



## INFLUENCE OF SOIL MOISTURE ON SOME PHYSIOLOGICAL CHARACTERS AND ROOT AND ALKALOID YIELDS OF *RAUVOLFIA SERPENTINA*

D Paul, N K Paul \* and P Basu

Department of Botany, North Bengal University, Raja Rammohanpur, Darjeeling, India

\* Department of Botany, University of Rajshahi, Rajshahi, Bangladesh

### Abstract

Relative leaf water content of the irrigated plants of *Rauvolfia serpentina* was significantly higher than that of the rainfed plants. Soil moisture effect was found to be significant for chlorophyll a, b and total chlorophyll. Rainfed plants had significantly higher proline and sugar content than the irrigated plants. Main root length, total alkaloid and reserpine contents were unaffected by soil moisture, but air-dried root yield gradually increased with the increase of irrigation frequency.

**Key words:** Irrigation, relative leaf water content, chlorophyll, sugar, root yield, reserpine.

### Introduction

*Rauvolfia serpentina* grows wild in forests under high rainfall conditions of about 100 to 150 cm per annum. The natural habitat of the plant suggests that it is grown in partial shaded areas as undergrowth. As a result, plant water deficit usually increases less quickly and photosynthesis proceeds for longer period in shelter. However, little information is available on the irrigation and water requirement of *R. serpentina* as a plantation crop (Sahu 1972, Maheswari *et al.* 1991).

The objectives of the study were to gain information about the effect of soil moisture on relative leaf water content, some biochemical parameters, root and alkaloid yields of *R. serpentina*.

### Materials and Methods

The experiment was carried out in the experimental field of North Bengal University, Darjeeling, India. The field was prepared after repeated ploughing. A basal dose of urea (80 kg/ha), TSP (50 kg/ha) and MP (40 kg/ha) were added to the field. Uniform and healthy seedlings of *R. serpentina* of 30-40 days old were transplanted in the field on 28 September 1998. A spacing of 30 cm x 30 cm was followed and there were 3 replications.

Three levels of irrigation treatment were adopted viz., (i) rainfed ( $I_0$ = no irrigation), (ii) irrigation once in every month ( $I_1$ ) and (iii) irrigation twice in every month ( $I_2$ ). On each occasion, 20 mm of irrigation water were uniformly added over the irrigated plots with sprinklers. Irrigation started from November, 1998 and continued up to May, 1999.

Relative leaf water content (RLWC) was determined from the fully matured leaves. The leaves were collected at 8 am, 12 noon and 4 pm and RLWC was determined according to Barrs and Weatherley (1962). Chlorophyll content (Arnon 1949), proline content (Bates *et al.* 1973) and sugar content (Jayaraman 1975) were estimated at three times, i.e., at 120, 180 and 240 days after transplanting (DAT).

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\* To whom all correspondence should be addressed.

After 18 months of planting, plants were dug out in March, 2000 and the roots were separated and washed in the running tap water. The roots were air-dried to a constant weight. Six randomly selected plants from each treatment and replication were used for this purpose. Root samples were analysed for total alkaloid and reserpine contents (Paul 2001).

## Results and Discussion

Relative leaf water content (RLWC) of the irrigated plants ( $I_1$  and  $I_2$ ) was significantly higher than that of the rainfed plants ( $I_0$ ) (Table 1). Similar result was reported in wheat by Sarker *et al.* (1999) and Rahman and Paul (1998), in rape by Raja and Bishnoi (1990) and Kundu and Paul (1996) and in mustard by Begum and Paul (1993).

**Table 1.** Relative leaf water content (%) of *R. serpentina* at different times of the day as influenced by soil moisture.

Treatment	Time		
	8 am	12 noon	4 pm
$I_0$	88.0	75.0	75.8
$I_1$	93.2	79.3	82.0
$I_2$	95.7	80.0	84.7
LSD 5%	3.2	2.7	4.0

In all the three treatments, RLWC was higher towards the morning, got reduced at noon and again showed some recovery towards the afternoon (Table 1). This behaviour was related to the environmental conditions and is in agreement with earlier reports (Begum and Paul 1993, Mondal and Paul 1996, Sarker *et al.* 1999).

