

## THE EFFECT OF SHADE ON GROWTH OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL) AND EASE OF ROOTING OF ITS CUTTINGS

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*Keywords:* Tomato (*Lycopersicon esculentum* Mill), effect of shade, growth, rooting, cuttings.

### RINGKASAN

Kesan lindungan terhadap pembesaran pokok ibu (induk) dan juga kemudahan pengakaran keratan dari pokok tomato telah dikaji. Pokok ibu yang terlindung adalah lebih tinggi dari pokok yang tidak dilindung disebabkan oleh ruas yang lebih panjang. Melindung seluruh pokok selama empat minggu dapat memperbaiki mutu pengakaran tetapi tidak terhadap bilangan keratan yang berakar.

### INTRODUCTION

Reduced sunlight influences plant growth in a number of ways. Light attenuation causes endogenous changes, such as a reduction in net assimilation (BLACKMAN and WILSON, 1951) or changes in hormonal levels (KLEIN, 1967). Shading can result in a number of morphological changes, such as stem elongation (SACHS, 1965) or it can affect leaf size (BLACKMAN and RUTLER, 1948) and reduce flower size (LU, 1968) and number (JOHNSON, 1970).

The inhibitory effect of light on rooting has been reported by many workers. According to SHAPIRO (1958), the development of preformed root primordia in poplar was inhibited by exposing the cuttings to light. Stem cuttings of pea grown under red light, initiated fewer roots than those grown in darkness (GALSTON and BAKER, 1953).

Several workers had found that shading the entire stock (mother) plants promoted rooting of cuttings taken from them. BIRAN and HALEVY (1973) shaded dahlia mother plants and studied the effects on rootability of cuttings using three cultivars, 'Choot Hashani', 'Orpheo' and 'Lavender Perfection'. Reducing natural light intensity by approximately 50%, increased the rooting of 'Orpheo' cuttings, but did not affect rooting of the less easy-to-root 'Lavender Perfection'. Shading stock plants during midday hours only caused internode elongation in 'Orpheo'

but did not increase rooting. In 'Choot Hashani' the same shading treatment promoted rooting. They concluded that the effect of shading was limited to the root initiation region.

This study was undertaken to investigate the influence of shade on growth of mother plants and the rooting of tomato cuttings. It is also hoped that results from this study could be used in devising a technique in cloning good tomato varieties. The tomato was chosen because it is easily available and could be raised in large numbers in relatively short time.

### MATERIALS AND METHODS

#### Raising of mother plants

The tomato (*Lycopersicon esculentum* Mill.) variety Craigella Resistant was used for this study. The seeds were sown in trays in a compost containing Irish moss peat, 10% grit and a commercial fertilizer (N; P; K = 6.8; 2.5; 6.1). The trays were placed under growth room conditions of 22°C and 16 hour day length fluorescent light for 20 days. Watering was done whenever required and no nutrient solution was fed to the seedlings. After 20 days, the trays were transferred into the glasshouse at 24 to 26°C and normal day-length for two to three days for hardening before potting. Additional light from mercury lamps was provided when necessary.

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The seedlings were potted into 9 cm. pots when they were 23 days old. The peat compost medium consists of the following mixtures; Irish peat moss, commercial fertilizer (6.8; 2.5; 6.1) containing calcium oxide and 20 percent grit.

### Shade treatments

The shade treatments were whole plant shading, basal stem shading and unshaded (control).

The duration of the shade treatment was for four weeks and started when mother plants were 60 days old. Each plant was given 50 ml of complete nutrient solution of long Ashton (HEWITT, 1952) at 40, 50 and 55 days old.

Whole plant shading was achieved by placing a single layer of muslin cloth around a metal framework measuring  $0.9 \times 0.6 \times 1.1$  m into which mother plants were placed. The top part of the framework was covered with  $2.0 \times 3.5$  cm. wire mesh, the presence of the mesh not only to support the muslin cloth from sagging but also to provide shading.

The amount of shading as compared to control was about 20 percent (i.e. 80 percent of the light was excluded by the structure). The shade regime was determined with the aid of a solarimeter at noon on a sunny day and at random positions within the structure at the start and end of the four weeks duration (June/July 1980).

The shading of just the basal stem region of the mother plant was achieved by covering the stem section with polythene sheet (black one side, white the other), and after making the necessary slits to accommodate the leaf petioles and side shoots. The white surface was on the outside while black on the inside facing the stem. This arrangement indirectly prevented over-heating for the covered region. Over-heating was further reduced by allowing water during watering to pass through the covered area. The stem was not constricted by the polythene. The length of

the cover along the stem was about  $10.7 \pm 0.4$  cm, which at the start of the treatment, corresponded to 52.2 percent of the mean overall plant height. The cover was placed between  $3.2 \pm 0.3$  cm and  $13.9 \pm 0.4$  cm marks along the stem, measured from the soil surface.

