QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 416

EFFECT OF TEMPERATURE ON THE POST-HARVEST DETERIORATION IN QUALITY OF BEANS

By M. D. LITTMANN, B.Sc.

SUMMARY

Seed size increased at both 70 and 55°F, and fell after an initial rise at 38°. Fibre content increased at 70°, and although regression lines at 55 and 38° did not differ significantly from zero, mean fibre over all days was greater at 55 than at 38° F.

The importance of temperature on the deterioration of pods prior to marketing was illustrated by an assessment of quality utilizing Queensland grade standards for fresh beans.

I. INTRODUCTION

Beans grown in Queensland, whether marketed locally or transported to southern markets, are consumed several days after harvest, and although the characteristics of quality of pods at harvest are well appreciated, there is little information in the literature on changes in quality characteristics after harvest.

At harvest, the most frequently used objective characters for assessment of quality are seed size and texture, and investigations covering these factors are well documented. Gould (1950) and Ross, Brekke, and Moore (1956) have assessed varieties for processing purposes, Gould (1951) has observed the effects of processing treatments on quality, and investigations into maturity at harvest have been conducted by Culpepper (1936), Stark and Mahoney (1942), and Board and Coote (1959). Seed size, based on seed lengths of $\frac{1}{2}$ in. and $\frac{3}{8}$ in., is prescribed in the grade standard regulations for fresh beans in Queensland.

There are very few data, however, on changes in physical factors after harvest. Changes in chemical composition have been studied by Parker and Stuart (1935) and Guyer, Kramer, and Ide (1950) and under modified atmospheres by Platenius and Jones (1944) and Groeschel, Nelson and Steinberg (1966). Guyer, Kramer, and Ide (1950) also followed physical changes, but found little or no effect on seed or fibre contents during storage for 10 days at 35, 50 or 70°F. H. M. Groszmann (personal communication 1964) showed that relatively large increases in seed size occur after harvest. Tests conducted in this laboratory have also shown significant post-harvest increases in seed size and fibre.

The purpose of this work was to investigate the effects of temperature on seed and fibre development after harvest.

II. MATERIALS AND METHODS

All beans used in the experiments were *Phaseolus vulgaris* L. cv. Redlands Belle, harvested from properties of commercial growers in the Cleveland area, near Brisbane. The pods were brought to the laboratory on the morning of harvest, and all infected, broken or misshapen beans were rejected.

In the seed-size experiment, pods containing fewer than four seeds were also rejected. Samples of 50 pods were taken and placed at three storage temperatures (38, 55 and 70°F). Removals were made three times per week over a period of 2 weeks. Total seed fresh weight was measured for each pod to 0·001 g and the average seed fresh weight then calculated. Seeds were dried in a vacuum oven at 80°C overnight, and the average seed dry weight then calculated.

Fibre was determined using the method of Rowe and Bonney (1936) with slight modifications. To avoid dilution of the caustic soda solution by the moisture of the fresh bean compared with partly dried out pods, all samples, after pulping, were made up to a constant volume with water. Evenness of samples was improved by calculating average pod weight and the number of average pods per 100 g. All samples were then weighed to contain the same number of pods, and to have an original fresh weight of $100 \pm 0\cdot5$ g. Samples were stored at 38, 55 and 70°F respectively and removals made three times per week over a period of 2 weeks.

III. RESULTS

Fresh and dry seed weights are plotted against time of storage at three temperatures in Figures 1 and 2. Each point represents an average of 50 pods and about 260 seeds.

