QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 595

EFFECT OF TEMPERATURE ON THE PRECLIMACTERIC LIFE OF PEARS

By B. C. PEACOCK, B.Sc., and J. R. BLAKE, B.Sc.

SUMMARY

Temperature reduction increases the preclimacteric life of pears by about the same proportion as has been shown for post-climacteric life by other authors. The onset of the climacteric rise in respiration may be inhibited by temperatures as low as 15°C.

I. INTRODUCTION

The general effect of temperature on the storage life of fruit has been extensively studied (Wardlaw 1937; Wright, Rose and Whiteman 1954). In such investigations, however, the end of storage life has been assessed in terms of senescence characteristics such as edibility (Tindale, Trout and Huelin 1938), susceptibility to fungal attack (Kidd and West 1936*a*) or the development of a physiological disorder such as internal breakdown in apples (Kidd and West 1936*a*). Assessments of this nature frequently overlook the fact that during storage a fruit may pass through several distinct physiological states, during which temperature may exert markedly different effects.

Kidd and West (1936*b*), however, in a study on pears, recognized this possibility and differentiated between the climacteric and preclimacteric state. They determined the effect of temperature on the climacteric life of pears where this was measured as the time from the onset to the peak of the climacteric rise in respiratory activity. From the results of storage trials they also concluded that temperature had little effect on the preclimacteric life of these fruits. Since this is contrary to results obtained with bananas (Peacock and Blake 1970), a small investigation aimed at clarifying the situation was conducted. This paper deals with the results of this investigation.

II. MATERIALS AND METHODS

Two experiments were carried out, one in the 1967-68 pear season and one in the 1968-69 season.

1967-68.—In this experiment the temperatures used were −1.1, 4.4, 10, 15.6 and 21.2°C. All pears were selected to be as uniform in size as possible. Twelve pears were stored individually in ventilated containers under high humidity at each of the three higher temperatures, 10, 15.6 and 21.2°C. Respiration rate of these fruit was measured daily and the time to the onset of ripening (green-life) determined.

Two other samples of pears were held at −1.1 and 4.4°C in bulk containers which were ventilated with humidified air at a rate equivalent to 50 ml/min/fruit. After each of the following periods of storage: 1, 5, 11, 14, 18, 21, 25, 28 and 31 days, five fruit were removed from each container and held individually at 20°C in ventilated containers. The respiration rates of these fruit were measured daily for 5-7 days. From the resultant respiratory patterns an estimate was made of the average time taken for the fruit to enter their climacteric at −1.1 and 4.4°C.

1968–69.—In this trial a wider range of temperatures was used, viz. 0, 5, 10, 15, 20, 25, 30, and 35°C. Green-life at 0 and 5°C was estimated by removing samples to 20°C and following their respiratory behaviour for 5 days. To improve the accuracy of this estimate these samples contained 30 fruit, as against 5 used in 1967-68. Six pears were held continuously at each of the other temperatures. Attempts were made to measure green-life of individual fruits directly at 0 and 5°C. However, respiration rates were so depressed that it was impossible to estimate the onset of the climacteric rise.

III. RESULTS AND DISCUSSION

The mean green-lives, showing standard deviations, obtained at each temperature are shown in Table 1. Over the range 0-10°C, the data clearly show that temperature does have a marked effect on the preclimacteric period. This is contrary to the observation by Kidd and West (1936*b*) but in agreement with observations on bananas (Peacock and Blake 1970). Above 15°C, green-life increased markedly with temperature. That all fruit are not affected to the same extent is clearly shown by the sudden increase in standard deviation (Table 1) above this temperature.

TABLE 1

MEAN GREEN-LIVES, WITH STANDARD DEVIATIONS, OBTAINED AT EACH STORAGE TEMPERATURE

1967–68 season							
Storage Temperature (°C) ..	−1·1	4·4	10	15·6	21·1		
Mean Green-Life (days) ..	25	11	6·6	6·6	22·4		
S.D.	—	—	1·28	6·23	16·33		
1968–69 Season							
Storage Temperature (°C) ..	0	5	10	15	20	25	30
Mean Green-Life (days) ..	32	16	12·7	10·1	23·1	26·6	92·8
S.D.	—	—	1·69	2·12	13·05	19·96	23·77

NOTE.—No estimate of S.D. at the temperatures of −1·1, 4·4 and 5°C can be given because of the method used to estimate green-life at these temperatures—see text.

Up to about 10°C, the relationship between green-life (g) and temperature (θ) is closely represented by the formula $1/g = b\theta$ (Figure 1). The regression coefficients for this relationship are shown in Table 2. Kidd and West (1936*b*) found that the effect of temperature on the climacteric life of pears and apples also followed this relationship. An approximate coefficient obtained from their data is also shown in Table 2. A comparison of these coefficients shows that, at least for pears, the effect of temperature in the preclimacteric state is very similar to its effect in the climacteric state.

