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PHYSIOLOGICAL TRAITS AND YIELD PERFORMANCE OF MUNGBEAN (*Vigna radiata* (L) Wilczek) AS INFLUENCED BY LIGHT INTENSITIES

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Abstract

An experiment was carried out at the Crop Physiology and Ecology Research Field, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the period from March to June 2016 to evaluate some physiological traits and yield performance of mungbean variety under different light intensities and to find out potential mungbean variety as intercrop. The experiment was laid out in a split -plot design with three replications. Three light intensities (L_{100} - full sunlight, L_{75}- 75 % of full sunlight and L_{50}- 50% of full sunlight) were assigned in the main plots and four varieties (BARl Mung-6, Binamoong8, Binamoong5 and BU Mug-4) in the subplots. White and red colour Mosquito nets were used for maintaining 75 and 50 percent of full sunlight. Light percentages of mosquito nets were measured by light meter (21YE35). Mosquito nets of different colors and pore size were used for maintaining 75 and 50 percent of full sunlight. The seed yield of BARI Mung-6 and Binamoong8 performing well in under partial shade condition but the grain yield of Binamoong5 and BU Mug-4 was reduced drastically under partial shade condition. Greater proline accumulation in leaf, higher leaf chlorophyll content, higher pods plant^{-1}, higher seeds pod^{-1}, greater seed size and better seed yield plant^{-1} under partial shade condition were contributed to better tolerance of BARI Mung-6 and Binamoong8 under low light stress.

Introduction

Mungbean (*Vigna radiata* (L) Wilczek) is one of the important pulse crops in Bangladesh. The agro ecological condition of Bangladesh is quite favorable for growing the crop. The crop is usually grown in kharif-I and kharif- II seasons with little or no inputs but it adds a lot to improve the soil health. Mungbean (*Vigna radiata* L.) has the potential to be used as profitable intercrop. But most of the grain legumes are sensitive to partial shading and often suffer from low light stress caused by associated tall crops (Miranda-Abilay and Lantican, 1982). The reduction in light reaching the legume canopy when intercropped with maize was about 30 - 50% of the total incoming radiation and began around 30-35 days after maize seeding (Polthanee and Changsri, 1999; Polthanee and Treloges, 2002; 2003). Shading causes decreasing of quantity and quality of the sun light intercept to the crop and it affects the productivity of the intercrops. Yield reduction by shading depends upon crop species as well as the degree of shading. The degree of shading is generally controlled by the nature, age and characteristics of upper storied crops. The yield of soybean was decreased by 25 under 47% shade cover in the field (Wahua and Miller, 1978) and it was decreased by 30 under 40% artificial shade (Lantican and Catedral, 1977). In contrast under 40% artificial shade the yield of mungbean was decreased by 70% (Lantican and Catedral, 1977).

Shading leads to phenotypic change in their photosynthetic apparatus (Sundari, 2009). Shading reduced photosynthesis due to increase in stomatal and mesophyll resistance, transpiration, partioning of biomass from vegetative parts to economic parts (Nygren and Killomaki, 1993). However, responses of mungbean to change in light intensity may vary in different genotypes. Hence, developing variety adapted to low light condition is important and a need for selecting mungbean genotypes for shade tolerance. The mungbean genotypes could be the most tolerant and least decrease in grain yield, number of pods per plant, per cent leaf N and total stem N (Wahua and Miller, 1978). Therefore, the present investigation was conducted to find out the effect of reduced light intensities on some physiological traits of different mungbean varieties and to find out the low light tolerant varieties of mungbean.

Materials and Methods

The experiment was conducted at Crop Physiology and Ecology Research Field, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the period from March to June 2016. The experiment was laid out in a split- plot design with three replications. Three light intensity treatments (L_{100} - full sunlight, L_{75}- 75 % of full sunlight and L_{50}- 50% of full sunlight) were assigned in the main plots and four varieties (BARI Mung-6, Binamoong-8, Binamoong5- and BUMug-4) in the sub-plots. White and red color Mosquito nets were used for maintaining 75 and 50 percent of full sunlight. Light percentages of mosquito nets were measured by light meter (21YE35). Chlorophyll content of the flag leaf at 48 days after sowing was estimated according to Witham *et al.* (1986). The proline content of the fully expanded youngest leaf was determined as Bates *et al.* (1973).

