OnLine Journal of Biological Sciences 2 (11): 765-766, 2002
ISSN 1608-4127

Performance of Red Amaranth under Shade Condition for Agroforestry Systems

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Abstract: Performance of red amaranth (*Amaranthus gangeticus*) under four levels of light- 100, 75, 50, and 25% photosynthetically active radiation (PAR) was evaluated to judge its suitability for inclusion in agroforestry systems. Mosquito nets of different mesh size have been used to create desirable light levels. It was observed that in red amaranth, any reduction in PAR affected all morphological and yield parameters of red amaranth negatively. Plant height, number of leaves plant^{-1}, leaf size, stem girth, fresh and dry yield were decreased significantly with decreasing light levels but the trend of response of different morphological parameters to different light levels were different. The mean fresh and dry yield (t ha^{-1}) of red amaranth grown under 100, 75, 50 and 25 % PAR levels were 12.77, 9.54, 5.75, 3.19 and 1.27, 0.92, 0.55, 0.26, respectively. Therefore, red amaranth may not be included in tree-crop agroforestry system.

Key words: Red amaranth, shade condition, agroforestry system

Introduction

Red amaranth (*Amaranthus gangeticus*) is one of the most important and popular vegetable in Bangladesh for their quick growth and higher yield potential. The fresh tender leaves and stem of red amaranth are delicious when cooked by boiling and mixing with condiments. The seeds have various bakery uses. Red amaranth can play a vital role in elevating the nutritional status specially vitamins and minerals of Bangladesh (Hossain, 1995). Amaranth is the most common leafy vegetable grown during summer and rainy seasons. It fits well in crop rotation because of its very short duration and high yield of edible matter per unit area. It is usually grown in kitchen gardens and high lands. It can be grown as mixed crops along with cereals, pulses and vegetables. The leaves and tender stems of red amaranth are rich in protein, minerals, vitamin A and C. The fresh tender leaves and stem of amaranth are delicious when cooked like other leafy vegetables.

The current trend of production strategy is to grow more than one crop including a perennial wood species simultaneously in order to maximize the productivity of a unit area. Therefore, it is necessary to evaluate the performance of an annual agricultural crop before going to undertake a joint production system, which is otherwise known as agroforestry.

Therefore, this study was undertaken to evaluate the performance of red amaranth under different degrees of light intensity to determine its suitability under tree-crop agroforestry systems.

Materials and Methods

This study was conducted at the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) farm during the period from March to July 1999 with four light intensities viz. 100, 75, 50 and 25% photosynthetically active radiation (PAR). The reduced light levels (75, 50 and 25% PAR) were maintained by mosquito nets of different sieve sizes. The mosquito nets were imposed at 8 feet height over the plots in order to cut the incoming light radiation. The treatments were arranged in a randomized complete block design (RCBD). The size of each plot was 2.5 x1.25 m^2. Red amaranth seeds were sown at 25 cm apart lines continuously and uniformly @ 1.5 kg ha^{-1} on 6th April 1999. Recommended doses (5 ton cowdung, 220 Kg urea, 70 Kg TSP and 60 kg MP ha^{-1}) of fertilizers were applied in the plots (Islam and Haque, 1992) and full doses of fertilizers were applied at the time of final land preparation. Necessary cultural operations were done as and when necessary. Red amaranth was harvested at 26 days after sowing (DAS) when the crop reached at edible size. Plant samples of red amaranth were collected randomly from all rows of the respective plots. A total of 25 (5 from each row) plants of red amaranth were selected from each plot for data collection. Samples were collected at 26 DAS (edible stage) for measuring plant height (cm), leaf size (length x breadth), stem girth (cm), weight of leaves plant^{-1} (g), weight of stem plant^{-1} (g), leaf stem ratio, fresh and dry yield (t ha^{-1}). Dry matter yield was calculated using the following formula:

$$\text{Total dry weight} = \frac{\text{Oven dry weight}}{\text{Fresh weight}} \times \text{Total fresh weight}$$

Data were analyzed and mean separation was performed by LSD (Zaman *et al.*, 1982).

