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10

The Effect of Planting Space on Nutrient Composition of *Indigofera zollingeriana* in Coconut Plantation

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Abstract. The purpose of this research was evaluate leaf and stem nutrient composition of *Indigofera zollingeriana* with three different planting space in coconut plantation and to determine the suitable planting space of indigofera that produced highest nutrient in the system. The experiment was done at the experimental station of Assessment Institute Agricultural Technology (AIAT) of North Sulawesi, located 12 km from Manado City, North Sulawesi Province. This experiment was conducted using Completely Randomized Design (CRD). The treatment consisted of three planting space, (1) 1.0x0.5m, (2) 1.0x1.0m, and (3) 1.0x1.5m, each treatment had six replications. Nutrient composition was observed. Data were analyzed using analysis of variance and HSD test. The variables measured were dry matter content, protein content and crude fiber content in leaf and stem. The results showed that different planting space were significant different ($P < 0.05$) on leaf protein content, leaf crude fiber content and stem crude fiber content but were no significant different ($P > 0.05$) on leaf and stem dry matter content. HSD test showed that planting space 1.0m x 1.5m have highest leaf protein content (32.46%) and lowest leaf crude fiber content (10.04%). Based on this research it can be concluded that planting space 1.0m x 1.5m of *Indigofera zollingeriana* in coconut plantation have the highest nutrient composition.

Key words : *Indigofera zollingeriana*, planting space, nutrient content

7 Introduction

Interspecies competition is mediated through competition for soil, water, available nutrient and solar radiation, although other factors such as temperature fluctuation, pest infestation and agro-management practices are equally important. Density has several effects on crop yield because the aim of appropriate spacing between plants is to provide an appropriate combination of environmental factors (water, climate, light and soil) for maximum performance with optimum quality [1]. The complexity of resource competition is derived not only from the variability of resource limitation in space and time and among species, but also from the complexity of the resources themselves. Nutrients, water and light each differ in their properties, which generates unique ways that plants compete for these resource [2].

Indigofera sp. is a member of the legume group (family Fabaceae) with genus *Indigofera* and has 700 species spread in Africa, Asia, Australia, and North America [3]. *Indigofera species* has great promise as forages for ruminants. It is a potential legume because it has a good growth [4] with high production [5] and nutritive value [6,7]. Protein content of indigofera's herbage is 29.16 % [8], total dry matter production for 88 day after pruning is up to 5,410 kg/ha/harvest [9]. *Indigofera* has been utilized as protein sources in ruminant ration. The use of this legume species increased protein



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content of ration, dry matter degradability, and volatile fatty acid value in *in vitro* rumen model[10]. The high protein levels of indigofera[4] and the ability to tolerate drought, floods, and salinity make them agronomically desirable, while the deep-rooted growth form, ability to respond to small rainfall, and resistance to herbivore make them potentially valuable cover crops and forage species for semi-arid and arid areas [11]. Nutrient composition of *I. zollingeriana* equals to the tree legumes such as *C. calothyrsus*, *L. leucocephala* and *G. sepium*, except higher crude protein [12]. *Indigofera* sp. have high productivity and nutrient content as forage. Leaf flour *Indigofera* sp. contained crude protein 27.9%, crude fiber 15.25%, Ca 0.22%, and P 0.18% [13].

The leguminous plant needs a large amount of phosphor for nodulation and nitrogen fixation. The amount of legume nodule increased a long with increased phosphor availability. The number of nodule density (the nitrogen fixation part by rhizobium) and Nitrogen fixation velocity are stimulated by phosphor. There are no reports on nutrient composition of legume indigofera on coconut plantation in different planting space system. This study was conducted to evaluate the nutrient content of plant density legume indigofera on coconut platation.

