Tea Q. 51 (4), 160-168, 1982. Printed in Sri Lanka

EFFECTS OF PROPAGATION METHODOLOGY ON GROWTH OF YOUNG TEA (*CAMELLIA SINENSIS* L.)

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Some of the methods employed in the vegetative propagation of tea were examined when severed shoots were stored over prolonged periods of time. Cuttings from shoots stored over a period of 3 days showed better survival and plant growth similar to those from freshly severed shoots. Better plant growth was obtained when cuttings were kept moist and planted by 1100 h. When light was limiting cuttings exposed to about 2 h of sunshine after planting produced better plants than those shaded.

Significant interactions between period and type of storage, time of planting and condition of cuttings and exposure treatments and type of clone were noted for a number of attributes in respect of each interaction.

INTRODUCTION

The performance of tea cuttings depend largely on the condition of the shoots severed from stock plants. Great care must be exercised to ensure that cuttings are taken with the minimum delay from these shoots for planting. However, under commercial conditions, very often, due to inadequate planning cuttings are not taken immediately and shoots are allowed to wilt; even when taken immediately, the cuttings are not quickly planted out but are done so at various times of the day subjecting them to stress factors. Further, in some plantations due to lack of recommended clones, shoots are purchased from other plantations and transported over long distances. Shade is another factor that is important during the early stages of new growth from cuttings. Exposure to direct sunlight scorches the nodal leaf of these cuttings impairing photosynthetic efficiency and leading to death or poor growth.

A previous study showed that some of the factors causing variation in growth of tea plants in nurseries are due to differences within and between stock plants (Kathiravetpillai and Kulasegaram, 1980). The present study examined some of the methods employed in the vegetative propagation of tea with a view to effecting refinements in them for the production of uniform plants in the nursery.

MATERIALS AND METHODS

The study was carried out at St Coombs Estate, Talawakele (1372 m AMSL) from May to August 1980. The clones used were TRI 2025, DT 1 and CY 9. In all experiments, the treatments included the normal practice and those simulating conditions prevailing in plantations. Details of climatic data for seven days commencing 28 May 1980 are given in Table 1.

TABLE 1 — *Climatic data at commencement of experiments*

		Sunshine (hrs)	*Rainfall (mm)*	*Temperature°C* Max	Min
May	28	2.9	1.7	25.0	15.0
	29	0.4	0.8	24.0	16.5
	30	1.3	7.7	24.5	16.5
	31	0.5	57.8	23.0	16.0
June	1	2.2	9.8	24.0	16.5
	2	0.2	0.5	25.0	16.0
	3	0.3	2.1	22.0	16.5
	4	5.6	—	22.5	15.5
	5	9.6	—	23.0	15.5
	6	8.5	0.5	25.0	15.5
	7	1.5	13.4	23.5	14.0
	8	0.2	1.2	20.5	16.0

Time of planting cuttings from freshly severed and stored shoots

On day 1 shoots of clone TRI 2025 were severed and a batch of cuttings from these shoots were planted immediately. One half of the remaining shoots was stored after wetting in perforated polythene bags with moistened cotton wool wrapped round their bases while the other half was stored in pails of water and daily left in the shade. Cuttings from the stored shoots were put out about 2 hours later on day 1 and again on day 3, 6, 9 and 12. On each occasion, cuttings from freshly severed shoots were also planted. The treatments were replicated thrice.

Time of planting partially wetted and exposed cuttings

Cuttings of TRI 2025 were divided into two batches. One batch was kept in a tray full of water according to normal practice; the other batch was partially wetted and kept in a tray without water and left in partial shade. Cuttings from these two batches were planted hourly, from 0800 to 1200 hours. The design was of the split plot type replicated thrice.

Effect of shade on growth of cuttings

Cuttings from each of clones TRI 2025, DT 1 and CY 9 were planted at the same time. The treatments were shading one batch of cuttings normally with coir matting from time of planting to entire duration of experiment, exposing to the sun from 0800 hours successive batches of cuttings to 1, 2 and 3 hours for 7 consecutive days from 28 May 1980, at the end of which all treatments that were exposed continued to remain shaded. The exposure treatments were effected by rolling back the coir matting on the iron frame structure. The treatments were replicated 4 times.

