

**Modulation in levels of inorganic ions, dry matter,  
and nitrogen fractions in mulberry under different moisture regimes**

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**ABSTRACT.** – Influence of moisture stress on the levels of soil moisture (%) water potential, inorganic ions, dry matter and nitrogen fractions was studied in mulberry. Leaf water potential decreased with decrease in soil moisture level. Inorganic ions, calcium, potassium and sodium increased in roots and leaves with increasing intensity of stress. The reduction in dry matter of roots and leaves was higher in severe and very severe stress than in mild and moderate stress. The root and leaf total and protein nitrogen content decreased over control in all stress treatments. In contrast soluble nitrogen content increased with increase in stress treatments.

**KEY WORDS:** Water stress, *Morus alba*, Nitrogen fractions, inorganic ions.

## INTRODUCTION

Water stress causes accumulation of certain organic (Joyce *et al.*, 1992) and inorganic ions (Ford and Wilson, 1981; Sreenivasulu Reddy and Sudhakar, 1992) in plants. It also induce major departure of nitrogen metabolism from its normal pattern. Moisture stress affects total nitrogen differently in different plants (Devries *et al.*, 1989). Nandual *et al.*, (1992) reported nitrogen partitioning and its efficiency in Pigeonpea under drought and during recovery. In the present study nitrogen partitioning among different plant components, changes in levels of inorganic ions and dry matter were studied at different moisture regimes.

## MATERIAL AND METHODS

Mulberry (*Morus alba* L) cuttings of approximately 12-15 cm and 8-10 mm length and diameter respectively with 3 to 4 active buds were maintained in earthen pots (12" × 15") containing 4 Kg soil and farmyard manure. Three months old plants were subjected to water stress by withholding water, control plants were maintained by adding water daily to field capacity (Per cent soil moisture at field capacity). Soil moisture content was determined in soil samples taken between 11 h and 12 h and drying them in an oven at 129 °C. Values are expressed as percentages on dry weight basis. Physiological variables were studied in roots and third, fourth and fifth leaves from the apex.

The leaf water potential was measured by dye method (Knipling, 1957). The plant material was digested by wet digestion according to the method of Humphries (1956) and Na, K and Ca were estimated with flame photometer (Elico Model CLZZA). Total nitrogen was estimated in roots and leaves according to the method of Makham (1942) and protein nitrogen was estimated according to the method of Thimann and Loss (1957). Soluble nitrogen was obtained by subtracting the protein nitrogen from total nitrogen content.

## RESULTS AND DISCUSSION

The shoots of 3 months-old plants produced 3 to 4 branches and 10-12 fully expanded leaves. The plants began to wilt on 5th day in stress treatments. Hence observations were made on plants after 5 days of stress treatment. The per cent soil moisture at permanent wilting point (PWP) was 19.00.

Table 1 depicts the average of five replications on the levels of soil moisture (%), dry weights and inorganic ions (Sodium, Potassium and Calcium) in roots and leaves of local mulberry variety. Water potential of roots and leaves decreased under stress treatments compared to control (Ford and Wilson, 1981; Goswami and Baruah, 1994). The fall in water potential in stress treatment is higher in leaves than in roots.

Inorganic ion levels increased significantly both in roots and leaves to water deficits. The accumulation of sodium and calcium was significant in roots and leaves from mild stress onwards. Potassium accumulation was significant only in moderate and severe stress treatments.

Accumulation of sodium and potassium under water deficits has been observed in several species, contributing for osmotic adjustment (Ford and Wilson, 1981; Sreenivasulu Reddy and Sudhakar, 1992). In contrast, green panic and field grown *Sorghum* did not accumulate potassium during water deficits (Ford and Wilson, 1981; Turner *et al.*, 1978). The accumulated potassium may also help in regulating the potassium dependent phosphorylase activity (Hawker *et al.*, 1979).

Large amounts of calcium accumulation in mulberry under stress results in the formation of rigid calcium pectate (Tagawa and Bonner, 1957) cell walls thus helping decreased water holding capacity and increased osmotic potential and under water stress and hence maintenance of turgor.

