Effect of Soil Moisture on the Recovery of Sandblasted Tomato Seedlings[1]

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Abstract. Increasing the length of time that 4-week-old tomato seedlings are exposed to a 13.4-m/sec (30 mph) windspeed and an abrasive flux of 0.2 ton/rod width/hr decreases the dry weight of tops, decreases height of the tops, delays first bloom, lowers potential yields, and increases the number of plants killed irrespective of the pre- or post-soil moisture level. Irrigation or rainfall immediately after exposure can reduce the damage.

Introduction

WIND and sandblast injury to vegetable crops is a serious problem where large acreages of vegetables are grown on sandy soils. Wind alone can cause damage and desiccation (10) but wind laden with sand and soil is much more destructive. Studies dealing with abrasive injury to cotton seedlings (1), grass and alfalfa seedlings (7), green bean seedlings (9), and to established wheat stands (11) have provided some information on soil abrasive injury to plants. No previous work on the effect of soil moisture on the recovery of sandblasted plants could be found but its importance is mentioned (1). This study was undertaken to determine the effect of soil moisture level before and after abrasive injury to tomato seedlings.

Materials and Methods

Tomatoes, *Lycopersicon esculentum* L. var 'Homestead 24', were grown in the greenhouse in 61- by 15- by 23-cm flats filled with sandy loam soil. The plants were fertilized according to recommended cultural practices.

Treatment variables were pre-exposure soil moisture level (low—6 to 12 atm tension, medium—$\frac{1}{3}$ to 6 atm tension, and high < $\frac{1}{3}$ atm), post-exposure soil moisture level (low, medium, high), and length of exposure (0, 5, 10, and 15 minutes) to a 13.4-m/sec (30 mph) windspeed and 0.2-ton/rod width/hr abrasive flux. Treatments were arranged factorially and replicated 3 times.

Two-week-old plants were thinned to 4 plants per flat and the pre-exposure soil moisture levels imposed. Soil moisture levels were maintained by

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daily weighing and adding water when the lower limit was reached.

Four-week-old plants were exposed in the wind tunnel using the same equipment as Skidmore (9). After exposure the flats were returned to the greenhouse and post-exposure soil moisture levels established.

Date of first bloom on each flat was recorded. When plants were 8 weeks old, the height, number of live plants, number of buds, number of blooms, fresh weight of tops, and dry weight of tops were recorded.

Results

Linear regression coefficients (Table 1) revealed that post-exposure soil moisture level was significantly related to dry weight of tops, number of buds and flowers, age at first bloom, and height at the 1% level but not to per cent of plants killed. Pre-exposure soil moisture level was not related to any of the variables measured and length of exposure time was significantly related only to per cent of plants killed. Number of buds and flowers and per cent of plants killed are the only data discussed because linear regression revealed a significant relation between number of buds and flowers and all other variables except per cent of plants killed (Table 1).

Pre-exposure soil moisture level, post-exposure soil moisture level, and length of exposure time had a significant (1% level) effect on all dependent variables measured (Table 2). The significant interactions reveal that the effect of any one main effect cannot be discussed without specifying the level of the other two main effects.

Increasing the soil moisture level before or after exposure increased the number of buds and flowers (Fig. 1) regardless of length of exposure. Exposure for more than 5 minutes reduced the number of buds and flowers regardless of the moisture treatment. Increasing the soil moisture after exposure increased the number of buds and flowers more than increasing the soil moisture before exposure, except when exposed for 15 minutes.

More plants under low pre-exposure soil moisture survived than those under medium pre-exposure soil moisture when the length of exposure was less than 15 minutes (Fig. 2). All plants exposed 15 minutes with low pre-exposure soil moisture and low post-exposure soil moisture were killed. The plants growing on the high pre-exposure soil moisture were not killed by sandblasting but were blown out of the ground because of shallow root development. Increasing soil moisture after exposure increased survival regardless of length of exposure.

When the soil moisture was high prior to, or after exposure, survival was 90% or better (Fig. 2).