RESULTS

Time of planting cuttings from freshly severed and stored shoots

Cuttings from shoots stored over a period of about 3 days as well as those from freshly severed shoots showed greater survival and rooting and had more and longer roots resulting in better shoot growth and of dry weight of plant (Tables 2 and 3).

TABLE 2 — *Effect of interval of storage of shoots on growth of cuttings (means of 90)*

	Day of planting after severing of shoots					
	1	*3*	*6*	*9*	*12*	*LSD (P=0.05)*
No. of deaths*	1.14	1.00	1.14	1.85	1.92	0.24
No. of cuttings rooted	8.44	8.77	6.11	4.88	4.33	2.48
Root number	10.23	10.90	6.40	6.31	4.80	4.56
Length (cm) of roots	59.83	58.74	28.29	29.95	21.39	23.27
Length (cm) of new shoot	2.69	2.88	2.30	1.97	0.56	1.06
Leaf No.	4.87	4.21	3.84	2.73	1.41	1.68
Dry weight (g)						
New shoots	0.05	0.05	0.04	0.03	0.02	0.01
New leaves	0.05	0.05	0.04	0.04	0.02	0.02
Roots	0.22	0.21	0.17	0.14	0.12	0.05
Plant**	1.38	1.36	1.20	1.21	1.14	0.11

* Analyses done on $\sqrt{n+1}$ transformed data
** Plant dry weight includes the dry weights of original cutting and mother leaf

TABLE 3 — *Effect of type of storage of shoots on growth of cuttings*

	Type of storage of shoots			
	Freshly severed	*Polyethylene bags*	*Water*	*LSD (P=0.05)*
No. of deaths*	1.08	1.45	1.69	0.17
No. of cuttings rooted	8.39	5.33	5.79	1.19
Root number	10.52	5.03	7.63	1.93
Length (cm) of shoots	56.95	22.53	39.43	9.98
Length (cm) of new roots	5.01	2.05	3.34	0.69
Leaf number	4.85	2.40	2.98	0.87
Dry weights (g)				
New shoots	0.05	0.05	0.04	0.01
New leaves	0.06	0.02	0.04	0.02
Roots	0.20	0.14	0.17	0.02
Plant**	1.33	1.18	1.26	0.09

*Analyses done on $\sqrt{n+1}$ transformed data
**Plant dry weight includes the dry weights of original cuttings and mother leaf

Significant interactions between the interval and type of storage of the shoots were noted for root number (Fig. 1), casualties, number of cuttings rooted, length of roots and of new shoots, leaf number and dry weight of plant (Table 4).

