Morphological Characteristics and Biomass Production of Chicory (*Cichoriumintybus* L.) in Yogyakarta

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ABSTRACT

This study was aimed at determining morphological characteristics, adaptability and biomass production of chicory planted in Yogyakarta, Indonesia. This study was carried out by observing the morphology, adaptability to pests and diseases, and biomass production of the crops during the vegetative phase, first and second defoliation. This study used chicory from Crop mark Seed Company New Zealand. The plants were planted in a plot size of 1 m^2 by spreading the seeds and each plant got 3 repetitions. The variables observed in this study were the growth of plants, plant morphology, pests and diseases on plants which were analyzed descriptively, as well as the biomass production, dry matter (DM) and organic matter (OM) of each plant which was analyzed by using Independent Samples T-test. Biomass production was taken from crop production on the first and second harvest. Plant morphology showed that the plants have a good development and the growth data showed that all of these plants have good growth. Adaptability of the chicorywas good because it was free from pests and diseases. The first harvest of chicoryproduced 1.04±0.80 tonnes / ha (DM 9.63±0.21%; OM 78.79±0.46%; the second production 1.47±0.11 tonnes / ha (DM 8.17±0.18%; OM 83.88±0.60%). The analysis showed thatchicoryproduction at the first harvest was significantly different ($P<0.05$) from the second defoliation. Conclusion of this study showed that chicoryfrom New Zealand can grow well in Yogyakarta based on morphological and biomass production.

Keywords: Chicory, Adaptation, Morphology, Biomass production.

INTRODUCTION

Forage is the basic feed of ruminants. Forage can be classified into 3 types; grass, legumes, and forbs. Forages are classified into two groups;sub-tropical and tropical plant. Forages are classified into groups based on their pathway of photosynthesis, especially in biochemical processes inusing electrons from light that convert CO_2 to carbohydrates.Sub-tropical planthave C_3 photosynthetic pathway because the initial product of CO_2 capture is converted to carbon chain 3. Tropical plants have C_4 photosynthesis pathway that convert CO_2 in mesophyll cells to be used by the phosphoenopyruruate carboxylase (PEPc) enzyme. It converts the carbon chain 3 to carbon chain 4 (Barnes *et al.,* 2007).

Introduction of feed plant is meant to bring varieties of plant from abroad to a country, because it has high productivity (Prawiradiputra *et al*., 2006). New Zealand is one of sub-tropical country with 4 seasons, but Indonesia, especially Yogyakarta, is tropical country with 2 seasons. Their climate differences are the background of this study to observe the

characteristics of morphology, adaptability, and production of introduction plant from New Zealand to Indonesia. This study was expected to improve the quality of feed plants in Indonesia. Type of introduction of feed plants used was a type of forbs, C_3 plant, namely chicory (*Cichorium intybus* L.). It is widely developed in New Zealand because it has high productivity and dryness resistance.

MATERIALS AND METHODS

This study was conducted for 4 months in the field of Pasture and Forage Science Laboratory, Animal Science Faculty, Universitas Gadjah Mada, Yogyakarta. Secondary data used in this study included soil data from analysis result at Agricultural Technology Yogyakarta, rainfall, temperature, and moisture data from Meteorology, Climatology and Geofisika Agency Yogyakarta.

Materials. The material used was chicoryseedfrom Crop Mark Seed Company, New Zealand.

Methodology. Roundup the field, plowed fields, then water flowed, and left for 3 weeks. Second roundup was done. Formed plotsize 1x1 m. Chicory seed was weighed according to the determined amount of New Zealand of 3 g/m^2. The seed was planted in a plot size of 1 m^2 by spreading them and every plant got 3 repetitions. Maintenance was conducted during the vegetative phase. The variables observed during plant growth was germination time. All of the morphological observation and measurement comprised plant height, plant length, main stem diameter, leaf length, leaf width, and part of plant (shape and type of leaf, ligule, auricle, petiole, shape and type of flower, shape and type of stem, leaf number, and plant root). Biomass production was calculated based on analysis of dry matter and organic matter by using AOAC method (2005). Data of the morphological characteristics, adaptability and biomass production were analyzed descriptively. Data of the first and second harvest were analyzed by using independent sampel T-test.

