# Some Effects of Commercial-Type Peanut Sheller Design and Operation on Seed Germination

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**ABSTRACT**

Investigations were conducted with commercial-type peanut shellers to determine the effects of several variables of mechanical shelling on seed germination. The investigated variables were types of shellers, grate design, cylinder design, direction of cylinder rotation, radial distance between cylinder and grates, cylinder speed, and techniques of feeding peanuts into the sheller. Statistical analysis of the data indicated that only the effects of cylinder speed were statistically significant. Although the effects of feed techniques were not statistically significant, it appeared that some feed techniques lowered the germination by several percentage points. Operating commercial-type shellers so as to obtain a maximum whole-seed outturn and treating the shelled peanuts with the fungicide immediately after shelling minimized the detrimental effects of mechanical shelling on germination.

Shelling peanuts with commercial shelling equipment results in the splitting and breakage of some seed. The split peanuts cannot be used for seed and the whole peanuts with broken seed coats (testa) are more susceptible to seed rot fungi than undamaged seed. Bell (*1*) and Sturkie and Buchanan (*7*) reported poor germination results for machine-shelled seed not treated with a suitable fungicide. Even when recommended growing and processing practices were used, differences between the percentages of germination of treated, hand-shelled seed and treated, machine-shelled seed have been noted (*3, 5*).

Seed-coat breakage and seed splitting usually occur during the shelling operation. Using a seed sheller approximately one-fourth the size of a commercial-type sheller, Reed and Coppock (*6*) reported some effects of sheller operation on seed quality of "Alabama Runner" peanuts. Their results indicated that seed peanuts, shelled on properly adjusted shellers and stored under dry conditions, germinated nearly as well as hand-shelled peanuts when the seed were treated with an acceptable fungicide before planting.

Since these early investigations, changes have occurred in commercial shellers, varieties, seed treatments, and practices used during growing, harvesting, drying, and processing. This paper presents some current data on the effects of sheller design and settings on the percentage of germination for mechanically shelled peanuts.

## Materials and Methods

All tests were conducted in the USDA pilot shelling plant using full-size commercial type shellers. All commercial peanut shellers used in the United States have the same general design, consisting of a 10- to 12-inch diameter shelling cylinder rotating inside a 12- to 14-inch diameter sheller grate. Three major types of commercial shellers investigated were the cast-iron sheller, perforated-basket sheller, and T-bar sheller. These shellers differ primarily in the design of the cylinder and grate. The variables investigated were types of shellers, grate design, cylinder design, direction of cylinder rotation, radial distance between cylinder and grates, cylinder speed, and techniques of feeding peanuts into the sheller.

High quality Spanish- and Runner-type farmers stock peanuts were obtained from Commodity Credit Commission commercial-storage warehouses. Peanuts of each type consisted of mixed varieties. The Spanish-type peanuts were primarily "Starr" and "Argentine" varieties, and the Runner-type peanuts were "Florunner" and "Early Runner" varieties. The moisture content of the seed was approximately 7 percent wet basis. Peanuts from each lot were divided into 750-pound test samples. A representative 5-pound subsample was taken from each shelling test sample with an automatic spout sampler and shelled with the Federal State Inspection Service sheller (*4*). From this subsample 400 seed were used as a control sample to monitor the seed quality of each test sample in order to insure that variations in seed quality did not influence comparisons of commercial-type shellers. Data for the control samples did not show any large variations in seed quality among test samples of each individual lot. Thus, data for the control samples were not included in the report.

During each pilot-plant shelling test, another 400-seed germination sample was collected from the stream of peanuts flowing from the primary sheller. Germination samples contained only whole unskinned seed that rode a 15/64 slotted hole screen. Immediately after shelling all germination samples were treated with a captafol-DCNA mixture (35 percent cis-N-[(1,1,2,2-Tetrachloroethyl)thio]-4-cyclohexene-1, 2-dicarboximide and 35 percent 2,6-dichloro-4-nitroaniline). The samples were sealed in plastic bags and stored for 1 to 4 weeks until they could be placed in the incubator. The control and germination samples were placed in the incubator simultaneously and handled in the same manner. Seed germination tests were conducted using equipment and procedures recommended by the Georgia Seed Testing Laboratory. The seed that failed to germinate were inspected for abnormal root systems and mold infestation. The percentage of molded kernels was used to identify possible reasons why seed failed to germinate.

## Results

Less than 1 percent of the mechanically shelled seed displayed abnormal root systems or other evidence of severe mechanical injury. The remaining ungerminated seed became contaminated with mold during the first 7 days in the germinator.

When the three types of shellers were operated to obtain maximum whole-seed outturn (minimum splitting), no significant differences were found in germination (table 1). Even when grate design and configuration were varied slightly, differences were not significant. (Differences in means were considered significant at the 0.05 level and highly significant at the 0.01 level.)

