of branches per plant increased progressively with time after transplanting (Table 1; $P<0.001$). Number of primary branches increased until 50 days after transplanting then decreased with time, while numbers of both secondary and tertiary branches increased progressively over time.

Table 1. Effects of plant age on *Asystasia gangetica* growth indicators.

Parameter	Age (days after transplanting)					s.e.m.	P
	30	40	50	70	90		
Plant height (cm)	27.9d	72.1c	95.6b	97.9b	131a	0.55	<0.001
Number of leaves	66.4d	306c	372bc	423b	635a	3.19	<0.001
Number of branches							
Primary	2.3b	2.6a	2.8a	2.3b	2.1c	0.06	<0.001
Secondary	3.8c	7.2bc	13.8b	23.7a	24.1a	0.18	<0.001
Tertiary	2.7e	6.0d	11.2c	31.1b	36.1a	0.27	<0.001
Dry weight (g/plant)							
Leaf	1.3c	5.5c	8.0b	8.6b	11.6a	0.07	<0.001
Stem	0.6d	5.9c	9.5b	10.4b	19.0a	0.11	<0.001
Total	1.8d	11.4c	17.6bc	19.0b	30.6a	0.09	<0.001
Leaf:stem ratio (dry weight basis)	2.3:1	0.95:1	0.84:1	0.82:1	0.61:1		

Means in the same row without common letters are different at P<0.001.

Forage yield

Dry matter (DM) yields of both leaf and stem increased (P<0.001) progressively with age and reached 11.6 g leaf DM and 19.0 g stem DM/plant at 90 DAT (Table 1). Leaf:stem ratio (DM basis) declined progressively with age from 2.3:1 at 30 DAT to 0.6:1 at 90 DAT. Figure 1 demonstrates changes in appearance of plants as they aged, with changes in leaf:stem ratio and senescence of leaves by 90 DAT being quite noticeable.

Forage quality

Leaf crude protein (CP) concentration peaked at 24.2% at 40 DAT, then declined progressively to 8.4% at 90 DAT (P<0.01; Table 2). The pattern for stem CP was similar but concentrations were much lower (peak of 10.6% at 40 DAT, declining to 2.8% at 90 DAT) (P<0.01).

Crude fiber (CF) concentrations increased with age (P<0.01; Table 2) for both leaf and stem; stem CF concentrations, however, were much higher than in leaf.

30 DAT 40 DAT 50 DAT 70 DAT 90 DAT

Figure 1. *Asystasia gangetica* plants of different ages (DAT, days after transplanting).

Table 2. Effects of plant age on nutrient concentrations (% DM) in leaf and stem of *Asystasia gangetica* forage.

Plant part/Nutrient	Age (days after transplanting)					s.e.m.	P
	30	40	50	70	90		
Leaf							
Crude protein	16.6b	24.2a	20.7b	10.4c	8.4c	0.59	<0.01
Crude fat	2.1	2.7	1.8	3.4	4.7	0.11	<0.01
Crude fiber	10.6c	9.7c	12.0b	11.9b	17.3a	0.21	<0.01
Ash	15.5	14.7	12.3	13.3	15.4	0.14	<0.01
Stem							
Crude protein	7.6b	10.6a	7.7b	3.6c	2.8c	0.28	<0.01
Crude fat	1.2	0.8	4.1	1.8	0.9	0.11	<0.01
Crude fiber	23.2b	31.3ab	39.0a	39.4a	39.2a	0.46	<0.01
Ash	17.3a	11.0ab	7.7b	9.8b	14.0a	0.27	<0.01

Means in the same row without a common letter are different at P<0.01.

Discussion

This study has provided useful information on changes in nutrient concentrations with age in *A. gangetica* forage. As was expected, increasing age had positive effects on plant height, number of leaves and numbers of secondary and tertiary branches, resulting in marked increases in dry matter yields. Plant height and number of branches in this study followed a different pattern from that reported by Asbur et al. (2018b). Plants in our study were taller and displayed much greater branching due to being grown in full sunlight (Samedani et al. 2013) as opposed to former research where plants were grown under palm plantation shading (Asbur et al. 2018b). While biomass yields of both leaf and stem increased progressively with age, leaf:stem ratio declined progressively. As can be observed in Table 1, the number of primary branches declined from 50 to 70 DAT as a result of senescence.

