Path Analysis for Grade Components in Peanut: Predicting Final Grade from Easily Measured Components

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Abstract

Farm gate value of peanut is partly determined by a grading process whereby the percentage of total sound mature kernels (TSMK) is measured. Peanut cultivars vary considerably in the traits that result from the grading process. In order to evaluate breeding lines for grade components peanut breeding programs measure the grading components in a manner similar to the commercial process. This process requires about 20 minutes per sample making it one of the most time-consuming steps in the breeding process. This and the volume of seed needed prohibits measuring grade components of single plant selections and limits the number of samples that can be graded each season. The aim of this study was to determine if the percentage TSMK could be predicted from other grade components using regression and path analysis. The percentage of total meat (peanut) content is highly predictive of percentage TSMK. When the percentage of virginia (large) pods and the weight of 100 seeds are added to the regression, the prediction is even better than with the percentage of total meat alone. Path analysis shows that meat content is highly correlated with TSMK, but the correlation between TSMK and virginia pods and weight of 100 seeds is lower.

Introduction

- The percentage of total sound mature kernels (TSMK) determines the final value of farmer stock peanuts
  - $TSMK = Medium\ Kernels + Jumbo\ Kernels + No.1\ Kernels + Split\ Kernels$
- Measuring TSMK requires 20 minutes and at least 200 g of peanut pods
- A technique is needed to speed the process and possibly to allow prediction of small breeding samples

Materials and Methods

- Data from 8672 grade samples from 2004 and 2005 were collected
  - Variables were the percentage of meat (MT), virginia pods (VP), medium kernels (MK), jumbo kernels (JK), number one kernels (NK), other kernels (OK), split kernels (SK), and the weight of 100 kernels (SDWT)
- Regression procedures in SAS were used to identify a multiple regression equation predictive of TSMK (Figure 2.)
  - $TSMK = -22.98 + 1.2(MP) - 0.0048(VP) + 0.083\ (SDWT) + error$
  - $R^2 = 0.82$, $P < 0.0001$ for b_{MT}, b_{SDWT}, & b_{VP}
- The equation was used to predict TSMK from samples graded in 2006.
  - Overall predictive ability using 2915 individual samples
  - Rank correlations within 12 individual tests
- Path analysis was used to break down relationships
  - between TSMK and MT, VP and SDWT

	Number 1	Medium	Jumbo
C-99R	4%	30%	38%
Georgia Green	7%	45%	19%
Screen size (inches)	16/64	18/64	21.5/64

Figure 1. Sample of 15 peanut kernels in each size category from two cultivars.

Results

- TSMK predicted from 2006 samples was highly related to actual TSMK in 2006 (Figure 3)
  - Actual $TSMK(2006) = 7.77 + 0.91(predicted\ TSMK(2006))$
  - $R^2 = 0.75$, $P < 0.0001$ for b
- Rank correlations within individual test were highly significant (Table 1)
  - Rank correlations were 0.90 or higher in 11 of 12 tests
  - Among 12 individual tests: (Table 2)
    - 3 to 5 of the top 5 entries were within the predicted top 5
    - 8 to 10 of the top 10 entries were within the predicted top 10
    - 11 to 14 of the top 15 entries were within the predicted top 15
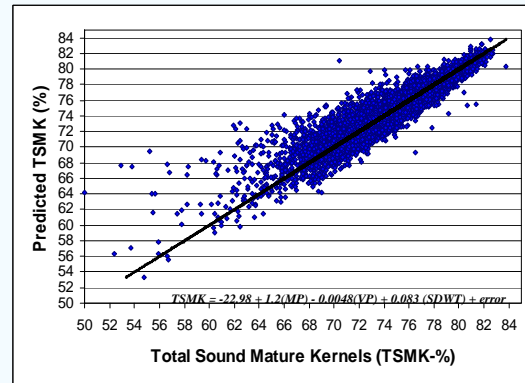- Path analysis showed the greatest correlation between MT and TSMK (Table 3, Figure 4)

Figure 2. Predictive equation for total sound mature kernels developed from 8672 peanut grade samples from 2004 and 2005 in the University of Florida peanut breeding program.

Inside figure: $TSMK = -22.98 + 1.2(MP) - 0.0048(VP) + 0.083\ (SDWT) + error$
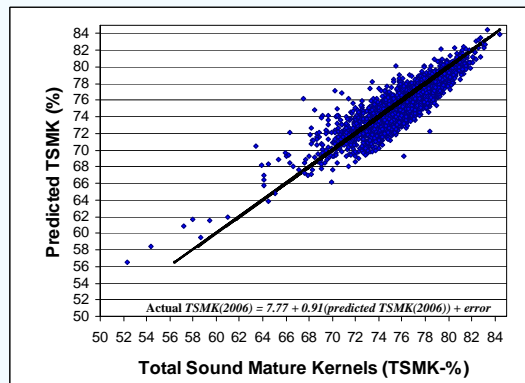

Figure 3. Predictive ability of the equation described in Figure 2 when applied to 2914 grade samples from 2006 in the University of Florida peanut breeding program.