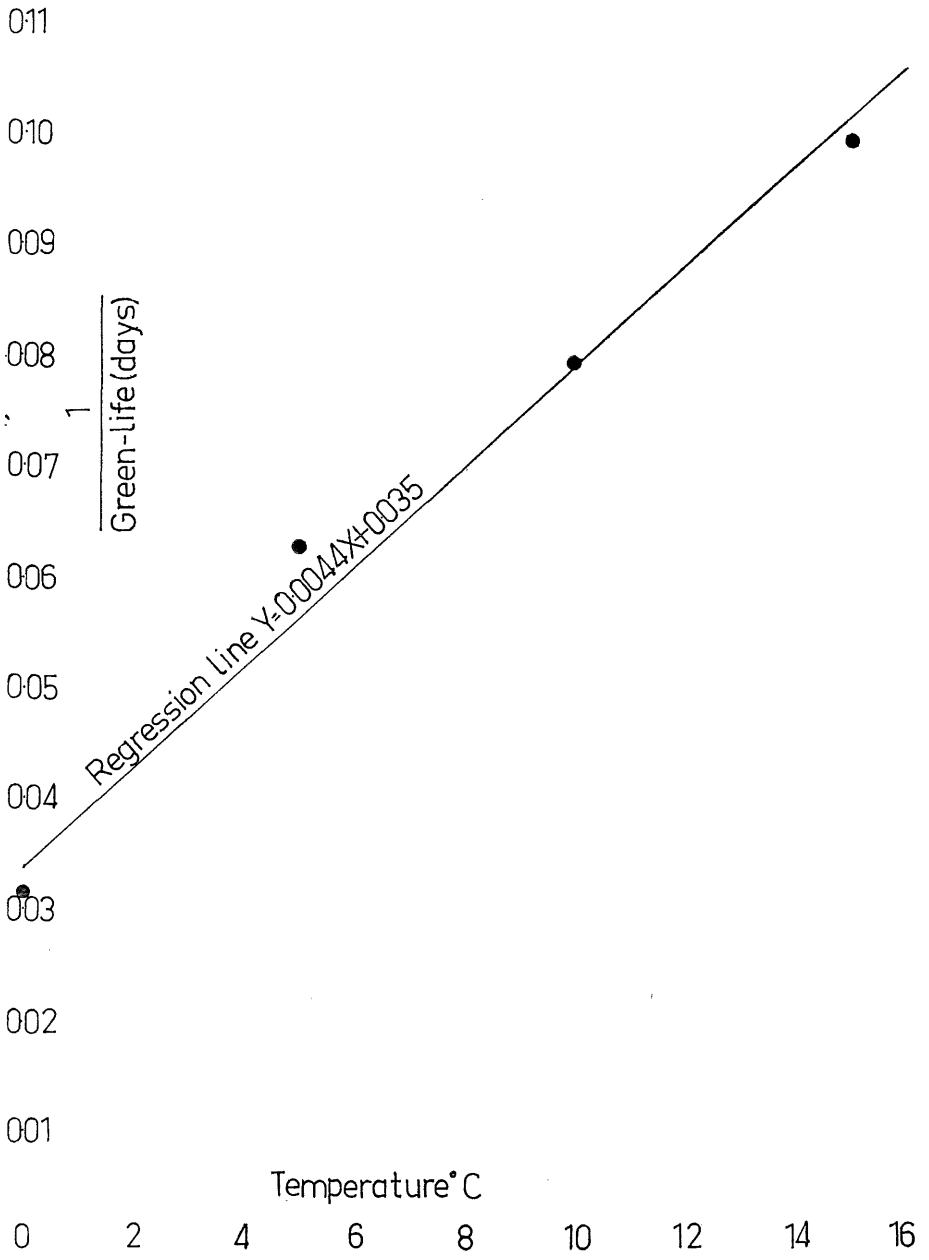

Fig. 1.—Relationship between temperature and 1/g.

TABLE 2

REGRESSION COEFFICIENTS FOR THE RELATION BETWEEN GREEN-LIFE AND TEMPERATURE SHOWN IN COMPARISON WITH DATA OF KIDD AND WEST (1936)

Data	*Regression Coefficient (1/g against T)
1967–68 season	0·0100
1968–69 season	0·0044
Kidd and West (1936)	0·0048

* For the data of 1967–68 and 1968–69, g = green-life in days, while for the data of Kidd and West (1936), g = time from the onset to the peak of the climacteric in days.

