Proc. Fla. State Hort. Soc. 103:100-101. 1990.

RELATION OF LIGHT INTENSITY TO RADISH ROOT SHAPE

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Additional index words: Raphanus sativus

Abstract. **Radish (*Raphanus sativus* L.) plants were subjected to various light intensities following germination. Root elongation occurred when plants were grown under light intensities of 175 μE/m²/s or less. As little as one day at 110 μE/m²/s at emergence followed by full sunlight resulted in elongated roots at harvest. The intensities of light used were in the ranges of light intensities that were measured on dark, overcast days.**

The storage organ of the radish, generally called the root, consists of root and hypocotyl tissue with the latter being predominant. At times, the roots of normally round types become elongated during growth. The elongated roots may be ovate in shape tapering to a point at the stem or may be oblong with reduced thickening throughout. The duration and intensity of light have been shown to be factors in the elongation response. Plitt (3) observed that radishes grown at a 7.5-hr photoperiod had fewer thickened hypocotyls than those grown at a 15-hr photoperiod. Hayata et al. (2) found that with 10-Klx of light the hypocotyl elongated to a maximum in 11 days with little thickening of the hypocotyls through 33 days. At 25 Klx, the hypocotyls were of normal length and thickness at 33 days. The photoperiod was 12 hr with the day/night temperature being 23/18C. Craker, et al. (1) found a strong interaction of photoperiod and light intensity for leaf growth but not root growth. Root growth was affected more by intensity than photoperiod. The present work was done to determine the minimum light intensity required to prevent elongation and produce normal thickening of the roots. These results would allow comparison with intensities which might occur on overcast days.

Materials and Methods

'Red Prince' radish seeds were sown in a peat-vermiculite medium (Vegetable Plug-mix) in 12 x 12 x 5 cm flats or in plastic pots 15-cm in diameter and depth. Nutrients were supplied by wetting the medium with a soluble fertilizer (14N-10P-20K) solution. Uniform seedlings were selected soon after emergence such that they were nearly equidistant apart. The other seedlings were removed.

The plants were grown in Apopka-type growth rooms fitted with cool-white fluorescent and incandescent lamps in 3 experiments. The plants in the fourth experiment were grown under similar lights in an air-conditioned laboratory at 23 to 25C. Light levels were controlled by varying the distance from the light source to 2.5 cm above the surface of the growth medium. The light intensity was measured as photosynthetically active radiation in microeinsteins per square meter per second (μE/m²/s) using a Li-Cor quantum photometer. The photoperiod was 16 hr in all experiments.

At harvest, the length and width of each root was measured and the length/width ratio calculated. The average of these measurements of the roots in each replication was taken as the value for that replication in the statistical analysis.

Experiment 1. The light intensities were 75, 125, 175 and 250 μE/m²/s. There were 5 replications of 16 plants each for each light intensity. The plants were harvested 28 days after sowing the seeds. The growth chamber temperature was 25C.

Experiment 2. Two light intensities, 100 and 300 μE/m²/s, were compared at 2 temperatures, 21 and 27C. Two rooms were used with 1 for each temperature. Five replications with 20 plants each were used for each treatment. The high-light plants at each temperature were harvested 29 days after sowing. The low-light plants were harvested 42 days after sowing to determine if root thickening would occur with a longer growth period.

Experiment 3. Plants were grown under light intensities of 120 and 250 μE/m²/s until roots at the latter intensity began to thicken at which time half the plants at each light intensity were transferred to the opposite one. The growth chamber temperature was 25C. Four replications of 16 plants each used for each of the 4 treatments. The roots were harvested and measured 30 days after sowing.

Experiment 4. Plants were held at 25C under light intensities of 110, 190, or 370 μE/m²/s for 0, 1, 2, or 3 days after emergence. At the end of each period the plants were transferred to outdoor conditions of normal sunny days. There were 3 replications of 5 plants each grown in plastic pots for each treatment. The plants were harvested 34 days after sowing.

Results and Discussion

Experiment 1. Roots of plants grown at a light intensity of 175 or 250 μE/m²/s were shorter, wider and had a smaller length to width ratio than roots of plants grown at 75 or 125 μE/m²/s (Table 1). The roots grown at 250 μE/m²/s were of normal round shape and size. Those grown at 175 had not attained the full round shape. The larger the length to width ratio, the more elongated and less round the roots.

Experiment 2. This experiment was treated as 2 experiments, 1 at each light intensity, because of the different growth periods. Statistical comparisons were made be-

Table 1. Effect of light intensity during growth on the length, width, and length to width ratio (L/W) of radish roots 28 days after sowing.

Light intensity (μE/m²/s)	Length (mm)	Width (mm)	L/W (ratio)
75	26.9 a[z]	1.9 a	16.5 a
125	25.8 a	4.6 a	9.5 b
175	21.1 b	15.1 b	1.6 c
250	22.4 b	22.9 c	1.0 c

[z]Mean separation in columns by Duncan's multiple range test, 1% level.

Univ. of Florida Agr. Expt. Journal Series No. N-00285.

Table 2. Effect of light intensity and temperature during growth on the length, width and length to width ratio (L/W) of radish roots.