2. Materials and Methods

2.1. Title and Location

This experiment was done at the experimental station of Assessment Institute Agricultural Technology (AIAT) of North Sulawesi, located 12 km from Manado City, from March to September 2018. Light transmission at 10.00 a.m on a sunny day as PAR underneath mature tall coconuts averaged 73%. The soil color was dark brown clay. The pH of the fertile, sandy loam soil is around 6. Air temperature ranged from 25^oC to 37^oC.

2.2. Material and Plot Design

The materials used in this study were the seed of *Indigofera zollingeriana* obtained from Agrostology Laboratory Faculty of Animal Science IPB. The plot size was 4 x 3m. The total number of plot was 18 consisting of 3 planting space and 6 replications. *Indigofera zollingeriana* seeds were planted in seeding tray. Three weeks after seedlings the plants were transplanted to polybag (1 plant/polybag) which were filled with 2 kg growing media (consisting of 1 kg latosols and 1 kg cattle manure). The plants were nursed for two months in growing media. After two months nursery period the plants were transplanted to experimental plot in the field.

2.3. Experimental Design

This experiment was conducted using Completely Randomized Design. The treatment were three planting space that PS1: 1.0 x 0.5m, PS2: 1.0 x 1.0m, and PS3: 1.0 x 1.5m, each treatment have six replicates. Data were then statistically analyzed by using analysis of variance (ANOVA) by means of MINITAB (Version 16) and Honestly Significance Difference (HSD) was applied to determine the difference among treatments. Differences were considered at p<0.05.

2.4. Parameters Observation

Harvesting *Indigofera* was done ± 90 days after plantin. *Indigofera* were defoliated at height level 100 cm above ground. Samples were dried at 60^oC for about 48 hours to determine the dried weight. The samples were analyzed for dry matter, crude protein, and crude fiber according to the standard procedure of Association of Official Analytical Chemists (2005). The parameters including leaf and stem dry matter content (%), leaf and stem crude protein content (%), and leaf and stem crude fiber content (%)

3. Results

The influence of planting space treatments on dry matter leaf, dry matter wood, crude protein leaf, crude protein wood, crude fiber leaf and crude fiber wood traits variable measured can be seen in Table 1.

3.1. Dry Matter

The dry matter leaf content around 17.52% to 18.46% and the dry matter wood content around 29.37% to 30.76%. The planting space give non-significantly ($P>0.05$) dry matter leaf content and dry matter wood content (32.46%). Any changes in the planting space of indigofera had no effect on dry matter leaf content and dry matter wood content.

Table.1. Nutrient composition of *I. zollingeriana* under difference planting spacing In coconut plantations area.

Variable	Treatment			MSE	Pvalue
	PS1	PS2	PS3		
Dry matter leaf	17.52	18.69	18.46	1.423	0.829
Dry matter wood	29.37	30.72	30.76	1.943	0.849
Protein leaf	30.98 ^b	31.36 ^{ab}	32.46 ^a	0.334	0.018
Protein wood	11.85	11.00	10.67	0.466	0.214
Crude fiber leaf	13.21 ^a	10.72 ^{ab}	10.04 ^b	0.716	0.017
Crude fiber wood	34.39 ^b	35.68 ^{ab}	37.38 ^a	0.722	0.033

Notes : PS1= planting spacing 1 x0.5 m; PS2 = planting spacing 1x1m; PS3 = planting spacing 1x1.5 m. DW=dry weight. ^{a,b,c} Means in the same row with different letters show significant differences ($P<0.05$).

3.2. Crude Protein

The crude protein leaf content around 30.98% to 32.46% and the crude protein wood content around 10.67% to 11.85%. The widest planting space (1.0m x 1.5m) give significantly the higher protein leaf content (32.46%), compared to planting 1.0m x 1.0m (31.36%) and narrowest planting space 1.0m x 0.5m (30.98%), but there were non-significant different ($P>0.05$) on crude protein wood content. Any changes in the planting space of indigofera had no effect on crude protein wood content.

