Impact of Applications of Calcium to Seed Potatoes on Next Season Production

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The fundamental understanding of nutrient relationships in higher plants continues to evolve, as new evidence is uncovered. While the roles of the macronutrients N, P&K, are perhaps best understood there is undoubtedly more to be learned. Micronutrient understandings have been somewhat less thoroughly explored. This knowledge base continues to expand however regarding rates, timings, placement and product formulations as more and more focused work is undertaken. The importance of some micronutrients now appears to be considerably greater than previously believed. Perhaps much of this has become apparent, as management strategies have been refined to more precisely coincide with the optimum levels and the balanced nutrient requirements of crops. Only in a precisely balanced, optimum situation can we see what a plant's true growth potential and need relationships are.

Specifically, there has been a substantial resurgence of interest in, and work done on the nutrient Calcium. The increased importance of this divalent Cation is being supported by the work of many investigators on a wide range of crops and climatic situations. Not the least of these is Irish potatoes. More and better understandings of the role(s) calcium plays in cell wall rigidity, membrane integrity, its hormone like messenger role at the cellular level and its relationship to plant vigor and physiological disorders are coming to light. There are still many unanswered questions and a great deal more to learn about the many partially understood actions, reactions and interactions associated with calcium.

From the commercial production and marketing aspects of plant nutrition, it is the ways that calcium can be used to enhance crop performance and profitability that are among the aspects being most aggressively pursued. At the present time there is very little information in the literature regarding the effects of micro and minor element applications to seed potato crops and how these treatments will affect the performance of that seed during the next season as a commercial crop.

These studies are focused on the use of calcium formulated as calcium nitrate solution applied to potatoes during the seed production cycle. The product used in these trials was Hydro Agri s' CN-9, a 12.2 lb/gal colorless solution formulated as 9-0-0-11Ca. Three two-year studies each examine ten treatments applied at specific times and rates to Russet Burbank potatoes being grown in west central Montana. This seed-producing region was selected because it is from the Montana seed industry that the majority of the certified seed planted in the Columbia Basin of Washington State originates. Since Montana currently is this regions' most important source of seed potatoes, it was considered the most appropriate site for conducting the seed treatment portion of this study. Evaluations of the treatments applied to the seed trial are exhibited in the

measurable differences that the treatment rates, timings and number of applications have on the next generations' commercial crop when grown in the Columbia Basin of Washington State.

The seed potato segments of these trials were each hand planted with carefully selected Russet Burbank single-drop tubers from the seed lot being planted by the cooperating certified seed grower in Montana. The support provided by these growers was invaluable and contributed much to the success of this project. Thirty seed pieces were planted in the center 25-foot length of row of each three-row wide treatment block. Only the middle row of each treatment block was harvested and used as seed in the next season. The trial consisted of nine treatments and an untreated check (UTC) representing the seed growers' standard program. A ten-inch hand planted seed interval was used throughout the trial. All the seed tubers selected for the center rows these projects weighed between 2 and 2.5 ounces and were planted whole. The two outside rows in each treatment block were planted with machine cut seed and used a separator to ensure complete treatment isolation.

Treatment List

1. Evaluate the performance of liquid calcium nitrate as CN-9 at the specified rate of 6 lb/a as nitrogen (38 lbs formulated) applied at planting time to the soil covering the seed in an 8.5 inch wide band.

2. Evaluate the performance of liquid calcium nitrate as CN-9 at the specified rate of 12 lb/a as nitrogen (76 lbs formulated) applied at planting time to the soil covering the seed in an 8.5 inch wide band.

3. Evaluate the performance of liquid calcium nitrate as CN-9 at the specified rate of 24 lb/a as nitrogen (152 lbs formulated) applied at planting time to the soil covering the seed in an 8.5 inch wide band.

