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Peanut Maturity Method Evaluations. I. Southeast

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ABSTRACT

Arginine maturity index, methanol extract, shellout, and seed-hull maturity index methods of determining peanut (*Arachis hypogaea* L.) maturity were compared. Peanuts from four planting dates in 1978 were used. The comparisons showed that some of the methods are affected by date of planting and environmental factors, such as drought stress. Under the conditions of this test, the seed-hull maturity index and shellout were the most consistent indicators of the optimum yield period in 1978.

Key Words: *Arachis hypogaea*, Groundnut, Arginine Maturity Index, Seed-Hull Maturity Index, Shellout, Methanol Extract

Determining the optimum time for harvesting peanuts (*Arachis hypogaea* L.) is complicated by the presence of seed at various stages of maturity on the plants at any given time, and the subterranean fruiting habit. Because of increasingly close profit margins, peanut producers must harvest the crop when the greatest proportion of high quality, sound mature fruit are on the plants. For many years the shellout method (SO) has been the standard for determining harvest time. By that method, all the pods, excluding those that are obviously immature, are cracked open; then, their maturities, subjectively evaluated on the basis of seed coat and internal pericarp color, are used to determine overall crop maturity. Some producers still erroneously use age of the peanut plants as the sole basis for determining harvest date. A method, such as the SO method, that indicates whether or not the crop is ready to be harvested immediately is of immense value; however, a method enabling the producer to predict the date of optimum yield would be more useful, allowing him to manage labor and equipment with maximum efficiency at harvest. There are, of course, conditions of weather and disease that might override any prediction. In recent years, three additional methods of predicting and/or estimating peanut crop maturity were developed — the arginine maturity index (AMI) (9-11), methanol extract (ME) (1, 2, 6), and seed-hull maturity index (SHMI) (4-5) methods. These and the shellout method of maturity determination were compared in 1977 and 1978. A progress report on the 1977 single planting date study has been published (7). Our present report is based on the comparative information for the 2 years and includes important observations on the effects of four different planting dates and drought stress on the use of the various maturity methods.

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Materials and Methods

Florunner peanuts were grown in 1978 at the Coastal Plain Experiment Station, Tifton, GA, in Tifton sandy loam soil. Peanuts were planted in an approximately 1.2 ha field on 5/1, 5/12, 5/22, and 6/1 in a standard 0.9-m row pattern. A randomized block design was used, with four replicates (18.3-m rows) on each planting date. Maturity samples were taken from three replications and yield data were based on four replications. Samples were taken for the four methods, and two-row beds on either side of the randomly selected sampled rows were harvested for yield calculations at weekly intervals. In each replication, seven to nine plants were taken for AMI, three plants for ME, two plants for shell-out, and four plants for SHMI. Separation of plants to obtain these numbers was done with extreme care to avoid any pod loss. Plants were carefully placed in plastic bags and transported to the laboratory, where peanuts were hand picked, washed, and towel dried.

AMI was determined by standard procedures (9-11) within 3 hr of digging and within 1 hr of removal of all peanuts from the plants.

ME was determined by grinding all peanuts (peg swellings to obviously mature fruit) in methanol (2 ml per gram) according to Holaday *et al.* (2). Optimum digging date was determined by the following formula derived from their data: days to harvest = 30 -2(75 - X), where X = % light transmittance of the methanolic extract at 450 nm.

For SHMI all peanut pods on the plants were opened, and those at or beyond the maturity stage characterized by cracks in the white internal pericarp were separated into seed and hull. Less mature pods with no such cracks were placed with the hulls. Samples were dried for 18 hr at 130 C, and the SHMI was determined as the quotient of the seed dry wt divided by the hull dry wt.

In the shellout method, obviously immature (soft, watery) peanut pods were excluded. The others were opened and examined for any tan to dark brown coloration inside the hull, and the coloration was used as an indication of maturity. The percentage of mature peanut pods on a plant was then determined.

