Pod and Seed Size Relation to Maturity and In-Shell Quality Potential in Virginia-Type Peanuts[1]

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ABSTRACT

In-shell peanut sales provide a consistent market for large-seeded virginia-type peanuts. In this market, maintenance of a high quality product, which includes fresh roasted peanut flavor, is a recurring challenge. A maturity-seed size-quality relationship has been established for shelled peanuts. To determine if this relationship is true for in-shell peanuts, the relationships of maturity, pod size, and seed size were investigated. In two crop years (1992 and 1993) and on four to five harvest dates, virginia-type peanuts (cv. NC 9) were harvested at Lewiston, NC and sorted into hull scrape maturity classes: black, brown, orange B, orange A, and yellow. After pods were dried, they were screened to obtain the pod size distribution. Sized pods were hand-shelled, and the seed were screened to obtain the seed size distribution from each pod size from each maturity class. Hull scrape pod maturity profiles revealed a decrease of *ca.* 14% in yellow/orange A and an increase of *ca.* 14% in brown/black over the 4- to 7-d harvest period. Overall, pod size distribution did not change over time although slight differences were noted between years. Pod size distributions within individual maturity classes were more variable. The data indicated that the Jumbo in-shell grade contained higher percentages of brown and black maturity classes than the fancy grade. Fancy grades contained 26-49% immature pods (yellow and orange A maturity classes).

Key Words: Maturity, seed size distribution, pod size distribution, quality.

Peanuts (*Arachis hypogaea* L.) have an indeterminate flowering pattern which dictates that at any harvest date, fruit of a wide range of maturity are harvested. Peanut cleaning and processing operations for both the in-shell and shelled markets separate peanuts by size without regard to maturity. Although a size-maturity relationship exists, it is not absolute, and peanuts of different maturities are sized together. Variability in quality potential from lot to lot of shelled peanuts has been documented (Sanders, 1989).

In-shell virginia-type peanuts are marketed in jumbo and fancy commercial grades. A search of the literature suggests a paucity of information on in-shell peanut quality. This lack of information indicates a need to understand the relationships between in-shell peanut grades and quality. Information on the maturity-seed size-quality relationship for shelled peanuts suggests that determination of maturity-size relationships in the two in-shell grades should provide a strong indication of quality in those grades (Williams *et al.*, 1987; Sanders, 1989; Sanders *et al.*, 1989a,b).

Quality, as measured by roasted initial flavor and shelf-life, is variable within and among shelled peanut lots of the same commercial size (Sanders, 1989; Sanders and

[1]The use of trade names in this publication does not imply endorsement by the U.S. Dept. of Agric. or the North Carolina Agric. Res. Serv. of the products named, nor criticism of similar ones not mentioned.

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Bett, 1995). Because maturity is significantly related to flavor, shelf-life and other quality characteristics (Sanders, 1980a,b, 1989; Pattee *et al.*, 1981, 1982; Sanders *et al.*, 1987, 1989a,b 1990; Sanders and Bett, 1995), the variability in maturity distributions (percentage of various maturity classes) within commercial sized in-shell lots was examined to determine differences in distributions as an indication of product quality potential.

Materials and Methods

Virginia-type peanuts (cv. NC 9), grown according to conventional, irrigated cultural practices, were hand-harvested from the North Carolina Dept. of Agriculture Peanut Belt Research Station at Lewiston, NC. Samples of 98 kg or larger were dug by hand between 13-19 Oct. 1992 and 5-8 Oct. 1993 in a nonreplicated manner. The large samples in each year were used as replications for statistical analysis.

Pods of all samples were removed from the plants by hand and subjected to gentle abrasion with a slurry of small glass beads in water (Williams and Monroe, 1986) to remove the exocarp. The exposed mesocarp color was used to sort pods into hull scrape maturity classes designated as yellow, orange A, orange B, brown, and black. Color class designations corresponded to numbered classes 3-7 described by Williams and Drexler (1981). Orange A and orange B both corresponded to class 5, and separation was based on yellow-orange in orange A and brown-orange in orange B. At this point in maturation, internal hull color is just beginning to darken (Sanders *et al.*, 1980). This separation corresponds also to the maturity level commonly used to separate mature and immature pods in the shellout method (Sanders and Williams, 1978).

