Original Scientific paper
10.7251/AGRENG2001022K
UDC 582.916.51

EFFECT OF CUTTING INTERVALS ON YIELD AND QUALITY OF THE GREEN FODDER *TRICHANTHERA GIGANTEA*

Tu Trung KIEN, Mai Anh KHOA, Tran Thi HOAN, Tu Quang HIEN*

Thai Nguyen University of Agriculture and Forestry, Thai Nguyen Province, Viet Nam
*Corresponding author: tqhien.dhtn@moet.edu.vn

ABSTRACT

This study was aimed to determine the effect of cutting intervals on leaf yield and quality of the green fodder *Trichanthera gigantea* used as feed material, mostly in poultry and rabbit diets, in order to improve farm animal products (such as meat and egg). This study included five different formulas (NT) representing five different cutting intervals, namely: NT1: 40 days, NT2: 50 days, NT3: 60 days, NT4: 70 days and NT5: 80 days of cutting intervals. All treatments were allocated in a complete block randomized design; each treatment was repeated 5 times. The other factors such as plantation density, cutting height and fertilizer dosage were similar among the treatments. The obtained results showed that from NT1 to NT5, the leaf dry matter yields were 7.34, 12.13, 12.41, 11.94 and 11.80 tons/ha/year, respectively; crude protein yields were 1.88, 3.13, 3.06, 2.78 and 2.69 tons/ha/year. When the cutting intervals increased from 40 to 80 days, the proportion of dry matter in the fresh leaves increased from 12.91% to 21.04%, crude protein proportion on dry matter decreased from 25.56% to 22.77%; crude fiber proportion on dry matter increased from 9.92% to 12.50%. Based on statistical analysis of dry matter yield and leaf chemical composition of green fodder *T. gigantea*, it is recommended that the most suitable cutting intervals for *Trichanthera gigantea* should be 50 – 60 days.

Keywords: Cutting intervals, leaf yield and quality*, Trichanthera gigantea.*

INTRODUCTION

There is a number of factors which greatly affect the quantity as well as the quality of the green fodders, for example, the plant varieties, season of the year (dry or raining season), fertilizer application, irrigation, plantation and harvesting technique etc. Of the harvesting, a cutting interval which is also called the gap between the two cuttings greatly affects the productivity and quality of green fodders. The cutting interval too short or too long may reduce the productivity of the following harvest because with a short cutting interval, the plants are not able to accumulate enough nutrients for the later regeneration, and a long cutting interval will push back the following harvest until after the dry season, causing the decrease of yield. This statement has been approved by Fadiyimu et al. (2011), Quang et al. (2013), Hien et al. (2019) when studied on harvesting intervals of several green fodders. On the other hand, the long cutting interval will increase the proportion of mature foliage, leading to a reduction of crude protein and an increase of fiber contents in leaves, thus reduces the quality of feed (Kien et al., 2010; Nouman, 2012; Hien et al. 2013; Hien et al., 2019). Therefore, it is important to determine an appropriate cutting interval in the development of green fodder production.

MATERIALS AND METHODS

The study focused on the green fodder *Trichanthera gigantea* and it was conducted at Thai Nguyen University of Agriculture and Forestry, Thai Nguyen Province, Vietnam from March 2017 to March 2019. Meteorological data (temperature, humidity and rainfall) from April to October (raining season) was favorable for green food crops to grow and develop, the rest (dry season) was less favorable for plant development. The experimental soil was of an average fertile type.

