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# Mechanical Conditioning for Controlling Excessive Elongation in Transplants

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## Summary

Excessive stem elongation in transplants hinders mechanical transplanting and reduces plant survival in the field. Mechanical stimulation is an effective method for reducing stem elongation during transplant production. This investigation determined how to optimize the treatment and the consequences it has on subsequent field performance. This research examined the effects of varying the dose, the interval between brush strokes during stimulation, the time of day that stimulation was applied and the time application was started. Tomato seedlings and grown at 2,100 plants per $m^2$ were reduced in height by 20% when brushed with 10 strokes per day from canopy closure until they were ready to set out. More intense treatment did not further reduce the height. The interval between strokes could range from none to 10 minutes with no difference in the effect. The treatments were similarly effective whether applied in the morning or in the afternoon. Treatments begun at different canopy heights were shorter in direct proportion to the number of days of treatment. The plants grew 6 mm per day when they were not treated and 3 mm per day during treatment. In the field, treated and untreated processing tomatoes recovered from transplant shock equally based on the resumption of elongation growth. Leaf area development and yield were also equal. Furthermore, fresh-market tomatoes were unaffected in earliness, and no treatment-related defects were noted in the fruits. Treated plants were more tolerant of wind. In wind-tunnel tests, treated plants resisted wind speeds about 4 km・$h^{-1}$ higher. A field planting subject to 70 km・$h^{-1}$ wind had 12% mortality in untreated plants but only 2% in treated plants. Mechanical conditioning with brushing and impedance produced transplants with desirable qualities without adverse effects on field performance.

## Introduction

Mechanical perturbation has long been known to slow elongation growth (Jaffe, 1973; Turgeon and Webb, 1971) and investigation into its potential for controlling transplant elongation have been ongoing for over 20 years (Mitchell et al., 1977). The feasibility of the technique has been established, various ways to implement it have been tested (Garner and Björkman, 1996, 1997; Garner et al., 1997; Johjima et al., 1992), and recommended to growers (Latimer and Beverly, 1993). This paper describes recent advances in optimizing the technique for plug transplant production.

## Materials and Methods

Tomato transplants were grown at 2,100 seedlings/$m^2$ in plastic plug trays filled with a peat-perlite growing medium. The standard treatment was to begin brushing the seedlings when they were about 5 cm tall. This is when canopy closure occurs. Seedlings were brushed with 10 strokes each morning for about 14 days, until the treated plants were 15 cm tall. Each of these parameters was varied individually in the experiments described. Fresh-market tomatoes were grown in larger cells(365/$m^2$) until the treated plants were 40 cm tall. In field experiments, plants were transplanted into a field at the research farm in late May and grown with standard commercial practices until harvest.

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## Results and Discussion

*Transplant production: Dose*

Stem growth responded to brushing with a relatively small stimulus. Increasing the stimulus did not correspondingly increase the inhibition of growth. Ten daily strokes reduced the growth of tomato transplants, but