Maintaining harvest date and maturity class integrity, pods in mesh bags were dried with ambient air until the mean seed moisture was 7-8%. Pods were sized according to thickness over a series of slotted screens that conformed to U.S. commercial grade standards for peanuts (USDA, 1993). The screen slots had a length of 76.2 mm and widths of 19.1 mm (Screen No. 48), 18.3 mm (Screen No. 46), 17.5 mm (Screen No. 44), 16.7 mm (Screen No. 42), 15.9 mm (Screen No. 40), 15.1 mm (Screen No. 38), 14.7 mm (Screen No. 37), 14.3 mm (Screen No. 36), 13.5 mm (Screen No. 34), 12.7 mm (Screen No. 32), 11.9 mm (Screen No. 30), 11.1 mm (Screen No. 28), 10.3 mm (Screen No. 26), and 9.5 mm (Screen No. 24). The pods from each individual screen number were weighed and counted. The percentage of pods by weight that rode each screen and fell through Screen No. 24 was calculated to provide the pod size distribution. Commercial in-shell sizes were considered as follows: Jumbo $\geq$ 14.7 mm, fancy < 14.7 mm and $\geq$ 12.7 mm, and unclassified < 12.7 mm. After pods in each maturity class were sized, the total weight from each maturity class in each commercial pod size was determined. These weights were totaled and percentage weight contribution of each maturity class in each commercial pod size was calculated. Each maturity class was hand-shelled and seed were sized according to diameter over a series of slotted hole screens having length of 25.4 mm and widths of 11.1 mm (Screen No. 28), 10.3 mm (Screen No. 26), 9.5 mm (Screen No. 24), 8.7 mm (Screen No. 22), 8.3 mm (Screen No. 21), 7.9 mm (Screen No. 20), 7. 1 mm (Screen No. 18), 6.4 mm (Screen No. 16), 5.6 mm (Screen No. 14), and 4.8 mm (Screen No. 12). Pod and seed sizes are presented in units of commercial screen number (size in mm = Screen No. × 0.397). The percentage of seed by weight that rode each screen and fell through Screen No. 12 was calculated to provide the seed size distribution. Data were analyzed using the Chi Square Test (χ^2).

Results and Discussion

Peanut maturity progression with concomitant weight and grade changes over time has been documented by many maturity methods (Sanders *et al.*, 1980). Sanders and Bett (1995) used hull scrape methodology to demonstrate a consistent pattern of pod maturation occurring in consecutive weekly harvest dates. In 1992, approximately 50% immature (yellow and orange A) and 50% mature (orange B, brown, and black) pods were harvested on the initial harvest date (Fig. 1). As maturation

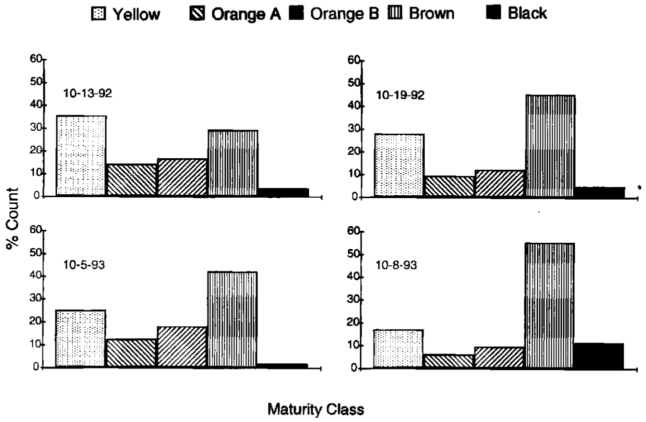

Fig. 1. Pod maturity profiles expressed by percent count for initial and final harvest dates for 1992 and 1993.

continued, 38% immature and 62% mature pods were harvested 5 d later (χ^2 = 559.22, P $\leq$ 0.01). For the 1993 crop year (Fig. 1), 38% immature and 62% mature pods were harvested initially, and 4 d later 23% immature and 77% mature were harvested (χ^2 = 1219.41, P $\leq$ 0.01). Pod maturity progressed over the 4- to 7-d period in both years. The profiles changed enough based on published information (Sanders, 1980a,b; Pattee *et al.*, 1981a,b; Sanders *et al.*, 1989a,b) to reasonably expect a potential difference in the quality of the peanuts harvested at the beginning and end of the sample periods.

