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RESEARCH ARTICLE

Growth dynamics in some mulberry genotypes during water deficit stress

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SUMMARY

Water is the most limiting factor for plant productivity and plant growth rates are proportional to water availability. As water plays an essential role in plant metabolism, any decrease in water availability has an immediate effect on plant growth. Mulberry, *Morus* spp., plants respond to drought on a whole plant basis. Research on the effects of stress in mulberry has so far focused mainly on above ground organs, leaving many questions about the sensitivity of the root system to stress. It is, therefore, present investigation was carried out in mulberry to study root growth responses to water deficit conditions. Cuttings of Local, K-2, S-13, S-36, V-1 and AR-10 were raised in nursery. Crop wise pot plantations were taken up utilizing the saplings and respective water deficit, mild water stress, moderate stress and severe stress were imposed. Impact of water stress treatments on shoot and root systems was studied *vis-à-vis* control for five crops. Adverse impact of different stress treatment on leaf yield and yield attributes was observed. Maximum reduction in leaf yield was recorded in K-2 followed by S-36 showing a stress index of 16.8 and 20.6 per cent, respectively in response to severe stress as compared to their controls. Maximum reduction in leaf yield was in the genotype K-2 (83.16%) where as the least reduction in S-13 (65.62%). Among the varieties the root weight per plant under severe stress was 32.26 g in AR-10 followed by 31.71g in S-13 with least in K-2 (23.62 g). The shoot-to- root ratio was found to be 0.98 in AR-10 and 0.95 in Local revealing more root mass. Water relation studies indicated variety specific variation in relative water content (RWC) and water saturation deficit (WSD) to stress treatments.

Key Words : Water deficit, Stress, Growth, Mulberry, Genotypes

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Water is the most limiting factor for plant productivity and plant growth rates are proportional to water availability. As water plays an essential role in plant metabolism, any decrease in water availability has an immediate effect on plant growth. Drought is one of the most important environmental stresses influencing the productivity of agricultural system around the world (Hmada, 2000). Mulberry, *Morus* spp., is an economically important plant. Being sole food plant for mulberry silkworm, the silk producing caterpillar, it is planted in 1.81 lakh ha in India (Anonymous, 2012). The losses of mulberry leaf production under water deficit stress conditions can be devastating.

Mulberry plants respond to drought on a whole plant basis. Research on the effects of stress in mulberry has so far focussed mainly on above ground organs, leaving many questions about the sensitivity of the root system to stress. A lack of information exists about the differential response of roots and shoots water-deficit stress particularly the dynamics of root growth. Detailed description on root and plant growth during stress will be of benefit to modeling mulberry plant response to stress and enable the plant breeders to assess drought resistant traits more adequately. It is, therefore, present investigation was carried out in mulberry to study root and plant growth responses to water deficit conditions.

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MATERIAL AND METHODS

Cuttings of Local, K-2, S-13, S-36, V-1 and AR-10 were raised in nursery. Saplings of respective mulberry varieties were planted in Wagner's pots, each pot containing same quantity of soil and farm yard manure mixture (3:1 ratio). Control set of pots were watered regularly. In another set of pots, water stress was induced by withholding water to give 75 per cent, 50 per cent and 25 per cent of field capacity (FC), characterized as mild stress, moderate stress and severe stress treatments, respectively. Five replications per treatment were maintained and stress studies were carried under green house conditions. Studies on root and shoot system were carried out after 60 days in all the treatments and control. Impact of water stress treatments on shoot and root systems was studied *vis-à-vis* control for five crops.

Root length and weight were determined using standard methodology. To determine dry weight, the washed and cleaned roots were dried in an oven at 60 to 75 ^{0}C till constant weight. Relative water content was measured as per Barrs and Weatherly (1962). The water saturation deficit of the leaves was calculated as described by Stocker (1929).

RESULTS AND DISCUSSION

Adverse impact of different stress treatments on growth, leaf yield and yield attributes have been observed and are presented in Table 1 to 12.

Table 1: Effect of water deficit stress on length of root per plant (cm)

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	50.50	51.00	43.40	37.70
K2	48.90	52.79	38.90	34.40
S13	36.69	38.50	39.50	36.79
S36	48.00	45.70	41.00	42.60
AR10	49.00	52.10	41.70	38.29
V1	55.40	51.60	43.40	40.10

C.D. at 5%		
Between variety	Between treatment	Variety x treatment
4.711**	3.846**	NS

** Indicate significance of value at P=0.01, NS=Non-significant

Table 2: Effect of water deficit stress on fresh weight of root /plant (g)

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	66.78	50.48	30.81	24.78
K2	61.76	45.96	27.51	23.62
S13	58.74	41.98	31.96	31.71
S36	70.15	44.85	29.31	27.59
AR10	66.95	52.43	36.18	32.26
V1	66.91	48.55	31.58	24.33

