Peanut Science (1981) 8, 97-98

Variation in the Seed Hull Maturity Index in Commercial Peanut Fields[1]

Harold E. Pattee, Francis G. Giesbrecht, James W. Dickens and Thomas B. Whitaker[2]

ABSTRACT

Previous research studies have indicated that peanut cultivars Florigiant and NC6 have a maximum crop value when the Seed Hull Maturity Index (SHMI) is 3.0. This SHMI value may be used as a guideline by the peanut grower to help determine the time to dig his peanuts. In order to determine the sample size needed to determine the SHMI, we have measured the variance among SHMI values for individual plant samples within commercial fields of peanuts. The average variability found among SHMI values was 0.166 with a maximum variance of 0.276. Using this information it was determined that 17 plant samples from a field would be adequate for most situations. However, if a field appeared to present unusually variable conditions an increased sampling rate to a maximum of 28 plant samples might be desirable. A plant sample may have one to three plants because of the entwining of plants. Recommended procedures are presented for sampling the field, subsampling of bulked peanut fruits, and determining SHMI for actual farm situations.

Key Words: Seed Hull Maturity Index, Sampling field variation.

A statistical evaluation of the Seed Hull Maturity Index (SHMI) by Pattee et al. (3), using data sets covering a nine-year period, concluded that SHMI can be used as an estimator of the dollar value of a peanut crop in the field and suggested a maximum practical SHMI value (3.0) for the peanut cultivars Florigiant and NC6. The suggested maximum SHMI value may be used as a guideline by the peanut grower to help determine the time to dig his peanuts. In order to make use of the guide line it is necessary to estimate the SHMI value for each field of peanuts.

In order to develop a sampling technique for SHMI it is necessary to determine the plant sample to plant sample variation of SHMI within typical peanut fields. The purpose of this study was to make these determinations and to develop recommendations for field sampling to determine SHMI values.

Materials and Methods

Twenty sampling sites, 58.2 m wide by 137.2 m long, within commercial peanut fields were used in the study. The sampling sites were located on 5 different farms in Bertie County, NC and were selected to provide the range in peanut growing conditions normally found within commercial fields of peanuts. The sampling sites received recommended cultural practices and appeared to be free of disease in August, 1980.

Rather than hand dig the plants we collected plant samples from the windrow after they were mechanically dug. The cultivar grown in the fields sampled was Florigiant and no major pod losses were observed as a result of mechanical digging. The digging dates were selected by the individual growers and no attempt was made to obtain maximum SHMI values. The longest time period between digging and sampling was 4 days. Sampling started on September 22 and ended on October 1, 1980. It was observed that the sampling sites at location 4 were severely infected with a Rhizoctonia-Pythium pod rot complex at the time of digging.

After the peanuts were dug, the sampling sites contained 32 windrows that were 137.2 m long. Ten samples spaced approximately 16.2 m apart were taken from the first windrow and every eighth windrow thereafter for a total of 50 samples per sampling site. Each sample consisted of 1 to 3 plants because they were entwined. After the samples were air dried at room temperature, the SHMI for each sample was determined as described by Pattee et al. (4).

Results and Discussion

The variance (s^2) of SHMI values for plant samples from each of the 20 sampling sites is shown in Table 1. As described in the procedure, the average SHMI and variance among SHMI values could be estimated from a maximum of 50 samples. However, only 25 samples were used to estimate σ^2 since a confidence interval determination (2) on the averaged variance from 5 sampling sites (Location 1, sampling sites 4-8) indicated only a small loss in precision when estimating σ^2 from 25 instead of 50 samples.

Table 1 shows the observed means and variances for the 20 sampling sites. A plot of means against variances suggests that there may be some relationship between the two, with the more mature sites being less variable. Bartlett's test confirms the evidence of non-homogeneity of variance. However the variances in Table 1 can still be used to estimate the number of peanut plants needed from the field to estimate the true field SHMI value denoted by μ, especially since a given sample size will give increased accuracy with increasing maturity of the field.

Table 1. Estimates of the variance and coefficients of variation among SHMI values of samples taken from individual fields.

Location	Sampling Site Number	Samples	Harvest Date	SHMI Average	Variance	Coefficient of Variation
1	1	25	09-25-80	1.92	0.187	22.51
	2	25	10-01-80	2.33	0.263	21.99
	3	25	09-25-80	1.89	0.212	24.28
	4	26	09-22-80	2.18	0.180	19.43
	5	29	09-22-80	2.34	0.243	21.08
	6	25	10-01-80	2.27	0.166	17.98
	7	25	10-01-80	2.26	0.097	13.75
	8	50	09-22-80	2.24	0.128	15.97
2	9	25	09-29-80	1.87	0.157	21.77
	10	25	10-01-80	1.72	0.127	20.77
	11	26	09-22-80	1.75	0.219	40.65
	12	25	09-22-80	1.14	0.246	43.52
3	13	25	09-29-80	2.33	0.047	9.27
	14	25	09-29-80	2.58	0.116	13.19
	15	25	09-29-80	2.47	0.103	12.98
	16	25	09-29-80	2.35	0.080	21.08
4	17	25	09-29-80	1.16	0.276	45.15
	18	25	09-29-80	1.24	0.142	30.42
	19	25	09-29-80	1.60	0.156	24.66
5	20	25	09-25-80	1.53	0.165	26.58

[1]Paper Number 6918 of the Journal Series of the North Carolina Agricultural Research Service, Raleigh, NC 27650. The use of trade names in this publication does not imply endorsement by the USDA or North Carolina Agricultural Research Service nor criticism of similar ones not mentioned.

