BCSIR

Available online at www.banglajol.info

Bangladesh J. Sci. Ind. Res. **45(4)**, 331-336, 2010

BANGLADESH JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

E-mail: bjsir07@gmail.com

Effect of Soil Moisture Regimes on Growth and Yield of Mulberry

N. K. Paul[a] and M. A. Qaiyyum[b]*

[a]Department of Botany, University of Rajshahi, Rajshahi 6205, Bangladesh and [b]Bangladesh Sericulture Research and Training Institute, Rajshahi, Bangladesh

Abstract

Effect of three levels of irrigation viz., no irrigation (I_0), irrigation once a month (I_1) and irrigations twice a month (I_2) on some growth attributes and leaf yield and some of its components of five mulberry varieties were studied in field condition. Significant effect of irrigation on relative growth rate (RGR), net assimilation rate (NAR), leaf area ratio (LAR), and relative leaf growth rate (RLGR) was observed. lrrigation also had significant effect on leaf yield and some of its components. The overall results indicated that twice irrigations in a month with mulberry variety BM-4 could be used for higher leaf yield.

Key words: Mulberry, lrrigation, Growth parameters, Leaf yield

Introduction

Mulberry is a perennial woody plant and forms the basic food material for silkworms and bulk of the silk goods produced in the world are from mulberry silkworms. Sericulture involves four distinct phases of activity, namely mulberry cultivation, which is the agricultural part of sericulture, silkworm rearing, reeling and weaving, Mulberry is mainly cultivated under irrigation condition, but due to hardy plant it can also be cultivated under rainfed condition. The climatic conditions of Bangladesh are suitable for the luxurious growth of mulberry. But during the drought period, such as November-April, due to scanty rainfall, extra moisture supply through irrigation must be done.

Irrigation is an agricultural practice tends to increase in most agricultural crops and plants. Kasiviswanathan and Iyengar (1965) investigating on mulberry observed that irrigation increased about 68% of leaf yield. The irrigation given during November-April (drought period) around 15 days interval for clayey loam soil outyielded monthly irrigation (Mukherjee *et al* 1972.; Rangaswami *et al*,; 1976).

Little work has been done regarding the effect of irrigation on growth and yield of mulberry in Bangladeshi growing condition. Therefore, the present experiment was set up to obtain such information.

Materials and Methods

Five improved mulberry varieties viz., BM-1, BM-2, BM-3, BM-4 and BM-5 were used. The experiment was conducted in the research field of Bangladesh Sericulture Research & Training Institute, Rajshahi. Soil of the field was sandy clay loam having pH 7.2 and low in organic matter (0.77%) and N (0.08%). The experimental field was prepared by deeply (30-35 cm) and repeatedly ploughing, cross-plough and leveled properly for preparing it homogenous as far as possible. Basal dose of organic manure at the rate of 19 t/ha was applied. The inorganic fertilizers such as NPK were applied at the rate of 150 kg N/ha,75 kg P/ha and 35 kg K/ha.

The experiment was conducted in a split plot design with 3 replications. Mulberry cuttings were planted in pit system. Initially, 3 cuttings were planted in each pit but only the vigorous one was finally allowed to grow per pit. The distance between the lines and that between the plants was 60 cm and 45 cm, respectively, proper cultural operations, particularly weeding digging and proper pruning were done regularly as and when necessary.

Three levels of irrigation were used as follows: I_0= No irrigation, I_1= Irrigation once in a month (mid time) and I_2= Irrigations twice a month (15 days interval). The experiment

* Corresponding author: E-mail:

was done only in two seasons in a year, which were the drought period. The seasons were February-April and November-January. The pooled data are presented in this paper. Three harvests were done in each season as H_1= 30 days after planting (DAP), H_2= 60 DAP and H_3= 90 DAP.

Measurement of dry weight (stem and leaves) and leaf area were recorded. Growth attributes were calculated according to Radford (1967). Leaf yield and yield component characters such as plant height, branch number/plant, leaf number/branch, leaf size and leaf yield/plant were recorded. Statistical analysis of the data was done.