3.3. Crude Fiber

The crude fiber leaf content around 10.04% to 13.21% and the crude fiber wood content around 34.39% to 37.38%. The widest planting space (1.0m x 1.5m) give significantly the higher crude fiber wood content (37.38%), compared to planting 1.0m x 1.0m (35.68%) and narrowest planting space 1.0m x 0.5m (34.39%), contrast with the crude fiber leaf content that the widest planting space (1.0m x 1.5m) give significantly the lower crude fiber leaf content (10.04%), compared to planting 1.0m x 1.0m (10.72%) and narrowest planting space 1.0m x 0.5m (13.21%).

4. Discussion

The nutrient composition of plants influenced by fertility rate of the growing media and some factors of the biotic environment. Short distance (increased density) increases nutrient requirement and sunlight competition. In addition, increasing density affected environment temperature and humidity. Air humidity affects physiology process of plant. High air humidity inhibits transpiration process. Planting space affected micro environment (temperature, humidity and light) and expanded the rod to uptake nutrient. Increasing number of plant population per square space would cause higher dry matter production. Density of plants caused by difference planting space did not affect dry matter production of leaf and branch [13]. Plants compete for nutrients by pre-empting nutrient supplies from coming into contact with neighbours, which requires maximizing root length. Although water is also a soil resource, competition for water is generally considered to occur by availability reduction, favouring plants that can withstand the lowest water potential. Because nutrient is supplied from above plants, individuals that situate their leaves above those of neighbours benefit directly from increased photosynthetic rates and indirectly by reducing the growth of those neighbours via shade [2].

Planting space affects plant growth stage. Decreasing plant density with increasing spacing causes plants to have a longer chance to develop their roots and accumulate photosynthetic

results into the root system. So that the carbohydrates found in the stem and roots are immediately used to be transformed into energy for the growth of new shoots, thus allowing the plants to quickly produce new plant shoots and produce high crop production. Increased narrow plant spacing up to 1 x 0.5 m significantly increased plant height. The increase in plant heights in a narrower spacing is probably be due to high rate of stem elongation. Stem elongation is related to the competition to get light between plants in narrow plant spacings that results in a significant taller plant compared to those in wider plant spacings [2].

Transpiration is important in mineral transportation from root to other parts of plant such as leaf. Plant density does affect the photosynthetic apparatus of crop. Plant density did not have a major effect on leaf area, which has to do with the morphology of that part of the plant [14]. Although leaf area/plant was greatest in wide row crops the sparse density resulted in low radiation interception compared to high density of plant stand. In wide row crops, low intra-specific competition ensures a more uniform growth of individual plants within a stand; this attribute did not result into improved light attenuation/perception especially [15]. Physiology and morphology of plant activity was disturbed by limited water availability. Plant converts photosynthesis product to be structural component faster along with increasing temperature [13]. Photosynthetic rate and the content of chlorophyll reduced with the increase of planting density [16]. Differences in row spacing enhanced plant-plant variation in terms of accumulated biomass. This phenomenon which affected grain yield and the stability of dry matter partitioning to seeds. Size dependent reproductive efforts reflected in differences in ability to partition accumulated biomass to seeds, seed number and seed yield per plant [15]. Planting density did not affect plant DM biomass or its nutritional quality. The similar per-plant biomass and nutritional quality among different densities can be explained by the abundant precipitation observed during this growing season. Corn plant density did not affect the quality of whole-plant corn destined for silage when precipitation was abundant [17].

Row spacing is cultural practices that may modify resource availability per plant, a practice which may influence the ability of each plant to allocate to the ear/head minimum assimilate required for seed set. Increased stand densities and hence inter-plant competition, reduced ability for resource capture as evident in biomass production and impaired grain production at high densities [15].

4. Conclusion

Planting space indigofera zollingeriana in coconut plantation had no effect on leaf and stem dry matter content but had effect leaf protein content, leaf crude fiber content and stem crude fiber content. Planting space 1.0m x 1.5m of Indigofera zollingeriana in coconut plantation have the highest nutrient composition.

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