C.D. at 5%		
Between variety	Between treatment	Variety x treatment
NS	3.668**	NS

** Indicate significance of value at P=0.01, NS=Non-significant

Table 3: Effect of water deficit stress on shoot growth as indicated by average shoot length (cm)

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	79.82	56.90	49.82	41.11
K2	62.17	54.71	39.37	27.47
S13	74.95	56.94	43.67	34.65
S36	71.83	44.65	38.75	34.25
AR10	68.17	58.07	49.69	39.31
V1	69.55	57.16	52.48	38.04

C.D. at 5%		
Between variety	Between treatment	Variety x treatment
5.600**	4.572**	NS

** Indicate significant of value at P=0.01, NS=Non-significant

Root growth :

Moderate and severe water deficit stress reduced root growth in general (Table 1). However, under conditions of mild water deficit stress root elongation was slightly increased in Local, K2, S13 and AR10, though increase was insignificant at 5 per cent level. However, in variety S36 and V1 reduction in root growth was recorded under mild water stress conditions also. Induction of water stress resulted in reduced fresh root weight (Table 2). In present study small roots were found to be more sensitive to drought than those of medium size. Small roots in present study grew less than medium roots. Among the varieties the highest root weight per plant under severe stress was 32.26 g in AR-10 followed by 31.71g in S-13 with least in K-2 (23.62 g) (Table 1 and 2).

Shoot growth

Under conditions of this study, number of branches/ plant, shoot growth and stem weight/plant decreased under all treatments in all genotypes tested, except in variety Local and S36 where insignificant increase in number of branches/ plant under mild stress conditions was recorded (Table 3,4 and 5).

Leaf yield and yield parameters :

Yield parameters like number of nodes/plant and number of leaves/plant decreased in all the genotypes due to drought stress (Table 6 and 7). However, deleterious effect was least in genotype AR10 followed by S13 and Local. The genotypes which performed well under irrigated

Table 4: Effect of water deficit stress on number of branches/plant

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	3.33	3.50	2.33	2.58
K2	3.08	2.66	2.58	2.58
S13	3.00	2.50	2.58	2.66
S36	2.83	2.91	2.50	2.33
AR10	4.83	4.58	3.25	3.25
V1	2.83	2.75	2.50	2.50
		C.D. at 5%		
Between variety		Between treatment		Variety x treatment
0.341**		0.279**		NS

** Indicate significance of value at P=0.01, NS=Non-significant

Table 5: Effect of water deficit stress on stem weight/plant (g)

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	43.75	30.85	13.42	9.05
K2	40.83	28.91	12.58	13.71
S13	44.17	27.33	15.79	18.00
S36	52.66	29.91	16.04	14.33
AR10	44.83	28.87	17.25	13.16
V1	47.92	31.91	15.00	9.16
		C.D. at 5%		
Between variety		Between treatment		Variety x treatment
NS		3.598**	NS	

** Indicate significance of value at P=0.01, NS=Non-significant

Table 6: Effect of water deficit stress on number of nodes/plant

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	67.37	44.25	30.12	28.50
K2	53.12	38.50	28.00	22.00
S13	49.37	35.00	32.37	33.25
S36	44.62	35.62	23.50	22.12
AR10	71.00	62.62	43.12	46.00
V1	58.00	41.75	28.75	23.25
		C.D. at 5%		
Between variety			Between treatment	Variety x treatment
5.530**			4.515**	NS

** Indicate significance of value at P=0.01, NS=Non-significant

(control) conditions did not do well under drought (water deficit stress) conditions for leaf yield and biological yield (Table 8 and 9). Maximum reduction in leaf yield was recorded in K-2 followed by S-36 showing a stress index of 16.8 and 20.6 per cent, respectively in response to severe stress as compared to their controls. Maximum reduction in leaf yield was in the genotype K-2 (83.16%) where as the least reduction in S-13 (65.62%).

Shoot- to – root ratio :

The greater sensitivity of leaf growth compared with root elongation is reflected in Shoot- to - root ratios (Table 10). Under severe stress conditions, the shoot-to- root ratio was found to be 0.98 in AR-10 and 0.95 in Local revealing more root mass. Under severe stress the shoot- to- root ratio was highest in variety S13 (Table 10).

