Horticultural Evaluation of Four Russet Norkotah Line Selections

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INTRODUCTION

Russet Norkotah is an early maturing cultivar released in 1987 by North Dakota State University (American Potato Journal 65:597-604, 1988). Currently, Russet Norkotah is the third most planted potato variety in Washington State, behind Russet Burbank and Ranger Russet (National Potato Council 2003 Annual Report). Russet Norkotah has become the dominant russet cultivar used for fresh markets in the United States (National Potato Council 2003 Annual Report). The cultivar's popularity stems from the fact it is widely adapted and capable of producing relatively high yields in a short growing season. A high percentage of the tubers produced are attractive U.S. #1 tubers.

Despite its popularity, Russet Norkotah has many production weaknesses. The cultivar has a high nitrogen requirement and has notoriously weak vines. Norkotah has very low tolerance to heat and drought stress. The plants are susceptible to most potato diseases and are a symptomless carrier of Potato Virus Y. To identify Norkotah plants with more desirable characteristics, selections of vigorously growing plants were made from commercial fields by researchers in Colorado, Texas, and other locations. These selections were evaluated for horticultural characteristics and the best selections variety protected and released. Four of these selections, Colorado Russet Norkotah Selection 3, Colorado Russet Norkotah Selection 8, Texas Norkotah Strain 223 and Texas Norkotah Strain 278 have become popular for fresh market production in the Columbia Basin of Washington State.

This trial was designed to evaluate the response of standard Russet Norkotah and the four Norkotah line selections (commonly referred to as strains) popular in Washington State to different nitrogen fertility and the effectiveness of Rely® herbicide for vinekill and skin set. Norkotah and the strains were grown under two nitrogen fertility regimes and either vine killed with Rely® (glufosinate) or were not chemically vinekilled. The plants were monitored for in-season growth characteristics and tuber yield and quality were measured at harvest.

METHODS

The Norkotah Strain/Rely® trial was located at the Irrigated Agriculture Research and Extension Unit at Othello, Washington. The trial was grown on a Shano silt loam soil, irrigated with an overhead linear move system. The experiment included: certified standard Norkotah and four Norkotah line selections (Colorado Russet Norkotah Selection 3 (CORN-3), Colorado Russet Norkotah Selection 8 (CORN-8), Texas Norkotah Strain 223 (TXNS 223) and Texas Norkotah Strain 278 (TXNS 278)). Seed pieces cut from certified seed tubers were planted in a randomized complete block with a split plot (high and a low nitrogen treatments) with a nested strip plot (nontreated and Rely® treatments). Seed pieces (2-3 oz) were planted on April 25, 2003 using a Braco® assisted feed two-row plot planter with an in-row spacing of 10-in and a between-row spacing of 34-in. Each plot was three-rows wide and 20-ft long with a four-ft alley between plots. Only the center row was used for data collection.

A 135-300-240 fertilizer blend was preplant applied by a commercial applicator. The high nitrogen treatments were created by side-dressing an additional 100 lbs of 40-0-0 on May

13. The Rely® (glufosinate-ammonium, EPA Reg # 264-652) was applied at the rate of 3 pt/A on August 18 using a Cub tractor equipped with a custom-built electric sprayer (2.5 mph, 20-in boom height, 20-in nozzle spacing, Tee Jet WR8004 nozzles, 30 PSI operating pressure and an application rate of 31.6 GPA). In-season fertility and irrigation management were typical for commercial Norkotah potato production in the Columbia Basin. Insect and disease pests were monitored and pesticides were applied aerially as required.

Percent groundcover was recorded weekly beginning 40 days after planting using a 34 x 30 in groundcover grid. Each grid was divided into 100 equal rectangles. One measurement over the center row of each plot was made counting the number of rectangles more than 50% filled with green leaf and stem. When groundcover for all treatments reached 100% or failed to increase, groundcover measurements were no longer recorded. Percent leaf and stem death were recorded for all treatment combinations on August 18 and every seven days thereafter (August 25, September 2 and September 8) until harvest on September 8.

The center row of the three-row plot was harvested with a Braco® one-row plot harvester. Harvested tubers were washed and graded on an electronic sorter. Samples were removed for specific gravity measurement and to examine for internal defects (hollow heart, brown center, internal brown spot, blackspot bruise) as well as, shatter bruise. A visual rating of skin set was recorded as the tubers were sorted. Tubers were rated using a one to five scale, with one denoting severe feathering of the skin with virtually no skin set and five denoting no feathering and very good skin set. In addition, the skin set was measured using a rotating drum on September 18 using the same visual scale used for the sorter readings.

RESULTS

Stand Establishment and Plant Development: The CORN-3 and both TXNS strains had greater than 90% emergence 40 days after planting (Fig. 1). Norkotah had less emergence, with 81% and CORN-8 plants showed delayed emergence, with only 64% emergence 40 days after planting. The final plant stand, which was determined 60 days after planting, was similar for Norkotah and the four strains (Fig. 1). Similarly, Norkotah and CORN-8 had delayed row closure as compared to the other strains, with percent ground cover readings less than the other three strains until the July 3 reading (Fig. 2). Norkotah failed to achieve 100% ground cover during the entire growing season.

Nitrogen Levels: Although two nitrogen fertility levels were used, the intended differences in soil fertility were not achieved. Organic release of nutrients from the fall seeded mustard cover crop incorporated in October of 2002 decreased or eliminated most of the effects anticipated from the different levels of nitrogen application. Mid-season soil samples found as much as 320 lbs. of soil nitrogen in some locations of the field. The petiole nitrogen profile of the strains in the low nitrogen plots (Fig. 3) and high nitrogen plots (Fig. 4) are similar the entire growing season.

Plant Desiccation: Leaf and stem condition of the nontreated and treated plots were similar when the Rely® herbicide was applied on Aug. 18 (Figs 5-8). Norkotah had the highest amount of dead leaves and stems and CORN-3 had the lowest leaf and stem death at the time of application (Figs 5-8). The percent of dead leaf and stem tissue in Norkotah and all of the strains in the nontreated plots naturally increased from the date of application until harvest (Fig. 5). In the nontreated plots, plants of Norkotah had 95% of the leaf and stem tissue dead at harvest, compared to CORN-3 plants which were still quite green (20% leaf and 17% stem death). Research out of Colorado (Thompson, S., Davidson, R. 1999. Russet Norkotah, Russet Norkotah-Selection 3, Russet Norkotah-Selection 8. Production Profile. Department of Horticulture & Landscape Architecture, San Luis Valley Research Center, Colorado State University) has shown that CORN-3 plants require considerably less nitrogen than regular Norkotah. Since all the entries in the trial received the same amount of Nitrogen (more than actually intended, a result of the high organic release) the luxuriant growth seen in the CORN-3 plants late in the season was probably a result of an over abundance of nitrogen. One week after treatment (8/25) with Rely®, all strains with the exception of CORN-3 had more than 85% leaf death (Fig. 6). On August 25, CORN-3 had 70% dead leaves. By Sept. 2nd, all strains, including CORN-3, had more than 90% leaf death.

