BROWN CENTER AND HOLLOW HEART AS A QUALITY FACTOR [1]

by
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Potato quality must be considered right from the beginning with seed selection, proper size and planting, continuing through the growth and development stages and harvesting to storage on to the processor or consumer. The tuber disorders brown center and hollow heart are definitely important quality factors in the evaluation and measurement of our Washington potatoes, and, unfortunately, have become more of a problem in recent years. Although the weather in 1981 was generally favorable for brown center and hollow heart formation, the severity of the growers' problem at harvest could have depended on the production practices and management alternatives utilized.

The internal tuber defects called brown center (BC) and hollow heart (HH) are physiological disorders because they are related to environmental and growth relationship factors rather than caused by diseases or insects. These disorders can be considered as two phases. The first is initiation or induction of cellular death, appearing as a single group of dead, brown cells in the pith area of the tuber. This is the brown center stage. The second phase of the manifestation or actual development of the cavity -- the hollow heart stage. If these stages oc cur early in the season, the disorder(s) are located nearer the stem end and we refer to this as early-season, stem-end, or brown-center hollow heart (BCHH). If the disorder is manifested later in the growing season, it is usually located nearer the bud end of the tuber and we term this bud-end hollow heart (BEHH). These disorders should not be confused with internal brown spot (IBS), which appears as a flecking of several, randomly scattered discolored areas within the tuber.

Brown center can be initiated very early in the season in very small tubers. We have reported at previous conferences the influence of low temperatures at, and shortly after, the time of tuber initiation (1, 2). Thus, it is most important to monitor potato fields and inspect tubers at this time -- not wait until later in the growing season. Especially important would be a week or two of exceptionally cool temperatures and rainy weather or heavy irrigation (2). Although low temperature should not be considered the sole factor in BC induction, our results have shown it to be consistently associated with the disorder in controlled environment experiments and field plots. Much of our research on these disorders can be summarized in four basic statements on BC:

1. Initiated by COOL TEMPERATURES from TI to four weeks after TI.
2. Increased by HIGH SOIL MOISTURE.
3. Severity increased by RAPID TUBER GROWTH.
4. May DISSIPATE later in the growing season.

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The relationship of low temperatures with BC induction is illustrated in the soil temperature charts for 1976 (Fig. 1) and 1979 (Fig. 2). In 1976, the temperatures at tuber initiation (TI) 1 and 2, corresponding to planting dates 1 and 2, were 55°F or below, but for TI3, the temperature was nearly 60°F and continued to increase. The % of BC was much higher in the two early plantings compared to planting date 3 (Fig. 1). In 1979, the cool period usually experienced in the spring occurred much later in terms of calendar dates. The temperatures for planting dates 2 and 3 at the time of TI were again 58°F or below and the % BC was correspondingly higher than for the first planting date (Fig. 2). Thus, in addition to possibly considering slightly later planting dates in most years, it is necessary to continually monitor the weather, soil temperatures, and stages of potato growth, in particular the time of tuber initiation.

A summary of our field observations over the six-year period 1976 to 1981 clearly indicates the influence of low soil temperatures on increased BC and BCHH induction (Fig. 3). The critical temperature at which BC is greatly reduced appears to be around 60°F. Figure 4 also indicates the relationship on increasing soil temperatures for later planting dates and corresponding reduction in severity of tuber disorders. However, an additional consideration in terms of delayed planting dates is the effect on total yield. Our results over the six-year period did show a reduction in yield for later planting dates (Fig. 5). However, total yield is, or should not be, the final objective in potato production. Rather it should be the yield with the highest quality. If we deduct the amount of potatoes lost based on percentage of disorders, and consider this as usable potatoes, we can determine a breakeven point where total usable yield is optimum, i.e., total usable yield is maximized and internal disorders are minimized (Fig. 6).

A second factor related to BC induction is that of soil moisture, particularly extremely wet fields or areas of fields early in the growing season just as the potatoes were beginning to emerge through the period of tuberization. As soil moisture increases, the soil temperatures will be lower and more solar energy is required to raise the temperature for any given soil. Our research efforts in 1981 were primarily to consider this factor of soil moisture. It must be emphasized that what is reported now is based on only one-year's data and that the levels of soil moisture utilized in our plots were very extreme in order to magnify any possible effect.

