Growth and biomass production of chicory (*Cichorium intybus* L) planted in intercropping system with *Pennisetum purpureum* cv. Mott and cut at different ages

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**Abstract.** This study aimed to determine the growth and biomass production of chicory planted in intercropping system with *Pennisetum purpureum* cv. Mott (idot grass) and on different ages. Planting were carried out on plots measuring 2.5x2.5 m with 40x40 cm of sub plots for chicory. *Odot* grass stems were planted, 9 stems in 1 plot and chicory seeds were spread on the sub plots between the *odot* grass. Experimental treatments were three different cutting ages, i.e. 30, 45 and 60 days (U1, U2, and U3 respectively). Each treatment was replicated 3 times, resulting in 9 plots in total. The observed variables were plant height, fresh production, dry matter, and organic matter content. The results of the study showed that different cutting ages produced significant differences on height, fresh production, dry matter content, and organic matter content (P value <0.05). The highest production of chicory and *odot* grass was observed highest on cutting age of 60 days, namely 7.95 ton/ha and 15.14 ton/ha. However, the dry matter content of *odot* grass was not significantly different. It can be concluded that chicory planted on intercropping system with *odot* grass and cut on 60 days old yields the highest production.

1. **Introduction**

The low development of forage, especially the poor management of feed plants in the community, creates a low quality and quantity of forage in Indonesia. The condition is considered as one of obstacles in the efforts of increasing livestock productivity. One of means to improve the quality and quantity of forage is by introducing new plants that are superior and can be developed in Indonesia, e.g. Chicory with the scientific name of *Cichorium intybus* L.

Chicory (*Cichorium intybus* L.) is a type of forb with a high nutrient content for grazing ruminants in summer [1]. Chicory has another function as an anthelminic which is anti-parasitic agent in the animal digestive tracts. Providing chicory by about 70% can reduce Ostertagi worm population which can cause infection in livestock [2]. Feeding chicory to sheep and cattle can also increase growth and milk production [3].

New plant introduction systems will not have optimal quality and quantity if the management system is poor. A good forage management system of feed plants, one of which is intercropping system, leads to increased crop production. Intercropping planting of chicory plants with grass is an alternative that can be done to increase forage production, so that in one land the nutrient content needs and forage production for livestock can be fulfilled. The grass that is planted with chicory is
Odot grass. Odot grass was chosen because of its superiority, which is one of the grasses that has a high production, favored by ruminants, has better nutritional quality than other grasses and is resistant to drought.

Including easiness aspect in plant management, i.e. setting up the cutting age, is important. The determination of cutting age is needed for plant growth so that it will produce optimal nutrient production and content. The best time for crop defoliation should support the formation of sapling responses, the maximum harvest quantity of nutrients per unit area, improve forage quality for the next grazing period, increase the botanical composition or create other indispensable effects [4].

This research was conducted to evaluate the effect of cutting age on chicory growth and biomass production planted in intercropping system with odot grass.

2. Materials and methods
This research was conducted for 6 months, consisting of two stages, i.e. planting stage which was carried out in the area of the Animal Forage Laboratory and the analysis stage. The materials and research tools used consisted of chicory seeds from the New Zealand Crop Mark Seed company and odot grass stems originating from the UGM Faculty of Animal Husbandry, leaf-based fertilizer, NPK fertilizer, hoe, sickle, newspaper, measuring instrument, willey mill, electric scales, 55°C and 105°C oven, strepler, and proximate analysis instruments (dry and organic matter evaluation).

This research was carried out on a plot measuring 2.5 x 2.5 m with a distance of 50 cm between plots. Furthermore, odot grass cuttings are planted first with a total of 9 odot grass cuttings in 1 plot until the height reaching 10-15 cm. Then chicori seeds were planted by spreading as many as 1 gram by using a mixture of sand between odot grasses. Spacing between grasses odot was 60 cm. Harvesting chicory and odot grass is done at 30, 45 and 60 days by cutting the grass 10 to 15 cm above the ground. This treatments were named U1, U2, and U3 respectively. Each treatment was repeated 3 times so that the total plot was 9 plots. Plotting was carried out on a random basis.

Samples of plants that have been harvested were taken as many as 800 grams, placed in newspapers that have been weighted. Chicory and odot grass samples in newspaper were dried in a 55°C oven for approximately 3 to 5 days (until reaching a constant weight) to obtain air-dried weight. Samples that have been dried were ground using a willey mill with a sieve hole diameter of 1 mm. The milled sample were analyzed for dry and organic matter contents.

All data were evaluated by analysis of variance in accordance with the one-way ANOVA design. Significant differences between groups were followed by the Duncan's Multiple Range Test (DMRT). It is expected that the content of production will increase so that it can be developed as an alternative in increasing the quality and quantity of forage.