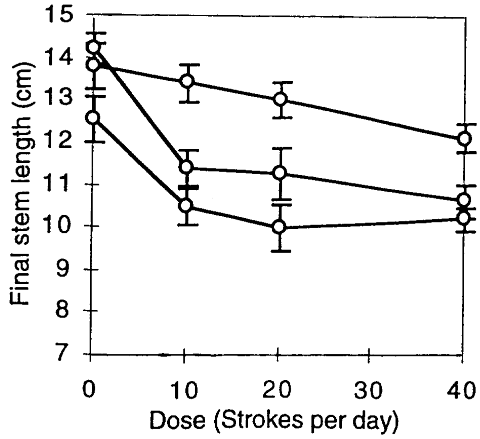


**Fig. 1.** Effect of the amount of brushing on tomato seedling growth. Each line is a separate experiment.

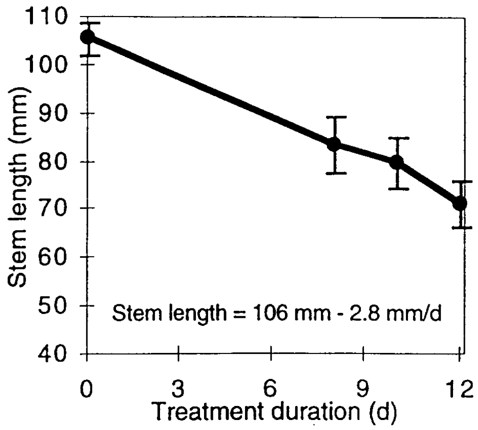


**Fig. 2.** Effect of the number of days of brushing treatment on the height of tomato transplants.

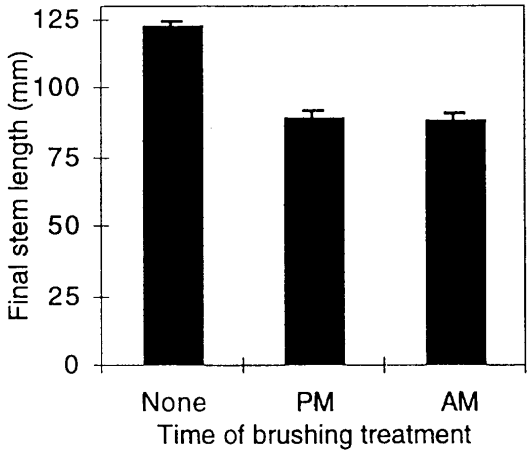


**Fig. 3.** Effect of time during the day that a brushing treatment was applied on the height of tomato transplants.

greater daily stimulation did not further inhibit them (Fig. 1). In contrast, the amount of growth reduction was directly related to the number of days of treatment (Fig. 2).

*Transplant production: Timing*

Tomato seedlings grow fastest at night, and slowly during the day (Garner and Björkman, 1996). Treating just before evening may be expected to have the greater effect. But we found that treatment in the morning and that in the late afternoon have the same effect (Fig. 3).

*Transplant production: Memory*

The interval between strokes depends on the technique being used to treat the plants. Using 10 strokes per day, the response was the same whether the treatment was 10 strokes all at once or 10 minutes between the strokes (Fig. 4). The plant can add up individual small stimuli over time to give a full response. Therefore, the technique can be mechanized to allow brushing of the whole length of the bench with a modified irrigation boom.

*Field performance: Transplant shock*

The main concern with any growth-inhibiting treatment is that it has persistent effects. After transplanting, brushed or impeded transplants began to grow at exactly

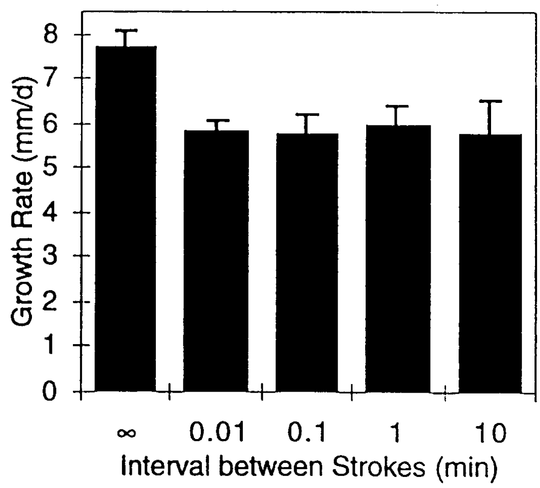


**Fig. 4.** Effect of the interval between strokes on the growth rate of tomato seedlings. Ten pairs of strokes were applied each day and the growth rate was measured for 10 days.

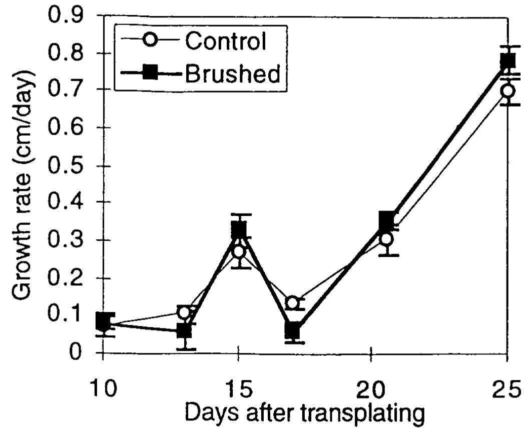


**Fig. 5.** Growth rate of tomato transplants after transplanting in the field.

the same time and at the same rate (Fig. 5). Mechanical conditioning has no persistent effect.

*Field performance: Yield*

Mechanical stimulation can result in a reduction in dry weight accumulation (Mitchell et al., 1977) and could therefore be expected to reduce yield. In several years of field trials, no yield reduction could be found in either processing (Table 1) or fresh-market (Table 2) tomatoes. Furthermore, there was no delay in flowering, nor any increase in fruit defects.

*Field performance: Wind tolerance*

A benefit of mechanical conditioning in addition to reducing the rate of elongation is to strengthen the stem. We tested this in two ways. In a wind tunnel, we investigated the progressive tipping of seedlings as wind speed increased. The speed for 50% of the seedlings to be bent over was increased from by 4.4 km $h^{-1}$ after being brushed on 10 consecutive mornings, and by 12 km $h^{-1}$ after being impeded for 10 consecutive nights.