Field plots on the WSU Othello Research Unit were either not irrigated until four weeks following tuber initiation (low H_2O) or furrow-irrigated normally through the spring to maintain high soil moisture levels. The high soil moisture levels were at 85% of field capacity or above whereas the low plots were in the 25 to 35% of field capacity range. Following tuber initiation, all plots were irrigated equally utilizing hand-move sprinkler lines. The results showed that the higher soil moisture levels greatly increased the amount of BC and BCHH in our first two planting dates compared to the low soil moisture plots (Fig. 7), but no differences existed between the soil moisture levels for the later two plantings. The greater severity of internal disorders from the earlier planting dates agreed with previous results (Fig. 3 and 4) and indicated the apparent relationship with soil moisture levels. Sampling throughout the growing season indicated that BC and BCHH occurred very early in the high moisture plots and then remained constant or dissipated slightly (Fig. 8). Yields were reduced under the low moisture levels (Fig. 9) being influenced somewhat by the number of tubers set per plant (Fig. 10), but it must be remembered that these plots were extremely dry because of the experimental objectives. Further research is needed to determine proper soil moisture levels during this tuber initiation period which will allow reduced BC induction and not affect the number of tubers set or total yield.

Another experiment in 1981 studied the effect of heavy irrigation following a water-stress period late in the season on Lemhi. The % HH increased dramatically in Lemhi when a heavy irrigation was provided to correct that stress as compared to light watering (Fig. 11). These results from one year indicate that, even though the water-deficient period may cause the tubers to be susceptible, the heavy water application following the stress actually was more important in HH manifestation.

Some cultural practices and management alternatives that should be considered important relative to these internal disorders include:

1. Establish a good stand
   a) use good seed, properly cut and planted
   b) reduce planter skips
2. Consider later planting dates
3. More stems per plant (average of 3 stems per plant)
4. Establish a good root system
5. Proper fertilization -- amount and timing
6. Maintain an even rate of growth
7. Good soil moisture management
   a) maintain proper soil moisture levels
   b) uniform water distribution
   c) use dam pitters to reduce runoff
   d) monitor soil moisture levels

Remember that even though NATURE may control the initiation of these disorders, YOU can control the development. Know the growth stage in each field and keep your eye on the weather. Then modify your management alternatives as necessary. The continued production of maximum yields of Washington potatoes must also be in terms of maximum quality.

References Cited

1. Hiller, L. K., D. C. Koller and R. W. Van Denburgh. 1979. Brown Center of potatoes - what have we learned? Proc. Washington State Potato Conf. 18:21-27.

2. Hiller, L. K. and D. C. Koller. 1981. Brown center/hollow heart of potatoes -- what do we know? Proc. Washington State Potato Conf. 20:73-80.

Figure 1.

