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PHYSIOLOGICAL RESPONSES OF *MORUS ALBA* L. TO WATER STRESS

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The influence of water stress on shoot height, root lenght, fresh and dry weights of roots and leaves and leaf water potential was studied in three months old mulberry plants at four levels of water stress. The root and shoot growth slightly decreased at all stress levels, except in roots of moderate stress. The fresh and dry weights of roots and leaves and leaf water potential decreased over control in all stress treatments. The physiological implication of these results are discussed.

Keywords : Leaf water potential; *Morus alba;* Water stress.

Introduction

Many effects of water deficits on growth and yield of plant are clearly evident throughout arid and semi arid regions of the world. Water deficits especially have profound effect on plant growth and metabolism. The first sign of water shortage in the field usually is a restriction in foliage growth.[1] The growth and development of a plant depends on continuing cell division, on the progressive initiation of the primordia and the enlargement of cells[2]. Cell enlargement is generally regarded as more sensitive to water deficit than cell division[3].

A general decrease in height of the plant during stress has been reviewed by several investigators[4,5]. In several species the rate of root elongation and the number of growing roots are strongly influenced by environmental factors mainly water stress. The influence of water deficits on root growth is particularly controversial. A few studies suggest that water deficit induce an absolute increase in the depth and weight of roots[6]. There were also reports stating that water deficit decreases the root growth[7].

A significant reduction in fresh and dry weight was noted in pea under stress condition[8]. There are several reports that decreased soil water potential resulted in a decrease in leaf water potential[9]. With the above background an attempt was made to study the influence of different intensities of water stress on mulberry with respect to shoot growth, root growth, biomass of plant and leaf water potential.

Materials and Methods

Mulberry *(Morus alba* L var. 5) cuttings of lengths 12 to 15cm and diameter 8 to 10mm with 3 to 4 active buds was maintained in earthern pots (12" x 15" size). Soil moisture was determined by taking soil samples between 11 to 12 hrs and dried them in an oven at 120°C. Values are expressed as percentage on wet weight basis.

Three months old plants with approximately equal height and number of leaves were selected as experimental materials. Experiment was conducted during summer season. One set of plants were irrigated daily to field capacity and are termed as controls. Water stress was induced by adding required volume of water daily in the morning to give 50%, 25%, 12.5% 0% field capacity by withholding water and were characterized as mild, moderate, severe and very severe treatments respectively. The post were kept in the university botancial garden under natural photoperiod. Data were collected on 3rd, 5th and 7th day after induction of stress on length and fresh and dry weight of root and shoot. The leaf water potentials were measured by a dye method[10].

Results and Discussion

The soil mosture content decreased over control with increase in stress intensity and duration (Table 1). The root and shoot length decreased at all stress levels, except in moderate stress treatments where there was a slight increase in root lenght, which were not significant. The percent decrease in root length was ranged from 2 to 14 and shoots it was ranged from 1 to 12 (Table 2). The fresh and dry weights of roots decreased with increase in stress intensity. However, the decrease was significant only in severe and very severe stress treatments. The percent decrease was ranged from 1 to 56 in fresh weights and 1 to 65 in dry weights (Table 3). The leaf water potential decreased over control in all stress treatments. The decrease was significant in all stress treatments. It remained nearly constant in control plants. The decrease in leaf water potential was dependent on the intensity and duration of stress. The percent decrease was ranged from 32 to 183 (Table 4).

The present investigation has shown the degree of tolerance to water deficits in mulberry and the morphological and physiological responses to water deficits with a few interesting points. Root and shoot growth decreased at all stress levels and it was higher in severe and very severe stress treatments. However, slight increase in root length was observed in mild and moderate stress treatments. The extent and the pattern of root development are closely related to the ability of he plant to absorb water and hence is of great significance in drought resistance. The low soil water content induces the plant to produce deeper and longer roots. The growth of deep root system is to explore the deeply stored soil moistures when surface water is depleted thereby plant can avoid the drought. This has been demonstrated in soybean, where it was observed that roots deep in the profile extracted more effectively per unit root length than roots nearer to the surface. In contrast to that cessation of root growth was also reported in rice[12]. In the present investigation root length increased at mild and moderate stress conditions and decreases in severe and very severe stress treatments. This may be a morphological adaptation for efficient water uptake and dehydrogen postponement, which are considered to be the mechanisms to evade drought[13]. Water deficit limits stem growth by reducing water uptake and wall extension[14]. The present study also revealed a reduction in shoot height during stress conditions and the reduction was stress intensity dependent. The decreased height of the plant during stress conditions may help in reducing the distance for water movement and thereby increase the tolerance of plant to grow at such adverse

Table 1. Soil moisture content (% g) in control and stressed samples.

Days	Control	Mild stress	Moderate stress	Severe stress	Very sevcre stress
3	20.27	20.52	17.13	16.41	3.41
	(100.00)	(70.10)	(58.52)	(56.06)	(12.77)
5	31.71	12.98	10.28	4.66	2.59
	(100.00)	(40.93)	(32.41)	(14.72)	(8.16)
7	31.91	8.43	5.37	2.70	-
	(100.00)	(26.41)	(16.82)	(8.46)	-

Table 2. Root and shoot lengths (cm) in control and stressed plants of mulberry ± S.E.

