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The Effect of Harvest Age on Different Regrowth on Chicory *(Cichorium intybus L.)* Forage Yield by Intercropped with *Pennisetum purpureum* cv. Mott

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ABSTRACT

This research was carried out to examine the chicory forage yields on different regrowth which were intercropped with *Pennisetum purpureum* cv. Mott (dwarf elephant grass) on different regrowth due to various harvest age. The research was conducted in the Laboratory of Forage and Pasture, Faculty of Animal Science UGM for 7 months, with a split-plot design and analyzed by Duncan with a total of 9 plots and an area of 2.5x2.5 m^2 for each plot. The main plot was the harvest age treatment (30, 45, and 60 days) and the subplot was the regrowth (first and second). In the first stage, as many as 9 cuttings of dwarf elephant grass in one plot were planted with a spacing of 1x1 m^2 until the plant height reaches 10 to 15 cm, then the chicory seeds were spread among the dwarf elephant grass plants with the sand mixture. The results showed the harvest age had a significant effect ($P<0.05$) on chicory's plant height, fresh forage yield, dry matter content, dry matter digestibility, and organic matter digestibility. The 30 to 45 days harvest age performed a higher fresh production more than the 45 days to 60 days harvest age. The 60 days harvest age and second regrowth yielded the highest mixed fresh production compared to the other harvest ages, namely from 12.50 ton/ha to 25.26 ton/ha. Based on the research results showed that the older the harvest age (60 days) increased the biomass of plant production but decreased the plant digestibility. The second regrowth was able to produce higher than the first regrowth, but there was no significant effect on the dry matter content and forage digestibility.

Keywords: *Cichorium intybus*, Harvest age, Intercropping, Productivity, Regrowth

Introduction

The main feed for livestock comes from grass, nuts, agricultural waste, and *forbs*. Grass and nuts are the main components in the forage, however *forbs forage* is not familiar to breeders where it has a high nutrient content in meeting livestock requirements. Therefore, introducing *forbs* as forage feed in cultivation needs to be given to breeders. *Forbs* is a subtropical plant (C3), where the forage plant cultivation is divided into 2, namely C3 and C4 plants. One of the C3 plants that is drought tolerant and not yet widely planted by breeders is chicory (*Cichorium intybus)*. Chicory is a *forbs* plant and has the potential to be cultivated and developed in Indonesia. Chicory is drought tolerant and all parts of the chicory plant can be utilized as animal feed, medicine or food (Street *et al*., 2013). Chicory has many benefits, namely being able to increase the mineral layer of the soil because it has deep roots, planting *mixture which able* to improve soil microbial composition which is important in the carbon and nitrogen cycle (Dhamala *et al.,* 2016). However, chicory has a low biomass production, where the chicory biomass yield production at the first harvest of 1.04 ton/ha (Umami *et al.*, 2017).

Plant must fulfill the requirements to be used as feed. It must have good quality, high palatability, and can be given to livestock continuously. Based on these characteristics, forage biomass production is important in meeting the amount of forage feed. One of the ways to increase forage yields is by *intercropping* planting. Beets (1982) stated that *Intercropping* is a planting system of two or more types of crops on the same land within one year. Gebru (2015) added that the *intercropping* planting system has many advantages over monoculture cropping systems such as stabilizing yields, efficient resources, reducing weeds, and efficient use of fertilizers.

Different harvest age and *regrowth* determines the forage yield produced as feed, the older the harvesting age, the forage yield will increase. Matt *et al*. (2003) stated that the 3rd week of chicory harvest yielded protein content (200 g kg/BK) and NDF (507 g kg/BK). Otherwise, the crop harvest will affect the *regrowth* process. The growth of tillers will increase along with *regrowth* plant. Based on the number of different plant production, becomes the background for conducting research on *intercropping planting with Pennisetum purpureum cv. Mott* on chicory's growth, production and digestibility. Harvest age at various *regrowth* of chicory was hoped to improve the quality of forage feed, both in terms of nutrients and biomass. This study aimed to increase that the production of biomass per unit area of forage so that it can be developed as an alternative in increasing the quality and quantity of forage.

