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Morphological and Physiological Characteristics of Shading Tolerant and Sensitive Mungbean Genotypes

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Study of morphological and physiological characteristics of the tolerant and sensitive mungbean genotypes to shading was carried out in the Station Research of the Indonesian Legume and Tuber Crops Research Institute (ILETRI) from September to December 2004. Nine tolerant genotypes (MMC 87 D-KP-2, MLG 369, MLG 310, MLG 424, MLG 336, MLG 428, MLG 237, MLG 429, and VC2768B) and three sensitive genotypes to shading (Nuri, MLG 460, and MLG 330) were tested in two shading levels, that were without shading and shading of 52%. The randomized complete block design with three replications analysis. The results showed that leaf characters of shading tolerant and sensitive genotypes were different. The shading tolerant mungbean genotypes had good response to light stress so that the growth and development of the leaves were better than that of sensitive genotypes. The shading tolerant mungbean genotypes had bigger and thicker leaves than that of sensitive genotypes. The shading treatments caused reducing rate of PAR absorption, transpiration, photosynthesis, and CO_2 stomata conductance. The reduction of all parameters in tolerant genotype was smaller than that of sensitive genotype. The specific leaf area at four weeks after planting could be used as shading tolerant indicator of mungbeans.

Key words: mungbean, characteristics, morphology, physiology, leaves, tolerant, sensitive, shading

INTRODUCTION

Shading is a factor affecting the plant productivity at plantations of agriculture as well as forestry crop. Shading was an important phenomenon to be known and if it was possibly to be controlled. Shading will cause decreasing of quantity and quality of the sunlight intercept to the crop, and it will affect the productivity of photosynthesis.

Respones of most crop to change in light intensity varies depend on the species (Thompson *et al*. 1992). Light intensity requirement of each plant species was different depended on the age, environment condition, and length of day. The physiological behavior of young plants of *A. rosaeodora* to different light intensities suggests that its photosynthetic apparatus was more efficient when they were grown on medium light intensity (500 a 1000 $\mu mol.m^{-2}.s^{-1}$). However, their photosynthetic activity were suppessed when they were grown in low or height light intensity (de Carvalhu Gonsales *et al*. 2005).

Effect of low irradiance on leaf of C_3 plants lead to phenotypic changes in their photosynthetic apparatus. The shade tolerant species had wider leaves, and played a role to the absorbtion of photosynthetically active radiation (PAR) under low irradiance (St-Jacques *et al*. 1991; Poorter *et al*. 1995). The aim of this research was to determine leaf morphological and physiological characteristics of mungbean shading tolerant and sensitive genotypes.

MATERIALS AND METHODS

The research was conducted in the Kendalpayak research station of the Indonesian Legume and Tuber Crops Research Institute (ILETRI) from September to December 2004. The place was located at 450 m above sea level, which had Entisol soil and with C3 climate type according to Oldeman. Nine shading tolerant genotypes of mungbean (MMC 87 D-KP-2, MLG 369, MLG 310, MLG 424, MLG 336, MLG 428, MLG 237, MLG 429, and VC2768B) and three sensitive genotypes (Nuri, MLG 460 and MLG 330) were tested on two different shading levels, i.e. without shading and 52% shading. The experiment was set up using randomized complete block design with three replications.

The treatment of 52% shading was set up using two layers of black screen at the high of 1.8 m from soil surface. The light intensity was measured using Lux meter.

Each genotype was planted five seeds per hole, with planting distance of 0.40 x 0.15 m. Fertilization was applied at the time of planting with 50 kg ha^1 Urea, 50 kg ha^1 KCl, and 100 kg ha^1 SP36. The thinning was conducted at ten days after planting by leaving two crops per hole. The thinning and weeding were done at four weeks after planting (WAP). The pest and disease control, were conducted regularly every three days.

Observation of leaf number, leaf area, specific leaf area (SLA), rate of PAR absorbtion, photosynthesis, transpiration

activities, the stomatal CO_2 conductance and chlorophyll content was conducted regularly every two weeks from four weeks up to harvest. The leaf area was measured by the gravimetric methods (Sitompul & Guritno 1991). The specific leaf area (SLA) was measured by the SLA = ((LAi/LDWi). The chlorophyll content was observed using spectrophotometric method. The rate of PAR absorption, photosynthesis, transpiration and stomatal CO_2 conductance were observed using LCi Portable Photosynthesis System (3015). The data were statistically analyzed using Duncan's test in the 5% á level and Contrast of Ortogonal test.

