A DETAILED LOOK AT HOW THE RUSSET BURBANK GROWS

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For over 100 years people have grown and studied the growth of the Russet Burbank potato. Yet it would seem that the only thing we know for sure is that the Russet Burbank is very sensitive to changes in the environment at any time during the season. Most studies focus on the growth of one plant part, be it vines, roots or tubers and the conclusions are based on early season growth, yield and quality <u>or</u> final yield and quality. Often the two sets of data don't make sense when you try and relate one to the other. What this presentation attempted to do was study the season long growth of Russet potatoes by detailing the way in which individual plants grow. We studied plants with various stem numbers coming from the same seed piece. Information was collected from each stem and the tubers associated with those stems and the internal quality (focusing on hollow heart-brown center (HHBC)) of those tubers. We then attempted to relate these findings to different planting dates and preplant fertility levels. Both of these cultural practices have been used in an attempt to reduce HHBC in Russet Burbank potatoes.

Figure 1 is provided to help you understand some of the terms that are used in subsequent graphs related to stem numbers. The terms dominant and nondominant stems are used to distinguish between stems of different sizes. The stem(s) on a 1 or 2 stem plant are always considered to be dominant while the smaller stem(s) from a 3 or 4 or more stemmed plant are considered nondominant. The main stem is always the largest stem on any plant.

Figure 2a-d is shown to illustrate only the main (primary) stem from plants with various numbers of stems. These comparisons point out that the main stem from a single stem plant has more tubers, tuber weight (or growth rate), occurrence of HHBC and the percent of HHBC throughout the growing season. Also, in general, the more stems per plant, the less tubers, tuber weight and HHBC on the main stem.

Figure 3 gives a look at the same tuber characteristics as discussed in figure 2, but additionally you see how these relationships change on a second and third stem from a double, triple or multiple stemmed plant. On these charts the data for stem 1 on a single stem plant is always equal to 100% since there is only 1 stem on a single stem plant.

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Figure 3a-c clearly shows that not only do you have a consistent decrease in tuber number, weight and HHBC from the main stem with each plant type as demonstrated in figure 2, but you also have a further reduction of these tuber characteristics, with each additional stem, on a plant.

Stem 1 consistently bears the most tubers, tuber weight and HHBC, regardless of how many stems on a plant and stem 2 bears more than stem 3. It should also be noted that in these experiments that the first 3 stems on a multiple stemmed plant accounted for only 78% of the tubers, but 85% of the tuber weight and 98% of the hollow heart-brown center. It is remarkable that the relationship between tuber number, weight and HHBC stays so consistent from stem to stem and plant type to plant type.

Figure 4 and 5 illustrate the differences between dominant stems coming from single or double stem vs. triple or multiple stemmed plants and dominant vs. nondominant stems from triple or multiple stem plants. The charts for figures 4 and 5 should be viewed together so that you can see the very close relationship which develops between tuber size (growth) and HHBC. Inserts for total tuber weight and total HHBC closely parallel each other, similar to what was shown in figure 2 and 3 for each stem on a given plant type. It is not surprising then, that the dominant stem from a single or double stemmed plant has more tuber weight and the most weight is concentrated in a larger tuber size at any given time during the season. The largest portion of HHBC is also concentrated in those same larger tubers for a given time period. The bigger the stem and the less there are per plant, the faster the tubers grow. Consequently, the more HHBC associated with those type of stems, tubers and plants.

Figures 6a and b are designed to help you understand how HHBC may occur in Russet Burbank potatoes. Figure 6a measures only tubers which have been scored for HHBC and the tuber sizes where the HHBC occurred throughout the season. As you know, when tubers are just beginning to grow during June, we observe a lot of brown center initiation. As the season progresses hollow heart and or brown center begins to show up in several tuber sizes. This graph, however, shows that about 50% of all the HHBC is concentrated in a given tuber size, and is associated with the largest tubers at any time during the season. Because we evaluated HHBC on a tuber number basis i.e. HHBC tubers/total tubers x 100 = %HHBC, the following statement can be made: If all of the HHBC is initiated during the early part of the growing season, then the %HHBC measured during the season (figure 6b) should remain at a constant level after the early season period. But figure 6b clearly indicates that HHBC increased late in the season, as the tubers began to bulk rapidly. It is proposed that Russet Burbank not only has the possibility of getting HHBC early, but also later in the season, when some of the most rapid tuber bulking rates occur. This type of HHBC might be very similar to the HHBC we witness in Norgold Russet.

Now lets try to apply some of the stem and tuber size data to situations which you and I face each year. Decisions have to be made such as when to plant and how much preplant fertilizer to put down. Concerns about HHBC may influence these decisions.

For some time both delaying the date of planting and reducing the amount of preplant nitrogen have been used with some success to avoid or minimize HHBC. The consequences of changing these cultural practices were measured in a four year study at AgriNorthwest. Figure 7 indicates that we may receive yield benefits from reducing our preplant nitrogen and that as you delay planting, yield potential is reduced. It should also be noted that although the yield was consistently higher when a lower preplant application was used, yields still declined as planting date was delayed. Figure 8 is provided to show you how the nitrogen was applied during the season. How is it that changing these cultural practices influences HHBC? Figures 9-11 are designed to help illustrate the differences between the practices and the stem and tuber data (fig. 2-6) can help explain why these practices influence HHBC.