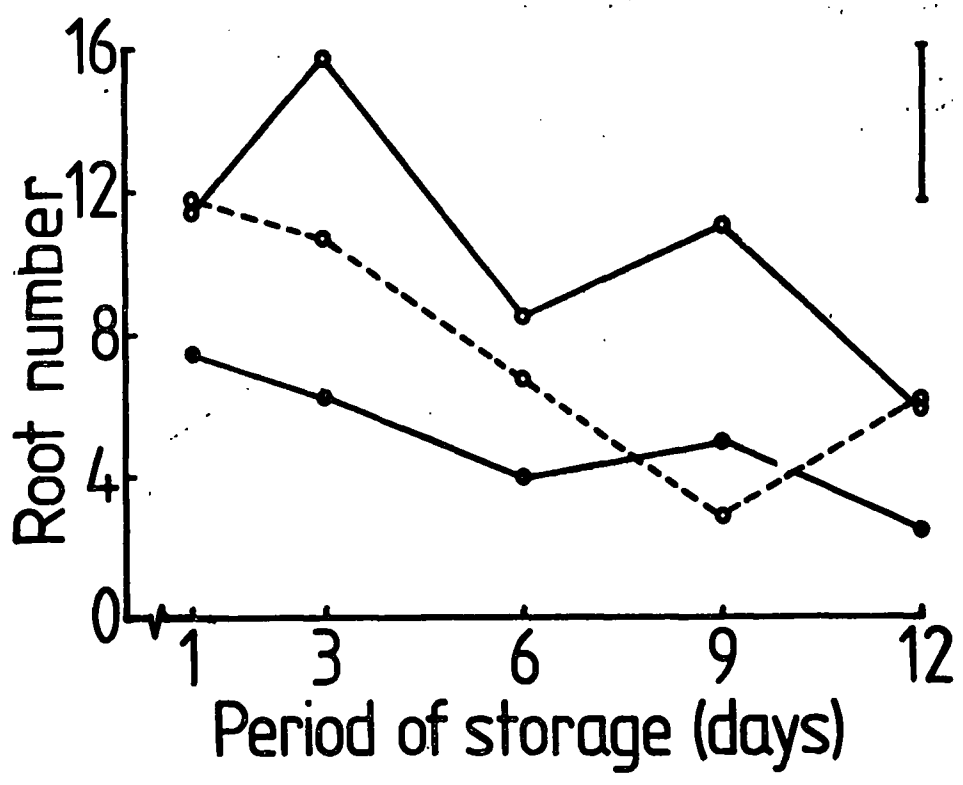

Fig. 1.—Interaction between period and type of storage on root number. Vertical bar indicates LSD at P=0.05. ○——○ = fresh cutting; ○- - - -○ = stored in water; ●——● = stored in polyethylene.

TABLE 4 — *Interactions between interval (1, 3, 6, 9, 12 = days from severing of shoots) and type (F = freshly severed, P = polyethylene bags, W = water) of storage of shoots on growth of cuttings*

	*No. of deaths**	*No. of cuttings rooted*	*Length (cm) of roots*	*Length (cm) of new shoots*	*Leaf No.*	*Dry weights (g)*			
						New shoots	*New leaves*	*Roots*	*Plant***
F × 1	1.14	9.33	65.74	4.32	6.34	0.07	0.09	0.25	1.63
F × 3	1.00	9.67	95.85	4.75	6.63	0.07	0.07	0.25	1.56
F × 6	1.00	7.00	39.13	2.85	4.86	0.04	0.05	0.19	1.14
F × 9	1.28	8.66	54.10	2.83	5.05	0.04	0.07	0.18	1.22
F × 12	1.00	7.33	29.96	0.30	1.40	0.02	0.01	0.14	1.09
P × 1	1.28	7.00	38.99	1.94	3.99	0.04	0.03	0.19	1.19
P × 3	1.00	7.33	23.78	0.68	1.56	0.03	0.01	0.15	1.12
P × 6	1.28	5.00	19.47	1.31	2.27	0.03	0.02	0.15	1.16
P × 9	1.63	4.00	21.84	1.48	2.54	0.02	0.02	0.11	1.23
P × 12	2.06	3.33	8.60	0.74	1.68	0.03	0.01	0.11	1.20
W × 1	1.00	9.00	74.76	1.81	4.30	0.04	0.03	0.23	1.32
W × 3	1.00	9.33	56.61	3.21	4.46	0.06	0.06	0.22	1.40
W × 6	1.14	6.33	26.27	2.76	4.41	0.04	0.06	0.18	1.29
W × 9	2.64	2.00	13.93	1.06	0.60	0.03	0.02	0.12	1.19
W × 12	2.69	2.33	25.61	0.66	1.16	0.01	0.03	0.11	1.12
LSD (P=0.05)	0.38	2.67	22.33	1.53	1.94	0.02	0.03	0.05	0.21

* Analyses done on $\sqrt{n+1}$ transformed data
** Plant dry weight includes the dry weights of original cutting and mother leaf

Time of planting partially wetted and exposed cuttings

In general, cuttings planted by 1100 hours showed improved growth (Table 5). Cuttings stored in water had more and longer roots resulting in better growth (Table 6). Significant interactions between time of planting and condition of cuttings were seen for root number (Fig. 2) number of cuttings rooted, length and dry weight of roots (Table 7).