3. Result and discussion
The plant growth studied were plant height and fresh production, while nutrient content evaluation comprised dry matter and organic matter content. The results of this study is presented on Table 1.
Tabel 1. Growth and biomass production of chicory and odot grass.

| Species      | Variables          | Cutting Age |
|--------------|--------------------|-------------|
|              |                    | U1          | U2          | U3          |
| chicory      | Plant height (cm)  | 30.94±0.39c| 36.52±1.00cd| 41.50±0.86d|
|              | Fresh production (ton/ha) | 4.92±0.21c| 6.38±0.20d | 7.95±0.49c|
|              | Dry matter (%)     | 9.97±0.12c | 10.23±0.14cd| 12.05±1.21d|
|              | Organic matter (%) | 80.63±0.00c| 82.84±0.00d | 83.22±0.36c|
| Odot grass   | Plant height (cm)  | 48.27±1.33c| 59.0±14.4b  | 77.44±4.00a|
|              | Fresh production (ton/ha) | 6.17±1.69c| 7.46±1.68d | 15.14±2.02c|
|              | Dry matter (%)     | 20.05±1.4  | 21.13±0.45  | 22.48±2.62 |
|              | Organic matter (%) | 81.49±0.73c| 84.12±1.85d | 84.45±2.20d|

Notes
Superscripts on the same row indicates significant difference between groups (P value <0.05).
U1: Cutting age of 30 days
U2: Cutting age of 45 days
U3: Cutting age of 60 days

3.1. Plant height
The results analysis on this study found that intercropping planting patterns with different cutting ages had a significant effect (P <0.05) on the height of chicory plants and odot grass. Plant height of U3 group (41.50 cm) was highest compared to U1 and U2 (30.94 and 36.52 cm, respectively). The similar result was also found in the odot grass which U3 produced the highest compared to U1 and U2 (77.44 vs 48.27 and 59.0 cm). That might be due to the longer age of plants enable plants to bind nutrients in the soil for more optimal plant growth. The longer the cutting plant, the more opportunity for plants to grow and carry out photosynthesis so that the accumulation of carbohydrates that are formed will be used for cell wall division and plant stem growth [5].

3.2. Fresh production
Fresh production of chicory and odot grasses were significantly altered by different cutting ages (P value <0.05). Fresh production of U3 group was the highest (7.95 tons/ha) than the U1 and U2 groups (4.92 and 6.38 tons / ha). This may be due to the increasing of plant height along with their cutting ages, by 6% of each cutting age. Chicory cut on week- 8 yielded 6,402 kg/ha of DM biomass production, higher than the those were cut on week- 1, 2 and 4, namely 2,187; 3,262; and 4,869 kg/ha of DM [6]. Chicory has a deep root system so N rhizodeposition also arises because of the decomposition of dead plants that can provide nitrogen components so that the availability of nitrogen in the soil remains fulfilled [7].

U1 group of odot grass had significantly lower fresh production (6,17 tons/ha) compared to U2 and U3 (7,46 and 15,14 tons/ha). The result might be due to the longer cutting age of plants which affect fresh production per unit area even though at U2 and U3 fresh production were not much different. The production of fresh odot grass which was planted mixed with legume was 77.66 tons/ha/year [8]. Intercropping planting will increase depending on the combination of types of plants [9]. A good combination of them is the type of plants that have different age, plant height, root system and nutrient requirements in plants

3.3. Dry matter value
The analysis showed that in this study it was known that intercropping planting patterns with different cutting ages had significant difference on dry matter content of chicory but no significant on dry matter of odot grass. However, U3 chicory group produced the highest dry matter compared to U1 and U2 (12.05% vs 9.97 and 10.23%). The odot grass on U3 produced the highest dry matter compared to U1 and U2 (22.48% vs 20.05 and 21.13%). The result is because of the shade provided by odot grass for chicory. so that they can hold water in the soil thereby reducing evaporation rates. Longer cutting
age had maximum shade. Li and Kempt [10] state that the frequency of cutting is able to affect the dry matter of plants. Cutting at 6 weeks can produce 26% compared to cutting every 3 weeks. The cutting age of 30 days resulted in a higher dry matter content of 20.89% compared to the age of cutting day of 19.37% [11]. Clark et al., [6] stated that the dry matter content of odot grass and elephant grass mixed with legume produced mixed dry matter by 16.64%.

3.4. Organic matter value

Different cutting ages affect organic matter content of chicory and odot grass planted in intercropping system (P value <0.05). The highest organic matter in chicory was U3 compared to U1 and U2, respectively (83.22% vs 80.63 and 82.84%) and organic matter of odot grass U3 and U2 were not different, but U1 group had fewer organic matter content compared to other treatments (84.45% and 84.12% vs 81.49%). Although with intercropping planting patterns the content of organic matter increased. The result is due to the correct and good intercropping patterns such as the cutting age which causes the organic matter content to increase, corresponding to the decreasing inorganic content. Wijaya et al., [8] stated that the later of age of cutting plants caused less water content of plants, but the proportion of cell walls will increase compared to cell contents, so that plant organic matter will also increase. Li and Kempt [10] stated that chicory which was grazed at 4 weeks had an organic matter content in leaves of 86.56% while in stems was 89.41%. Wijaya et al., [8] also stated that the organic matter content of a mixture of odot and elephant grass plants was 84.90%.

4. Conclusion

Cutting age of 60 days resulted in the highest average of plant height, fresh production, dry matter and organic matter value compared to other treatments. The organic matter value of odot grass between 45 and 60 days were the same. It might be caused by the fact that dry matter value was not different. Cutting age affected growth and production of chicory planted in intercropping system with odot grass.

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