

SOME EFFECTS OF TEMPERATURE ON THE SHOOT GROWTH OF CHERRY SEEDLINGS

L. SMEETS

Institute of Horticultural Plant Breeding, Wageningen, Netherlands

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INTRODUCTION

For cherry breeding it is important to know the factors governing the growth and development of cherry seedlings (4). To this end experiments on the influence of the photoperiod were started in the phytotron of our Institute. Some of the results have been published in a previous paper (7). It was found that in a number of first-year seedlings the duration of growth was affected by the photoperiod, whereas this was not the case in second-year seedlings.

However, growth is affected not only by the light conditions, but also by temperature. Therefore some experiments on the influence of temperature on the growth of cherry seedlings were carried out. Since it is known from the literature (2, 3, 8) that an alternation of temperatures within a 24 hour's cycle may increase growth significantly, compared with the growth of plants kept at constant temperatures, the effect of both day and night temperature was studied. In this paper the results obtained so far will be reported and discussed.

MATERIAL AND METHODS

First- and second-year seedlings of Limburgse Boskriek (*Prunus avium* L.) were used as test plants. They were grown from seed supplied by the Netherlands Inspection Service for Arboriculture (N.A.K.-B).

The experiments were carried out in air-conditioned glasshouses in the phytotron of our Institute. Details of the equipment have been published in a previous issue of this periodical (1).

The effect of both day and night temperature on shoot growth under natural day-length conditions was studied. The plants, which were placed on trolleys, were either grown at various constant temperatures during the day and night or at the same temperatures by day (from 8 a.m. till 4 p.m.) but at lower temperatures at night. In general the maximum deviation from the mean temperature was about 1°C. Only on exceptionally hot days did the temperature rise in the 20°C glasshouse to about 25°C in the afternoon (1).

The height of the plants was measured at intervals from the beginning of the experiments until the termination of shoot growth. At the same time the number of leaves was counted. KEULS' application of the "studentized range" method (5) was used to find out what temperature treatments resulted in mathematically reliable differences in shoot length and leaf number.

EXPERIMENTAL RESULTS

In the first experiment, seedlings of Limburgse Boskriek in their first year of growth were used as test plants. They were grown from seed stratified from September 30 until December 29, 1953; then the seeds were sown in seed-trays and placed in a coldhouse. The young seedlings were pricked off in pots on April 2, 1954. The plants were divided into 10 groups on April 27 and grown one at each of the temperature treatments shown in table 1.

All groups of plants consisted of 20 plants except those grown at a day temperature of 23°C and a night temperature of 20° or 17°C, which consisted of 19 plants each. About 20 plants per treatment agrees with a recommendation of NEUMANN (6) based upon a coefficient of variation of the same magnitude as those found in the present experiments.

Table 1 shows that the plants grown at constant temperatures of 17° and 20°C terminated their growth much sooner than those grown at 23° and 26°C. At 20°C the majority of the plants seemed to cease growth somewhat earlier than at 17°C, whereas at 26°C termination of shoot growth occurred markedly later than at 23°C.

TABLE 1. INFLUENCE OF THE TEMPERATURE ON THE TERMINATION OF SHOOT GROWTH IN FIRST-YEAR SEEDLINGS OF LIMBURGSE BOSKRIEK (*PRUNUS AVIUM* L.)

Temperatures (degrees C)		Total number of plants which had terminated growth on the date mentioned at the head of each column									
Day	Night	14/6	22/6	30/6	7/7	16/7	26/7	9/8	16/8	23/9	20/10
17	17	1	3	7	13	19	20				
20	17	—	3	9	13	19	20				
20	20	1	9	13	16	19	19	20			
23	17	—	1	4	8	12	17	17	17	18	19
23	20	—	2	6	9	12	16	18	18	18	19
23	23	—	2	3	10	11	14	15	17	19	20
26	17	1	2	5	6	10	13	18	20		
26	20	1	4	5	12	15	16	16	18	20	
26	23	—	—	2	3	8	15	16	16	18	20
26	26	—	—	—	2	3	8	10	14	17	20

The night temperature had a distinct effect only on plants grown at a day temperature of 26°C. At night temperatures of 23°, 20° and 17°C, the majority of the plants ceased growth earlier than those grown at 26°C during the day and night. However at a night temperature of 20°C termination of shoot growth occurred earlier than at 23°C, while there was no difference in this respect between the plants grown at night temperatures of 20° and 17°C. There was no effect of the night temperature on the plants grown at a day temperature of 23°C. In the plants grown at a day temperature of 20°C and a night temperature of 17°C termination of shoot growth occurred somewhat later than in those grown at a constant temperature of 20°C.