Although hull scrape pod maturity profiles are usually presented on the basis of pod count (Fig. 1), other interesting relationships become evident when profiles are presented on the basis of cured pod weight in each maturity class (Fig. 2). The profile shifts somewhat, in that the percentage contribution of immature peanuts (yellow and orange A) is much less on a percentage weight basis (χ^2 = 1104.67, P $\leq$ 0.01 and χ^2 = 2482.74, P $\leq$ 0.01, respectively). This is due to the individual pod size/weight difference in mature pods (orange B, brown, and black) pods compared to the size/weight of immature pods. The data in Fig. 2 also indicate the progression of maturity from early harvest to later harvest as found in the percentage count data. The weight data show the cumulative effect of the increase in the number

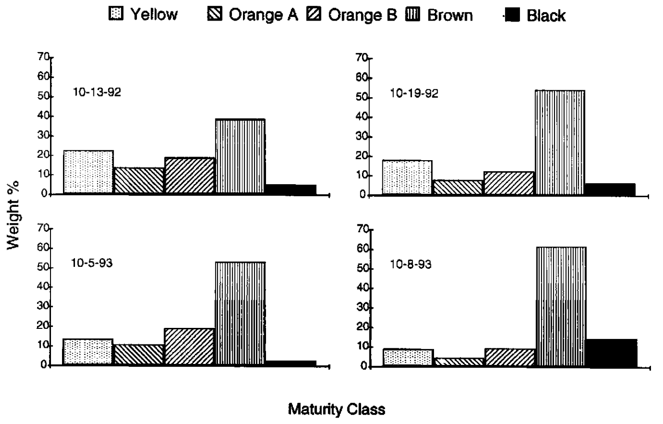

Fig. 2. Pod maturity profiles expressed by weight percent for initial and final harvest dates for 1992 and 1993.

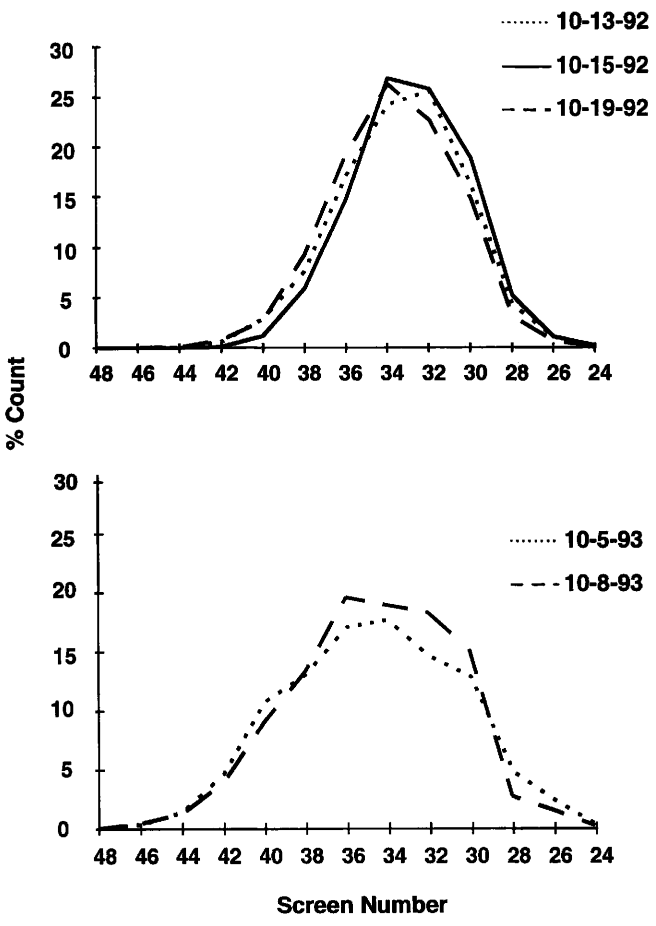

Fig. 3. Pod size distribution by harvest date in 1992 and 1993.

of pods in the mature classes as well as the difference in weight per pod of those classes. Figure 2 shows the progression of maturation by relative weight percentages for 1992 and 1993 crop years, respectively. Immature pods decreased by 11%, while mature pods increased by 11% for the 1992 crop year. A similar trend was evident in the 1993 crop year with a decrease of 11% in immature pods and an increase of 11% in mature pods.

Because of the photosynthetic temperature response in peanuts, photosynthetic efficiency decreases in late season (Bhagsari, 1974). Although the dates of harvest in these studies were near the end of the growing season for virginia-type peanuts, the data demonstrate continued maturation as well as the effectiveness of the hull scrape method for peanuts in the Virginia-Carolina growing region.

Pod size distribution changed little with harvest date in either year (Fig. 3). The 2 yr were somewhat different in pod size range in that 1993 contained more large pods (χ^2 = 1349.95, P $\leq$ 0.01 and χ^2 = 907.49, P $\leq$ 0.01, respectively). Several factors may have influenced the higher percentage of large pods and thus the percentage of other sized pods. Sanders and Blankenship (1984) reported that cool soil temperatures resulted in a pod distribution containing more large pods.

