

Lettuce Seed Development Following Brief Exposures to High Temperature

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INTRODUCTION

Lettuce (*Lactuca sativa*) seeds are produced mostly in semi-arid areas in the United States, Mexico and Australia, because rain is undesirable during flowering and seed maturation. However, these areas also have high temperatures during seed development. High temperature decreases seed set and quality in some crops. The objective of this study was to determine how high temperature affects lettuce seed development.

PROCEDURES

An early flowering line (D-20M) of leaf lettuce (*Lactuca sativa* L.) was grown in 13 cm pots in a peat:perlite:vermiculite (2:1:1) mixture in a growth chamber at 21/10°C (day/night) with 16 hrs of light at an intensity around 250 $\mu\text{mol/s/m}^2$, and relative humidity around 50-60%. Plants were fertilized with a complete liquid fertilizer. Plants were moved into different chambers at temperatures of 28, 35, 38, and 42°C for various periods of time (1, 4 or 7 hrs) when flowers were present at several developmental stages. After the treatment, plants were returned to the original growth chamber (21/10°C) until seeds were harvested. Seed number per flower head and seed weight were measured.

RESULTS AND DISCUSSION

Both number of seeds per head and weight of seeds per head decreased significantly at 42°C relative to the lower temperatures (Table 1). Seed set and seed weight did not significantly differ when lengths of exposure to high temperature varied from 1 to 4 to 7 hours (Tables 2 and 3). Although values for both seed set and weight tended to be lower at 4 and 7 hours than at 1 hour, this difference was not significant due to a large amount of variability. Responses were similar at all three temperatures (35, 38, 42°C).

Seed set and weight showed similar responses when lettuce was exposed to high temperature with flowers at various developmental stages (Tables 4 and 5). At 35°C, flowers at anthesis during the high temperature exposure were most sensitive, and flowers at pre- or post-anthesis showed no large differences in sensitivity. At 38°C, anthesis was still the most sensitive flower stage, although flowers at pre-anthesis were now more sensitive than those at post-anthesis. At 42°C, flowers at anthesis and pre-anthesis showed similar sensitivity, which was far greater than flowers at post-anthesis.

These data suggest pollination and/or fertilization may be more sensitive to high temperature than early embryo development would be. The reason is that pollination and fertilization would be complete in the post-anthesis treatment, but embryo development would just have begun.

These data suggest that high temperature for brief periods around anthesis of lettuce can have a significant negative effect on seed set and weight. High temperatures used in these studies are within the range of those experienced by lettuce plants during flowering and seed development. Further studies are underway to evaluate quality of the seed produced after exposure to the various temperatures and to determine what processes are the cause of the reduction in seed set and weight.

Table 1. Seed set and weight of lettuce exposed to high temperatures near anthesis.

Temperature (°C)	Number of seeds per head	Weight of seed per head (mg)
21	3.8 a ^z	5.9 a
28	4.0 a	6.1 a
35	3.5 a	5.3 a
42	0.7 b	1.0 b

^zMean separation within columns by Duncan's multiple range test, 5% level.

Table 2. Seed set of lettuce exposed to high temperature for various lengths of time.

Hour(s)	Number of seeds per head		
	35°C	38°C	42°C
1	6.4 ± 2.9	4.7 ± 3.3	3.0 ± 3.4
4	4.9 ± 2.7	4.1 ± 3.3	2.5 ± 3.1
7	5.7 ± 2.7	4.4 ± 3.6	2.3 ± 2.9

Table 3. Seed weight of lettuce exposed to high temperature for various lengths of time.

Hour(s)	Weight of seed per head (mg)		
	35°C	38°C	42°C
1	10.2 ± 4.0	7.6 ± 4.9	4.7 ± 5.3
4	7.8 ± 4.0	6.5 ± 4.9	3.3 ± 4.1
7	9.0 ± 4.0	6.7 ± 5.1	2.6 ± 3.4

Table 4. Seed set of lettuce exposed to high temperature with flowers at various developmental stages.

Days from anthesis ^z at time of exposure	Number of seeds per head		
	35°C	38°C	42°C
+3 ^y	8.4 a	7.0 a	6.3 a
+2	7.1 ab	6.6 a	4.4 b
+1	7.4 ab	8.3 a	6.6 a
0	1.4 d	0.5	0.0 c
-1	5.4 b	1.7 c	0.0 c
-2	5.9 bc	4.2 b	0.1 c
-3	4.1 c	2.5 bc	0.6 c

^zAnthesis refers to the one day when the lettuce flower is open.

^y(+) = Post-anthesis, (-) = pre-anthesis

Table 5. Seed weight of lettuce exposed to high temperature with flowers at various developmental stages.

Days from anthesis ^z at time of exposure	Weight of seed per head (mg)		
	35°C	38°C	42°C
+3 ^y	12.6 a	10.4 a	8.3 ab
+2	10.9 ab	10.0 ab	6.1 b
+1	11.5 ab	12.7 a	9.1 a
0	2.5 d	1.0 d	0.1 c
-1	9.2 bc	3.0 cd	0.0 c
-2	9.3 bc	7.1 b	0.1 c
-3	7.0 c	4.4 bc	1.1 c

^zAnthesis refers to the one day when the lettuce flower is open.

^y(+) = Post-anthesis, (-) = pre-anthesis