SUPPORTING PAPERS
ISBN 979-97243-9-2

PHOTOSYNTHESIS AND YIELD OF FORAGE CROP LEGUMES ON THE DIFFERENCES OF LIGHT WAVELENGTH

Budi Adi Kristanto, D.W. Widjajanto, Sutarno

Faculty of Animal Agriculture, Diponegoro University
Semarang, INDONESIA

ABSTRACT

Experiment was aimed to investigate the effect of light wavelength on the leaf area and the content of chlorophyll, rate of photosynthesis and dry matter (DM) yield of forage crops (Puero, *Pueraria phaseoloides*; Calopo, *Calopogonium muconoides* and Sentro, *Centrosema pubescenes*). It was conducted in the green house, Forage Crops Science Laboratory, Faculty of Animal Agriculture, Diponegoro University, Semarang, INDONESIA. Split plot design with 3 replications was used to arrange the experiment. The main plot was (color/light wavelength) consists of poly chromatics, sunlight that was forwarded with uncolored paper (Poly), red (R), yellow (Y) and green (G). The sub plot was (forage crop legumes) consists of Puero (L_1), Calopo (L_2) and Sentro (L_3). The leaf area and the content of chlorophylls, photosynthesis and DM yield of forage crop legumes were recorded throughout the experiments. The leaf area, content of chlorophyll and rate of photosynthesis were measured using the leaf area meter, spectrophotometer, and photosynthesis atomic absorption (PAA), respectively. Experiment resulted that the R (wavelength 660μm) was higher, while Y at 580 μm and G at 520 μm were lower on the leaf area and the content of chlorophyll, rate of photosynthesis and DM yield compared to that of Poly.

Key words : calopo, chlorophyll, forage crop legumes, photosynthesis, puero, sentro

INTRODUCTION

Sunlight used by crops for photosynthesis is called visible light (poly chromatics light) with wavelength range between 320 to 720 nm (Devlin and Witham, 1983). Each color light of monochromatic has own wavelength and energy that cause the differences effectiveness in the process of photosynthesis. High levels crop, *in vivo*, have chlorophyll a and b that capable to absorb maximum red light at wavelength between 643 to 650 nm for chlorophyll b and 662 to 682 nm for chlorophyll a, respectively (Holtz in Zelitch, 1971). Sunlight may be used as natural lighting, while 80 watt of lamplight may be used as man-made lighting (Lanvens and Sorgeloos, 1996).

Puero (*Pueraria phaseoloides*); Calopo (*Calopogonium muconoides*) and Sentro, (*Centrosema pubescenes*) are leguminous forage crops that have chlorophyll a and b. Chlorophyll a ($C_{55}H_{72}O_5N_4Mg$) is dark green colored and it will turn into red in fluoresces, while chlorophyll b ($C_{55}H_{70}O_6N_4Mg$) is light green colored and it will turn into brownish red in fluoresces (Dwijoseputro, 1978). The effectiveness of chlorophyll is depending on such factors as received lightning that can be measured through the rate of photosynthesis and photosynthetate.

MATERIALS AND METHODS

The experiment was conducted in the green house, Forage Crops Science Laboratory, Faculty of Animal Agriculture, Diponegoro University, Semarang, INDONESIA. Split plot design with 3 replications was used to arrange the experiment. The main plot was (color/light wavelength) consists of poly chromatics, sunlight that was forwarded with uncolored paper (P), red (R), yellow (Y) and green (G). The sub plot was (forage crop legumes) consists of Puero (L_1), Calopo (L_2) and Sentro (L_3). The leaf area, chlorophyll content, photosynthesis rate and DM yield of forage crop legumes were collected throughout the experiments. The leaf area, chlorophyll content and photosynthesis rate were measured using leaf area meter, spectrophotometer, and photosynthesis atomic absorption (PAA), respectively. Collected data was analyzed using ANOVA and DUNCAN test (Gomez and Gomez, 1983).