As expected, nutrient concentration in *A. gangetica* leaves was better than in stems (Table 2). While crude protein concentrations (CP%) in both plant parts declined progressively from 40 DAT, at 50 DAT CP% still exceeded the critical level of 7% for satisfactory functioning of rumen microflora (Ansah et al. 2018). Peak protein concentrations (24.2%) in leaf at 40 DAT was higher than 17.5% reported by Herilimiansyah (2019) for 50 DAT but DM yields were still relatively low at this stage. Growth for the next 10 days was not rapid and protein concentration of forage declined to a greater degree. While marked increases in DM yields of both components, especially stem, occurred after 70 DAT, CP% had dropped to low levels by this time with CP% of stems (3.6%) being well below maintenance levels.

As can be seen in Figure 2, decisions on when to utilize the forage would be a compromise between DM yields of both leaf and stem and CP% of these 2 components. While this is a pot study, it would seem that harvesting between 40 and 50 DAT would give a reasonable compromise between DM yield and CP% in the available forage, as leaf:stem ratio still exceeded 0.8 at 50 DAT. The leaf material produced would be of high CP% and should provide an excellent supplement to low quality roughage for ruminants. However, feeding studies with animals are needed to determine responses of animals when this forage is fed as supplements with other forage sources or as a complete ration.

It must be stressed that these data are for single plants grown in polybags and competition between plants would not have been expressed as would occur in swards in the field. Further studies under field situations are needed to verify that the results obtained in our study represent those obtained in commercial situations and how the situation might change when grown under shade in palm plantations.

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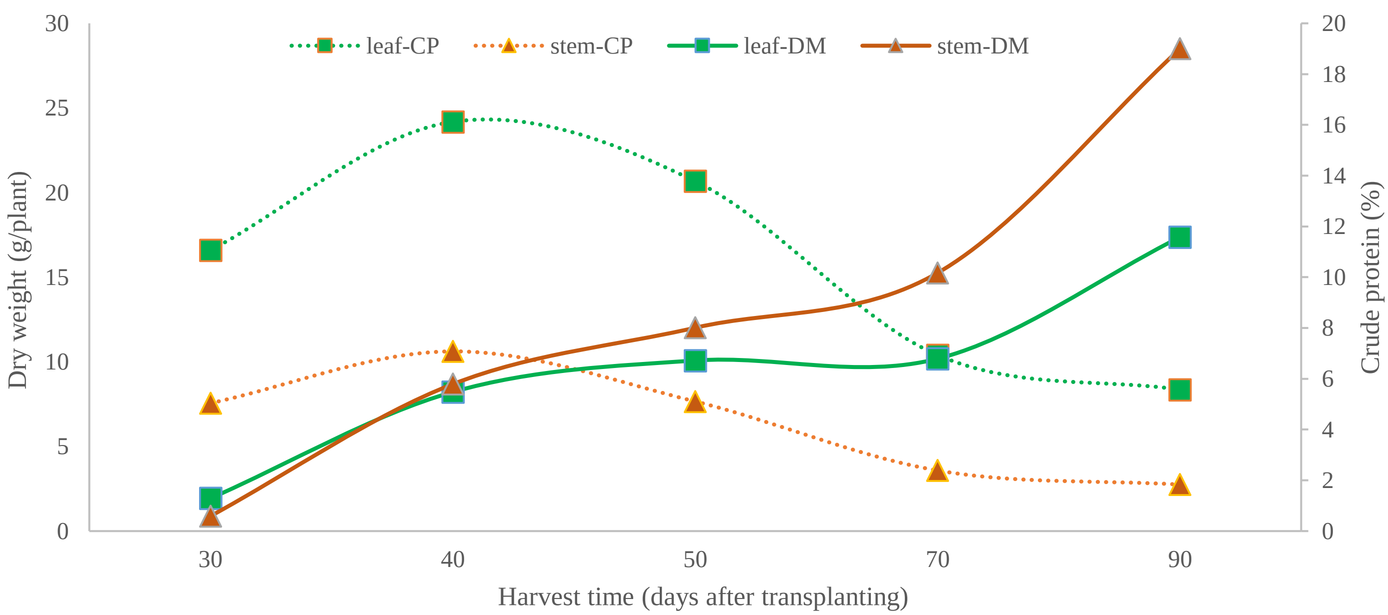

Figure 2. Effects of harvest time (days after transplanting) on DM yields and crude protein concentrations (% DM) in leaf and stem of *Asystasia gangetica*.

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(Note of the editors: All hyperlinks were verified 28 April 2020.)

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