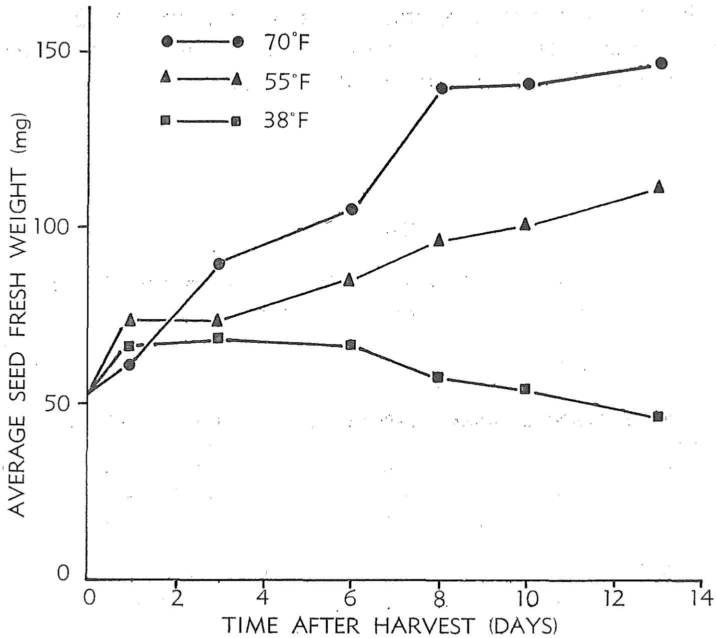

Fig. 1.—Effect of temperature on seed fresh weight development.

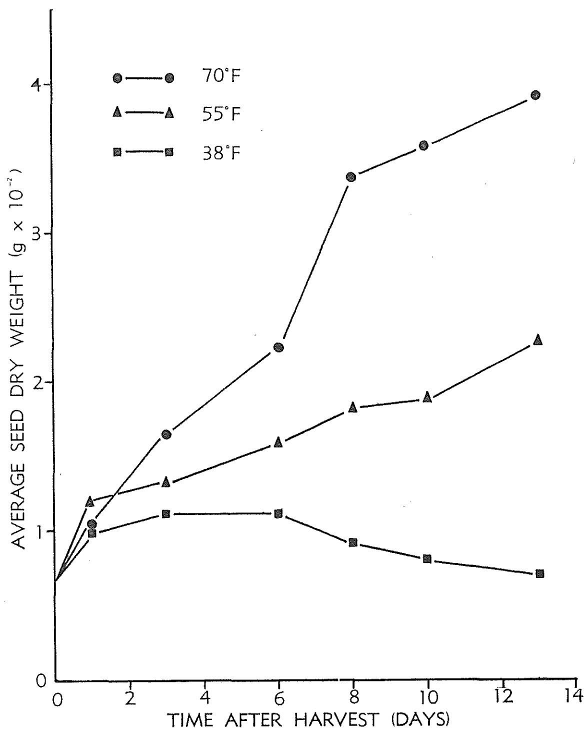

Fig. 2.—Effect of temperature on seed dry weight development.

The relationship between average seed weight and quality, as assessed by Queensland grade standards for fresh beans, is shown in Table 1. The percentages given are based on samples of 50 pods.

TABLE 1

PERCENTAGE OF PODS WITH AVERAGE SEED FRESH WEIGHT GREATER THAN 0·11 g AND 0·27 g AND ASSOCIATED GRADE RATING*

Temperature	38°F			55°F			70°F		
Days in Store	%>0·11 g	%>0·27 g	Grade	%>0·11 g	%>0·27 g	Grade	%>0·11 g	%>0·27 g	Grade
0	4	0	A	4	0	A	4	0	A
1	8	2	A	14	0	B	4	0	A
3	10	2	A	8	2	A	32	2	B
6	10	2	A	16	2	B	38	2	B
8	8	0	A	30	0	B	56	6	B
10	4	2	A	36	2	B	66	4	B
13	2	0	A	42	8	B	72	0	B

* Queensland grade standards for French beans are contained in " The Fruit and Vegetable Grading and Packing Regulations of 1960." For A grade beans, the total number of beans in any lot having an average seed length greater than three-eighths of an inch shall not exceed 10% of the total number of beans. For B grade beans, the total number of seedy beans (beans having an average seed length greater than half an inch) shall not exceed 20%.

Weights were much easier to measure accurately than length, and by substitution in equations to regression lines drawn through suitable segments of a seed length/seed weight graph (Figure 3), seed lengths of one-half and three-eighths of an inch were found to correspond to 0·27 and 0·11 g respectively. These values are to the nearest 0·01 g. Equations to the regression lines are:—