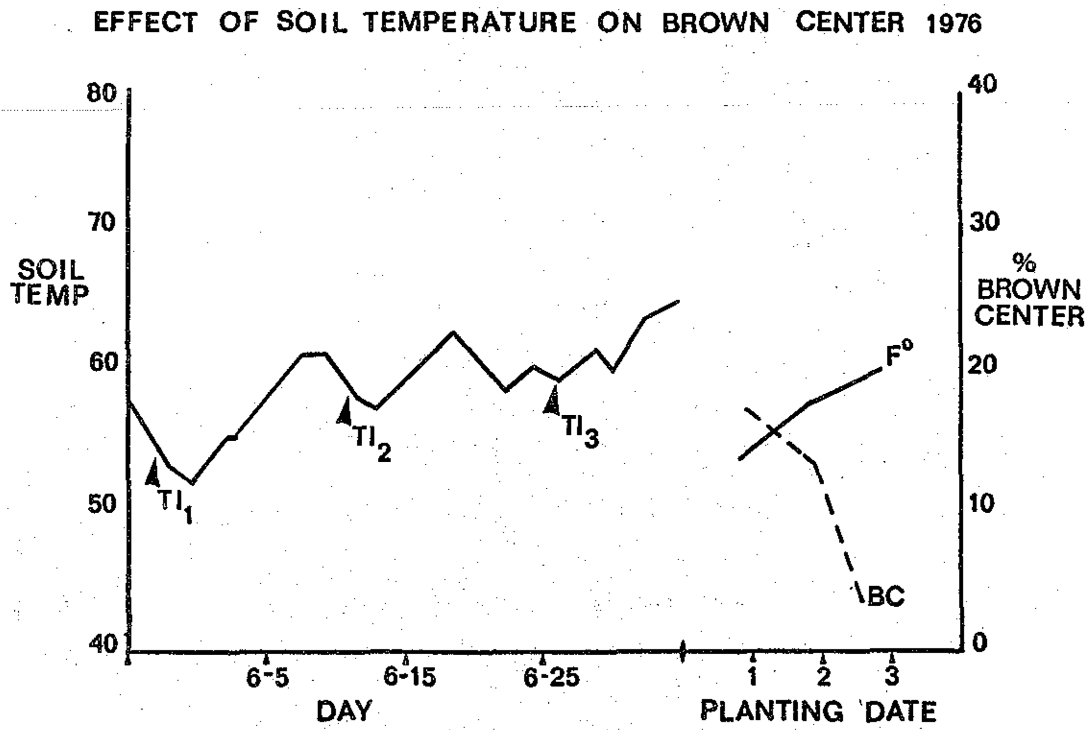


Figure 2.

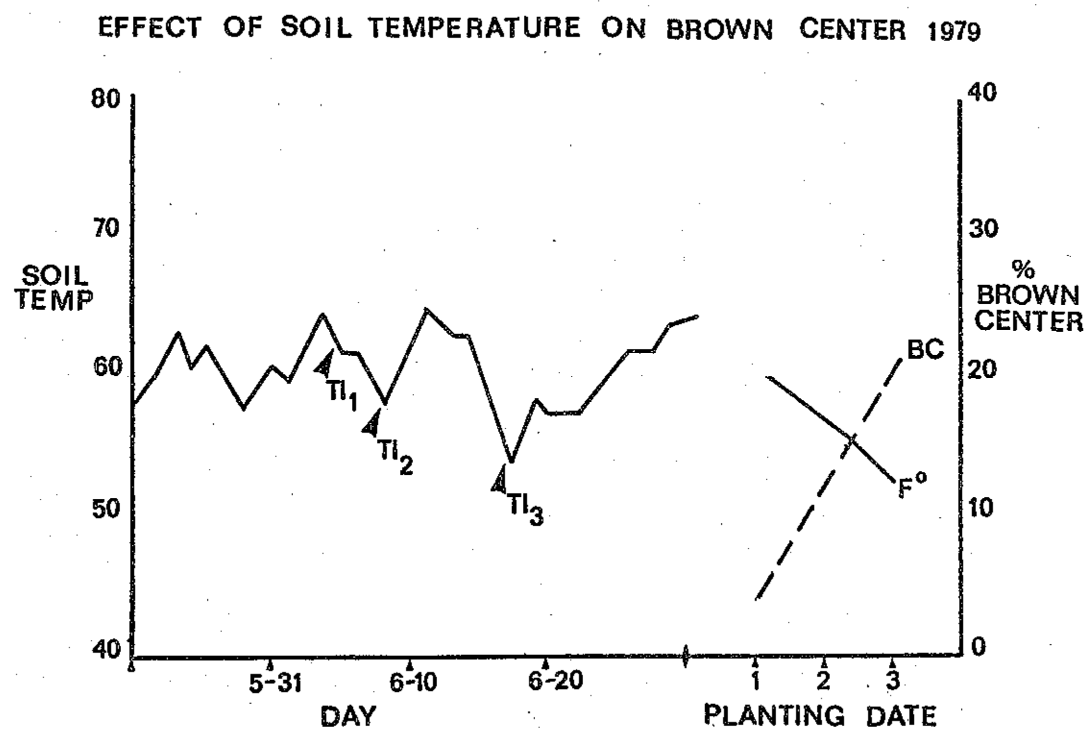


Figure 3.

