INFLUENCING HOLLOW HEART - BROWN CENTER BY ALTERING TRADITIONAL CULTURAL PRACTICES

by
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The goal of this research was to find a method(s) which influence the initiation and/or expression of brown center and resulting hollow heart. Three factors were examined; planting date, irrigation (Field Capacity) during early tuber development and preplant nitrogen levels. Parameters measured included yield, percent undersize, percent No. 1's and 2's, specific gravity and hollow heart - brown center (HHBC).

The research was performed under a randomized complete block design. Each block was 30 ft. long by 6- 34 inch rows wide. Each treatment was replicated ten times. A linear move irrigation system with low impact nozzles was used to supply the sandy loam soil with water and in-season nitrogen.

TREATMENTS

1984

*5 planting dates equally spaced between March 5th and May 3rd.

*2 irrigation treatments. Wet - soil was irrigated at 80-90% of field capacity (FC) throughout the growing season. Dry - this treatment began when brown center (BC) initiation was first observed. Soils were allowed to drop to 65-75% of FC before being irrigated. These levels continued until three weeks after the brown center began to dissipate (disperse). Then soil FC levels were increased and maintained at 80-90% for the remainder of the season.

*3 preplant nitrogen treatments. 50, 100 or 200 lbs. of ammonium nitrate in a 150-250 dry blend of phosphate and potassium. Additional ammonium nitrate was supplied to maintain the treatment levels until BC initiation was observed. Nitrogen was then withheld until three weeks after the start of BC dissipation. During the remainder of the growing season each treatment received an additional 250-300 lbs. of nitrogen.

1985

*3 planting dates equally spaced between April 2nd and April 29th.

*2 irrigation treatments. Wet - soil irrigated at 80-90% of FC throughout the season (same as in 1984). Dry - soil irrigated at 65-75% FC from tuber initiation (as compared to BC initiation in 1984) until three weeks after BC dissipation was first observed. Then, soil was irrigated at 80-90% FC as in 1984.

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*2 preplant nitrogen treatments. 50 or 200 lbs. Early season soil nitrogen levels were allowed to slowly decline until BC initiation, (as compared to maintaining the treatment soil levels in 1984) then no additional nitrogen was supplied until three weeks past the start of BC dissipation. Each treatment then received 250-300 lbs. of nitrogen during the remainder of the season.

1986

*3 planting dates equally spaced between April 1st and May 5th.

*4 irrigation treatments were imposed. Wet - soil irrigated at 80-90% FC (same as in 1984 and 1985). Dry - soils were held at 65-75% FC from tuber initiation through initial BC dissipation plus 1, 2, or 3 weeks, termed dry, drier and driest treatments. The "driest" treatment was the same as the dry treatment imposed in 1985.

*4 fertility programs. High - 200 lb preplant nitrogen (same as in 1985). Low - three 50 lbs. nitrogen treatments. Nitrogen levels were allowed to decline slowly until BC initiation (same as in 1985). No additional nitrogen was supplied until the beginning of BC dissipation plus 1, 2, or 3 weeks, termed low, lower and lowest. The "lowest" treatment was the same as the 50 lb. treatment imposed in 1985. Each treatment then received supplemental nitrogen to reach 400-450 lbs. total.

1988

This experiment was performed in a greenhouse where 70°F day, and 60°F night temperatures were imposed throughout the experiment. Five treatments were set up as follows:

*2 beds were held at a constant soil temperature of 70°F. One bed received 50 lbs. of preplant nitrogen, the other 200 lbs.

*2 beds were held at a constant soil temperature of 60°F and treated with 50 or 200 lbs. of preplant nitrogen.

*The soil temperature in the fifth bed was allowed to fluctuate with the diurnal air temperature changes described above and was supplied with 200 lbs. of preplant nitrogen.

RESULTS

1984

A decline in yield occurred with a delay in planting date (Figure 1). This yield response was typical for all the treatments across planting dates (Figure 2). The cultural conditions examined in this research were not effective in reducing the yield decline, resulting from delayed planting. There were only small yield differences between the wet and dry treatments.

Reducing preplant nitrogen under the wet irrigation treatment, however, either increased yield (1st planting) or had little effect (3rd and 5th plantings). When combined with the dry treatment, reduced nitrogen levels increased yield over higher preplant levels for all plantings.

The percentage of undersize tubers decreased with wetter irrigation and this difference was largest when the highest preplant nitrogen treatment was imposed. (Figure 3). This may have been directly related to the increased heat runners and chain tubers observed in the dry irrigation and high nitrogen plots.

Figure 4 shows the total HHBC which occurred in 1984. The scale is a relative measure of HHBC. This same type of scale was used for each year. The legend displays the lowest, highest and average amount of HHBC which occurred across the five plantings. The 50 lb. nitrogen treatment had the lowest levels of HHBC and the amount increased as more preplant nitrogen was used. The dry irrigation treatments had slightly more HHBC when measuring the lowest incidence that was observed. The highest levels of HHBC were variable and did not correspond to any treatment pattern. The average HHBC measurement, however, illustrated the same low nitrogen to high nitrogen gradient with irrigation level having little influence on this average.

Specific gravities were reduced by dry irrigation and further depressed by the 50 and 100 lb. preplant nitrogen treatments. There was, however, little influence from soil nitrogen levels under wet (normal) irrigation.

1985

In 1985, as in 1984, there was no treatment which offset the declining yields experienced by delayed planting date (Figure 6). Higher yields resulted from the wet and 50 lb. preplant nitrogen treatments. In addition, the difference between nitrogen treatments was largest at planting date 3. Higher early season nitrogen and drier soil conditions also increased the percentage of undersize tubers, particularly when both treatments were used in combination (Figure 7). This data compliments the yield data from above. It is unfortunate, however, that reducing the amount of preplant nitrogen appears to have a detrimental affect on production of high grade tubers (Figure 8). The highest percent No. 1 tubers were from the wet and high preplant nitrogen treatments.

In 1985, the amount of hollow heart - brown center was distributed evenly between tuber grades (Figures 9 & 10). However, for both No. 1's and 2's, the wet irrigation and high preplant nitrogen treatments resulted in more scorable HHBC. Figures 11 and 12 are pie charts showing the distribution of HHBC which occurred in the No. 1 tubers. These figures illustrate that a majority of the scorable HHBC resulted from the higher preplant nitrogen application, regardless of irrigation level.

The amount of total HHBC found between treatments showed the same pattern as for HHBC in percent No. 1's and percent No. 2's (Figure 13). Wet irrigation and higher preplant nitrogen treatments resulted in increased levels of HHBC. The majority of HHBC across irrigation levels was, again, caused by the higher preplant nitrogen treatment (Figures 14 & 15). However, higher specific gravities were also found with this treatment (Figure 16). As in 1984, lower gravities resulted from dry and lower preplant nitrogen treatments, and together the treatments lowered gravities even further.

1986

In 1986, as in 1985, lower preplant nitrogen levels increased yields (Figure 17). Even under a dry irrigation schedule the 50 lb. preplant nitrogen treatment had increased yields over the high nitrogen treatment under a wet irrigation schedule. Shortening the period for restarting nitrogen may decrease yield (Figure 17, left). This may be due to the 50 lb. nitrogen application given these treatments when nitrogen was restarted. A gradual re-introduction of nitrogen may have caused a different affect. By delaying the restart of normal (wet) irrigation levels, yields may suffer (Figure 17, right). However, regardless of the schedule for increasing soil moisture levels, lower yields appear to be an inevitable consequence if higher preplant nitrogen levels were used to start with.

The longer the nitrogen or higher moistures were withheld past BC dissipation, the lower the percent No. 1's (Figure 18). Higher nitrogen again produced the most No. 1 tubers, and the dry treatment in combination with lower preplant nitrogen yielded the fewest No. 1 tubers.

For No. 1 and No. 2 tubers, delaying nitrogen after BC dissipation had variable affects on HHBC (Figures 19 & 20, left). All lower preplant nitrogen treatments, however, had little HHBC. In contrast, with high preplant nitrogen, it appears that delaying irrigation for three weeks past the start of BC dissipation was necessary to lower HHBC in both grades of tubers (Figures 19 & 20, right). A shorter waiting period increased HHBC substantially.

Figures 21 and 22 are used to, again, illustrate that a majority of the HHBC, regardless of irrigation level, was found under the higher preplant nitrogen treatment.

Reducing the time between BC dissipation and nitrigation had no clear benefit on specific gravity (Figure 23, left). The higher nitrogen treatment, however, again had higher gravities, even under the dry irrigation treatment.

The longer the delay from "normal" irrigation practices, the lower the specific gravities (Figure 23, right). The lowest gravities, as in 1985, came from the combination of dry irrigation and lower preplant nitrogen.

1988 - Greenhouse Study

Warmer soil temperatures and higher preplant nitrogen levels promoted vine growth (Figure 24), but reduced tuber growth (Figure 25). The check bed mirrored the higher preplant nitrogen treatment, but because soil temperatures fluctuated, this treatment did not show the extreme differences from the 60° soil temperatures.

As long as warm soils persisted, higher preplant nitrogen did not enhance HHBC substantially (Figure 26). If, however, soil temperatures were cool, much more HHBC resulted from higher preplant nitrogen applications. The amount of HHBC illustrated in this graph would be even more striking had the percent HHBC been calculated on a weight basis rather than tuber number. However, this graph still shows the increased potential for a bad HHBC crop with a 200 lb. preplant nitrogen program in place, if the weather conditions favor cool soil temperatures.

