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Prohexadione Calcium or Seed Aging?

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Introduction

In Virginia, growers regularly apply prohexadione calcium (PC) to control vine growth and help with digging of peanut (Arachis hypogaea L.). There are expectations that PC treatment may provide increased yield over non-treated fields, but results are inconclusive. Inconclusiveness could be caused by several factors including cultivar differences and potential PC effect on maturity and seed properties.

Preliminary data, in 2022, showed a negative impact of PC on seed weight, in particular for the large-seeded peanut varieties that may result in inconclusive overall benefit to pod yield and grade (Fig. 1) (Balota et al., 2023). Coincidently, in 2022, some seed samples received by the Virginia Crop Improvement Association (VCIA) from growers indicated stubby root development on the young seedlings (Fig. 2). These seedlings originated from plants that received PC in 2022. In addition, uneven stands were noticed in spring 2023 by numerous peanut growers using seed produced in 2022. If true, PC impact on seed germination can be detrimental to the peanut grown for certified seed, which represents the majority of peanut fields in Virginia.

On July 19, 2023, a meeting with peanut growers was held at the Tidewater AREC. At this meeting, researchers presented preliminary data on the effect of PC on yield, seed weight and maturity. This paper presents the 2022 preliminary data with the addition of germination analysis recently completed on saved seed from the 2022 test.

Description

Objectives

The objectives of this study were to determine the effect of PC on peanut yield, maturity, 100-seed weight, and seed germination from PC treated plants. The seed used for the 100-seed weight evaluation in Fig. 1 was saved and, in Dec 2023, sent to the Virginia Department of Agriculture and Consumer Services (VDACS) Seed Lab for germination analysis.

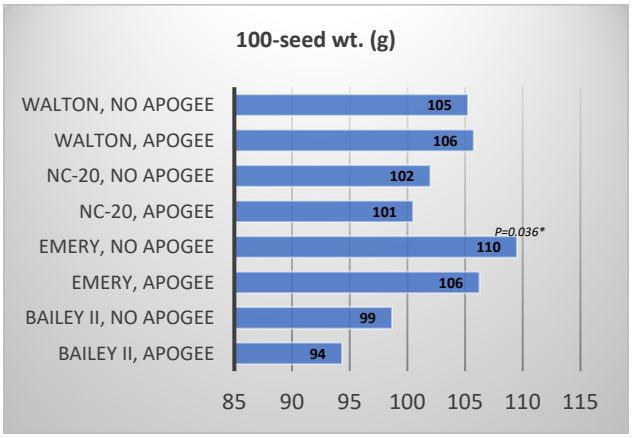

Figure 1. Reduction of 100-seed weight in response to prohexadione calcium applied as Apogee on five peanut cultivars in 2022.

Figure 2. Stubby roots on peanut seedlings.

Methods

In 2022, a replicated experiment was carried on at the Tidewater AREC in Suffolk, VA, using four virginia-type cultivars, ‘Bailey II’, ‘Emery’, ‘N.C. 20’, and ‘Walton’. Two applications of PC at 7.25 oz/A (Apogee) with 16 oz UAN and crop oil were applied at vine touching (Jul 25 - Aug 10) and 14 days after the first application. Applications were performed on

6-row strips randomly selected to receive or not receive PC within two-acre large fields planted with the individual cultivars. In each field, 4 strips or replications, the length of the entire field (over 100 feet long) received and 4 did not receive the growth regulator. General management of the fields followed recommendations of the Virginia Production Guide (Balota, 2023). At 100, 115, 130, and 155 days after planting (DAP) approximately 2-200 pod samples were collected in each strip and maturity was determined by the pod mesocarp color method (Williams & Drexler, 1981) (Fig. 3). Pod maturity index (PMI) was calculated as the ratio of orange, brown, and black pods from all pods. At the physiological maturity (155 DAP), yield and 100-seed weight were recorded. The same seed used for the 100-seed weight was saved and kept in the laboratory until Dec 2023, when seed was shipped to VDACS for germination testing following the Association of Official Seed Annalists (AOSA) Rules for Testing.

Yield and 100-seed Weight

Even though yield was significantly (*P=0.0382*) affected by cultivar and field (each cultivar was planted in a different field, they were not planted side by side), yield was not significantly affected by the PC application (Fig. 4). There were significant (*P=0.0001*) differences among cultivars for the 100-seed weight, and Emery and Walton had the greatest weight in comparison with N.C. 20 and Bailey II (Fig. 1). There were also significant (*P=0.0784*) differences between growth regulator treatments, with PC application resulting in reduced 100-seed weight across cultivars. In particular for the large-seeded Emery, Apogee produced a significant (*P=0.0369*) reduction in seed weight (Fig. 1).