The total nitrogen content decreased both in roots and leaves in all stress conditions. This decrease may be due to inadequate uptake of nitrogenous compounds from the soil. Similar trend in protein nitrogen content was noticed at depleting soil moisture levels. The decrease in roots was significant in severe and very severe stress treatments (Table 2). The decrease in protein nitrogen content during stress condition may be due to the inhibition of protein synthesis under stress conditions (Bewley and Larsen, 1980) or may be due to the hydrolysis of existing proteing. Increase in soluble nitrogen content in roots and leaves was noticed under stress treatments (Table 2).

From the above it is concluded that the accumulation of ions, reduction of dry matter and total, protein nitrogen content reveals better adaptive nature of mulberry to moisture stress.

TABLE 1

SOIL MOISTURE CONTENT (%), ROOT AND LEAF WATER POTENTIAL (-BARS), SODIUM, POTASSIUM, CALCIUM (mg g<sup>-1</sup> AND DRY WEIGHTS (g) OF CONTROL AND 5 DAYS WATER STRESSED MULBERRY PLANTS ± S.E.)

		Control	Mild stress	Moderate stress	Severe stress	Very severe stress
Soil moisture content		31.71	12.98	10.98	4.66	2.59
Water potential	Roots	3.5 ± 0.05	4.4 ± 0.10	3.2 ± 0.15	2.6 ± 0.11	2.2 ± 0.12
	Leaves	9.70 ± 0.49	19.90 ± 0.54	21.0 ± 1.20	23.38 ± 1.20	27.90 ± 1.40
Sodium	Roots	7.15 ± 0.32	10.85 ± 0.60**	12.05 ± 0.70**	12.15 ± 0.63**	12.66 ± 0.68**
	Leaves	3.21 ± 0.22	4.01 ± 0.35	4.42 ± 0.40	4.42 ± 0.38**	5.02 ± 0.38**
Potassium	Roots	27.35 ± 1.50	28.00 ± 1.65	32.12 ± 2.00**	51.42 ± 4.50**	60.15 ± 5.51**
	Leaves	11.57 ± 0.30	13.46 ± 0.58**	13.48 ± 0.64**	22.72 ± 1.20**	23.14 ± 1.35**
Calcium	Roots	7.11 ± 0.28	8.46 ± 0.45	8.58 ± 0.50	9.32 ± 0.61*	10.05 ± 0.95*
	Leaves	0.53 ± 0.03	1.70 ± 0.07**	1.71 ± 0.08**	1.96 ± 0.10**	2.20 ± 0.20**
Dry weight	Roots	1.42 ± 0.10	1.26 ± 0.08	1.25 ± 0.05**	1.15 ± 0.18**	0.74 ± 0.05**
	Leaves	2.69 ± 0.23	1.87 ± 0.24	1.60 ± 0.06**	0.79 ± 0.06	0.55 ± 0.02**

\* Significance at 5% level.

\*\* Significance at 10% level.

TABLE 2

TOTAL NITROGEN, PROTEIN NITROGEN AND SOLUBLE NITROGEN OF (mg g<sup>-1</sup>/dry wt) CONTROL AND 5 DAY STRESSED ROOTS AND LEAVES OF MULBERRY ± S.E.

		Control	Mild stress	Moderate stress	Severe stress	Very severe stress
Total nitrogen	Roots	13.12 ± 0.50	12.90 ± 0.84	12.38 ± 0.94	11.94 ± 0.80	10.28 ± 0.59
	Leaves	13.80 ± 0.48	13.48 ± 0.43	12.52 ± 0.59	12.14 ± 1.02**	9.82 ± 0.86
Protein nitrogen	Roots	8.72 ± 0.19	8.34 ± 0.30	7.74 ± 0.53	7.14 ± 0.54*	4.68 ± 0.33**
	Leaves	9.80 ± 0.35	8.58 ± 0.49	7.32 ± 0.31**	6.44 ± 0.25**	3.25 ± 0.14**
Soluble nitrogen	Roots	18.56 ± 0.63	23.32 ± 0.92**	29.88 ± 1.68**	28.19 ± 2.19**	23.09 ± 1.24**
	Leaves	29.14 ± 1.67	29.53 ± 1.68	29.74 ± 2.07	30.18 ± 2.27	22.40 ± 2.03**

\* Significance at 5% level.

\*\* Significance at 10% level.

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