Stem death in the nontreated plots followed a pattern quite similar to that for leaf death (Fig. 7). Natural stem senescence was apparent in all entries, with the exception of the CORN-3, where stems were still very green at harvest (<20% stem death). Stem death was slower than leaf death following the Rely® application (Fig. 8 vs. Fig. 6). Seven days post treatment (8/25), Norkotah and both TXNS strains had 90% stem death, while CORN-8 had 71% and CORN-3 had only 48% stem death. By Sept 2 (two weeks post treatment), Norkotah and all the strains, except CORN-3, had more than 90% stem death. CORN-3 had 85% stem death. At the final reading (three weeks post treatment) only CORN-3 with 89% had less that 98% vine death. No differences were detected between leaf (Fig. 9) and stem (Fig. 10) death between the nitrogen treatments in either the nontreated or the Rely® treated plots.

Skin Set: Only the visual skin set ratings taken as the tubers were sorted were used for analysis. The skin set data taken with the rotating drum are not reported because the test was performed after a ten-day delay, allowing the skin to set on all tubers, rendering treatment differences present in the field undetectable. Regardless of treatment, skin set on tubers from the trial was less than expected, but the various strains had different levels of skin set (Fig. 11). Norkotah, CORN-8, and TXNS 278 had the higher skin set than CORN-3. Examining the strain results by vinekill treatment shows a similar pattern in strain response in both the Rely® treated and nontreated plots (Fig. 12). The nontreated plots had unacceptably low levels of skin set, especially CORN-3, which had a skin set rating of one (very poor). The poor skin set of CORN-3 in both the nontreated and Rely® treated plots was not surprising, considering the vigorous green vine growth at vinekill and the delayed leaf and stem death (Figs. 3-6). No nitrogen effect on skin set was detected in this trial (Fig. 13, Nitrogen Level). As expected, those plots treated with Rely® had considerably higher skin set than the nontreated plots at harvest (Fig. 13, Vinekill Treatment).

Harvest Yield and Quality: Total yields for all trial entries were excellent with a high percentage of the tubers grading U.S.#1 (Fig. 14). Norkotah had lower total and U.S. #2 and cull yield than the strains. Both TXNS strains had a higher total and U.S.#1 yield than Norkotah. Differences were not detected between nitrogen or vinekill treatments in total yield or the yield of U.S.#1 and U.S.#2 and cull tubers in this trial (Fig. 15). Tuber specific gravity was similar for Norkotah and the strains, all near 1.067 (Fig. 16). No differences in tuber specific gravity were detected between the nitrogen and vinekill treatments (data not shown).

Examining the yield by strain shows that in some strains there were differences in yield resulting from the Rely® treatment (Fig.17). Regardless of nitrogen level in CORN-3 plots, the nontreated plots had higher total and U.S.#1 yield than the Rely® treated plots (Fig. 17). The yield difference is a result of the CORN-3 nontreated plants continuing to bulk after the Rely® treated plants had begun to dessicate. A similar, although less pronounced pattern between the nontreated and Rely® treated plots is apparent in CORN-8 and the low nitrogen treatments of TXNS 278 (Fig. 17).

Tuber size distribution was modified by both nitrogen level and Rely® treatment. The tuber size distribution of Norkotah was influenced more by the nitrogen treatment than by the Rely® treatment (Fig. 18). The low nitrogen treatment has more yield in the 10-12 oz and 12-14 oz size ranges, as compared to the high nitrogen treatment (Fig. 18). The size distribution of CORN-3 (Fig. 19) is considerably different from Norkotah (Fig. 18). The nontreated plots had much of their yield profile skewed toward 14 oz, as compared to the Rely® treated plots (Fig. 19). The hexagon size difference depicts the yield difference seen in Figure 17. The difference in tuber size distribution was a result of the healthy plant condition of CORN-3 at vine kill (Figs. 5-8) that allowed continued bulking in the nontreated plots after the Rely® plots had been treated. There was a similar trend in the CORN-8 (Fig. 20), but it is much less pronounced than CORN-3 (Fig. 19). No meaningful differences are apparent between nitrogen and vinekill treatments in TXNS 223 (Fig. 21). Much of the yield in the TXNS 278 plots was in the greater than 14 oz size category (Fig. 22). There is an apparent nitrogen treatment effect, as both the low nitrogen nontreated plots and Rely® treatments resulted in a greater yield of 10-12 oz and 12-14 oz sized tubers, an indication that the lower nitrogen levels may have resulted in improved tuber bulking.

CONCLUSIONS

The results of this trial show that the Norkotah strains tested perform well grown under the climatic conditions of the Columbia Basin of Washington State. All the strains tested had higher total yields than standard Norkotah. The trial results indicated that Rely® is an effective vinekill method for all of the strains tested with the exception of the CORN-3 strain grown under the nitrogen rates in the trial. This strain had very green vines at vinekill and nitrogen management more suited to the culture of this strain may have resulted in more mature vines that would have been more easily killed. Although skin set in all of the Rely® plots was better than that seen in the nontreated plots, the skin set was less than desired with a three-week period between Rely® application and harvest. The high petiole nitrogen levels may have caused a delay in tuber maturity, resulting in the poor skin set.

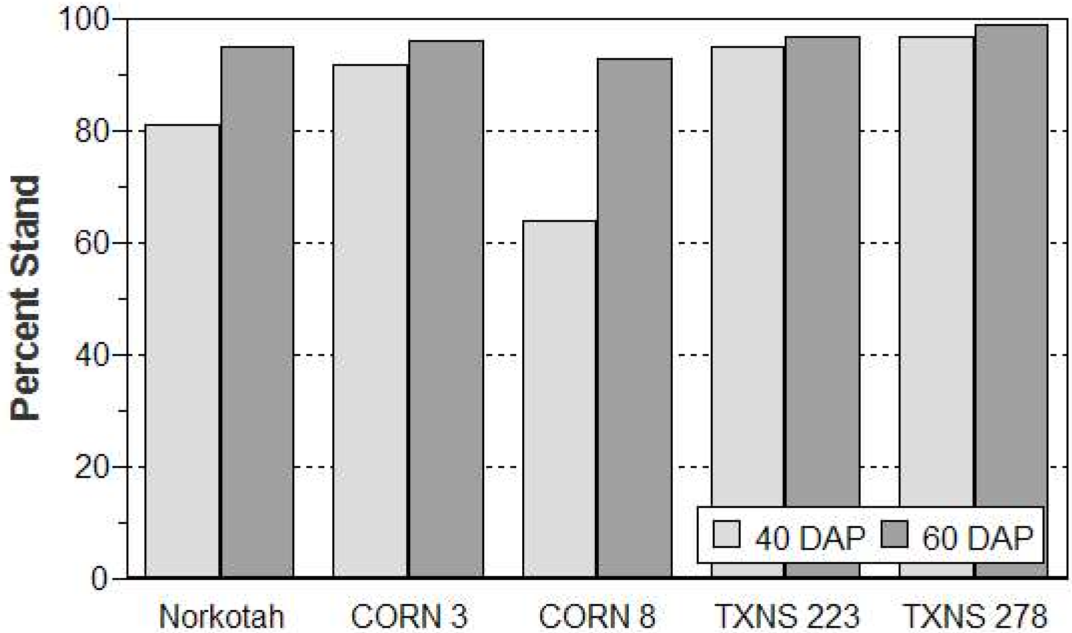

Figure 1. Plant stand measured 40 and 60 days after planting (DAP) for Norkotah and the four strains averaged over nitrogen and vinekill treatments.