A change in the planting date affected stem number, but varying the preplant nitrogen level did not (fig. 9). This would indicate that the seed, although from the same lot, aged between planting dates. This occurred even though the seed tubers were held in a refrigerated, cool environment and were delayed only 3-4 weeks before planting the seed.

More stems per plant means a higher proportion of triple and multiple stem plants as well as more nondominant stems and main stems with slower growing tubers. Could this be one of the main reasons for reduced HHBC in later planted fields? Less yield potential, smaller, slow growing tubers. Although warmer weather usually accompanies the period of early HHBC development with a delay in planting, which can affect the development of early season HHBC, the HHBC which may occur during the late season would be controlled by slower growing tubers and more stems per plant. This would seem to be the case shown in fig. 10, where over a two year period the only HHBC difference between planting dates was expressed in the two largest tuber sizes. Comparing these results with the information collected on differences between preplant nitrogen levels (fig. 11) it should be noted that stem number was not different between these treatments (fig. 9). Vine and tuber growth rate, however, did vary. Vine growth was significantly slowed by reducing preplant nitrogen, however plant growth, as a whole, was merely shifted to the tubers (fig. 11a and b). It would appear that through decreased vine growth, a lower preplant nitrogen regime can reduce the level of early season HHBC (fig. 11c). However as tuber growth during late July and August began to increase, the amount of HHBC produced during this same time period was very similar.

Delaying the date of planting and reducing preplant nitrogen levels would appear, then, to affect plant growth and subsequently HHBC development in different ways. Increasing stem numbers per plant and the reduction in tuber growth rates is an important factor in influencing late season HHBC by delaying your planting date. Lower nitrogen levels, on the other hand, appears to reduce early season HHBC symptoms, while having little influence on the HHBC which develops during the late season, as the tubers grow rapidly.

In summary, I hope a few things about how the Russet Burbank potato grows have been illustrated. First, that each stem and the number of stems on a plant influence tuber number and size and consequently the appearance of HHBC. Second, that there would appear to be two distinctly different types of periods for HHBC initiation. The classic early season HHBC which we have all acknowledged, and also a late season HHBC period, where because of rapid tuber sizing, the tuber may develop the disorder, much like the Norgold variety does. Finally, that a change in either planting date or lower preplant nitrogen level can lead to a reduction in the expression of HHBC, but this is accomplished for distinctly different reasons.

Figure 1. Illustration of different Russet Burbank plant types.