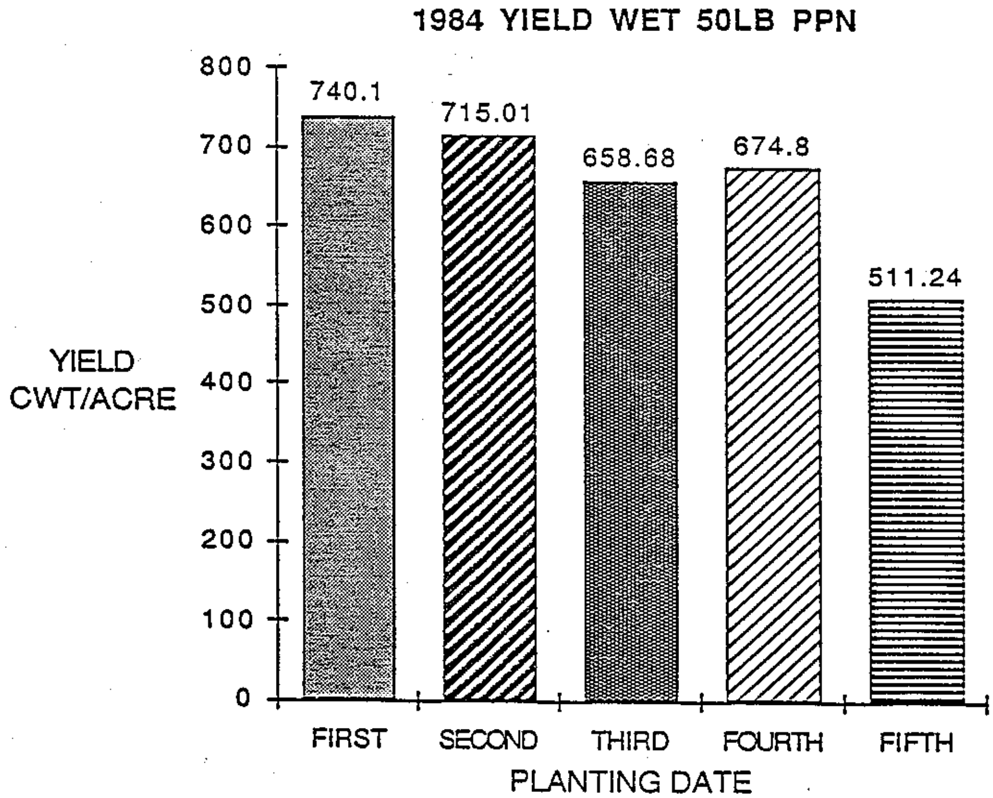
SUMMARY

This series of illustrations was designed to show the influences of various cultural practices on tuber yield and quality. It was disappointing to find that none of the treatments imposed here could offset declining yields experienced from delayed planting. Lowering the amount of preplant nitrogen, however, reduced the influence of delayed planting, and also produced good yields with early plantings.

It was shown that reducing soil moistures and nitrogen levels during brown center initiation can reduce hollow heart - brown center. These practices, taken to extremes in this study were, however, not without drawbacks. Drier soils decreased yield, percent No. 1's and specific gravities. Lower preplant nitrogen and delayed nitrogen past BC dissipation also reduced No. 1 tubers and gravities. Both treatments imposed together were especially tough on these factors. High preplant nitrogen practices also had some negative responses. Yields were never high and as planting date was delayed, yield decreased rapidly and percent undersized tubers increased. The amount of HHBC was always higher even with reduced yields, and in a year when cool spring soils persist, the higher preplant nitrogen can lead to very high internals.

It is unfortunate that delaying the onset of normal irrigation far into the growing season, which causes decreased yields and quality, appears to be critical in reducing HHBC under a dry irrigation program. The delay in nitrogen past BC dissipation does not, however, seem to be as crucial in the control of HHBC by reduced nitrogen levels. This, and the consistent increases in yield, points to continued emphasis on studying reduced nitrogen programs. It may ultimately be possible to reduce or eliminate the negative tuber responses produced by this program. This would leave little question about cultural practices to follow for best potential results.

Figure 1.



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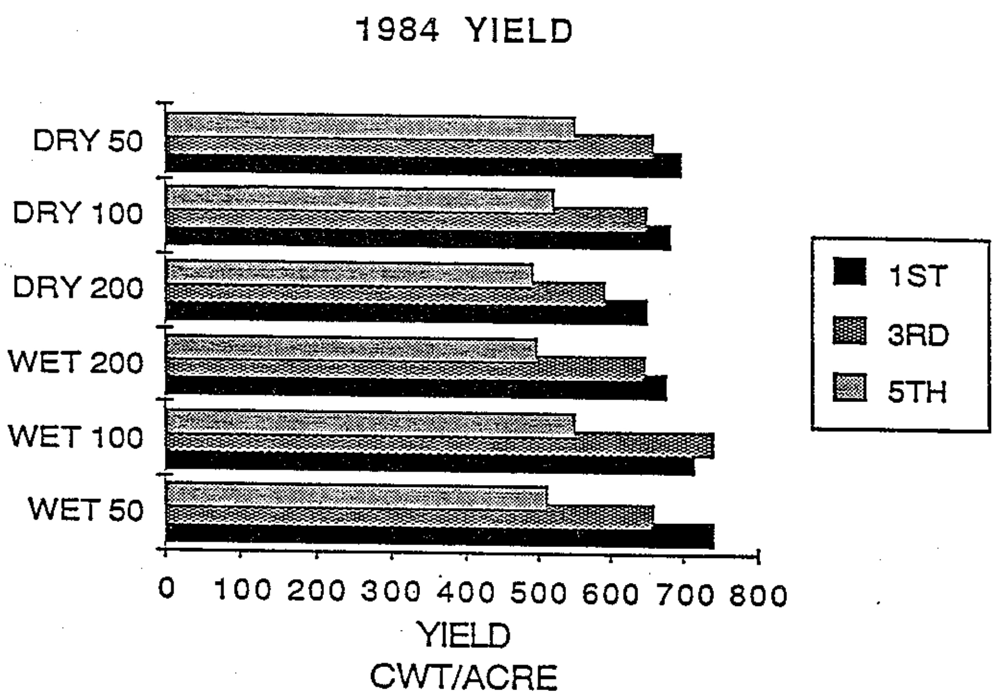

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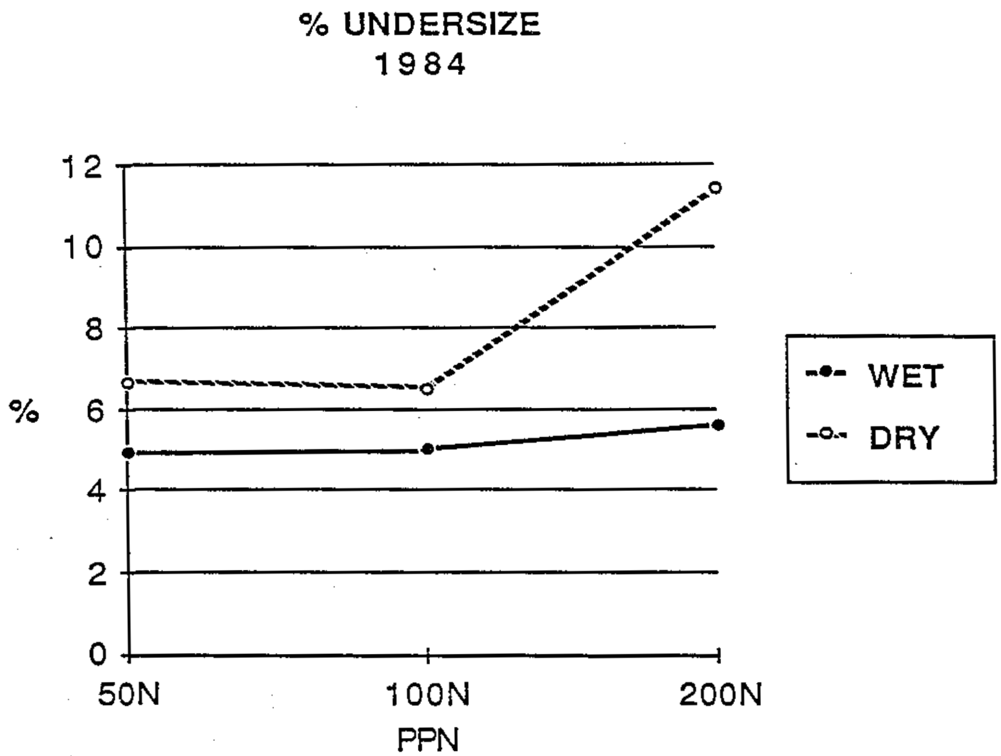

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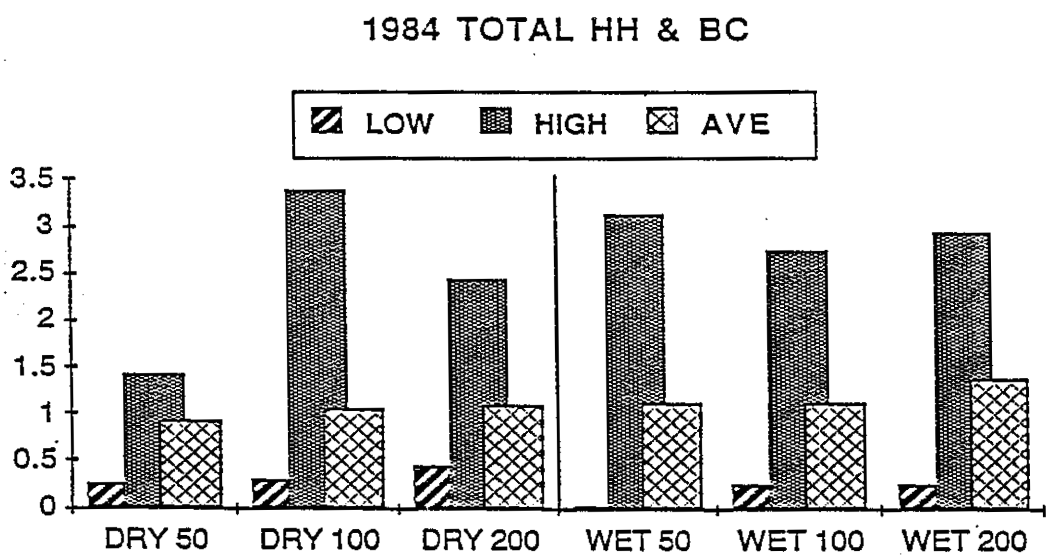