The experiment included 5 treatments (NT), representing 5 different cutting intervals, so-called as NT1: 40, NT2: 50, NT3: 60, NT4: 70 and NT5: 80 days/cutting interval. Each treatment was carried out on an area of $24m^2$ with 5 replicates (5 lots/treatment), and arranged in a complete randomize block design. The other factors such as plantation density, cutting height and fertilizer dosage were similar among the treatments. The monitoring indicators included the productivity and yield of biomass, fresh leaves, dry matter, crude protein and leaf chemical composition. The productivity and yield were determined following the method from Hien et al. (2002). Productivity is total biomass or fresh foliage or dry matter obtained/ha/harvest; the unit expressed as kg/ha/harvest. In this trial, the biomass productivity was determine by cut and weigh the whole biomass of each lot, then divided by $24m^2$ to calculate the biomass productivity of $1m^2$ and 1ha of the lot, productivity of 1 treatment was the average of 5 lots. The fresh foliage productivity was calculated by multiply biomass productivity with the percentage of fresh foliage in biomass (this ratio (y%) was determined by weighing the biomass (a), separated the leaves from the branches then weigh (b), Y% =b/a x 100). Foliage dry matter productivity was calculated by multiply foliage productivity with its dry matter content. Production yield is the total biomass or fresh foliage, dry matter, crude protein harvested within a year; expressed as ton/ha/year. Yield was calculated by adding productivity (biomass, fresh foliage, dry matter) of all harvests of production year or by multiply the average harvest productivity/year (biomass, fresh foliage, DM) with the numbers of harvest/year; these 2 calculations differed from 0 – 5‰. CP yield was calculated by multiply DM yield with CP percentage in DM. The chemical composition of leaves was analyzed according to A.O.A.C (1990). Each criterion was analyzed with 5 replicates (n = 5). To assess the quality of green fodder, some of the main chemical components of *T. gigantea* leaves in different cutting intervals including dry matter (DM), crude protein (CP), crude lipid (Ether Extract - EE), crude fiber (CF), total mineral (Ash) were analyzed; Nitrogen-free extract (NFE) is calculated by DM - (CP + EE + CF + Ash).

Results were statistically analyzed following the method described by Oanh and Phu (2012) using IRRISTART software 5.0.2009.

RESULTS AND DISCUSSION

Effects of cutting intervals on the productivity of T. gigantea

The average productivity of biomass, fresh leaves, dry mater per hectare per cutting of 2 experimental years are presented in Table 1.

Table 1. The productivity of *T. gigantea* at different cutting intervals (kg/ha/harvest)

Treatments	Biomass	Fresh leaves	DM
NT1 (40 days)	13,597^{d}	8,746^{c}	1,129^{d}
NT2 (50 days)	23,223^{c}	14,529^{b}	2,205^{c}
NT3 (60 days)	29,598^{b}	15,753^{a}	2,758^{b}
NT4 (70 days)	33,283^{a}	15,453^{a}	2,986^{a}
NT5 (80 days)	33,537^{a}	14,025^{b}	2,951^{a}
SEM	**1103.0**	**563.4**	**99.8**
P	**0.000**	**0.000**	**0.000**

The values with different letters are significantly different ($p \leq 0.001$) in accordance with the LSD test.

Effects of cutting intervals on biomass productivity

Biomass productivity included whole stems, branches and foliage of green fodder plants obtained per ha per harvest. This was the basis for calculating the productivity of fresh leaves and dry matter. The average biomass productivity/harvest of both years (kg/ha/harvest) increased from 13,597 (NT1) to 33,537 (NT5). The average biomass productivity of different treatments differed significantly with $P < 0.001$, except NT4 had no difference from NT5. Therefore, increasing cutting intervals from 70 to 80 days did not make a significant difference in biomass productivity. The main reason was that the long cutting intervals pushed the harvests until after the dry season, leading to low productivity. The average biomass productivity of 5 treatments of 2 years of *T. gigantea* reached 26,600 kg/ha/harvest. In previous studies, the average biomass productivity (kg/ha/harvest) of 2 years of cassava for leaf collection was 17,400 (Hien and Trung, 2016), of *L. leucocephala* was 15,100 (Hoan et al, 2017), of *S. guianesis* was 19,400 (Hien et al, 2017), of *M. oleifera* was 22,000 kg/ha/harvest (Hien et al, 2019). Thus, the average biomass productivity of *T.gigantea* in this experiment was higher than the average biomass productivity of the green forage crops commonly used to produce leaf meal in Vietnam, which were informed by the previous researchers.

Effect of cutting intervals on productivity of fresh leaves

When producing leaf meal, stems and branches of the green food plants are often removed, and only fresh leaves are used. Therefore, it is necessary to determine the productivity of fresh leaves. The foliage productivity determination was described in the Materials and Methods (M&M) section showed that fresh foliage productivity not only depended on biomass productivity but also on ratio of fresh leaves/biomass, this ratio varies with age (cutting intervals) of plants; accordingly, when the cutting interval is short, the plants are young and the branches are small, so the ratio is high; when the cutting interval is long, the old stems and big branches cause the low rate. The weighted average percentage of fresh leaves/biomass of harvests of NT1, NT2, NT3, NT4 and NT5 were determined as 61.32%; 62.56%, 53.24%, 46.43% and 41.82% respectively. Fresh leaf productivity did not follow the rules of biomass productivity. It did not increase steadily when the cutting intervals increased, but the average productivity of fresh leaves/harvest/2 years increased from NT1 to NT3 from 8,746 to 15,753 kg/ha/harvest. After that, it gradually reduced to 14,025 kg/ha/harvest in NT5 because the increase of cutting intervals resulted in the decrease of the rate of fresh leaves/biomass as explained above. The average productivity of fresh leaves/ harvest/2 years was significantly different with $p < 0.001$; however, there was no significant difference between NT3 and NT4 and between NT2 and NT5.

