Growth, Yield and Transpiration Rate of *Cymbopogon nardus* L. at Different Shade Levels

Nurlaili Habibi Danata[1], Nurul Aini[1*], Cicik Udayana[1], Adi Setiawan[1], Febriliana Kurnianingrum[1]

[1] Department of Agronomy, Faculty of Agriculture, Brawijaya University
Jl. Veteran, Malang City 65145, East Java, Indonesia
[*]**Correspondence** : E-mail: nra-fp@ub.ac.id, Phone +6281334110303

ABSTRACT

Essential oils are widely used for various fields ranging from medicine, pharmacy and aromatherapy. One of the raw materials used comes from Citronella oil obtained from Cymbopogon nardus. With the limites availability of land, it becomes a challenge to be able to cultivate C. nardus to obtain economic benefits. The development of lemongrass can be done with an agroforestry system to utilize the available land. The limiting factor in agroforestry systems is limited light due to shade. Low light causes the physiological processes of plants to be disturbed which then affects the production results. Therefore, it is necessary to know the percentage of shade that can be tolerated by C. nardus so that they can be developed in agroforestry systems. This study tested three varieties of citronella, namely Seraiwangi1, Sitrona 1 Agribun and Sitrona 2 Agribun . Each verieties planted under a different percentage of shade levels, namely 0% (no shade), 25, 50% and 75% shade percentage levels. Parameters observed included plant length, number of tillers, plant moisture content, fresh weight and transpiration rate. The results showed that increasing the percentage of shade decreased the growth of C. nardus. C. nardus can be used as an intercrop in agroforestry systems with 25% shade. Based on observations of several parameters, the Seraiwangi 1 variety has better growth than the Sitrona 1 Agribun and Sitrona 2 Agribun varieties.On the growth parameters, yield and transpiration rate of C. nardus have poor yields when cultivated in denser shade. Increased 50% and 75% shade reduced severe C. nardus growth. Tolerable shade 25% shade.

Keywords: *Agroforestry, Cymbopogon, growth, shade, varieties*

INTRODUCTION

The use of essential oils for various kinds of needs is currently increasing. One of the raw materials used is Citronella oils derived from the Citronella (*Cymbopogon nardus* L.). Citronella oil has very diverse compounds, but the main components include citronellol, citronellal, geraniol, nerol and citral. Citronella oils are widely used for household purposes, pharmaceuticals, medicine to insecticides. In the pharmaceutical and medicinal fields, lemongrass oil is used as a reliever for flatulence, hypertension, cramps and indigestion (1). The market demand for citronella oils is not only for the domestic market but also for foreign demand. In this era the use of diffusers as aromatherapy is also one of the factors in increasing market demand for Citronella oils. Citronella oil originating from Java is in great demand by developed countries as an ingredient for making perfumes such as the United States with a demand of 698.8 tons per year, France with 302.3 tons per year, England 205.75 tons per year, the Netherlands 86.5 tons per year and Germany. 77.5 tons (2).

C. nardus are widely adapted plants, these plants are able to grow in tropical and sub-tropical regions. A warm and humid climate is a preferred condition for citronella. This plant requires direct sunlight with the required rainfall ranging from 1300-2000 mm per year (3). The air temperature that is able to support the growth of citronella ranges from 20°C to 30°C (4). The desired growing media is media that has good drainage ranging from sandy, mineral to organic soil types with a

pH of around 6. Suitable for cultivation at an altitude of 150-200 masl and still grows well at an altitude of 700 masl (5). The ideal planting season is during the rainy season then summer is the best time for harvesting.

Citronella is a C4 plant that requires full sun. However, given the increasingly limited availability of land and competition with primary commodities such as food crops, it is necessary to develop *C. nardus*, one of which is cultivation in an agroforestry system. Lemongrass is a plant that is easy to care for, so it is very suitable to be used as an intercrop in agroforestry systems. In agroforestry systems, there is a higher canopy so that it blocks the sunlight that is captured by intercrops. Low light intensity can affect plant morphology and physiology so that it will affect the growth and productivity produced (6). Plants in low light have thinner leaves and wider sizes to increase light absorption (7). Another response is to increase the chlorophyll content in order to be able to maintain and increase the rate of photosynthesis even in limited light (8).

