AGRONOMIC PERFORMANCE AND NUTRIENT COMPOSITION OF *INDIGOFERA ZOLLINGERIANA* UNDER DIFFERENT PLANTING DISTANCES AND CUTTING INTERVALS

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ABSTRACT

The availability of improved forage for pasture development is the main concern for increasing livestock productivity. The study was conducted to evaluate the agronomic performance and nutrient composition of *Indigofera zollingeriana* under different planting distances and cutting intervals. A total of 360 seedlings was allotted to six treatments; Treatment A – 1.0m x 0.5m planting distance (PD), 50 – day cutting interval (CI); Treatment B – 1.0m x 0.5m PD, 70 – day CI; Treatment C – 1.0m x 0.5m PD, 90 – day CI; Treatment D – 0.8m x 0.6m PD, 50 – day CI; Treatment E – 0.8m x 0.6m PD, 70 – day CI; and Treatment F – 0.8m x 0.6m PD, 90 – day CI following the Randomized Complete Block Design in 2 x 3 factorial with three replications per treatment. The following parameters were recorded: Dry matter yield and chemical analysis. CI showed significant (p=0.0001) effect on the yield; the longest CI at 90 day obtained the highest significant yield (P<0.05) compared to other treatments; while decreasing the defoliation time to 50 day CI gave the highest crude protein (p=0.0001) and phosphorous (p=0.0235). Hence, cutting on longer defoliation time decreased the quality of the Indigofera. In conclusion, yield and nutrient quality of Indigofera affected mainly by CI.

Key words: cutting interval, forage, indigofera, planting distance

INTRODUCTION

Forage, the main feed for ruminants, is also becoming an important component of ration being fed to non – ruminants, particularly the native pigs and chickens. The availability of improved forage for pasture development is the main concern for increasing ruminant productivity. The Indigofera is one of the potential forage legume species which possesses good agronomic characteristics, contains high protein, has high palatability to ruminants, and tolerates drought, flood, and salinity (Skerman, 1982). Indigofera belongs to a large genus with some 700 species in tropical Africa, Asia, Australia, and North and South America. The species are distributed across a wide range of agro ecological area, which ranges from arid to sub humid conditions at an altitude of less than 2200m (Abubeker Hassen, 2006). The key attributes which make Indigofera a valuable forage species are its palatability (Coppock *et al*. 1986), resistance to pest (Bamberg 1986; Mugambi 1989), and ability to respond to small rainfall events (Coughenour *et al*. 1990).

Forage, particularly grasses contains lower crude protein of 7 – 11% and total digestible nutrients (TDN) of 50 – 60% than those nutrients required by animals. This means that farmers have to add other sources of nutritious feed in ration in order to meet nutritional needs and sustain animal performance. Production of high yielding and good quality fodder legume such as Indigofera for ruminants may be one of the adoptable feeding management to improve animal nutrition and production. In the study of Abdullah and Suharlina (2010), they found out that *Indigofera zollingeriana* leaves and soft twigs contained 27.60% crude protein, with *in vitro* DM digestibility 67% - 81%, and produced 4,096 kg leaf DM/ha/harvest at 68 – day cutting period. This high yield may be supported by availability of bud meristem after defoliation (Stür *et al*. 1998) and it can be attributed to its high rate of leaf (Edward *et al*. 2012).

At the moment, there is no local study has been done about the agronomic performance and nutrient composition of *Indigofera zolligeriana* using two variables (planting distances + cutting intervals). Despite the benefits of *Indigofera zollingeriana as* forage for livestock*,* the legume receives less attention and is underutilized locally. This may be due to limited information on its herbage yield production and nutritive quality, as well as its efficacy as feed for animals. Hence, if this study can generate science based information on planting distances, cutting intervals, and nutrient quality of *Indigofera zollingeriana* it might be used as guide for propagation methods and leaf production as feed for ruminants.

MATERIALS AND METHODS

Experimental plant. Indigofera seedlings (1 – 2 month old) were procured from a private farm in Alaminos, Laguna. The plant herbarium sample with flowers and fruits was sent to Museum of Natural History in College of Forestry, UPLB, Los Baños, Laguna for the identification of species.

Experimental treatment and design. A total of three hundred sixty (360) *Indigofera zollingeriana* were used in the study. The treatments were as follows: Treatment A – 1.0m x 0.5m PD, 50 – day CI; Treatment B – 1.0m x 0.5m PD, 70 – day CI; Treatment C – 1.0m x 0.5m PD, 90 – day CI; Treatment D – 0.8m x 0.6m PD, 50 – day CI; Treatment E – 0.8m x 0.6m PD, 70 – day CI; and Treatment F – 0.8m x 0.6m PD, 90 – day CI following the Randomized Complete Block Design in 2 x 3 factorial with three replications per treatment.