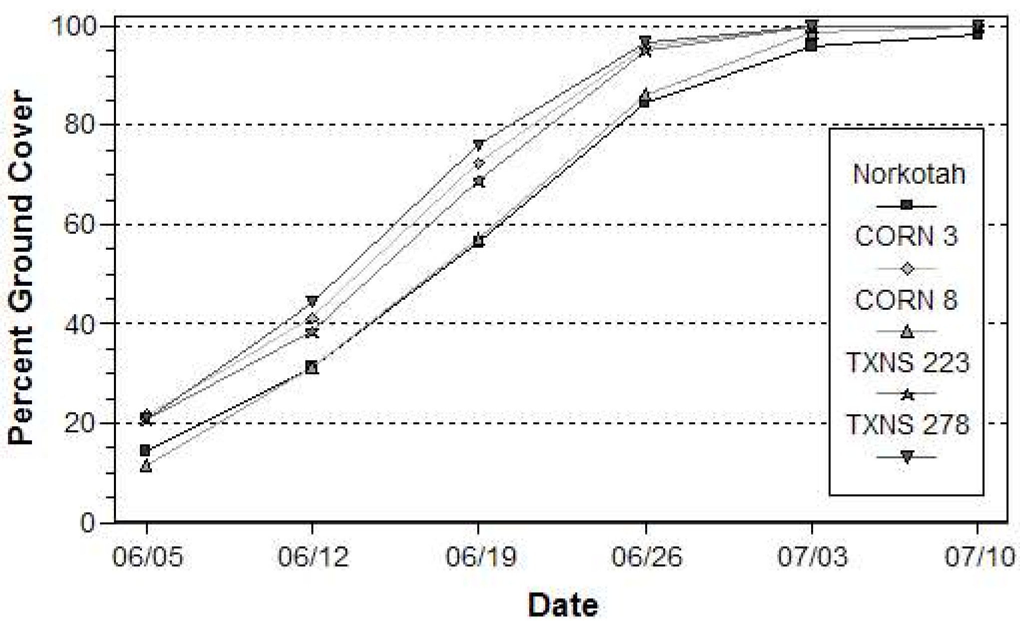

Figure 2. Changes in percent ground cover for Norkotah and each of the four strains averaged over nitrogen and vinekill treatments.

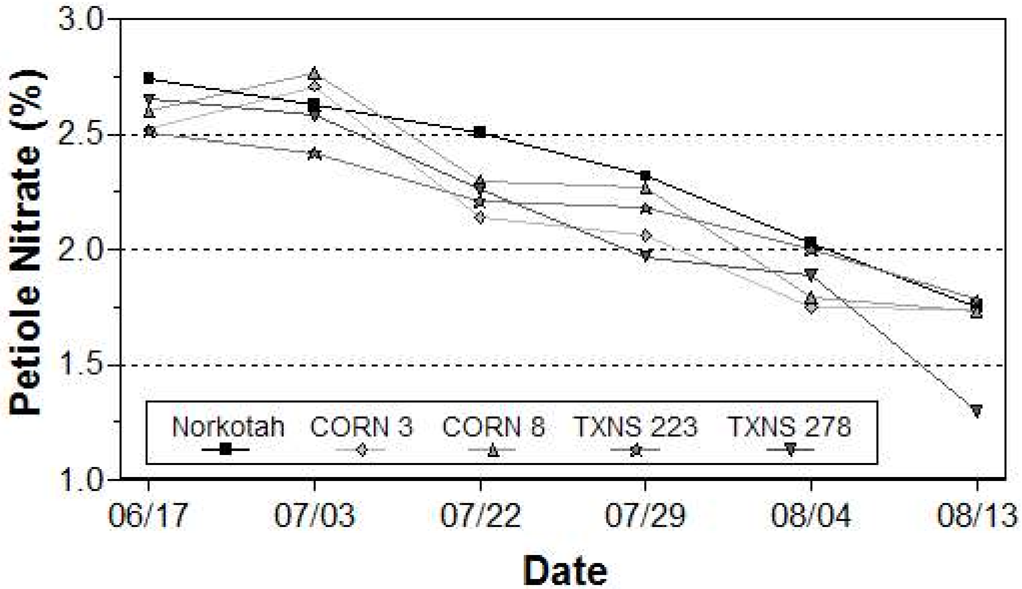

Figure 3. Season petiole nitrogen levels for Norkotah and the four strains in the low nitrogen treatment plots.

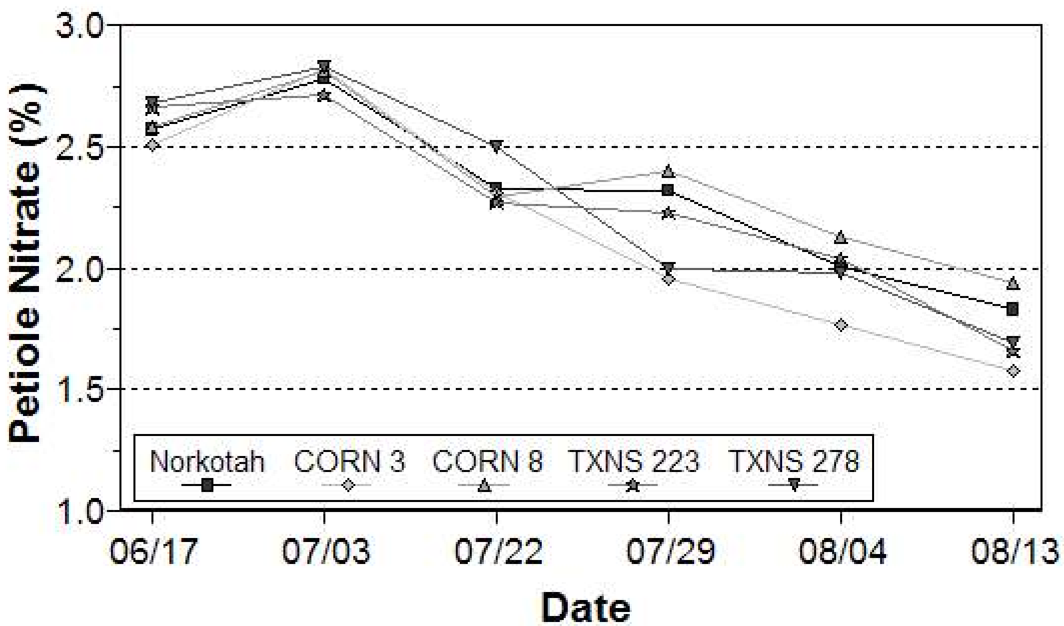

Figure 4. Season petiole nitrogen levels for Norkotah and the four strains in the high nitrogen treatment plots.