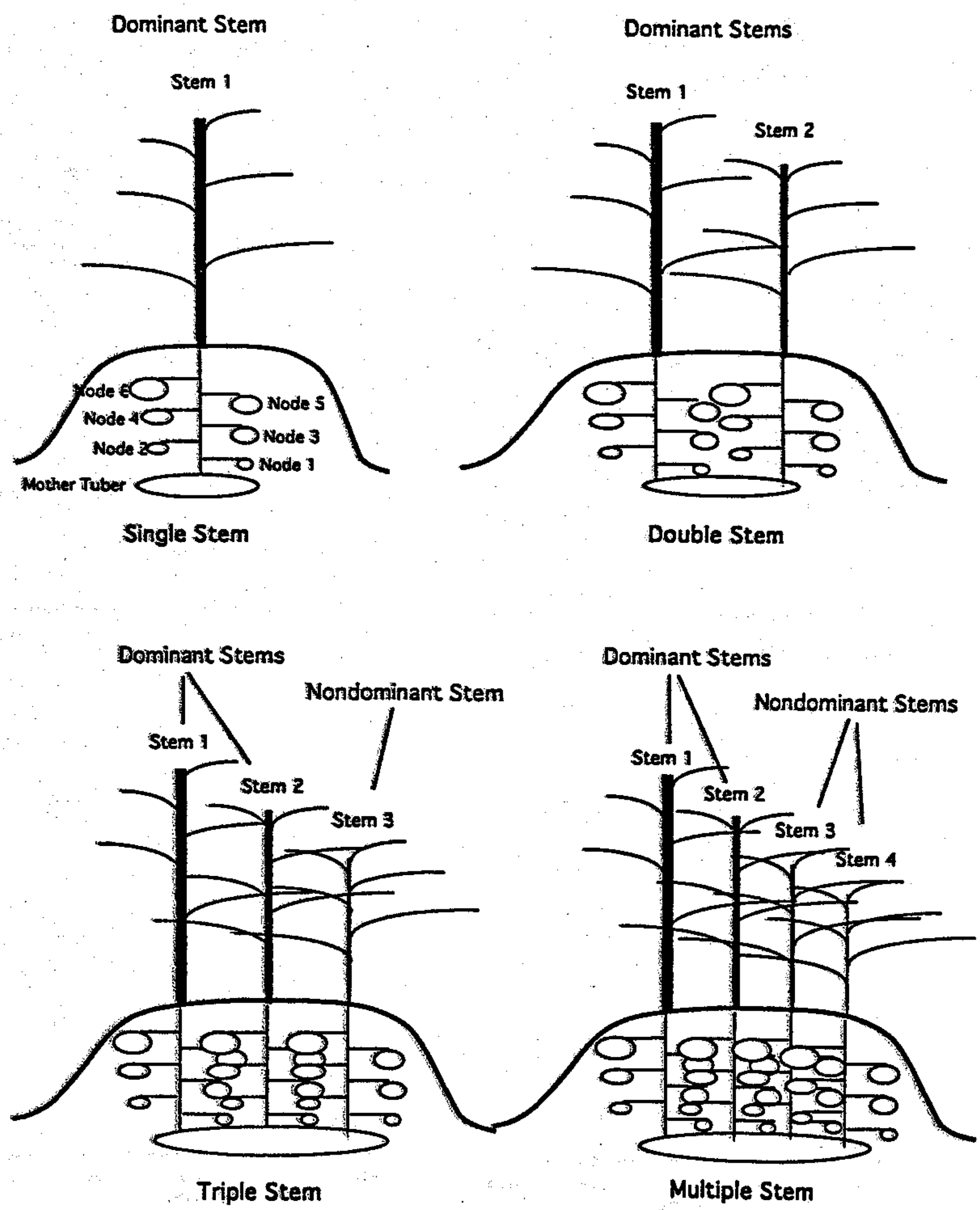


Figure 2. The a) number of tubers b) weight of tubers c) frequency of hollow heart/brown center (HHBC) and d) percentage of tubers with hollow heart/brown center on the main stem of Russet Burbank potato plants with different number of stems at five harvest (sample) dates. Abbreviations are as follows: E and L are early and late; respectively. Single, Double, Triple, and Multiple are 1, 2, 3 and 4 or more stemmed plants; respectively. Values with the same letter from the same sampling period are not significantly different (P <.05).