Results and Discussion

Published data (7) on maturity evaluations in the 1977 crop indicated that the optimum yield period occurred between 146-153 days after planting (DAP). In 1977, both AMI and ME methods provided predicted digging dates occurring in or near the high yield period; however, digging dates based on AMI and ME taken during the high yield period generally failed to substantiate previously predicted optimum digging dates. Ideally, a peanut maturity method should provide an adequate prediction 1-3 weeks before the optimum yield period and, thereafter, refinements of that prediction. Also in 1977, the shellout method indicated that the proportion of mature peanuts was 80% at 139 DAP, and the proportion did not change significantly through 167 DAP. SHMI (DMI in the previous publication) was about 3.7 during the high yield period in 1977.

Four planting dates (PD1-4) in 1978 allowed us to compare the efficiency of each method on a crop exposed to different environmental conditions at different stages of plant and fruit development. Peanuts from the two earliest planting dates were exposed to moderate drought stress; and peanuts from the later planting dates to severe drought stress. In 1977 (7), moisture was deficient in the early stages of pod development, but was adequate throughout the remainder of the peanut growing season. In 1977 yield increased to a maximum then declined. In 1978, no such pronounced rise and decline were evident, partially no doubt because of the drought conditions during the latter part of the growing season. Visual inspection revealed that pegs, which are normally moist, had cured (dried) in the soil, and microbial activity normally contributing to pod loss had no doubt been reduced. Of the yields for the four planting dates (Tables 1-4), the PD-1 yield showed the greatest tendency to reach a maximum and then decline, whereas, the PD-4 yield did not change significantly during the 34-day sampling period. In southern Georgia, peanuts are usually planted during late April or early May, and 140 days is often accepted as sufficient time for peanuts to reach optimum maturity. Data for the four 1978 planting dates and for 1977 indicated that the length of time for maximum yield is related to planting date and to environmental conditions. In 1978 the optimum periods for harvesting PD1-4 began about 150, 139, 129, and 119 DAP, respectively. Drought stress can affect the maturation of peanuts, and determination of when to harvest is even more difficult and critical since resumption of good moisture conditions may result in greatly increased pod loss and decreased yields (unpublished data).

PD-1

The yield of PD-1 (Table 1) was highest at 150 DAP and did not change significantly (DNMR, 5% level) thereafter, although mean values for 157 and 164 DAP were about 450 and 360 kg/ha less, respectively. AMI predictions at 121 and 129 DAP were 13 and 6 days earlier than the maximum yield date, whereas those made at 136 and 143 DAP indicated harvest dates that were 2 and 3 days late, but still well within the optimum yield period. Apparently, young peanuts were added at an appreciable rate between 121 and 136 DAP since AMI value changed little. However, between 136 and 143 DAP, some change occurred that substantially reduced the AMI value. This change should indicate that fruit already set are maturing and that the rate of addition of new fruit was insufficient to significantly affect the AMI value. AMI is normally determined first at about 125 DAP (or 30-40 days before expected harvest) and again at 14-21 days before harvest, based on the first estimate. The two dates should agree relatively well, and if so, they may be averaged (personal communication, C. T. Young). In the southeast, after AMI drops below approximately 100 or a minimum value has been reached, no prediciton should be made; therefore, no prediction would have realistically been made using AMI on 143 or 150 DAP.

ME analyses made at 121 and 129 DAP resulted in predicted harvest dates that were about a week earlier than the date of maximum yield. The ME procedure suggests that a light transmittance value of 60 or below generally indicates that peanuts should be dug. This value might vary somewhat depending on the number of pods that reach maturity in any year due to environmental and disease conditions (2). The published procedure suggests that a sample be analyzed at 140 DAP and another