Results and Discussion

Plant height: Plant height of red amaranth grown under different light levels (% PAR) was affected significantly (Table 1). Among the four light levels, the tallest plants (30.57 cm) were produced under 100% PAR level and then progressively reduced as the light level decreased although the differences of plant height at 75% (25.08 cm) and 50% (22.98 cm) PAR were non significant. Similar trend of plant height of red amaranth under shading was reported earlier by Ali (1999).

Leaf number: The effect of different reduced light levels on the number of leaves plant^{-1} of red amaranth was almost similar to the effect on plant height where number of leaves plant^{-1} decreased consistently as the light levels reduced (Table 1). The number of leaves plant^{-1} grown under 100, 75, 50 and 25% PAR were 15.49, 11.27, 9.93 and 8.67, respectively. Ali (1999) observed similar trend of leaves plant^{-1} under shade. The lower number of leaves plant^{-1} at the reduced light conditions may be due to lower production of photosynthates under low light conditions for a longer period (Miah *et al.*, 1999).

Leaf size (length × breadth): Both leaf length and breadth of red amaranth were significantly affected by different light levels, where the largest leaf was obtained under 100% PAR and then reduced progressively as the light levels reduced. At 75% PAR, the mean leaf length was 6.98 cm, which was statistically identical to that of 100% PAR (7.18 cm). In fact, reduction of PAR to 50% reduced the leaf length significantly to 5.82 cm and further reduction of PAR to 25% reduced the leaf length to 5.40 cm. The leaf breadth ranged from 5.65 cm at 100% PAR to 3.73 cm at 25% PAR and followed exactly the similar trend to that of leaf length due to variation in light availability (Table 1).

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Table 1: Effect of different reduced light level (PAR) on the morphological characteristics of red amaranth

Light level (% PAR)	Morphological characteristics of red amaranth							
	Plant weight (cm)	Number of leaves/ plant	Leaf length (cm)	Leaf breadth (cm)	Stem girth (cm)	Weight of leaves/ plant (g)	Weight of stem/ plant (g)	Leaf stem ratio
100	30.57	15.49	7.18	5.65	2.56	5.50	9.38	0.58
75	25.08	11.27	6.98	5.42	2.34	4.28	7.16	0.60
50	22.98	9.93	5.82	4.21	1.98	2.78	4.49	0.62
25	18.69	8.67	5.40	3.73	1.58	1.56	2.41	0.65
LSD (0.05)	3.48	2.61	0.95	0.92	0.32	1.73	1.45	0.03

Table 2: Effect of different reduced light levels (PAR) on the yield of red amaranth

Light levels (% PAR)	Yield (t ha^{-1})	
	Fresh yield	Dry yield
100	12.77	1.27
75	9.54	0.92
50	5.75	0.55
25	3.19	0.26
LSD (0.05)	1.51	0.14

Stem girth: Stem girth of red amaranth was influenced significantly by reduced light levels and followed a similar trend to that leaf size. Like leaf size, the highest stem girth was recorded in 100% PAR (2.56 cm) and the lowest in 25% PAR level (1.58 cm). Similar to other parameters, stem girth started reducing significantly from 50% PAR level.

Leaf weight: Reduced light levels had significant effects on the weight of leaf biomass of red amaranth where higher leaf biomass $plant^{-1}$ was obtained from higher light levels. At 100% PAR, the biomass yield was 5.50 g $plant^{-1}$ which was non significantly followed by 75% light level (4.28 g $plant^{-1}$). Leaf biomass obtained from 50% light level (2.78 g $plant^{-1}$) and from 75% light level (4.28 g) were statistically similar. The higher leaf biomass at higher light levels was probably due to higher production of photosynthates.

Stem weight: Weight of stem $plant^{-1}$ of red amaranth was also significantly affected by different reduced PAR levels (Table 1). Among light levels, the highest weight of stem $plant^{-1}$ obtained under 100% PAR level was 9.38 g and then decreased substantially as the light level decreased. The stem weight $plant^{-1}$ under 75, 50 and 25% light levels were 7.16, 4.49 and 2.41 g, respectively. Like leaf weight similar reason might be responsible for the poor stem biomass at relatively more shade level.