Materials and Methods

This research was conducted for 7 months from May to November 2019 in the forage land of Laboratory of Forage and proximate analysis was analyzed in the Laboratory of Forage and Pasture, Faculty of Animal Science UGM. The material used in the study consisted of materials and tools. The research material included chicory seeds which were obtained from *Crop Mark Seed Company* and dwarf elephant grass cuttings obtained from forage land, organic fertilizers, and NPK fertilizers. Equipment used included agricultural tools such as tractors, hoes, sickles, buckets, gauges, ropes, plastic bags, sprinkles, newspaper bags, digital scales, oven dryers 55ºC, oven 105ºC.

The research stage started from land preparation, a plot of land was cleared beforehand, and then watered to facilitate the process of land plowing and compost application of 5 ton/ha. After that, the plowed land was divided into 9 plots, each with a size of 2.5x2.5 m^2 with a distance between plots of 0.5 m. Each treatment has 3 replications then planted with the *intercropping* system. As much as 9 dwarf elephant grass cuttings with a distance of 1x1 m were planted until the plant height reaches 10-15 cm, then the chicory seeds were spread as much as 1 gram between the dwarf elephant grass. NPK fertilizer was given a week before and after harvest at a dose of 200 kg/ha. NPK fertilizer was given by immersing it in the soil at a distance of 5 cm from the planting hole, and it was taken care not to hit the plant because it can cause the plant to die. Harvesting was carried out at the age of 30, 45, and 60 days as the main plot and the first and second *regrowth* as the subplot. The plants were cut 10 to 15 cm from the top.

The whole sample of the harvested plants then put into a newspaper bag (newspaper weight was already known). The sample in a newspaper bag was put in the oven 55ºC for 5 days until constant dry. The oven sample was then ground with a porosity with 1mm diameter. The data taken included chicory plant height, fresh forage yield, and dry matter. The data were analyzed using a split-plot design, further test was carried out by Duncan's Multiple Range Test (DMRT) to determine the result difference.

Results and Discussion

Plant height

Different *regrowth* gave a significant effect ($P<0.05$) on the chicory plant height (cm). Result served in Table 1 below.

Table 1 shows that the second *regrowth* height (40.25 cm) ($P<0.05$) was longer compared to the first *regrowth* (36.32 cm). This was due to the second *regrowth* had a higher number of plants. Therefore, when the harvesting was done the ability of stress increases at the tip of the plant shoots so that plant growth will be faster. At times of *regrowth*, meristem conditions will stimulate growth and this increase is a genetic response. Chicory is a *forbs* with rapid growth where it can be carried out uniformly or harvested at the age of 21 days. This was in line with Chapman *et al*. (2008) research, where chicory planted with *Lotus corniculatus* and *Medicago sativa* in the second harvest (28 cm) was higher than the first harvest (21 cm). In addition, the plant's genetics affects plant growth where it is in accordance with Roustakhiz and Majnabadi (2017) statement that chicory is an annual plant that grows upright, has deep roots so that it can withstand drought, is 80-90 cm high and if allowed to grow upright it can reach 200 cm without harvesting. Harvest age had a significant effect ($P<0.05$) on the chicory plant height. Harvest at 60 days gave the highest significant results ($P<0.05$) compared to 30 and 45 days (33.83 cm and 38.07 cm). Umami *et al.* (2017) stated the chicory plant height at week 4 was 17.63 cm, while at week 6 was 32.64 cm. Cranston *et al*. (2015) stated that chicory has an internal root system (*deep taproot*) so that the root weight (*root mass*) and the diameter of the taproot is larger. Thus, it can bind water for growth with a depth of 1.9 m in the first year.

Fresh forage production

The research results in Table 2 indicated that chicory with different *regrowth* gave significant results ($P<0.05$) on fresh production (ton/ha). Fresh forage production is one of the parameters to determine the forage yield. Difference *regrowth* the first and second had an effect on chicory biomass production, namely 6.42 ton/ha and 7.50 ton/ha, respectively. Based on the study results, the second *regrowth* had a higher average fresh production compared to the first *regrowth*. This was because the increase in fresh production is related to plant height. Plant height is an indicator to determine the amount of biomass production. Li *et al.* (1997) stated that the chicory production in New Zealand Parmerston North which was harvested in the 2nd year, the biomass production was 9.4 ton/ha higher than the first year of 8.5 ton/ha. Silungwe (2011) explained plant height and plant biomass yield have a positive relationship. Table 2 shows that dwarf elephant grass planted with chicory also has a significant effect ($P<0.05$) on fresh production (ton/ha).