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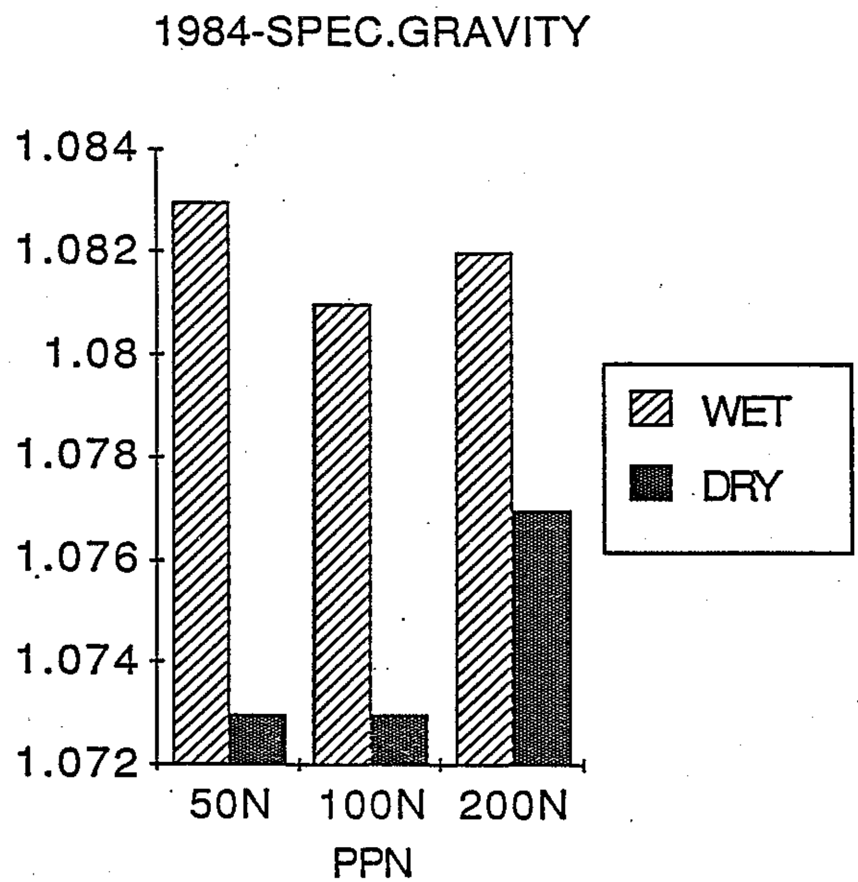

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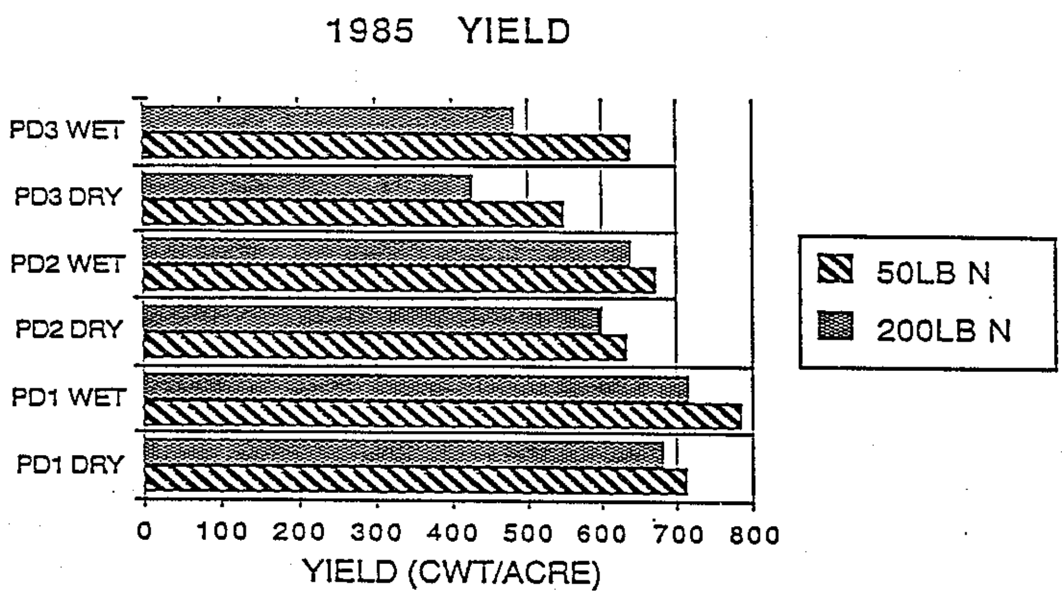

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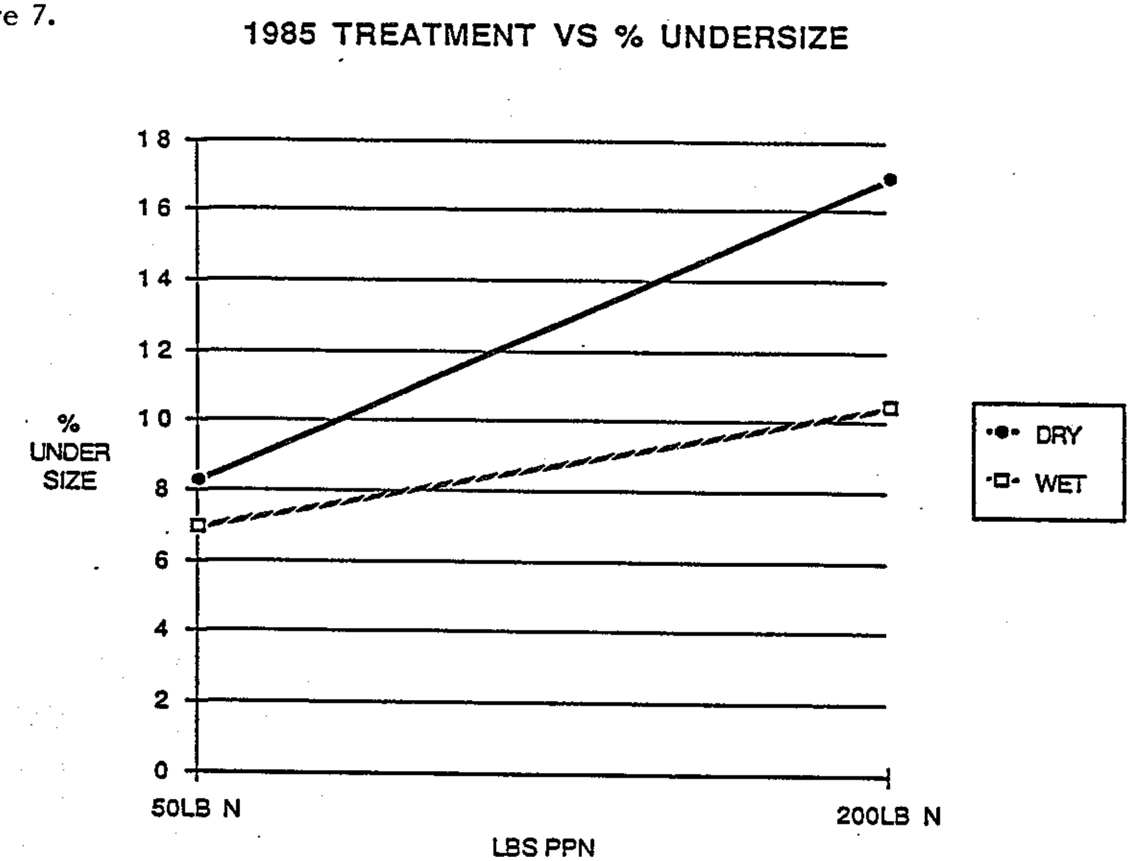