4. Apply 20 lbs/a as nitrogen two weeks after emergence.

5. Apply 40 lbs/a as nitrogen two weeks after emergence.

6. Apply 15 lbs/a as nitrogen at weeks two, four, six, eight and ten after emergence.

7. Apply 20 lbs/a as nitrogen at weeks two, four and six after emergence.

8. Apply 20 lbs/a as nitrogen at weeks six, eight and ten after emergence.

9. Untreated check.

10. Apply 40 lbs/a as CN-9 at weeks four, six and ten.

In each trial, three of the treatments were applied in-furrow. After the seed was planted and counted to insure uniformity, it was partially covered with two-inches of soil. The in-furrow applications were made to this new soil surface in an 8-½ inch wide band centered over the planted seed tubers. The hilling process was then completed to form a finished hill with a cross section profile that closely matched the row shape formed by each seed grower's planter.

The first post-emergence applications were made two weeks after emergence. The rates applied were those prescribed in the project protocol. The calcium nitrate formulation was diluted with water and applied as a tank mix at 25 gallons per acre.

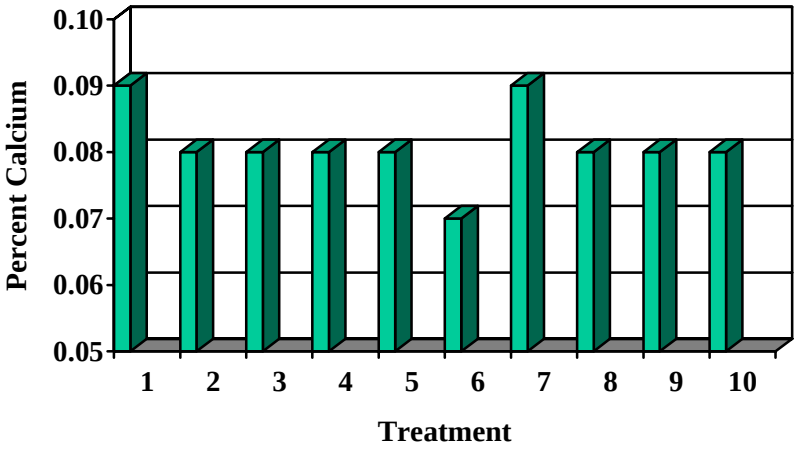
All post-emergence applications were directed to the soil surface as close as possible to the plants without contacting any part of the foliage. Both sides of all three rows were treated. Spraying only the soil was done to avoid possible phytotoxic injury symptoms to the vine canopy and to minimize the risk of plant removal in the seed growers rouging operations. This technique was designed to simulate early season ground application.

Later on, our treatments simulated fertigation practices without altering the seed growers' irrigation practices. Additional applications were made at four, six, eight, and ten weeks after emergence in the manner prescribed for each of the specified treatments. Once row closure by the foliage canopy had occurred, the vines were rolled first to one side and then to the other to expose the shoulders of the hill for the directed spray to the soil surface. This was done with considerable care to avoid any possibility of physical damage to the stems and petioles. After the application, the foliage was gently returned to its original position. All of the cultural practices and product application inputs made to the commercial seed crop during this season were also made to the plot sites. The foliage appearance, rate of growth, yield, and tuber size distributions at harvest in the seed production portion of these trials exhibited no obvious differences.

In mid-September, when the vines were senesced to the extent that all tuber growth had ceased, the seed plots were deemed ready for harvest. The vines of the center row in each treatment block were removed by hand to facilitate a clean sample harvest. All of the plants in the center row of each of the ten plots were hand dug using twelve-tine potato forks. The tubers were hand sorted into two groups as, either single-drop 2 to 2.5 oz. weights or tubers large enough to require cutting prior to planting. Separate small burlap bags were used to hold the samples. Identification tags were put in zip lock plastic bags and inserted with the tubers in each sample bag. Identical tags were wired to the exterior of each sack when they were tied shut. All of the samples were delivered to the cooperating seed growers' storage facility on the day they were harvested. The samples were held in these buildings through the winter in order to provide an over-wintering exposure that would duplicate the conditions in which certified seed is stored.

