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Arginine Maturity Index: Relationship With Other Traits In Peanuts[1]

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ABSTRACT

'Spancross', 'Florunner', and 'Florigiant' cultivars were used to determine the relationship between arginine maturity index (AMI) and other traits in peanut (*Arachis hypogaea* L.). Samples were taken weekly beginning 73 days after planting in 1973 and biweekly beginning 77 days after planting in 1974. AMI-1 was measured on fresh fruit and AMI-2 was measured on dry seed. The relationship between these two characters was greater than r = 0.85 in each cultivar tested. Both AMI-1 and AMI-2 were positively correlated to percent of other kernels and negatively correlated to pod yield, and percentages of total sound mature kernels, total kernels, dry matter, and mature seed. Among these correlations AMI-pod yield was weakest, whereas AMI-percent of total sound mature kernels was strongest. The quadratic polynomial, $Y = a + bx + cx^2$, was used to fit the distribution curve for each trait. Florunner and Florigiant appeared to have similar patterns in all traits except percent of mature seed, but they differed from Spancross in these traits.

Key Words: *Arachis hypogaea* L., Correlation, Fruit Yield, Groundnut.

The peanut *(Arachis hypogaea L.)* is indeterminate in growth habit (1, 3, 4, 7, 17). Under favorable environmental conditions free from disease and insect damages, it flowers and fruits over several months. All fruit do not set at the same time, and there is no single time at which the fruit is uniformly mature. Thus, determining when to harvest the crop for maximum yield and shelling quality is difficult.

Several methods (3, 8, 10-12, 14, 19, 21-24) have been used to determine the level of maturity of the peanut fruit. Most common is the "shell-out" method, which is a subjective evaluation of the brown coloration on the inner surface of the shell (2, 6, 15, 16). The internal surface of shells become progressively more brown as they mature, because of increased tannin and sugar content. By the time the seed is fully mature, the inner surface may be a very dark brown (15, 16).

Mason et al. (11) found that changes in free arginine were very dramatic and that its concentration was inversely correlated with maturity of peanut seeds. From measurements of free arginine content Young (22) developed the arginine maturity index (AMI) to estimate the maturity level of peanut fruit and to predict the optimal digging date. Young and Hammons (23) reported that cultivar and harvesting time affect AMI.

This study examines the relationship between AMI and other traits with three peanut cultivars.

Materials and Methods

Three widely adapted cultivars, 'Spancross', 'Florunner', and 'Florigiant', representing the three principal market types grown in the United States, were studied in 1973. Only Spancross and Florunner were planted in 1974. Spancross (9) is a bunch-type peanut developed by continuous selection for Spanish-type progenies from the interspecific cross *A. hypogaea X A. monticola* Krap. et Rigoni. Florunner (13), a commercial runner-type, exhibits the typical sequential branching pattern of Runner- and Virginia-type cultivars. Florigiant (5) is a large-seeded Virginia-type peanut. Spancross is early-maturing and Florunner and Florigiant are medium-maturing (3).

Peanuts were grown on a Tifton loamy sand (Plinthic, Paleudult) soil at the Coastal Plain Station, Tifton. Weeds were controlled by preplant herbicides. In 1973, we planted on May 12 and harvested samples at twelve 1-week intervals from July 24 to October 8 (from 73 to 150 days after planting). In 1974, we planted on April 23, and harvested at eight 2-week intervals from July 9 to October 15 (from 77 to 175 days).

The design in both years was a split-plot with 3 replications. The 3 cultivars were whole-plot treatments in a randomized complete block, and digging dates were sub-plots. Test plots of 2 adjacent rows were 1.8 m x 7.6 m. Moisture was supplemented by irrigation during droughts.

Freshly dug peanuts were sampled from each plot to fill a 0.5-liter plastic bag for the determination of AMI-1. Peanuts were refrigerated overnight and were cleaned in the laboratory with water. Two sub-samples of 30 g each were analyzed for AMI using a continuous flow automated analytical method (22). The remaining peanuts were dried for three days in the field, windrowed, and then threshed with a stationary plot picker. These peanuts were artificially dried for 4 days. Supplemental heat to a maximum of 35 C was used only when relative humidity was greater than 50%. Yield in kg/ha was calculated from each test plot on a net weight basis (8% moisture content and no foreign matter).