RESULT AND DISCUSSION

Leaf area of Calopo (*C. muconoides*) was wider compared to that of Puero (*P. phaseoloides*) and Centro (*C. pubescenes*). This is due to the fact that, in the same conditions, Calopo has more opportunity in producing higher leaf area, chlorophyll content, and DM yields than that of Puero and Centro. Red lightning (R) (λ 660 nm), increased leaf area, chlorophyll content, photosynthesis rate and DM yield higher than that of poly chromatics (P), Yellow (Y) (λ 580 nm), and Green (G) (λ 520 nm). Red lightning with the highest wavelength and the lowest energy showed more effective than others, in promoting auto transformation process by changing proto chlorophyll to chlorophyll through reduction process. In the R, therefore, chlorophyll was formed faster compared to P, Y and G, and this phenomenon may be indicated through leaf area and chlorophyll content.

Dwijoseputro (1978) stated that proto chlorophyll is a precursor for chlorophyll a that in auto transformation 2 H^+ will be reduced. In this case, chlorophyll will be formed very fast, and chlorophyll a and b will do photosynthesis soon. Chlorophyll a and b are very effective in using lighting with λ 662 to 682 nm and λ 643 to 650 nm, respectively, for chlorophyll a and b. Therefore, R lightning (λ 660 nm) showed that the leaf area, photosynthesis rate, and DM yield were higher than that of others. Amount of leaves and chlorophyll content, which were bigger than others use R lightning to do photosynthesis faster, and resulted in the higher leaf area, chlorophyll content, photosynthesis rate and DM yield compared to other treatments. The R lightning component is still exists in P lightning, while Y and G lightning do not exist in P lightning anymore. Therefore photosynthesis decreased as the λ decreased. The pattern of 4 parameters relatively constant due to the lighting treatment as it increased from P to R, and then decreased at Y and G at all of forage legumes (Table 1).

It was concluded that treatment of mono chromatics (R, λ 660 nm) increased leaf area, chlorophyll content, photosynthesis rate and DM yield of Puero, Calopo and Sentro, while Y and G light decreased all of parameters.

Table 1. Leaf area, chlorophyll content, rate of photosynthesis of forage legumes at different wavelength of light

ISBN 979-97243-9-2

Legumes	Light/ Wavelength of light	DM yield (g)	Leaf area (dm^2)	Chlorophyll content (mg/g leaf)	Photosynthesis Rate (ppm CO_2/l/sec)
Puero	Poly chromatics	16.0^{de}	87^{g}	20.7^{e}	31.5^{d}
	Red (λ 660 nm)	18.0^{d}	137^{f}	23.4^{d}	45.5^{b}
	Yellow (λ 580 nm)	9.5^{de}	38^{h}	20.7^{e}	31.0^{d}
	Green (λ 520 nm)	7.4^{e}	34^{h}	20.1^{e}	30.5^{d}
Calopo	Poly chromatics	43.2^{b}	505^{b}	32.9^{b}	43.5^{b}
	Red (λ 660 nm)	62.5^{a}	586^{a}	35.7^{a}	63.0^{a}
	Yellow (λ 580 nm)	32.0^{c}	336^{c}	32.7^{b}	44.0^{b}
	Green (λ 520 nm)	15.0^{d}	225^{d}	28.5^{c}	29.0^{d}
Centro	Poly chromatics	9.7^{de}	102^{g}	20.9^{e}	37.5^{c}
	Red (λ 660 nm)	11.7^{de}	178^{e}	23.8^{d}	62.0^{a}
	Yellow (λ 580 nm)	9.0^{de}	99^{g}	18.0^{ef}	34.3^{c}
	Green (λ 520 nm)	7.5^{e}	91^{g}	15.5^{f}	30.0^{d}

Different letter abstract superscripts at each column of parameters and leguminous forage crops showed significantly differences at $P<0.05$.

ACKNOWLEDGEMENT

The authors thank the Head of Forage Crops Science laboratory, Faculty of Animal Agriculture, Diponegoro University for allowing the use of the facilities during the experiment. Thanks are also extended to Ms. Rury and Mrs. Okta for the practical works.

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