Leaf stem ratio: Leaf stem ratio increased gradually with decreasing light levels where the highest leaf stem ratio was observed under 25% PAR level (0.65), but it was statistically identical to that of 50% (0.62) PAR level. On the other hand, the lowest leaf stem ratio observed under 100% PAR (0.58) was statistically similar to the leaf stem ratio observed under 75% PAR level (0.60) (Table 1).

Fresh yield: The fresh yield of red amaranth showed remarkable variation among the four light levels where fresh yield decreased gradually with reducing light levels or increasing shade levels. The highest fresh yield of red amaranth was produced under 100% PAR level (2.77 t ha^{-1}). Similar yield response was reported by Nayak and Murty (1980) who observed lower yield of rice under shade conditions.

Dry yield: The effect of different light levels on the dry yield of red amaranth was almost identical to that of fresh yield. The dry yield obtained from 100% light level was 1.27 t ha^{-1} and then decreased substantially under 75, 50 and 25% light levels to 0.92, 0.55 and 0.26 t ha^{-1}, respectively.

Similar yield response was also reported by Ali (1999), who found poor yield of red amaranth under guava tree, probably due to poor PAR availability which might be due to heavy and bushy branching habit of guava trees. The lower dry yield of rice crop under shade was also observed by many investigators (Chaturvedi and Ingrum, 1989; Nayak and Murty, 1980; Miah *et al.*, 1995).

Relationship between light (% PAR) and fresh yield of red amaranth: A linear relationship between light (% PAR) and fresh yield of red amaranth was estimated as: $Y = -0.32 + 0.13x$ ($R^2 = 0.96^{**}$) where R^2 is quite high and significant. The R^2 value indicated that about 96% of red amaranth yield was attributed due to percent PAR. Similar relationship between % PAR and red amaranth yield under 8 years old drumstick tree was reported by Ali (1999). The relationship also stated that fresh yield of red amaranth was changed @ 0.13 t ha^{-1} for per unit change in percent PAR. Using this equation, fresh yield of red amaranth did not decrease significantly up to 10% light reduction i.e. red amaranth can be grown up to under 90% PAR without significant yield loss.

References

Ali, M.A., 1999. Performance of red amaranth and lady's finger growth at different orientations and distances under guava and drumstick trees. M. Sc. Thesis, BSMRAU, Gazipur, Bangladesh.

Chaturvedi, G. S. and K.T. Ingram, 1989. Growth and of low land rice in response to shade and drainage. Philippine J. Crop Sci., 14: 61-67.

Hossain, S.M.M., 1995. Agro- ecology and varietal characteristics of leafy vegetables. A Training Manual, Summer and all Season Vegetables and Spices Production, pp: 89-92.

Islam, M.S. and M.A. Haque, 1992. Soil and fertilizer for vegetables. In: Vegetable Production and Marketing. Proceeding of a National Review of Planning Workshop, 26-29 July, BARI, Joydebpur, Gazipur, Bangladesh, pp: 116-129.

Miah, M.G., D.P. Garrity and M.L. Argon, 1995. Light availability to the under storey annual crops in an Agroforestry system. In: Sinoquet, H. and P. Cruz (Eds.), Ecophysiology of Tropical Inter Cropping. IRNA Editions, Paris, Franch, pp: 99-107.

Miah, M.G., M.A. Rahman and M.M. Haque, 1999. Performance of onion under different reduced light levels for intercropping and intercropping systems. Bull. Inst. Trop. Agric. Kyushu Univ. 22: 31-38.

Nayak, S.K. and K.S. Murty, 1980. Effect varying light intensities on yield and growth parameters in rice. Indian J. Pl. Physiol., 23: 309-316.

Zaman, S.M.S., K. Rahim and M. Howlader, 1982. Simple Lessons from Biometry. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh, pp: 1-171.