Neth. J. agric. Sci. 17 (1969) 272—278

Maturation in peas. II. Spread in maturity

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Received 2 April 1969

Summary

It is shown that a good impression can be obtained of the spread in maturity within a crop of green peas at 'optimal harvest date' by applying the method described in Part I, which is based on the visual maturity of individual pods.
It is shown that differences between varieties exist, but also that varieties show differences in reaction to growing conditions.
At optimal harvest date, an appreciable proportion of pods contain peas which are too old but also a considerable proportion of pods contain peas which are far too young. Therefore, under commercial conditions of once-over harvest, the actual yield of good quality peas stays far below the potential yield.

Introduction

In Part I of this publication (Schippers, 1969) a description was given of a method to assess the maturity of green peas by visual classification of the maturity of their pods. An advantage of this method, particularly for selection purposes in breeding work, would be that it would offer the possibility to obtain information on the spread of maturity within a crop.
Current methods indicating maturity, such as the determination of the content of alcohol-insoluble solids or of the mechanical resistance of peas by instruments, give only average values, but do not tell anything about the spread in maturity of the individual peas in the sample.
With the present practice to harvest for processing purposes all peas of a crop mechanically in one operation, the spread in maturity becomes of utmost importance. It makes a considerable difference whether, at a certain level of alcohol-insoluble solids or tenderometer value, the crop contains large or small proportions of peas which are too old, since the quality of a sample, as experienced by the consumer, is not simply the weighted average of the quality of the individual peas, but is strongly determined by the number of peas which are too old, as a relatively small proportion of starchy peas is sufficient to render the sample unpalatable.

Materials and methods

The plant material was the same as described in Part I of this publication.
After harvest, pods were classified in maturity groups according to the method de-

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scribed previously. Pods and seeds in each group were counted and weighed and the alcohol-insoluble solids (AIS) content of the peas of each maturity group was determined. After weighting pods of maturity *c* by a factor 1, those of maturity *d* by a factor 2, those of maturity *e* by a factor 3, etc., the sample standard deviation of visual maturity could be calculated and this was used as an estimate for the spread in maturity.

Results

Relation between visual maturity of pods and AIS of seeds

Before being able to use the sample standard deviation of the visual maturity as an estimate of the spread in maturity, it is necessary to know how the relation is between the visual maturity of pods and the AIS content of their seeds. This relation should be

Table 1 Relation between maturity of pods and AIS of seeds

Variety	*Year*	*Harvest date*	*Number of observations*	*Correlation coefficient*	*b* *	*C* **
CDSP	1964	21/12	10	.990	4.32	7.97
	1965	13/12	18	.966	3.65	6.85
	1965	15/12	18	.946	3.57	8.13
	1965	17/12	18	.911	3.23	13.55
Gf	1964	21/12	6	.957	2.65	8.90
	1964	23/12	11	.992	3.45	7.47
	1965	13/12	17	.977	3.01	6.00
	1965	15/12	18	.974	3.10	6.73
	1965	17/12	18	.975	3.39	4.96
L2	1964	14/12	11	.993	4.41	4.70
	1964	17/12	12	.983	3.89	6.34
	1965	9/12	15	.986	3.61	5.33
	1965	14/12	18	.970	3.69	5.23
	1965	16/12	18	.973	3.53	5.85
VF	1964	16/12	8	.991	3.56	6.25
	1964	21/12	11	.989	3.63	7.10
	1965	8/12	15	.966	3.06	6.46
	1965	10/12	15	.976	3.38	5.80
	1965	14/12	17	.964	3.14	6.94
WM	1964	4/12	7	.963	3.52	7.44
	1964	8/12	10	.974	4.23	7.40
	1964	11/12	11	.976	4.20	7.77
	1965	29/11	11	.957	4.23	5.22
	1965	1/12	12	.962	4.22	5.37
	1965	6/12	17	.963	3.61	6.45
TB	1966	11/11	17	.948	2.74	4.90
	1966	14/11	17	.972	2.77	5.64
	1966	18/11	30	.975	2.57	7.07
	1966	22/11	34	.960	2.91	6.87

* Stage c = 1, stage d = 2, etc. (see Part I)
** AIS (%) = b × Mat. + C

very close and preferably rectilinear. In Table 1 data are given based on at least four maturity classes for various harvest dates.

As deviations from linearity were significant in none of the samples in 1964 and 1965, it follows that the visual classification has been satisfactory. In 1966 deviations from linearity were significant at the 5 % level for three of the four dates but a clear curvilinearity was not visible.