In a separate test for plant emergence and crop yield, several hundred pounds of Florunner peanuts were shelled with the perforated basket sheller and the T-bar sheller. The seed were then treated by a commercial seed processor and planted by a cooperative farmer in Terrell County, Georgia.

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Table 1. Effect on germination by type of sheller and grate design.

| Type of peanuts | Type of sheller | Number of runs | Grate design and configuration | Germination (average) |
|---|---|---|---|---|
| | | | | Percent |
| Spanish | Cast iron | 3 | Four cast iron grate sections | 89.1 NS1/ |
| Spanish | Cast iron | 3 | Two cast iron grates and two T-bar grates | 87.5 |
| Spanish | T-bar | 3 | Four T-bar grate sections | 88.4 |
| Spanish | Perforated basket | 3 | Perforated sheet metal grate | 89.2 |
| Runner | Cast iron | 4 | Four cast iron grate sections | 91.6 NS1/ |
| Runner | Cast iron | 4 | Three cast iron grate sections | 90.0 |

1/ No significant differences among values.

No significant difference was found in plant emergence or yield for the peanuts shelled by the two types of shellers.

Commercial-type shellers have three to nine sheller bars on the shelling cylinder. In tests with the perforated-basket sheller (table 2), no significant difference was found in germination of Spanish peanuts shelled by three or nine sheller bars.

Shelling plant operators sometimes reverse the rotation of the shelling cylinder to obtain even wear on the grates and sheller bars. In shelling tests with Spanish peanuts (table 3), reversing the direction (counterclockwise) of the shelling cylinder of T-bar and perforated-basket shellers did not significantly affect the percentage of germination.

One sheller setting frequently changed to shell various size peanuts is the radial distance between the outside surface of the sheller bar and the inside surface of the sheller grate. Only one setting provides a minimum of seed splitting for any given peanut size. In a series of shelling tests with Spanish peanuts, the best setting (1 1/8-inch) for obtaining a minimum outturn of split seed was determined for the cast iron sheller by varying the setting (table 4). For the various settings investigated, the radial distance between the shelling cylinder and sheller grates did not significantly affect the percentage of germination (table 4).

Table 2. Effect on germination by number of sheller bars on the perforated basket sheller.

| Type of peanuts | Number of runs | Number of sheller bars | Germination (average) |
|---|---|---|---|
| | | | Percent |
| Spanish | 5 | 3 | 81.5 NS1/ |
| Spanish | 5 | 9 | 81.4 |

1/ No significant difference between values.

Table 3. Effect on germination by the direction of cylinder rotation.

| Type of peanuts1/ | Type of sheller | Number of runs | Direction of cylinder rotation | Germination (average) |
|---|---|---|---|---|
| | | | | Percent |
| Spanish SW. | T-bar | 9 | Clockwise (normal) | 88.6 NS2/ |
| Spanish SW. | T-bar | 9 | Counterclockwise | 91.4 |
| Spanish SE. | Perforated basket | 9 | Clockwise (normal) | 86.2 NS2/ |
| Spanish SE. | Perforated basket | 9 | Counterclockwise | 85.1 |

1/ SW. and SE. are abbreviations for Southwest and Southeast, respectively. They indicate the area of the United States where the peanuts were grown.

2/ No significant differences among values.

Since a wide range of cylinder speeds are used by the shelling industry, several cylinder speeds were tested to determine their effect on germination. Within the low-speed range (160-220 rpm), no consistent effect of cylinder speed was found on percentage of germination (table 5). However, when peanuts were shelled at the higher cylinder speed range (260-320) rpm), as much as 6 percent less germination resulted than at the low-speed range (160-220 rpm). Differences in germination for the two speed ranges were highly significant for peanuts grown in the Southwest. Relatively large variations in germination percentages for the lot of Southeast peanuts resulted in mean germination percentages that were not significantly different. However, there was an 85 percent probability that the Southeast peanuts shelled at the low-speed range had a higher germination percentage than those shelled at the high-speed range.

Reed and Coppock emphasized (6) the need for supplying a sufficient amount of peanuts into the shellers. Since a number of operators have in-

**Table 4. Effect on germination from radial distance between sheller bar and grates when shelling Spanish-type peanuts with cast iron sheller.**

| Number of runs1/ | Radial distance between bars and grates | Germination (average) |
|---|---|---|
| | Inches | Percent |
| 3 | 3/4 | 90.4 |
| 5 | 7/8 | 87.8 |
| 3 | 1 | 89.1 NS2/ |
| 5 | 1 1/8 | 89.1 |
| 4 | 1 1/4 | 88.6 |

1/ Five shelling tests were conducted at each setting, but germination samples were not prepared for all tests. Data were statistically analyzed by using Fisher's LSD test.

2/ No significant differences among values.