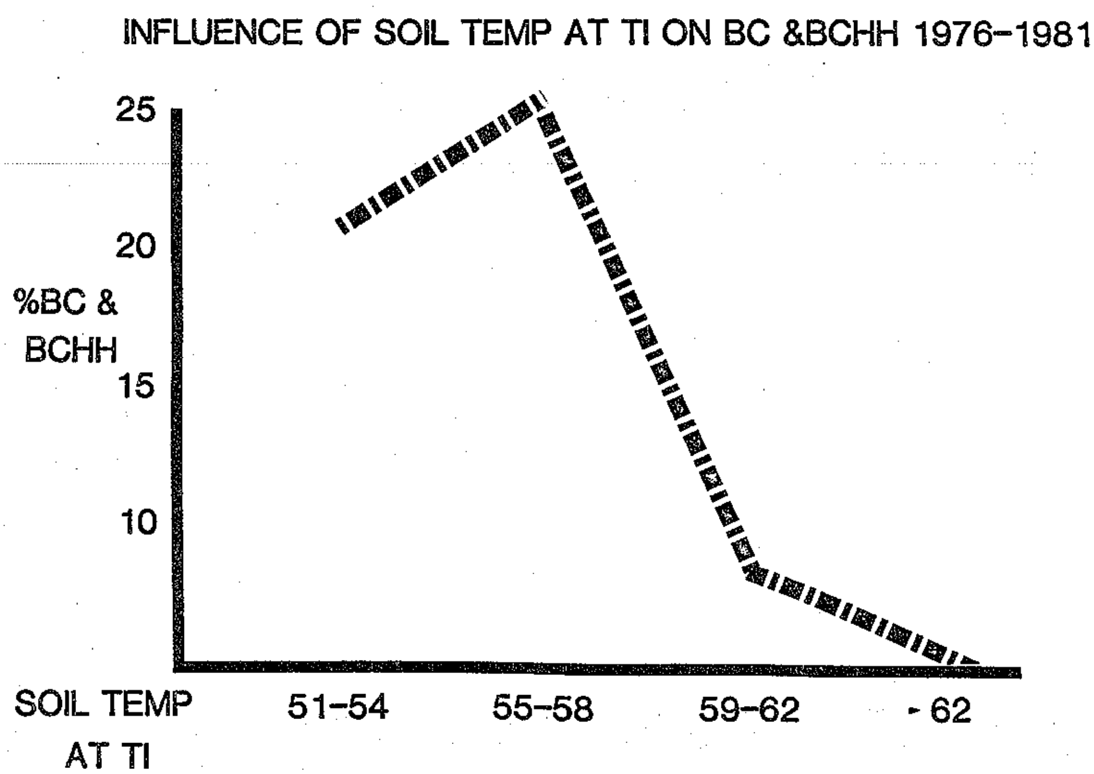


Figure 4.