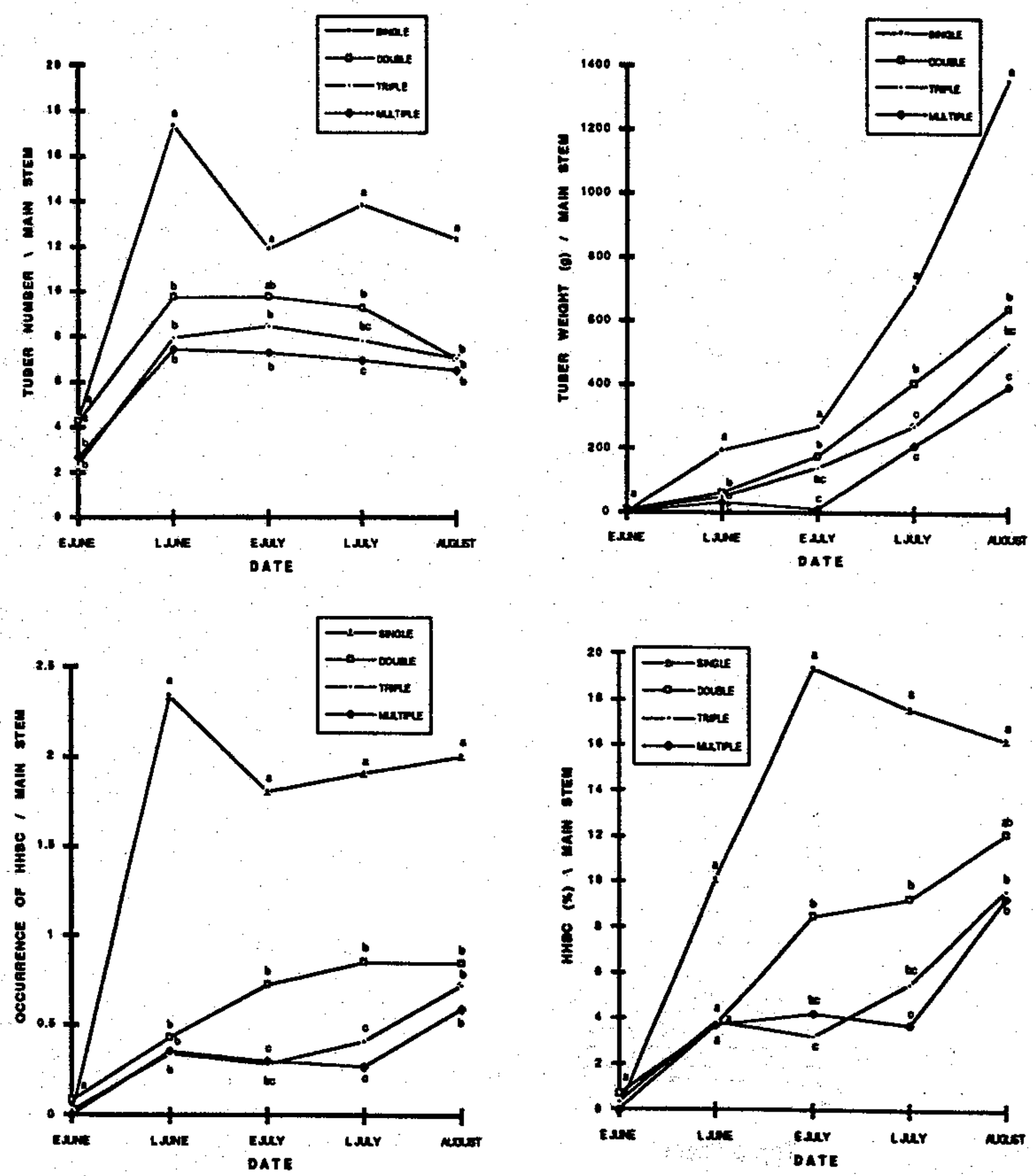
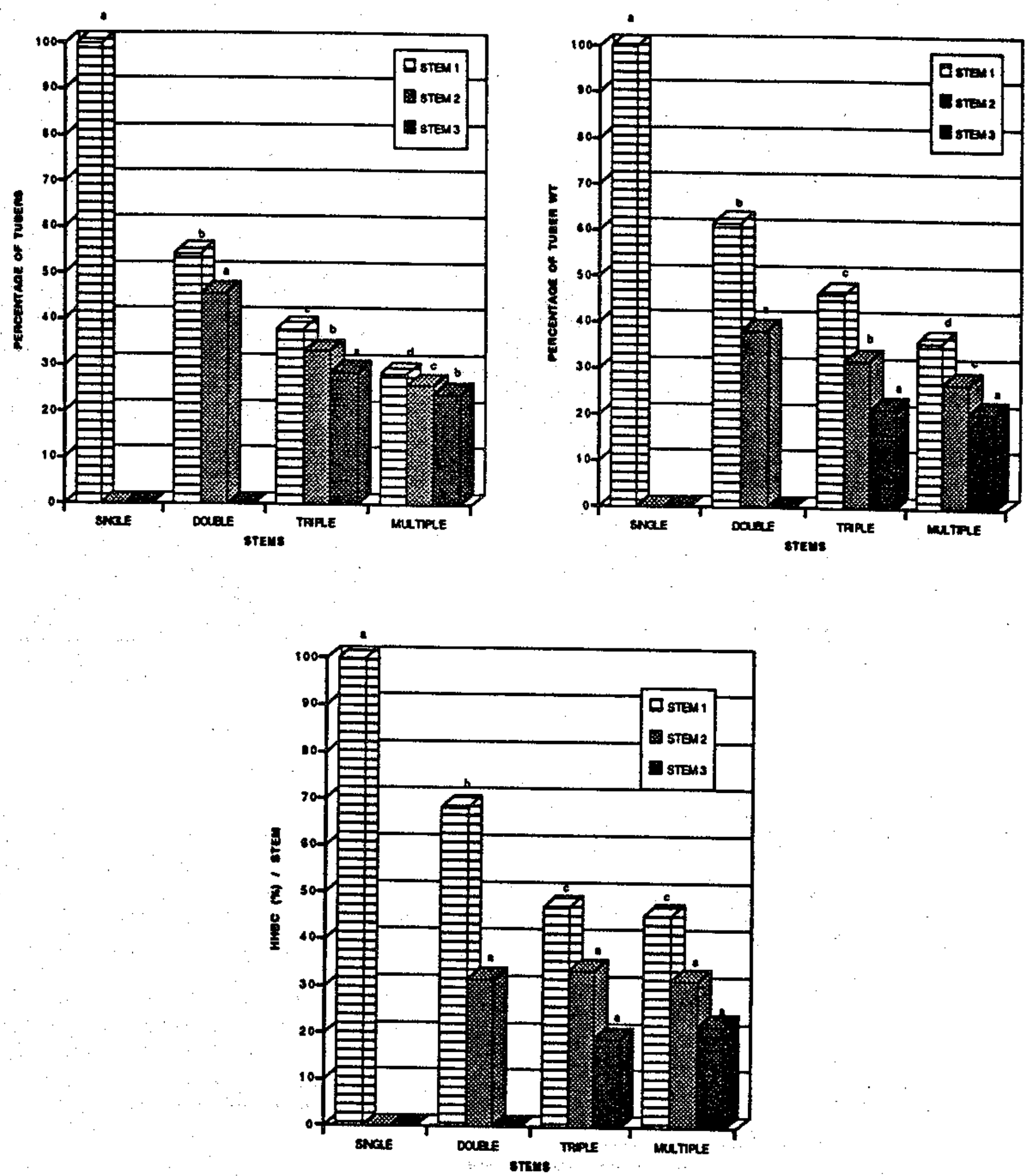
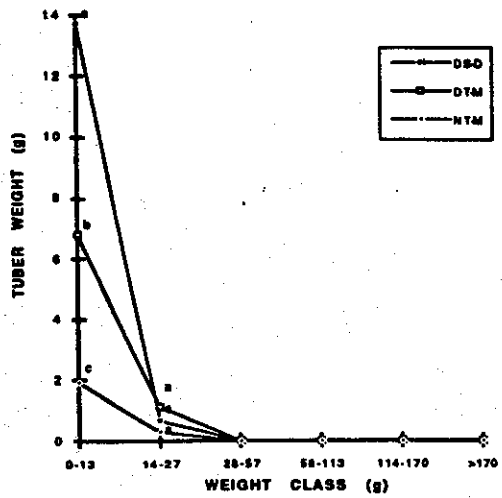
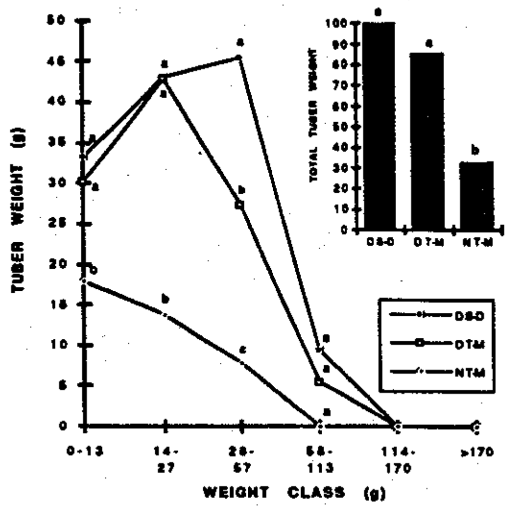
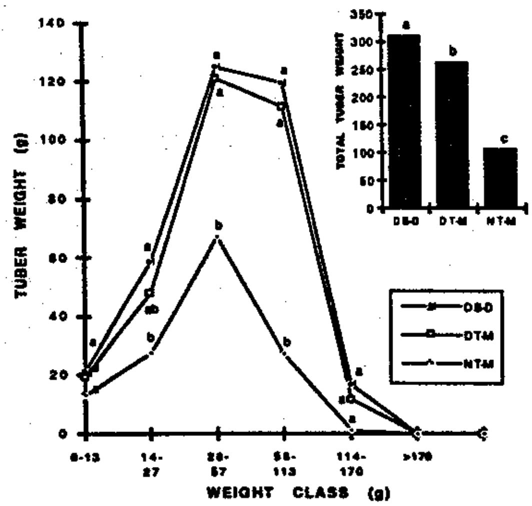