Days	Organ	Control	Mild stress	Moderate stress	Severe stress	Very severe stress
3	Roots	22.16 ± 1.69	22.27 ± 1.50	22.40 ± 1.49	20.00 ± 1.50	19.45 ± 1.60
		(100.00)	(100.49)	(101.08)	(90.25)	(87.77)
	Shoots	33.20 ± 2.60	32.70 ± 1.86	31.15 ± 2.11	31.00 ± 2.14	30.00 ± 2.40
		(100.00)	(98.49)	(93.82)	(93.37)	(90.36)
5	Root	23.50 ± 1.83	23.00 ± 0.86	24.10 ± 1.25	21.90 ± 1.69	20.00 ± 1.80
		(100.00)	(97.87)	(102.55)	(93.19)	(85.10)
	Shoots	36.40 ± 2.49	35.50 ± 2.27	34.00 ± 1.39	32.90 ± 2.32	31.70 ± 2.52
		(100.00)	(97.52)	(93.40)	(90.38)	(87.08)
7	Roots	25.45±1.04	25.60±2.00	26.20±2.36	22.55±1.73	-
		(100.00)	(100.58)	(102.94)	(88.60)	-
	Shoots	38.70 ± 3.20	38.00 ± 2.57	35.40 ± 3.51	34.00 ± 3.09	-
		(100.00)	(98.19)	(91.47)	(87.85)	-

Figures in parenthesis indicate percent control.

Table 3. Fresh (F.W.) and dry weights (D.W.) (g) in control and stressed plants of mulberry ± S.E.

Days	Organ		Control	Mild Stress	Moderate stress	Severe stress	Very severe stress
3	Roots	F.W	2.46 ± 0.17 (100.00)	2.30 ± 0.18 (93.49)	2.38 ± 0.18 (96.74)	1.62 ± 0.25** (65.85)	1.08 ± 0.17** (43.90)
		D.W.	1.24 ± 0.19 (100.00)	1.09 ± 0.02 (87.90)	1.05 ± 0.04 (84.67)	0.65 ± 0.05** (52.41)	0.43 ± 0.04** (34.67)
	Leaves	F.W.	5.42 ± 0.24 (100.00)	4.30 ± 0.20** (87.90)	3.35.0.22** (61.80)	2.55 ± 0.08** (52.40)	1.72 ± 0.08** (43.90)
		D.W.	1.95±0.16 (100.00)	1.57 ± 0.04 (80.51)	1.30 ± 0.03** (66.66)	0.94 ± 0.09** (43.78)	0.62 ± 0.04** (31.79)
5	Roots	F.W.	2.79 ± 0.09 (100.00)	2.65 ± 0.20 (98.51)	2.74 ± 0.09 (98.20)	1.93 ± 0.12** (69.17)	1.32 ± 0.10** (47.13)
		D.W.	1.42 ± 0.10 (100.00)	1.26 ± 0.08 (88.73)	1.25 ± 0.05 (88.02)	0.79 ± 0.06** (55.63)	0.55 ± 0.02** (38.73)
	Leaves	F.W.	5.86 ± 0.32 (100.00)	4.86 ± 0.25** (82.93)	3.72 ± 0.19°° (63.48)	3.11 ± 0.18** (52.27)	2.00 ± 0.08** (34.12)
		D.W.	2.69±0.23 (100.00)	1.87±0.24 (69.51)	1.60±0.07** (59.47)	1.15±0.18** (42.25)	0.74±0.05** (30.48)
7	Roots	F.W.	3.15 ± 0.27 (100.00)	3.06 ± 0.21 (97.14)	2.92 ± 0.18 (92.69)	2.26 ± 0.08** (71.75)	-
		D.W.	1.64 ± 0.14 (100.00)	1.62 ± 0.11 (98.78)	1.45 ± 0.08 (88.41)	0.94 ± 0.03** (57.31)	-
	Leaves	F.W.	6.53 ± 0.12 (100.100)	5.39 ± 0.18** (90.00)	4.50 ± 0.26** (68.92)	3.95 ± 0.23** (60.49)	-
		D.W.	3.15 ± 0.17 (100.00)	2.39 ± 0.03** (75.87)	2.00 ± 0.18** (63.49)	1.50 ± 0.13** (47.60)	-

*Significant at 5% level; **Significant at 10% level; figures in parenthesis indicate percent control conditions. The dry weight decrease as a result of water stress may be attributed to the altered carbon and nitrogen metabolism which are responsible for total dry mass production[15].

In the present observation root dry mass was higher in mild stressed plants than in moderate stressed plants. This may be due to increase in root density in mild stress treatment to absorb the water at surface layer of the soil. The dry weight decrease was higher in leves than in roots. Leaf water potential is the primary index of crop water status. Any loss of water from the cells must concentrate the solution with the cell and leads to a decrease in water potential.

Decrease in leaf water potential during stress condition noticed in this study is in confirmity with earlier report in water stress conditions[16].

Table 4. Leaf water potentlal (-bars) in control and stressed plants of mulberry ± S.E.

Days	Control	Mild stress	Moderate stress	Severe stress	Very severe stress
3	9.70	9.70	12.90	16.20	19.90
	(100.00)	(100.00)	(132.98)	(167.00)	(205.15)
5	9.70	19.90	21.00	23.38	27.90
	(100.00)	205.15)	(216.49)	(241.03)	(287.62)
7	9.90	23.00	27.10	28.10	—
	(100.00)	(232.32)	(273.73)	(283.83)	

Figures in parenthesis indicate percent over control

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