Two dry peanut samples were drawn from each plot. One was graded according to the procedure of the United States Department of Agriculture (20) and the other was hand-shelled for maturity classification. Fruit were classified as mature, intermediate, or immature according to the brown coloration of inner shell, seed size, and testa color (3, 6, 16, 19).

Market quality factors, measured as percent of total sample weight, were: sound mature kernels (SMK), sound splits (SS), other kernels (OK), and total kernels (TK). SMK were sound and mature kernels riding the following screens: 5.95 x 19.05 mm for Spanish, 6.35 x 19.05 mm for Runner, and 5.95 x 25.40 mm for Virginia. SS were undamaged split or broken seeds greater than 6.35 mm in length. OK were kernels that pass through the size screen for SMK. TK were total kernels. TSMK combines SMK and SS. Dry matter (DM) was determined as described previously (22).

The values for foreign material, loose shelled kernels, hulls, and damaged kernels were less significant in this study. Therefore, only TSMK, OK, and TK were examined further.

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The AMI of dry seed (AMI-2) was determined by measuring the free arginine content from a graded sample that included TSMK and OK. Two 20 g subsamples from each sample were analyzed as described. The 3-replicate average was used in 1974.

The quadratic polynomial, $Y = a + bx + cx^2$ was appropriate for examining the trend of the traits as the age of peanut plants increased (18). In the equation, a, b, and c were real numbers. The parameter Y represented the trait, such as pod yield, % TSMK, etc.; and X was time which was calculated from (days from planting minus 66)/7 for the 1973 test and from (days from planting minus 64)/14 for the 1974 study.

Results and Discussion

The coefficients of correlation (r) between AMI-1 (fresh fruit) and AMI-2 (dry seed) for three peanut cultivars in 1973 and two cultivars in 1974 were very high (Table 1). The results showed that peanuts with high AMI of fresh fruits tended to have high AMI of dry seed.

Table 1. Coefficients of correlation (r) between AMI-1 and AMI-2 for three peanut varieties in 1973 and two varieties in 1974.

Variety	1973†	1974‡
Spancross	0.869	0.977
Florunner	0.935	0.995
Florigiant	0.918	--

AMI-1 = Arginine maturity index measured on fresh fruit samples; AMI-2 = Arginine maturity index measured on dry seed samples.

† = Significance for 34 df = 0.330 (P = 0.05) or 0.424 (P = 0.01).

‡ = Significance for 6 df = 0.707 (P = 0.05) or 0.834 (P = 0.01).

Both AMI-1 and AMI-2 were negatively related to pod yield, % TSMK, % TK, % DM and % mature seed for the 3 cultivars grown in 1973 (Table 2). They were positively related to % OK and % immature. Among these 7 traits, correlation between AMI and % TSMK was highest, and correlation between AMI and pod yield was lowest. Among the cultivars examined, Florunner had the highest and Spancross the lowest correlation coefficients between AMI and other traits. These results indicate that AMI gives a better estimation of the level of % TSMK than of pod yield. Because market value is predicated on % TSMK and not on pod yield only, this attribute has considerable economic implications. The AMI may be a better estimate of maturity in Florunner than in either Spancross or Florigiant.

Correlation coefficients were higher in 1974 than in 1973 (Tables 1, 2, and 3). Most of the r values were greater than 0.90. The difference between 1973 and 1974 crops might be caused by the different sampling technique. In 1973, 12 weekly samples were taken whereas, in 1974, 8 biweekly samples were taken. However, the correlation coefficients might vary annually because of climatic factors.

The regression equations for various characters are shown in Figs. 1-3 and Table 4. AMI-1, AMI-2, and % OK had a C>0 and their polynomials had one peak. The results for the 1973 crop, as shown in Figs. 1 and 2, indicated that both Florunner and Florigiant had similar curves in regression equations for all traits except % mature seed. Each of these cultivars differed from Spancross (Fig. 3) in all of those traits.

Table 2. Coefficients of correlation (r) between Arginine maturity index (AMI) and seven other traits in three peanut varieties, 1973.