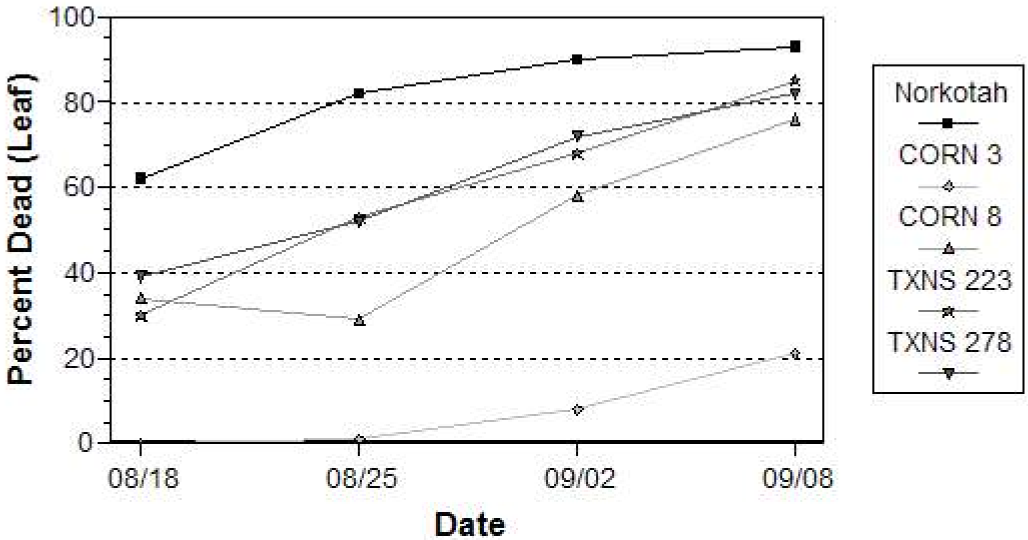

Figure 5. Changes in percent leaf desiccation over time for Norkotah and each of the four strains in nontreated plots averaged over the nitrogen treatments.

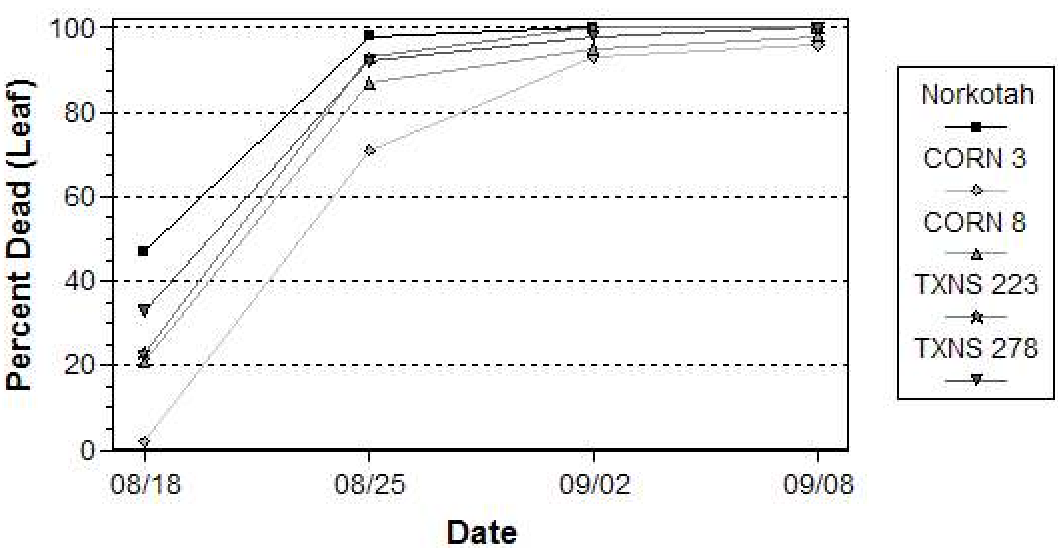

Figure 6. Changes in percent leaf desiccation over time for Norkotah and each of the four strains in Rely® treated plots averaged over the nitrogen treatments.

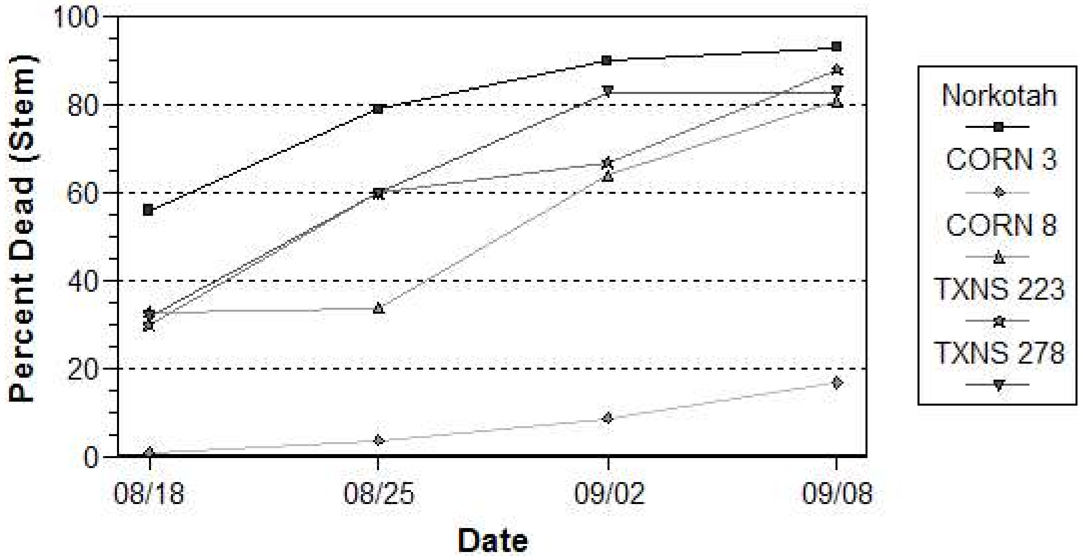

Figure 7. Changes in percent stem desiccation over time for Norkotah and each of the four strains in nontreated plots averaged over the nitrogen treatments.

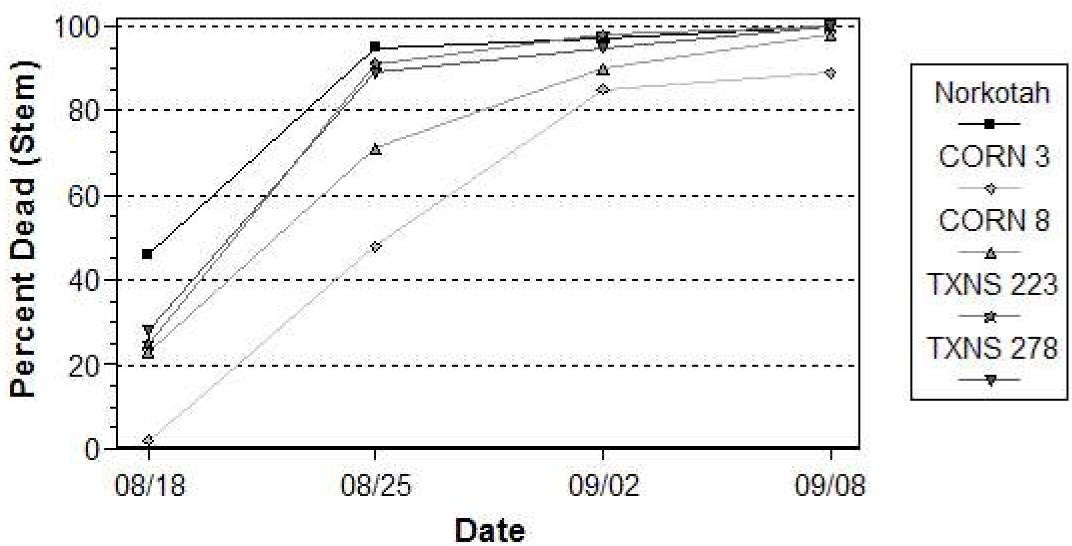

Figure 8. Changes in percent stem desiccation over time for Norkotah and each of the four strains in Rely® treated plots averaged over the nitrogen treatments.