Table 1. Chicory plant height (cm) at different harvest age and *regrowth*

Harvest age (days)	*Regrowth*		Average
	1	2	
30	30.94±0.39	36.69±2.16	33.82±3.48[e]
45	36.52±1.09	39.62±1.00	38.07±1.93[d]
60	41.50±0.86	44.44±0.90	42.97±1.79[c]
Average	36.32±3.15[z]	40.25±2.20[y]	

[c, d, e]Different superscripts in the same column indicates differences (P<0.05)
[y, z]Different superscripts on the same line indicates a difference (P<0.05)

Table 2. Production of fresh forage (ton/ha) chicory intercropped with dwarf elephant grass at different harvest age and *regrowth*

Plants	Harvest age (days)	*Regrowth*		Average
		1	2	
Chicory	30	4.92±0.21	5.93±0.24	5.42±0.58[e]
	45	6.38±0.20	6.80±0.43	6.59±0.38[d]
	60	7.95±0.49	9.77±0.56	8.86±1.10[c]
	Average	6.42±1.34[z]	7.50±1.78[y]	
Dwarf Elephant Grass	30	6.17±1.69	7.97±2.26	7.07±2.04[e]
	45	7.46±1.68	10.35±2.07	8.91±2.31[d]
	60	15.14±2.02	17.65±0.36	16.40±1.88[c]
	Average	9.01±3.18[z]	11.76±4.15[y]	
Chicory + Dwarf Elephant Grass	30	11.09±1.90	13.90±2.51	12.50±2.51[e]
	45	13.85±1.60	17.15±1.64	15.50±2.31[d]
	60	23.09±2.15	27.43±0.92	25.26±2.7[c]
	Average	16.01±5.68[z]	19.49± 6.31[y]	

[c, d, e] The same superscript in the column chicory, dwarf elephant grass, and chicory + dwarf elephant grass indicate a significant difference (P<0.05).
[y, z] Different superscripts on the same line indicate a significant difference (P<0.05).

Intercropping planting dwarf elephant grass with chicory on *different regrowth* gave a significant effect (P<0.05) on fresh production (ton/ha) of dwarf elephant grass. Table 2 shows that the second *regrowth* produced the highest fresh production (P<0.05) compared to the first *regrowth* (9.01 ton/ha). This was because dwarf elephant grass had more tillers so that the harvest is at the second *regrowth* the tillers' growing abilities were greater in comparison to the first *regrowth*. Sajimin and Purwantari (2019) stated the number of tillers in the dry season *Pennisetum purpureum* cv. Taiwan as much as 13.8, *Pennisetum purpureophoides* as much as 9.6 meanwhile *Pennisetum* cv. Local as many as 11.8. Bilal *et al.* (2001) stated that the tiller count *Pennisetum purpureum* cv. Mott was greater during the dry season. Planting dwarf elephant grass by *intercropping* system with chicory increased plant biomass production. In addition, the harvest age had a significant effect (P<0.05) on the fresh production of dwarf elephant grass. The fresh production of harvest age at 60 days (16.40 ton/ha) was significantly higher (P<0.05) than the fresh production of harvest age at 30 and 45 days.

Fresh production at 30 and 45 days had a significant difference (P<0.05) with harvest age of 60 days. The 60-day fresh production was the highest due to the ratio between stems and leaves, where it had more stems, then affected the biomass production. Also, *intercropping* planting was able to provide an adequate water supply to keep the land from drying out. It gets shade from dwarf elephant grass so that the longer the harvest age, the plants ability to absorb soil nutrients for the growth process will increase. Dhamala *et al*. (2016) explained that *intercropping* planting with chicory has N *rhizodeposition* which are useful for the decomposition of dead plants including nodules, roots and leaf parts provide nitrogen components so that the availability of nitrogen in the soil is still fulfilled. Powell *et al.* (2007) certified chicory fresh production at 8 weeks of age was 280 kg/ha, lower than the harvest age of 12 weeks, and 19 weeks as much as 1465 and 3026 kg/ha. The chicory fresh production was higher than the literature, this was due to the different planting locations which affect the availability of nutrients in the soil for growth. Different *regrowth* and harvest age gave significant results (P<0.05) on fresh production (ton/ha). Chicory at an older harvest age was able to increase fresh production (P<0.05). Mulatsih (2013) added that a longer harvest age can increase plant fresh weight because the longer the harvest, the percentage of leaves will decrease, otherwise the percentage of stems will increase.