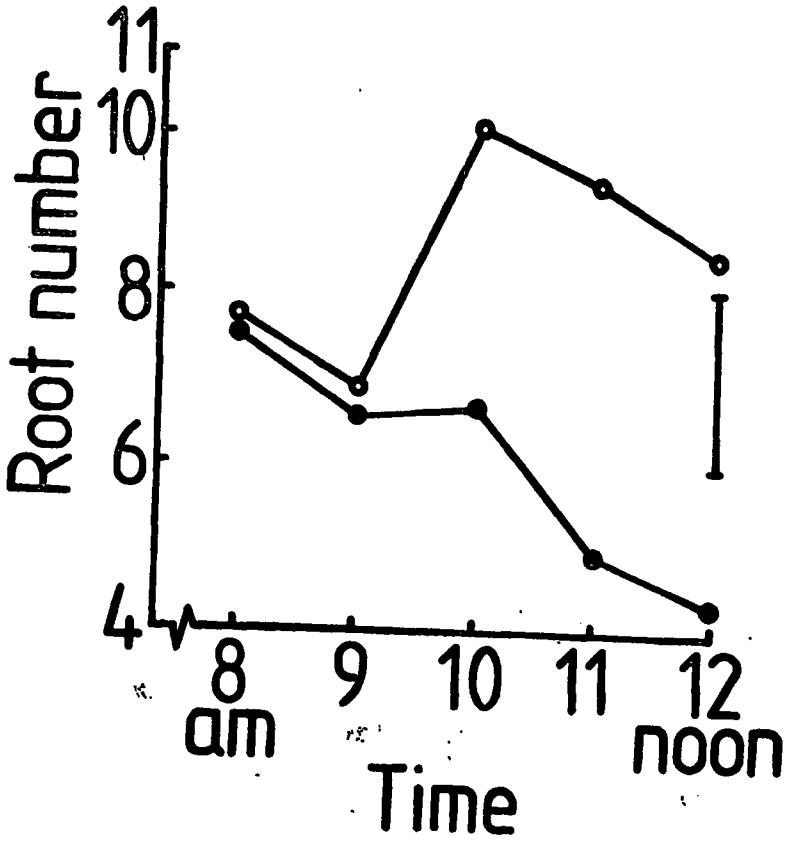

Fig. 2. —Interaction between time and condition of cutting on root number. Vertical bar indicates LSD at P=0.0.5. ○—○ *= wetted cuttings;* ●—● *= unwetted cuttings (partially moistened).*

TABLE 5 — *Effect of time of planting of cuttings on growth (means of 60)*

	Time					
	8 am	*9 am*	*10 am*	*11 am*	*12 noon*	*LSD (P=0.05)*
No. of deaths*	1.07	1:12	1.07	1.27	1.88	0.45
No. of cuttings rooted	7.67	7.17	7.34	6.50	5.17	NS
Root number	7.71	6.78	8.41	7.20	6.47	NS
Length (cm) of roots	48.49	42.62	50.09	35.34	40.29	NS
Length (cm) of new shoots	2.21	1.44	1.80	1.22	0.85	0.58
Leaf number	3.78	2.86	2.88	2.21	1.66	0.79
Dry weights (g)						
New shoots	0.05	0.03	0.03	0.03	0.03	NS
New leaves	0.04	0.02	0.03	0.04	0.03	NS
Roots	0.20	0.18	0.17	0.16	0.14	NS
Plant**	1.28	1.25	1.25	1.25	1.17	0.06.

