Effect of Soil and Seed Calcium on Peanut Seed Quality
APPA-RIA03-SOIL&SEED CALCIUM

Principle Investigators
Julie A. Howe, Agronomy and Soils, Auburn University
Kris Balkcom, Agronomy and Soils, Auburn University
James Bostick, Alabama Crop Improvement Association, Headland, AL
Glendon H. Harris, Crop and Soil Sciences, University of Georgia
Kip Balkcom, National Soil Dynamics Laboratory, Auburn, AL
Francisco Arriaga, National Soil Dynamics Laboratory, Auburn, AL

Objectives
1. Determine the feasibility of using seed-calcium (pre- and/or post-harvest) as an indicator of potential seed quality prior and/or post storage.
2. Establish a minimum seed-calcium level that ensures calcium is not limiting in seed quality.
3. Identify relationships between quality seed, seed-calcium, and soil-calcium.
4. Evaluate current recommendations for gypsum application in seed production.

Executive Summary for 2009
Gypsum applications of 0, 500, and 1000 lb/A were evaluated for their effect on Georgia 06G and Georgia Green yield, grade, germination, and seed calcium at Headland, AL, and Tifton, GA. Lime (2 T/A) and a liquid calcium fertilizer were also evaluated, but only on Georgia 06G in Headland, AL. Sites were selected with a relatively low initial soil calcium level (< 400 lb/A) in the pegging zone. Gypsum treatments increased yield in both Georgia 06G and Georgia Green in Tifton, but not in Headland.

In Georgia 06G, seed calcium increased with 1000 lb/A gypsum and lime. The liquid calcium treatment was equivalent to the control treatment. In Georgia Green, the 1000 lb/A gypsum treatment had the highest seed calcium. Both cultivars at both sites had strong trend of increasing seed calcium with increasing gypsum treatment. Warm germination test results indicate an increase in germination with additional gypsum in both Georgia 06G and Georgia Green. Lime also increased germination of Georgia 06G equivalent with the highest gypsum application rate. Correlation of germination to seed calcium was strong ($R^2=0.84$ for Georgia 06G and 0.65 for Georgia Green), indicating that seed calcium is a good measure of germination potential. In general, seeds with $>300$ mg/kg Ca have $>90\%$ germination.

Although this is the second year of data, results from both years indicate that supplemental calcium has a greater effect on seed quality (i.e., grade and germination) than on overall yield. Lime appears to be as good as gypsum as a source of calcium, but may cause high soil test calcium values that are not translated into seed calcium; thus, making soil test calcium (using the traditional Mehlich I extractant) potentially unreliable as an indicator for available calcium. There appears to be a good relationship between seed-calcium and germination and may prove to be a technique to evaluate seed quality. Unlike 2008, results from 2009 suggest that current calcium recommendations for production maybe slightly low. Both sites were $>300$ lb/A calcium (critical calcium value according to Alabama recommendations) and had a Ca:K ratio $>3:1$ (sufficient Ca:K ratio according to Georgia recommendations); thus, no calcium would have been recommended for these sites. However, both Georgia 06G and Georgia Green exhibited a yield response to gypsum in Tifton. Lack of response in Headland, as well as Headland and Tifton in 2008, is likely due to high rainfall events following gypsum application that may have leached calcium out of the pegging zone for part of the season.
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Objectives
1. Determine the feasibility of using seed Ca (pre- and/or post-harvest) as an indicator of potential seed quality prior and/or post storage.
2. Establish the minimum seed-Ca level that ensures Ca is not limiting in seed quality.
3. Identify relationships between quality seed, seed Ca, and soil Ca.
4. Evaluate current recommendations for gypsum application in seed production.

Extended to 6/30/10.
Interim Report done thru 12/09

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Results and Discussion

Peanut yields from Headland did not differ among treatments (Figure 1). This may be because soil Ca levels were adequate prior to gypsum application (300 ± 13 ppm Ca). Although, results were not significant, yield decreased for both peanut varieties in the 1000 lb/A gypsum application. This was also observed in 2008 and may be due to excess Ca competing with K uptake. Peanut yields from Tifton did increase with application of gypsum; however there was no difference between 500 and 1000 lb/A gypsum applications (Figure 1).

![Graph showing peanut yield by treatment and location]

**Figure 1.** Effect of Ca amendment on the yield of Georgia Green and 06G peanut varieties in Headland, AL and Tifton, GA. Data are mean ± standard error.

Hot and cold germination tests were used to evaluate peanut seed quality. Although tests have been conducted, the cold germination results are currently being processed. Results from the hot germination test on Headland 06G peanuts showed that while differences were not significant, there was a slight trend of increasing germination with increasing gypsum application (Figure 2). The same trend was observed in 06G in Tifton and in Georgia Green at both locations with significantly lower germination in peanuts from the 0 Ca treatment. No difference was observed between 500 and 1000 lb/A gypsum with 06G or Georgia Green.
Figure 2. Effect of Ca on seed quality assessed by the hot germination test of Georgia Green and 06G peanut varieties in Headland, AL and Tifton, GA. Data are mean ± standard error.