Effect of cutting intervals on productivity of dry matter

After the fresh leaf productivity was defined, the dry matter (DM) productivity was calculated. The DM productivity which previously described in M&M section showed that DM productivity not only depended on fresh foliage productivity but also on DM content in fresh foligae, this ration also changed in accordance with cutting intervals; It was low when the cutting interval was short because young leaves had a high rate of water, low rate of DM and vice versa. The rate of DM/fresh leaves from intervals of 40 to 80 days were determined as 12.91%; 15.18%; 17.51%; 19.32% and 21.04%, respectively.

The productivity of DM was similar to that of biomass but there was a difference that when cutting intervals increased, the average productivity/harvest/2 years increased sharply from NT1 to NT3 (from 1129 to 2758 kg/ha/harvest) but only slightly increased in the later treatments. The productivity of DM was significantly different ($p < 0.001$) among treatments, except NT4 compared with NT5.

The influence of the cutting intervals on the productivity of green food crops had been studied by many scientists who concluded that too short intervals (too early harvest) would give low productivity/harvest; lengthening cutting intervals could increase productivity/harvest but when the intervals were too long, the productivity did not increase much, sometimes even decreased (Kien et al. 2010; Fadiyimu 2011; Quang et al. 2013; Hien et al. 2019).

Effect of cutting intervals on yield of T. gigantea

Yield is the total volume of biomass or fresh leaves, dry matter, crude protein obtained per hectare/year. Cách tính the yield of biomass, fresh leaves, dry matter and the crude protein yield which described in the M&M section. The average yields of biomass, fresh leaves, DM and crude protein per hectare per year of two experimental years are presented in Table 2.

Table 2. Yield of *T. gigantea* in different cutting intervals (tons/ha/year)

Treatments	Biomass	Fresh leaves	DM	Crude protein
NT1 (40 days)	88.383[b]	56.848[d]	7.339[b]	1.876[c]
NT2 (50 days)	127.729[a]	79.907[a]	12.130[a]	3.125[a]
NT3 (60 days)	133.147[a]	70.887[b]	12.412[a]	3.062[a]
NT4 (70 days)	133.133[a]	61.813[c]	11.942[a]	2.781[b]
NT5 (80 days)	136.146[a]	56.100[d]	11.803[a]	2.688[b]
SEM	**5.046**	**2.711**	**0.457**	**0.111**
P	**0.000**	**0.000**	**0.000**	**0.000**

The values with different letters are significantly different (p≤0.001) in accordance with the LSD test.

Although biomass productivity increased sharply from NT1 to NT5, biomass yield increased only from NT1 to NT3, and then hardly increased in the next treatments. The reason is that NT4 and NT5 had higher productivity of biomass/harvest, but had fewer harvests than NT1, NT2 and NT3. Biomass yields of NT2 - NT5 were significantly different from NT1 (p <0.001) but there was no significant difference among them (p> 0.05).

The yield of fresh leaves increased from NT1 to NT2, then decreased gradually. Fresh leaf yield of NT5 was only equivalent to NT1 because the increase of cutting intervals caused the development of stems and branches, leading to a reduction in the ratio of fresh leaves/ biomass from N1 to NT5 (from 64.32% to 46.43%). The fresh leaf yield of different treatments differed significantly with p <0.001.

Dry matter yield increased sharply from NT1 to NT2, slightly from NT2 to NT3, then decreased gradually in NT4 and NT5. The DM yields of NT2 to NT5 were not significantly different (p> 0.05) but they were significantly different from that of NT1. Thus, based on DM yield, *T. gigantea* should not be harvested in the cutting interval of 40 days.