RESULTS

Effect of Shading on Leaf Number and Morphology. Leaf number at six and eight WAP was difference (Table 1). Generally, leaf number at without shading treatment more than that of shading treatment. The greatest leaf number at six WAP was achieved by MLG 429 genotype and the fewest was found on MLG 460 genotype. The greatest leaf number at eight WAP was achieved by Nuri genotype and the fewest was found on MLG 424, MLG 460, and MLG 330 genotypes. Interaction of genotype and shading also had a significant effect to leaf area (Figure 1). Except MLG 424 genotype, all tested genotypes showed negative response to shading.

In four and eight WAP, interaction between genotype and shading showed the significant effect on the specific leaf area (SLA) (Table 1). SLA was increased sharply at the initial growth, then it was constant at initial generative phase and it was decline in the further phases (Table 1).

Results of the contrast test (Table 2) showed that leaf area and morphology of shading tolerant genotypes were different from shading sensitive genotypes. Leaf area of shading tolerant genotype was bigger than that of sensitive genotype at four and six WAP. Leaf number of shading tolerant and sensitive genotypes did not show the difference, however leaf number reducing of tolerant genotype was relatively less than that of sensitive genotype, especially at six and eight WAP. SLA values of shading tolerant and sensitive genotypes did not show significant difference, except at four WAP. At four WAP, SLA value of shading tolerant genotypes smaller than that of sensitive genotypes. It mean that leaves of shading tolerant genotypes were thicker than that of sensitive genotypes (Table 2).

Plant Physiology. Photosynthetically active radiation (PAR) absorption rate of each genotype showed significant difference (Figure 2). The result showed that shading treatment caused reduction of PAR absorption rate at four and six WAP. The highest reduction of PAR absorption rate was reached by MLG 429 genotype and the lowest was found on MLG 424 and MLG 428 genotypes at four and six WAP respectively. At eight WAP, the highest reduction of PAR absorption rate was reached by MLG 310 genotype and the lowest by VC 2768B genotype (Figure 2).

Genotype and shading interaction had significant effect to transpiration rate (Figure 3). The shading treatment could reduce transpiration rate. At four WAP, the highest reduction of transpiration rate was achieved by MLG 429 genotype and the lowest was found on MLG 369 genotype (Figure 3a). The highest reducing of transpiration rate in six WAP was reached

Table 1. Leaf number per plant and specific leaf area (cm^2/g) of twelve mungbean genotypes at two shading levels

Shade (%)	Genotypes	Leaf number at:			Specific leaf area (cm^2/g) at:		
		4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP
0	MMC 87 D-KP-2	12	22efgh	21e	276.8efg	214.8	140.6 k
0	MLG 369	13	26de	26c	267.1efg	220.2	189.8gh
0	MLG 310	13	25ef	26c	285.5ef	216.8	192.2g
0	MLG 424	13	22efg	20ef	347.9d	218.8	175.2ghi
0	MLG 336	14	24ef	29b	240.4hi	216.8	160.4ijk
0	VC 2768B	14	26de	24d	286.8e	190.0	148.6jk
0	MLG 428	14	18ghij	27c	284.0ef	199.1	165.7ij
0	MLG 237	13	29cd	26c	236.8i	194.4	162.6ijk
0	MLG 429	15	41a	26c	257.9ghi	232.2	235.2def
0	Nuri*	16	36b	32a	288.1e	226.2	179.4ghi
0	MLG 460*	15	22efg	18fg	281.2efg	219.7	193.1g
0	MLG 330*	13	31c	26c	261.4fgh	211.5	168.3hij
52	MMC 87 D-KP-2	11	17ij	16hi	338.3d	252.3	193.0g
52	MLG 369	12	16ij	15i	376.1bc	310.9	268.1abc
52	MLG 310	11	16ij	15i	371.1c	304.1	246.3cde
52	MLG 424	13	19ghij	14i	342.2d	314.4	255.6bcd
52	MLG 336	13	17ij	15i	383.2bc	287.8	250.2cd
52	VC 2768B	12	17hij	17gh	399.6ab	294.9	226.2ef
52	MLG 428	12	19ghij	18g	379.7bc	285.3	218.7f
52	MLG 237	15	22efgh	20e	344.9d	300.6	277.6ab
52	MLG 429	14	23efg	21e	396.7ab	344.9	289.2a
52	Nuri*	13	21fghi	21e	417.9a	322.8	276.0ab
52	MLG 460*	14	15j	14i	389.6bc	253.1	197.1g
52	MLG 330*	12	19ghij	14i	382.6bc	323.2	244.6cde
Variance coefficient (%)		11.03	11.03	10.42	4.07	12.85	6.21

in the same column, the number was followed the different letter showed was significantly according to the DMRT test 5%; WAP: the week after planted; *: the genotype was sensitive to the shading.