INFLUENCE OF PLANTING DATE AND SOIL TEMP

ON BC/HH 1976-1981

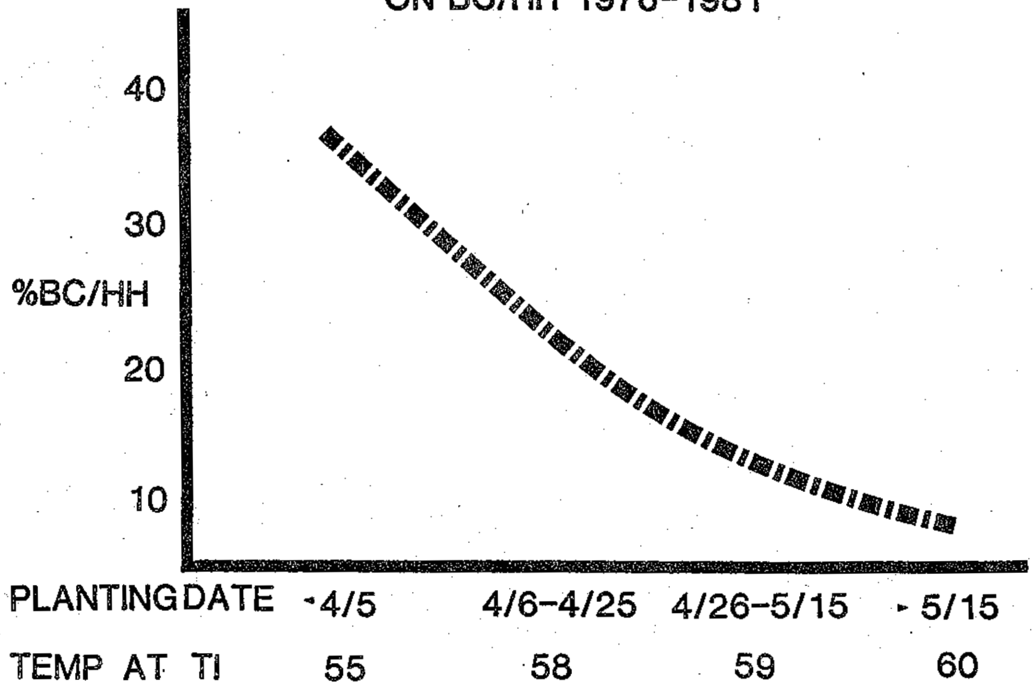
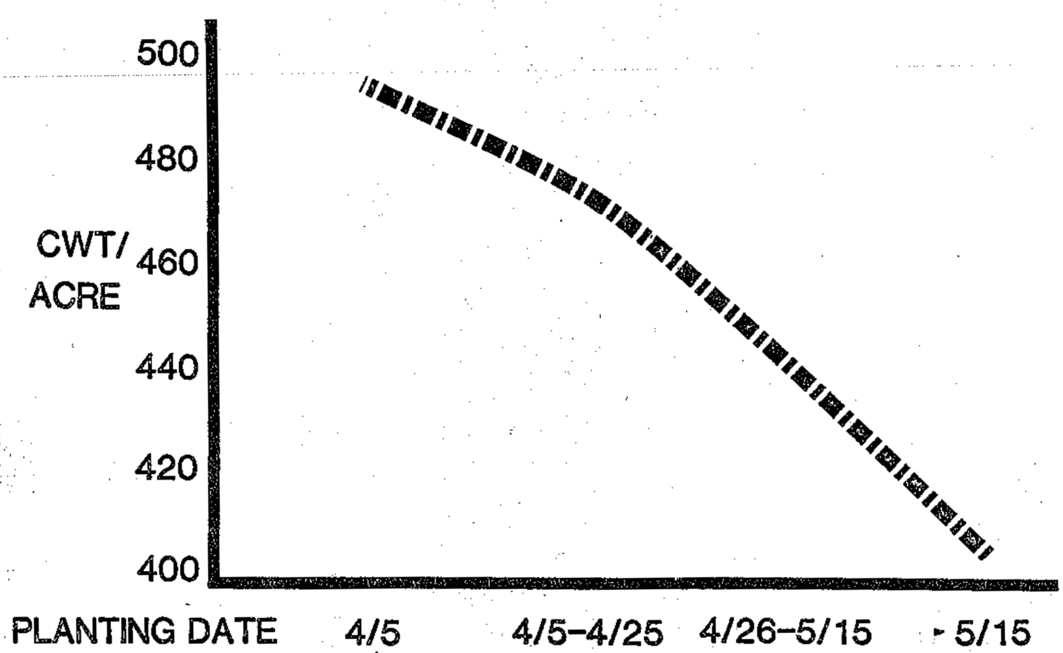


Figure 5.

