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The effect of different shade levels on the growth and yield of *Asystasia gangetica* (L.) subsp. Micrantha

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Abstract
The availability of forage in the rainy season is very abundant, in contrast to shaded areas which have constraints in the form of low light intensity which can reduce the production of dry forage matter. Research to determine the effect of different shade levels on the growth and yield of *Asystasia gangetica* (L.) subsp. Micrantha. The experiment was carried out for 6 weeks, using a completely randomized design (CRD) with 4 treatments and each treatment was repeated 15 times. Shade level treatment using paranet: N0: 0% (without paranet); N1: 20% (1 layer of paranet); D2: 40% (2 layers of paranet); and D3: 60% (3 layers of paranet). The variables observed were growth variables, yield variables and plant growth characteristics. The results showed that 20% shade treatment was able to increase the growth and yield of *Asystasia gangetica* (L.) subsp. Micrantha, while treatment with 40% and 60% shade levels reduced the growth and yield of *Asystasia gangetica* (L.) subsp. Micrantha. It can be concluded that 20% shade level is able to give the best results in increasing the growth and yield of *Asystasia gangetica* (L.) subsp. Micrantha.

Keywords: *Asystasia gangetica*, yield, shade, growth

Introduction
One of the determining factors in increasing the productivity of ruminants is the availability of adequate and quality and sustainable feed. Forage for ruminants in the form of grass and legumes in fresh or dry form (70 - 90%). Forage production throughout the year is not constant, during the rainy season it is very high and during the dry season the production of forage is very low, resulting in decreased body weight of livestock, decreased milk production and disturbed livestock growth. Efforts with setting cropping patterns and utilization of planting layouts for the development of forage are very appropriate. Constraints in developing forage such as forage intolerant to shade due to constraints on receiving low light intensity.

Both natural and artificial shade reduce the amount of light that plants receive. Lack of light results in disruption of metabolism thereby reducing the rate of photosynthesis and carbohydrate synthesis (Sopandie *et al*., 2003) [10]. Most tropical plants experience a decrease in production in line with the decrease in sunlight intensity. The results of research by Alvarenga *et al.* (2004) [1] showed that plants grown under shaded conditions tended to have higher root dry weight production than shaded plants. Ella (2010) [3] stated that differences in growth, production and climate responses due to shade were higher in light shade compared to medium shade and heavy shade. Yanuar (2013) [14] further stated that the production of fresh and dry matter did not differ in the degree of shade treatment. The potential to increase production and continuity of forage availability by planting forage species that have high adaptation and tolerance to shade levels, such as *Asystasia gangetica* (L.) subsp. Micrantha.

Asystasia gangetica (L.) subsp. Micrantha is a weed, commonly found in oil palm plantations and yards, roadsides, gardens and open fields (Setiawan, 2013) [9]. This plant grows like a shrub that grows spread out and in groups, so it is very easy to cultivate. Grubben (2004) [5] states that *Asystasia gangetica* has high palatability and digestibility so used as ruminant animal feed and has a crude protein content of 19.3% to 33% depending on the part of the plant used (Putra, 2018) [6]. Utilization of *Asystasia gangetica* (L.) subsp. Micrantha commercially in the long term as animal feed requires proper cultivation to provide continuous forage with good quality. Based on this description, as well as the limitations of research on this matter, it is necessary to carry out this research to determine the effect of different shade levels on the growth and yield of *Asystasia gangetica* (L.) subsp. Micrantha.

Material and Methods

Research Flow Chart

The use of shade from paranet to reduce the intensity of light received by plants. Some plant species during vegetative and generative growth require low to high light intensity. In this experiment, we tried to observe the growth of *Asystasia gangetica* (L.) subsp. Micrantha at various levels of shade, so the results can be recommended that the effect of shade levels can increase the growth and yield of *Asystasia gangetica* (L.) subsp. Micrantha.

Land and Water

The soil used for the research was taken from the land around the greenhouse. The soil taken was air-dried, then the soil was sieved using a wire sieve (2x2 mm). The water used for watering the plants comes from the well water where the research is conducted. The results of soil analysis at the Soil Science Laboratory, Faculty of Agriculture, Udayana University: pH: 6.8 (neutral); C-organic: 1.61 (low); N total: 0.88 (very high); Available P: 263.45 (very high); and available K: 257.49 (high).

Experimental design

The experiment used a completely randomized design (CRD) with 4 treatments and each treatment was repeated 15 times, so there were 60 experimental units. Shading level treatment: N0:0% (without paranet); N1: 20% (1 layer of paranet), N2: 40% (2 layers of paranet); N3: 60% (3 layers of paranet).

Observed Variables

Variables observed was plant height, number of leaves, number of branches, dry weight of leaves, dry weight of stems, total dry weight of forage, dry weight of roots, ratio of dry weight of leaves to dry weight of stems, ratio of total dry weight of forage to dry weight of roots and area leaf pot^{-1}

Statistical analysis

The data obtained were analyzed by means of variance. If differences were found (p<0.05) then further analysis was performed with Duncan's multiple range test (Steel and Torrie, 1991) [11], using the SPSS statistical version 26 program.

