Nutrient content of Alfalfa (Medicago sativa L.) regrowth I in different fertilizers and lighting

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Abstract. This research was conducted to study the effect of fertilizer types and photoperiod on the nutrient content of regrowth I on alfalfa (Medicago sativa L.). The variables measured were nutrient content i.e dry matter (DM), organic matter (OM), crude protein (CP), and crude fat (CF). The research applied statistical analysis Completely Randomized Design (CRD) factorial pattern 5x3 and t-test. If it resulted in a significant effect, it was continued with Duncan’s multiple range test (DMRT). The first factor was types of fertilizer consisted of P0=control, P1=green fertilizer and dolomite, P2=manure, green fertilizer and dolomite, P3=dolomite, and P4=green fertilizer® and dolomite. The second factor was the photoperiod consisted of C0=12 h, C1=16 h, and C3=20 h. The results showed that the fertilizer types treatments were significantly affected (P<0.05) regrowth I DM, and regrowth I CF. While photoperiod treatment were significantly affected (P<0.05) regrowth I DM, regrowth I OM, and regrowth I CF. The interaction between the types of fertilizer and photoperiod treatment was significantly affected (P<0.05) regrowth I DM and CF. Based on research results, it can be concluded that the types of green fertilizer from PLAT and dolomite to produce the nutrient content regrowth I was the highest, resulting in 22.18% DM, 29.32% CP, 9.38% CF respectively. The nutrient content of regrowth I that produce the highest results of photoperiod was 12 h = 28.80% CP, 16 h = 20.92% DM, 20 h = 89.38% OM, 9.16% CF.

1. Introduction
Alfalfa (Medicago sativa L.) is a legume that has been developed in tropical areas such as Indonesia. Alfalfa is a type of legume that has a stable nutrient and productivity. Its high nutrient content and productivity cause many people to choose to grow alfalfa as it has been widespread in several countries. Alfalfa has the potential to be developed in tropical regions such as Indonesia [1] Alfalfa is developed in Indonesia to obtain the productivity of farming in the tropics. This plant requires a long photoperiod (long day plant) to produce optimum vegetative and generative growth. The nutrients of soil play an important role to gain optimum productivity. Bambang Suwignyo et al. [2] states that the treatment of alfalfa with SP-36 fertilizer and arbuscular mycorrhizal fungi (CMA) gives a very significant influence on the content of dry matter (DM) and organic matter (OM) as well as digestibility due to the interaction of the two. Alfalfa is a plant that has the ability to regrow after cutting. Alfalfa after cutting (regrowth) has different nutrient content because of the availability of nutrients in different planting media and the growth phase when cutting. This study aimed to learn and determine the effect of fertilizer types and lighting durations on the nutrient content of alfalfa plants in regrowth I. This research was expected to provide information about the content of alfalfa nutrients with different types of fertilizer and
lighting durations. This research was also expected to be a reference for other research in the field of forage.

2. Material and Methods
The study was conducted from March 2017 to March 2018. The research was carried out in the greenhouse and at the Laboratory of Forage and Pasture Science, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta. The fertilizer treatment and photoperiod carried out in this study are presented in Table 1.

Table 1. Types of fertilizer and lighting durations on alfalfa regrowth I

| Type of fertilizer | Lighting duration  |
|--------------------|--------------------|
|                    | C0                 |
| P0                 | C0P0               |
| P1                 | C0P1               |
| P2                 | C0P2               |
| P3                 | C0P3               |
| P4                 | C0P4               |

| Lighting duration  | C1                 |
|--------------------|--------------------|
| C0                 | C1P0               |
| C1                 | C1P1               |
| C2                 | C1P2               |
| C3                 | C1P3               |
| C4                 | C1P4               |

| Lighting duration  | C2                 |
|--------------------|--------------------|
| C0                 | C2P0               |
| C1                 | C2P1               |
| C2                 | C2P2               |
| C3                 | C2P3               |
| C4                 | C2P4               |