INFLUENCE OF PLANTING DATE ON YIELD 1976-1981



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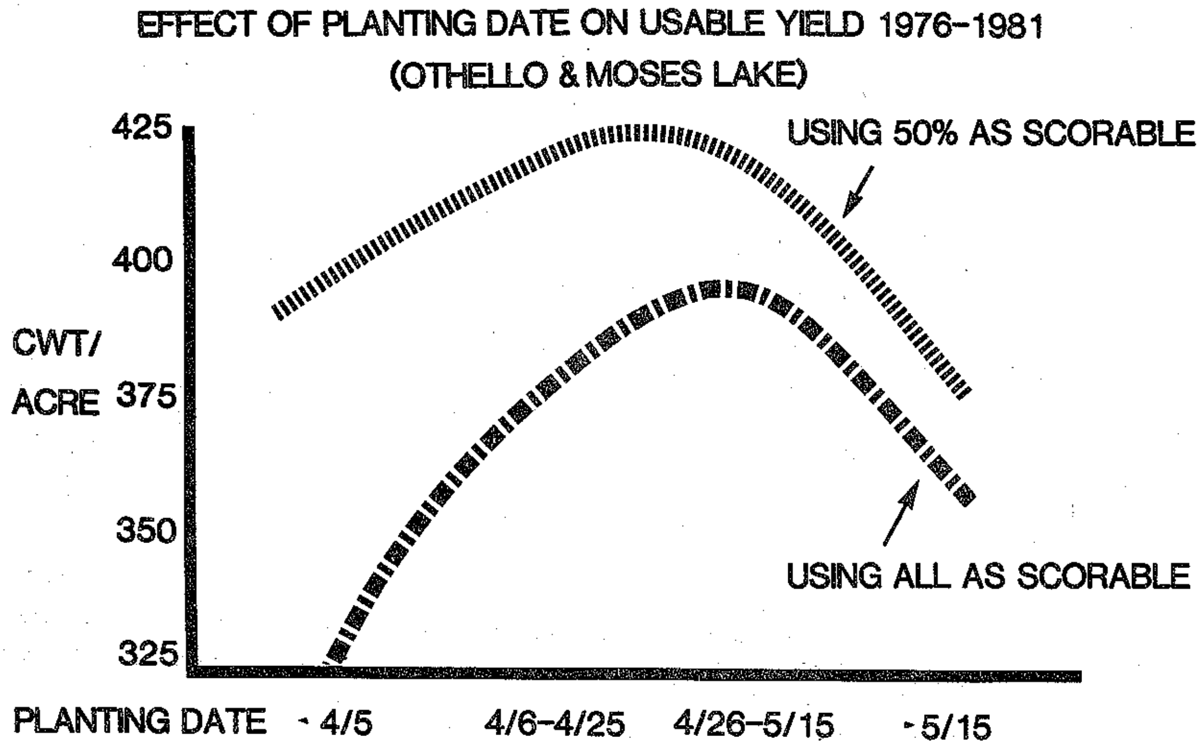


Figure 7.