Since shading of whole plants reduced photosynthesis and bud growth and thus reduced the number of available cuttings (BIRAN and HALEVY, 1973), about 25 percent more mother plants were raised for both treatments to compensate for this reduction.

The control mother plants were grown in the same glasshouse as the treated plants. Twenty leaf-bud cuttings were harvested from the middle stem section of each plant of each treatment. The leaf blade was trimmed before being put under mist.

Additional records were taken to denote growth of mother plants by taking all the eight leaves, counted from below, from four selected mother plants for each treatment. Leaf eight was chosen because it was located in the middle stem region and had the highest dry weight compared to the rest of the leaves at the age studied (unpublished). The leaves from the middle part of the plant were usually fully matured and well grown compared to older and younger leaves. Older leaves showed early signs of decay and approaching senescence while younger leaves were immature and had a greater tendency to increase in weight in a relatively short time.

### Method of propagation of cuttings

All the cuttings were propagated in individual pots (7 cm) containing complete perlite medium. They were placed under intermittent mist for two weeks on a propagation bench with bottom heat ( $27$  to  $30^\circ\text{C}$ ). No rooting hormone was used. The bases of the cuttings were dipped in captan (50 percent wettable powder) to a depth of 1–2 cm before placed in the pots.

The number of rooted cuttings and the quality of the roots produced were recorded after the two-week period.

## RESULTS AND DISCUSSION

### Effect of shade on growth of mother plant

The effect of shade on plant height is shown in *Table 1*. Mother plants under 80 percent shade for four weeks before harvest of cuttings were significantly taller than either plants grown unshaded or those that

had their basal stem portion shaded for the same duration. No significant difference occurred in height between plants grown without shade and those with the basal stem shaded.

The data taken on leaf eight is shown in *Table 2*. Shading has no significant effects on either the fresh or dry weights. In terms of

TABLE 1. EFFECT OF SHADE OF HEIGHT (CM) OF MOTHER PLANTS  
MEAN OF TEN VALUES

Mother plant shading	Pre-treatment (60 days)	Height (cm)	
		Post-treatment (80 days)	Increase
Unshaded	21.43	51.66a	30.24a
Whole plants	19.99	70.88	50.89
Basal stem	21.05	51.99a	30.94a
Level of significance	NS	***	***
L.S.D.	—	4.79	4.71

Values having same letter are not significantly different;  
\*\*\*, significant at 0.1%; NS, Not significant.

TABLE 2. EFFECT OF SHADE ON POSITION AND WEIGHTS (G) OF LEAF  
EIGHT OF MOTHER PLANTS. MEAN OF FOUR VALUES

Mother plant shading	Height (cm)			Weight (g)		Percent dry matter per g fresh weight
	Leaf	Percent of Overall	Length (cm)	Fresh	Dry	
Unshaded	25.27a	48.40a	18.88a	2.28	0.633	21.85a
Whole plant	37.33	49.34	25.08	3.18	0.512	16.19
Basal stem	30.88a	57.27	18.63a	2.66	0.613	22.93a
Level of significance	***	**	***	NS	NS	***
L.S.D.	6.46	6.25	3.39	—	—	4.39

Values having same letter are not significantly different; \*\*\*, significant at 0.01%; \*\*, significant at 1%; NS, no significant.

Note: 1. Percent of overall, calculated as  $\frac{(\text{Height leaf eight}) \times 100}{(\text{Post treatment height})}$

2. Length leaf eight, measured from tip of leaf blade to end of petiole.

3. Fresh weight, weight after cleaning the leaf with tissue paper.

4. Dry weight, weight after 24 hours and 100°C.

5. Percent dry matter, calculated as  $\frac{(\text{dry weight}) \times 100}{(\text{fresh weight})}$

dry matter content, leaf eight from fully shaded mother plants was significantly lower than that of unshaded or basal stem shaded mother plants. Although the height of leaf eight from whole shaded mother plants were significantly higher than unshaded or stem shaded mother plants, when expressed as a percentage of overall plant height, it was no better from unshaded plants. Leaf eight from whole shaded mother plants was the longest compared with unshaded and basal shaded mother plants.