* Analyses done on $\sqrt{n+1}$ transformed data

** Plant dry weight includes the dry weights of original cutting and mother leaf

TABLE 6 — *Effect of condition of cutting on growth (means of 150)*

	Condition of cutting		*LSD*
	Wetted	*Unwetted*	*(P.=0.05)*
No. of deaths*	1.21	1.35	NS
No. of cuttings rooted	7.00	6.53	NS
Root number	8.58	6.04	0.98
Length (cm) of roots	51.78	34.95	6.84
Length (cm) of new shoots	1.93	1.07	0.53
Leaf number	3.29	2.07	0.80
Dry weights (g)			
New shoots	0.04	0.03	0.004
New leaves	0.05	0.02	0.02
Roots	0.18	0.16	0.02
Plant**	1.26	1.22	NS

* Analyses done on $\sqrt{n+1}$ transformed data

** Plant dry weight includes the dry weights of original cutting and mother leaf

TABLE 7 — *Interactions between time (8 a.m., 9 a.m., 10 a.m., 11 a.m., 12 noon = time of planting) and condition (W = wetted. U = unwetted) of cuttings on growth*

	No. of cuttings rooted	*Length (cm) of roots*	*Dry wt. (g) of roots*
W × 8	6.67	51.98	0.20
W × 9	6.33	40.89	0.19
W × 10	8.67	62.52	0.17
W × 11	7.33	49.03	0.15
W × 12	6.00	54.50	0.18
U × 8	8.67	45.00	0.19
U × 9	8.00	44.35	0.17
U × 10	6.00	37.66	0.17
U × 11	5.67	21.65	0.16
U × 12	4.33	26.08	0.10
LSD (P=0.05)	1.66	15.28	0.04

Effect of shade on growth of cuttings

Cuttings exposed to one and two hours of sunshine as well as those of clones DT 1 and CY 9 showed better survival and of rooting (Tables 8 and 9).

TABLE 8 — *Effect of exposure of cuttings on growth (means of 120)*

	Shade	*1 H*	*2 H*	*3 H*	*LSD (P=0.05)*
No. of deaths*	1.16	1.00	1.03	1.37	0.13
No. of cuttings rooted	8.75	9.50	9.50	8.08	0.62
Root number	12.37	16.32	15.28	12.07	1.46
Length (cm) of roots	81.83	131.07	116.79	94.58	17.11
Length (cm) of new shoots	1.64	2.70	2.37	1.66	NS
Leaf number	3.56	4.78	4.51	3.75	NS
Dry weights (g)					
New shoots	0.03	0.07	0.03	0.03	NS
New leaves	0.02	0.02	0.02	0.01	NS
Roots	0.17	0.27	0.23	0.22	0.03
Plant**	0.98	1.17	1.10	1.12	0.09

* Analyses done on $\sqrt{n+1}$ transformed data

** Plant dry weight includes the dry weights of original cutting and mother leaf

TABLE 9 — *Effect of type of clone on growth of cuttings (means of 160)*

	TRI 2025	*DT 1*	*CY 9*	*LSD (P=0.05)*
No. of deaths*	1.29	1.07	1.05	0.15
No. of cuttings rooted	7.50	9.50	9.88	0.48
Root number	10.25	13.20	18.58	1.32
Length (cm) of roots	65.99	69.95	182.27	13.89
Length (cm) of new shoots	2.31	1.31	2.67	0.48
Leaf number	4.47	3.36	4.62	0.63
Dry weights (g)				
New shoots	0.06	0.03	0.03	NS
New leaves	0.03	0.01	0.01	0.01
Roots	0.27	0.14	0.27	0.02
Plant**	1.48	0.85	0.96	0.06

* Analyses done on $\sqrt{n+1}$ transformed data
** Plant dry weight includes the dry weights of original cutting and mother leaf

Cuttings exposed to one and two hours had more and longer roots. More dry weight of roots was seen in cuttings exposed to one hour while plant dry weight was greater in all the treatments that were exposed. Cuttings of clone CY 9 had more and longer roots, while those of TRI 2025 and CY 9 had longer new shoots, more new leaves and dry weight of roots. Clone TRI 2025 had greater dry weight of new leaves and of plant as well.

Significant interactions between the exposure treatments and the type of clone were noted for root number (Fig. 3), number of cuttings rooted, length of new shoots, leaf number and dry weight of new leaves, roots and of plant (Table 10).