P0 = 100% land (control); P1 = 50% soil + 50% green fertilizer + dolomite 180 g / polybag; P2 = 50% soil + 25% manure + 25% green fertilizer + dolomite 180 g / polybag; P3 = 100% soil + dolomite 180 g / polybag; P4 = 50% soil + 50% green fertilizer + 180 g dolomite / polybag; C0 = 12 hour irradiation; C1 = 16 hour irradiation; C2 = 20 hour irradiation

Watering was done once a day, in the afternoon at 17.00 WIB, with 500 mL of water for each polybag. The plant was harvested at 11th week after planting (MST) on 1st regrowth by cutting about 5 cm above the soil surface. Alfalfa plant during regrowth was added with SP36 fertilizer of 2 tons/ha for P2O5 needs of 15 grams/polybag. Data were analyzed by using a completely randomized design (CRD) factorial pattern (5x3) and to determine the nutrient content of regrowth I with the t-test design. If it gave a significantly different result, it continued with DMRT (Duncan's Multiple Range Test) [3] applying the Statistical Product and Service Solution (SPSS) program version 16.0 for Windows

3. Results and Discussion
3.1. Dry Matter (DM)
The results of 1st Regrowth (Table 2) showed that the treatment of different lighting durations and types of fertilizer has a significant effect (P <0.05) on the DM content of alfalfa. The interaction between different lighting durations and types of fertilizer had significant effects (P <0.05) on the DM content of alfalfa. The DM content of alfalfa plants increased at 16 hours of lighting duration and decreased at 20 hours of lighting duration. It was because of the maximum photoperiod in alfalfa plants, which was in agreement with [4] that the optimal maximum photoperiod (MOP) for alfalfa plants is 18 hours. Purbajanti [5] states that about 90% of DM content is the result of photosynthesis.

Table 2. Average dry matter content (%) of alfalfa1st regrowth on different types of fertilizers and lighting durations

| Types of fertilizer | Lighting duration  | Average   |
|---------------------|--------------------|-----------|
|                     | 12 hours           | 16 hours  | 20 hours |
| P0                  | 19.55±1.17abc      | 18.08±1.16ab | 18.04±0.80ab | 18.55±1.20x    |
| P1                  | 19.25±2.58abc      | 20.58±1.75bcd | 20.04±1.18abc | 19.96±1.83x    |
| P2                  | 20.62±1.26bcd      | 21.21±1.07cde | 17.70±2.27cde | 19.84±2.17x    |
The average of DM (P <0.5) at the treatment of P4 fertilizer was higher compared to P0, P1, P2, and P3. It was because nutrient needs had been fulfilled with the provision of green fertilizer® and dolomite so that the treatment of other types of fertilizers exceeded the nutrient requirements. Rukmana [6] states that excess nutrients for plants can interfere with growth that causes symptoms in plants such as nutrient poisoning. The average dry matter content of every treatment can be seen in Table 2.

The interaction produced the highest DM content of alfalfa 1st regrowth (P <0.05) was 22.81% in the treatment of adding 20 hours of lighting by giving green manure® and dolomite (C2P4). DMRT showed that there were significant differences (P <0.05) between C2P4 and C2P0, C2P1, C2P2, C2P3, C1P0, C0P1, C0P0, C0P3, C0P4. DM accumulation reflects the ability of plants to bind energy from sunlight through the process of photosynthesis and their interactions with environmental factors [7]. DM plant production depends on the reception of solar radiation and taking CO$_2$ and water in plants. One of the factors that influence DM production is climate such as temperature, day length and water availability [8].