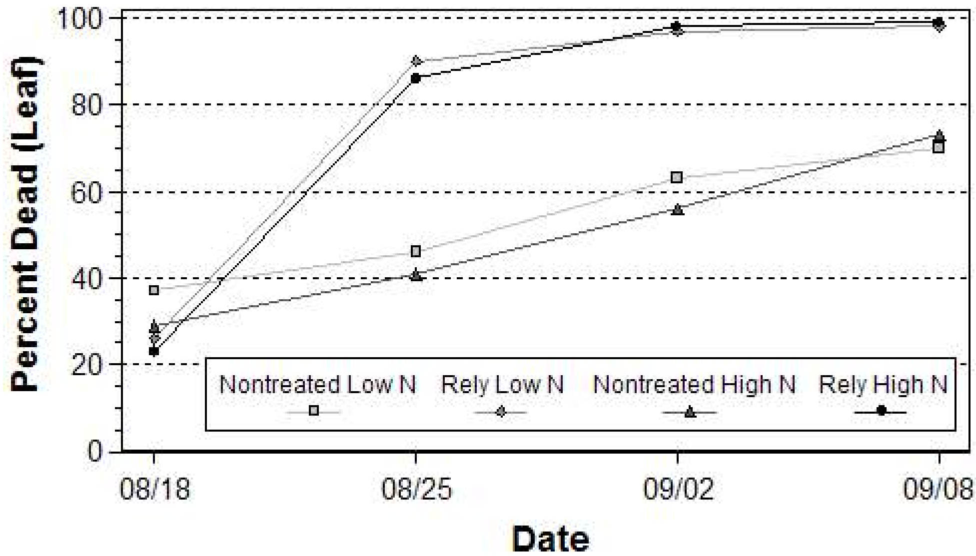

Figure 9. Changes in percent leaf desiccation over time for both treatment levels of nitrogen in the nontreated and Rely® treated plots averaged over Norkotah and the four strain plots.

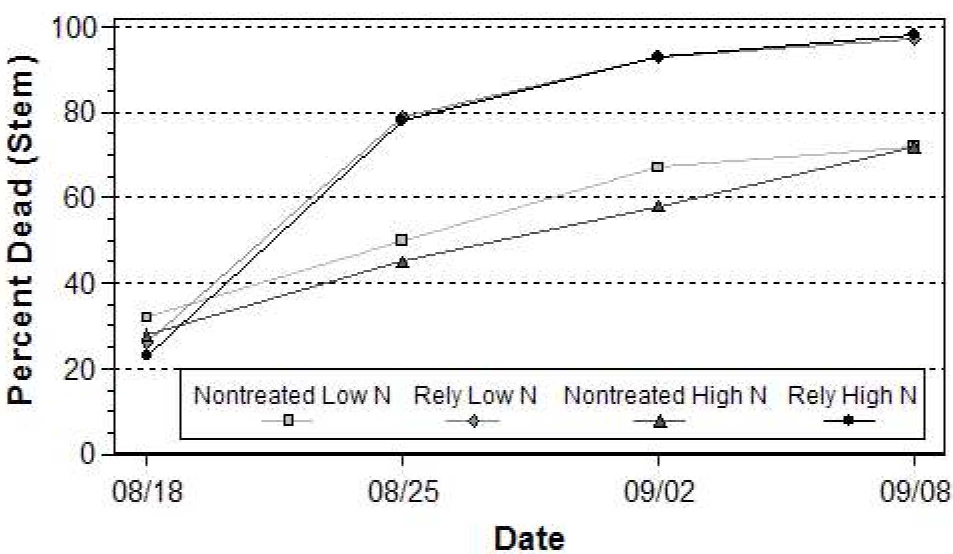

Figure 10. Changes in stem desiccation over time for both treatment levels of nitrogen in nontreated and Rely® treated plots averaged over Norkotah and the four strain plots.

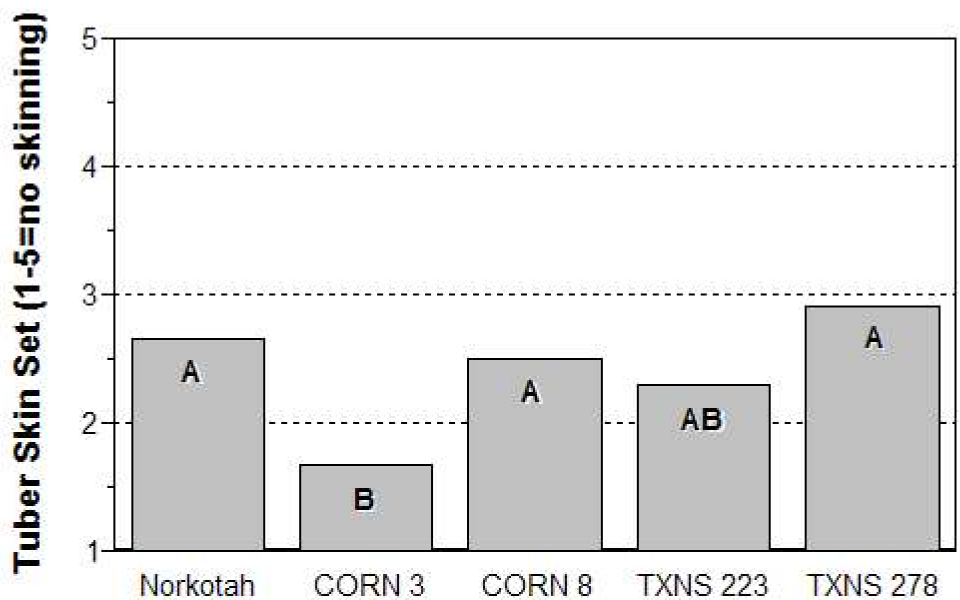

Figure 11. Skin set on tubers from Norkotah and the different strains. Results are of a visual skin set reading taken at harvest (1-5 = no tuber skinning). Bars with different letters are significantly different using Duncan's Multiple Range test p<0.05.