Character	Spancross AMI-1	Spancross AMI-2	Florunner AMI-1	Florunner AMI-2	Florigiant AMI-1	Florigiant AMI-2
Yield	-0.412	-0.529	-0.663	-0.718	-0.584	-0.556
% TSMK	-0.805	-0.930	-0.923	-0.982	-0.916	-0.955
% OK	0.747	0.910	0.904	0.968	0.926	0.955
% TK	-0.804	-0.894	-0.902	-0.961	-0.894	-0.934
% DM	-0.720	-0.762	-0.876	-0.828	-0.841	-0.820
% Mature Seed	-0.775	-0.942	-0.778	-0.741	-0.619	-0.648
% Immature Seed	0.730	0.924	0.895	0.915	0.805	0.835

Significance for 34 df = 0.330 (P = 0.05) or 0.424 (P = 0.01).

Table 3. Coefficients of correlation (r) between Arginine maturity' index (AMI) and five other traits in two peanut varieties, 1974.

Character	Spancross AMI-1	Spancross AMI-2	Florunner AMI-1	Florunner AMI-2
Yield	-0.916	-0.650	-0.891	-0.704
% TSMK	-0.996	-0.968	-0.984	-0.995
% OK	0.996	0.973	0.997	0.996
% TK	-0.983	-0.936	-0.857	-0.978
% DM	-0.900	-0.862	-0.958	-0.962

Significance for 6 df = 0.707 (P = 0.05) and 0.834 (P = 0.01).

Table 4. Polynomials of the variables for investigation of AMI in peanuts, 1974.

SPANCROSS

Pod Yield	$Y = 496.37798 + 1294.35714X - 78.48512\ X^2$
AMI-1	$Y = 236.49732 - 47.26071X + 2.94196\ X^2$
AMI-2	$Y = 55.90030 - 5.64881X + 0.29018\ X^2$
% TSMK	$Y = 23.89152 + 10.66488X - 0.51056\ X^2$
% OK	$Y = 34.25446 - 6.57500X + 0.32054\ X^2$
% TK	$Y = 57.00833 + 4.37976X - 0.19643\ X^2$
% DM	$Y = 19.43721 + 7.38600X - 0.37321\ X^2$

FLORUNNER

Pod Yield	$Y = -2526.18899 + 2705.19643X - 148.13244\ X^2$
AMI-1	$Y = 382.46964 - 72.05000X + 4.08036\ X^2$
AMI-2	$Y = 141.26339 - 20.93452X + 0.96280\ X^2$
% TSMK	$Y = -8.09048 + 16.64523 - 0.74643\ X^2$
% OK	$Y = 39.48571 - 7.00952X + 0.31548\ X^2$
% TK	$Y = 31.56161 + 9.56071X - 0.42232\ X^2$
% DM	$Y = 7.21225 + 7.35971 - 0.290536X^2$

X = (Days from planting - 64)/14.

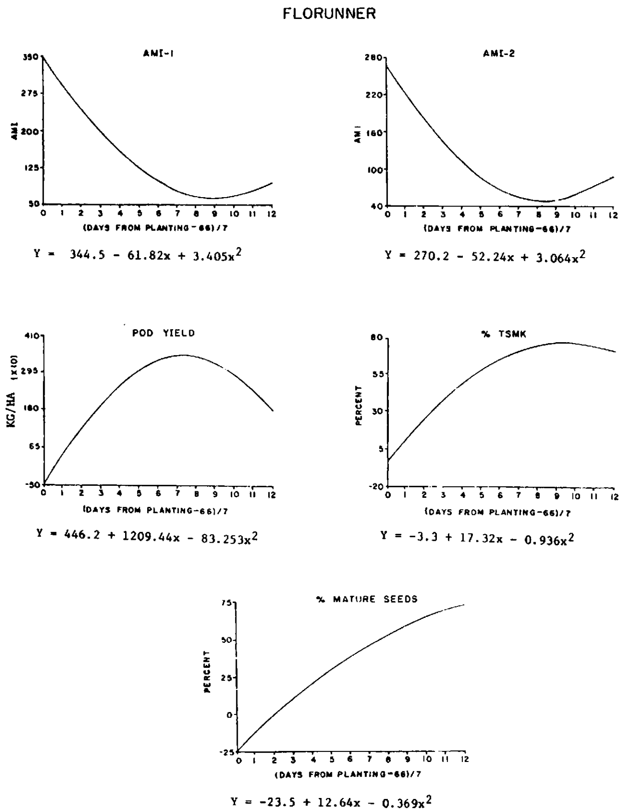

Fig. 1. Polynomials fitted by function of weekly data collection, 1973, for various traits of Florunner.

