ROOT STARCH IN DEFOLIATED SUGAR MAPLES FOLLOWING THRIPS DAMAGE

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Abstract

Sugar maple root starch evaluations were done in 1987 and 1988 as a service to Vermont sugarmakers concerned about tree health. Trees were rated for starch content in late fall, using a visual iodine-staining technique. On the average, trees with heavy pear thrips damage in the spring of 1988 had higher levels of root starch the following fall than trees with light or moderate damage. Trees with heavy damage actually had more starch in 1988 than they had the previous fall. Starch in trees with light and moderate defoliation did not increase. Possible explanations for higher starch in heavily damaged trees include early refoliation, energy reserves from the first leaf flush, and 1988 drought conditions.

Introduction

The health of sugar maples is a major concern to Vermonters. Previous research has shown that root starch is a useful indicator of tree condition. Starch rating could help sugarmakers decide whether trees are healthy enough to tap. This hypothesis was evaluated in a pilot test begun in 1987. The results of this test provide an indication of the impact on tree health of damage from the 1988 pear thrips outbreak.

Materials and Methods

Root starch levels were evaluated from 152 trees in 19 sugarbushes during the fall of 1987. Most of the sugarbushes had been damaged by thrips the previous spring or were stressed by other factors. Root starch in these trees was evaluated again in 1988. Three undefoliated, healthy stands were added that year. In 1988, 276 trees from 22 stands were evaluated.

A visual iodine staining technique (Wargo 1977, 1988) was used to evaluate root starch. Samples were taken from large roots or smaller, thumb-sized roots below the soil line. In 1988, two roots were sampled from 150 of the sample trees. Root sections were stained with iodine and color-rated by comparison with published photographs (Wargo 1977). Although ratings were subjective, there were clear differences between roots rated high in starch and those rated low or depleted in starch.

Trees were rated in the summer of 1988 for thrips damage and crown dieback. Those having severely stunted leaves or no leaves at all were rated as heavily defoliated. Trees having thin foliage that was crinkled and deformed were rated as moderately defoliated. Trees with either moderate or heavy damage refoliated in June. When thrips-damaged trees refoliated, the new leaves were undamaged by pear thrips, but were slightly reduced in size.

Because starch ratings provided helpful management information, a starch testing service was offered in the winter of 1988-89 to Vermont sugarmakers. Based on starch ratings, participants were advised whether or not to reduce tapping or delay thinning. Sugarmakers were advised to tap conservatively, or not at all in sugarbushes in which over half of the trees were rated low or depleted in starch.

For statewide testing, defoliation ratings were reported by participating sugarmakers. Results are presented from 27 sugarbushes involved in this program.

Results

A relationship was found between the root starch rating in the fall of 1988 and crown dieback the previous summer (Fig. 1). Trees having over 50% dead branches had roots that were either low or depleted in starch. Trees with no dieback were more likely to have roots with high or medium starch levels. This supports the assumption that root starch ratings provide valuable information about tree health.