Table 1. Maturity method comparisons on peanuts planted on May 1, 1978

Sample Date	DAP	AMI	AMI Prediction (DAP)	ME (%T 450 nm)	ME Prediction (DAP)	SO (% mature)	SHMI	Yield (kg/ha)
8/29	121	112 A	137	71.8 ± 1.4 A	144	48.7 ± 6.1 A	2.81 ± 0.02 A	-
9/7	129	105 A	144	66.9 ± 2.0 AB	143	60.5 ± 9.6 B	3.16 ± 0.32 B	-
9/14	136	107 A	152	58.4 ± 6.3 BC	<60	66.0 ± 1.4 B	3.16 ± 0.18 B	5261 ± 348 A
9/21	143	89 A	153	60.7 ± 3.2 BC	<60	66.3 ± 6.2 B	3.24 ± 0.10 B	5989 ± 200 B
9/28	150	86 A	159	59.4 ± 6.7 BC	<60	77.5 ± 3.5 C	3.59 ± 0.14 C	6492 ± 409 C
10/5	157	-	-	57.7 ± 4.0 C	<60	78.2 ± 3.7 C	3.94 ± 0.28 D	6043 ± 195 BC
10/12	164	-	-	64.4 ± 6.0 ABC	<60	76.3 ± 0.7 C	3.87 ± 0.12 CD	6130 ± 274 BC

DAP = days after planting; AMI = Arginine Maturity Index; ME = Methanol Extract; SO = Shellout; SHMI = Seed-Hull Maturity Index. Numbers in a column followed by the same letter are not significantly different (5% level, Duncan's New Multiple Range Test).

<60 = %T now or previously below 60, no prediction made

on the harvest date predicted (2). If ME were the only method used to determine maturity of peanuts from the planting date, they would no doubt have been dug early. The increase in percent transmittance at 164 DAP may be an indication that some of the more mature fruit were lost.

In the shellout method 75-80 percent mature pods is usually sufficient indication that harvest of the crop will provide good yields. The number of immature seed that will soon move into the mature category is also considered. At 150 DAP the shellout percentage was 77.5 and this corresponded with the maximum yield period. The shellout percentages at 150-164 DAP did not change significantly and probably indicate a somewhat stabilized crop maturity level.

In 1977 SHMI values of 3.69 and 3.67 corresponded with the optimum yield period and were in good agreement with data from North Carolina in 1974 and 1975 (4). In Table 1 the SHMI was about 3.6 at 150 DAP and 3.9 at 157 DAP; therefore, the values agreed with past data and denoted the period of optimum yield very well. Weete *et al.* (8) reported that a SHMI (DMI) of 3.87-4.13 corresponded to the maturity classifications acceptable for harvest. Although they did not report SHMI for all peanuts on the sample plants, obviously addition of the immature pods, which would be added to the hull weight, would lower the ratio somewhat. Overall for the first planting date, strict utilization of a chemical method would probably have resulted in a slightly early harvest of the crop; however, use of either one of the subjective methods would have provided an indication that harvest should be delayed. PD-2

PD-2

Yield of PD-2 (Table 2) was maximum about 139 DAP, and the AMI predictions at 125-139 DAP correspond well with that time. Although AMI values under 100 are not recommended for use, in this case, they provided an excellent indication of the correct harvest date. The date (139 DAP) on which percent transmittance of the ME first dropped below 60 corresponded to the start of the optimum yield period. The ME prediction at 109 DAP was accurate, but the next two samplings resulted in predicted dates 6-8 days before the optimum yield period began.

A shellout percentage of 83.5 at 139 DAP corresponded to the beginning of the maximum yield period. Also, SHMI for PD-2 was similar to that found in PD-1 except that the 3.7 ratio probably occurred approximately 11 DAP earlier. Thus, all maturity methods provided accurate results for PD-2 when used according to recommended procedure.

PD-3

At 115 DAP, AMI for PD-3 (Table 3) was well below the low-prediction limit value of 100. The rapid decrease in AMI value between 108 and 115 DAP is probably an indication of the effects of low water availability. During drought stress, fruit set is drastically reduced and young fruit often dry in the soil. Under these environmental conditions, use of normal AMI procedures is somewhat restricted. As with PD-2, however, AMI values below 100 did provide adequate prediction dates.

The high yield period in PD-3 began 129 DAP, and ME percent light transmittance was less than 60% at 136 DAP. The extended optimum yield period was doubtless due to the drought conditions and probably does not provide an adequate test of the predicting ability of the ME method.