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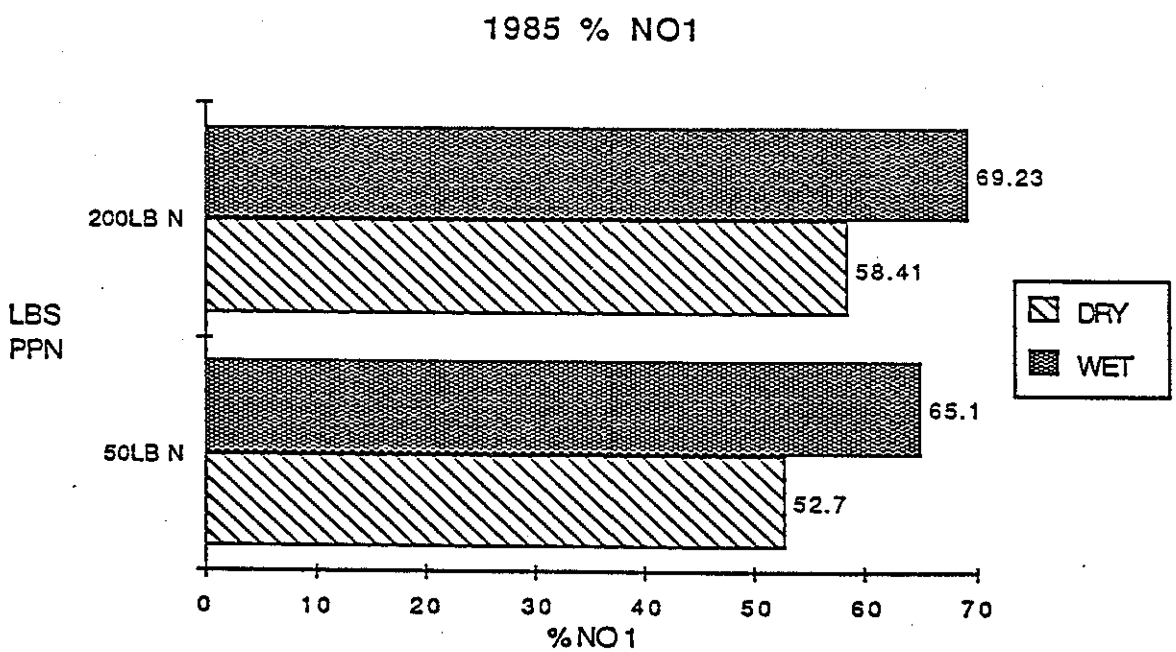

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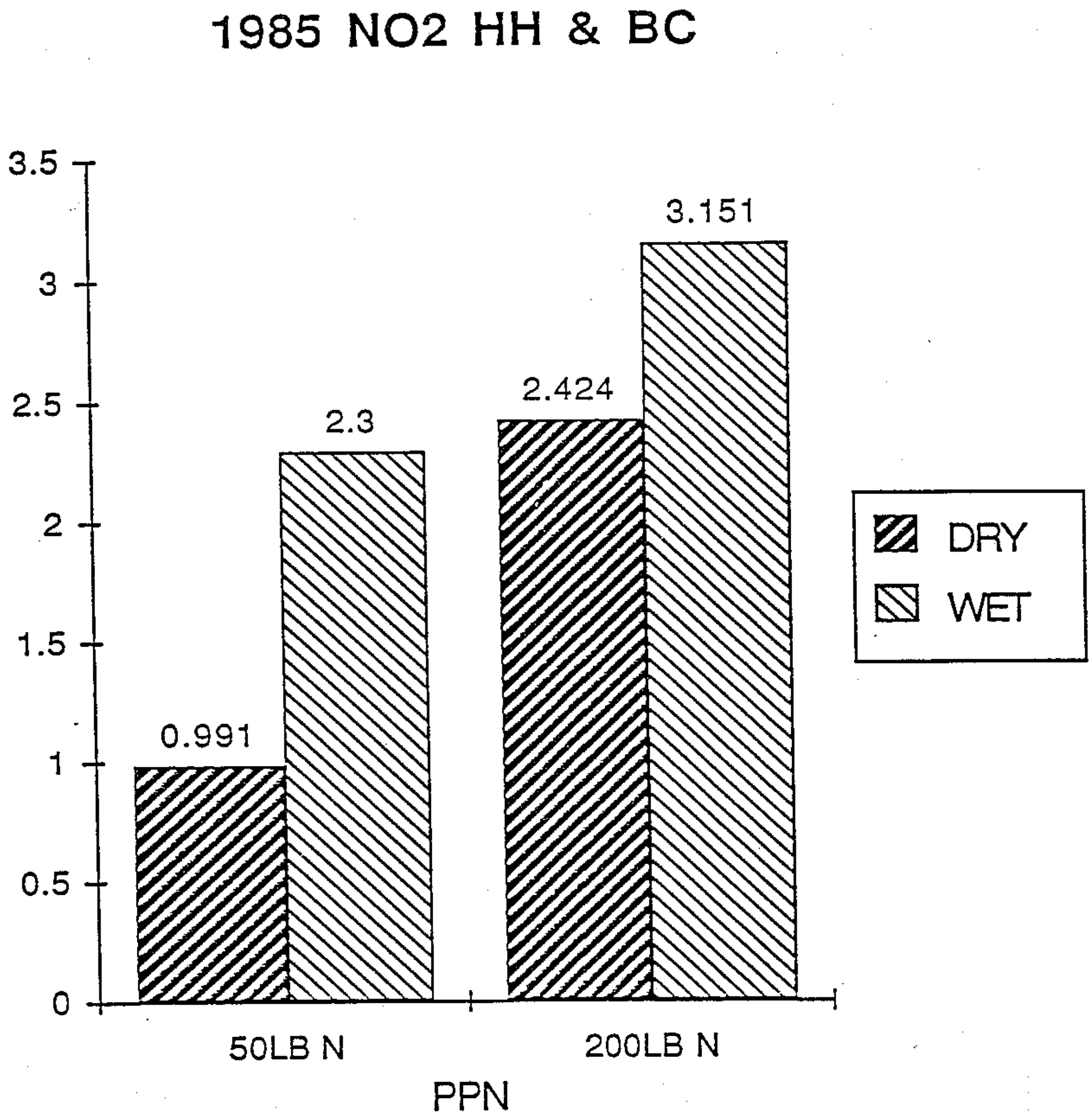
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3.5
3
2.5
2
1.5
1
0.5
0
0.991
2.3
2.424
3.151
DRY
WET
50LB N
200LB N
PPN

Figure 10.

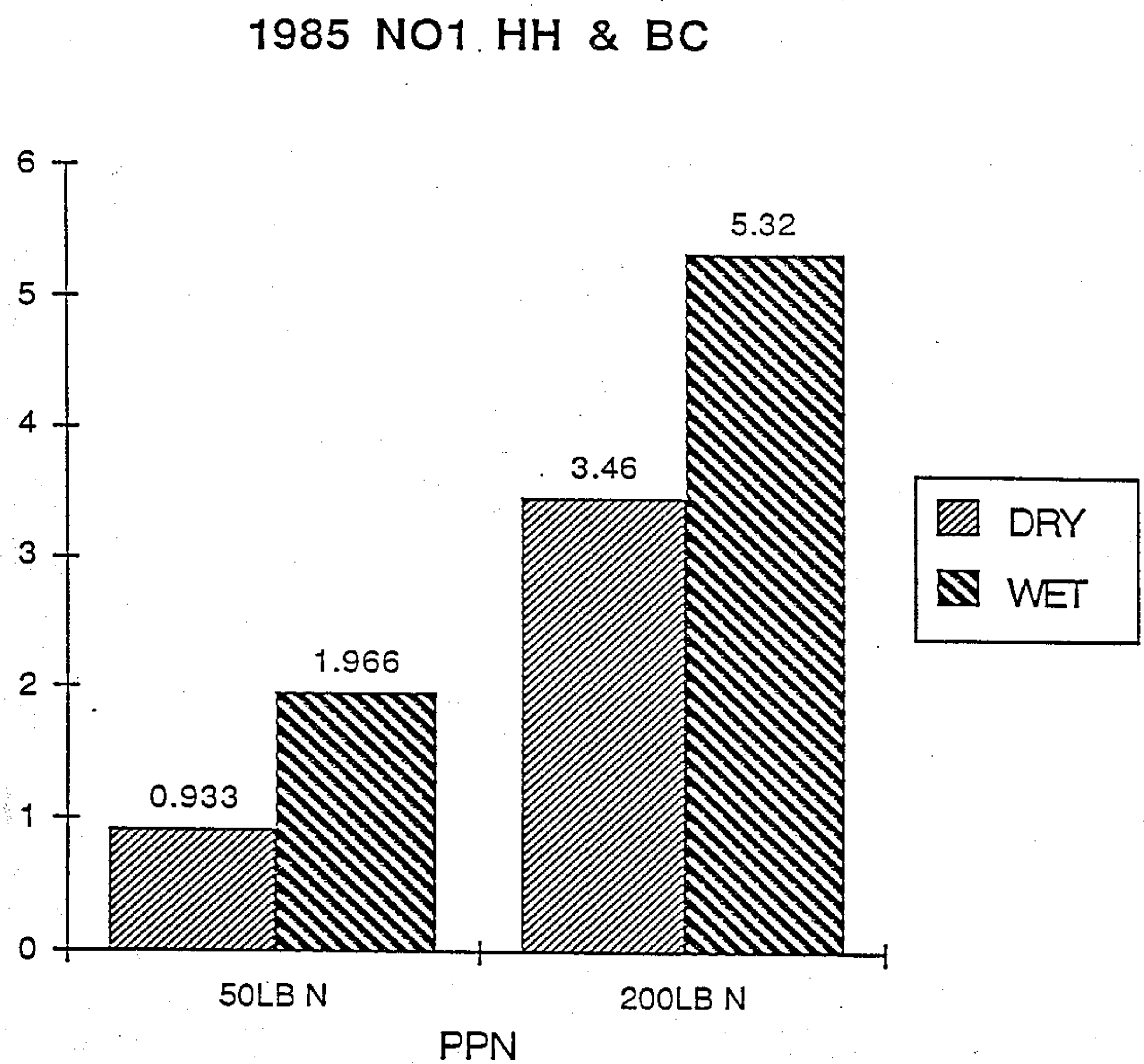
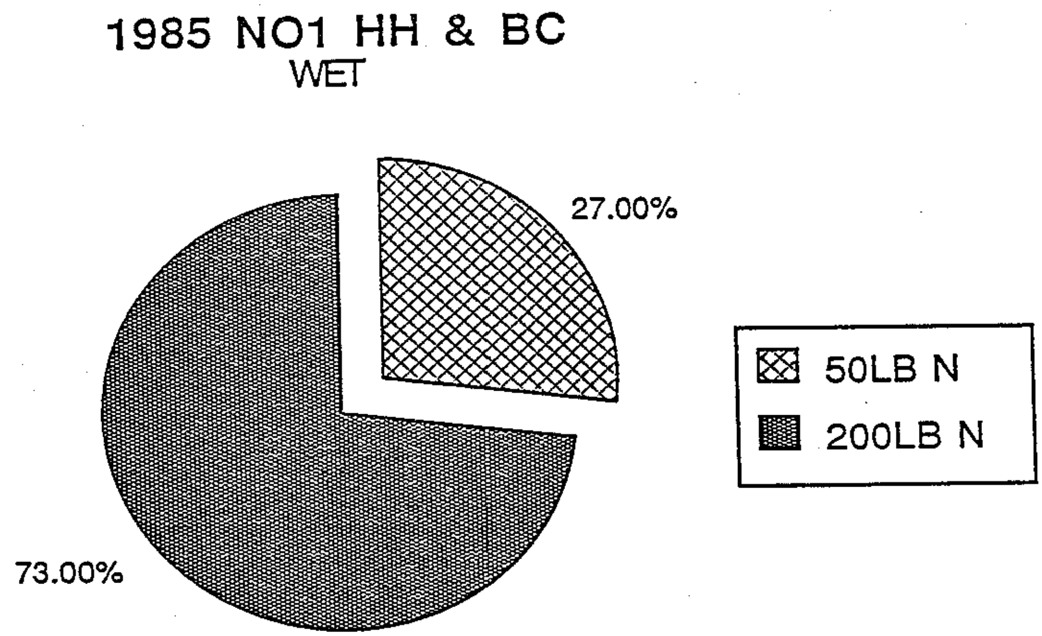