General management. A total of 21.8m x 16m piece of land in NSPRDC, Lagalag, Tiaong, Quezon was used for the experiment. Plowing and harrowing of the soil was done one (1) month before transplanting of seedlings. Weeding was regularly done whenever necessary. Three months after seedling were transplanted; sample plants were randomly selected and were tagged for proper identification. Four months after transplanting, initial cutting was done at 1.0m height starting from the soil surface. Plant height and stem diameter (for initial cutting only) were gathered using meter stick; herbage yield (edible and non – edible) were harvested and recorded using pruning shears and weighing scale, respectively. Subsequent scheduled harvests were strictly followed.

Data gathered and analysis. Edible and non – edible yield were gathered at 50, 70, and 90 cutting intervals. All the data were subjected to analysis of variance (ANOVA) following a Randomized Complete Block Design (RCBD) in 2 x 3 factorial. Significant treatment means were subjected to Fisher's Least Significant Difference (LSD) at confidence level of 95%.

Chemical analysis. Composite samples of edible and non-edible herbage weighing 300g were taken from each treatment and were dried in the oven set at 70°C for 72 hours. The dry weights were recorded and dry matter yield (DMY) was computed. The dried samples were ground and placed inside polyethylene bag and stored inside a chiller. The ground samples were sent to Veterinary Laboratory Division (VLD) of BAI for complete proximate, calcium and phosphorous (AOAC, 17th Edition).

RESULTS AND DISCUSSIONS

Initial data of Indigofera. Table 1 showed the initial height, stem diameter and yield *Indigofera zollingeriana* planted in two planting distances after four months from transplanting. The height of Indigofera under PD 1.0m x 0.5m was taller compared to PD 0.8m x 0.6m with values of 223.3 and 212.33cm, respectively; while stem diameter at PD 0.8m x 0.6m was larger compared to PD 1.0m x 0.5m with values of 2.20 and 2.13cm, respectively. Planting distance 1.0m x 0.5m showed higher edible dry matter yield (EDMY) compared to PD 0.8m x 0.6m with values of 183.39 and 155.31g, respectively. Same trend was observed on non – edible dry matter yield (NEDMY) with values of 124.18 and 108.69g.

Agronomic performance. The summary of the agronomic performance of the Indigofera *zollingeriana* planted under different planting distances and cutting intervals is presented in Table 2. After two (2) years of continuous defoliation following the treatments, the data on EDMY (Table 2) showed that herbage yield was significantly affected by defoliation time, with highest yield at 90 – day cutting interval (Treatments C and F) were significantly different ($P<0.05$) compared to Treatments A, D, B and E with values of 265.69g, 282.69g; 83.85g, 97.88g; and 127.79g, 130.53g, respectively. While

70 – day cutting interval (Treatments B and E) were significantly different ($P<0.05$) compared to Treatments A and D. Planting distance has no significant effect on the yield of Indigofera (Table 2) which is in contrast with the study of Kumalasari et al. (2017) wherein there were significant differences in fresh and dry matter forage yields between different plant spacing. The highest fresh forage yield was recorded in the narrower plant spacing. Average EDMY increased significantly ($P<0.05$) when defoliation time was extended from 50 to 70 and 90 days by 30% and 67%, respectively; while delaying defoliation time from 70 to 90 days increased EDMY significantly by 53%. The result was in agreement with the result of Abdullah and Suharlina (2010), wherein total dry matter production increased significantly ($P<0.05$) when the defoliation time was delayed from 38 to 68 and 88 by 53.2% and 124%, respectively. According to Schaufele & Schnyder (2000), herbage production is contributed by leaf and stem formation, which was affected by cell division and elongation. Cell division and elongation zones are the sites of high metabolic activity (growth hormones) and dry matter accumulation, which were associated with defoliation.

Generally, the non – edible dry yield (NEDMY) showed the same trend with edible yield; whereby, plants under Treatments C and F obtained similar values but were significantly ($P<0.05$) different compared to Treatments A, D, B and E (Table 2). Stem formation increased significantly when defoliation time was increased from 50 to 70 and 90 days by 26% and 94% respectively; while delaying defoliation time from 70 to 90 days increased NEDMY by 73%.

Nutrient composition. Crude protein (CP) content is one important quality measure of forage. The results showed that Indigofera's vegetative parts contained high CP with values of 21.67 to 24.64% (Table 3). This was comparable with Tjelele (2006) result, who reported that CP content of *Indigofera arrecta* ranged between 24.61 to 26.1%. Protein is an important nutrient for ruminant. It supports rumen microbes that consequently degrade forage and enables high protein digestibility (Newman et al., 2009). Results showed that Treatments A and D were similar but significantly different (P<0.05) compared Treatments B, E, C and F with values of 24.5%, 24.6%; 23.2%, 23.33%; and 22.93%, 21.67%, respectively; while Treatment B and E were significantly different compared to Treatment A and D. Average CP decreases as defoliation time was extended from 50 to 70 and 90 days by 0.05% and 0.09%, respectively. The result was in agreement with the study of Herdiawan *et al.* (2014), wherein defoliation interval significantly decreases on CP. In contrast with both experiments, the result of Abdullah and Suharlina (2010) showed that there was no effect of defoliation time on CP content in herbage samples of branch base. However, defoliation time significantly affected CP content from the herbage samples of shoot tip.