For collecting data on yield components ten plants from each experimental unit were selected randomly at flowering stage. At maturity, pods were harvested three times by hand pickings. The harvesting of mungbean pods was started at 60 days after sowing (DAS) and ended at 80 DAS. Plant height, length of individual pod, pods plant^{-1}, seeds pod^{-1}, 1000-seed weight and yield plant^{-1} were also recorded from the ten randomly selected plants of each plot. The data were analyzed and the treatment means were compared using Tukey's Test.

Results and Discussion

Proline content

The interaction of light intensities and mungbean varieties influenced the proline content of leaf significantly at 50 DAS (Fig. 1). The maximum proline content was recorded in Binamoong8 (0.91 µmoles g^{-1} FW) with 50% of full sunlight which was statistically identical to those recorded in BARI Mung-6 (0.82 µmoles g^{-1} FW) with 50% of full sunlight, Binamoong 8 (0.79 µmoles g^{-1} FW) with 75% of full sunlight and Binamoong5 (0.76 µmoles g^{-1} FW) with 100% of full sunlight. The loweer proline content was recorded in BU Mug-4 (0.47 µmoles g^{-1} FW) with 100% of full sunlight which was statistically identical to BARI Mung-6 (0.53 µmoles g^{-1} FW) with 100% of full sunlight and BU Mug-4 (0.61 µmole g^{-1} FW) with 50% of full sunlight. The results regarding proline content revealed that proline level was increased with the reduction in light levels in BARI Mung- 6, Binamoong 8 and Binamoong 5. In BU Mug-4, proline content was increased at 75% of full sun light thereafter decreased at 50% of full sun light.

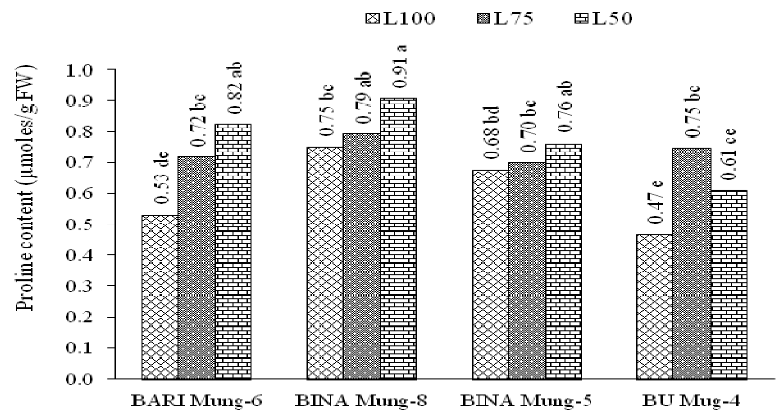

Fig.1. Leaf proline content as influenced by light intensities and mungbean varieties at different days after sowing. Means followed by different letter(s) differed significantly by Tukey's test at P $\leq$ 5% level of probability. L_{100} = 100 % of full sunlight (open field control), L_{75} =75 % of full sunlight, L_{50} = 50% of full sunlight