Whole plant shading produced the tallest plants due mainly to longer internodes. The leaf-blade and petiole of the matured leaves located at the bottom stem region of unshaded or basal stem shaded mother plants were yellow in colour, easily detached and approach senescence very much earlier and more obvious than the corresponding leaves of fully shaded mother plants which still appeared green and not easily detached.

The production and development of side shoots (axillary buds) from the mother plants seemed to be affected by shade. Unshaded mother plants produced buds throughout the plant. The majority of the fully shaded mother plants (16 out of 18) however produced side shoots in the lower one-third of the

plant only. In the basal shaded mother plants, none had side shoots in the top section, a few had side shoots in the middle, but most of them had side shoots in the basal stem region.

#### Effect of shading mother plants on number of rooted cuttings

The effect of shading mother plants on number of rooted cuttings after two weeks under mist is shown in *Table 3*. There was no significant differences in the number of rooted cuttings taken from shaded or unshaded mother plants.

#### Effect of shading mother plants on quality of roots of cuttings

The effect of shading mother plants on root fresh weight, total root length, root number and root length is shown in *Table 3*.

##### (a) Root fresh weight per rooted cutting

Cuttings from fully shaded mother plants produced the highest root fresh weight per cutting and was significantly higher than that of unshaded or basal stem shaded mother plants, which were not significantly different from each other.

TABLE 3. EFFECT OF SHADE ON NUMBER OF ROOTED CUTTINGS, ROOT FRESH WEIGHT (G) AND QUALITY OF ROOTING

	Per cutting				
	Number rooted (out of 20)	Root fresh weight (g)	Total root length (cm)	Root Number	Root length (cm)
Unshaded	20	0.09a	26.50a	11.15ab	2.49a
Whole plant shading	20	0.25	77.30	11.72a	6.20a
Basal stem shading	20	0.08a	35.40a	7.24b	4.60a
Level of significance	NS	***	***	**	***
L.S.D.	—	0.10	29.7	3.07	1.88

Values having same letter are not significantly different; \*\*\*, significant at 0.1%; \*\*, significant at 1%; NS, not significant.

- (b) **Total root length per rooted cutting**  
 Cuttings from fully shaded mother plants produced significantly longer total root length than cuttings from unshaded or basal stem shaded mother plants. The latter two treatments were not significantly different from each other.
- (c) **Root number per rooted cutting**  
 Shade affected the number of roots produced in the following manner. Cuttings from fully shaded mother plants produced significantly more roots than those from unshaded plants. Cuttings from basal stem shaded mother plants did not produce more roots than those from unshaded plants.
- (d) **Root length per rooted cutting**  
 Cuttings from shaded plants, irrespective of entire or basal stem shading, produced significantly longer roots compared to cuttings from untreated mother plants.

Although no marked differences were found between any treatments in the number of cuttings rooted (*Table III*), the quality of the roots produced was affected by shading. Cuttings whose mother plants had been completely shaded produced higher root weights and longer roots per cutting than those from unshaded or partially shaded mother plants (*Table III*). The beneficial effects of shade on rooting of cuttings found in this study is in agreement with many workers on a variety of crops (GALSTON and BAKER, 1953; SHAPIRO, 1958; JOHNSON and ROBERTS, 1971 and BIRAN and HALEVY, 1973). Since all the studies were carried out under glasshouse conditions, it should be noted that unshaded control plants did not receive full sunlight.

LAWRENCE (1950) showed that up to 50 per cent of the sunlight may be lost due to the glasshouse structure itself.

The beneficial effects of shade on rooting maybe due to two main reasons. Etiolated tissues contained higher auxin levels than unetiolated ones. This was found by HERMAN and HESS (1963) in their studies with cuttings of Hibiscus and Red Kidney Bean. Their studies also showed that etiolated tissues contained less starch compared to unetiolated tissues. Anatomically, etiolated cuttings were much less differentiated and undoubtedly exhibited a greater potential to become meristematic than green cuttings (HERMAN and HESS, 1966). As a follow-up exercise, the technique could also be repeated to older plants that have flowered and fruited as one would only prefer to clone plants that have proven themselves with the desired characteristics, such as high yielding or disease resistant.

In conclusion, it was found that shading the entire mother plants for four weeks before obtaining cuttings improved their rooting abilities. Etiolating part of the cuttings that were to be propagated was also found to be beneficial in improving rooting.

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#### SUMMARY

The effects of shade on the growth of mother plants as well as on the ease of rooting of cuttings of tomato were studied. Shaded mother plants were taller than unshaded plants due mainly to longer internode. Shading the entire plant for four weeks improved the quality of roots but not the number of cuttings rooted.

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