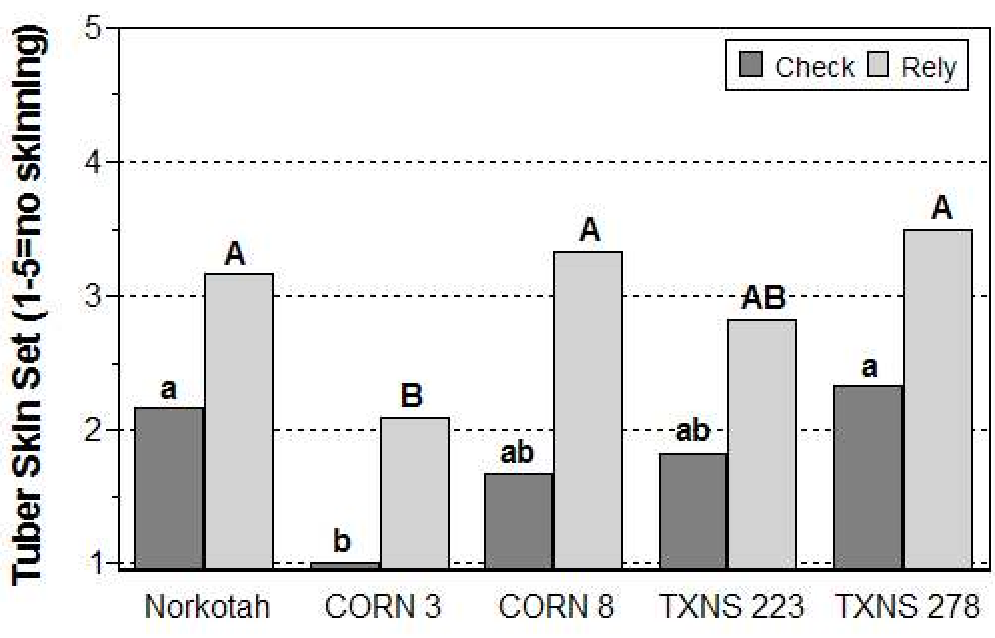

Figure 12. Skin set on tubers from Norkotah and the different strains in the nontreated and Rely® treated plots averaged over nitrogen levels. Results are of a visual reading taken at harvest (1-5 = no tuber skinning). Bars within the check (lower case) and Rely® treatments (capitals) with different letters are significantly different using the Duncan's Multiple Range test p<0.05.

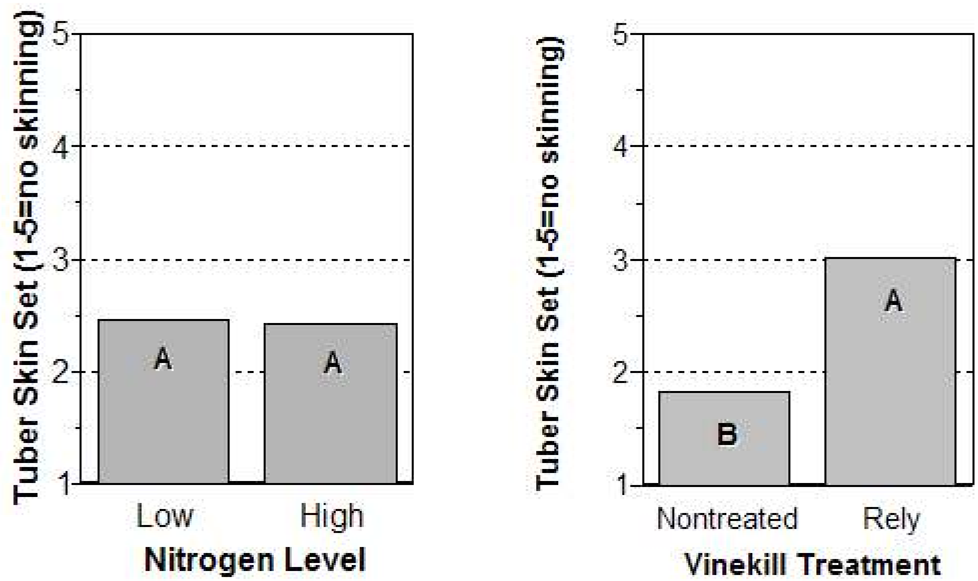

Figure 13. Skin set on tubers from the different nitrogen levels and vinekill treatments averaged over the Norkotah and strain plots. Results are of a visual reading taken at harvest (1-5 = no tuber skinning). Bars with different letters are significantly different using Duncan's Multiple Range test $p<0.05$.

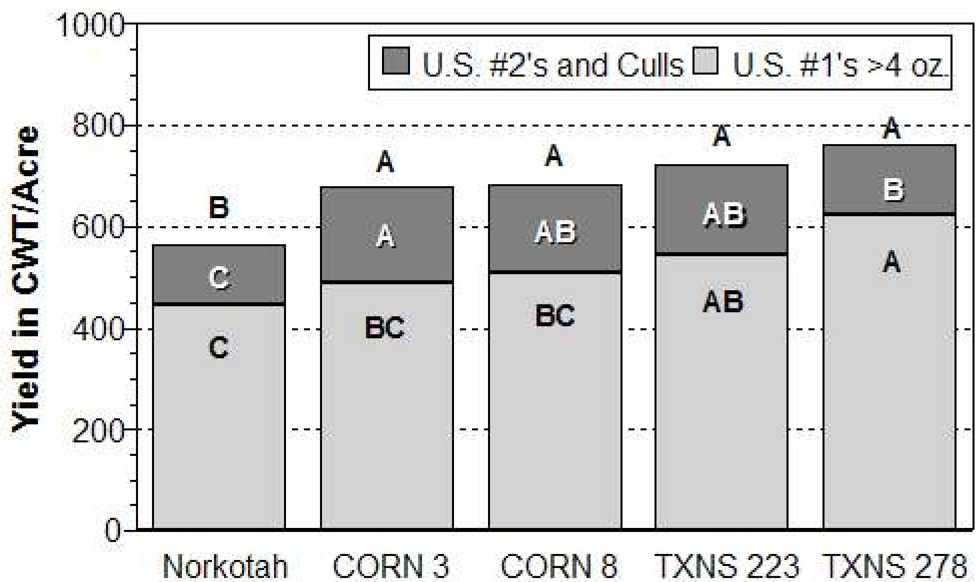

Figure 14. Yield of U.S. #1> 4 oz (light gray bars) and U.S. #2's and culls (dark gray bars) and total yield (both bars added together) for Norkotah and the strains averaged over nitrogen and vinekill treatments. Bars with different letters (black letters within light gray bars are for U.S.#1's, white letters within dark gray bars are for U.S. #2's and culls, and black letters above the bars are for total yield) are significantly different using the Duncan's Multiple Range test $p<0.05$.

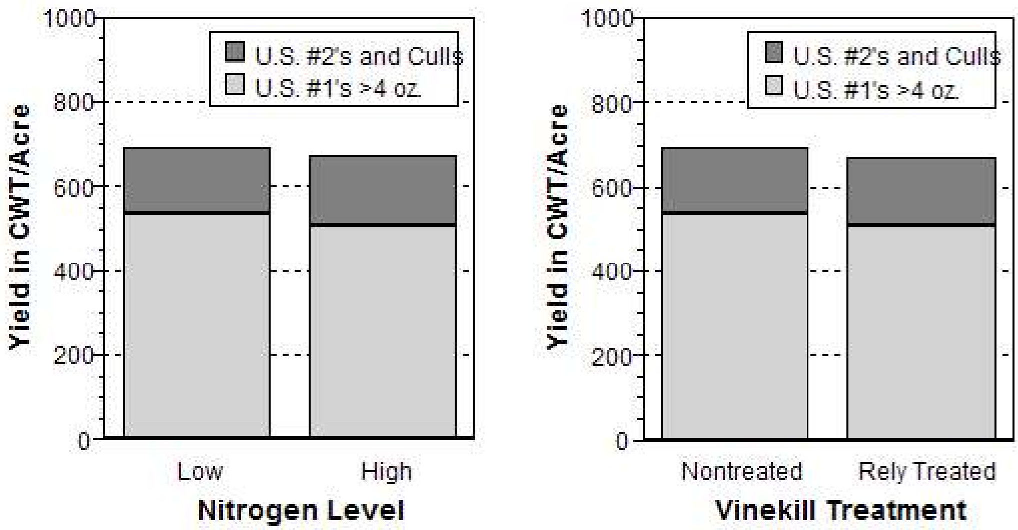

Figure 15. Yield of U.S. #1> 4 oz (light gray bars) and U.S. #2's and culls (dark gray bars) and total yield (both bars) for nitrogen and vinekill treatments averaged over the Norkotah and strain plots.