Chlorophyll content

Chlorophyll a content in leaf was not influenced significantly by the interaction effect of light intensities and mungbean varieties (Table 1). Numerically, maximum chlorophyll a (0.32 mgg^{-1}) was obtained in BU Mug-4 at L_{50} and the minimum (0.23 mgg^{-1}) in Binamoong5 at L_{75}. Chlorophyll b content in leaf was influenced significantly by the interaction effect where highest chlorophyll b (1.51 mgg^{-1}) was observed both inBinamoong8 followed by BU Mug-4 at $L_{75,}$ which was statistically similar to Binamoog 8 (1.50 mgg^{-1}) at L_{50}, and Binamoong 5 (1.47 mgg^{-1}) at L_{50}, and (1.39 mgg^{-1}) of same variety at L_{100} and BU Mug-4 (1.39 mgg^{-1}) at $L_{50.}$ The lowest chlorophyll b was observed in BARI Mung-6 (1.24 mgg^{-1}) at L_{100} which was statistically similar to those recorded in BU Mug-4 (1.25 mgg^{-1}) at $L_{100,}$ BARI Mung-6 (1.29 mgg^{-1}) at $L_{75,}$ Binamoong 8 (1.30 mgg^{-1})at $L_{100,}$ BARI Mung-6 (1.33 mgg^{-1}) at L50 and Binamoong 5 (1.34 mgg^{-1}) at L_{75}. Similar trend was followed in Chlorophyll a to b ratio.

Total chlorophyll content was influenced significantly by the interaction effect of light intensities and mungbean varieties (Table 1). The maximum total chlorophyll (1.81 mgg^{-1}) was observed in Binamoong 8 at L_{50} whereas lower total chlorophyll was observed in BU Mug-4 (1.49 mgg^{-1}) at L_{100}..The overall results in chlorophyll content indicated that total chlorophyll content was increased due to reduction in light intensities. The increase in total chlorophyll content under partial shade was mainly due to reduction in chlorophyll b content. As chlorophyll a content remained more or less unchanged due to partial shade the chlorophyll a to b ratio in BARI Mung-6, Binamoong 8 and and Binamoong 5 with L_{75} and remained unchanged with L_{50} but in BU Mug-4 the ratio was remain unchanged L_{75} and increased with L_{50}. Islam *et al.* (1993) and, Miranda- Abilay and Lantican (1982) found higher chlorophyll content in mungbean due to increased shading.

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Table 1. Chlorophyll a, chlorophyll b, chlorophyll a to b ratio and total chlorophyll content of leaf as influenced by light intensities and mungbean varieties

Variety	Light level	Chl a (mgg^{-1})	Chl b (mgg^{-1})	Chl a to b ratio	Total chl (mgg^{-1})
	L_{100}	0.27	1.24 e	0.22 ac	1.50 cd
	L_{75}	0.25	1.29 ce	0.20 bd	1.54 bd
BARI Mung- 6			(4.03)	(-9.09)	(2.67)
	L_{50}	0.28	1.33 be	0.22 ac	1.60 ac
			(7.23)	(0.00)	(6.67)
	L_{100}	0.27	1.30 ce	0.21ab	1.56 ad
	L_{75}	0.27	1.51 a	0.18 cd	1.78 a
Binamoong8			(16.15)	(-14.29)	(14.10)
	L_{50}	0.31	1.50 a	0.21ab	1.81 a
			(15.38)	(0.00)	(16.03)
	L_{100}	0.28	1.39 ac	0.20 bd	1.66 ab
	L_{75}	0.23	1.34 be	0.17 d	1.57 ad
Binamoong5			(-3.60)	(-15.00)	(-5.42)
	L_{50}	0.29	1.47 ab	0.20bd	1.76 ab
			(5.76)	(0.00)	(6.02)
	L_{100}	0.25	1.25 de	0.20 bd	1.49d
	L_{75}	0.30	1.51 a	0.20bd	1.81 a
BU Mug- 4			(20.80)	(0.00)	(21.48)
	L_{50}	0.32	1.39 ac	0.23 a	1.71 ab
			(11.20)	(15.00)	(14.77)
CV(%)		9.97	3.43	4.34	2.92

In a column, means followed by different letter(s) differed significantly by Tukey's test at $P \leq 5\%$ level of probability. L_{100} = 100 % of full sunlight (open field control), L_{75} = 75 % of full sunlight, L_{50} = 50% of full sunlight