$$y = 0{\cdot}2592 + 1{\cdot}0952\ x$$

$$y = 0{\cdot}3000 + 0{\cdot}7355\ x$$

where y = seed length and x = seed weight

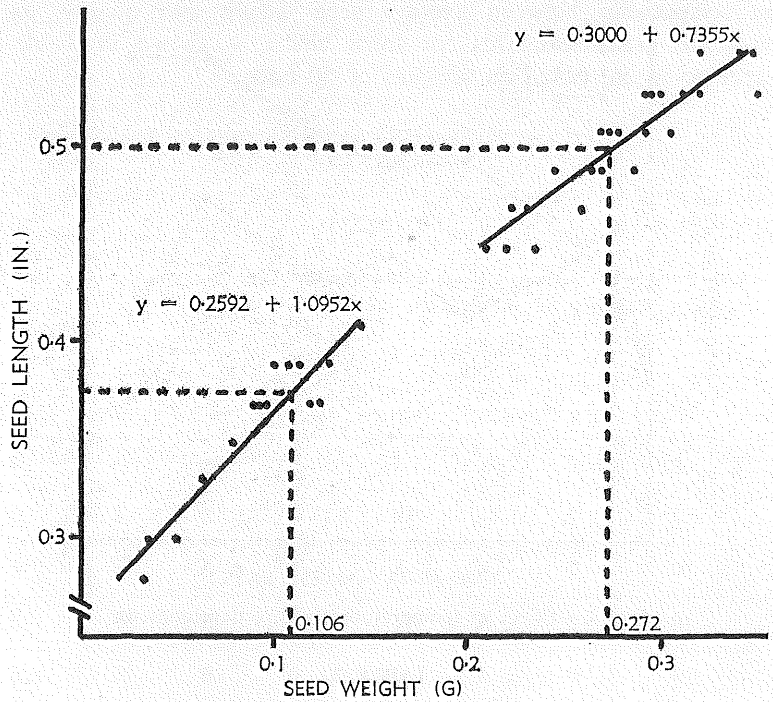

Fig. 3.—Regression lines relating seed weight and length.

Fibre content (Figure 4) is expressed as a percentage of the original fresh weight. Each point represents an average of eight samples of 100 g original fresh weight, and each sample contains 16 pods. The regression lines are dotted and equations to them are:—

70°F $y = 0 \cdot 160253 + 0 \cdot 005926x$

55°F $y = 0 \cdot 153863 + 0 \cdot 001133x$

38°F $y = 0 \cdot 142162 - 0 \cdot 000732x$

where y = percentage fibre, and x = time. More accurately, regression coefficients are:—

70°F $b = 5 \cdot 926 \pm 1 \cdot 001$

55°F $b = 1 \cdot 133 \pm 1 \cdot 298$

38°F $b = -0 \cdot 732 \pm 1 \cdot 261$

and significance relationships between these, and between each with zero slope, are given in Table 2.

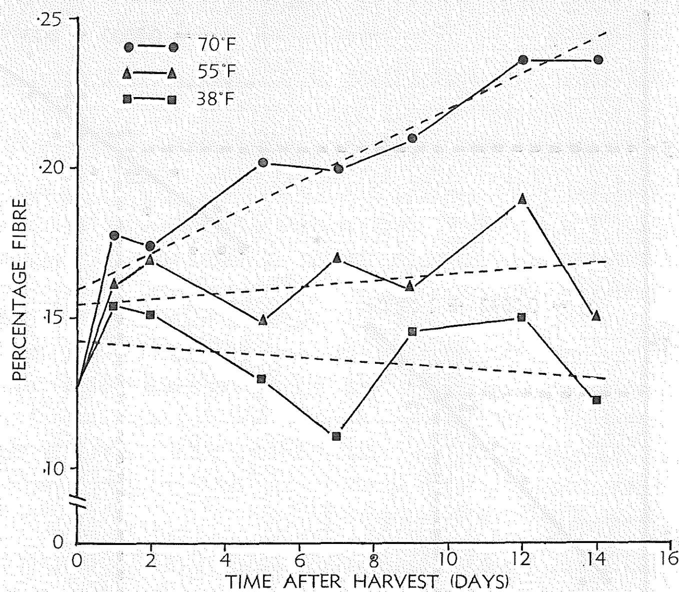

Fig. 4.—Effect of temperature on fibre development.

TABLE 2

Percentage Levels of Significance for Comparisons of Fibre Regression Values

—	b_{70}	b_{55}	b_{38}	b = 0
b_{70}	. .	5	1	1
b_{55}	5	. .	N.S.	N.S.
b_{38}	1	N.S.	. .	N.S.

A further comparison, performed between mean fibre values at 55 and 38°F, over all days, gave a mean difference of 0·02673 ± 0·00702, which is significantly different at the 1% level.