The hand harvested samples stored very well throughout the winter with not a single tuber showing evidence of deterioration or decay when examined as they arrived in the early spring. The following spring the single-drop portion of the harvested samples were shipped to the Columbia Basin. The samples were held for approximately two weeks to precondition the tubers to the level of physiology appropriate for planting. All of the samples were held at 50°-52° F until they were planted. The physiology of the seed tubers at the time of planting was determined to be as desired for a three stem per hill average. Later examinations of the emerged plants confirmed the at-planting seed physiology was correct. A plot site was prepared for planting the ten samples in a replicated, complete randomized block plot arrangement. All samples were hand planted on a single day to coincide with the mechanical planting of the adjacent commercial crop. The soil temperature at seed depth on the days of planting ranged from 50.7°F. to 52°F.. The few extra seed tubers from each treatment were taken to a tissue-testing lab to be analyzed for calcium content.

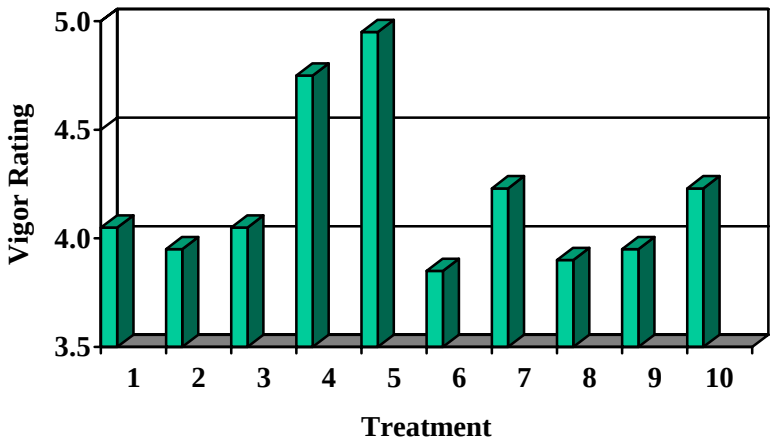
Seed Tuber Calcium Level at Planting Time



The same planting techniques and objectives were included in the commercial trial as were used in the previous years' seed study, except, no buffer rows were included to separate the treatment rows. The larger tubers from each treatment were shipped directly from the seed growers to Dr. Terry Miller, Miller Research Inc. in Kimberly Idaho where they were cut and planted in similar fashion. Full emergence was achieved between May 7th and May 10th. Stand count assessments were made ten days after full emergence. Every row in the entire plot of all three trials had 100% plant stands. None of the 1200 seed pieces planted had failed to emerge and none were late. Early vigor evaluations were performed just a few days prior to row close.

Early Vigor Evaluation Commercial Production Result

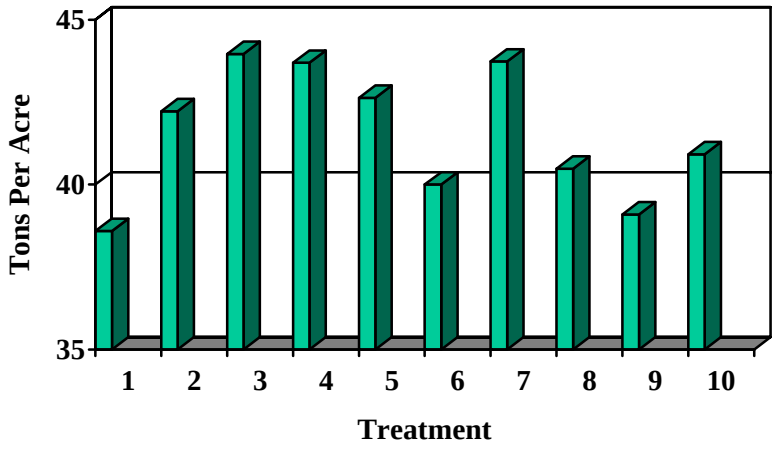
Vigor scale: 1= = poor, 5 = best



At this stage, there were significant visual differences in the size of the plants in some rows when compared to others. The vigor differences ultimately were attributed to the effects of some of the CN-9 treatments made during the year before. The largest and most luxurious plants were in the rows that had been treated with the highest rate of CN-9 at the two-week after emergence timing with calcium nitrate at the 20 & 40 lbs of nitrogen per acre (treatments 4 &5). The plots were monitored twice weekly during the balance of the season to ensure they remained weed free, devoid of insect pest populations and without significant pathogen infections.