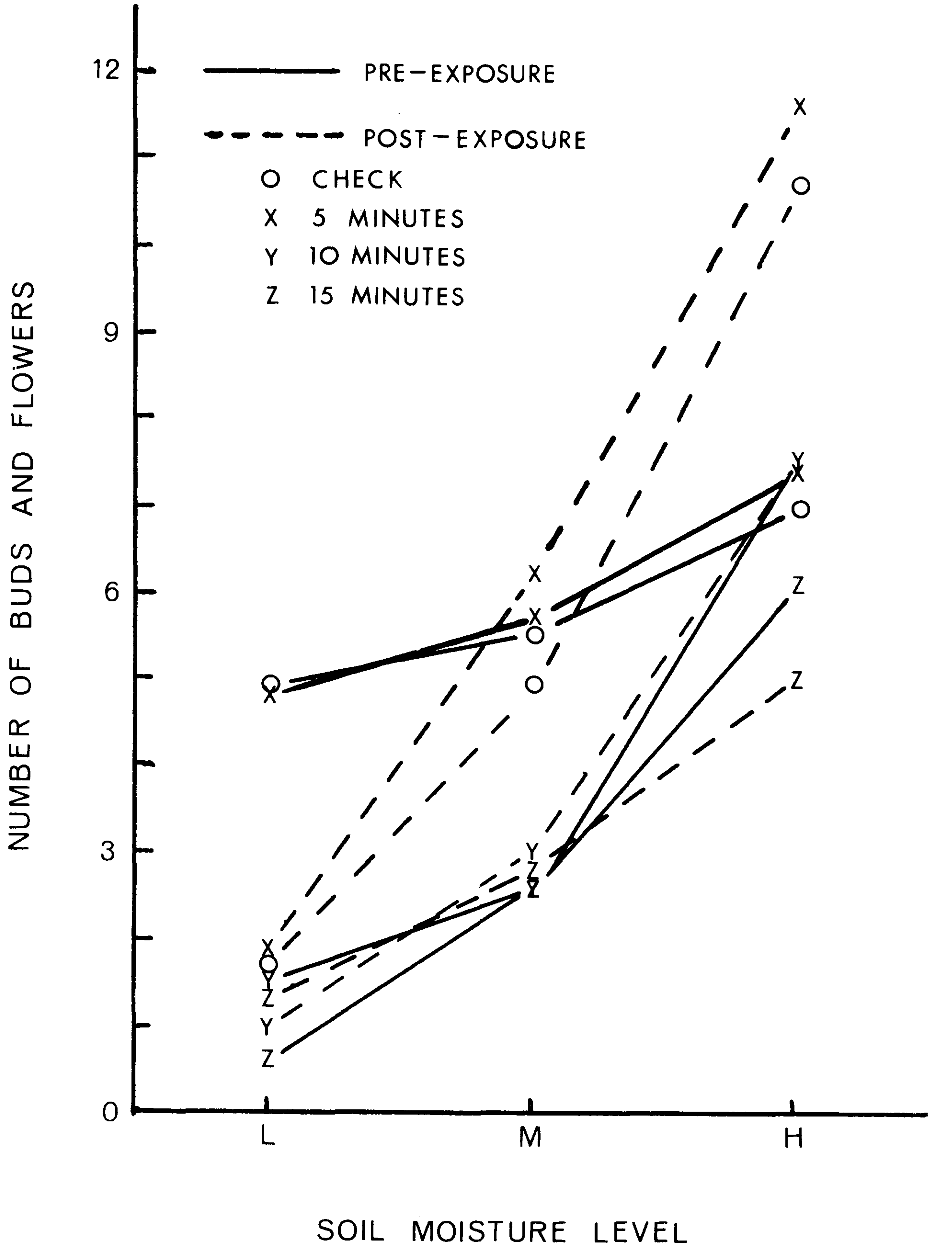

Fig. 1. Effect of pre- and post-exposure soil moisture levels on number of buds and flowers when seedlings are exposed to abrasive injury for 0, 5, 10, and 15 minutes.