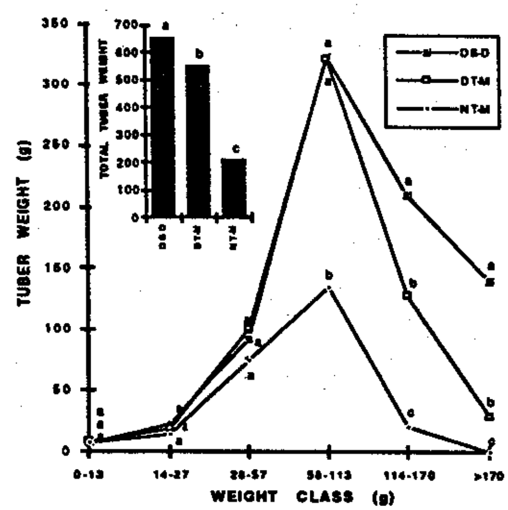
Figure 3. The a) percentage of tubers b) percentage of tuber weight c) percentage of hollow heart/brown center (HHBC) on each of the first three stems of Russet Burbank potato plants with differing number of stems. Stem 1, 2, or 3 are the Main (primary), Secondary, or Tertiary stems; respectively. Single, Double, Triple, and Multiple indicate 1, 2, 3, or 4 or more stems; respectively. Values with the same letter from the same stem are not significantly different (P <.05).