The gaps in the agroforestry system are very unfortunate if they are not used. With easy care, citronella which belongs to the Graminae family can be cultivated as an intercrop at certain times with a certain percentage of shade. Therefore, in this study, several varieties of lemongrass were tested at different percentages of shade, to determine the effect of shade and response to each variety so that it can be applied to agroforestry systems.

MATERIAL AND METHODS

The research was conducted in July-October 2022 in Jatimulyo Village, Lowokwaru District, Malang City, East Java with an altitude of approximately 445 meters above sea level. The study was conducted using a split plot with two factors. The first factor is the variety which consists of V1 (Seraiwangi 1), V2 (Sitrona 1 Agribun) and V3 (Sitrona 2 Agribun). The second factor is the difference in shading levels, namely N0 (no shade), N25 (25% shading), N50 (50% shading) and N75 (75% shading). Each experiment was repeated three times.

The tools used in the experiment included lux meters, oven, digital scales, meters, rulers, buckets, hoes, scissors, stationery and treatment boards. The materials used include bokashi fertilizer, NPK fertilizer, envelopes, saplings of *C. nardus* varieties namely Seraiwangi 1, Sitrona 1 Agribun and Sitrona 2 Agribun.

Observations made were observations of plant height, number of tillers, plant water content, fresh weight and plant transpiration rate. Observations of plant length and number of tillers were carried out three times at 5, 7 and 9 WAP. Observations of plant water content and plant fresh weight were observed at 9 WAP. Observation of transpiration rate using Li-cor *LI-6400XT Portable Photosynthesis System.*

RESULT

Plant Height

Based on observations of plant length, it can be presented in Figure 1. Based on these data, the provision of shade and the use of different varieties showed significant differences. Plant length increased with increasing shade percentage. On 9 WAP, the highest increase in plant length was found in the provision of 75% shade, in this treatment the plant length increased by 32.14% compared to treatment without shade. The Seraiwangi 1 variety showed a greater increase in plant height compared to other varieties, followed by the Sitrona 2 Agribun and Sitrona 1 Agribun varieties with the lowest plant heights.

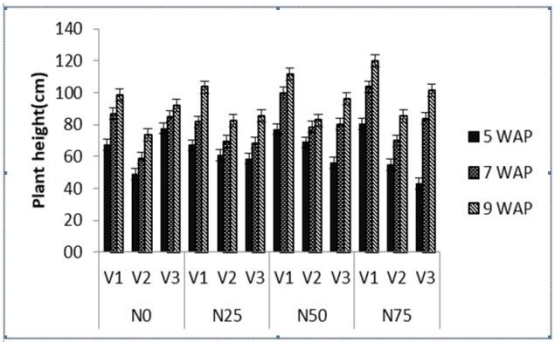

Figure 1. Plant Height

Number of Tillers

The average number of tillers of *C. nardus* is presented in Figure 2. Based on the histogram below, increasing the percentage of shade decreases the number of tillers in all varieties of citronella. On 9 WAP, shade of 25%, 50% and 75% showed a decrease in tillers of *C. nardus* by 35.2%, 75.9% and 57.4% compared to *C. nardus* in conditions without shade. The citronella variety 1 had more tillers than the other varieties at 0%, 25% and 50% shade conditions. Under 75% shade conditions, all varieties had no significant difference in tillering values.