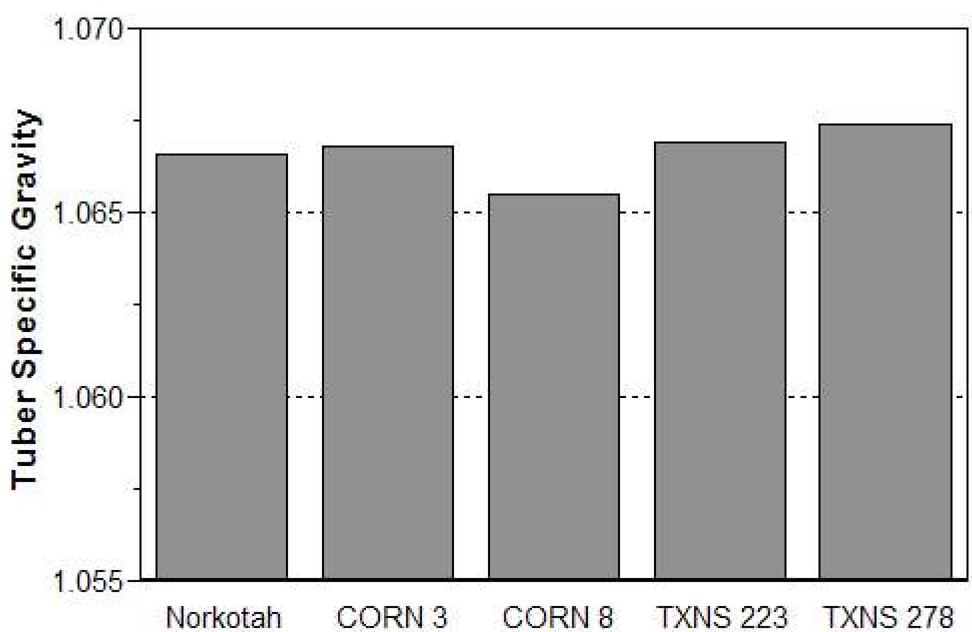

Figure 16. Tuber specific gravity measured at harvest for Norkotah and the four strains averaged over nitrogen and vinekill treatments.

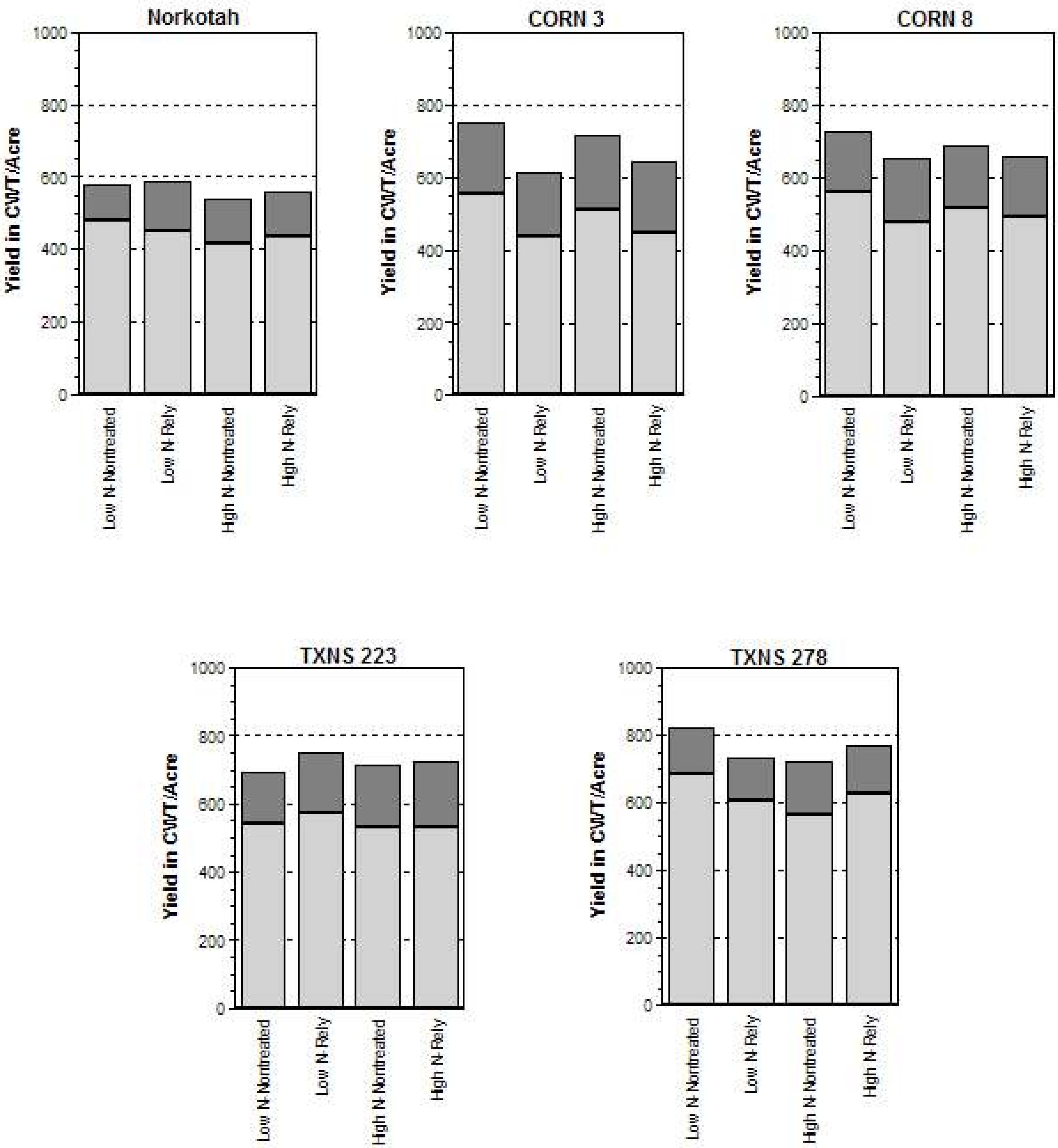

Figure 17. Yield of U.S. #1 >4 oz (light gray bars) and U.S. #2's and culls (dark gray bars) and total yield (both bars added together) for each nitrogen and vinekill treatment combination in Norkotah and the four strains.

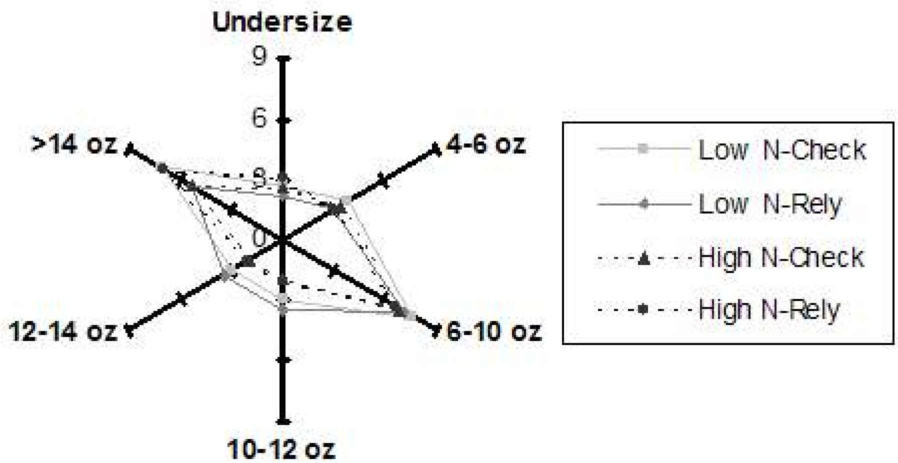

Figure 18. Effect of nitrogen and vinekill treatments on the tuber size distribution of Norkotah. Each axis indicates the yield of the labeled size category in tons per acre.