Number of pods plant^{-1}

The interaction effect of light intensity and mungbean varieties on number of pods plant^{-1} was significant (Table 2). The maximum number of pods plant^{-1} (10.00) was observed in BARI Mung-6 with 100% of full sunlight, which was statistically similar to those recorded in BINA moong 5 (9.90) with 100% of full sunlight, Binamoong 8 (9.63) with 75% of full sunlight, BARI Mung-6 with 75% (9.57) and 50% (9.27) of full sunlight, Binamoong 8 with 50% (9.07) and 100% (8.97) of full sunlight and BU Mug-4 with 100% of full sunlight (8.93). The minimum number of pods plant^{-1} was observed in BU Mug-4 with 50% of full sunlight (6.07) which was statistically similar to that recorded in Binamoong 5 with 75% of full sunlight (7.03). Percent change from L_{100} values indicated that the number of pods plant^{-1} was reduced with reduction in light intensities in BARI Mung-6, Binamoong 5 and BU Mug-4 but it was even increased in Binamoong 8 under low light intensities. The reduction in number of pods plant^{-1}

with the reduction of light intensities was more in BIinamoong and BU Mug-4 than that in BARI Mung-6.

Table 2. Yield attributes of mungbean as influenced by light intensities and varieties

Variety	Light level	Pods plant^{-1}	Seeds pod^{-1}	1000-seed wt (g)	Seed yield (g plant^{-1})
BARI Mung- 6	L_{100}	10.00 a	8.57 ef	45.20 b	3.07 a
	L_{75}	9.57 ab	9.15 bc	47.23 a	3.07 a
		(-4.30)	(6.77)	(2.03)	(0.00)
	L_{50}	9.27 ab	9.03 bd	44.00 b	2.89 ad
		(-7.30)	(5.37)	(-2.65)	(-5.86)
Binamoong 8	L_{100}	8.97 ab	8.08 g	45.28 b	3.01 ac
	L_{75}	9.63 ab	8.62 ef	44.09 b	2.86 bd
		(7.35)	(6.68)	(-2.63)	(-4.98)
	L_{50}	9.07 ab	8.40 fg	45.11 b	2.84 cd
		(1.11)	(3.96)	(0.38)	(-5.64)
Binamoong5	L_{100}	9.90 a	9.20 bc	38.26 d	2.89 ad
	L_{75}	7.03 de	9.32 b	38.91 d	2.47 e
		(-28.99)	(1.30)	(1.70)	(-14.53)
	L_{50}	7.70 cd	8.95 cd	40.49 c	2.28 e
		(-22.22)	(-2.72)	(5.83)	(-21.11)
BU Mug- 4	L_{100}	8.93 ac	9.20 bc	45.40 b	3.00 ac
	L_{75}	8.27 bd	9.73 a	41.87 c	2.75 d
		(-7.39)	(5.76)	(-9.85)	(-8.33)
	L_{50}	6.07 e	8.78 de	41.65 c	2.02 f
		(-32.03)	(-4.56)	(-8.26)	(-32.67)
CV (%)		5.97	1.25	1.26	2.66

In a column, means followed by different letter(s) differed significantly by Tukey's test at $P \leq 5\%$ level of probability. L_{100} = 100 % of full sunlight (open field control), L_{75} = 75 % of full sunlight, L_{50} = 50% of full sunlight

Number of seeds pod^{-1}

The interaction effect of light intensities and mungbean varieties on number of seeds pod^{-1} was significant (Table 2). The maximum number of seeds pod^{-1} was recorded in BU Mug-4 (9.73) with 75% of full sunlight, which was followed by all other treatment combinations. The lowest number of seeds pod^{-1} was recorded in Binamoong 8 (8.08) with 100% of full sunlight, which was statistically similar to same variety (8.40) with 50% of full sunlight. Percent change from control (L_{100}) values indicated that the number of seeds pod^{-1} was increased with reduction in light levels in BARI Mung-6 and Binamoong 8. On the other hand, in Binamoong 5 and BU Mug-4 it was increased in 75% of full sunlight but decreased in 50% of full sunlight.