Table 2 shows the average shoot length and number of leaves at the different temperatures on June 8, 1954, and after termination of growth. The results of the statistical analysis of these data are presented in table 3.

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TABLE 2. INFLUENCE OF THE TEMPERATURE ON GROWTH OF FIRST-YEAR SEEDLINGS OF LIMBURGSE BOSKRIEK (*PRUNUS AVIUM* L.)

Temperatures (degrees C)		June 8, 1954		After termination of growth	
Day	Night	Average shoot length (cm)	Average number of leaves	Average shoot length (cm)	Average number of leaves
17	17	31.5	12.7	46.8	18.0
20	17	38.1	13.9	56.4	19.1
20	20	42.7	15.2	59.5	20.6
23	17	42.2	14.8	78.2	24.7
23	20	43.5	15.3	66.4	24.2
23	23	41.2	15.3	80.4	27.7
26	17	49.3	15.9	78.3	25.0
26	20	51.9	17.9	76.5	27.0
26	23	42.8	16.5	76.4	28.8
26	26	48.3	17.9	100.0	37.1

TABLE 3. RESULT OF A STATISTICAL ANALYSIS OF THE FIGURES GIVEN IN TABLE 2, SHOWING WHETHER THE DIFFERENCES IN SHOOT LENGTH AND LEAF NUMBER BETWEEN THE TEMPERATURE TREATMENTS IN THE HEADINGS AND THOSE IN THE FIRST COLUMN ARE SIGNIFICANTLY POSITIVE (+), OR NEGATIVE (-), ON A 1% LEVEL

Temperatures (degrees C)		June 8, 1954								After termination of growth								
		Average shoot length (cm)				Average number of leaves				Average shoot length (cm)				Average number of leaves				
Day	Night	17	20	23	26	17	20	23	26	17	20	23	26	17	20	23	26	
17	17																	
20	17		+	+	+						+	+	+				+	+
20	20	-				-						+	+				+	+
23	17	-				-						+	+	-				+
23	20	-				-						+	+	-				+
23	23	-				-						+	+	-				+
26	17	-				-						+	+	-				+
26	20	-				-	-	-				+	+	-				+
26	23	-				-	-	-				+	+	-				+
26	26	-				-	-	-				+	+	-				+

Let us consider first the differences in shoot length and leaf number after termination of growth. It appears that the plants grown at a constant temperature of 26°C differed significantly from all others both in shoot length and leaf number. The plants grown at 23°C during the day and night also differed in this respect from those grown at lower day temperatures (see also Fig. 1). So significant differences in both shoot length and leaf number appear to occur only in those cases in which the duration of growth is affected either by the day or night temperature (cf. Tables 2 and 3 with Table 1). Now it might be questioned whether these differences were only due to differences in the duration of growth or whether they were also affected by the rate of growth. From table 3 it appears that on June 8, 1954, i.e. before any effect of temperature on the