[2]Research Chemist, AR/SEA, USDA; Professor, Statistics; Supervisory Agricultural Engineer, AR/SEA, USDA: Research Agricultural Engineer, AR/SEA, USDA, North Carolina State University, Raleigh, NC 27650.

Assuming that the peanut grower specifies that the average SHMI value $\bar{x}$ should be within d units of the true field SHMI value μ 95% of the time ($d = \bar{x} - \mu$), then the number of plant samples (n) must consist of at least $4\mu^2/d^2$ plant samples where μ^2 is estimated by s^2 (1). It is recognized that the sample variances given in Table 1 are determined from the experimental values of SHMI and differ only slightly from those calculated from the direct measurement of hull weights and seed weight (Appendix A Eq. Al).

Given the above assumptions and approximating μ^2 by the mean of the 20 s^2 values in Table 1, ($s^2 = 0.166$), we may calculate the number of equally spaced peanut plant samples needed from a field to estimate its SHMI value. The calculated number of plant samples is 17 based on d = 0.2. If we select the most extreme value from Table 1, s^2 = .276 the calculated sample size is 28. Thus a sample size of 17 would appear adequate for most situations, but if a field appeared to present unusually variable conditions an increased sampling rate to a maximum of 28 might be desirable.

The effect of d on sample size is shown in Table 2 where μ^2 was chosen to be 0.2.

Table 2. Effect of d (Δ allowable between sample SHMI value and true value) on sample size. Variance is assumed to be 0.2.

d	Sample Size
0.05	320
0.10	80
0.15	36
0.20	20

It has been previously shown (4) that the amount of work in determining SHMI can be reduced materially by shelling only a subsample of the peanut fruits removed form the plant sample. It is shown in Appendix A that the increase in variance due to subsampling is negligible and thus can be ignored provided the subsample consists of at least 100 to 150 peanut fruit. From this information it may be concluded that a subsample of 100 peanut fruit from a random sample of $4\mu^2/d^2$ plant samples should give an estimate of SHMI that differs from the true value for the field by more than d fewer than once in 20 times.

Recommended Commercial Field Procedure.

It is recommended that the peanut grower use a sampling method which insures that the plant samples come from all parts of the field by selecting 25 uniformly spaced plant samples from the entire field and then hand-harvesting the peanut fruit. If soil is tight and dry, use a shovel or other implement to assist in removing plants from the soil to avoid stripping mature peanuts from the plant. Remove all fruit including small peg swellings from the selected plants and place them in a container large enough to thoroughly mix the bulked batch of peanut fruits. If a divider is available, divide out a sample of 100-150 fruits. If a divider is not available, randomly sample the bulked peanuts with small container (cup) three or four times to obtain 100-150 fruit. Place the subsample in a paper bag or wire container and dry for 5-6 hr at 135-150 C. Allow the sample to cool and shell all fruit except the raisins and pops. Place the raisins and pops with the hulls. Weigh the hull and seed fractions. Divide the seed weight by the hull weight. The value obtained is an estimate of the SHMI of the field with an average standard deviation of 0.1.

From a previous study (3) it has been determined that an SHMI vaue of 3.0 would provide the maximum crop value possible for Florigiant, and NC6 using the 1979 pricing schedule. Modifications in the pricing schedule from year to year can produce slight variations in the SHMI value that corresponds with maximum crop value. However, these variations would probably fall within SHMI values of 2.8 to 3.0. The estimated increase in dollar value of the peanut crop over this range is $50-60 per ha. The grower should thus consider digging his crop when an SHMI value of 2.8 or greater is first encountered.

Literature Cited

1. Cochran, W. G. 1977. Sampling Techniques. Wiley, 3rd ed., New York, NY.
2. Dixon, W. J. and F. J. Massey. 1957. *Introduction to Statistical Techniques*. McGraw Hill Book Company, 2nd ed., New York, NY.
3. Pattee, H. E., F. G. Giesbrecht, J. W. Dickens, J. C. Wynne, J. H. Young and R. W. Mozingo. 1982. The seed hull maturity index as an estimator of yield and value of peanuts. Peanut Sci. 9:(in press).
4. Pattee, H. E., J. C. Wynne, T. H. Sanders and A. M. Schubert. 1980. Relation of the seed/hull ratio to yield and dollar value in peanut production. Peanut Sci. 7:74-77.

Appendix A

Assume a sample of N peanuts. The true SHMI for this sample is the ratio

$$R = \frac{\text{total seed weight}}{\text{total hull weight}}$$

If a subsample of n peanuts is shelled this ratio is estimated by

$$\hat{R} = \frac{\text{total seed weight in subsample}}{\text{total hull weight in subsample}}$$

The variance of this ratio is (1)

$$\frac{(N-n)}{Nn} R^2 (C_{ss} + C_{hh} - 2C_{sh}) \quad \text{Eq. A1}$$

where C_{ss} and C_{hh} are the coefficients of variation of seed weight and hull weight respectively and C_{sh} is the anaologous relative covariance. Since one would consider subsampling only when N is large, it is sufficiently accurate to consider

$$\frac{R^2}{n} (C_{ss} + C_{hh} - 2C_{sh}) \quad \text{Eq. A2}$$

Two samples, consisting of peanuts from 21 and 7 plants respectively were shelled and the seed and hulls weighed individually. The estimates for C_{ss}, C_{hh} and C_{sh} were .35, .21 and .20 for the first sample and .48, .28 and .26 for the second sample. Even with R approaching 3 the additional variance due to subsampling will be less than 2/N.

Accepted July 8, 1981