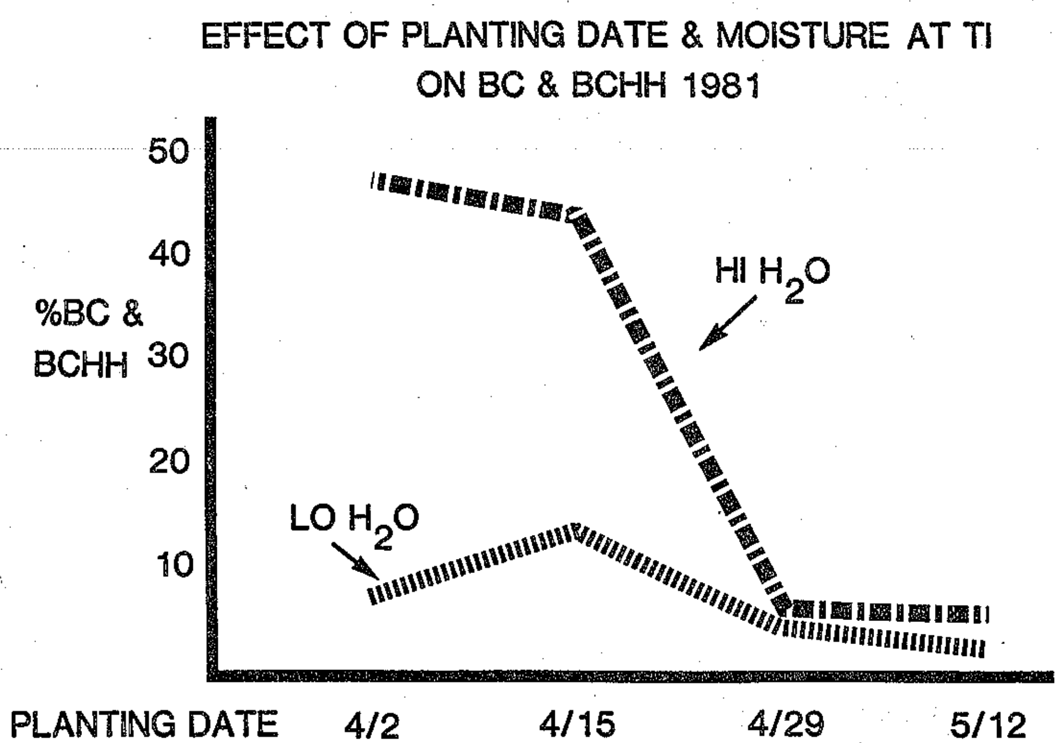
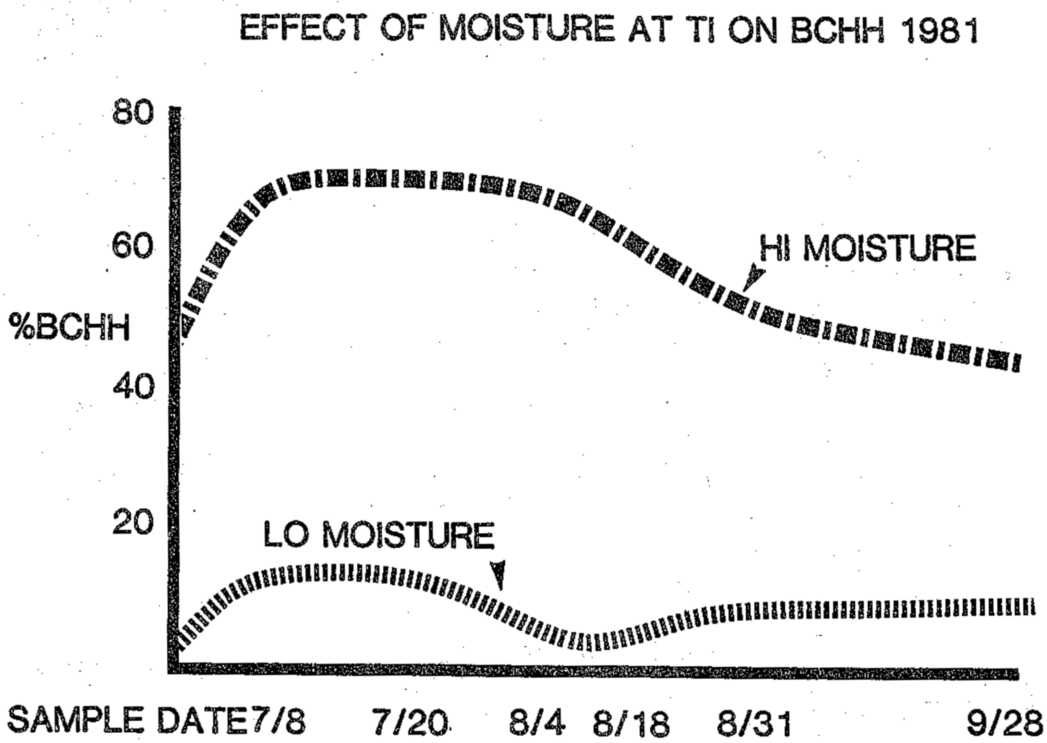


Figure 8.



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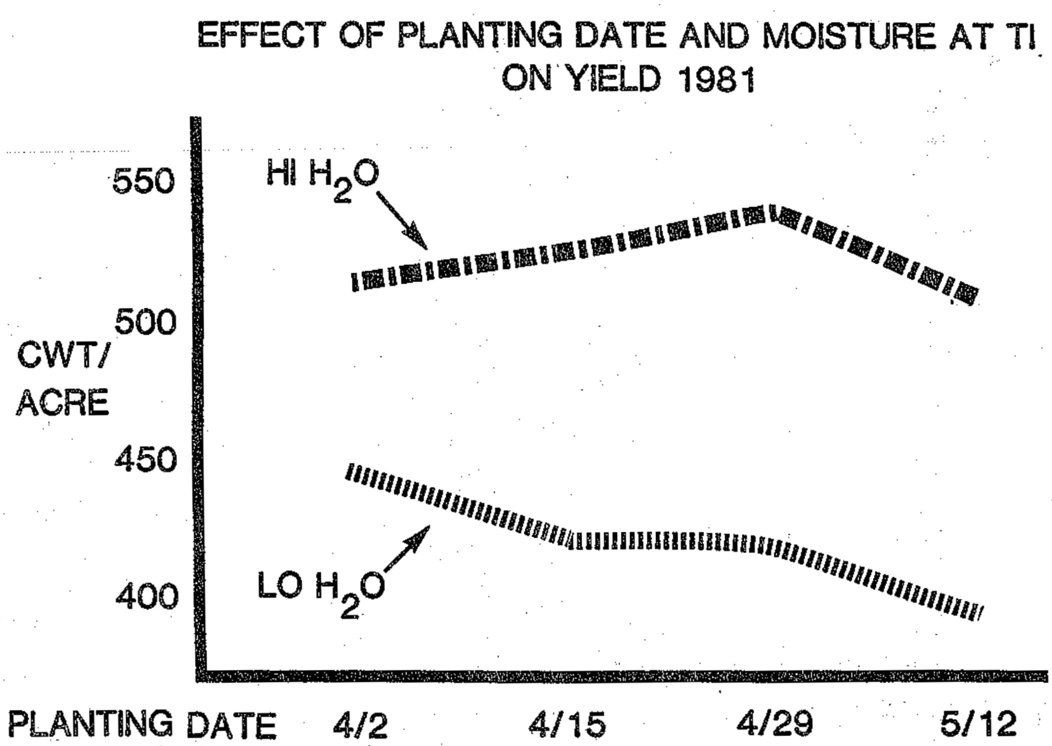