Thousand seeds weight

The interaction effect of light intensities and mungbean varieties on thousand seeds weight was significant (Table 2). The maximum seeds weight was observed in BARI Mung-6 (47.23 g) at L_{75}, which was followed by all other treatment combinations while lowest seeds weight was observed in Binamoong5 (38.26 g) at L_{100}, which was statistically similar to same variety (38.91 g) at L_{75}. The results showed that increased or remained more or less unchanged due to low light intensities in BARI Mung-6, Binamoong 8 and Binamoong5 but it was reduced with the reduction in light intensities in BU Mug-4.

Seed yield

The interaction effect of light levels and mungbean varieties on seed yield plant^{-1} (Table 2) and seed yield were significantly influenced (Fig.2). The maximum seed yield plant^{-1} was observed in BARI Mung-6 (3.07 g) both at L_{100} and L_{75}, which was statistically similar to those obtained from Binamoong 8 (3.01 g) at L_{100}, BU Mug-4 (3.00 g) at L_{100}, BARI Mung-6 (2.89 g) at L_{50} and Binamoong (2.89 g) at L_{100}. The lowest seed yield plant^{-1} was observed in BU Mug-4 (2.02 g) at L_{50}. These results indicated that the seed yield plant $^{-1}$ was remain unchanged or decreased with the reduction in light levels but the reduction was more in Binamoong 5and BU Mug-4 than in BARI Mung-6 and Binamoong8. The maximum seed yield per hectare was recorded in BU Mug-4 with 100% of full sunlight (0.94 t ha^{-1}) which was statistically similar to those recorded in Binamoong 8 with 100% of full sunlight (0.90 t ha^{-1}). Lower grain yield per hectare was recorded in BU Mug-4 with 50% of full sunlight (0.52 t ha^{-1}) which was statistically similar to Binamoong 5 with 50% of full sunlight (0.60 t ha^{-1}).

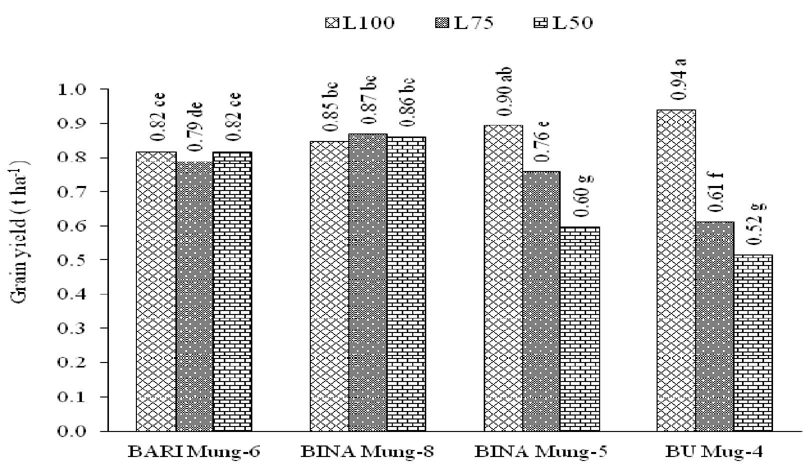

Fig. 2. Seed yield (t ha^{-1}) as influenced by light intensities and mungbean varieties at different days after sowing. Means followed by different letter(s) differed significantly by Tukey's test at $P \leq 5\%$ level of probability. L_{100} = 100 % of full sunlight (open field control), L_{75}-= 75 % of full sunlight, L_{50} = 50% of full sunlight

The results in seed yield per hectare also indicated that the yield was remained statistically unchanged due to lower light levels in BARI Mung-6 and Binamoong 8 but in Binamoong 5 and BU Mug-4, the seed yield was reduced with the reduction in light levels. Seed yield of mungbean is attributed by number of pods, number of seeds per pod and seed size. These yield attributes were severely affected by degree of shading. Lantican and Catedral (1977), Laosuwan *et al.* (1992) and Miranda-Abilay and Lantican (1982) observed lower seed yield for shaded grown mungbean plant. Polthanee *et al.* (2011) showed that seed yield of soybean was significantly ($p < 0.05$) decreased under the low light intensity at 30% of natural light both in wet and dry season. Akhter *et al.* (2009) reported reducing the light intensity from 100 to 25% exerted variable quantity of reduction of dry seed yield plant^{-1} in different genotypes and the reduction of seed yield plant^{-1} was attributed to lower pod plant^{-1}, seed pod^{-1} and smaller weight seed. Islam (1995) found pods per plant decreased with the increase of shading.