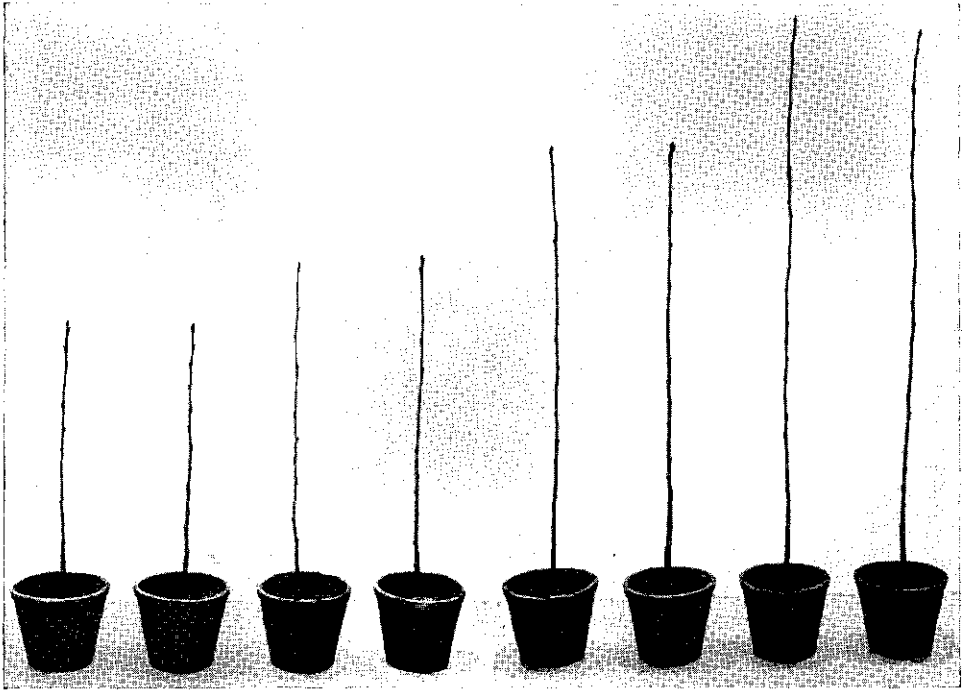


FIG. 1 FROM LEFT TO RIGHT, PAIRS OF FIRST-YEAR SEEDLINGS OF LIMBURGSE BOSKRIEK (*PRUNUS AVIUM* L.), GROWN AT CONSTANT TEMPERATURES OF 17°, 20°, 23° AND 26°C RESPECTIVELY, SHOWING THE AVERAGE PLANT HEIGHT AFTER TERMINATION OF GROWTH. THE PHOTOGRAPH WAS TAKEN WHEN THE PLANTS HAD DROPPED THEIR LEAVES DUE TO A COLD TREATMENT AFTER TERMINATION OF GROWTH.

duration of growth was noticeable, there were already significant differences both in shoot length and leaf number between the plants grown at constant temperatures of 26° and 23° on the one hand and 17°C on the other, which means a higher rate of growth in the former case than in the latter. Although in some cases the final differences in shoot length and leaf number between the temperature treatments mentioned above are affected by the rate of growth, it appears that they are mainly due to the effect of temperature on the duration of growth.

On June 8, 1954, there were no differences in shoot length and number of leaves between the plants grown at different night temperatures but at the same day temperature. This was also the case after termination of growth except for the plants grown at a constant temperature of 26°C, which differed significantly both in shoot length and leaf number from those grown at the same temperature by day but at lower temperatures at night, obviously as a result of differences in the duration of growth. Consequently, within the range of temperatures studied in this experiment, there was no effect of the night temperature on the rate of growth of the plants.

At the end of this experiment the plants were transferred to a coldhouse in order to bring about leaf-abscission and break the dormancy of the buds. Early in February 1955

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the plants, which had been cut back to a height of about 10 cm, were placed at a constant temperature of 20°C for bud break. Only one shoot from the developing buds of each plant was retained.

On February 25, 1955, the plants were divided into 6 groups of 20 plants, in such a way that the plants of the first year groups were equally distributed among the groups of the second year. A statistical analysis showed that in this way the effect of the positive correlation between the final height of the individual plants in their first and second year of growth was eliminated. Three groups were grown one at each of the constant temperatures 17°, 20° and 23°C. Two groups were grown at a day temperature of 23° and at a night temperature of 20° and 17°C respectively. One group was grown at a day temperature of 20°C and a night temperature of 17°C.

Table 4 shows that growth was terminated much sooner at constant temperatures of 17° and 20° than at 23°C, whereas most of the plants at 20°C ceased growth sooner than at 17°C.

TABLE 4. INFLUENCE OF THE TEMPERATURE ON THE TERMINATION OF SHOOT GROWTH IN SECOND-YEAR SEEDLINGS OF LIMBURGSE BOSKRIEK (*PRUNUS AVIUM* L.)

Temperatures (degrees C)		Total number of plants which had terminated growth on the date mentioned at the head of each column									
Day	Night	6/4	14/4	21/4	28/4	6/5	13/5	20/5	27/5	3/6	20/6
17	17	2	5	8	17	19	19	19	19	20	
20	17	4	9	14	20						
20	20	5	10	18	19	20					
23	17	5	10	14	17	19	20				
23	20	1	8	15	17	18	19	19	19	19	20
23	23	3	3	3	3	3	4	6	14	18	20

The night temperature had a distinct effect on the plants grown at a day temperature of 23°C. At night temperatures of 20° and 17°C the majority of the plants terminated their growth much sooner than those grown at 23°C during the day and night. There was no effect of the night temperature on the plants grown at a day temperature of 20°C.

Table 5 shows the average shoot length and number of leaves at the different temperatures both after termination of growth and on March 22, 1955, i.e. before any effect of temperature on the duration of growth was noticeable. The results of the statistical analysis of these data are presented in table 6.

As the results were similar to those obtained in the experiment with first-year seedlings it will suffice to mention only the conclusions that may be drawn from tables 5 and 6. It appears that significant differences occurring simultaneously in shoot length and leaf number after termination of growth were mainly due to the effect of temperature on the duration of growth. Within the temperature range studied no effect of the night temperature on the growth rate of the plants was observed.

TABLE 5. INFLUENCE OF THE TEMPERATURE ON GROWTH OF SECOND-YEAR SEEDLINGS OF LIMBURGSE BOSKRIEK (*PRUNUS AVIUM* L.)