### 3.2. Organic Matter (OM)

The results of regrowth I (Table 3) showed that the treatment of lighting durations has a significant effect (P <0.05), while the treatment type of fertilizers has no significant effect (P <0.05) on the alfalfa OM content. The interaction of lighting duration and types of fertilizer did not occur on OM alfalfa content.

| Type of fertilizer | Lighting duration (hours) | Average |
|--------------------|---------------------------|---------|
|                   | 12                        | 16      | 20      |       |
| P0                 | 88.0±0.78                 | 87.0±1.38 | 87.7±1.26 | 87.9±1.12 |
| P1                 | 87.7±1.12                 | 88.5±0.28 | 89.0±0.58 | 88.4±0.88 |
| P2                 | 87.2±0.90                 | 87.0±1.90 | 88.9±1.88 | 88.1±1.10 |
| P3                 | 87.0±1.56                 | 88.9±1.69 | 88.9±1.88 | 88.1±1.16 |
| P4                 | 87.5±1.24                 | 87.0±1.49 | 89.3±1.42 | 87.9±1.42 |
| Average            | 87.6±1.07$^a$             | 87.8±1.05$^a$ | 89.1±0.66$^b$ | (-)       |

$^a$non significant. $^x$superscript in the same line show a significant differences (p <0.05). Sign (-) indicates no interaction.

$^x$superscript in the same column and $^p$ in the same row show significant differences (p <0.05). The (+) sign indicates an interaction.

Note: P0 = 100% land (control); P1 = 50% soil + 50% green fertilizer + dolomite 180 g/polybag; P2 = 50% soil + 25% manure + 25% green fertilizer + dolomite 180 g/polybag; P3 = 100% soil + dolomite 180 g/polybag; P4 = 50% soil + 50% green fertilizer + 180 g dolomite/polybag

The treatment with 20 hours of lighting duration was significantly different from the treatment of 12 and 16 hours. It was due to the increased lighting duration. Wahyuni and Kamaliyah [9] states that the increase in plant OM content is influenced by irradiation time, in which high light intensity will
stimulate the rate of photosynthesis to be optimum so that the cell components that support DM will increase. The increase in DM content was followed by an increase in OM content.

The average OM content resulted in the study is categorized as high value; It was identified by Widyantono's research [10] that proves that the highest OM content obtained was 82.810%. Karef et al. [11] state that the high OM content is due to the influence of sufficient N availability in the soil. The availability of N is the most accumulated element in OM because it is one of the most important elements in microbial cells involved in the process of soil OM remodeling.

3.3. Crude Protein (CP)

The results (Table 4) showed that the treatment of differences in lighting duration and types of fertilizer has no significant effect (P <0.05) on the CP content of alfalfa. The lighting duration and types of fertilizer did not affect the interaction with the CP of alfalfa. The duration of lighting in this study did not significantly affect the CP content of alfalfa and the highest CP content (P <0.05) at 12 hours of treatment. It was because the high production of alfalfa will affect the CP content of alfalfa. Rizki [12] states that the CP content in alfalfa is inversely proportional to the CP content of alfalfa. High production can increase the CP content but can reduce the CP content.

| Table 4. Average crude protein content (%) of alfalfa plant's regrowth I in different types of fertilizers and lighting duration |
|-----------------------------------------------|
| Types of fertilizer | Lighting duration (hours) | Average |
|                   | 12          | 16           | 20           |
| P0                | 29.55±1.78  | 29.88±2.82   | 26.19±3.85   | 28.54±3.18   |
| P1                | 27.18±1.59  | 22.92±4.92   | 28.52±4.43   | 26.21±4.34   |
| P2                | 27.29±2.86  | 28.00±2.66   | 28.27±1.72   | 27.85±2.27   |
| P3                | 27.68±2.43  | 30.78±1.58   | 27.12±0.85   | 28.53±2.30   |
| P4                | 32.27±7.27  | 26.87±2.25   | 28.83±0.52   | 29.32±4.61   |
| Average            | 28.80±3.92  | 27.69±3.92   | 27.79±2.66   | (-)          |

**Note:** P0 = 100% land (control); P1 = 50% soil + 50% green fertilizer + dolomite 180 g / polybag; P2 = 50% soil + 25% manure + 25% green fertilizer + dolomite 180 g/polybag; P3 = 100% soil + dolomite 180 g/polybag; P4 = 50% soil + 50% green fertilizer + 180 g dolomite/polybag

The types of fertilizer treatment did not significantly affect the CP content. It was due to the types of fertilizer used contained sufficient nutrients for CP. This opinion is following the explanation from [13] who states that the CP content can increase because there is a substantial N contribution from green fertilizer which is used as a basic fertilizer, which is then utilized by plants in leaf growth thus increasing CP content.