Results

The results showed that the average plant height of *Asystasia gangetica* (L.) Subsp. Micrantha in the N0: 0% treatment (without paranet) was 31.01 cm (Table 1). In treatment N1: 20% (1 layer of paranet); N2: 40% (2 layers of paranet); and N3: 60% (3 layers of paranet) respectively: 31.91; 30.42; and 28.93 cm, not significantly (p>0.05) with N0: 0% treatment (without paranet).

Table 1: The Effect of Different Shade Levels on the Growth and Yield of *Asystasia gangetica* (L.) Subsp. Micrantha

Variable	Perlakuan[1)]				
	N0	N1	N2	N3	SEM[3)]
Plant height (cm)	31.01[a]	31.91[a]	30.42[a]	28.93[a]	3.83
Number of leaves (strands)	47.50[b2)]	51.85[a]	44.18[c]	43.73[c]	7.97
Number of branches (branches)	11.56[b]	13.40[a]	9.66[c]	9.12[c]	2.67
Leaf dry weight (g)	1.71[b]	2.59[a]	2.69[a]	1.95[a]	0.69
Stem dry weight (g)	5.17[a]	4.82[ab]	3.96[b]	2.27[c]	1.53
Total dry weight of forage (g)	6.88[a]	7.41[a]	6.65[a]	4.22[b]	1.76
Root dry weight (g)	5.46[a]	4.90[b]	3.36[c]	3.20[c]	1.09
Ratio of dry weight leaf/stem	0.33[b]	0.53[a]	0.67[a]	0.85[a]	0.28
Ratio of total dry weight of forages/roots	1.26[b]	1.51[a]	1.97[a]	1.31[b]	0.82
Leaf area pot^{-1} (cm^2)	1536[b]	2388[a]	1829[b]	1594[b]	665

Notes

1. N0: 0% (without paranet); N1: 20% (1 layer of paranet); N2: 40% (2 layers of paranet) dan N3: 60% (3 layers of paranet)
2. Values with different superscripts on the same line indicate a significantly different (p<0.05)
3. SEM: Standard Error of the Treatments Means

The average number leaves in the N0 treatment was 47.50 strands (Table 1). In treatment N1, N2 and N3 respectively: 9.15%, 6.98% and 7.93% significantly different (p<0.05) compared to N0. Treatment N1 with average number leaves of 51.85 leaves was significantly different (p<0.05) treatments N2 and N3, respectively: 44.18 and 43.73 leaves, while between treatments N2 and N3 the difference was not significant (p>0.05). The average number branches in the N0 treatment was 11.56 branches (Table 1). N1, N2 and N3 treatments: 15.91%, 16.43% and 21.10% significantly different (p<0.05) with treatment N0. N1 treatment with average of 13.40 branches it was significantly different (p<0.05) with treatments N2 and N3 respectively: 9.66 and 9.12 branches, while between N2 and N3 it was not significantly different (p>0.05).

The average leaf dry weight of *Asystasia gangetica* (L.) Subsp. Micrantha in the N0 treatment was 1.71 g (Table 1). N1, N2 and N3 treatment respectively: 51.46; 57.31 and 14.03% significantly (p<0.05) higher than N0. Stem dry weight in the N0 treatment showed average of 5.17 g (Table 1). N1 treatment of 6.76% not significantly (p>0.05) lower than the N0, but N2 and N3 treatments: 23.40 and 56.09% significantly (p<0.05) lower than the treatment N0. In treatment N1 the average dry weight of stem was 4.82 g, in treatment N2 it was 17.84% not significantly different (p>0.05), but with N3 52.90% significantly (p<0.05) lower than with N1. Treatment N2 showed an average stem dry weight of 3.96 g and treatment N3 was significantly different (p<0.05) by 42.67% compared to N2. The average total dry weight in the N0 treatment was 6.88 g (Table 1). In the N1 and N2 treatments respectively: 7.70 and 3.34% were not significantly different (p>0.05) compared to N0, but with the N3 treatment 38.66% significantly (p<0.05) lower than N0. Root dry weight in the N0 treatment averaged 5.46 g (Table 1). In treatment N1, N2 and N3 respectively: 10.25; 38.46 and 41.39% significantly (p<0.05) lower than N0. Treatment N1 with an average of 4.90 g was significantly different (p<0.05) from N2 and N3, respectively: 31.42 and 34.69%. Treatments

N2 and N3 were statistically not significantly different (p>0.05).

The ratio of leaf dry weight to stems dry weight of *Asystasia gangetica* (L.) Subsp. Micrantha in the N0 treatment averaged 0.33 (Table 1). N1 and N2 treatments respectively: 0.53 and 0.67 were not significantly different (p>0.05) with N0, but with the N3 treatment it was 157.57% significantly (p<0.05) higher than N0. Treatments N1, N2 and N3 respectively: 0.53; 0.67 and 0.85 showed not significantly difference (p>0.05). The average ratio of total dry weight forage to root dry weight N0 treatment was 1.26 (Table 1). N1 and N2 treatment respectively: 19.84 and 56.34% significantly (p<0.05) higher than N0, but N3 treatment showed no significant difference (p>0.05) with N0. Leaf area pot^{-1} in the N0 treatment showed an average of 1,536 cm^2 (Table 1). The N2 and N3 treatments were statistically not significantly different (p>0.05), but N1 treatment was 55.27% significantly (p<0.05) higher than N0.