High-temperature inhibition of ripening was probably first reported by Shamel (1917), who observed that Bartlett pears remained in a hard green condition for 30 days when held at temperatures of the order of 90°F. He thought the effect was due to the high relative humidity in which they were held, basing this belief partly on the observation that the calyces of lemons held under similar conditions "retained their original green colour and living condition even during long periods of storage". The lemons themselves remained in extremely good condition.

Retardation of ripening at high temperatures has been reported for plums (Fidler and Furlong 1949), pears (Overholzer and Taylor 1920; Ulrich 1961) and tomatoes (Craft and Heinze 1960), while other authors have described abnormal ripening at high temperatures in pears (Kidd, West and Trout 1932), plums (Uota 1955) and bananas (Gane 1936). Burg (1962) stated that many fruits, if not all, are unable to produce ethylene at temperatures above approximately 35°C and suggested that this may be reflected in the failure of many fruits to ripen normally above 30 to 35°C. This could explain the results reported here. However, the low temperature (20°C) at which the effect is first obvious suggests that either the ethylene production of some fruit can be effected at temperatures well below 35°C or the high temperatures are retarding some other process critically involved in the initiation of the climacteric. The effect may well be occurring as low as 15°C, since the data obtained in 1967-68 show no reduction in green-life when the temperature was raised from 10 to 15.6°C. The first of these alternatives is probably the most likely, since Ulrich (1961) showed inhibition of ripening that occurs with Passe-Crassane pears at 18°C can be overcome by the application of ethylene. A similar effect has been reported for Kelsey plums (Furlong and Fidler 1949).

IV. ACKNOWLEDGEMENT

The assistance of Miss J. M. Cushing in carrying out respiratory determinations is gratefully acknowledged.

REFERENCES

BURG, S. P. (1962).—The physiology of ethylene formation. *A. Rev. Pl. Physiol.* 13:265-302.

CRAFT, C. C., and HEINZE, P. H. (1960).—Effect of storage temperatures and treatments on respiration and ethylene production by tomatoes. A.I.B.S. Meeting, Stillwater, Oklahoma 1960.

FIDLER, J. C., and FURLONG, C. R. (1949).—The effect of exposure to a temperature of 26·7°C (80°F) on the quality of Kelsey plums. *Rep. Fd Invest. Bd* for 1939:70.

FURLONG, C. R., and FIDLER, J. C. (1949).—The effect of acetylene and ethylene on the ripening of South African Kelsey plums. *Rep. Fd Invest. Bd* for 1939:70-2.

GANE, R. (1936).—A study of the respiration of bananas. *New Phytol.* 35:383-402.

KIDD, F., and WEST, C. (1936*a*).—Temperature and duration of life in apples. *Rep. Fd Invest. Bd* for 1935:97-101.

KIDD, F., and WEST, C. (1936*b*).—The cold storage of English-grown Conference and Doyenne de Comice pears. *Rep. Fd Invest. Bd* for 1935:85-96.

KIDD, F., WEST, C. and TROUT, S. A. (1932).—The gas storage of pears. *Rep. Fd Invest. Bd* for 1931:92-9.

OVERHOLZER, E. L., and TAYLOR, R. H. (1920).—Ripening of pears and apples as modified by extreme temperatures. *Bot. Gaz.* 69:273.

PEACOCK, B. C., and BLAKE, J. R. (1970).—Some effects of non-damaging temperatures on the life and respiratory behaviour of bananas. *Qd J. agric. Anim. Sci.* 27:147-68.

SHAMEL, A. D. (1917).—Some observations upon the relation of humidity to the ripening and storage of fruits. *Mon. Bull. Calif. St. Comm. (n) Hort.* 6 (2):39-41.

TINDALE, G. B., TROUT, S. A., and HUELIN, F. E. (1938).—Investigations on the storage, ripening and respiration of pears. *J. Dep. Agric. Vict.* 36:34-52, 90-104.

ULRICH, R. (1961).—Temperature et maturation. Le cas des poires necessitant un traitement prealable par le froid. *Fruits d'outre Mer* 16 (1):3-8.

UOTA, M. (1955).—Effect of temperature and ethylene on evolution of carbon dioxide, ethylene and other oxidizable volatiles from three varieties of plum. *Proc. Am. Soc. hort. Sci.* 65:231-43.

WARDLAW, C. W. (1937).—Tropical fruits and vegetables: An account of their storage and transport. *Mem. low Temp. Res. Stn Trin.* No. 7.

WRIGHT, R. C., ROSE, D. H., and WHITEMAN, T. M. (1954).—The commercial storage of fruits, vegetables, and florist and nursery stocks. *Agric. Handb. U.S. Dep. Agric.* No. 66.

(Received for publication April 2, 1971)

The authors are officers of Horticulture Branch, Queensland Department of Primary Industries, and are stationed at the Sandy Trout Food Preservation Research Laboratory, Brisbane.