1985 NO1 HH & BC
6
5
4
3
2
1
0
5.32
3.46
1.966
0.933
DRY
WET
50LB N
200LB N
PPN

Figure 11.



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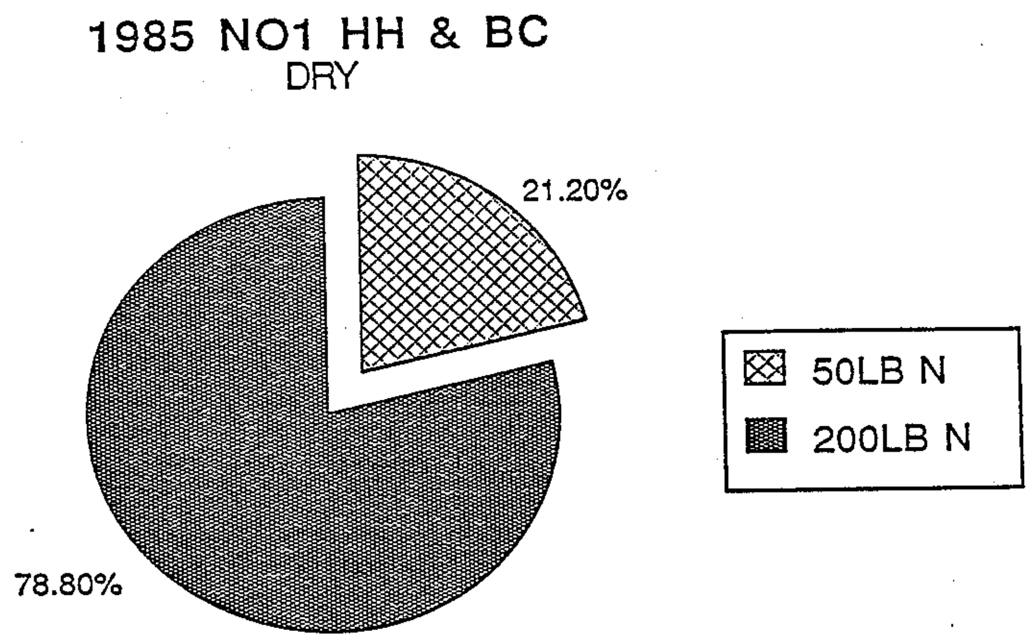

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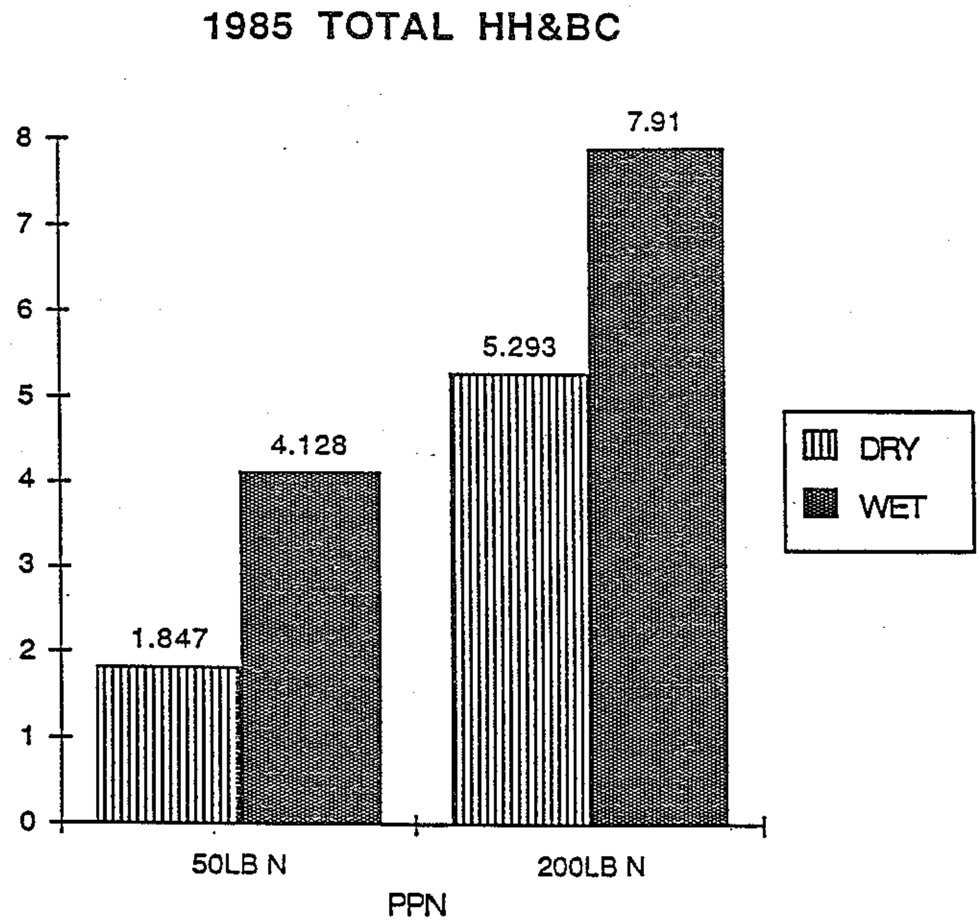

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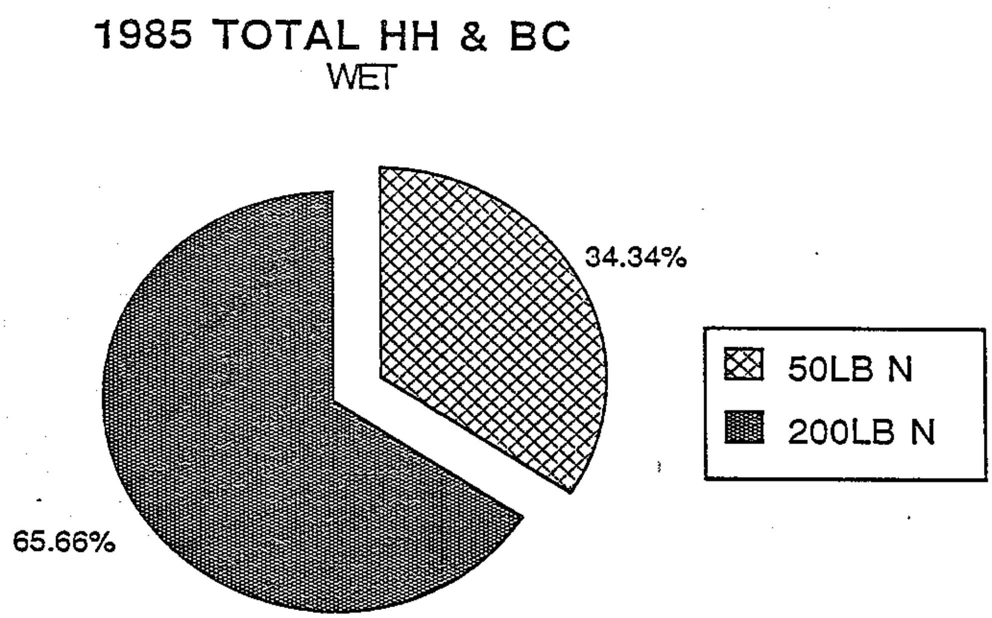