When pod size distribution in each maturity class (Fig. 4) was examined for the 1992 initial and final harvest dates, changes in pod size distribution were evident in some classes (χ^2 = 111.44, P $\leq$ 0.01 and χ^2 = 25.03, P $\leq$ 0.05, respectively). Two examples of these changes were that larger (Screen Nos. 40 and 38) brown pods matured to black and midsized (Screen No. 34 to Screen No. 32) yellow matured to orange A. In 1993 (Fig. 4), a similar type maturity size change occurred as Screen No. 38 browns matured to Screen No. 38 blacks, resulting in evident changes in the brown and black size profiles (χ^2 = 503.99, P $\leq$ 0.01 and χ^2 = 62.47, P $\leq$ 0.01, respectively). Even though the pods were not increasing in size, maturation was progressing. Further, these data (Figs. 3 and 4) demonstrate that, although overall pod size distribution did not change, the maturity of individual pods of all sizes continues to change with time.

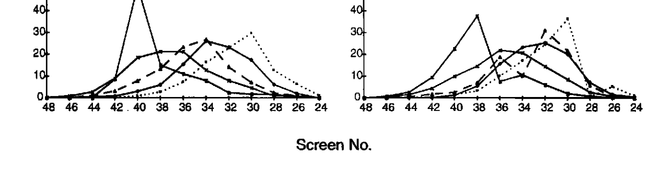

Fig. 4. Pod size distribution of individual hull scrape maturity classes for initial and final harvest dates in 1992 and 1993.

In-shell virginia-type pod commercial grade sizes are designated in the USDA,ARS Milled Peanuts Inspection Instructions (1993) as U.S. Jumbo Hand Picked or U.S. Fancy Hand Picked. As indicated in Table 1, U.S. Fancy Hand Picked are designated as greater than Screen No. 32, thus U.S. Jumbo Hand Picked may be included in and graded as fancy. However, because of price differentials,

Table 1. U.S. grades for virginia-type in-shell peanuts.

Seed size	Screen size	Count
	mm	Pod/lb
Jumbo	>37/64	176.0
Fancy	>32/64	225.0

processors commonly remove jumbo peanuts as a separate category. Therefore, data are presented in size designations greater than or equal to Screen No. 37 equivalent to jumbo and less than Screen No. 37, but greater than or equal to Screen No. 32 equivalent to fancy.

The maturity distribution of peanuts in the jumbo grade for both crop years (Fig. 5) illustrated the consistent relationship between size and maturity. Jumbo, being the largest in-shell category, contained high percentages of mature pods (orange B, brown and black). On an immature (yellow and orange A)-mature basis (orange B, brown and black), the percentage of mature pods was greater than 90%. Maturation over time in the jumbo category resulted in some increases in the brown class, but maturation was even more evident in increases in percentage of the black class. Earliest harvest date pod maturity percentages in the fancy grade (Fig. 6) were relatively uniform for yellow through brown and ranged from 17 to 32% (χ^2 = 373.27, P ≤ 0.01 and χ^2 = 814.87, P ≤ 0.01, respectively). Increases in percentage of the brown class were evident in the later harvest date in the fancy grade. Fancy grade contained 26 to 49% immature pods inclusive of all harvest dates. The reason for higher percentages of immature in the fancy grade is the size-maturity relationship in pods. In both grade sizes, harvest date progression resulted in higher percentages of mature pods; however, the higher percentages of mature pods in the jumbo grade suggest a higher quality potential. These data are consistent with changes in the pod maturity profiles based on count (Fig. 1) and weight (Fig. 2).

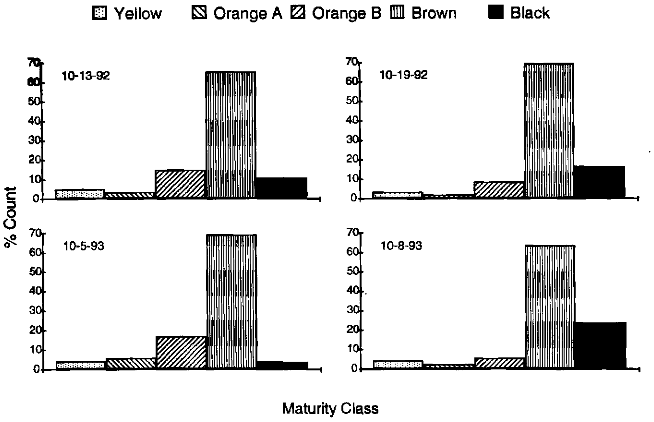

Fig. 5. Pod maturity distribution for jumbo in-shell grade for initial and final harvest dates in 1992 and 1993.

