

HOLLOW HEART OF POTATOES ¹

by
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Factors associated with reduced tuber quality have long been a concern to the Washington State potato industry and research programs. The internal tuber disorders, brown center and hollow heart, are problems which have plagued potato growers for decades, but have become worse and more widespread in the Columbia Basin over the past few years, resulting in large losses to growers. Losses from hollow heart and brown center result from the elimination of affected tubers during processing and loss of entire lots when internal defects cannot be sorted out in fresh packing. In 1976 Washington State produced nearly 56 million hundred weight on 124 thousand acres of potatoes, for a value of \$139.5 million. Thus, a 1% loss, based on the value of potatoes produced, would equal \$1.4 million.

Brown center and hollow heart are physiological disorders of the potato tuber. Cells in the center pith area of the tuber die; this is followed in some cases by the development of a hollow area surrounded by brownish, discolored wound cambium. Most of you are certainly familiar with the appearance of hollow heart; however, let us review briefly the stages of hollow heart development.

Symptoms of this physiological disorder first appear as a small group of dead, brownish-colored cells in the pith of the tuber, some still containing starch grains. This area is surrounded by several layers of living, starch-free cells. The dead cell area is later surrounded by a layer of cambium cells several layers deep. As the tuber enlarges, a cavity surrounded by collapsed, dead cells develops. The hollow heart cavity enlarges mainly in the short axis of the tuber, rather than along the pith, and on reaching full size is completely surrounded by large, sausage-shaped cells. In some years, or in certain cases, the appearance of the hollow heart cavity does not necessarily follow progressively after the initial appearance of the brown center. This suggests that the initial cause of the brown center initiation not only precedes, but may be different from those factors which lead to the manifestation of the actual hollow heart cavity.

Before developing a preventative program for these disorders, the time and initial cause of brown center and hollow heart must be established. The literature, as well as grower observations, contain considerable controversy as to when these disorders are initiated; however, most of the information indicates that hollow heart initiation occurs shortly after tuber set. Several factors have been reported to influence initiation and development of hollow heart: temperature, soil moisture variation, fertilization, plant spacing, tuber set, amount of light and growth rates. Temperature appears to play a role in the initiation, but the exact nature is not understood. Results of field observations in experimental studies have been inconsistent in providing answers to this problem. Potato growers, who follow management practices recommended to decrease hollow heart, still occasionally experience large losses due to this disorder. Conditions, which will consistently result in the initiation and development of brown center and/or hollow heart, have not been established. During the growing seasons of 1976 and 1977, we have conducted field plots on research station land and growers' fields, investigating the relationship of planting date, moisture and fertility. Earlier planting dates have resulted in an increased percentage of these disorders, but has not been consistent relative to brown center or hollow heart findings. More severe tillage (i. e., disruption of the root system) has generally resulted in an increase of either one of these disorders, but also has not been consistent. Moisture and fertility levels, including foliar and soil-applied

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boron, have given variable results. Inspection of the seed lot trials has indicated no consistent relationship with seed source. In view of the above fact, that these results have been inconsistent, one must conclude that some other factor must be involved in the initiation stage.

Temperature has for some time been suspected to play a role in the early initiation; however, this factor has never been studied in any detail. Emphasis has been placed in our research program on the study of this factor in early stages of potato development in controlled, environmental growth rooms and greenhouses. A recent, major accomplishment has been the induction of brown center by low temperatures at, and shortly following, tuber initiation. Through the development of a method to consistently induce the brown center disorder, we will be able to study the relationship of the many other factors which may be associated with the manifestation and further development of the hollow heart problem. Our studies have also shown large differences to exist among cultivars and numbered lines which is seemingly due to their genetic characteristics, but the exact nature of this differential susceptibility and resistance must yet be determined. Our research has also shown that various mineral elements exist in differential gradients within a tuber which has hollow heart, as compared to a tuber which does not. Temperature can affect nutrient uptake and root growth, translocation and distribution of mineral elements; thus, the relationship of the low temperature induction which we have observed may have a definite relationship with the mineral elements in the initiation of this disorder.

In summary, although field results continue to be variable and contradictory, our research findings in the greenhouse, growth chamber and laboratory studies have definitely given new insight and a feeling of excitement towards the potential determination of the initial causes of the brown center disorder. Further investigations will endeavor to elucidate the relationships and interactions of these factors mentioned above for a more thorough and in-depth knowledge of these physiological disorders. With this goal in mind, the quality of Washington potatoes will be improved and maintained through a reduction of the internal disorders which have caused many losses in the past.