IV. DISCUSSION

From Figures 1 and 2 it is apparent that seeds change in both fresh and dry weight with time, and that the rate of change is significantly affected by temperature. After 13 days' storage at 70°F, mean fresh weight of seed had increased to three times, and dry weight to five times, its original value. Both were still increasing, although the rate of increase was falling. At 55°, both fresh and dry seed weight more than doubled, and the rate of increase was still being maintained. At 38°, both weights increased slightly over the first 3 or 4 days, and then fell continuously during the remainder of the experiment. This behaviour may be a result of chilling, because the time in store at which seed losses begin coincides roughly with the appearance of chilling symptoms.

The effect of seed size changes on quality is illustrated in Table 1, where seed weights are related to the Queensland grade standards.

In this experiment, storage periods of 3 days at 70° and 6 days at 55° were excessive. At no time had the pods stored at 38° become seedy enough to be classed as B grade, though seediness was high at 3-6 days from harvest. No sample increased sufficiently in seed weight to be rejected as B grade.

From Figure 3 it is evident that changes in fibre occur with time, and are dependent on temperature. Since variability is high, tests for significance were conducted. Significant differences (Table 2) were found between the 70° and the 55° regression line slopes, and also between those of 70° and 38°. No differences in slope exist between the 38° and 55° figures, nor do either differ significantly from zero. However, trends are in evidence which conform to the pattern of development found in seed weights, and at each removal average fibre percentage (F) follows the relationship $F_{70} > F_{55} > F_{38}$. Also, a highly significant difference was found between fibres at 55° and 38° when mean differences between them, over all days, were compared.

It is concluded that time and temperature have marked effects on the development of both seed and fibre after harvest, and that the prevention of heating after harvest is of considerable importance in the maintenance of quality.

V. ACKNOWLEDGEMENT

Acknowledgement is due to Miss E. Goward of the Biometrics Branch for the statistical analyses and for much helpful discussion of the work.

REFERENCES

BOARD, P. W., and COOTE, G. G. (1959).—The maturation of green stringless bush beans. *Tech. Pap. Div. Fd Preserv. Transp. C.S.I.R.O. Aust.* No. 12.

CULPEPPER, C. W. (1936).—Effect of stage of maturity of the snap bean on its composition and use as a food product. *Fd Res.* 1:357-76.

GOULD, W. A. (1950).—Seed length is good measure of maturity for snap beans. *Fd Pkr* 31 (8):54-5.

GOULD, W. A. (1951).—Quality evaluation of fresh, frozen and canned snap beans. *Res. Bull. Ohio Agric. Exp. Stn* No. 701.

GROESCHEL, E. C., NELSON, A. I., and STEINBERG, M. P. (1966).—Changes in colour and other characteristics of green beans stored in controlled refrigerated atmospheres. *J. Fd Sci.* 31:

GUYER, R. B., KRAMER, A., and IDE, L. E. (1950).—Factors affecting yield and quality measurements of raw and canned green and wax beans—a preliminary report. *Proc. Am. Soc. Hort. Sci.* 56:303-14.

PARKER, M. W., and STUART, N. W. (1935).—Changes in the chemical composition of green snap beans after harvest. *Bull. Md Agric. Exp. Stn* No. 383.

PLATENIUS, H., and BROWN JONES, JOSEPHINE (1944).—Effect of modified atmosphere storage on ascorbic acid content of some vegetables. *Fd Res.* 9:378-85.

ROSS, E., BREKKE, J. E., and MOORE, J. F. (1956).—The objective evaluation of some green bean varieties used for processing in the North West. *Proc. Am. Soc. Hort. Sci.* 67:398-411.

ROWE, S. C., and BONNEY, V. B. (1936).—A study of chemical and physical methods for determining the maturity of canned snap (stringless) beans. *J. Ass. Off. Agric. Chem.* 19:620-8.

STARK, F. C., Jr., and MAHONEY, C. H. (1942).—A study of the development of the fibrous sheath in the side wall of edible snap bean pods with respect to quality. *Proc. Am. Soc. Hort. Sci.* 41-351-9.

(Received for publication January 6, 1967)

The author is an officer of the Food Preservation Research Branch, Division of Plant Industry, Department of Primary Industries, and is stationed at the Food Preservation Research Laboratory, Hamilton, Brisbane.