**Table 5. Effect on germination by cylinder speed.**

| Type of peanuts | Type of sheller | Number of runs | Sheller speed | Germination (average) |
|---|---|---|---|---|
| | | | RPM | Percent |
| Runner | T-bar | 5 | 160 | 78.5 NS1/ |
| Runner | T-bar | 5 | 205 | 82.0 |
| Spanish SW. | T-bar | 4 | 160 | 94.4 NS1/ |
| Spanish SW. | T-bar | 4 | 205 | 91.5 |
| Spanish SW. | T-bar | 4 | 160-220 | 90.8 S2/ |
| Spanish SW. | T-bar | 4 | 260-320 | 85.6 |
| Spanish SE. | Perforated basket | 4 | 160-220 | 88.8 NS1/ |
| Spanish SE. | Perforated basket | 4 | 260-320 | 82.8 |

1/ No significant differences between values.

2/ Highly significant differences between values.

**Table 6. Effect on germination by column height.**

| Type of peanuts | Type of sheller | Number of runs | Column height above feed opening | Germination (average) |
|---|---|---|---|---|
| | | | Feet | Percent |
| Runner | T-bar | 3 | 4 | 91.5 NS1/ |
| Runner | T-bar | 3 | 8 | 88.8 |
| Spanish Lot 1 | T-bar | 4 | 4 | 87.8 NS1/ |
| Spanish Lot 1 | T-bar | 4 | 8 | 88.9 |
| Spanish Lot 2 | T-bar | 5 | 4 | 87.2 NS1/ |
| Spanish Lot 2 | T-bar | 5 | 8 | 89.9 |
| Runner | Cast iron | 3 | 4 | 89.1 NS1/ |
| Runner | Cast iron | 3 | 8 | 85.3 |
| Spanish | Perforated basket | 5 | 4 | 84.1 NS1/ |
| Spanish | Perforated basket | 5 | 8 | 81.4 |
| Runner | Perforated basket | 5 | 8 with dispersed feed | 88.1 NS1/ |
| Runner | Perforated basket | 5 | 8 with confined feed | 83.2 |

1/ No significant differences between values.

stalled a large bin of peanuts over the shellers so that a 4- to 8-feet high column of peanuts forces the peanuts into the sheller, several tests were conducted with columns of peanuts above the sheller feed opening (table 6). No significant difference in germination was found for the two column heights, when the peanuts were allowed to disperse into the surge hopper of the sheller. However, with the 8-feet column there was some evidence that germination percentages of the confined feed would be lower than the germination percentages of the dispersed feed.

# Discussion

Usually, shelling with these different types of shellers and sheller settings provided significant differences in split seed outturns, shelling rates, and shelling efficiencies; however, cylinder speed was the only investigated variable that provided a significant difference in percentage of germination. Although the difference was not significant, the difference in average values for dispersed and confined feed indicated that extreme pressure from a feed-column, forcing peanuts into the sheller, would lower the germination. Prior work (*3*) has shown that grate size may also effect germination. Fortunately, with these variables, the sheller settings that provide a maximum whole-seed outturn will also provide maximum germination percentages.

Because Tetrazolium tests were not conducted, the exact type of mechanical injury that resulted in lower germination percentages could not be positively defined. However, impact velocity for all cylinder speeds was less than 14 ft/sec considerable less than the 20 ft/sec that Turner et al. (*8*) found seriously affected germination. Results of recent research (*2*) indicate that mechanical damage to the testa may be the most serious type of damage. Evidently, a sound testa is a good barrier in preventing mold infestation of the seed. Undoubtedly, applying the seed treatment to the peanuts immediately after shelling minimized germination losses due to mold contamination. The effectiveness of seed treating equipment and operations should be checked frequently to insure complete coverage of all seed.

Since shellers inadvertently impart some damage to peanuts, shellers must be operated properly, and immediately after shelling, precautions must be taken to minimize losses in quality. Such precautions include placing peanuts in a cool dry storage, and treating seed peanuts with an approved fungicide. Seed placed in cold storage should be removed early enough for dormant seeds to recover by planting time.

Sheller settings for shelling seed peanuts should be based primarily upon whole-seed outturn since sheller settings that provide higher whole-seed outturn and higher seed germination are usually the same (5). The performance of shelling plant equipment and operations and the properties of the peanuts should be monitored continuously, so they can be adjusted to minimize damage and to provide maximum outturns of good quality edible and seed peanuts. Sampling at various locations within the plant can be a useful tool in pointing out the need for adjustments.

The seed quality of the peanuts used in these tests was generally better than for most seed lots. Poorer quality peanuts or peanuts planted in a seed bed under more adverse conditions may be affected more by changes in sheller settings than shown here. For adverse field (or simulated) conditions, the effects of sheller speed, feed techniques, and grate size on field emergence should be determined.

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