3.4. Extract Ether (EE)

The results (Table 5) showed that the treatment of differences in lighting duration and types of fertilizer has a significant effect (P <0.05) on the content of EE alfalfa. The interaction between differences in lighting duration and types of fertilizer had a significant effect (P <0.05) on the alfalfa EE content. Fertilizer treatment gave a significant difference to the EE content of alfalfa. It was caused by the availability of nutrients such as N in the fertilizer used was sufficiently available. Agustina [14] states that the N content in fertilizer can support the increase of EE. The treatment of 20 hours of lighting duration was significantly different from the treatment of 12 and 16 hours. This was due to the 20 hours of lighting duration affected the potential of alfalfa to produce flowers and pods, as seen by the results of the study that the alfalfa regrowth I plant with 20 hours of lighting in a condition of about 23.33%, in agreement with the opinion of [15] who states that alfalfa plant is a type of long-day plant, so the flowering process is strongly influenced by irradiation time. To produce flowers and seeds it needs special treatment in the form of additional
exposure at night to obtain irradiance higher than its critical point. Hermanto et al. [1] explain that seeds in a plant generally have a higher fat content.

Table 5. Average extract ether content (%) of alfalfa plants’ regrowth I in different types of fertilizers and lighting duration

| Types of fertilizer | Lighting duration (hours) | Average |
|---------------------|---------------------------|---------|
|                     | 12                         | 16      | 20      |
| P0                  | 7.91±0.60f               | 8.58±0.41bde | 10.16±0.60a     | 8.57±1.10f     |
| P1                  | 8.47±0.20bde             | 8.16±0.07bcde | 9.32±0.59def   | 8.88±0.61yz    |
| P2                  | 7.49±0.27a               | 8.56±0.36bde | 8.01±1.30bcde  | 8.65±0.85y     |
| P3                  | 8.63±0.35bde             | 8.40±0.85bcd  | 8.69±0.32bcde  | 8.02±0.53x     |
| P4                  | 9.11±0.77de              | 9.39±0.64def | 9.63±0.70df    | 9.38±0.67y     |
| Average             | 8.32±0.72p               | 8.62±0.64p   | 9.16±1.028q(+) |                 |

 superscripts in the same column and superscripts in the same row show significant differences (p <0.05). The (+) sign indicates an interaction.

Note: P0 = 100% land (control); P1 = 50% soil + 50% green fertilizer + dolomite 180 g / polybag; P2 = 50% soil + 25% manure + 25% green fertilizer + dolomite 180 g/polybag; P3 = 100% soil + dolomite 180 g/polybag; P4 = 50% soil + 50% green fertilizer + 180 g dolomite/polybag

Interactions that produce EE alfalfa on regrowth I content in the treatment of the addition of lighting for 20 hours without the addition of fertilizer (C2P0). DMRT test results showed that there were significant differences (P <0.05) between C2P0 and C2P2, C2P3, C1P0, C1P1, C1P2, C1P3, C0P0, C0P1, C0P2, C0P3, C0P4. The average EE content in alfalfa was still in a good range. Hermanto et al. [1] show their research that the highest EE content obtained from the interaction of fertilizer and lighting duration is 10.41% at 14 hours lighting duration and without the addition of fertilizer types. Setyadi et al. [16] state that EE content is influenced by plant types, processing, storage, plant material, and testing of feed ingredients.

4. Conclusion
The highest nutrient content of 1st regrowth was at 12 hours of lighting duration with CF 28.80%, 16 hours 20.92% DM, 20 hours 89.38% OM and 9.16% EE. The DM and OM content of alfalfa 1st regrowth increased but CF and EE content decreased.

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