RESULTS AND DISCUSSION

Chicory was a new plant in Indonesia because there was no other genus has grown in Indonesia. The adaptability of this plant was very good in Indonesia and the growth was also good. Chicory *intybus* was classified in the forbs, shape like mustard, but its leaves were longer, oval, slightly narrower, and hairy on all parts of the leaf. The young leaves were slightly brighter than old leaves. The leaf bark was greenish-white and pinnate with many branches.

Chicory stem will be visible when the plant entered the reproductive phase. It formed the stem that supports the flower on this plant. In the early stem elongation period, animal can consume most of the stem. The ratio between stem and leaf was 70: 30% and it means good in providing feed for animals. Chicory that has entered the reproduction period will thickening and stiffening so animal did not want to consume them (Li and Kemp, 2005). Chicory stem was hollow, easy to cut, and stem length approximately 2 m or more (Hare and Rolston, 1987). Chicory has taproot and were able to break up subsoil. Nolte (2010) was in agreement that chicory has a long and thick tap root, like dandelion plants. Root of chicory was relatively drought resist (Hall and Jung, 2008), tolerate in various types of soil including sand, peat, and loam soil, but did not tolerate puddle in long term because it can damage root and cause to decay (Bryan *et al.,* 2016). Chicory seed had a small and oval shape. It is brown. It was 2.5 to 3 mm in length, pale brown to dark brown at seed maturity (Hare, 1986), and a 1000 seed weight of ranging from 1.2 to 1.5 g.

The observation of chicory growth was conducted from germination period to vegetative phase. Based on the observation (Table 1), chicory germinated on day 4. The first growth of chicory began with the appearance of *plumule* that released 2 small leaves. The first year of chicory growth could be divided into 3 phases (Ameziane *et al.,* 1997). The first phase (young phase) was the phase of development of the plant that was characterized by structural growth, occurred for 1.5 to 2 months. The next phase was the development phase of the plant into mature plant that were characterized by synthesis and accumulation fructan, occurred for 2 to 2.5 month. The last phase was the aging phase that was characterized by stop-growing plant and accumulation fructan.

Figure 1. (a) Chicoryseeds; (b) Chicoryin 48 days after planting; (c) All part of chicory in 48 days after planting; (d) Chicoryleaf surface; (e) The underside of chicoryleaf; (f) Chicory Stemin 48 days after planting; (g) Chicoryrootin 54 days after planting.

Table 1. Growth of chicory at Yogyakarta

Week	Plant height (cm)				Plant length (cm)				Leaf number			
	PlotI	PlotII	PlotIII	Average	PlotI	PlotII	PlotIII	Average	PlotI	PlotII	PlotIII	Average
1	1.90	1.30	2.10	1.77	2.20	2.10	2.38	2.23	0.00	0.00	0.00	0.00
2	4.90	4.06	5.22	4.73	5.18	4.46	5.22	4.95	0.00	0.00	0.00	0.00
3	10.88	11.40	11.40	11.23	12.74	12.66	12.60	12.67	6.00	6.00	6.00	6.00
4	13.00	19.30	20.60	17.63	16.84	21.00	22.10	19.98	7.00	7.00	7.00	7.00
5	21.30	24.70	23.50	23.17	22.90	31.40	31.60	28.63	6.00	6.00	7.00	6.00
6	26.22	36.60	35.10	32.64	27.28	37.60	40.70	35.19	7.00	9.00	7.00	8.00
7	37.20	34.00	42.30	37.83	38.50	35.30	43.50	39.10	8.00	9.00	8.00	8.00

Chicory was harvested twice. The first harvest was conducted atday 54 or 8 weeks with plant height of about 37.83 cm and the average leaf number of 8 pieces per plant. The second harvest was conducted at day 46 with height plant of about 38.77 cm and the average leaf

number of 9 pieces per plant. Bryan *et al*. (2016) suggested that the best time for chicory first grazing was when the plant had the average leaf number of at least 7 pieces per plant. This phase could be achieved in 8 to 12 weeks with appropriate moisture and soil temperature. The plant height before grazing was at least 20 to 25 cm and after grazing should be at least 5 cm from soil surface so it could re-growth well.

Table 2 showed production of chicory at the first harvest was significantly different ($P<0.05$) from the second harvest. The first chicory harvest produced 1.04±0.80 tonnes/ha (DM 9.63±0.21%; OM 78.79±0.46%) and the second production was 1.47±0.11 tonnes/ha (DM 8.17±0.18%; OM 83,88±0,60%). This difference was suspected due to the defoliation effects. Li *et al.* (1997) suggested that defoliation promoted the development of secondary buds but suppressed the development of the primary one. Chicory was more sensitive to defoliation frequency than defoliation intensity. The best accumulation of stem or leaf biomass of chicory was obtained at the defoliation interval for 4 weeks.