Results and Discussion

Growth Attributes

In this study, significant effect of irrigation on RGR was observed (Table I). On average, higher RGR in I_1 at (60-30) DAP and I_2 at (90-60) DAP were found. Similar result was reported by E1 Nadi (1969) and Nerkar *et al.* (1981) in *Vicia faba* and Kundu and Paul (1998) in rape.

RGR attained a higher value at (60-30) DAP and then declined at (90-60) DAP, Similar result was reported in sugar beet, potato and barley (Thorne, 1960), in black gram (Pandey *et al.*, 1978), in repe (Murtaza and Paul, 1986; Roy and Paul, 1991) and in mustard (Begum and Paul, 1993). In the present study it was observed that BM-3 and BM-1 had the highest and BM-4 and BM-2 had the lowest RGR at (60-30) DAP and (90-60) DAP, respectively.

Significant differences were observed among the treatments for NAR. Higher NAR was found in I_0 plants followed by I_1 and I_2 Plants at (60-30) DAP, but at (90-60) DAP, I_2 had higher NAR followed by I_1 and I_0. Higher values of NAR were found at (60-30) DAP and declined at (90-60) DAP. Similar results were found in *Vicia faba* (E1 Nadi, 1969; Nerkar *et al.*, 1981 . in rape (Kundu and Paul, 1998) and in mustard (Khan and Paul 1993). Among the varieties, BM-3 and BM-2 had higher NAR in the well-moistured condition (Table I).

LAR was higher in the well moistured plants and that between the irrigations, I_1 plants at (90-60) DAP and I_2 at (60-30) DAP had higher LAR (Table I). This result is similar to that reported by Khan and Paul (1993) in mustard. They reported that LAR was higher in the well-watered plants than the water-stressed plants. LAR was higher at (60-30) DAP and lower at (90-60) DAP. Among the varieties, BM-2 and BM- always had higher and lower LAR at each harvest interval. Wallace and Munger (1965) reported that in grain legumes, LAR was highest during the early stage, but at the later staga decreased. This might be due to abscission of older mature leaves, Similar result was reported by Pandey *et al*. (1978) in black gram, Hossain and Paul (1984) in jute, Shamsuddin and Paul (1988) in sweet potato and Kundu and Paul (1998) in rape. Among the varieties, BM-5 and BM-2 had higher LAR in the well- watered condition (Table I).

RLGR was higher in the well-moistured plants with some exceptions. Between the irrigations, 1_1 plants had higher RLGR than i@ plants. (Table I). Similar results were found by Kundu and Paul (1998) in rape, Mondal and Paul (1992) and Begum and Paul (1993) in mustard. Higher and lower values of RLGR were observed at (60-30) DAP and (90-60) DAP, respectively, Pandey *et al.* (1978) attributed the decline of RLGR at the later stage due to the abscission of older or matured leaves, but the abscission was greater in the water-stressed plants (Sharma and Kumar, 1989).The decline in RLGR with time was reported by Paul (1980) in swede, rape, kale and turnip Among the varieties, BM-4 and BM-3 had higher RLGR in the well-moistured condition.

Leaf Yield and Components

Significant effects of soil moisture and variety was found for plant height (Table II). Among the treatments, the highest plant height was observed in 1_2 plants followed by I_1 and 10 (Table II). Similar results were reported by Kasiviswanathan and Lyengar (1965) and Rangaswami *et al.* (1976) in mulberry. Taller plant due to soil moisture in mulberry is an important character for contributing higher yield. Among the varieties, BM-3 had tallest height (Table II).

With some exceptions, greater number of branches/plant and leaves/branch were/observed in the well-moistured plants (Table II). This was due to the rapid differentiation of leaf initials and faster emergence of leaves in the nonstress condition. Numbers of branches and leaves are the most important characters for mulberry varieties to enhance the leaf yield (Susheelamma *et al.*, 1988). Among the varieties, BM-3 and BM-1 had higher number of branches/plant and leaves/branch, respectively.

