Effects of different level of nitrogen fertilizer on growth and production of *Cichorium intybus* at the eighth regrowth

A M Tilova, N Umami, B Suhartanto, A Astuti and N Suseno

Department of Animal Nutrition, Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna No. 3, Bulaksumur, Yogyakarta, Indonesia

Email: nafiatul.umami@ugm.ac.id

Abstract. This study aimed to determine the effects of different levels of nitrogen (N) fertilizer on the growth, production, and nutrient content of *Cichorium intybus*. The study was carried out at the Faculty of Animal Science, Universitas Gadjah Mada. *Cichorium intybus* were cultivated on a 1x1.5 m plot. Treatments on this study were different levels of nitrogen fertilizer: 0 kg/ha (N0); 25 kg/ha (N1); and 50 kg/ha (N2), with 3 replications on each treatment. Fertilizing was performed once, on day-5 of the growing phase. The height and length of the plants were recorded once a week for 21 days. The *Cichorium intybus* were defoliated on day-21. For the harvesting, the plants were cut 7.5 cm above the soil. Variables observed in this study include vegetative growth parameters (height and length of the plant, length of the leaf, the width of the leaf, and several leaves) and biomass production (fresh, dry matter (DM) and organic matter (OM) productions). All data were analyzed using one-way variance analysis, followed by Duncan Multiple Range Test for significantly different results. According to this study, the different levels of nitrogen fertilizer significantly affected (P-value <0.05) plant height and length, length and width of leaf, and biomass production. The highest production was obtained on the group receiving 50 kg/ha of nitrogen fertilizer, which produced 16.74 ton/ha fresh production, 1.36 ton/ha DM, and 1.10 ton/ha OM. Hence, it can be concluded that 50 kg/ha of nitrogen fertilizer treatment yields the highest production.

1. Introduction
Forages are classified into grass, legume, and forbs. Plants forms are not categorized as forage and legume, with no stem, and exists in forb shape. Forbs are rich in minerals, which are essential for animal growth [1].

One of the forbs is *Cichorium intybus* or commonly called chicory. *Cichorium intybus* is widely known as a traditional herb that exhibits potency to produce in a large quantity as feedstuffs during summer or dry season with high quality. Chicory is usually used as vegetables, medicine, or feedstuffs [2].

Chicory can grow well during summer and in wide-ranging soil types, from sand, peatland to clay soil [3]. *Cichorium intybus* contains a small amount of cellulose and hemicellulose. In contrast, the high-soluble carbohydrate and pectin content are high. Chicory has the potency to increase the total solid content (MS) of dairy milk when added to the feed rations during summer to fall seasons [4].
Fertilization is seen as one of the determining factors for improving plant production. The use of fertilizer based on the recommendation delivers the economic benefit [5]. Nitrogen is one of the macronutrients required by plants in large quantity for their growth [6]. Therefore, this study aimed to examine the effects of different levels of nitrogen on the growth, biomass production, and nutrient content of *Cichorium intybus*.

2. Materials and methods

This study was carried out for 6 weeks in the field facility of Laboratory of Animal Forage and Pasture, Faculty of Animal Science Universitas Gadjah Mada, Sleman, Yogyakarta Special Regions. Tools and instruments used in this study include hoe, peg, plastic rope, digital mass balance (1,000 g of capacity and 1 g of accuracy), analytical balance (220 g of capacity and 0.001 g of accuracy), ruler, scissors, stationary, blender, used newspaper, plastic clip, silica disc, oven, desiccator, tongs, and 550°C furnace. Materials used in this study were *Cichorium intybus*, urea fertilizer, KCl fertilizer, SP36 fertilizer, organic fertilizer, and water.

The study was performed on 1×1.5 cm² of *Cichorium intybus*-planted land age 7 months that had been harvested with 10 cm above soil surface-length of the base still intact. Treatments in this study were different levels of nitrogen fertilizer: 0 kg/ha (N0), 25 kg/ha (N1), and 50 kg/ha (N2). Each treatment was replicated 3 times, resulting in 9 plots in total. The placement of each plot was decided in orderly. Thus, plots of each treatment were situated in the same column or row. Defoliation was performed on day-21 after the cutting. Chicory was cut 7.5 to 10 cm above the soil. To evaluate the plant growth, some parameters were recorded, i.e. height and length of the plant, plant and width of leaf, and the number of leaves. Biomass production was evaluated according to fresh and dry matter production. Fresh production was determined by weighing the weight of freshly harvested chicory, which then converted into a ton/ha unit. Meanwhile, dry matter production was calculated by multiplying the fresh production (ton/ha) with the dry matter content of the chicory. Nutrient content of chicory was evaluated following the AOAC methods [7] that include dry matter, organic matter, crude fiber, and crude protein. Crude fat content was analyzed according to [8].

All data (growth, production, and nutrient content) were statistically analyzed using a one-way completely randomized design. Statistically, differences between treatments were then undergone further Duncan’s Multiple Range Test. All statistical evaluations were performed on the Statistical Product and Service Solution (SPSS) computer program.