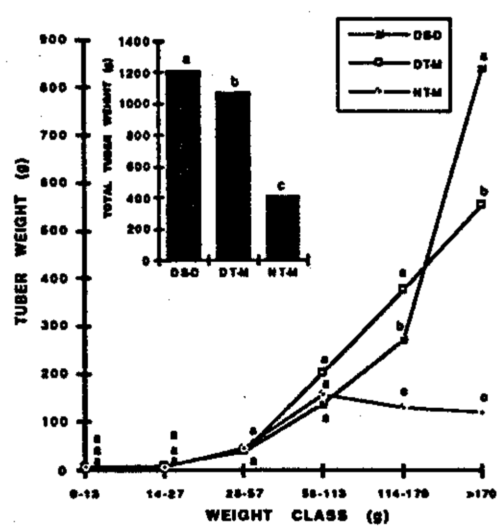
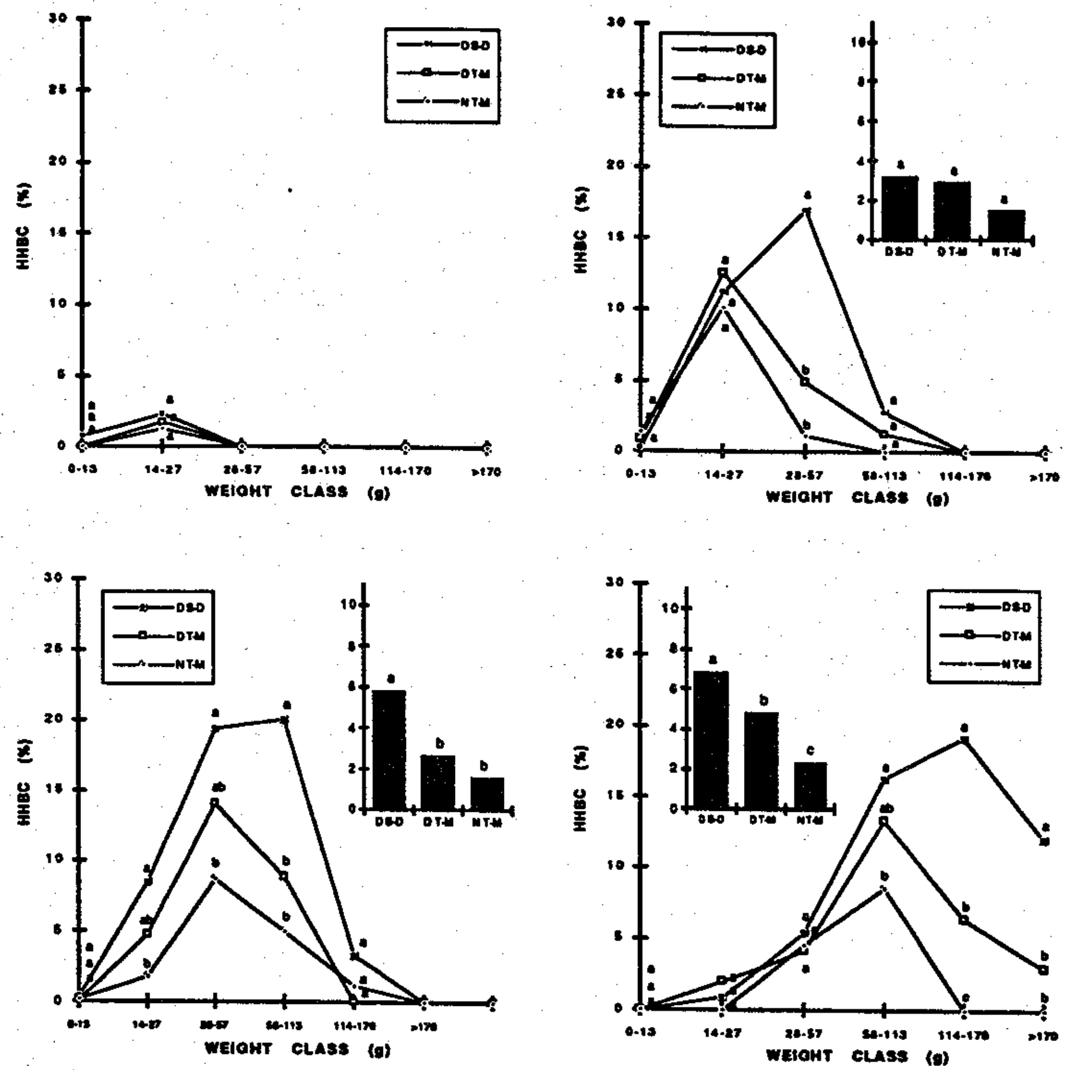


FIG. 4. The effect of stem hierarchy on tuber weight for Russet Burbank potato plants by weight in a) Early June b) Late June c) Early July d) Late July and e) August. Legend as described in Fig. 3. Insert is for total tuber weight across all weight classes. Insert is the total tuber weight from all weights. Values with the same letter within the weight class are not significantly different (P <.05).



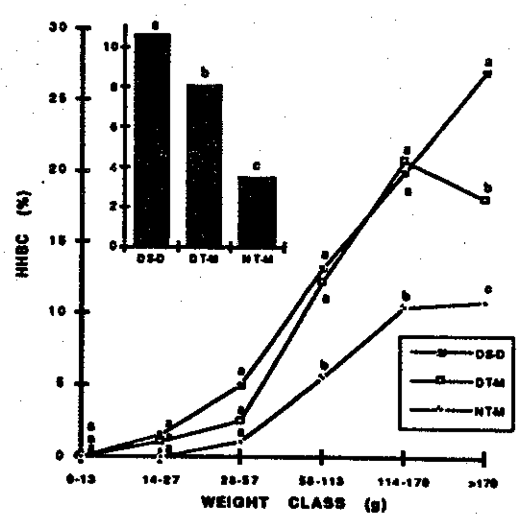
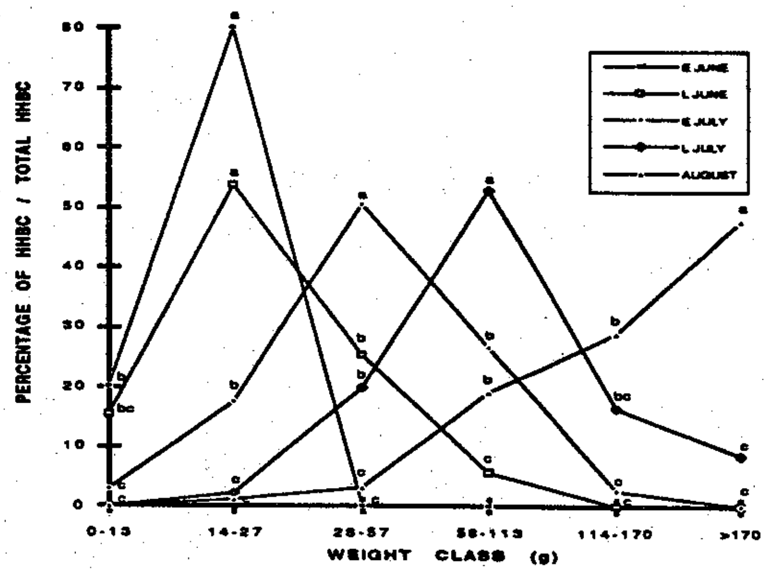