In the present study, soil moisture effect was found to be significant for chlorophyll a, b and total chlorophyll (Table 2). A reduction of chlorophyll formation due to water stress was also reported by Mondal and Paul (1992), Begum and Paul (1993), Kundu and Paul (1997) and Sarker *et al.* (1999). However, Saha and Paul (1997) did not find any significant effect of soil moisture on chlorophyll content of wheat.

**Table 2.** Mean values of chlorophyll content ( $\text{mg dm}^{-2}$ ) of *R. serpentina* leaf as influenced by soil moisture.

Treatment	Chlorophyll a	Chlorophyll b	Total chlorophyll
$I_0$	3.07	0.72	3.79
$I_1$	3.62	0.87	4.48
$I_2$	3.71	0.90	4.61
LSD 5%	0.13	0.09	0.14

The rainfed plants ( $I_0$ ) had significantly higher proline content than the irrigated plants ( $I_1$  and  $I_2$ ) (Table 3). Similar result was also reported in wheat (Saha and Paul 1997, Rahman and Paul 1998, Sarker *et al.* 1999), in rape (Paul and Kundu 1991, Kundu and Paul 1997) and in mustard (Begum and Paul 1993). Proline works as a source of energy, carbon and nitrogen and also protects several enzymes against the inactivating effects of heat during water stress (Paleg *et al.* 1981). Hence possibly proline accumulation under water stress helps the plant to resist drought.

**Table 3.** Proline content ( $\mu\text{g/g}$  fresh weight) of *R. serpentina* leaf as influenced by soil moisture at different stages of growth.

Treatment	Days after transplanting		
	120	180	240
$I_0$	249	265	272
$I_1$	166	170	180
$I_2$	148	174	191
LSD 5%	24	32	28

**Table 4.** Total sugar content ( $\text{mg/g}$  dry weight) of *R. serpentina* at three growth stages as influenced by soil moisture.

Treatment	Days after transplanting		
	120	180	240
$I_0$	12.6	13.5	14.8
$I_1$	11.7	11.5	12.4
$I_2$	9.5	9.8	11.5
LSD 5%	1.7	2.5	NS

Total sugar content was significantly higher (except at 240 DAT) in the rainfed plants (Table 4). Kundu and Paul (1997) and Sarker *et al.* (1999) obtained similar results. As the water stress increased at the later stage, the amount of sugar also increased in all the three treatments ( $I_0$ ,  $I_1$  and  $I_2$ ), but the amount was much greater in the rain fed plants.

The results of the present study indicate that moisture stress had an inhibitory effect on RLWC and chlorophyll content, but proline and sugar contents of leaves increased markedly as a result of soil dryness. High proline and sugar accumulation of *R. serpentina* in drought conditions might be an adaptation for tolerance of drought, which helps the plant to survive and continue production during the dry season.

**Table 5.** Effect of soil moisture on root yield and alkaloid content of *R. serpentina*.

Treatment	Main root length (cm)	Air-dried root weight/plant (g)	Total alkaloid content (%)	Reserpine content (%)
$I_0$	50	32	1.62	0.38
$I_1$	52	37	1.83	0.42
$I_2$	47	44	1.74	0.40
LSD 5%	NS	3	NS	NS

Effects of soil moisture on root yield and alkaloid contents are presented in Table 5. Main root length, total alkaloid and reserpine contents were unaffected by soil moisture, but air-dried root yield increased with the increase of irrigation frequency.

Little information is available on the irrigation and water requirement of *R. serpentina* as a plantation crop. Sahu (1972) reported that overall growth of *R. serpentina* plantation diminished with increasing water stress, but root growth was less influenced than was shoot growth. Root yield of the crop grown without irrigation was less than the irrigated ones.

The results of the present investigation indicated that better growth of *R. serpentina* is possible in well-watered condition, which ultimately considered as the basic need for satisfactory root yield. The results also suggest that during the dry season, irrigation of *R. serpentina* once in a month will assure high root yield.

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