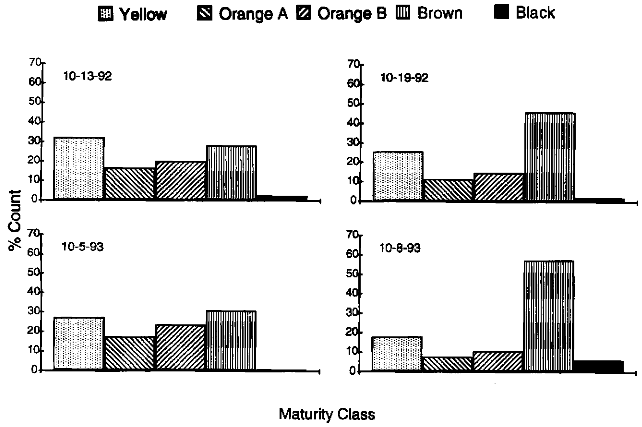

Fig. 6. Pod maturity distribution for fancy in-shell grade for initial and final harvest dates in 1992 and 1993.

Because in-shell peanuts are consumed one or two at a time, consumers have the opportunity to evaluate the pod size vs. seed size relationship. Seed size distributions from the jumbo and fancy in-shell grades are shown in Fig. 7. The jumbo grade contained larger pods than the fancy grade as well as seed distributions skewed to larger and more mature seed (χ^2 = 281.61, P ≤ 0.01 and χ^2 = 215.39, P ≤ 0.01, respectively). The combination of more large seed and greater percentage of mature seed/pod provide strong evidence that the jumbo in-shell

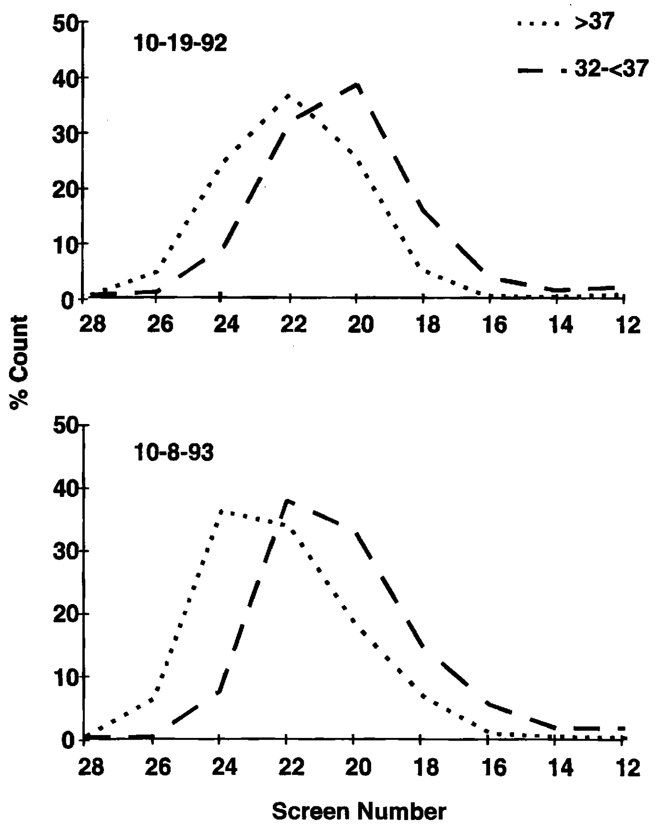

Fig. 7. Seed size distributions for jumbo and fancy in-shell grades for the final harvest dates in 1992 and 1993.

grade would be more consumer-acceptable than the fancy grade (Sanders, 1980a,b, 1989; Pattee *et al.*, 1981, 1982; Sanders *et al.*, 1987, 1989a,b, 1990; Sanders and Bett, 1995). Fancy pods contained 8.26 and 8.32% seed sized less than or equal to Screen No. 16 in 1992 and 1993, respectively, whereas jumbo pods contained 1.90 and 0.86%, respectively. The higher percentage of small seed in fancy pods may suggest the need to incorporate additional sorting methodology, such as density separation to decrease the number of pods with very small seed.

Conclusions

The data indicate that commercially sized in-shell virginia-type peanuts may contain widely varying pod maturity distributions. These distributions are related to harvest date and the fact that final pod size is attained before the final maturity level. In the jumbo in-shell grade, the more mature pod distribution, along with a size distribution containing more large pods strongly suggest a higher quality potential than that found in the fancy in-shell grade. Data indicated a positive effect of proper harvest timing in that more mature peanuts are harvested resulting in a distribution of more mature pods in in-shell products.

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Accepted 16 Dec. 1996