3. Results and discussions

3.1. Growth

The plant growth can be accelerated with fertilization. Table 1 demonstrates that different levels of nitrogen fertilization significantly altered plant height, plant length, leaf length, and leaf width (P<0.05). Conversely, several leaves were unaffected (P>0.05).

Plant height of groups receiving 50 kg/ha was significantly higher 38.12 cm) than groups receiving 0 and 25 kg/ha of nitrogen (28.92 and 32.32 cm; P<0.05). Nitrogen is essential in determining the vegetative growth of the plant, i.e. plant height [9]. Nitrogen fertilization supplies the nitrogen for plant to improve the vegetative growth process.

Similar to the plant height, the plant length of chicory receiving 50 kg/ha of nitrogen was longer (42.38 cm) than 0 and 25 kg/ha groups (32.94 and 35.40 cm; P<0.05). The sufficient nitrogen availability leads to the balance between leaf and root ratio, enabling vegetative growth to run perfectly [10]. The result might come from the increased availability of nutrient and organic matter in the soil.

The N2 group demonstrated a longer leaf length (33.27 cm; P<0.05) than N0 and N1 groups (26.39 and 28.85 cm). Nitrogen stimulates the growth of leaf which indicating plant growth in the photosynthesis
process [5]. Providing nitrogen to plants can raise the vegetative growth of the plant, so the leaves grow longer.

The leaf width of N2 groups was also observed larger (5.13 cm; P<0.05) compared to N0 and N1 groups (3.97 and 4.73 cm). The soil nitrogen positively affects the width and length of leaf, producing larger leaf which leads to efficient and maximal photosynthesis due to the increased surface area [11,12].

The number of leaves was not significantly different among treatments (P>0.05). However, the number of a leaf on the N2 groups tend to be larger (16.67) compared to N0 and N1 (15.33 and 16.33). The nitrogen on the soil are potentially used by undesired plants, readily loss due to erosion and washing, easily burned by sunlight while the soil has not been ready yet to absorb it, and easily broken down by soil microorganism [13].

Table 1. Average plant length and width, leaf length and width, and several leaves of chicory receiving different levels of nitrogen.

| Variables          | Treatments | Average     |
|--------------------|------------|-------------|
|                    | N0         | N1          | N2          |
| Plant height       | 28.92±2.45a| 32.34±1.41ab| 38.12±5.46⁬ | 33.12±5.07 |
| Plant length       | 32.94±2.71a| 35.40±1.47⁬ | 42.38±2.79b| 36.91±4.72 |
| Leaf length        | 26.39±4.40a| 28.85±0.44⁬ | 33.27±3.21b| 29.50±4.07 |
| Leaf width         | 3.97±0.55a | 4.73±0.29⁬  | 5.13±0.75⁬  | 4.61±0.71  |
| Number of leaves   | 15.33±3.21 | 16.33±2.08  | 16.67±3.21  | 16.11±2.57 |

Different superscripts on the same row indicate a statistical difference (P<0.05).

3.2. Production

The production of chicory in this study was determined by evaluation of the fresh, dry matter, and organic matter productions. Chicory production can be seen in table 2. According to this study, the different levels of nitrogen significantly changed the fresh, dry matter, and organic matter production (P<0.05). The nitrogen fertilization significantly improved the fresh production as clearly seen on the larger fresh production on N2 group (16.74 ton/ha) compared to N0 and N1 (7.14 and 10.02 ton/ha; P<0.05). Chicory planted Croatia in July and harvested in October yielded 15.8 to 33 ton/ha of fresh production [14]. The fresh production of chicory receiving 50 kg/ha of Nitrogen in this study was matched with the literature. The result demonstrates that a 50 kg/ha level of nitrogen fertilization is the fittest level to supply soil nutrients for chicory in Indonesia.

Table 2. Average of fresh, dry matter, organic matte productions of chicory receiving different levels of nitrogen fertilizer.

| Variables                      | Treatments | Average     |
|--------------------------------|------------|-------------|
|                                | N0         | N1          | N2          |
| Fresh production               | 7.14±1.61⁬ | 10.02±1.89⁬ | 16.74±1.13⁬ | 11.30±4.48 |
| Dry matter production          | 0.61±0.12⁬ | 0.89±0.12⁬  | 1.36±1.16⁬  | 0.95±0.35abc |
| Organic matter production      | 0.48±0.1⁬  | 0.73±0.93⁬  | 1.10±0.15⁬  | 0.77±0.29abc |

Different superscripts on the same row indicate statistical difference (P<0.05).
The dry matter production of chicory in this study was also significantly affected by the experimental treatments \((P<0.05)\). Dry matter production of chicory receiving 50 kg/ha nitrogen fertilizer was higher (1.36 ton/ha) than groups receiving 0 and 25 kg/ha of nitrogen fertilizer (0.61 and 0.89 ton/ha). Chicory planted in Timisoara on day-35 produced 0.75 to 2.48 ton/ha of dry matter [15]. The result comes from that the high availability of nitrogen allows quick and maximum plant growth and development. The high dry matter production of the chicory plant can be markedly seen by the well vegetative growth of the plant.