The crude protein yield depends on two factors, namely, DM yield and ratio of crude protein in DM; this ratio of NT1 to NT5 were 25.56%; 25.76%; 24.67%; 23.29% and 22.77% respectively. Thus, the percentage of crude protein/DM was high in short intervals and low in long intervals (i.e. 25.56% with interval of 40 days and 22.77% with interval of 80 days). Therefore, the change of crude protein yield among the treatments was similar to DM yield, which increased from NT1 to NT2 and then gradually decreased in NT3, NT4 and NT5. The crude protein yields of the treatments were significantly different (p <0.001), except for NT2 compared to NT3 and NT4 compared to NT5. Thus, based on crude protein yield, *T. gigantea* should be harvested in cutting intervals of 50 or 60 days, not in intervals of 40 or 70, 80 days.

Kien et al. (2010), Fadiyimu et al. (2011), Nouman (2012), Quang et al. (2013), Hien et al. (2013), and Hien et al. (2019) studied the effect of cutting intervals on the yield of different food crops. Their research results showed that increasing cutting intervals made the yield of green matter, DM and crude protein grow up, but the interval that was too long made the yield increase unremarkably and even decrease. In general, the selection of long or short cutting intervals depends on meteorology and soil nutrition, and has to ensure that the plants accumulate enough nutrients for later regeneration (Assefa, 1998; Latt et al., 2000).

Effect of cutting intervals on quality of T. gigantea

Results of foliage chemical composition are presented in Table 3.

Table 3. Chemical composition of *T. gigantea* leaves in different cutting intervals

Intervals (days)	**DM** in fresh leaves (%)	**% DM**				
		CP	**EE**	**CF**	**Ash**	**NFE**
40	12.91^{f}	25.56^{ab}	2.48^{d}	9.92^{c}	24.63^{a}	37.41^{a}
50	15.18^{d}	25.76^{a}	2.57^{cd}	10.01^{c}	23.72^{b}	37.94^{a}
60	17.51^{c}	24.67^{b}	2.80^{c}	11.19^{b}	22.90^{c}	38.44^{a}
70	19.32^{b}	23.29^{c}	3.36^{b}	11.96^{a}	22.00^{d}	39.39^{a}
80	21.04^{a}	22.77^{c}	4.18^{a}	12.50^{a}	20.94^{f}	39.61^{a}
SEM	**0.0171**	**0.0088**	**0.0116**	**0.0087**	**0.0101**	**0.0206**
P	**0.0038**	**0.0019**	**0.0026**	**0.0019**	**0.0023**	**0.0046**

The values with different letters are significantly different (p≤0.01) in accordance with the LSD test.

As shown in Table 3, when cutting intervals increased from 40 to 80 days, the rate of DM in fresh leaves increased by 8.13%, from 12.91% to 21.04%. This rate of five treatments had a significant difference with P <0.01. The rate of DM/fresh leaves remarkably affected DM yield, which was the main indicator of assessment on production capacity of green fodders. The rate of DM/fresh leaves in the interval of 40 days was the lowest (12.91%), which is one of the two main causes of low DM yield of this treatment and therefore it should not be selected for green fodder production.

The crude protein ratio in DM increased from the intervals of 40 days to 50 days, and then decreased at the cutting intervals of 60; 70 and 80 days (from NT2 to NT5 decreased by 2.99%). The crude protein rates in DM of five treatments had relatively remarkable differences (p <0.01), except for NT1 compared to NT2, NT3. The 50-day and 60-day cutting intervals had high DM yield and high protein/fresh leaf ratio, so the protein yields of these intervals were significantly higher than the remaining intervals. This is the factor that should be considered when choosing appropriate cutting intervals.

When cutting intervals increased from 40 to 80 days, the fiber ratio in DM increased sharply, from 9.92% to 12.50%. This rate was relatively different among treatments with p <0.01, except for NT1 compared to NT2. The high rate of fiber in feed will affect the amount of consumed feed and the rate of feed digestion of livestock. Therefore, to obtain good quality leaf meal, *T. gigantea* should not be

harvested in long cutting intervals (70, 80 days). The 40-day cutting interval had the lowest fiber/DM ratio (9.92%), but it had significantly lower DM and crude protein yield than the intervals of 50 and 60 days, so it should not be selected.
The rate of ash in DM decreased, while lipid and nitrogen-free extract in DM increased when cutting intervals increased. It was significant different among treatments ($p <0.01$).
The cutting intervals have a great influence on the quality of green fodder, so it has been paid attention by many scientists. For example, Kien (2010) studied cutting intervals for grass *P. atratum* and *B. brizantha* ; Fadiyimu et al. (2011), Nouman (2012), Hien (2019) studied intervals for *M. oleifera*; Hien et al. (2013) studied intervals of cutting on grass *B. decumbens*; Quang et al. (2013) had research on *S. guianensis*. These authors all pointed out that the raise of cutting intervals increased the rate of DM, fiber and reduced protein ratio. The longer the cutting intervals are, the more sharply the above rates grow up and down. This feature should be taken into account when producing green feed.