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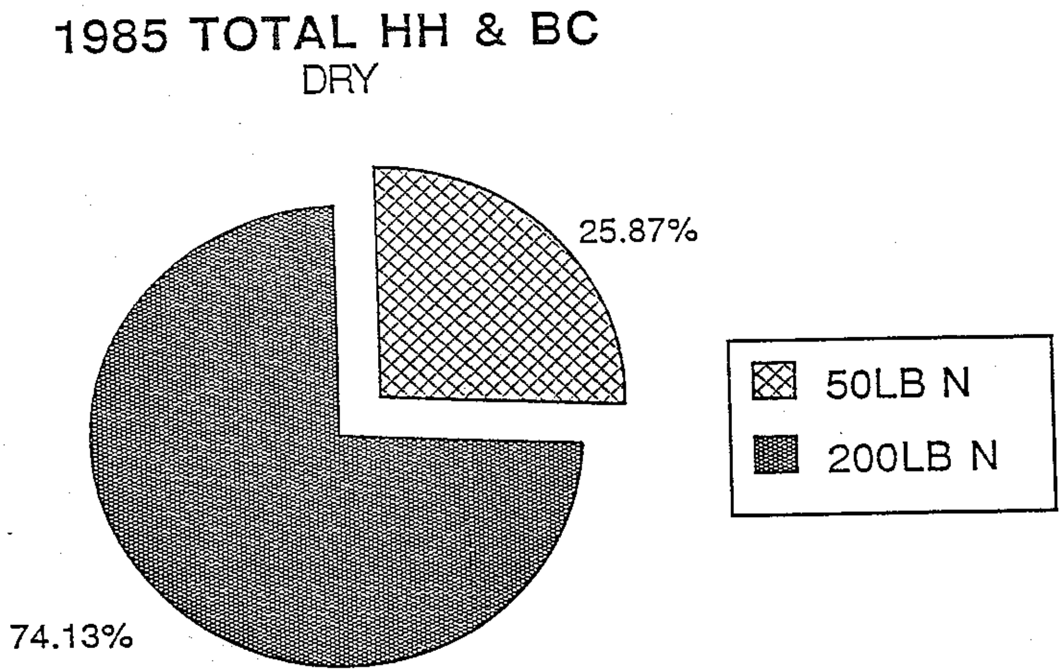

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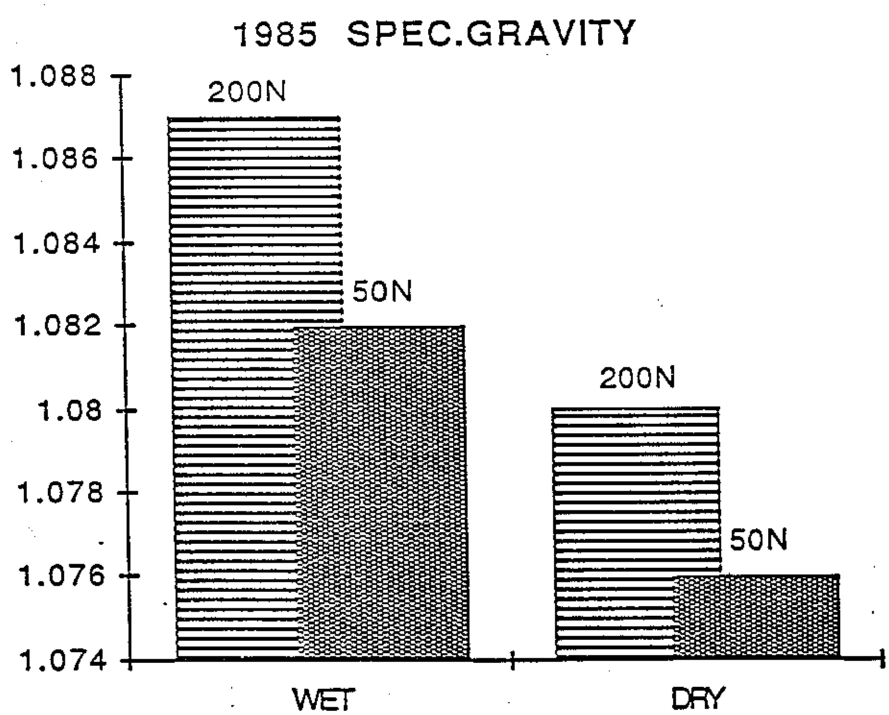

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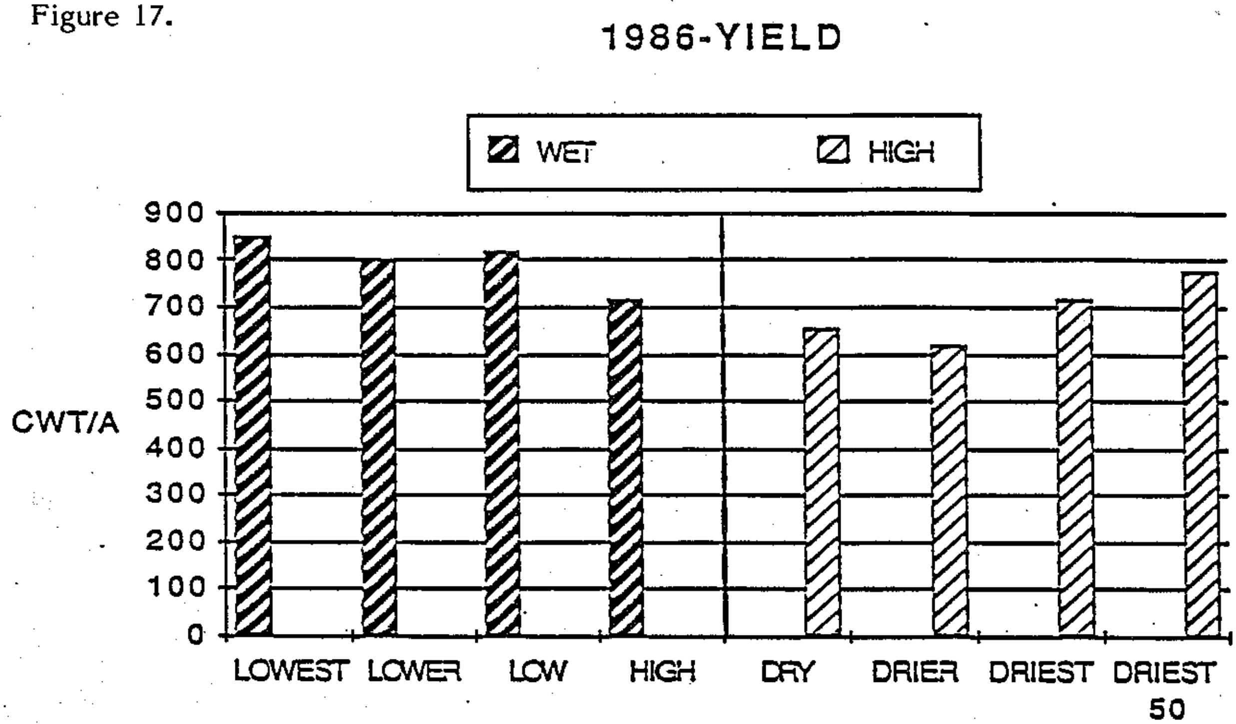

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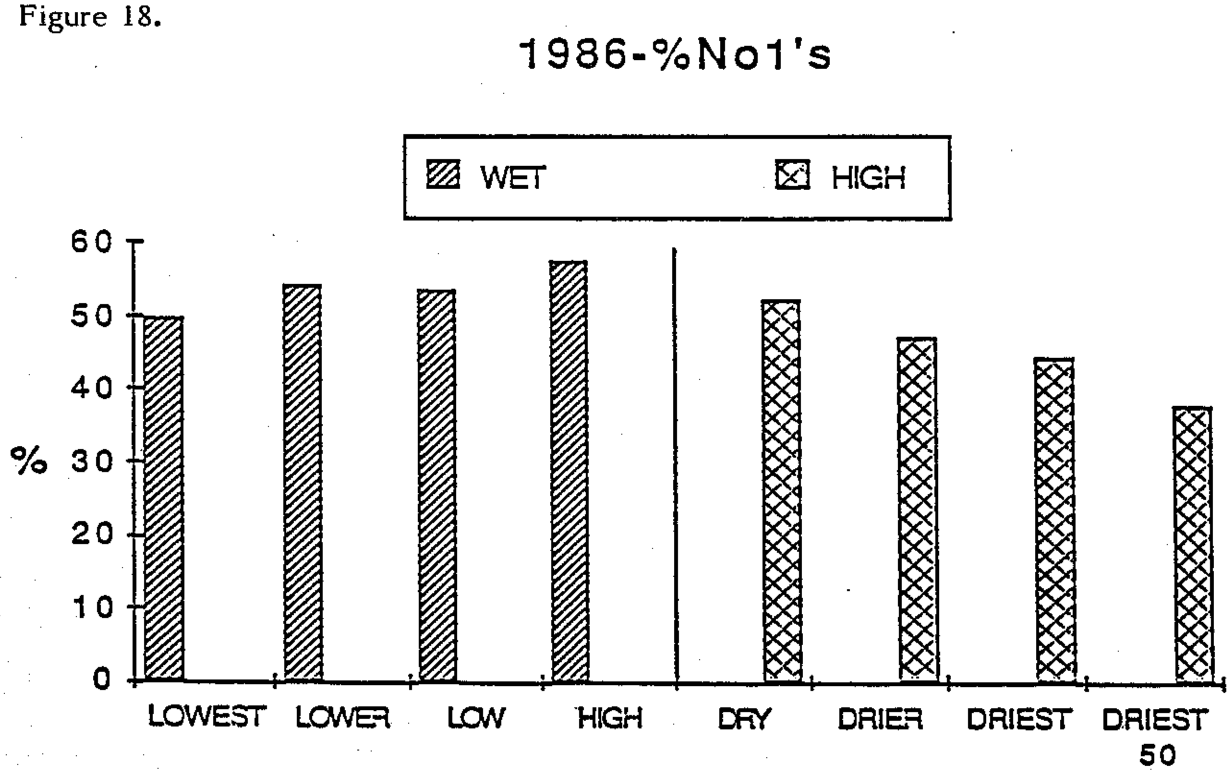