Temperature (C)	Light intensity: 300 μE/m²/s[z] Length (mm)	Width (mm)	L/W (ratio)	100 μE/m²/s[y] Length (mm)	Width (mm)	L/W (ratio)
21	23.3	22.2	1.0	22.5	15.6	2.1
27	27.0	22.2	1.2	27.6	12.7	3.2
F[x]	**	NS	**	**	NS	**

[z]Plants harvested 29 days after sowing.
[y]Plants harvested 42 days after sowing.
[x]F**significant at 1% level, NS not significant.

Table 3. Effect of switching light intensity from high to low or low to high during growth on the length, width, and length to width ratio (L/W) of radish roots 30 days after sowing.

Light intensity (μE/m²/s)	Root: Length (mm)	Width (mm)	L/W (ratio)
120	21.7 ab	11.4 c	2.9 c
120 to 250	26.6 b	18.5 b	1.6 b
250 to 120	21.1 a	20.4 b	1.0 a
250	24.2 b[z]	25.1 a	1.0 a

[z]Mean separation in columns by Duncan's multiple range test, 1% level.

tween temperatures at each light intensity. The roots grown at 27C were longer than those grown at 21C at each light intensity (Table 2). There was no effect of temperature on the root width at either light intensity. Roots at an intensity of 100 μE/m²/s did not attain the width of those at 300 even after 13 more days of growth. The L/W values were larger at 27C than at 21C at each light intensity.

Experiment 3. The length of roots grown at an intensity of 120 μE/m²/s did not differ from those grown under the other regimes (Table 3). The roots grown at 250 had the greatest width while those grown at 120 had the least width. Similar widths occurred whether the high or low light was applied first. Roots held initially or throughout at 120 were more elongated than those held at 250 μE/m²/s or those initially at 250 and then at 120 μE/m²/s.

Experiment 4. Roots grown at all light intensities increased in length with days but the greatest increases were at intensities of 110 and 190 μE/m²/s (Table 4). One, 2 and 3 days at intensities of 110 and 190 resulted in a reduction in root width at harvest even though the plants were grown outdoors under sunny conditions after the initial light treatments. The L/W values show that 1 day at low light resulted in some root elongation with greater elongation at 2 and 3 days.

Outdoor light intensity. On a heavily overcast, rainy day in Nov., the outdoor light intensity was 50 μE/m²/ sat 10:00 am and 100 μE/m²/s at 4:00 pm. The next day, which was clear and sunny, the light intensity was 1500 μE/m²/s at 10:00 am and 650 μE/m²/s at 4:00 pm. On another overcast day at 9:45 am the light intensity was 154 μE/m²/s.

Table 4. The effect of time at various light intensities on the length, width, and length-width ratio (L/W) of radish roots 34 days after sowing.

Light intensity μE/m²/s	Day 0	1	2	3	Light mean
	Root length (mm)				
110	24.7	28.5	30.3	35.7	29.8 a[z]
190	26.5	26.7	30.6	32.9	29.2 a
370	20.8	25.0	26.4	27.3	24.9 b
Day mean	24.0 a	26.7 ab	29.1 bc	32.2 c	

[z]Mean separation by Duncan's multiple range test, 1% level.

	Root width (mm)				
110	24.7	20.6	18.2	15.8	19.8
190	25.9	21.8	21.4	19.6	22.2
370	20.5	24.5	24.8	22.5	23.1
Day mean	23.7	22.3	21.5	19.3	

The F values were highly significant for light, days and their interaction.

	L/W				
110	1.1	1.4	1.8	2.4	1.7
190	1.0	1.2	1.4	1.8	1.4
370	1.0	1.0	1.1	1.2	1.1
Day mean	1.0	1.2	1.4	1.8	

The F values were highly significant for light, days and their interaction.

The next day, which was clear and sunny, the light intensity was 1500 μE/m²/s at 10:00 am and 650 μE/m²/s at 4:00 pm. On another overcast day at 9:45 am the light intensity was 154 μE/m²/s.

The experiments have shown that the roots of radish plants grown at light intensities of 190 μE/m²/s or lower become elongated. More elongation occurred at 27C than at 21C. The application of low light intensity for 1, 2, or 3 days after seedling emergence resulted in elongated roots. Low light applied later in growth had no effect on root length. This is in agreement with Hayata et al. (2) who found that elongation of the hypocotyl ceased within 4 days at low light.

Since low-light intensities that have been associated with root elongation can occur under outdoor conditions, it is possible in a field-grown radish crop to have elongated roots. The number of elongated roots would depend upon the intensity and duration of low light, temperature, and number of seedlings emerging under those conditions.

Literature Cited

1. Craker, L. E., M. Siebert, and J. T. Clifford. 1983. Growth and develpoment of radish (*Raphanus sativus*, L.) under selected light environments. Ann. Bot. 51:59-64.
2. Hayata, Y., Y. Shinohara, and Y. Suzuki. 1983. The effect of low light intensity on the early development of radish hypocotyl. J. Jap. Soc. Hort. Sci. 51:421-426.
3. Plitt, T. M. 1932. Some photoperiodic and temperature responses of the radish. Plant Physiol. 7:337-339.