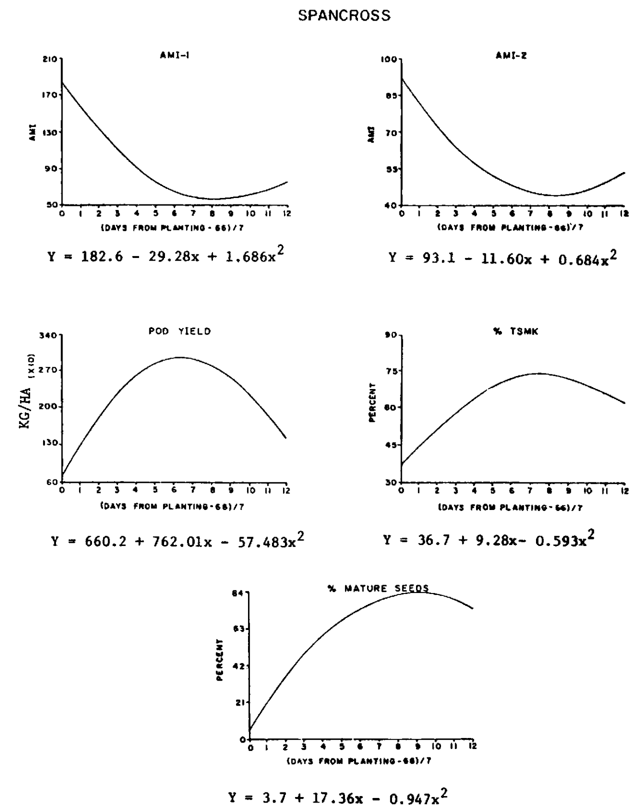

Fig. 3. Polynomials fitted by function of weekly data collection, 1973, for various traits of Spancross.

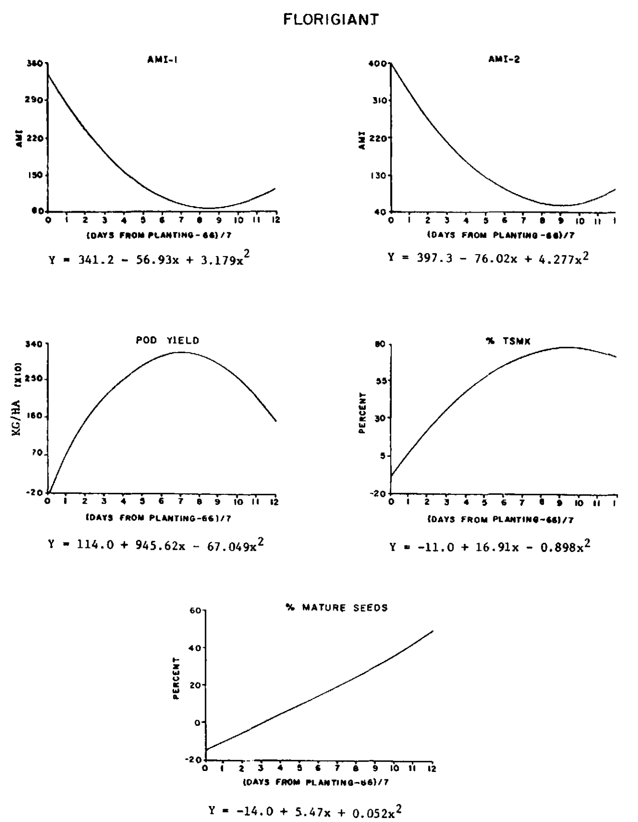

Fig. 2. Polynomials fitted by function of weekly data collection, 1973, for various traits of Florigiant.

If these regression equations are to be used to estimate days until harvest, values for a, b, and c must be measured with an adequate sampling. Experience in 1975 with 266 fields involving 7,000 acres in a 10-county continuous area across the peanut belt of Georgia indicated that 2- to 4-testings of 3 samples each are needed to evaluate a field.

Our research has shown that the rate of maturation is influencd by year-to-year and cultivar-to-cultivar differences. Although not examined in this study, location-to-location differences can occur for the same cultivar in a given year.

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