Dry matter content of chicory

Data on Table 3 shows that the first and second *regrowth* did not give any difference in the chicory dry matter content, around 10.75% and 10.16%. *Intercropping* chicory with dwarf elephant grass had no significant effect on chicory dry matter content (%). It was because of the same harvest time, hence the plants have the ability to contain dry matter that was not much different. The main factor that affected the dry matter content was the harvest age. Li *et al.* (1997) stated that chicory is more sensitive to defoliation frequency than harvest intensity. Chicory dry matter content on different regrowth and harvest age can be seen on Table 3 below.

Harvest age had a significant effect (P<0.05) on chicory dry matter content. The dry matter at 45 days old was not much different at 30 and 60 days, although at 60 days old yielded the highest dry matter (11.32%). This was because the older the plants are harvested, then more dry

Table 3. The average of dry matter content (%) of chicory at different harvest age and *regrowth*

Plants	Harvest age (days)	*Regrowth*		Average
		1	2	
Chicory	30	9.97±0.12	9.73±1.00	9.85±0.65[e]
	45	10.23±0.14	10.18±0.83	10.21±0.53[ed]
	60	12.05±1.21	10.58±0.44	11.32±1.15[d]
	Average[ns]	10.75±1.15	10.16±0.78	

[c, d, e]: Different superscripts in the same column indicate significant differences (P<0.05)
[ns]: Non significant.

matter content will increase because the young plants can carry out the process of cell division and tissue formation. This was in accordance with the opinion of Purbajanti (2013) which stated that the plant cell content will decrease as the plants get older, the rate of dry matter accumulation due to photosynthetic activity is greater than nutrient absorption. Li and Kempt (2005) stated that the frequency of harvesting was able to affect the dry matter of the plant, the harvest at week 6 was able to produce 26% compared to the harvest in every 3 weeks. Umami *et al*. (2019) stated that chicory harvested at the age of 30 days had 8.19% of dry matter content.

Dry matter digestibility

Table 4 shows that different *regrowth* and different harvest age did not make any significance to the overall dry matter digestibility results. Chicory dry matter digestibility ranged from 67.87 to 73.88%. The analysis of variance result showed that the harvest age and *regrowth* had no significant effect. Dry matter *In vitro* digestibility *Cichorium intybus* at the different harvest age with the *intercropping* planting with *Pennisetum purpureum cv. Mott* on various *regrowth* was presented in Table 4.

The harvest age for chicory showed a standard range of 63.64%. Candrasari *et al*. (2011) stated that the standard of *in vitro* method which used pangola grass had dry matter digestibility of 62.33%. *In vitro* method used in research has been successful in accordance with standards. Chicory dry matter digestibility was not affected by harvest age. The dry matter digestibility ranged from 67.87 to 72.10%. Ozturk *et al*. (2006) stated that different results, namely the harvesting of chicory at various phases, theoretically resulted in a significant decrease. If based on dry matter composition of chicory at various harvest age that showed a significant decrease, there should result in different dry matter digestibility values. However, this condition was not found in this study.

The chicory dry matter digestibility at different ages performed a decrease in the dry matter digestibility, but there was no significant effect between harvest ages. The lowest value of dry matter digestibility at 60 days harvest age indicated that the low levels of nutrients were digested by rumen microbes. The result was in line with Widodo's *et al.* (2019) research, where that the complete feed digestibility value with rice straw levels of 25, 30, 35, and 40% resulted in a not significantly different on digestibility. The composition of crude fiber and crude protein was relatively the same so that it had an effect on digestibility. Meanwhile, this study showed that the harvest age of plants was not the only factor that can significantly affect the value of dry matter digestibility, but there were other factors that can affect the value of dry matter digestibility. Yunus (1997) explained the factors that affect *in vitro* digestibility including mixing feed, rumen fluid conditions, temperature control, time variation, and analysis methods.