Water relation studies :

Variety specific variation in relative water content (RWC) and water saturation deficit (WSD) to stress treatments (Table 11and 12) was recorded in present study. There was marked depletion in relative leaf water content of all mulberry varieties

Table 7: Effect of water deficit stress on number of leaves/plant

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	61.00	42.41	25.58	27.41
K2	38.25	28.33	19.58	14.00
S13	41.33	28.28	23.25	18.17
S36	38.25	23.08	12.91	9.08
AR10	52.58	42.08	32.24	25.25
V1	31.33	32.42	21.58	16.32

C.D. at 5%		
Between variety	Between treatment	Variety x treatment
4.367**	3.566**	NS

** Indicate significance of value at P=0.01, NS=Non-significant

Table 8: Effect of water deficit stress on leaf yield/plant (g)

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	61.75	45.00	22.92	14.83
K2	63.33	34.75	18.00	10.66
S13	60.58	39.75	24.42	20.83
S36	82.66	38.25	20.67	17.00
AR10	58.16	37.24	25.41	18.41
V1	58.41	36.92	24.17	15.67

C.D. at 5%		
Between variety	Between treatment	Variety x treatment
3.824**	3.122**	7.648**

** Indicate significance of value at P=0.01, NS=Non-significance

Table 9: Effect of water deficit stress on biological yield per plant (g)

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	105.50	75.83	36.33	23.88
K2	104.16	63.67	30.58	24.37
S13	104.74	67.09	40.20	38.83
S36	135.33	68.16	36.70	31.33
AR10	103.00	66.11	42.66	31.57
V1	106.33	68.83	39.17	24.83

C.D. at 5%		
Between variety	Between treatment	Variety x treatment
NS	6.391**	NS

** Indicate significance of value at P=0.01, NS=Non-significant

subjected to water stress.

Overall, from the results of this experiment it can be concluded that water stress significantly reduces mulberry growth, leaf yield, root growth, root biomass, RWC, but increased WSD among all the six mulberry genotypes with some variations. Of these traits, root growth, shoot growth, leaf yield, RWC and root-to shoot ratio can be used to simulate growth model to understand drought impact. From results of present investigation it appears that S13 perform better as compared to other varieties under water deficit stress conditions. It is further noted that the trends observed in respect of some morpho-physiological

Table 10: Effect of water deficit stress on the ratio between ariel biomass (Shoot) to below ground biomass (Root)

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	1.58 : 1	1.50 : 1	1.18 : 1	0.95 : 1
K2	1.68 : 1	1.38 : 1	1.11 : 1	1.03 : 1
S13	1.78 : 1	1.59 : 1	1.25 : 1	1.20 : 1
S36	1.93 : 1	1.51 : 1	1.24 : 1	1.13 : 1
AR10	1.54 : 1	1.26 : 1	1.18 : 1	0.98 : 1
V1	1.59 : 1	1.42 : 1	1.24 : 1	1.02 : 1
		C.D. at 5%		
Between variety		Between treatment		Variety x treatment
0.0945**		0.0774**		NS

** Indicate significance of value at P=0.01, NS=Non-singificant

Table 11: Effect of water deficit stress on relative water content (%)

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	94.51	90.94	85.65	81.11
K2	91.41	90.86	88.88	85.22
S13	90.38	90.11	89.94	84.43
S36	92.57	89.26	85.81	81.04
AR10	89.59	87.91	86.66	82.11
V1	91.83	91.06	90.85	89.11
		C.D. at 5%		
Between variety		Between treatment		Variety x treatment
NS		2.156**		NS

** Indicate significance of value at P=0.01, NS=Non-significant

Table 12: Effect of water deficit stress on water saturation deficit (%)

Variety	Control	Mild water stress	Moderate water stress	Severe water stress
Local	8.04	8.17	8.33	8.50
K2	8.64	8.58	9.16	15.41
S13	9.86	9.72	15.56	26.60
S36	9.35	13.72	18.15	28.91
AR10	10.60	13.02	13.19	18.44
V1	6.78	11.32	20.94	31.60
		C.D. at 5%		
Between variety		Between treatment		Variety x treatment
0.800**		2.456**		NS

** Indicate significance of value at P=0.01, NS=Non-significant

parameters in different mulberry genotypes in response to various water deficit stress regimes under pot culture studies may be further studied under field conditions in relation to drought tolerance.

REFERENCES

Anonymous (2012). Annual Report 2011-12, Central Silk Board, BANGALORE, INDIA.

Barrs, H.D. and Weatherly, P.E. (1962). A reexamination of the relative turgidity technique for estimating water deficit in leaves, *Aust. J. Biol. Sci*., **15**: 413 – 428.

Hamada, A.M. (2000). Amelioration of drought stress by ascorbic acid, thiamin or aspirin in wheat plants, *Indian J.Plant Physiol*. (N.S), **5** (4): 358 – 364.

Sen, D.N. (1982). *Environment and plant life in Indian desert,* Published by Geobios International, Jodhpur, RAJASTHAN (INDIA).

Sharma, S.S. (1976). Ecophysiological studies on certain arid zone plants with special reference to water relations and stomatal behaviour, Ph.D. Thesis, University of Jodhpur, Jodhpur, RAJASTHAN (INDIA).

Stocker, O. (1929). Eine fieldmethode zur Bestimung der momentanen transpiration and evaporations, *Ber. Dt. Bot.Ges*., **23** :126 – 137.