Inside figure: $Actual\ TSMK(2006) = 7.77 + 0.91(predicted\ TSMK(2006)) + error$

Table 1. Rank correlations between actual total sound mature kernel percentage (TSMK) and the predicted TSMK percentage from 12 individual tests grown in 2006 in Marianna (MR) and Gainesville (GV), Florida.

Test	Total Number of entries	Number of actual within the predicted Top 5	Top 10	Top 15	Rank Correlation
06FT1-MR	30	3	9	14	0.94
06FT1-GV	30	4	9	13	0.95
06UPT-MR	34	4	8	11	0.70
06FT3-GV	22	4	9	14	0.91
06FT4-MR	32	4	10	13	0.95
06FT4-GV	32	4	9	14	0.94
06FT5-MR	36	4	10	14	0.96
06FT5-GV	36	4	9	13	0.93
06FT6-MR	30	3	9	13	0.91
06FT6-GV	28	3	8	14	0.92
06FT7-MR	32	5	9	12	0.91
06FT7-GV	32	4	9	13	0.94

Table 2. Rank of actual total sound mature kernel percentage (TSMK) and the predicted TSMK percentage from a test (06FT5-MR) grown in 2006 in Marianna, Florida. Actual ranks highlighted red fell outside of the predicted rank.

Genotype	Total Sound Mature Kernels (%) Actual	Actual Rank	Predicted	Predicted Rank
99x46-1-B2-1-1-B	82.9	1	82.5	1
97x15-HO2-1-Bx2-3-b2-B	80.9	2	80.7	2
95x43-10-1-2-b2-B	80.3	4	80.2	3
96x55-HO2-1-3-2-2-b3-B	80.1	7	80.0	4
GEORGIA-02C	80.3	3	79.8	5
98x102-3-3-1-3-b3-B	80.2	6	79.6	6
McCloud (UF03326)	79.9	8	79.2	7
98x107-5-1-2-b3-B	79.6	9	79.2	8
97x28HO-2-2-B2-4-1-2-B	79.5	10	79.1	9
96x70-HO3-1-1-2-1-b3-B	80.2	5	79.0	10
GEORGIA GREEN	79.4	11	78.9	11
McCloud (UF03326)	78.6	16	78.5	12
Florida-07 (UF04327)	79.2	12	78.3	13
McCloud (UF03326)	78.7	15	78.2	14
96x29-3-HO1-3-3-1-b3-B	79.1	13	78.2	15
97x48-HO-3-7-B2-2-b3-B	78.2	17	78.1	16
96x55-HO2-1-2-2-b2-B	77.6	20	77.9	17
96x70-HO1-3-3-1-1-b3-B	77.2	23	77.4	18
98x107-26-1-1-b2-B	78.1	18	77.1	19
UF03524(96x49-3-Bx-5-b3-B)	78.9	14	77.0	20

Table 3. Path coefficient anlaysis of the effect of total meat (peanut) content (MT), virginia pod percentage (VP) and the weight of 100 seeds (SDWT) on the percentage of total sound mature kernels (TSMK).

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meat  → TSMK
    direct                              0.91
    indirect via VP      -0.38*-0.03=   0.01
    indirect via SDWT  -0.18* 0.28=    -0.05
    correlation............................ 0.87 (P>0.001)
VP    → TSMK
    direct                             -0.03
    indirect via meat   -0.38* 0.91=   -0.35
    indirect via SDWT    0.77* 0.28=    0.21
    correlation............................ -0.17 (P>0.001)
SDWT  → TSMK
    direct                              0.28
    indirect via meat   -0.18* 0.91=   -0.15
    indirect via VP      0.77*-0.03=   -0.02
    correlation............................ 0.09 (P<0.001)
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Figure 2. Path diagram containing direct effects of predictor variables on the percentage of total sound mature kernels (TSMK) and correlations among predictor variables of meat content, virginia pods and the weight of 100 seeds.

Discussion and Conclusions

- The TSMK equation developed from samples graded in 2004 and 2005 was very accurate in predicting TSMK from MT, VP and SDWT from samples graded in 2006
- Measuring MT, VP and SDWT to predict TSMK would require about half the time as measuring actual TSMK
- We will apply the technique to breeding populations and measure subsequent TSMK