The organic matter production of chicory receiving 50 kg/ha of nitrogen was also significantly higher (1.10 ton/ha; \(P<0.05\)) than groups receiving 0 and 25 kg/ha of nitrogen fertilizer (0.48 and 0.73 ton/ha). The organic matter production of a plant can be determined by the fresh and dry matter production, as well as its organic matter content [16]. The increasing level of N fertilization caused quicker plant growth, affected the nutrient content, so the plant content higher organic matter. The organic matter production of a plant was also modified by high dry matter production.

4. Conclusion

Based on the results of this study, vegetative phase growth of chicory \((\textit{Chicory intibus} \text{L.})\), i.e. plant height and length, leaf length and width, and several leaves were improved on the 50 kg/ha levels of nitrogen group. Likewise, the biomass production of chicory, i.e. fresh, dry matter (DM), and organic matter (OM) productions were also significantly enhanced by nitrogen fertilizer treatment on the level of 50 kg/ha.

Acknowledgment

The authors would like to thank Gadjah Mada University that has facilitated this study, to the Directorate General for Higher Education Ministry of Education Republic Indonesia that has funded this study, and to Dr Tim Cookson from Crop Mark Seed Company and Brian Thorington from New Zealand provided constructive advice during the study.

References

[1] Crowder L V and Chedda H R 1982 \textit{Herbage Quality and Nutritive Value Tropical Grassland Husbandry} (New York: Longman Inc)

[2] Waugh C D, Clark D A, Harris S L, Thom E R, Copeman P J A and Napper A R 1998 Chicory For Milk Production \textit{Proceedings of the New Zealand Grassland Association} (New Zaeland) 33–7

[3] Bryan J, Klingender J, Lowes C, Brownlie S, Pavey D and M H 2018 \textit{Summer Forage Crop Guide} (New Zealand: Ravensdown)

[4] Lee J M, Hemmingson N R, Minnee E M K and Clark C E F 2015 Management strategies for chicory \((\textit{Cichorium intybus})\) and plantain \((\textit{Plantago lanceolata})\): impact on dry matter yield, nutritive characteristics and plant density \textit{Crop Pasture Sci.} 66 168–83

[5] Napitupulu D and Winarto L 2010 Pengaruh pemberian pupuk N dan K terhadap pertumbuhan dan produksi bawang merah \textit{Jurnal Hortikultura} 20 27–35

[6] Zainal M, Nugroho A and Suminarti N E 2014 Respon pertumbuhan dan hasil tanaman kedelai \((\textit{Glycine max} (L.) \text{Merill})\) pada berbagai tingkat pemupukan N dan pupuk kandang ayam \textit{Jurnal Produksi Tanaman} 2 485–90

[7] AOAC 2005 \textit{AOAC Official Method} 920.39C: Gravimetry (ether extraction) I. Pearl millet flour fibre, crude. ISO 5498:1981. \textit{In Official Methods of Analysis of the Association of Official Analytical Chemists} (Arlington: Association of Official Analytical Chemists)

[8] Eldin A K and Andersson R 1997 A multivariate study of the correlation between tocopherol content and fatty acid composition in vegetable oils \textit{J. Am. Oil Chem. Soc.} 74 375–80

[9] Erawan D, Yani W O and Bahrun A 2013 Pertumbuhan dan hasil tanaman sawi \((\textit{Brassica juncea} \text{L.})\) pada berbagai dosis pupuk urea \textit{Jurnal Agroteknos} 3 19–25
[10] Made U 2010 Respons berbagai populasi tanaman jagung manis (Zea mays saccharata Sturt.) terhadap pemberian pupuk urea Agroland Jurnal Ilmu-ilmu Pertanian 17 138–43

[11] Pramitasari H E, Wardiyati T and Nawawi M 2016 Pengaruh dosis pupuk nitrogen dan tingkat kepadatan tanaman terhadap pertumbuhan dan hasil tanaman kailan (Brassica oleraceae L.) Jurnal Produksi Tanaman 4 49–56

[12] Novizan I 2002 Petunjuk Pemupukan yang Efektif (Jakarta: AgroMedia Pustaka, Jakarta)

[13] Sigit P 2001 Pupuk Akar, Jenis dan Aplikasi (Jakarta: Penebar Swadaya)

[14] Custic M, Poljak M, Coga L, Cosic T, Toth N and Pecina M 2003 The influence of organic and mineral fertilization on nutrient status, nitrate accumulation, and yield of head chicory Plant Soil Env. 49 218–22

[15] Moraru N, Dragomir N, Puadeanu I, Dragomir C, Tarjoc F and Rechctean D 2013 Effect of chemical and organic fertilisation on common chicory (Cichorium intybus L.) in the first vegetation year Sci. Pap. Anim. Sci. Biotechnol. 46 172–5

[16] Abqoriyah, Utomo R, Suwignyo B 2015 Produktivitas tanaman kaliandra (Calliandra calothyrsus) sebagai hijauan pakan pada umur pemotongan yang berbeda Buletin Peternakan 39 103–8