Figure 3. Dr. Abhilash Chandel and graduate student Pius Jjagwe collecting peanut plants for maturity determination.

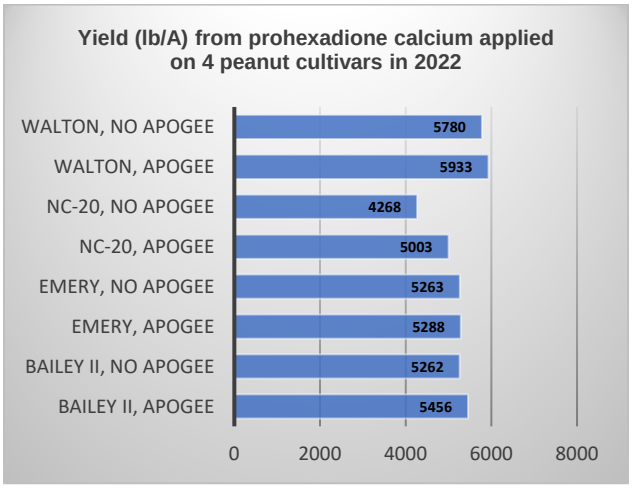

Figure 4. Yield of four peanut cultivars as affected by prohexadione calcium applications.

Maturity

There were no significant differences between PC treated and non-treated pod samples for maturity, regardless the cultivar and DAP. Year 2022 was a dry year with less than 17-inch total precipitation in Holland Virginia from May through October. June and July were particularly dry, with less than 2" for each month. Under these conditions, peanut required longer time to mature, for which the average PMI at 155 DAP was similar across cultivars with wide spread of pod maturity within each cultivar, due to large field variability (Fig. 5).

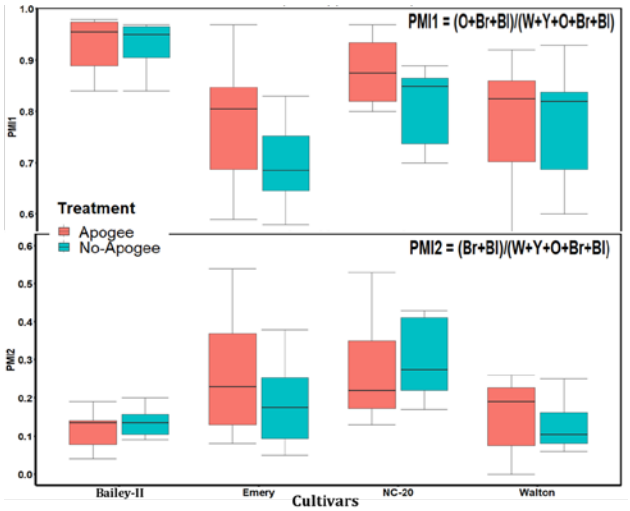

Figure 5. Pod Maturity Index (PMI) calculated based on the ratio of orange (O), Brown (Br), and black (Bl) pods from the total pod count including white (W) and yellow (Y) pods.

Seed Germination

After the 100-seed weight was taken, the seed samples were stored at room temperature. Unintentionally, the seed was kept for a year before

being shipped to the VDACS for germination analysis. The analysis provided percent germinated, abnormal, and dead seedlings from a total of 200 seeds per sample. Eight samples corresponding to 8 replications (4 Apogee-treated and 4 non-treated) per cultivars were analyzed. Although not statistically significant, in average of all cultivars, Apogee-treated seed had reduced germination (0.8% reduction) and increased number of abnormal seedlings (1% increase) (Fig. 6). More interestingly, the cultivar differences for germination were highly significant (*P=0.0001*). For example, Emery maintained an average germination close to 90% and Bailey II to 85%, while Walton had only around 70% germination. N.C.20 showed a significant 50% drop in germination within one year of storage (Fig. 6). Decrease in germination for N.C.20 and Walton could be due to more rapid seed "aging". Seed aging is a complex physiological process expressed during seed storage and associated with seed quality developed during seed development at the pre-harvest time (Moreno et al., 2024). For example, Moreno et al. (2024) determined that peanut seed achieved maximum physiological quality between "brown 1" and "brown 2" maturity stages which, depending on the season, coincides with 4 to 6 weeks after the first PC application (Fig. 7).