A further statistical analysis was carried out to see whether the slopes and/or elevation of the lines within varieties were constant. Fig. 1 gives the results of the topbearing selections of 1966 at various harvest dates. Differences in elevation were highly significant, but differences in slope were not. Evidently, earlier in the season peas from pods with a certain maturity had a lower AIS content than peas from pods of the same maturity later in the harvesting period. Since the same result was found in the majority of varieties, although more frequently in 1964 than in 1965, it seems certain that a systematical influence is at work. The fact, however, that the regression lines always run parallel means that the spread in maturity within a variety, expressed as standard deviation of visual maturity, represents an equivalent variation in AIS throughout the harvesting period.

If varieties are to be compared with respect to the relation between visual maturity of the pods and AIS of the peas, it is necessary to eliminate the influence of differences in maturity. Therefore, a regression analysis has been made with only the results of the harvests which were close to optimal harvest dates (Fig. 2 [1]).

Curvilinearity was only significant in 1965 in Line 2, the AIS increasing at slightly accelerated rate as visual maturity of pods proceeded.

Although the regression coefficients in the samples of 1964 were all higher than in the samples of the same varieties in 1965, only the differences in Victory Freezer and Line 2 were significant, indicating that in 1964 the lines of these varieties were steeper than in 1965. The differences in elevation of the lines, however, were all significant with the exception of Greenfeast. This means that in 1964 a certain maturity of the

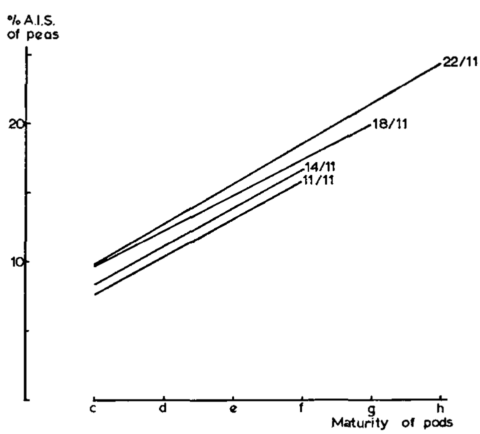

Fig. 1 Relation between visual maturity of pods and average AIS content of the peas from these pods at various harvest dates of 'topbearing' selections in 1966.

[1] It should be kept in mind that the AIS determination was done with a simplified method (see Part I) resulting in figures which were two or three percentage units higher than was obtained with the official method.

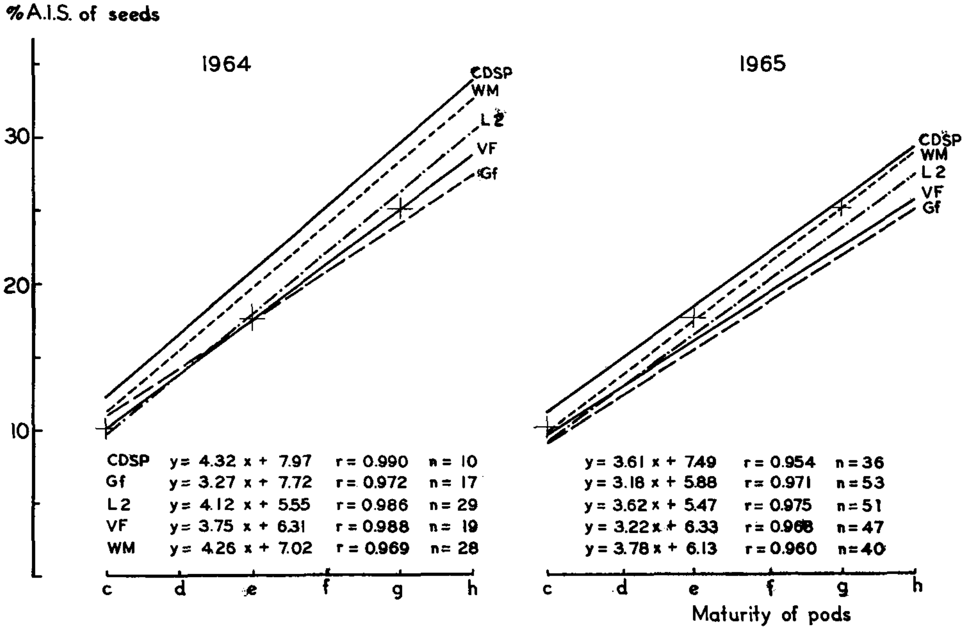

Fig. 2 Relation between visual maturity of pods and average AIS content of the peas from these pods for different varieties.

pods was accompanied by a higher percentage of AIS than in 1965.

