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MORPHOLOGICAL TRAITS AT FIRST CUTTING OF FAST GROWING TREE LEGUME *INDIGOFERA ZOLLINGERIANA* UNDER DIFRENT PLANTING SPACING IN COCONUTS BASED FARMING

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Abstract

The objective of this research was to assess the morphological response of Indigofera zollingeriana to differences in planting spacing at first cutting of three months after grown in the field. This study used a Completely Randomized Design consisting of 6 treatments, namely PS1: 100 cm x 50 cm, PS2: 100 cm x 100 cm, and PS3: 100 cm x 150 cm, each treatment was repeated 6 times. The measured variables were: plant height, stem diameter, the highest number of leaves, and number of branches. Further, we have measured also dry weight yield and leaf/wood ratio. The results showed that plant height and stem diameter in PS2 and PS3 treatments were significantly higher than PS. Number of leaves not effected but branches, leaf/wood ratio and total dry weight were significant effected by treatments. Based on the results of this study it can be concluded that the best morphological response of Indigofera in term of leaf/wood ratio and total dry weight at the three months in the fields was obtained in the 100 cm x 100 cm planting spacing.

Key words: *coconuts, cutting, indigofera, morphological, planting.*

INTRODUCTION

Plant growth is increase in length, stem diameter, plant covered area, volume or biomass, wet and dry weight of plants. *I. zollingeriana* is a mainstay plant tree legume alternate to *L. leucocephala* which is susceptible to leucaena psyllid (*Heteropsylla cubana*). This Indigofera is one of important forage legume in Indonesia because agronomical aspect grown well during dry season, produced fertile seeds, branch and leaf developed exponentially up to certain time of defoliation, contains relatively higher crude protein ranging from 22-29% and highly relished by livestock (Figure 1). However, this plant is widely studied in an open environment, while in shade conditions has never been reported. The limited land for forage planting is a common problem in the development of ruminant animals. Along with the increasing of human population, extensive forage fodder is decreasing, due to the development of food agriculture and other infrastructure. Therefore, there needs to be an effort to provide land for growing forage.

Farming systems applied in North Sulawesi eastern part of Indonesia is still an integrated land with industrial plantations include coconut that can be used for the development of forage crops (Anis et al., 2015).

Figure 1. *Indigofera zollingeriana* underneath coconuts plantation

However, this kind of integration is faced with competition for nutrients, water and sunlight. Many research has been done and reported concerning *I. zollingeriana* grown in full sun light but unfortunately limited study assess this plant under natural shade environment especially under coconut plantation.

Therefore, the objectives of this study is to examine the effect of planting spacing configuration patterns and population density of *I. zollingeriana* measured on their morphological response and dry matter yield in the coconut farming area.

MATERIALS AND METHODS

The study was conducted in the experimental station of Assessment Institute Agricultural Technology (AIAT) of North Sulawesi, located 12 km from Manado City. Experimental site receives an average rainfall of 2700 mm, and the distribution fairly even, except for the period of lower rainfall by 100-150 mm monthly, from July to September every year. The pH of the fertile, sandy loam soil is around 6. Light transmission at 10.00 a.m on a sunny day as PAR underneath mature tall coconuts averaged 73%.

Indigofera seeds sown on land that has been processed as a nursery. Plant seeds that have grown well are then moved into a 2.5 kg plastic bag that has already been filled with soil (one plant / plastic bag). After growing for 2 months in a plastic bag medium, the plant was then transferred to experimental site in a plot size of 3m x4 m that had been processed and divided into 18 plots to accommodate the 3 treatments of planting spacing (PS) namely PS1: 100 cm x 50 cm, PS2: 100 cm x 100 cm, and PS3: 100 cm x 150 cm, corresponding to the population densities of 21 plants/plot (1.75 plant/m^2), 12 plants/plot (1 plant/m^2), and 9 plants/plot (0.75plant/m^2), corresponding 5714 plant/ha, 10,000 plant/ha and 13,333 plant/ha respectively. Each plot of treatment had a size of 3x4 m (12 m^2) was then placed individually. Since the distance between plots of treatments were 1 meter apart, caused the space of land utilized of each plot enlarge up to 4x5 m (20m^2) in each 10x10 m of square pattern planting of coconuts. There by the number of plots of treatments in each space of coconut of 100 m^2 were then 5 plots.

The variables measured were: (1) plant height, (2) stem diameter, (3) leaves number, and (4) number of branches. Ten individual plants has been selected as sample in each treatment. The total number of plants as sample in this experiment were sum of 10 plants x 3 treatment x 6 replication = 180 plants. Morphological traits data were calculated each week along 3 months consecutive observations has been done before harvesting.

The plants that are sampled for counting the number of branches is in the middle of the experimental plot in order to avoid border effect, and to facilitate observation the sample plants are marked with a red ribbon. Harvesting was done by cutting the plant canopy, then the leaves and stems are separated. Samples of 500 g were then dried in an oven at a temperature of 105^0C for 24 hours to get dry weight. Crude protein (CP) content of leaf component varied from 33 up to 37% or an average 35%, steam component CP content average 17%, or the whole plant CP was average 26%.