Seed Ca increased with increasing gypsum application for both varieties (Figure 3). Application of gypsum or lime improved seed Ca, but liquid Ca did not at the Headland site. While seed Ca did not differ among treatments at the Tifton site, seed Ca increased with increasing Ca application. Seed Ca in both peanut varieties did not differ between 500 and 1000 lb/A gypsum at either site. Results indicate that liquid Ca does not provide enough Ca for adequate seed Ca levels, but that additions of 500 or 1000 lb/A gypsum or lime provide sufficient Ca for both 06G and Georgia Green peanut varieties.
Figure 3. Seed Ca at harvest for Georgia Green and 06G peanuts at Headland and Tifton. Data are mean ± standard error.

Germination (hot germination test) was compared with seed Ca (Figure 4) to evaluate potential relationships. Correlation between seed Ca content and percent germination were good, especially with the 06G variety. Linear regression of the data resulted in $r^2$ values of 0.84 for 06G and 0.65 for Georgia Green. These results indicate that seed Ca can be used as an indicator of seed quality. Seeds are currently being stored for reevaluation to determine the effect of seed storage on this relationship.
Figure 4. Linear regression of percentage germination (hot germination test) versus seed Ca. Data includes all treatments of 0, 500, 1000 lb gypsum/A, liquid Ca, and lime for Georgia Green and 06G varieties grown at Headland and Tifton.

Soil Ca was evaluated at Headland and Tifton sites before planting and post-harvest. Initial soil Ca was near 300 mg/kg. At harvest, soil Ca differed between added gypsum and no gypsum plots at Tifton, but not at Headland (Figure 5). The similarity between the 0, 500, and 1000 lb/A gypsum and liquid Ca plots at Headland may be attributable to leaching of gypsum below the pegging zone with the 19.2 inches of rainfall that occurred following gypsum application. Soils in Headland have a lower capacity to hold Ca than soils in Tifton. Interestingly, soil Ca was relatively consistent at Headland from bloom to harvest. This may indicate that gypsum was leached from the pegging zone between blooming and the first stage of pegging, which represents approximately 1 month from the end of June to the end of July. Loss of Ca from the pegging zone prior to peanut development could explain minimal effects of treatment on seed Ca and percent germination, as well as lower yield at the Headland site.
Figure 5. Soil Ca at harvest (mid October) at Headland and Tifton (0, 500, 1000 lb/A gypsum) sites. Data are mean ± standard deviation (SD).

Most research suggests that Ca is taken up during the early stages of peanut development. To evaluate the accuracy of this research, peanuts were collected, sorted by developmental age using the hull scrape method, and analyzed for seed Ca. As the peanut matures, it will transform through the following hull scrape classes: white, yellow, orange, brown, and black classes. Peanuts in the black hull class are considered ready for harvest and peanuts in the white and early stages of yellow classes are considered to adsorb Ca. In order to account for increasing seed mass during development, Ca is reported on a total Ca basis rather than Ca concentration. Ca concentrations were relatively uniform, but increases in total Ca were seen through each stage (Figure 6). Results indicate Ca was continually adsorbed into the seed up until harvest. Late applications of gypsum may provide benefit to peanuts, especially seed peanuts. In particular, this may be important in years with plentiful rainfall events (e.g., hurricane) that may leach Ca out of the pegging zone before the end of the growing season.
**Figure 6.** Total seed Ca in peanut seeds (Georgia Green) sorted by development stage using the hull scrape method. Development progresses from orange to brown to black.

**Conclusions**

1. Seed Ca appears to be a good indicator of potential seed quality at harvest.

2. Seeds with >300 mg/kg Ca have >90% germination

3. Seed Ca is correlated with germination (seed quality). Soil Ca in the pegging zone can be used to provide assessment of gypsum and liming needs; however, values are temporal and dependent on the source of Ca applied. Gypsum has a much higher tendency to leach out of the pegging zone, but lime provides high soil Ca without a corresponding increase in seed Ca.

4. Current recommendations for 500 lb/A gypsum are adequate for general peanut production. Only under extremely low Ca levels should 1000 lb/A gypsum be applied. For seed production, additional gypsum may be warranted as it may improve seed quality with a slight decrease in overall yield. Peanuts appear to take-up Ca up until harvest. In years when rainfall may cause Ca to leach below the pegging zone, an additional Ca application may be beneficial. Liquid Ca was not an effective Ca treatment. This is probably due to its low Ca content and high susceptibility to leaching. Future studies may be warranted to see if liquid Ca could provide a mid-season boost to pegging zone Ca.
when rainfall is plentiful.