A shellout percentage of 80% marked the beginning of the high yield period for PD-3. Percentages of about 90 indicate that the maturity process continued and the few obviously immature

Table 2. maturity method comparisons on peanuts planted on May 12, 1978

Sample Date	DAP	AMI	AMI Prediction (DAP)	ME (%T 450 nm)	ME Prediction (DAP)	SO (% mature)	SHMI	Yield (kg/ha)
8/29	109	138 A	131	75.0 ± 3.7 A	139	32.4 ± 5.5 A	2.64 ± 0.24 A	-
9/7	118	98 B	131	67.0 ± 5.3 AB	133	56.6 ± 4.7 B	3.04 ± 0.11 B	-
9/14	125	96 B	138	63.2 ± 7.8 B	131	73.0 ± 4.0 C	3.24 ± 0.15 B	4871 ± 239 A
9/21	132	78 B	137	67.5 ± 2.8 AB	147	72.9 ± 2.3 C	3.62 ± 0.23 CD	5723 ± 225 B
9/28	139	69 B	140	58.6 ± 6.8 B	<60	83.5 ± 7.0 D	3.55 ± 0.21 C	6553 ± 159 C
10/5	146	-	-	61.5 ± 4.0 B	<60	75.6 ± 7.7 CD	3.90 ± 0.23 DE	6632 ± 320 C
10/12	153	-	-	57.4 ± 5.6 B	<60	81.6 ± 3.8 D	4.14 ± 0.07 E	6278 ± 514 C

DAP = days after planting; AMI = Arginine Maturity Index; ME = Methanol Extract; SO = Shellout; SHMI = Seed-Hull Maturity Index. Numbers in a column followed by the same letter are not significantly different (5% level, Duncan's New Multiple Range Test).

<60 = %T now or previously below 60, no prediction made

Table 3. Maturity method comparisons on peanuts planted on May 22, 1978

Sample Date	DAP	AMI	AMI Prediction (DAP)	ME (%T 450 nm	ME Prediction (DAP)	SO (% mature)	SHMI	Yield (kg/ha)
9/7	108	108 A	124	70.3 ± 2.8 A	129	45.8 ± 2.6 A	2.80 ± 0.08 A	-
9/14	115	78 B	120	69.5 ± 1.6 A	134	62.1 ± 3.1 B	3.16 ± 0.11 B	-
9/21	122	58 B	122	70.9 ± 2.1 A	144	74.1 ± 6.1 C	3.56 ± 0.18 C	5363 ± 225 A
9/28	129	53 B	129	65.2 ± 3.2 A	150	80.1 ± 2.1 D	3.62 ± 0.13 CD	5803 ± 207 B
10/5	136	-	-	56.3 ± 8.2 B	<60	90.0 ± 3.9 E	3.80 ± 0.11 DE	5987 ± 371 B
10/12	143	-	-	64.4 ± 3.8 A	<60	91.0 ± 2.5 E	4.01 ± 0.22 EF	5875 ± 409 B
10/19	150	-	-	64.5 ± 1.3 A	<60	86.1 ± 4.3 E	4.13 ± 0.18 F	6014 ± 205 B

DAP = days after planting; AMI = Arginine Maturity Index; ME = Methanol Extract; SO = Shellout; SHMI = Seed-Hull Maturity Index. Numbers in a column followed by the same letter are not significantly different (5% level, Duncan's New Multiple Range Test).