Tabel 2. Production of chicory in Yogyakarta

Parameter	First harvest	Second harvest
Biomass production	1.04±0.80 tonnes/ha[a]	1.47±0.11tonnes/ha[b]
DM	9.63±0.21% [a]	8.17±0.18% [b]
OM	78.79±0.46% [a]	83.88±0.60% [b]

[a, b] Different superscripts on the same line show a significant difference ($P<0.05$)

This result was not in the same line with the result of Crop Mark Seed research in Paterangi, Waikato, New Zealand on November 2006 to Juli 2007. The result of Crop Mark Seed research showed that production of chicory at the first harvest was about 3 tonnes DM/ha and the second production was ranging from 2.5 to 3.0 tonnes DM/ha. Chicory productionin Yogyakarta, Indonesia was lower than in Waikato, New Zealand. This difference was affected by climate and soil factor. The soil condition in Yogyakarta had higher pH for chicory to grow. Lokasari (2009) suggested that soil pH affected plant growth through two ways; the direct affect of hydrogen ions and indirect affect on the availability of certain nutrients and affect the availability of N and P nutrients. Setiawan (2009) was in agreement that climate affect plant growth and productivity because it related to the biological reaction.

CONCLUSIONS

Based on this study, it can be concluded that chicory can be developed into feed plant because of it has good growth. It also has a good adaptability because it is free from pests and diseases. Chicory production increases from the first harvest to second harvest, and OM content is higher than the first harvest.

REFERENCES

Ameziane, R., E. Deleens, G. Noctor, J-F. Morot-Gaudry, and M. A. Limami. 1997. Stage of development is an important determinant in the effect of nitrate on photo assimilate (^{13}C) partitioning in chicory (*Cichorium intybus*). J. Experimental Botany 48: 25-33.

Barnes, R. F., C. J Nelson, M. Collins, and K. J. Moore. 2003. Forages: An Introduction to Grassland Agriculture. Blackwell Publishing Professional, Iowa.

Bryan, J., J. Klingender, C. Lowe, S. Brpwnlie, D. Pavey, and H. Murray. 2010. Summer Forage Crop Guide. Ravensdown. New Zealand.

Hall, H. M. and G. A. Jung. 2008. Forage Chicory. Agronomy Facts 45. College of Agricultural Sciences.Cooperative extension. The Pennsylvania State University.

Hare, M. D. 1986. Development of 'Grasslands Puna' chicory (*Chichorium intybus* L.) seed and the determination of time of harvest for maximum seed yields. J. Appl. Seed Prod. 4: 30-33.

Hare, M. D. and M. P. Rolston. 1987. Effect of time of closing and paclobutrazol (PP333) on seed yield of 'Grassland Puna' chicory (*Cichorium intybus* L.). New Zealand J. Experimental Agriculture 15: 405-410.

Li, G. D., P. D. Kemp, and J. Hudgson. 1997. Regrowth, morphology and persistence of grassland Puna chicory (*Cichorium intybus* L.) in response to grazing frequency and intensity. Grass Forage Sci. 52: 33-41.

Li, G. and P. D. Kemp. 2005. Forage chicory (*Cichorium intybus*): A review of its agronomy and animal production. Advances in Agronomy 88: 187-222.

Lokasari, T. A. 2009. Pengaruh pemberian pupuk urea dan dolomit terhadap perubahan pH tanah, serapan N dan P serta pertumbuhan tanaman jagung (*Zea mays* L.) pada ultisol. Skripsi. Universitas Sumatera Utara. Medan.

Nolte, K. 2010. Crop of the Week: Chicory. College of Agriculture and Life Sciences. Cooperative extension. The University of Arizona.

Prawiradiputra, B. R., Sajimin, N. D. Purwantari, dan I. Herdiawan. 2006. Hijauan Pakan Ternak di Indonesia. Badan Penelitian dan Pengembangan Pertanian. Jakarta.

Setiawan, E. 2009. Kajian hubungan unsur iklim terhadap produktivitas cabe jamu (*Piper retrofractum Vahl*) di Kabupaten Sumenep. Agrovigor. 2: 1-7.