Table I: Mean values of growth attributes of five mulberry varieties as influenced by soil moisture

Treatment	BM-1	BM-2	BM-3	BM-4	BM-5	Mean
			Relative growth rate (gg^{-1} day^{-1})			
			(60-30) DAP			
I_0	0.0246	0.0206	0.0226	0.0181	0.0266	0.0225
I_1	0.0211	0.0254	0.0244	0.0244	0.0217	0.0234
I_2	0.0219	0.0227	0.223	0.0232	0.0180	0.0216
Mean	0.0225	0.0229	0.0231	0.0219	0.0221	
LSD 5%	a) 0.0006	b) 0.0008	c) 0.0015			
			(90-60) DAP			
I_0	0.0067	0.0047	0.0077	0.0081	0.0050	0.0064
I_1	0.0102	0.0067	0.0060	0.0055	0.0065	0.0069
I_2	0.0084	0.0074	0.0070	0.0080	0.0079	0.0077
Mean	0.0084	0.0063	0.0069	0.0072	0.0065	
LSD 5%	a) 0.0007	b) 0.0009	c) 0.0016			
			Net assimilation rate (g cm^{-2} day^{-1}) x 10^{-4}			
			(60 - 30) DAP			
I_0	3.93	2.94	3.46	2.62	2.91	3.37
I_1	2.97	3.35	3.43	3.71	3.22	3.34
I_2	3.14	3.00	3.15	3.39	2.57	3.05
Mean	3.34	3.08	3.34	3.24	3.23	
LSD5%	a)0.16	b)0.21	c)0.37			
			(90-60) DAP			
I_0	1.28	0.75	1.39	1.41	0.87	1.14
I_1	1.92	1.06	0.99	0.94	1.16	1.21
I_2	1.62	1.18	1.15	1.42	1.36	1.35
Mean	1.60	0.99	1.17	1.25	1.13	
LSD 5%	a) 0.04	b) 0.06	c) 0.11			
			Leaf area ratio (cm^{-2} g^{-1})			
			(60 - 30) DAP			
I_0	62.95	70.67	65.39	69.14	68.63	67.35
I_1	71.04	75.85	71.34	66.36	66.98	70.31
I_2	69.73	75.59	71.20	68.43	70.13	71.01
Mean	67.90	74.03	69.31	67.97	68.58	
LSD 5%	a)0.22	b)0.27	c)0.47			
			(90-60) DAP			
I_0	54.58	62.85	55.40	57.54	58.09	57.69
I_1	53.47	63.99	60.16	57.63	57.32	58.51
I_2	52.19	63.30	60.57	56.57	58.92	58.31
Mean	53.41	63.38	58.71	57.24	58.11	
LSD 5%	a) 0.40	b) 0.50	c) 0.87			
			Relative leaf growth rate (cm^2 cm^{-2} day^{-1})			
			(60-30) DAP			
I_0	0.0168	0.0145	0.0179	0.0118	0.0189	0.0160
I_1	0.0066	0.0179	0.0171	0.0160	0.0142	0.0144
I_2	0.0065	0.0146	0.0175	0.0142	0.0110	0.0128
Mean	0.0099	0.0156	0.0175	0.0140	0.0147	
LSD 5%	a) 0.0009	b) 0.0011	c) 0.0020			
			(90-60) DAP			
I_0	0.0042	0.0024	0.0010	0.0017	0.0007	0.0020
I_1	0.0049	0.0021	0.0012	0.0037	0.0030	0.0030
I_2	0.0036	0.0031	0.0007	0.0034	0.0030	0.0028
Mean	0.0042	0.0025	0.0009	0.0029	0.0022	
LSD 5%	a) 0.0004	b) 0.0005	c) 0.0009			

Table II: Mean values of leaf yield and yield components of five mulberry varieties as influenced by soil moisture