Stover yield plant^{-1}

The interaction effect of light levels and mungbean varieties on stover yield per plant was significant (Table 3). The maximum stover yield per plant was observed in Binamoong8 (6.71 g) at L_{50} which was statistically similar to BARI Mung-6 (6.05 g) at L_{50}, Binamoong 8 (5.81 g) at L_{75}, BINA Mung-5 (5.44 g) at $L_{100,}$ BU Mug-4 (5.33 g) at L_{75} and (5.20 g) at $L_{50,}$ Binamoong 5 (4.98 g) at $L_{75,}$ BU Mug-4 (4.93 g) at L_{100} and BARI Mung-6 (4.77 g) at $L_{100.}$ The lowest stover yield per plant was observed in Binamoong 8 (3.41 g) at L_{100} which was statistically similar to in BARI Mung-6 (3.65 g) at $L_{75,}$ Binamoong 5 (4.20 g) at $L_{50,}$ BARI Mung-6 (4.77 g) at $L_{100,}$ BU Mug-4 (4.93 g) at $L_{100,}$ Binamoong 5 (4.96 g) at $L_{75,}$ BU Mug-4 (5.20 g) at L_{50} and (5.33 g) at L_{75} and Binamoong 5 (5.44 g) at $L_{100.}$

Harvest index (%)

The interaction effect of light levels and mungbean varieties on harvest index was significant (Table 3). The maximum harvest index was observed in Binamoong-8 (88.27) at L_{100} which was statistically similar to observed in BARI Mung-6 (84.11) at L_{75}. The lowest harvest index was observed in BU Mug-4 (38.85) at L_{50} which was statistically similar to those observed in Binamoong 8 (3.65 g) at L_{50} and BARI Mung-6 (47.77) at $L_{50.}$

Table 3. Stover yield and Harvest index of mungbean as influenced by light levels and varieties

Variety	Light level	Stover yield (g plant^{-1})	Harvest index (%)
BARI Mung- 6	L_{100}	4.77 ad	64.36 b
	L_{75}	3.65 cd (-23.48)	84.11 a
	L_{50}	6.05 ab (26.83)	47.77 de
Binamoong8	L_{100}	3.41 d	88.27 a
	L_{75}	5.81 ac (70.38)	49.23 d
	L_{50}	6.71 a (96.77)	42.23 e
Binamoong5	L_{100}	5.44 ad	53.13 c
	L_{75}	4.96 ad (-8.82)	49.80 d
	L_{50}	4.20 bd (-22.79)	54.29 c
BU Mug- 4	L_{100}	4.93 ad	60.85 bc
	L_{75}	5.33 ad (8.11)	51.60 cd
	L_{50}	5.20 ad (5.48)	38.85 ef
CV (%)		14.34	4.56

In a column, means followed by different letter(s) differed significantly by Tukey's test at $P \leq 5\%$ level of probability. L_{100} = 100 % of full sunlight (open field control), L_{75} = 75 % of full sunlight, L_{50} = 50% of full sunlight

Conclusion

The seed yield of mungbean var. BARI Mung-6 and Binamoong8 performing well in under partial shade condition but the seed yield of Binamoong5 and BU Mug-4 was reduced drastically under partial shade condition. Greater proline accumulation in leaf, higher leaf chlorophyll content, higher pods plant^{-1}, higher seeds pod^{-1}, greater seed size and better seed yield plant^{-1} under partial shade condition were contributed to better tolerance of BARI Mung-6 and Binamoong8 under low light stress.

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