Discussion

This study demonstrates that low rates of sand movement for short pe-

Table 1. Linear correlation coefficients.

Relationship	r
Pre-exposure soil moisture level × dry weight	.29 NS
Pre-exposure soil moisture level × number of buds and flowers	.43 NS
Pre-exposure soil moisture level × age at first bloom	−.35 NS
Pre-exposure soil moisture level × height	−.31 NS
Pre-exposure soil moisture level × percent of plants killed	−.23 NS
Post-exposure soil moisture level × dry weight	.81**
Post-exposure soil moisture level × number of buds and flowers	.73**
Post-exposure soil moisture level × age at first bloom	−.63**
Post-exposure soil moisture level × height	.86**
Post-exposure soil moisture level × percent of plants killed	−.32 NS
Length of exposure time × dry weight	−.30 NS
Length of exposure time × number of buds and flowers	−.30 NS
Length of exposure time × age at first bloom	.41 NS
Length of exposure time × height	−.28 NS
Length of exposure time × percent of plants killed	.49**
Number of buds and flowers × dry weight	.94**
Number of buds and flowers × age at first bloom	−.77**
Number of buds and flowers × height	.93**
Number of buds and flowers × percent of plants killed	−.43 NS

**Significant at 1% level.
NS Nonsignificant.

riods can severely damage tomato seedlings and that irrigation or rainfall immediately after the damage has occurred can reduce the effect.

Rates of soil movement used in this study are within the range of soil movement for naturally occurring storms for soils of average erodibility but below those of above-average erodibility. Chepil (3) reported that the rate of soil movement 40 rods across wind-eroded fields with a 30-mph wind at a height of 5 ft was 0.1, 0.5, and 1.4 tons/rod width/hr for a silt loam of below-average and average erodibility and a loamy sand of above-average erodibility, respectively.

Information on duration and frequency of natural winds that would cause these soil movement rates is limited. Zingg (12) indicated that winds of 40 mph at a height of 58 ft (comparable to 30 mph at a height of 5 ft) of 5-minute duration would occur about once a year at Dodge City, Kansas, and once each 18 months at Wichita, Kansas. A wind of that intensity lasting 1 hr could be expected once each 18 months at Dodge City and only once each 3 years at Wichita. Detailed data on winds at other locations are not available but wind erosion damage to vegetables has been reported in South Carolina (2), New Jersey (6), and Ohio (8) nearly every year.

This information indicates that every vegetable grower should expect wind erosion damage nearly every year, and should design and develop effective control methods. Information now available indicates that barriers, well-anchored vegetative material, and sprayed-on nonvegetative films effectively protect vegetable crops (4, 5). Barriers include corn, sorghum, grasses, trees or shrubs, or snowfences. To be most effective they should be planted or constructed in rows perpendicular to the prevailing wind erosion direction and at frequent intervals. Vegetative materials include rye, wheat, and hauled-in mulches such as wheat straw and native hay. Nonvegetative materials include by-products of the petroleum and chemical industries such as asphalt and latex. The application rates required are high and the materials are expensive, but they are effective and their use can be justified on high-income crops such as tomatoes.

Table 2. Analysis of variance, F values.

Variable	Reps.	Pre-exposure soil moisture level (O)	Post-exposure soil moisture level (F)	Exposure time (T)	0 × F	0 × T	F × T	0 × F × T
Dry weight (grams)	3.03 NS	44.47**	273.69**	26.06**	3.86 NS	2.60 NS	5.32**	1.95 NS
Number of buds and flowers	3.28 NS	85.27**	215.48**	30.75**	9.80**	4.34**	7.17**	1.76 NS
Age at first bloom (days)	0.13 NS	19.15**	62.79**	19.55**	1.21 NS	6.08**	2.88 NS	1.53 NS
Height (cm)	1.44 NS	42.24**	310.17**	20.99**	0.87 NS	2.73 NS	1.61 NS	1.00 NS
Percent of plants killed	0.41 NS	7.78**	10.16**	19.57**	4.96**	5.70**	4.23**	1.72 NS