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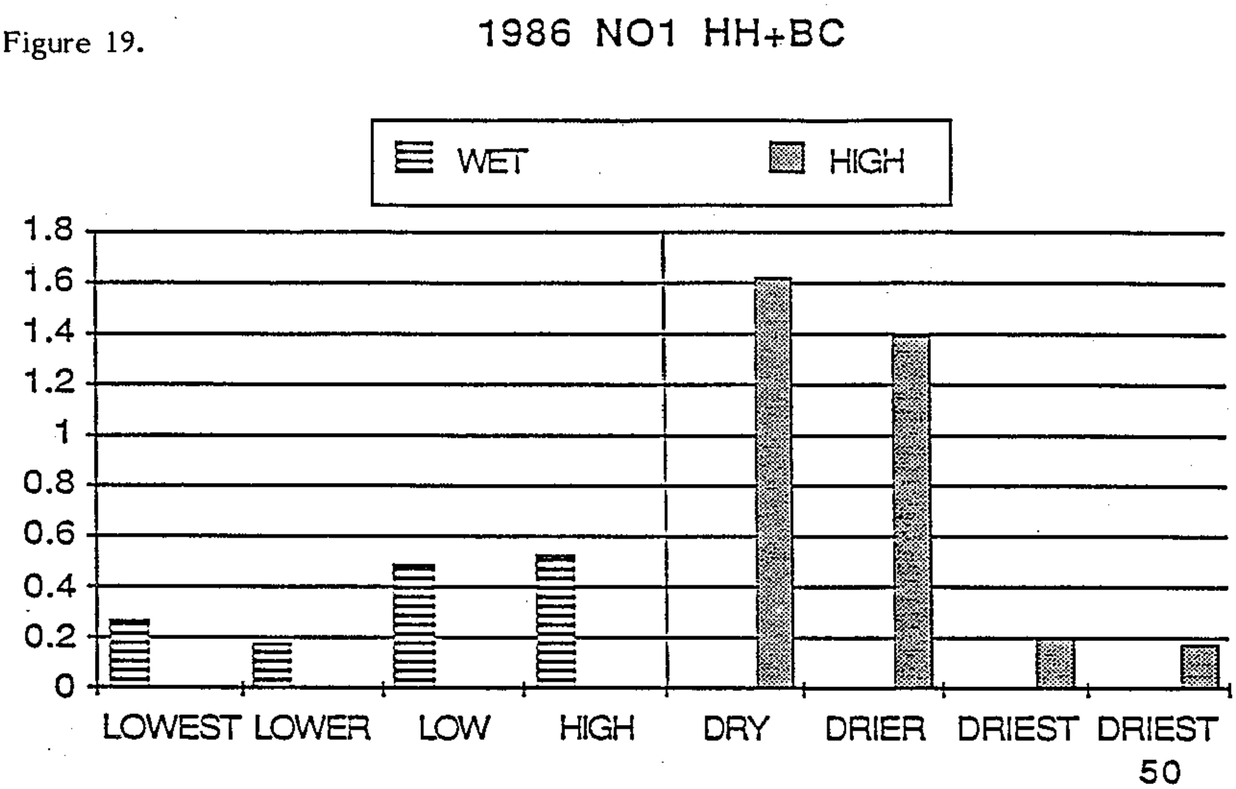

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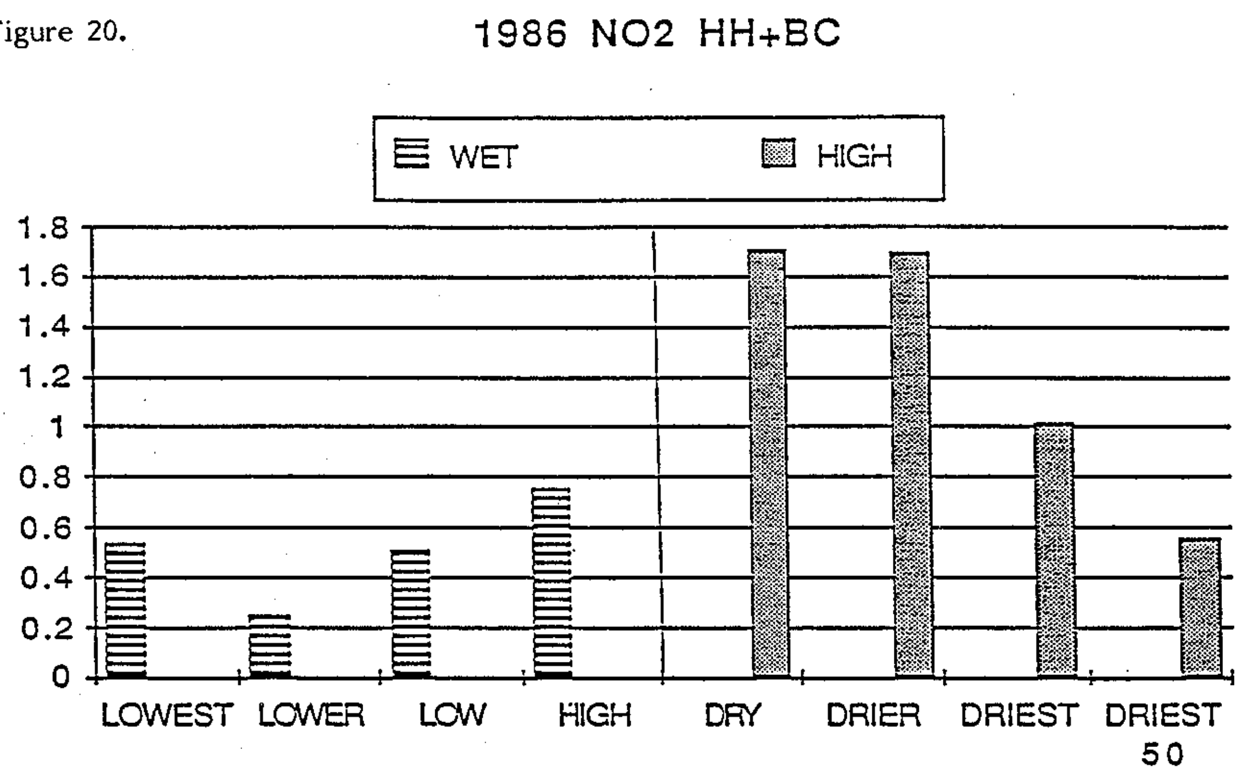

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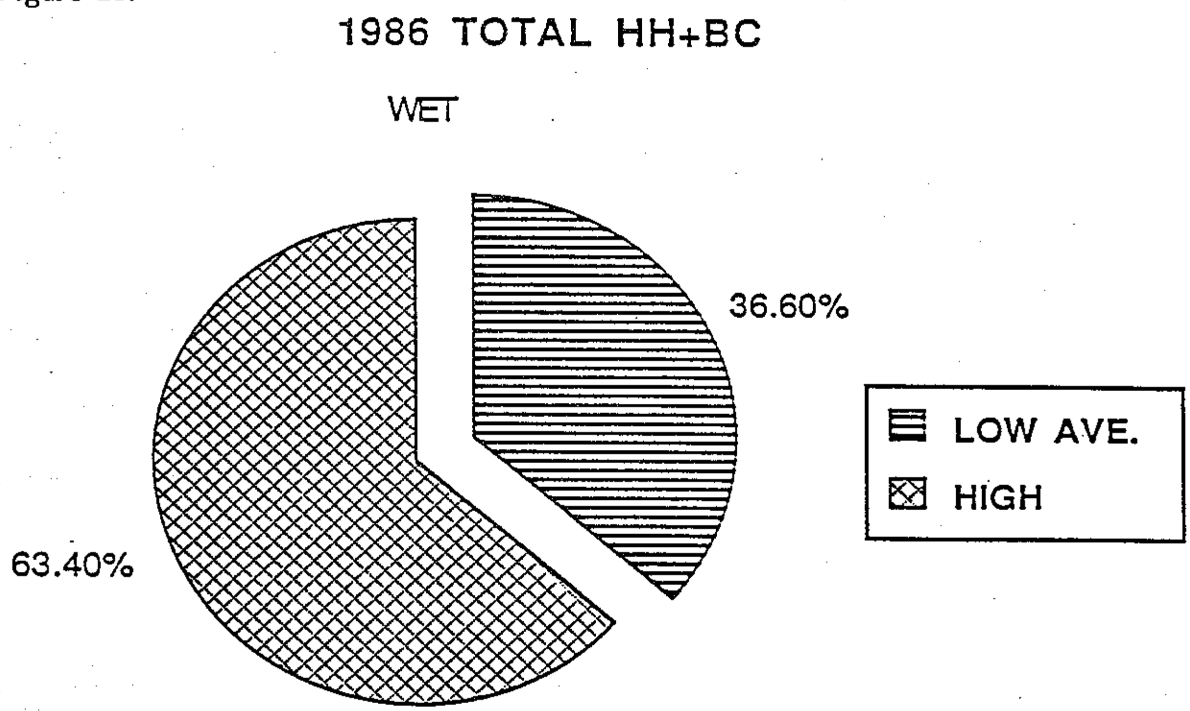