TABLE 10 — *Interaction between exposure (Sh = shaded, 1H, 2H, 3H, = hours of exposure) and type of clone (C_1 = TRI 2025, C_2 = DT 1, C_3 = CY 9) on growth of cuttings*

	No. of cuttings rooted	*Length (cm) of new shoots*	*Leaf number*	*Dry weights (g)* *New leaves*	*Roots*	*Plant***
C_1 × Sh	6.50	1.96	3.56	0.03	0.16	1.30
C_1 × 1H	8.50	3.39	6.35	0.04	0.35	1.65
C_1 × 2H	8.75	2.82	4.78	0.04	0.29	1.50
C_1 × 3H	6.25	1.05	3.20	0.01	0.27	1.46
C_2 × Sh	9.75	1.24	3.28	0.02	0.12	0.75
C_2 × 1H	10.00	1.51	3.78	0.01	0.18	0.93
C_2 × 2H	9.75	1.28	3.20	0.01	0.14	0.83
C_2 × 3H	8.50	1.19	3.17	0.01	0.11	0.87
C_3 × Sh	10.00	1.73	3.83	0.01	0.24	0.90
C_3 × 1H	10.00	3.19	4.20	0.01	0.27	0.93
C_3 × 2H	10.00	3.00	5.55	0.02	0.27	0.98
C_3 × 3H	9.50	2.74	4.88	0.01	0.29	1.02
LSD (P=0.05)	0.97	0.96	1.26	0.01	0.04	0.12

** Plant dry weight includes the dry weights of original cutting and mother leaf

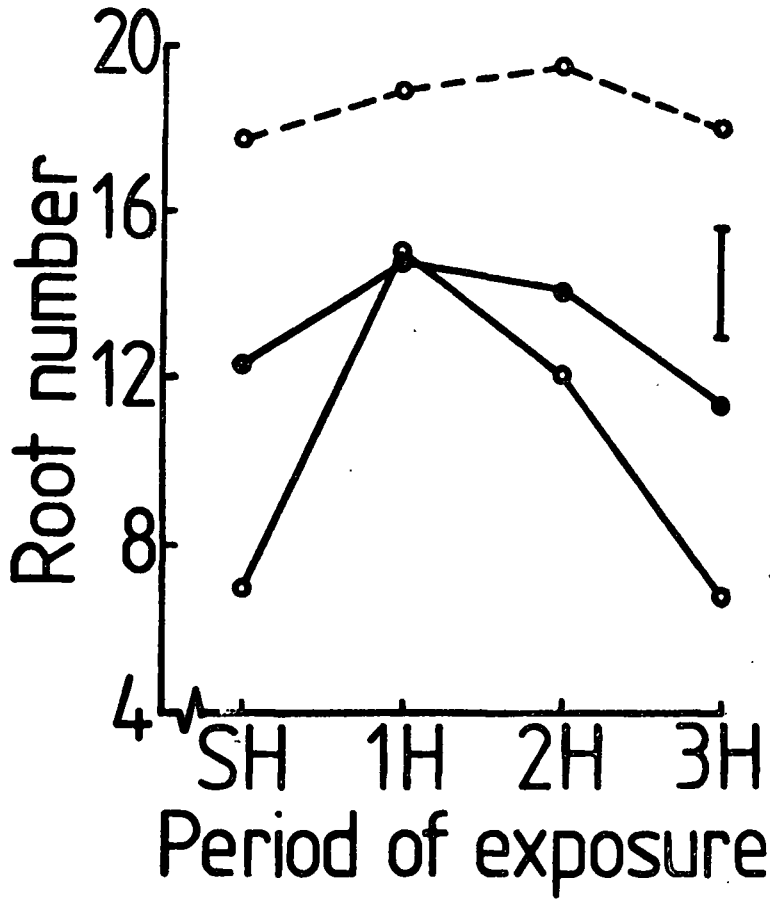

Fig. 3. — Interaction between period of exposure and type of clone on root number. Vertical bar indicates LSD at P=0.05. O—O = *TRI 2025*; ●——● = *DT 1*; O— — —O = *CY 9.*

DISCUSSION

The results of the experiments on propagation of cuttings from shoots that were stored and planted on different days as well as from freshly severed shoots from each of these occasions showed that it was always advantageous to plant cuttings from the latter type of shoots than from shoots kept in storage (Tables 2 and 3). Cuttings from fresh shoots showed greater survival resulting in better plant growth; irrespective of the type of storage delaying planting adversely affected their performance. Cuttings planted from shoots stored over a prolonged period resulted in more casualties and poor growth (Table 4).