<60 = %T now or previously below 60, no prediction made

Table 4. Maturity method comparisons on peanuts planted on June 1, 1978

Sample Date	DAP	AMI	AMI Prediction (DAP)	ME (%T 450 nm	ME Prediction (DAP)	SO (% mature)	SHMI	Yield (kg/ha)
9/7	98	134 A	119	75.8 ± 0.5 A	129	-	-	-
9/14	105	84 B	113	73.2 ± 1.9 A	131	39.0 ± 4.9 A	3.13 ± 0.11 A	-
9/21	112	61 BC	112	70.8 ± 2.7 AB	134	64.8 ± 6.3 B	3.31 ± 0.22 A	-
9/28	119	54 C	119	69.3 ± 0.6 AB	138	76.7 ± 7.3 C	3.70 ± 0.12 B	5022 ± 424 A
10/5	126	-	-	65.6 ± 2.8 BC	137	76.4 ± 6.2 C	3.78 ± 0.15 B	5564 ± 202 A
10/12	133	-	-	61.8 ± 4.0 C	137	79.0 ± 2.7 C	3.87 ± 0.30 B	5560 ± 568 A
10/19	140	-	-	58.7 ± 8.9 C	<60	84.8 ± 3.8 C	3.82 ± 0.14 B	5529 ± 537 A

DAP = days after planting; AMI = Arginine Maturity Index; ME = Methanol Extract; SO = Shellout; SHMI = Seed-Hull Maturity Index. Numbers in a column followed by the same letter are not significantly different (5% level, Duncan's New Multiple Range Test).

<60 = %T now or previously below 60, no prediction made

peanuts present had dried to a shriveled condition. SHMI was 3.6 at optimum yield initiation and had increased to 3.8 by the next sample date. This again is in agreement with previous data.

PD-4

Based on standard procedures, AMI could not be used for PD-4 (Table 4). However, the prediction at 98 DAP and the later ones based on AMI values of considerably less than 100 were relatively accurate. Utilization of AMI in the Southwest and Virginia-Carolina areas indicates the need for modified AMI procedures (personal communication, C. T. Young) and apparently drought conditions in the Southeast may also require some modification of the procedure.

ME predictions missed the beginning of the high yield period by 14-21 days, but the later predictions generally agreed with those made earlier. In contrast, in 1977, neither AMI or ME predictions remained constant as sampling continued.

The shellout and SHMI methods were accurate to the extent that percent mature fruit was >75% and ratio of seed to hull was 3.7 on the sample date when optimum harvest period began even though yield did not change significantly during the sampling period. This assumes that yield on 9/21 (no yield data taken) would have been significantly less than on 9/28.

Conclusions

These comparisons show that many factors affect the usefulness of the currently available maturity methods. Date of planting, moisture conditions, temperature, and disease all affect development of the crop as well as decrease in yield through pod loss. Obviously, the use of any maturity method must be integrated with careful field observation to determine the nature of environmental factors affecting the crop as it grows.

Methods to detemine the optimum time to harvest peanuts have definite economic benefits, as demonstrated in 1977 (7). Calculation of dollar return per acre showed that digging 7 days before or 7 days after the optimum yield period (146-153 DAP) resulted in losses of approximately $50 and $110 per acre, respectively. In 1978 yields for the four planting dates did not decrease as did the yield in 1977; therefore, late harvest-date-related dollar losses would not have been as evident. However, at least two factors point out the need for harvesting even a drought stressed crop as soon as it reaches the optimum yield level. First, rain after a drought period can markedly increase pod loss (unpublished data) and, hence, economic loss. Second, even if conditions remain dry and pod loss is minimal, indications of a high correlation of *Aspergillus flavus* invasion and aflatoxin in peanuts under late season drought, point to an increasing probability that losses will occur due to the crop being graded Segregation 3. In research situations, such as varietal production comparisons and seed increase in breeding programs, the use of maturity methods would provide some indication that seed are harvested at the optimum time.

This study shows that methods to determine peanut maturity can have a significant economic role in peanut production. In every instance in 1978, a shellout analysis of >75% mature fruit coincided with the high yield period. Overall, the SHMI was the most reproducible and consistent throughout the study with, a ratio of approximately 3.7 coinciding with initiation of the high yield period in every instance. The SHMI, as presently utilized, involves a subjective determination based on maturity stages as defined by Pattee *et al.* (3); however, a simplification of the SHMI is published concurrently (5). This simplification should be more suitable for routine use. Our observations indicate that a combination of as many methods as possible might be advisable; however, the accuracy demonstrated by the chemical methods under various conditions may not justify the expense of equipment and supplies involved. Under no circumstances, as noted by Weete *et al.* (8), should a maturity method be utilized without consistent field observations.

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