Crude fiber (CF) is structural carbohydrates which contain cellulose, hemi-celluloses and lignin (Delmer, 1999). CF content of Indigofera's herbage ranged from 14.47% to 18.63% (Table 4). Results showed that Treatments C and F were similar but significantly (P<0.05) different compared to Treatments A, D, B, and E with values of 18.10%, 18.63%; 14.60%, 14.67%; and 16.43%, 16.83%, respectively; while Treatment B and E were significantly different compared to Treatment A and D. Increasing the age of the plant increases the formation of cell wall from the stem which is associated with more fibrous stem. Average CF increases as defoliation time was increased from 50 to 70 and 90 days by 10% and 20%, respectively.

The result of Nitrogen Free – Extract showed that Treatments B and E were similar but significantly (P<0.05) different compared to Treatments A, D, C and F (Table 3). Phosphorous content is an important quality measure of forage especially for dairy animals. The results showed that Indigofera's vegetative parts contained high P with values of 0.33 – 0.47% (Table 3). Phosphorous contents of Treatment A were similar to all the treatments but significantly different to Treatments B and E. Higher mineral content is associated with age of the plants, the younger the plant the higher the mineral content. The result of Crude, Ash and Calcium showed no significant differences among the treatments (Table 3).

CONCLUSION

From the results of the two (2) years experiment, the following conclusions were arrived

- Planting distances had no significant effect in terms of EDMY, NEDMY and nutrient contents.
- Cutting intervals showed significant effect on the yields of the *Indigofera zollingeriana*; the longest CI at 90 – day obtained the highest significant yield compared to other treatments.
- Nutrient quality of *Indigofera zolligeriana* cut at 50 – day CI showed highest significant crude protein and phosphorous and it decreases as defoliation time lengthened. On the other hand, Indigofera cut at 90 – day CI showed highest significant crude fiber.

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Table 1. Initial height, stem diameter, EDMY, and NEDMY of *Indigofera zollingeriana* per tree under different planting distances at 4 – month old.

Planting Distance	Height (cm)	Stem Diameter (cm)	EDMY (g/tree)	NEDMY (g/tree)
1.0m x 0.5m	223.30	2.13	183.39	124.18
0.8m x 0.6m	212.33	2.20	155.31	108.69

Table 2. EDMY and NEDMY of *Indigofera zollingeriana* at different planting distances and cutting intervals (g/tree/harvest).

Variable	TREATMENTS						CV	p – value		
	A	B	C	D	E	F		PD	CI	PD x CI
EDMY	83.85±5.54^{c}	127.79±21.12^{b}	265.69±22.14^{a}	97.88±13.15^{c}	130.53±8.33^{b}	282.6912.73^{a}	20.03	0.864	0.0001	0.6939
NEDMY	14.11±2.60^{c}	71.63±18.40^{b}	249.80±36.37^{a}	16.71±14.0^{c}	62.61±24.80^{b}	245.13±9.30^{a}	20.05	0.982	0.0001	0.7701

***Different letters within column denote significant differences at level 5% LSD (P<0.05)**

Table 3. Proximate, calcium and phosphorous analyses of *Indigofera zollingeriana* at different planting distances and cutting intervals.

Variable	TREATMENTS						CV	p – value		
	A	B	C	D	E	F		PD	CI	PD x CI
CP	24.5±0.83^{a}	23.2±0.22^{b}	22.93±0.30^{c}	24.63±0.48^{a}	23.33±0.52^{b}	21.67±0.20^{c}	2.72	0.2913	0.0004	0.1378
C. fat	2.47±0.17	2.6±0.30	2.33±0.17	2.4±0.30	2.6±0.36	2.33±0.21	13.5	0.8897	0.4049	0.9800
C. Fiber	14.60±0.90^{c}	16.43±0.5^{b}	18.10±0.70^{a}	14.47±0.45^{c}	16.83±0.62^{b}	18.63±0.33^{a}	4.41	0.4556	0.0001	0.7121
Ash	14.67±0.46	15.30±0.13	15.47±0.10	14.37±0.67	16.27±0.17	16.13±0.21	5.32	0.8639	0.0566	0.4099
NFE	30.3±0.90^{b}	32.1±0.50^{a}	29.37±0.40^{b}	28.7±0.62^{b}	32.57±0.19^{a}	29.37±0.24^{b}	2.03	0.2358	0.0001	0.0367
Ca	3.5±0.14	3.54±0.14	3.23±0.26	3.60±0.17	3.57±0.10	3.3±0.10	6.11	0.2874	0.0958	0.9161
P	0.4±0.21^{a}	0.33±0.19^{b}	0.44±0.15^{ab}	0.47±0.02^{a}	0.37±0.01^{b}	0.4±0.02^{ab}	11.02	0.1348	0.0235	0.4437

***Different letters within column denote significant differences at level 5% LSD (P<0.05)**