In addition, brushed plants had less mortality after a natural wind stress. The evening after planting one field trial, the wind was 70 km $h^{-1}$ for several hours. The untreated plants had a mortality of 12% while brushed

**Table 1.** Yield of processing tomatoes with height controlled either by impedance of brushing during transplant production. None of the differences are statistically significant.

| Year | Treatment | |
|---|---|---|
| | Control | Brushed |
| 1993 | 83t/ha | 75 |
| 1994 | 76 | 74 |
| 1995 | 78 | 75 |

**Table 2.** Yield of fresh market tomatoes with height controlled by brushing during transplant production. None of the treatment differences is statistically significant.

| Year | Early yield | | Total yield | |
|---|---|---|---|---|
| | Control | Brushed | Control | Brushed |
| 1994 | 14.5 t/ha | 15.1 | 43.0 | 43.6 |
| 1995 | 14.6 | 14.0 | 118 | 98 |

plants experienced only 2% mortality.

Brushing is a versatile and easy way to control transplant height without any subsequent reduction in plant performance. Brushing has been successful with other crops than tomatoes. These are usually plants that have rapid growth rates and flexible stems (Garner et al., 1997; Latimer, 1991). In addition to controlling height and strengthening the stems, brushing also reduces pest insect populations (Latimer and Oetting, 1994).

## Literature Cited

Garner, L. and T. Björkman. 1996. Mechanical conditioning for controlling excessive elongation in tomato transplants : Sensitivity to dose, frequency and timing of brushing. J. Amer. Soc. Hort. Sci. 121 : 894-900.

Garner, L. and T. Björkman. 1997. Using impedance for mechanical conditioning of tomato transplants to control excessive stem elongation. HortScience 32 : 227-229.

Garner, L., F. A. Langton and T. Björkman. 1997. Commercial adaptations of mechanical stimulation for the control of transplant growth. Acta Hortic. 435 : 219-226.

Jaffe, M. J. 1973. Thigmomorphogenesis : the response of plant growth and development to mechanical stimulation, with special reference to *Bryonia dioica*. Planta 114 : 143-157.

Johjima, T., J. G. Latimer and H. Wakita. 1992. The effect of mechanical stress on transplant growth and subsequent yield of four cultivars of tomato and their hybrid lines. J. Amer. Soc. Hort. Sci. 117 : 384-388.

Latimer, J. G. 1991. Mechanical conditioning for control of growth and quality of vegetable transplants. HortScience 26 : 1456-1461.

Latimer, J. G. and R. B. Beverly. 1993. Mechanical conditioning of greenhouse-grown transplants. HortTechnology. 3 : 412-414.

Latimer, J. G. and R. D. Oetting. 1994. Brushing reduces thrips and aphid populations on some greenhouse-grown vegetable transplants. HortScience 29 : 1279-1281.

Mitchell, C. A., H. C. Dostal and T. M. Seipel. 1977. Dry weight reduction in mechanically-dwarfed tomato plants. J. Amer. Soc. Hort. Sci. 102 : 605-608.

Samimy, C. 1993. Physical impedance retards top growth of tomato transplants. HortScience 28 : 883-885.

Turgeon, R. and J. A. Webb. 1971. Growth inhibition by mechanical stress. Science 174 : 961-962.

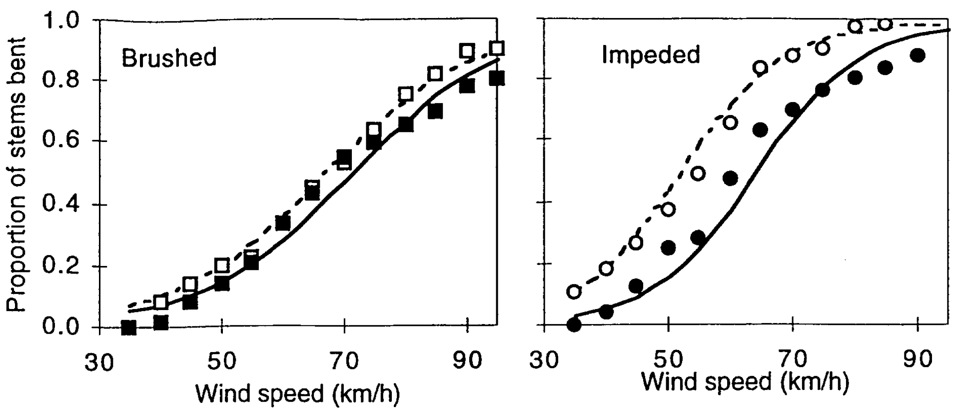


**Fig. 6.** Effect of mechanical conditioning on the tolerance of tomato seedlings to wind. Wind was applied progressively in a wind tunnel and bending of the stems was measured. A seedling was considered bent when the base of the stem was inclined 45° from the vertical. Impedance is another kind of mechanical conditioning (Garner and Björkman, 1977 ; Samimy, 1993).