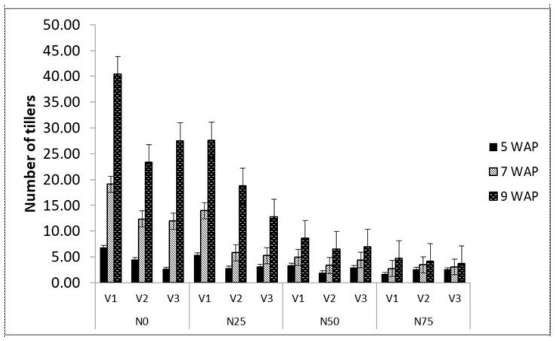

Figure 2. Number of Tillers

Water Content

The average water content of plants is presented in Figure 3. Based on the graph, the 25% intensity shade treatment had the highest average water content compared to plants under other shade treatments. Plants under 0% shade treatment, variety 1 had a higher moisture content of 67% compared to varieties 2 and 3, respectively, 22% and 57%. In the shade treatment with an intensity of 25%, variety 1 produced the highest percentage of water content of 76% compared to varieties 2 (33%) and 3 (39%). In the 50% intensity shade treatment, the highest water content was produced by variety 1 which was 34% and in the 75% shade treatment, the water content of varieties 1 and 3 was 23% higher than that of variety 2, which was 12%.

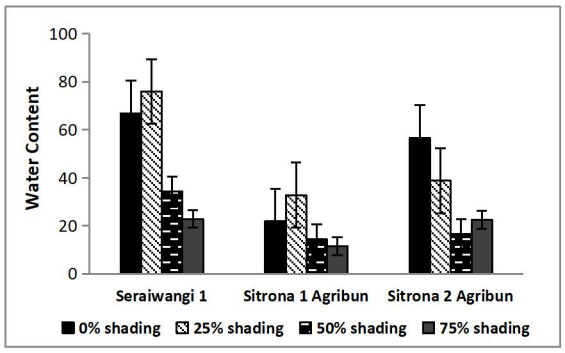

Figure 3. Water Content

Fresh Weight

The average fresh weight of *C. nardus* is presented in Figure 4. An increase in the percentage of shade in citronella cultivation shows a decrease in the fresh weight produced. On 9 WAP, shade conditions of 25%, 50% and 75% respectively reduced the fresh mean of *C. nardus* by 1.98%, 54.73% and 58.38% compared to the treatment without shade. The Seraiwangi 1 variety produced more fresh weight than the other varieties. The highest fresh weight of Seraiwangi 1 and Sitrona 1 was found at 25% shade treatment and then decreased to 0% shade, 50% shade and 75% shade. The highest fresh weight Citrona 2 variety was found in 0% shade treatment and decreased at 25%, 50% and 75% shade.

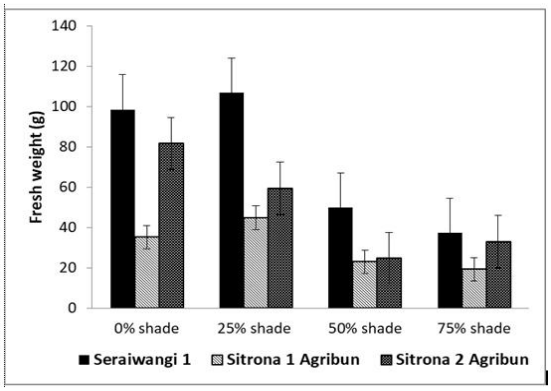

Figure 4. Fresh Weight

Transpiration Rate

The average transpiration rate of each variety at different shade percentages is presented in Figure 5. *C. nardus* cultivated in no shade (0%) had a higher transpiration rate than the other treatments. The increase in shade is inversely proportional to the transpiration rate, the higher the percentage of shade the lower the transpiration rate. The Sitrona 2 Agribun variety has a higher transpiration rate than the Seraiwangi 1 and Sitrona 1 Agribun varieties.