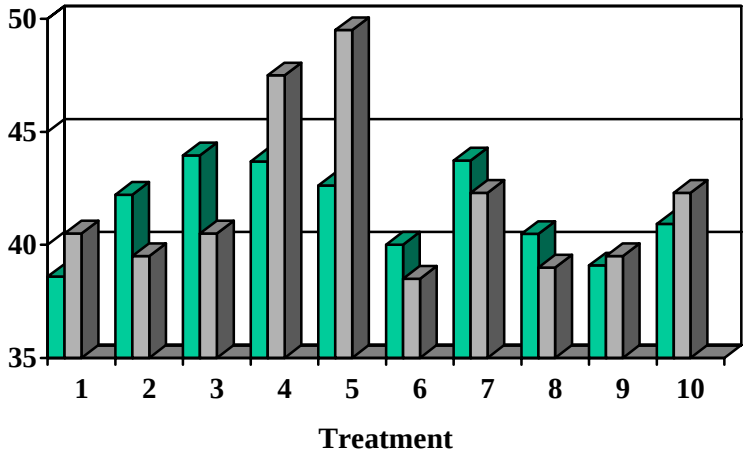
Following the senescence of the foliage canopy in the commercial field and the trial site vines were removed by hand. This was done to ensure that clean samples could be harvested. Every row of the plot was dug for harvest evaluation. All sacked and tagged samples were delivered the day following the harvest to a grade facility where State / Federal inspectors evaluated them. The current USDA out-of-field processing grade criteria for the Russet Burbank cultivar were used for these assessments. Evaluations include yield, grade, size distribution, total usables, culls, and tuber specific gravities for each treatment.

Total Yield Commercial Production Results



The treatment that received the highest in-furrow rate of CN-9 (treatment 3) produced the highest yields the next season. Two other post-emergence early season treatments 4 and 7 were very similar and not statistically different. Higher rates and additional applications however, did not increase yields further. The lowest rate applied in-furrow (treatment 1) and the UTC (treatment 9) had the two lowest yields. The early season applications during the seed production cycle always produced the better results the next generation in the commercial scenario. The late season application timings to the seed crop were not as effective during the succeeding generation. Multiple calcium applications did not contribute to improved commercial crop results in this trial. These results provide indications that calcium nitrate can improve commercial crop performance when applied to the seed crop at the proper time and rate. There was a very strong correlation between the treatments that exhibited strong early vigor and the treatments that produced the best yields.

Early Vigor - Yield Relationship Commercial Production Results



While many factors can impact crop performance, every effort was made in this project to ensure all the controllable variables were as nearly identical as was possible. One concern that developed in this trial that was beyond manageable control, was the additional nitrate contained in the CN-9. This available nutrient was not factored into the seed growers' in-season fertigation practices. It is entirely possible that nitrogen excesses occurred in those treatments that received the greatest amounts of calcium nitrate as CN-9. This may explain why the treatments that received multiple applications of CN-9 during the late post-emergence timings did not do as well.

Also, those that received CN-9 only during the second half of the season may not have performed as well, perhaps because the benefits of the calcium did not have as many growing days in which to perform its *magic*. There were no clear relationships between the various CN-9 treatments and the at harvest specific gravities. Among the ten treatments, average gravity differences were not great. They were in fact, not unlike random samples collected from adjacent sites within the same field. We must conclude that this trial did not provide a clear indication that the tested calcium treatments as CN-9 on seed potatoes had any predictable effect on the subsequent commercial crops' tuber dry matter. Yield and crop quality however, were affected and it is these parameters that profit oriented growers will always be most concerned with.