Teatment	BM-1	BM-2	BM-3	BM-4	BM-5	Mean
			Plant height (cm)			
I_0	94.30	86.60	103.20	82.20	82.95	89.89
1_1	133.95	136.00	151.40	112.05	113.25	129.33
1_2	143.70	130.45	155.15	115.50	118.50	132.68
Mean	123.98	117.68	136.58	103.25	104.90	
LSD 5%	a) 1.86	b) 2.41	c) 4.18			
			Branch number/plant			
I_0	5.15	8.15	9.20	5.35	6.25	6.82
1_1	8.40	11.35	13.40	7.95	7.65	9.75
1_2	8.10	11.40	14.15	8.20	7.60	7.89
Mean	7.40	10.30	12.25	7.16	7.16	
LSD 5%	a) 0.54	b) 0.70	c)1.22			
			Leaf number/branch			
1_0	23.10	25.40	22.15	19.55	20.80	22.20
1_1	13.20	37.65	31.90	26.30	26.55	30.72
1_2	33.20	36.05	32.20	27.20	29.50	31.63
Mean	29.16	33.03	28.75	24.35	25.61	
LSD 5%	a) 1.02	b) 1.31	c) 2.28			
			Leaf size (cm^{-2})			
1_0	148.80	163.20	158.60	190.85	185.20	169.33
1_1	230.10	215.75	214.45	257.05	259.00	235.27
1_2	233.45	218.45	213.60	267.25	250.30	236.61
Mean	204.11	199.13	195.55	238.38	231.50	
LSD 5%	a)1.90	b)2.46	c)4.26			
			Leaf yield/plant (g)			
1_0	161.00	175.45	190.00	194.50	187.80	181.75
1_1	259.30	282.70	282.90	295.65	263.50	276.81
1_2	259.30	276.50	298.50	300.50	275.25	282.01
Mean	226.53	244.88	257.13	263.55	242.18	
LSD 5%	a) 2.46	b) 3.10	c) 5.52			

Greater leaf size was observed in the well-moistured compared to the waterstressed plants. But I_1 and I_2 plants did not differ significantly however, 1_2 plants had larger leaf size compared to I_1 plants. Similar findings were reported by Rangaswami *et al.* (1976) and Anonymous (1975, 1985) in mulberry. Enlargement of leaf might be due to the increased cell division and greater elongation of cell due to higher turgidity of the irrigated plants (Allen *et al.*, 1976; Vivekanandan and Gunasena (1976)). Among the varieties, BM-4 had greater and BM-3 had smaller leaf size (Table II).

Leaf yield was significantly higher in the well-moistured plants. Between the irrigation treatments, I_2 plants had higher leaf yield, but no significant difference was observed between I_1 and I_2 plants (Table II). Similar findings were reported by Kasiviswanathan and Iyengar (1984). Mukherjee *et al.* (1972) reported that fortnightly irrigation in mulberry outyielded to monthly irrigation, while the yield was least in the non-irrigated plants. Average plant height and average number of branches/plant were considered superior characters for yield in the selection of mulberry genotypes under irrigated condition by Das and Krishnaswami (1969).

Conclusion

The overall results of the present investigation suggest that twice irrigations in a month with mulberry varieties BM-4 and next to it BM-3 and BM-5 could be used for higher leaf yield.

References

Allen L. H., Jr. Boote K. J. and Hammond L. C. (1976). Peanut stomatal resistance affected by soil water and solar radiation. *Proc. Soil Crop Soc. Fal.* **35:** 42-46.

Anonymous. (1975). Text Book of Tropical Sericulture. Japan Overseas Cooperation Volunteers, Tokyo, Japan. 91-92.

Anonymous. (1985) Mulberry Cultivation. Regional Sericulture Training Centre, Guangzhou China.

Begum F. A. and Paul N. K. (1993). Influence of soil moisture on growth, water use and yield of mustard (*Brassica juncea* L.). *J. Agron. & Crop Sci* . **170:** 136-141.

Das B. C. and Krishnaswamy S. (1969). Estimation of components of variation of leaf yield and its trait in mulberry. *J. Sericult. Sci. Japan.* **38:** 242-248.

EI Nadi A. H. (1969). Water relations of beans. 1. Effects of water stress on growth and flowering. *Expl. Agric* **5**:195-207.