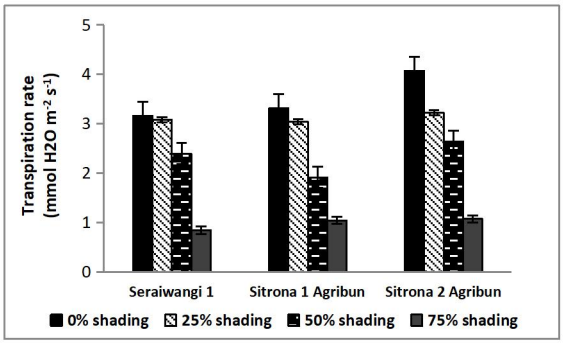

Figure 5. Transpiration Rate

DISCUSSION

Each variety gives a different response to the percentage level of shade. An increase in shade of 50% and 75% showed a very drastic decrease in growth (Figure 6). This shows that the light received by the *C. nardus* greatly affects its growth and physiological processes. All climate components such as light, temperature and humidity have a direct influence on the physiological, morphological and biochemical processes of plants where the intensity is too high or too low causes the accumulation of less biomass (9). At high light intensity, palisade and mesophyll tissue are thicker than plants in shade conditions (10).

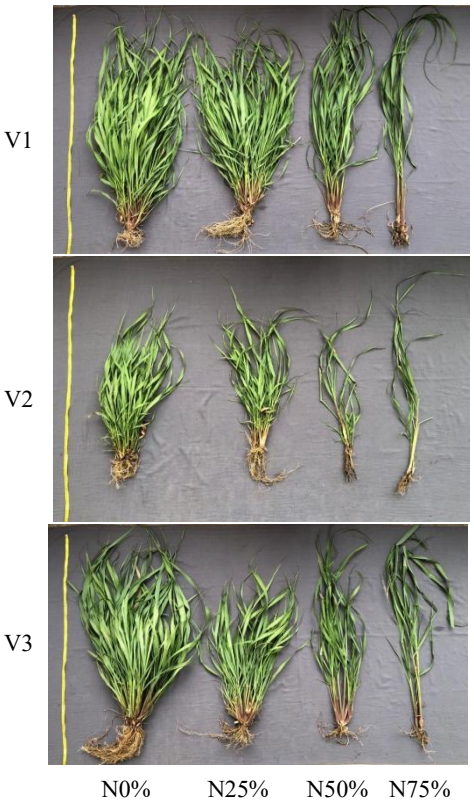

Figure 6. *C. nardus* Growth in Different Shade Levels

Plants that were treated without shade and shade with an intensity of 25%, produced higher water content than plants under 50% and 75% shade, respectively. It is suspected that the denser the light intensity, the less light is used for the metabolic process of the *C. nardus* so that the biomass produced is not optimal. High water content is shown in variety 1 which has wide leaves so that it can absorb enough sunlight. Light is needed by plants to be able to bind CO_2 and water so that they can produce carbohydrates. The intensity of light has a large enough influence on plant growth and development. Light intensity that is too

high can damage photosynthetic pigments so that plant production can decrease (11). Another influence is the rate of transpiration. The higher the intensity of solar radiation, the higher transpiration (12). Plants growing in the shade shade conditions show a significantly reduced stomatal density, so this affects transpiration or gas exchange in plants (13)

The adoption of citronella cultivation in an agroforestry system certainly changes the microclimate around the plant, in terms of light intensity, temperature and humidity. The intensity of light received in an agroforestry system depends on the type of plant, the spacing used and the age of the plant. Light received on teak stands at the age of 5 years ranged from 45%, while in teak aged 7 years the light intensity received was lower, namely 39% (14). sengon plants that are 2 years old have a light intensity of 64% (15). Rubber plants aged 1-2 years have a shade percentage of about 25%, at the age of 2-3 years the shade is 45% and at the age of 3-4 years the shade ranges from 68% (16).

CONCLUSION

Based on observations of several parameters, the Seraiwangi 1 variety has better growth than the Sitrona 1 Agribun and Sitrona 2 Agribun varieties. Increasing the percentage of shade reduces the growth of *C. nardus*. Increased 50% and 75% shade reduced severe *C. nardus* growth. Tolerable shade 25% shade.

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