**Significant at 1% level.
NS Nonsignificant.

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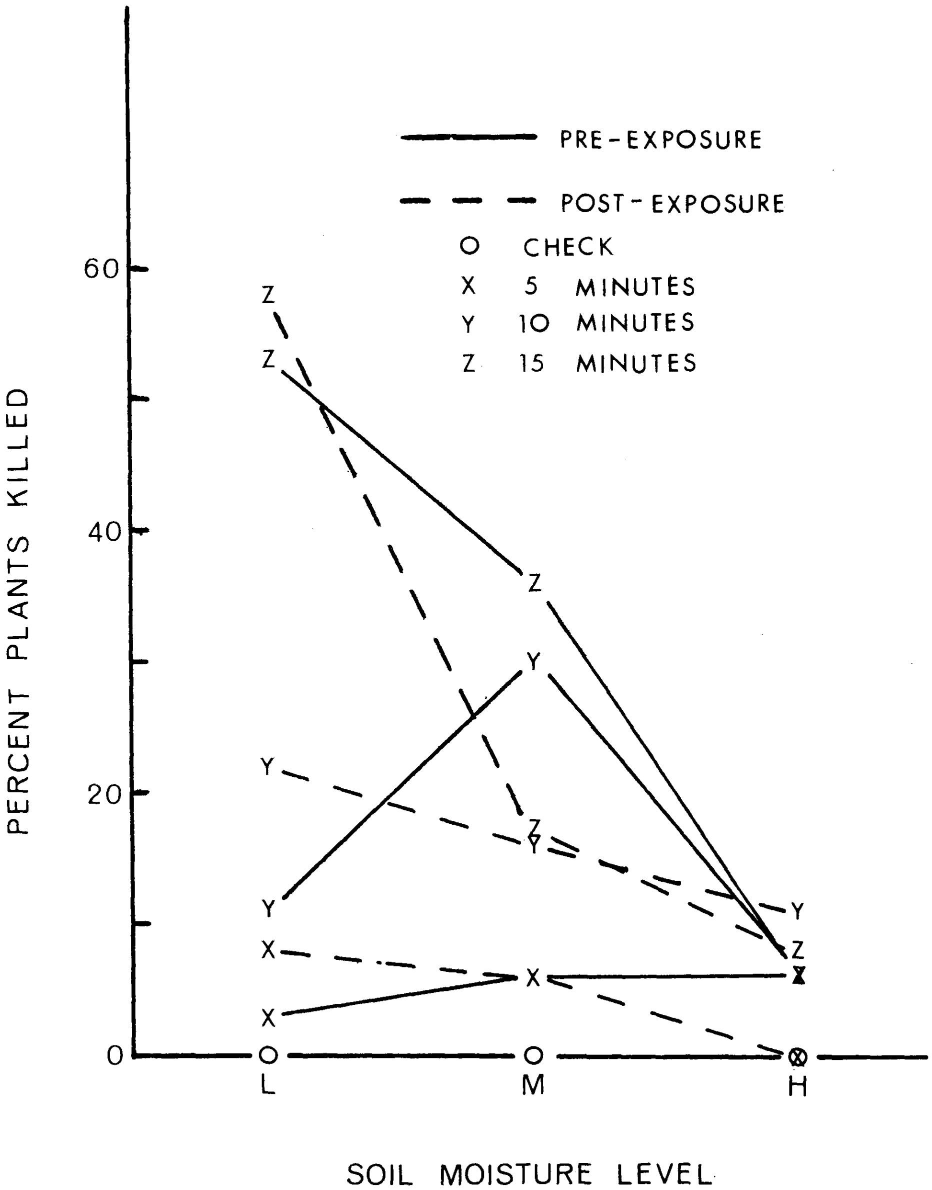

Fig. 2. Effect of pre- and post-exposure soil moisture levels on per cent of plants killed when seedlings are exposed to abrasive injury for 0, 5, 10, and 15 minutes.

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