FIG. 5. The effect of stem hierarchy on percentage of tubers with hollow heart/brown center (HHBC) for Russet Burbank potato plants by weight in a) Early June b) Late June c) Early July d) Late July and e) August. Legend as described in Fig. 3. Insert is for the total HHBC from all weights. Values with the same letter within the same weight class are not significantly different (P <.05).

Figure 6. The percentage of hollow heart/brown center (HHBC) occurring in various size Russet Burbank tubers of the a) total HHBC and b) %HHBC at five sequential harvest (sample) dates. E and L are early and late, respectively. Values with the same letter within the same sample period are not significantly different (P <.05).



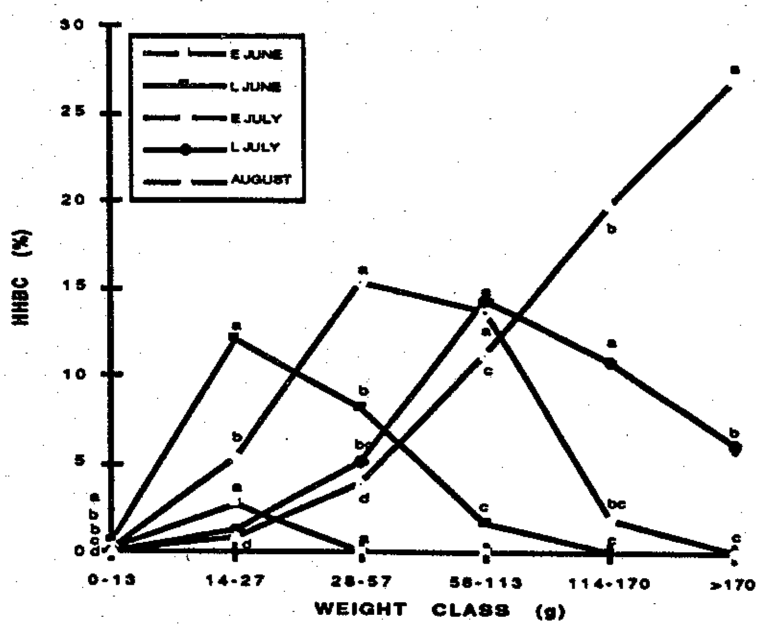


Figure 7. The effect of planting date (early, middle and late April) and preplant nitrogen application rate (56 or 224 kg ha^{-1}) on yield of Russet Burbank potatoes. Values labeled with same letter are not significantly different ($P < .05$).

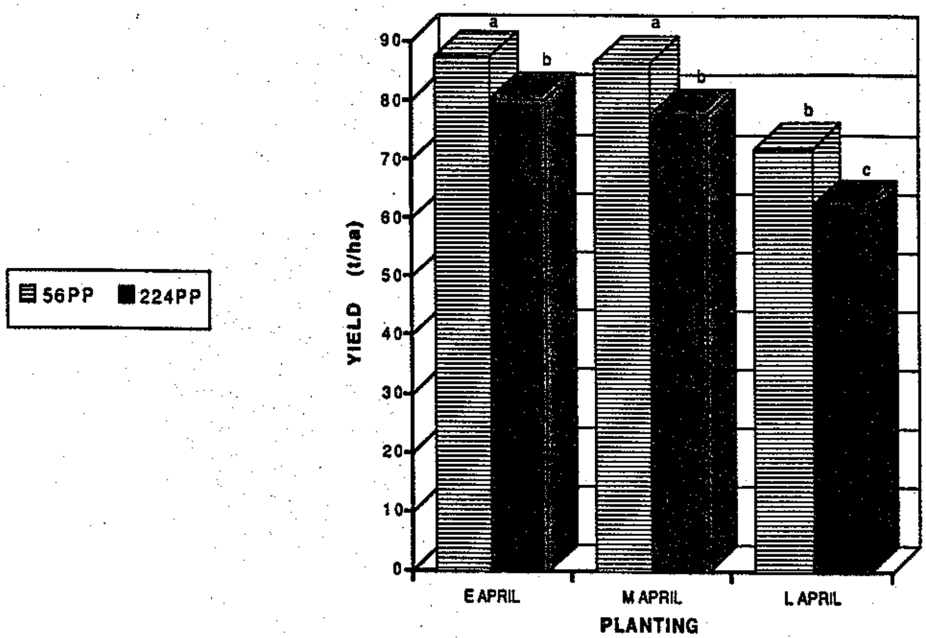


Figure 8. Nitrogen program used for the 4 year research period.