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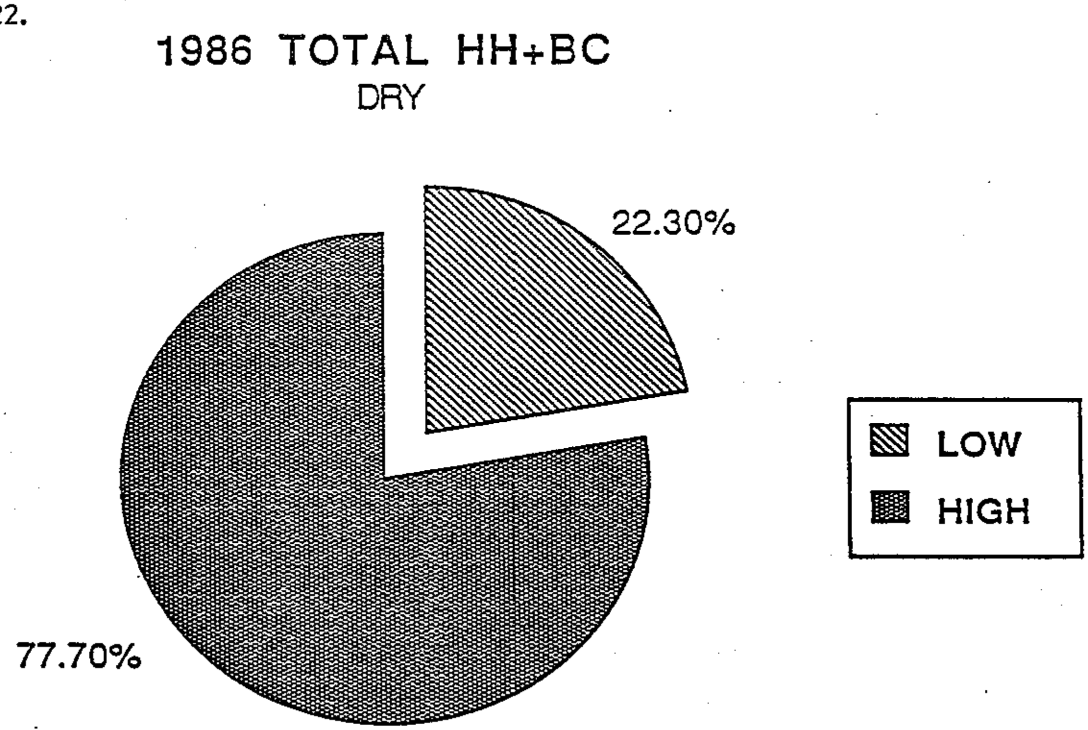

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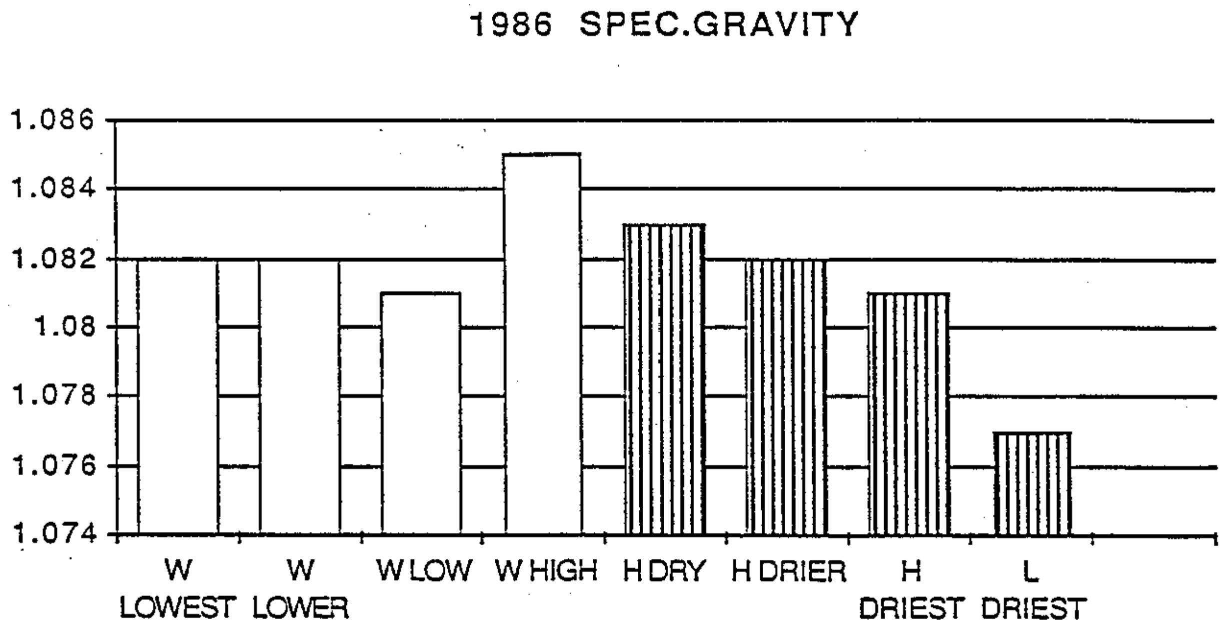

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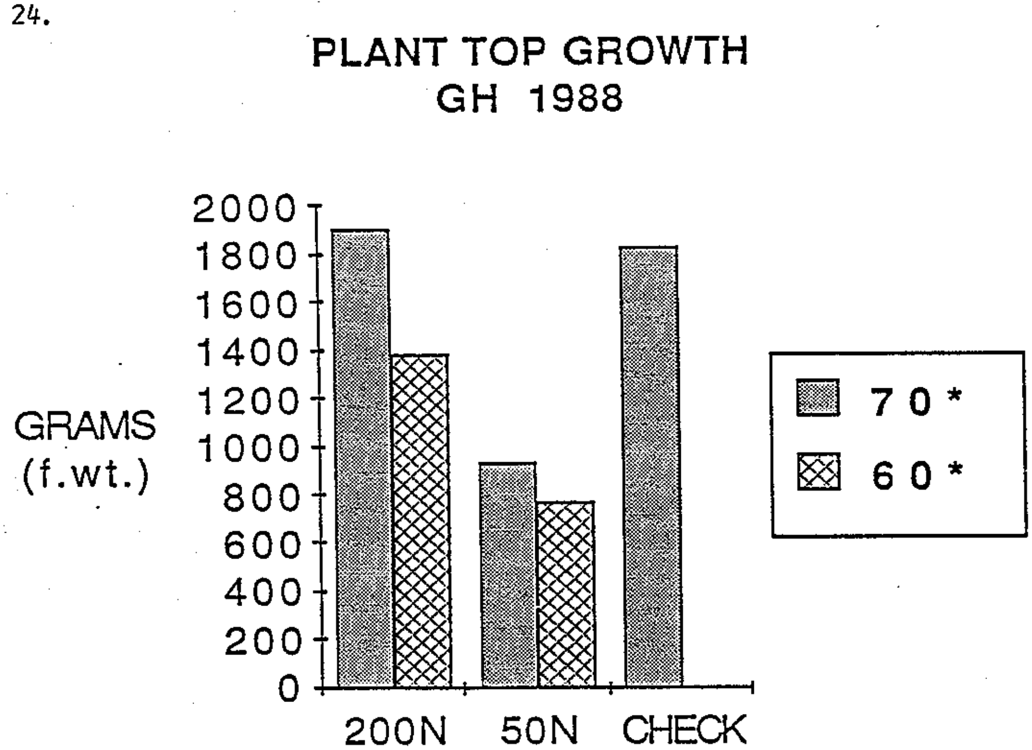

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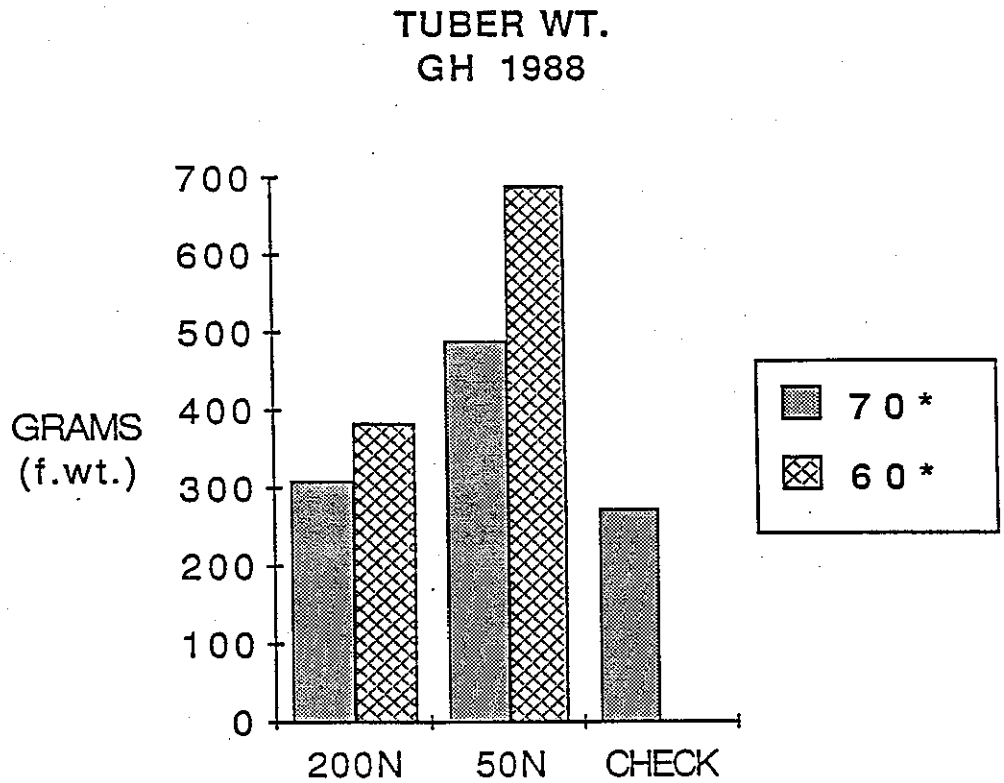

Figure 26.