Different *regrowth* had no significant effect on the chicory dry matter digestibility. The dry matter digestibility in different *regrowth* ranged between 69.81–71.41%. The results of the study did not perform significant effect presumably due to the composition of the dry matter on different *regrowth*. Hence, it led to the non-significant dry matter digestibility at different *regrowth*. But the results differ from studies that have been reported by (Lepcha *et al*., 2018) which showed that different *regrowth* in tall fescue plants had an effect on decreasing the digestibility of dry matter as well as decreasing the digestibility of NDF. Different *regrowth* treatment significantly decreased the digestibility but so far showed inconsistent results.

Organic matter digestibility

Organic matter in vitro digestibility *Cichorium intybus* on different harvest age *intercropped* with *Pennisetum purpureum cv. Mott* on various *regrowth* can be seen in Table 5.

Table 5 showed that the different harvest age on chicory had no significant effect on organic matter digestibility. The organic matter digestibility of the pangola grass as a standard was 68.71%. The different harvest ages showed the respective

Table 4. Average chicory dry matter digestibility (%) with different harvest age and *regrowth*

Plants	Harvest age (days)	*Regrowth*		Average[ns]
		1	2	
Chicory	30	73.88±11.94	70.32±7.36	72.10±9.08
	45	72.05±0.57	71.74±1.38	71.89±0.96
	60	68.29±2.34	67.87±1.22	67.87±1.73
	Average[ns]	71.41±6.57	69.84±4.24	

ns : Non significant.

Table 5. Average chicory dry matter digestibility (%) with different harvest age on the first and second *regrowth*

Plants	Harvest age (days)	*Regrowth*		Average^{ns}
		1	2	
Chicory	30	71.84±9.29	69.41±0.56	70.62±6.03
	45	70.71±0.40	67.87±5.83	69.29±4.01
	60	67.80±2.34	65.57±2.12	66.68±1.94
	Average^{ns}	70.11±5.01	67.62±3.53	

ns : Non significant.

percentages of 70.62%, 69.29%, and 66.68%. The percentage yield of organic matter digestibility was not much different from the standard pangola grass, which means the digestibility method with the *in vitro* method was successful. The organic matter digestibility result showed a pattern that was relatively the same as the dry matter digestibility. Tillman *et al*. (1998) stated that the dry matter digestibility is relatively similar to the organic matter digestibility because most of the organic matter is a component of dry matter. If the digestibility coefficient for dry matter is the same, then the digestibility coefficient for organic matter is also the same.

Chicory 60 days harvest age had the highest organic matter digestibility. This was presumably because the composition of chicory crude fiber at the age of 60 days was the highest. Therefore, it was difficult to digest by rumen microbes. This was in accordance with Oktafiani *et al*. (2015) research where the harvest age of flax plants on the 15th day was too early to be cut, causing higher NH3 production than the age of 30, 45, and 60 days. The early harvest age indicates that the fiber composition is still low so that it is quickly degraded in the rumen into NH3. Ozturk *et al.* (2006) stated that the value of chicory organic matter digestibility in various growth phases resulted in significant values, namely the vegetative phase (82.21%), flowering (74.23%), and the maturity phase (62.48%). Different studies where the digestibility value of organic matter was not significant, this may be because the methods used were different, namely, the Tilley and Tery method, while Ozturk *et al*. (2006) research used the *in vitro* fermentation kinetic (gas production) method.

Different *regrowth* treatment had no significant effect on chicory organic matter digestibility. Chicory organic matter digestibility on first and second *regrowth*, as much as 70.11% and 67.82%. Fathul and Wajizah (2009) stated that organic matter is part of the dry matter, so if the dry matter increases it will increase the organic matter, and vice versa. Therefore, this will also apply to the digestibility value, if the dr matter digestibility increases, thus the organic matter digestibility will also increase.

Conclusions

Based on the research results, it can be concluded that the second *regrowth* yielded the highest plant height and fresh production compared to the first *regrowth*. Growth, fresh production and forage dry matter increased but the digestibility value decreased alongside the older the harvest age after 60 days old.

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