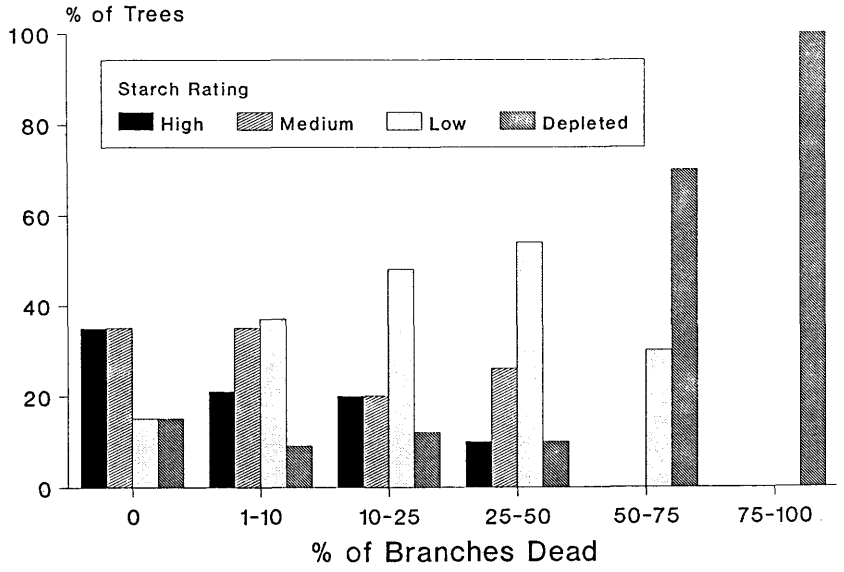

Figure 1. Percentage of trees in each starch rating category, in the fall of 1988 by crown dieback rating the previous summer.

In 1988, when two roots were sampled from each of 150 trees, only half the trees had identical ratings for both roots. In 35% of the trees, the starch content in the two roots differed by only one rating. This suggests that root starch levels are not uniform throughout the root system, and results from starch testing must be interpreted cautiously.

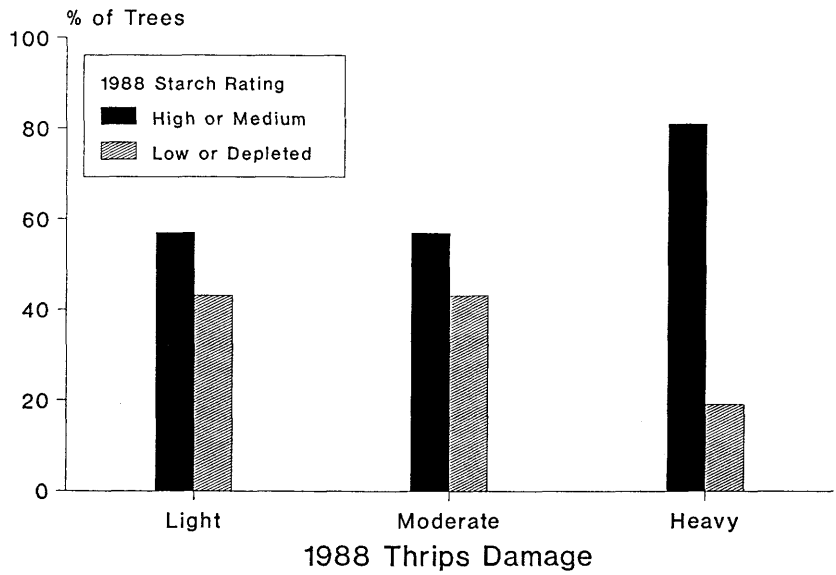

Figure 2. Percentage of trees in each starch rating group evaluated in the fall of 1988, by thrips damage the previous spring. Starch ratings are significantly different for heavily damaged trees (P = 0.01).

Stands with heavy thrips damage in 1988 had higher levels of starch the following fall than stands with light or moderate defoliation (P = 0.01) (Fig. 2). In fact, the 1988 root starch ratings from these heavily defoliated trees most often increased from 1987 levels (P = 0.01). Starch levels in trees with light or moderate defoliation were equally likely to increase as decrease between the two years (Fig. 3). For example, in one sugarbush, each tree sampled in 1987 was depleted in starch. After heavy defoliation by pear thrips in 1988, and a complete refoliation, the average starch rating for the sugarbush was moderate.

In the statewide testing program, sugarbush starch ratings were similar whether thrips damage was reported as light, moderate, or heavy. Two-thirds of the sugarbushes had a majority of trees rated high or medium in starch.