Hossain S. M. A. and Paul N. K. (1984). Growth pattern analysis in jute *(Corchorus capsularis* L. and *C. olitorius* L.). *B. J. Jute Fib. Res.* **9:** 1-7.

Kasiviswanathan K. and Lyengar M. N. S. (1965). Preliminary observation on varietal cum irrigational response to different levels of N on the seasonal and total yield of mulberry leaf. *Indian J. Seric.* **4:**22-33.

Kasiviswanathan K. and Iyengar M. N. S. (1984). Soil moisture utilization pattern of mulberry. *Indian J. Seric.* **9:** 1-6.

Khan M. R. and Paul N. K. (1993). Effect of soil moisture on growth attributes, physiological characters and yield of mustard. *Pro 7th. Bot. Conf.* 1992. 95-101.

Kundu, P. B. and Paul N. K. (1998). Effect of soil moisture on growth and yield of rape (*Brassica campestris* L.). *Rajshahi Univ. Studies***. 26:** 119-1238.

Mondal R. K. and Paul N. K. (1992). Growth and physiological characters of mustard under rainfed and irrigated condition. *Bangladesh J. Agri. Res*. **17:** 29-39.

Mukaherjee S. K., Ray D. and Pain A. K. (1972). Influence of different levels of irrigation on the yield of bushy mulberry raised under Bengal and Mysore systems of plantation. *Indian J. Seric.* **11:** 33-38.

Murtaza M. G. and Paul N. K. (1986). Effect of nitrogen on assimilation rate and growth of rape seed (*Brassica campestris* L.) *Bangladesh J. Agri. Res.* **11:**1-7.

Nerkar Y. S., Wilson D. and Lawes D. A. (1981). Genetic variation in stomatal characteristics and behaviour, water use and growth of five *Vicia faba* L. genotypes under contrasting soil moisture regimes. *Euphytica* **30:** 335-345.

Pandey R. K., Saxena M. C. and Singh V. P. (1978). Growth analysis of blackgram genotypes. *Indian J. agric. Sci.* **48:** 466-473.

Paul N. K. (1980). Environmental effects on growth and development of Brassicae. Ph.D. Thesis, University of Wales, U.K. pp.62-72.

Radford P. J. (1967). Growth analysis formulae-their use and abuse. *Crop Sci.* **7:**171-175.

Rangaswami G. M., Narasimahanna M. N., Kasiviswanathan K. and Sastry C. R. (1976). Sericulture Mannual. 1. Mulberry Cultivation. FAO, Rome.

Roy K. K. and Paul N. K. (1991). Physiological analysis of population density on rape (*Brassica campestris* L.). 1. Growth analysis. *Acta Agronomica Hungarica*, **40:** 339-345.

Shamsuddin S. A. K. and Paul N. K. (1988). Environmental effects on dry matter production and growth of sweet potato. *Bangladesh Hort.* **16:** 17-24.

Sharma D. K. and Kumar A. (1989). Effect of water stress on plant water relations and yield of varieties of Indian mustard (*Brassica juncea subsp.* juncea). *Indian J. Agric. Sci.* **59:** 281-285.

Susheelamma B. N., Jolly M. S., Giridhar K., Dwivedi M. K. and Suryanaryana M. (1988). Correlation and path analysis in mulberry under stress and non-stress conditions. *Sericologia,* **28:** 239-243.

Thorne G. N. (1960). Variation with age in net assimilation rate and other growth attributes of suger beet, potato and barley in a controlled environment, *Ann. Bot.* **24:** 356-372.

Vivekanadan A. S. and Gunasena H. P. M. (1976). Lysimetric studies on the effect of soil moisture tension on the growth and yield of maize (*Zea mays* L.) and groundnut (*Arachis hypogaea). Beitr, Trop. Landwirtsch. Veterinaermed.* **14:** 369-378.

Wallace D. M. and Munger H. M. (1965). Studies on the physiological basis for yield difference. 1. Growth analysis of six dry bean verieties. *Crop Sci.* **5**: 343-348.

Received : July 28, 2009;
Accepted : February 09 , 2010