If varieties within each year are compared, the statistical analysis shows that in 1964 the regression coefficient of Greenfeast was smaller than those of the other varieties, with the exception of Victory Freezer, and that in 1965 these two varieties had a more horizontal position than the remaining ones. With regard to the elevation of the lines, two groups can be discerned in 1964 (CDSP and WM high, L2, VF and Gf lower) and three in 1965 (CDSP and WM high, Gf low, L2 and VF at an intermediate level).

The relative behavior of the varieties in both years is strikingly similar, which indicates that the difference between varieties was not due to shortcomings of the visual method of maturity judgment but to the fact that the relation between maturity of the pods and maturity of the peas was different for different varieties. It can be seen in Fig. 2 that in the stages of maturity in which the peas should be harvested, the difference in AIS may be as great as 2 to 3 percentage units if pods of different varieties but the same visual maturity are compared.

The most important result in relation to the topic under discussion is that although quantitatively the relation between visual maturity of pods and AIS of seeds may be different from year to year or from variety to variety, the parallelism of the lines indicates that a certain spread in visual maturity will give a clear indication of the variation of maturity of the seeds within a crop.

The course of the spread in maturity during the harvesting period

Shortly after flowering, the peas which have been formed first will be in stage *c*. At that moment the spread in maturity will be zero. As these pods move on to the following stages, the spread in maturity will rise, since a continuous supply of younger pods is maintained. The maximum spread in maturity will be found at the time that the youngest peas are in stage *c* and the oldest ones have advanced to stage *g*, *h* or even further. As the supply of pods of stage *c* stops, the spread in maturity will decrease till all pods are in stage *j*, and at that moment the spread of maturity is again zero.

An illustration is given in Fig. 3, prepared from the results of Line 2 in 1965. This variety has been chosen since five harvests were carried out at dates which were not too close.

Optimal harvest date is situated on the rising part of the curve and in the lower half of the figure it can be seen that at that moment the spread in maturity was 1.29, based on 993 pods. Assuming that stages *c*, *d* and *e* represent the peas with good eating quality, the conclusion is that 18 % of the pods contained peas which were too old. Since peas in these pods are heavier than those in the younger pods, the proportion by weight of peas of inferior quality in the crop was even higher. Five days after optimal harvest dates the proportion of pods containing overmature peas was 50 %.

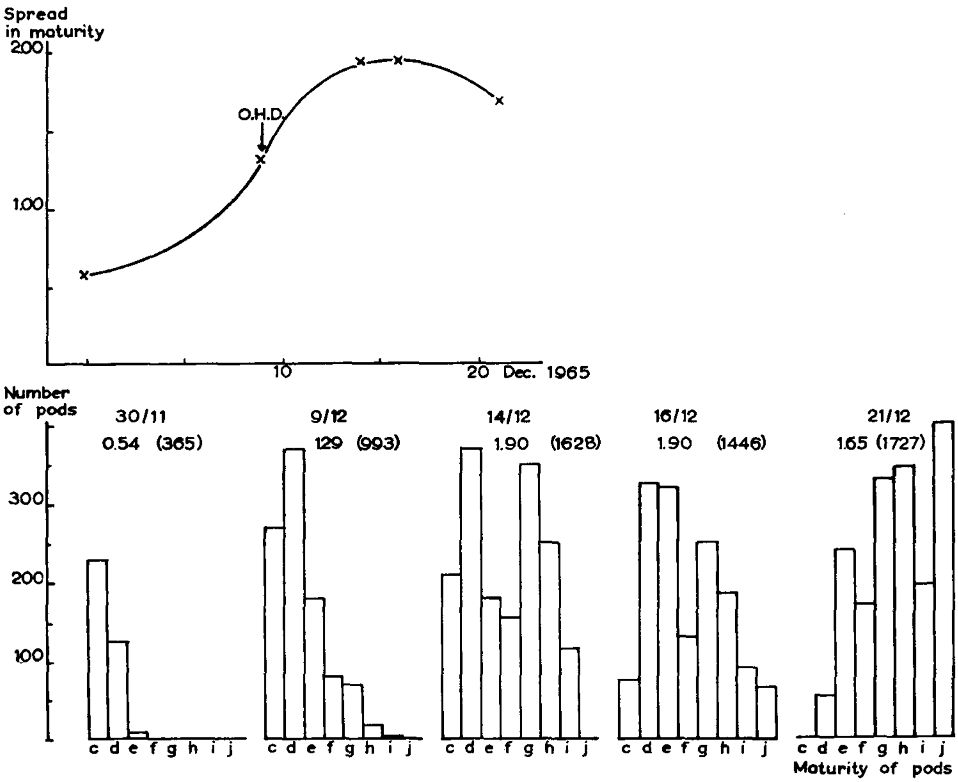

Fig. 3 *Course of the spread in maturity during maturation (top) and the maturity distribution of pods (bottom) at various harvest dates of Line 2.*