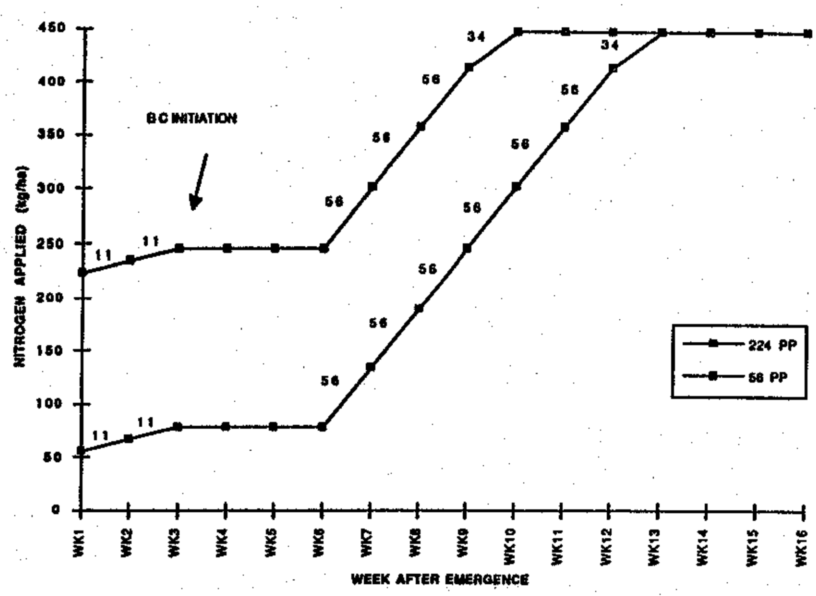


Figure 9. The effect of planting date (Early and Late April) and nitrogen (56 or 224 kg ha^{-1} applied preplant) on the number of stems produced per plant for Russet Burbank. Values with the same letter for a treatment are not significantly different (P <.05).

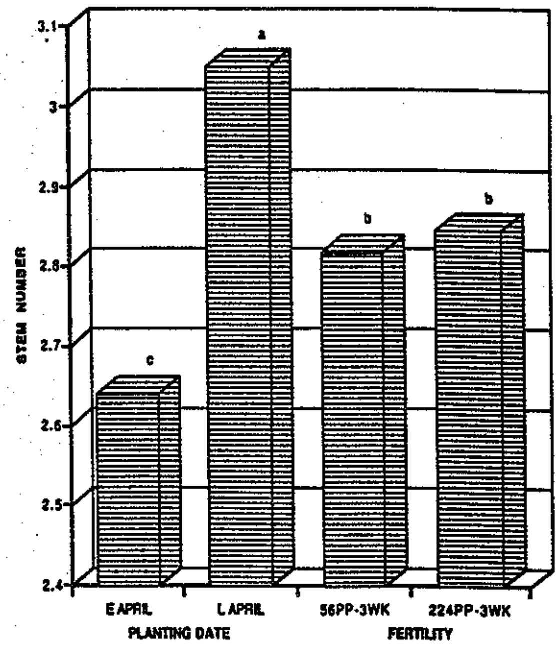


Figure 10. The influence of planting date (Early and Late April) on the amount of hollow heart/brown center (HHBC) in different size Russet Burbank tubers. Values with the same letter within the same weight class are not significantly different (P <.05).

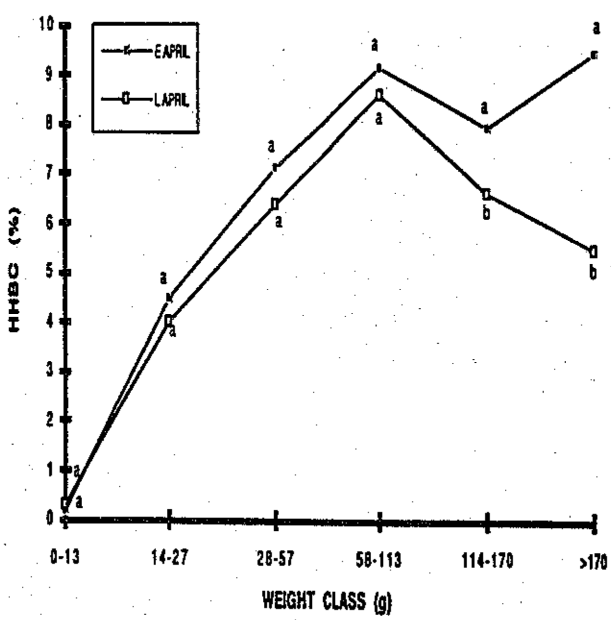


Figure 11. The seasonal effect of nitrogen management (56 or 224 kg ha^{-1} applied preplant) on a) haulm fresh weight b) total tuber weight and c) hollow heart-brown center (HHBC) for Russet Burbank potatoes. Insert shows the effect of nitrogen amount and timing for the two latest harvest (sampling) dates (late July and August) for a two year period. Legends are as follows: 1, 2, or 3wk indicates no additional nitrogen applied for 1, 2, or 3 weeks after brown center initiation; respectively. Values with the same letter from the same sampling period are not significantly different (P >.05).