This study used a Completely Randomized Design consisting of 3 treatments of planting spacing and 6 replications. Data were then statistically analyzed by using analysis of variance (ANOVA) by means of MINITAB (Version 16). Honestly Significance Difference (HSD) was applied to determine the difference among treatments. Differences were considered at $P<0.05$.

RESULTS AND DISCUSSIONS

The influence of planting spacing treatments on plant population and morphological traits variable measured can be seen in Table 1. The highest plant height at the age of 3 months, obtained at the planting spacing 100 cm x 100 cm (PS2) with a height reaching around 86 cm. This treatment (PS2) differs markedly ($P <0.05$) higher than planting spacing at 100 cm x 50 cm (PS1), but there is not difference ($P>0.05$) compared to planting spacing at 100 cm x 150 m (PS3).

Stem diameter and number of branch affected by planting spacing. At treatment PS2 and PS3 gives higher ($P<0.05$) in stem diameter and number of branches compared to those in narrower spacing 100 cm x 50 cm (PS1), but both last treatments were not different ($P>0.05$).

Table 1. Some morphological traits of *I. zollingeriana* under difference planting spacing in coconuts plantation area

Items	Treatments groups			SE	p value
	PS1	PS2	PS3		
Plant height (cm)	68.73[b]	86.57[a]	71.62[ab]	0.231	0.001
Stem Diameter	0.93[b]	1.18[a]	1.04[ab]	0.061	0.034
Leaves number	15.33	16.17	15.93	0.317	0.192
Number of branches	8.27[b]	11.60[a]	11.00[a]	1.361	0.214

[a,b]Means in the same row with different letters show differences (P < 0.05).

The highest number of leaves at 3 months after planting obtained at the planting spacing 100 cm x 100 cm with the average number reached around 16 leaf per plant. Analysis of variance showed that treatments has not affects differently (P>0.05), on the number of leaves. The effect of space between plants on the number of branches per plant is presented in Table 1. The highest number of branches at the 3 months, obtained at the planting spacing 100 cm x 100 cm (PS2) reaching at around 11 branch and significantly higher (P<0.01) than treatment PS1 (8.27) but not differ compared treatment PS3 (11.00).

Table 2 below presented data the effects of treatments on biomass dry weight based on population density or number of plants per hectare. Those populations were 5,710 plants, 10,000 plants and 13,333 plants, corresponding to PS1, PS2 and PS3 respectively. The ratio of leaves / wood instead is not affected by planting spacing. The highest dry weight production (24,1 kg/ ha /harvest) resulted from the treatment of planting spacing 100 cm x100 cm (PS2) and 24,9 kg/ha/harvest at planting distance 100 cm x 150 cm (PS3), and both treatments were higher (P<0.05) compared to treatment PS1 (21,2 kg/ha/harvest).

Table 2. Leaf (L), wood (W), L/W ratio and DW yield of *I. zollingeriana* under difference planting spacing in coconuts plantation area

Items	Treatments groups Number plant (ha^{-1})			SE	p value
	PS1 5,710	PS2 10,000	PS3 13,333		
Leaf DW (Kg. ha^{-1})	13,6[b]	16,59[a]	15,75[a]	0.730	0.033
Wood DW (kg.ha^{-1})	7,54[b]	9,31[a]	9,14[a]	0.231	0.001
Leaf/Wood ratio	1.81	1.78	1.72	0.056	0.242
Total DW (kg.ha^{-1})	21,2[b]	24,1[a]	24,9[a]	0.596	0.001

[a,b]Means in the same row with different letters show differences (P < 0.05)

Shorter plant height, smaller diameter and lower number of branches in treatment PS1 is in strong relation with the higher plant populations almost double compared to PS2 and PS3. It means this phenomenon occur is probably due to strong competition of nutrient and water, which is markedly arise in crowded plant population (Craine & Dybzinsky, 2013). Contrary the wider spacing of PS2 and PS3 showed plant height, stem diameter and number of branches were significantly superior compared to narrower spacing PS1. The increase in plant height in equidistant spacing (PS2) is probably be due to high rate of stem elongation. Stem elongation is related to the light competition among plants in narrow planting spacing (Widodo et al., 2016), followed with taller plant compared to those in wider spacing (Craine & Dybzinski, 2013). The increasing this plant height in PS2 treatment followed by increasing in stem diameter (1.18) and number of branches (11.60). This founding is in agree with previous statement that narrower row spacing at 1.0 m x 0.5 m (PS1) reduces the number of branches (Kumalasari et al., 2017). It is likely that the greater spacing between adjacent plants within rows enhances the abilities of the plants to convert the intercepted solar radiation to leaf production (Telleng et al., 2016). Nevertheless, leaf number was not affected by all plant spacing treatments. It is mean that this plant could produce same number of leaves at 3 months after planting for all treatments. This probably due to the age of tree legume plant at 3 months still in vegetative development stages which is leave component grown dominantly (Anis et al., 2016).