CONCLUSION

The experimental results with cutting intervals of 40, 50, 60, 70 and 80 days/harvest for green fodder *Trichanthera gigantea* showed that the yields of DM /ha/year of the intervals from 50 to 80 days had no significant difference but they were remarkably higher than that of the 40-day interval. The yields of crude protein/ha/year of the 50-day and 60-day intervals were higher with significant differences compared to the remaining intervals; 70 and 80-day cutting intervals had a significantly higher rate of fiber and remarkably lower rate of crude protein in DM than the shorter cutting intervals. These results allow to exclude the intervals of 40, 70 and 80 days, so the cutting intervals of 50 and 60 days are appropriate.

REFERENCES

A.O.A.C., (1990). *Official Methods of Analysis of the*.15th edition. A.O.A.C., Inc. Arlington, Virginia, USA. 746 pp.

Assefa G., 1998. Biomass yield, botanical fractions and quality of tagasaste, (*Chamaecytisus palmensis*) as affected by harvesting interval in the highlands of Ethiopia. Agrofor Syst 42: 13-23.

Fadiyimu A.A., Fajemisin A.N., Alokan J.A. and Aladesanawa R.D., (2011). *Effect of cutting regimes on seasonal fodder yield of Moringa oleifera in the tropical rainforest of Nigeria.* Livestock research for Rural Development 23 (2).

Hien Q.T., N. K. Quac, T. T. Nhung (2002). *Textbook for pastures and fodder trees*. Agriculture Publishing House, 112 pages.

Hien Q. T., T. T. Kien, T. T. Hoan (2013). "Determine the appropriate cutting intervals for *Brachiria decumhens* basilisk grown in Thai Nguyen". *TNU Journal of Science and Technology*, Vol.104(4), pp. 23 – 27.

Hien Q.T., and T. Q. Trung (2016). "Study on the ability to produce green matter and leaf meal of cassava for leaves in Thai Nguyen province ",*Journal of*

Animal Husbandry, Animal Husbandry Association of Viet Nam*,* No. 214, December, pp. 52 – 56.

Hien Q.T., T. T. Hoan, T. Q. Trung (2017). "Study the yield of green matter and grass meal of *stylosanthes guianensis* CIAT 184", *Vietnam Journal of Science and Technology,* Ministry of Science and Technology, Vol. 59 (4), pp. 23 – 27.

Hien Q. T., Hoang T. H. Nhung, T. Q. Trung (2019). " Determination of optimum harvesting interval for *Moringa oleifera* in first year production" *Vietnam Journal of Science and Technology,* Ministry of Science and Technology, 61(5), pp. 42 – 47.

Hoan T.T., T. Q. Hien, T. Q. Trung (2017). "Study on the production capacity of green matter and leaf meal of *L. leucoceppala* in Thai Nguyen", *Proceedings of the National Conference on Veterinary and Animal Husbandry,* Can Tho 11 – 12/3, pp. 290 – 296.

Kien T.T., T. Q. Hien, T. T. Hoan, T. T. Nhung (2010). "Study the effect of different cutting intervals on the ability to receive, the rate of grass used and the digestibility of some imported grass species (*P. atratum, B. brizantha, B. decumhens*) on beef cattle". *TNU Journal of Science and Technology*, Vol. 67 (5), pp. 109 – 112.

Latt C.R., Nair P.K.R. and Kang B.T., (2000). Interaction among cutting frequency, reserve carbohydrates, and post-cutting biomass production in *Gliricidia sepium* and *leucaena leucocephala*. Agrofor Syst 50: 27- 46.

Nouman W., (2012). Biomass production and nutritional quality of *Moringa oleifera* as field crop. Turk Agric Forestry 37: 410 – 419.

Oanh T.N.D and H. V. Phu (2012). *Textbook for method of field experiment*, Agriculture Publishing House, Hanoi, 210 pages.

Quang V. N., H. D. Hieu, B. V. Phong, P. N. Lieu (2013). "Influence of some technical measures on green matter yield of *S. guianensis* CIAT 184 and *S. guianensis* plus at Ben Cat, Binh Duong." *Journal of Animal Science and Technology,* Institute of Animal Husbandry, No. 44, pp. 21 – 32.