Figure 10.

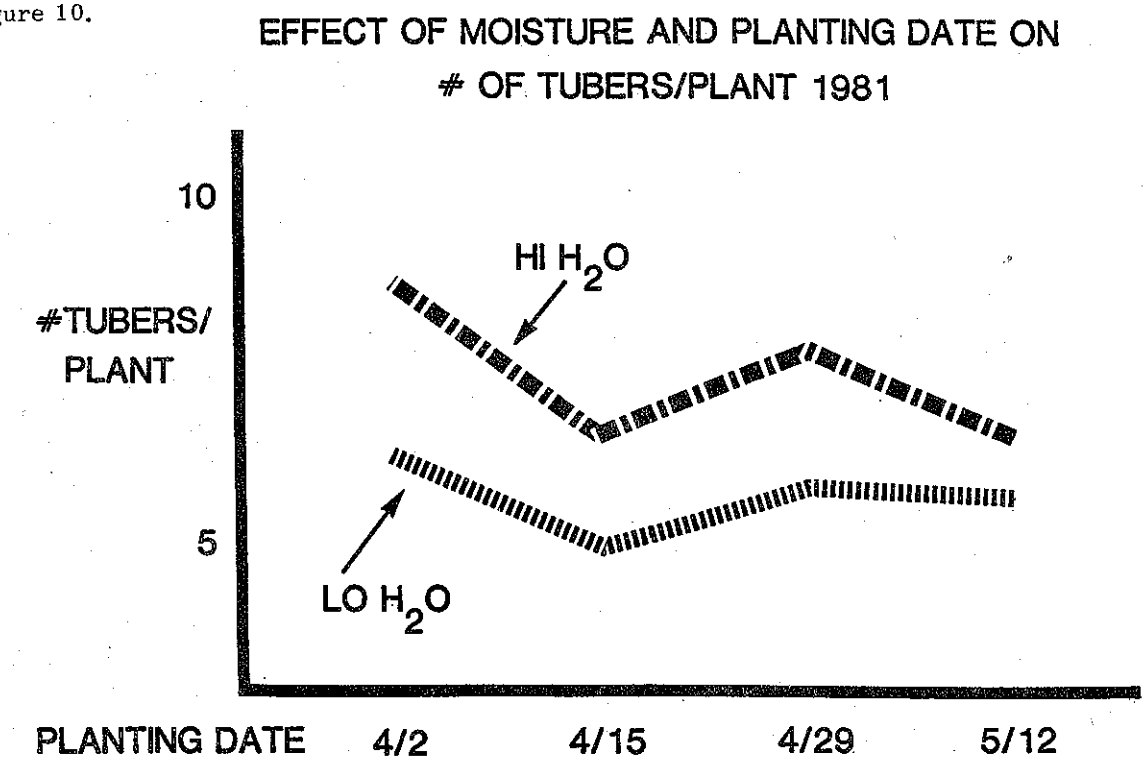

Figure 11.