*Table 2 Spread in maturity (σ) and % overmature pods at OHD (= 12 % AIS) or at maturity * 2.20*

Variety	*At 12 % AIS* σ	*At 12 % AIS* % pods in stage f–j	*At maturity 2.20* σ	*At maturity 2.20* % pods in stage f–j
1964				
CDSP	0.75	1.4	0.99	10.4
Gf	0.97	8.2	0.94	1.8
L2	0.90	7.2	1.00	8.8
VF	0.89	8.7	0.92	9.9
WM	0.79	2.9	1.09	13.4
1965				
CDSP	1.27	18.9	1.32	23.9
Gf	1.41	27.9	1.34	23.8
L2	1.24	32.3	1.14	29.7
VF	1.27	19.4	1.30	21.6
WM	0.94	9.9	0.94	8.8

* Stage c = 1, stage d = 2, etc.

The spread in maturity at optimal harvest date

The spread in maturity at optimal harvest date for the five varieties in 1964 and 1965 was found with the help of graphs similar to the upper half of Fig. 3. If optimal harvest date (OHD; see Part I) did not coincide with one of the actual harvest dates, it was found by interpolation. Table 2 gives the spread in maturity at optimal harvest date and the percentages of pods containing overmature peas. This table shows that in 1964 the spread in maturity at OHD was much smaller than in 1965. It seems also that in 1964 the spread in maturity was greater on the date that the average maturity was 2.20 than on OHD (12 % AIS). An explanation for this phenomenon, which occurred particularly in the varieties CDSP and WM, can be found in Part I.

An analysis of variance showed that the influences of year and variety and their interaction were highly significant. This holds for the results at OHD, as well as for the results of the date that average maturity of the pods was 2.20. WM showed the smallest spread in maturity, significantly less than L2, and latter variety significantly less than the remaining three varieties. The significance of year means that growing conditions had a certain influence on the spread in maturity, but the significance of the interaction between year and variety indicates that varieties did not react in the same way or to the same degree.

The results in Table 2 show that in 1964 less than 10 % of the pods were overmature but in 1965 this percentage was far higher. L2 gave an interesting result in 1965 in that its spread in maturity was only intermediate in spite of its high percentage of overmature pods. The explanation of this is that nearly all of the overmature peas were in class *f*, whereas in some other varieties which had a lower percentage of overmature pods, many pods were in maturity classes *g*, *h* or even higher.

How much of the yield potential is used?

In the preceding section it is shown that a considerable percentage of pods contains peas which are too old. These do not contribute to the quality of the crop but distract

Table 3 Percentage undermature (a, b), mature (c, d, e) and overmature (f, etc.) pods, when the crop was in the right stage of maturity

	At 12 % AIS			At maturity 2.20		
Variety	*a, b*	*c, d, e*	*f, etc.*	*a, b*	*c, d, e*	*f, etc.*
1964						
CDSP	29	70	1	23	69	8
Gf	39	56	5	44	55	1
L2	44	52	4	43	52	5
VF	31	63	6	29	64	7
WM	31	67	2	18	71	11
1965						
CDSP	10	73	17	8	70	22
Gf	14	62	24	12	58	30
L2	38	42	20	42	41	17
VF	28	58	14	26	58	16
WM	19	73	8	20	73	7

from it. On the other hand there are, at OHD, also a number of pods which do not contribute either to yield or to quality: the pods in maturity groups *a* and *b*, which are so young that they cannot be shelled.

Table 3 gives the distribution, at the critical dates, of pods which are too young (stages *a* and *b*), in approximately the right stage of maturity (*c*, *d* and *e*) and too old (*f*, *g*, etc.). This table indicates that a large proportion of the pods does not contribute to the yield under the commercial conditions of a once-over harvest.

Reference

Schippers, P. A., 1969. Maturation in peas. I. A visual method of maturity assessment. *Neth. J. agric. Sci.* 71: 153–160.

Erratum

In Part 1 of this study (Maturation of peas. I. A visual method of maturity assessment; *Neth. J. agric. Sci.* 17 (1969) 153–160) the captions of Fig. 1 and 2 should be interchanged.