The importance of planting as soon as the cuttings have been severed from the shoots and kept moist was underlined by the fact that wetted cuttings planted within about two hours after severing from the shoots showed better survival and improved plant growth (Tables 5 and 6). Growth was affected when cuttings left exposed over a long time and not sufficiently moistened were planted (Table 7). This is conceivable because a freshly severed cutting starts losing water and unless this is replaced it would lose its turgidity and will no longer be suitable for propagation.

It is to be noted that the performance of cuttings depend to a considerable extent on the condition of the shoots. Under plantation conditions where several tasks

are being performed at the same time adequate care is not given to all aspects of propagation. Very often due to improper planning cuttings are not taken from the shoots immediately and they are left exposed to the sun and wind to wilt or even if they are taken immediately they are not planted out quickly but at various times of the day. This results in planting cuttings that have been subjected to stress which affects their performance causing variation in growth and of casualties. In some plantations due to lack of shoots of recommended clones they are purchased from other plantations and transported over long distances involving considerable time during which period the shoots could wilt and die.

It was noted that more casualties were seen in cuttings exposed for long periods of time (Table 6). Shade is an important factor during the initial stages of rooting of cuttings. Shading of nurseries is undertaken for a number of reasons, chief among which are the prevention of mechanical damage by sun scorch and wind and to reduce transpiration. The leaves of the shoots from which cuttings are taken, get a certain amount of natural shade on the stock plants. However, when the cuttings are laid flat in the propagating bags they become suddenly exposed to direct sunlight and would be scorched unless artificially shaded. The only avenue of entry of water and nutrients into a cutting is through the basal cut surface of the stem, which is in contact with the soil. The surface area of this cut end is relatively small, compared to the transpiring surface area of the nodal leaf. It is, therefore, necessary to limit the rate of transpiration from the leaf but at the same time allowing a certain amount of transpiration to maintain the moisture and nutrient contents in the cutting itself. Shade is provided by open weaved coir matting of about 0.64 cm mesh width laid on an iron framework 90 cm above ground level or by inserting the fronds of ferns in between the propagating bags. When ferns are used, they must be inserted uniformly over the entire bed so as to ensure the same amount of shade. While coir matting ensures a uniform amount of shade, it also absorbs water and maintains a satisfactory relative humidity around the cuttings, besides preventing undue movement of air. Though coir matting is costly, with care it could be used for about two years or more. Shade, in either form, must be provided as planting is done. However, in practice, cuttings are planted on exposed beds and shaded much later. This would scorch the nodal leaves impairing the photosynthetic efficiency.

In this experiment, in general, better plant growth was obtained when the cuttings were exposed to sunlight for a few hours. It is to be noted that though some of the cuttings were exposed for one to three hours for seven days, the number of hours of sunshine over this period was generally limited due to overcast conditions (Table 1). The need for reducing light had already been mentioned but it must be emphasised that a certain amount of light is required for the production of carbohydrates. Thus light would have been limiting for the shaded cuttings. This in itself would have impaired the photosynthetic efficiency of the nodal leaf leading to the poor growth under the shade. On the other hand, since the duration of sunshine was only for a few hours, cuttings exposed to about 2 hours probably made the maximum use of the available light and hence produced better plant growth.

ACKNOWLEDGEMENTS

Thanks are due to Mr T. Thevathasan and Miss S. Puvanamalar for their advice and statistical analyses of the data. It is a pleasure to acknowledge the help of Mr D. L. Coonghe for the photographs.

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