Temperatures (degrees C)		March 22, 1955		After termination of growth	
Day	Night	Average shoot length (cm)	Average number of leaves	Average shoot length (cm)	Average number of leaves
17	17	63.0	16.9	104.0	27.3
20	17	63.4	17.6	91.7	25.4
20	20	69.5	18.5	95.3	26.4
23	17	69.1	18.9	99.0	26.9
23	20	73.8	20.2	105.6	30.0
23	23	75.3	20.6	142.0	39.0

TABLE 6. RESULT OF A STATISTICAL ANALYSIS OF THE FIGURES GIVEN IN TABLE 5, SHOWING WHETHER THE DIFFERENCES IN SHOOT LENGTH AND LEAF NUMBER BETWEEN THE TEMPERATURE TREATMENTS IN THE HEADINGS AND THOSE IN THE FIRST COLUMN ARE SIGNIFICANTLY POSITIVE (+), OR NEGATIVE (-), ON A 1% LEVEL

Temperatures (degrees C)		March 22, 1955						After termination of growth					
Day	Night	Average shoot length (cm)			Average number of leaves			Average shoot length (cm)			Average number of leaves		
		17	20	23	17	20	23	17	20	23	17	20	23
17	17			+			+			+			+
20	17			+			+			+			+
20	20									+			+
23	17				-					+			+
23	20	-			-					+			+
23	23	-			-			-	-		-	-	

DISCUSSION

In the previous section it was shown that first- and second-year seedlings terminated their growth much sooner at 17° and 20°C than at 23°C. There was not much difference between the effect of 17° and 20°C; probably termination of growth occurred somewhat earlier at the latter temperature.

The difference in the duration of growth between 20° and 23°C was greater in second- than in first-year seedlings. Apparently this accounts for the fact that only in second-year seedlings did the night temperature affect the duration of growth of plants grown at a day temperature of 23°C.

The difference in the duration of growth mentioned above might be due to differences in response between the seedlings in their first and second year of growth. However, the experiment with second-year seedlings was started earlier than that with first-year seedlings. Therefore it is also possible that differences in the light conditions may have had an effect.

In this connection, it is of interest to compare the influence of the natural daylength

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on the 20°C series with the effect of 8- and 16-hr. photoperiods on first- and second-year seedlings grown in previous experiments at a constant temperature of 20°C (6). In these experiments the plants received every day 8 hours daylight from 8 a.m. till 4 p.m.; after transference to air-conditioned rooms, they were either placed in darkness or received 8 hours additional incandescent light of low intensity. It was found that distinct differences in the duration of growth between the plants grown under 8- and 16-hr. photoperiods only occurred in first-year seedlings. In the present experiments, however, there were no distinct differences in the duration of growth between the seedlings in their first and second year of growth when grown at a constant temperature of 20°C. Apparently the variation in the duration of growth in first-year seedlings under long days is affected by the light conditions.

Finally it should be noted that in the Earhart Laboratory the effect of both day and night temperature on the growth of tomato, Chili pepper and tobacco has been studied extensively (2, 3, 8). It was found that at first the rate of growth of the stem was highest at fairly high constant temperatures. As the plants became taller, however, the optimal night temperature shifted to a lower temperature, resulting in a more rapid growth at alternating than at constant temperatures. However, within the temperature range studied in the experiments reported in this paper, no effect of the night temperature on the growth rate of the plants was observed.

SUMMARY

In the phytotron of our Institute the effect was studied of different day and night temperatures on the shoot growth of first- and second-year seedlings of Limburgse Boskriek (*Prunus avium* L.) grown under natural daylength conditions.

It was found that, after termination of growth, significant differences occurring simultaneously in shoot length and leaf number between the temperature treatments were mainly due to the effect of the day or night temperature on the duration of growth. In some cases these differences were also influenced by the effect of temperature on the rate of growth. Within the range of temperatures studied, no effect of the night temperature on the rate of growth was observed.

SAMENVATTING

Invloed van de temperatuur op de scheutgroei van kersezaailingen

In het fytotron van ons Instituut werd de invloed bestudeerd van verschillende dagen nachttemperaturen op de scheutgroei van zaailingen van Limburgse Boskriek (*Prunus avium* L.) in hun 1e en 2e groeijaar onder een natuurlijke daglengte.

Gebleken is dat, na het afsluiten van de groei, betrouwbare gelijktijdig voorkomende verschillen zowel in scheutlengte als aantal bladeren tussen de temperatuurbehandelingen in hoofdzaak het gevolg zijn van de invloed van de dag- of nachttemperatuur op de duur van de groei. In enkele gevallen werden deze verschillen ook beïnvloed door het effect van de temperatuur op de groeisnelheid. In het onderzochte temperatuurgebied werd geen invloed waargenomen van de nachttemperatuur op de groeisnelheid.

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