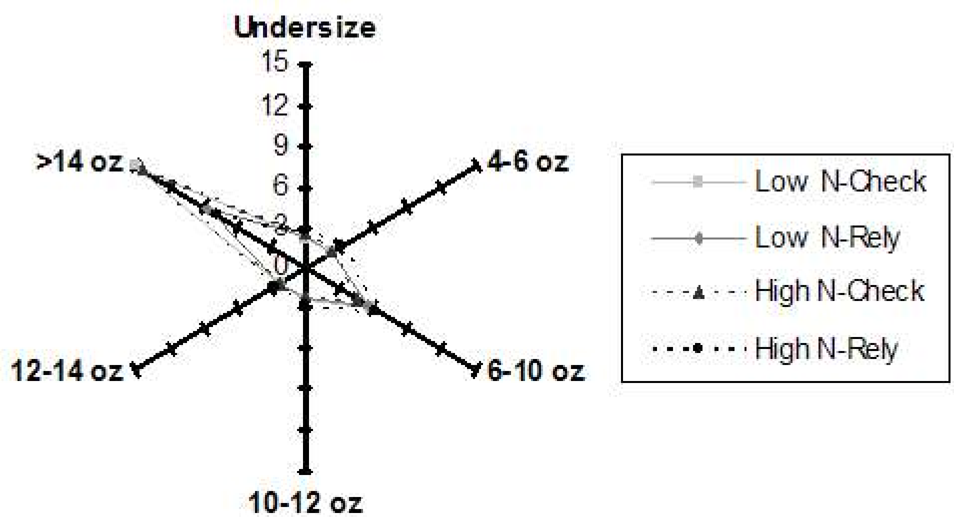

Figure 19. Effect of nitrogen and vinekill treatments on the tuber size distribution of CORN-3. Each axis indicates the yield of the labeled size category in tons per acre.

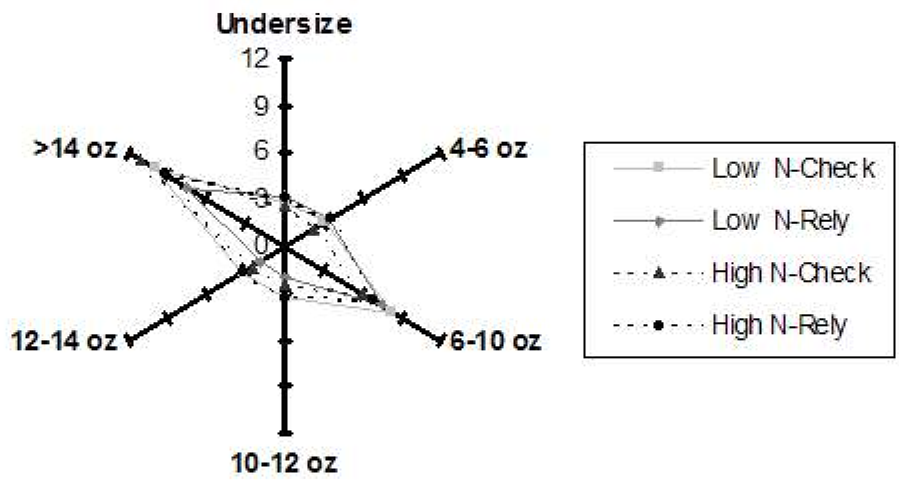

Figure 20. Effect of nitrogen and vinekill treatments on the tuber size distribution of CORN-8. Each axis indicates the yield of the labeled size category in tons per acre.

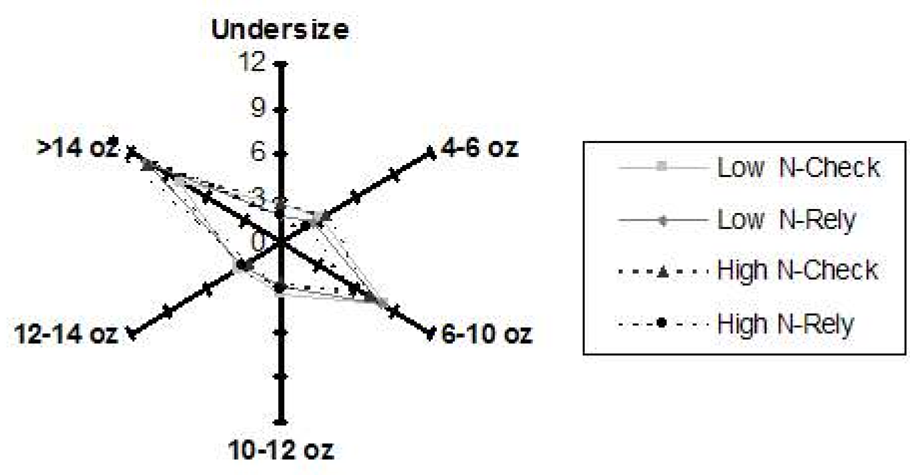

Figure 21. Effect of nitrogen and vinekill treatments on the tuber size distribution of TXNS 223. Each axis indicates the yield of the labeled size category in tons per acre.

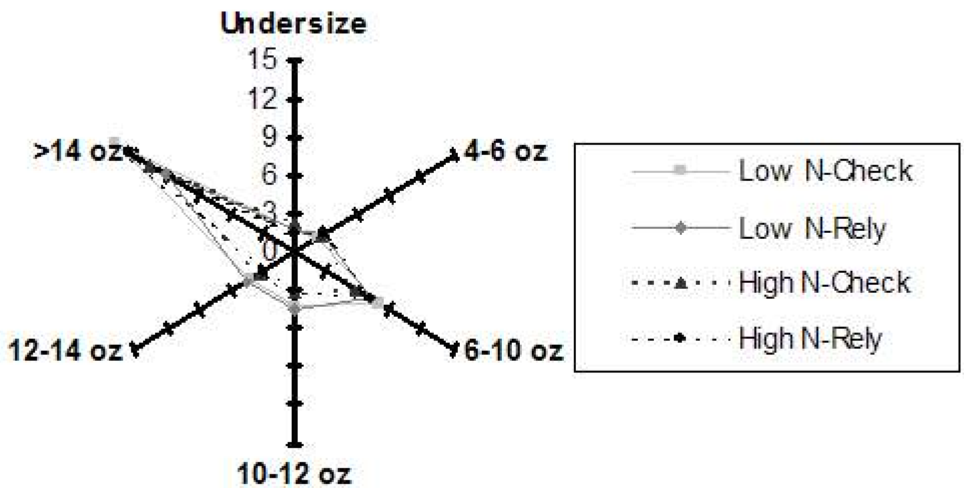

Figure 22. Effect of nitrogen and vinekill treatments on the tuber size distribution of TXNS 278. Each axis indicates the yield of the labeled size category in tons per acre.