Plant parts that are preferred by livestock and have higher nutritional quality are leaf fractions (Kaligis et al., 2018) so that the ratio of leaves / stems becomes important. From our finding the highest number of branches of Indigofera at the age of 3 months, obtained at the planting distance 100 cm x 100 cm (PS2) reaching at around 11 branches. The greater number of branches the higher growing point for leave development and will be related to the availability of energy reserves (carbohydrates) sustain re-growth of forages plant (Anis et al., 2016). Previous report stated that leaf and branch of *I. zolingeriana* grown exponentially up to sixth pruning and then decrease gradually (Abdullah, 2014). This research has been done under shading environment in coconut plantations. Even though the number of plant populations increased per hectare but dry weight has not increased linearly. Total dry weight, as well as leaves and wood dry weight increased up to the treatment PS2, and then almost reached plateau at PS3. This phenomenon is probably due to the shortages light in coconuts plantation. Discussion about coconut plantation is still important topic in rural development since this commodity as back bone economy at farmer level (Kaligis et al., 2017). The highest dry weight production of *I. zolingeriana* in this research was found at planting spacing PS2 and PS3. Forages dry matter production is contributed by leaf and stem formation, which was affected by cell division and elongation. Both physiology process was the sites of high metabolic activity, including dry matter accumulation through photosynthetic activity utilizing of CO2 atmospheric (Schaufele & Schneider, 2000).

CONCLUSIONS

Based on the results of this study it can be concluded:

1. The best morphological response of *I. zolingeriana* in term of leaf/wood ratio and total dry weight at the age of 3 months after planting was obtained in the 100 cm x 100 cm planting spacing underneath mature coconuts.

2. The more narrowing of planting spacing, results the more reducing the number of branches.

REFERENCES

Abdullah, L. (2010). Herbage production and quality of shrub indigofera treated by different concentration of foliar fertilizer. *Media Peternakan*, *33*(3), 169-175.

Abdullah, L., & Suharlina O. (2010). Herbage yield and quality of two vegetative parts of indigofera at different times of first regrowth defoliation. Prospektif agronomi dan ekofisiologi *Indigofera zollingeriana* sebagai tanaman penghasil hijauan *Media Peternakan, 33*(1), 44-49.

Abdullah, L. (2014). Pakan berkualitas tinggi. *Jurnal Pastura, 3*(2), 79-83.

Anis, S.D., Kaligis, D.A., & Pangemanan, S. (2015). Integration of cattle and Koronivia grass pasture underneath mature coconuts in North Sulawesi, Indonesia. *J. Livestock Research for Rural Development, 27*(7), 42-45.

Anis, S.D., Kaligis, D.A., Tulung, B., & Aryoanto, I. (2016). Leaf quality and yiels of *Gliricidia sepium* (Jacq) Steud under different population density and cutting interval in coconut plantation. *J. of the Indonesian Tropical Animal Agriculture, 41*(2), 91-97.

Craine, J.M., & Dybzinski, R. (2013). Mechanisms of plant competition for nutrients, water and light. *Funct. Ecol.,* 27: 833-840.

Kumalasari, N.R., Wicaksono, G.P & Abdullah, L. (2017). Plant growth pattern, forage yield, and quality of *Indigofera zollingeriana* influenced by row spacing. *Media Peternakan, 40*(1), 14-19.

Kaligis, D.A., Telleng, M.M., Anis, S.D., Waleleng, P., Oroh, F & Dalie, S. (2017). Utilization of signal grass pasture to support cattle production and economic value of coconut based farming. *Proceeding the 6th International Conference on sustainable Animal Agriculture for Developing Country*, Indonesia.

Kaligis, D.A., Telleng, M.M., Oroh, F.N & Anis, S.D. (2018). Tanggap morfologi *Indigofera zollingeriana* terhadap konfigurasi polatanam berbeda pada umur dua belas minggu setelah tanam di areal perkebunan kelapa. *Laporan penelitian*.

Schaufele, R., & Schnyder, H. (2000). Cell growth analysis during steady and non-steady growth in leaves of perennial ryegrass (*Loliumperenne L.*) subject to defoliation. *Plant Cell.Environ*., 23, 185-194.

Telleng, M., Wiryawan. K., Karti, P., Permana, I., & Abdullah L. (2016). Forages Production and Nutrient Composition of Different Sorghum Varieties Cultivated with *Indigofera* in Intercropping System. *Media Peternakan, 39*(3), 203-220.

Widodo, A., Sujalu, A.P., & Syahfari, H. (2016). Pengaruh jarak tanam dan pupuk NPK phonska terhadap pertumbuhan dan produksi tanaman jagung manis. *Jurnal AGRIFOR, 15*(2), 171-178.