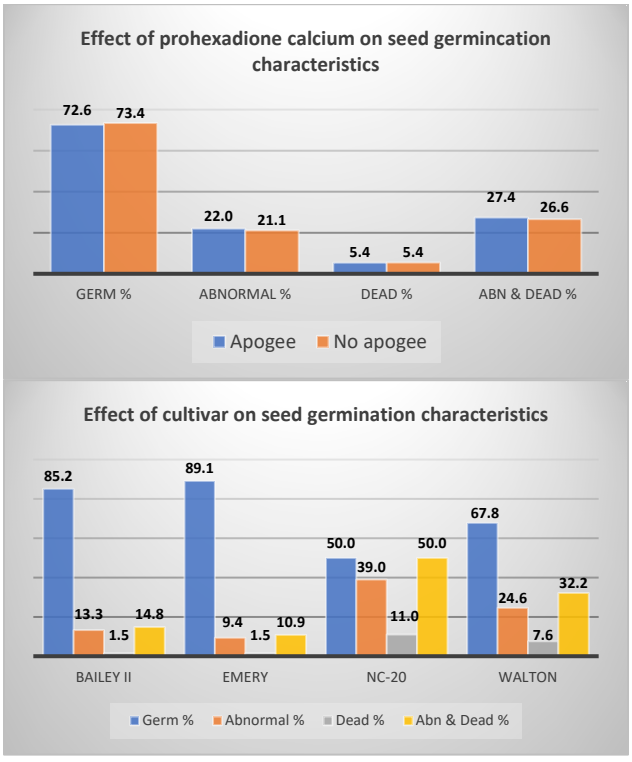

Figure 6. Effect of prohexadione calcium and cultivar on percent germinated, abnormal, dead, and the sum of abnormal and dead seeds of peanut.

Germination, vigor, desiccation tolerance, and aging are the main components of the physiological quality of seeds as defined by Popinigis (1985).

While germination decreased, percent of abnormal and dead seeds increased proportionally, more for N.C.20 and Walton than Bailey II and Emery (Fig. 6).

Cultivars showing reduction of germination due to PC were Emery (2.7% reduction) and N.C.20 (7% reduction). These cultivars, also had more abnormal seedlings on samples that received PC, 1.2% more for Emery and 3.5% more for N.C.20. Walton had numerically more abnormal seedlings when PC was applied but, germination wise, there were numerically higher values for this cultivar and Bailey II in the presence *versus* absence of the PC (Fig. 8).

Figure 7. Optimum vine growth for the first application of prohexadione calcium.

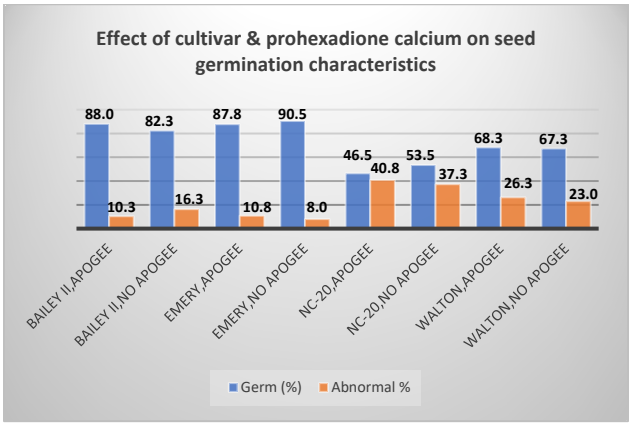

Figure 8. Interaction of cultivar and prohexadione calcium effect on germinated and abnormal peanut seedlings.

Summary

Peanut is a “cash” commodity for Virginians and most farmers grow this crop for certified seed. Seed quality and germination in particular are, therefore, very important. Even though the 2022 results were inconclusive, potential for prohexadione calcium to reduce germination and increase abnormal seedling production was clearly suggested by these data. The inconclusiveness could have been the result of a combination of factors, other than PC, affecting seed quality during storage. A differential response of the cultivars to both, seed aging and PC, was clearly suggested by our preliminary data. Evidence that PC may affect the seed quality, through seed weight, was also notable from the 2022 tests. Collaborators Balota, Langston, and Chandel have repeated this test in 2023, and the data from the field are currently being analyzed. Germination of the seed samples collected from 2023, comparing PC-treated and nontreated cultivars, will be performed in spring 2024 and this audience will be updated when analysis is complete. In addition, and because the Virginia Peanut Growers Association expressed interest and funded this test in 2024, the collaborators will continue the investigation in 2024.

Acknowledgements

The idea that PC may be the cause for stubby roots on the VCIA samples in 2022 was suggested by David Langston, Professor and Extension Specialist, School of Plant and Environmental Sciences, Tidewater Agricultural Research and Extension Center, Virginia Tech. We appreciated Dr. Langston’ s suggestion and saved the seed for further investigation.

In 2024, replication of this test will be funded by the Virginia Peanut Growers Association, which is highly acknowledged by the investigators.

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