Discussion

The results showed that the shade level of 20% using 1 layer of paranet (N1) the best gave the growth and yield of *Asystasia gangetica* (Table 1) was compared with 40% shading (2 layers of paranet) and 60% shading (3 layers of paranet). Shade treatment both naturally and artificially results in a reduction in the amount of light received by plants. Dense shade causes very little sunlight to be received by plants and can interfere with plant growth, while shading is not dense with receiving more sunlight giving better plant growth. Differences in growth due to the influence of shade caused by radiation and the intensity of sunlight received by plants can cause the plants photosynthetic rate to not be optimal. This opinion is supported by Salisbury and Ross (1995) [7] that the factor affecting plant growth is the rate of photosynthesis in the parts of the plant that contain chlorophyll, while the process of photosynthesis is highly dependent on the intensity and irradiation of sunlight. The rate of photosynthesis is closely related to the availability of water (H_2O), carbon dioxide (CO_2), available energy in the form of heat and light so that these materials can be used for growth and produce plant dry matter. Intensity, quality, duration (periodity) and direction of light are supporting factors for plant growth. If the received light intensity is low, then the amount of light received by each leaf surface area in a certain period of time is low (Gardner *et al.*, 1991) [4]. Lack of light results in disruption of metabolism, causing a decrease in the rate of photosynthesis and carbohydrate synthesis (Sopandie *et al*., 2003) [10].

Production of *Asystasia gangetica* with 20% shade also showed the best results among other treatments (Table 1). Shade treatment in this study had an impact on forage production which decreased in line with the decrease in the intensity of sunlight received by plants. This shows that *Asystasia* gangetica to be able to produce optimally require sunlight to support the plant growth process. Sunlight is used to help expedite the process of photosynthesis. The process of photosynthesis in plants occurs in leaves that have leaf chlorophyll. The results of the study on the effect of shade (N1) showed that the number of leaves, dry weight of leaves and leaf area per pot gave the best results (Table 1) and had a linear relationship, namely increasing the number of leaves followed by increasing leaf area and the resulting leaf dry weight. The greater number of leaves and leaf area will affect the results of photosynthesis to produce more carbohydrates and protein for food reserves that are translocated as a result of plant dry weight. This opinion is supported by Witariadi and Kusumawati (2017) [13] that the results of photosynthesis in plants in the form of increased carbohydrate and protein content causes the dry weight of the plants produced to be higher. Further stated Gardner *et al.* (1991) [4] that the higher the photosynthetic yield, the greater the accumulation of food reserves which are translocated to produce plant dry weight. Budiana (1993) [2] stated that the more carbohydrate and protein content in a plant, the higher the dry weight of the plant. In addition to the light factor that plants receive, crop production is also influenced by the type of plant. Types of plants that are resistant to shade often show a relatively smaller decrease in production or even increase in moderate shade. Samarakoon *et al.* (1990) [8] that forage production in plants that are tolerant to shade can still increase under moderate shade.

Shading naturally or artificially results in a reduction in the amount of light received by plants. Lack of light conditions result in disruption of metabolism, thus causing a decrease in the rate of photosynthesis and carbohydrate synthesis (Sopandie *et al*., 2003) [10]. The results of the root dry weight study (Table 1) were the highest in the treatment without shade (N0). Alvarenga *et al.* (2004) [1] stated that plants grown in conditions without shade tended to have higher root dry weight production than plants with shade. Differences in response to growth and production due to shade were higher in light shade compared to medium and heavy shade. The potential to increase the production and continuity of the availability of this forage is by selecting forage species that have high adaptation and tolerance to shade.

The ratio of dry weight of leaves to dry weight of stems and the ratio of total dry weight of forage to dry weight of roots of *Asystasia gangetica* at different shade levels showed different results. The effect of light shading (N1) can increase the value of the dry weight ratio. If the dry weight of the leaves is lower than the dry weight of the stems, then the ratio of the dry weight of the leaves to the dry weight of the stems will be small, similarly if the total dry weight of forage is lower than the dry weight of the roots, then the ratio of the total dry weight of forage to the dry weight of the roots will be small. The resulting ratio value is used as an indicator in determining the quality of the forage in the plant, indicating good quality if the ratio value is greater. Widana *et al.* (2015) [12] stated that the production of forage of the same quality was caused by an increase in leaf dry weight followed by an increase in stem dry weight, as well as an increase in total forage dry weight followed by an increase in root dry weight.

Conclusion

The results of the study can be concluded: (1) different shade levels can increase the growth and yield of *Asystasia gangetica* (L.) subsp. Micrantha; (2) 20% shade level (1 layer of paranet) gave the best results in increasing the growth and yield of *Asystasia gangetica* (L.) subsp. Micrantha.

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Conflict of interest declaration

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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