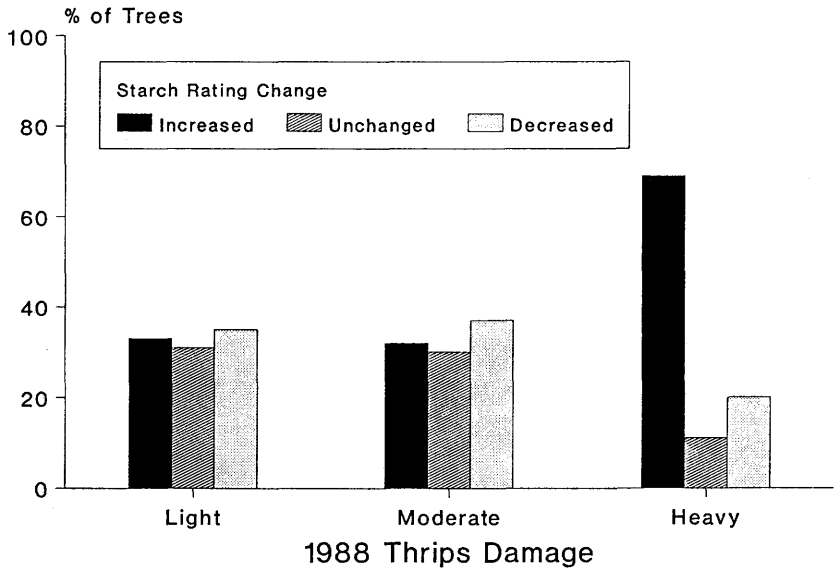

Figure 3. Percentage of trees with root starch levels that increased, stayed the same, or decreased between fall, 1987 and fall, 1988, by thrips damage in the spring of 1988. Change in starch rating is significantly different for heavily damaged trees ($P = 0.01$).

Discussion

Thrips damage occurs against a background of other stresses which also affect tree health. Much of the root starch data in this report were collected from sugarbushes that were already stressed prior to the 1988 defoliation. Prior stress was an important factor in 1988 because of low rainfall during that growing season. Stressed trees are particularly vulnerable to drought conditions.

There are several possible explanations for higher starch ratings in heavily damaged trees. One is the early refoliation of defoliated trees. Refoliation was complete by the end of June. The rest of the growing season was available for food production.

Another possible explanation is the severity of bud damage. Spring bud development in heavily damaged stands produced no leaves. Stored food reserves, which would have gone to the first flush of leaves, were still available when refoliation occurred.

Additionally, drought may have caused more stress to trees with a full complement of leaves than those which were defoliated in May and June. Trees with light or moderate damage continued to transpire during the period of little or no rainfall. Less soil water may have been lost, through transpiration, in stands which were heavily defoliated at that time.

Before management recommendations can be made, or pest control measures undertaken, it is important to know the significance of insect damage to tree health. Based solely on stored root starch levels, thrips damage in 1988 did not adversely impact sugar maple tree health in the sugarbushes sampled. In fact, trees in the heavily damaged stands had higher levels of starch than did those in light and moderately damaged stands. Further studies are needed to determine whether this relationship is found using a controlled sample and under different weather conditions. Other possible impacts, such as reduced radial growth or shoot elongation, were not evaluated but should provide further information about the impact of thrips damage. Further evaluation and standardization of root sampling and visual starch rating would be helpful to improve the reliability of root starch analysis.

References Cited

Wargo, P. M. 1977. Estimating starch content in roots of deciduous trees - a visual technique. USDA For. Ser. Res. Paper NE-313.

Wargo, P. M. 1988. Judging vigor of deciduous hardwoods. USDA Information Bull. No. 418.

Discussion Period

Question: In light of your findings that severe pear thrips damage followed by tree refoliation resulted in above average root starch levels, what tapping guidelines would you recommend to sugarmakers who had very severe thrips damage this past year? Should they tap conservatively as originally recommended and is the root starch level a valid test to use for determining tapping levels?

Burns: At this time we are still recommending that sugarmakers tap their trees conservatively in stands that were severely defoliated by thrips. These guidelines were written for sugarmakers this summer and are available from the VT Dept. of Forests, Parks and Recreation. We offered a starch testing program to sugarmakers this year, regardless of the defoliation that occurred in their stands. In sites showing relatively high or normal root starch levels, we did recommend that the sugarmakers tap as usual, following standard tapping guidelines. So the starch testing was used to override tapping recommendations based on foliage damage alone. However, we are still cautioning people to tap conservatively recognizing that thrips damage must stress trees to some extent.

Comment: I noticed that my tap holes are healing well and my trees look generally healthy, so why not tap them? One more tap hole isn't going to kill the tree, and I can't afford not to tap. In fact I think probably the year we shouldn't have tapped was the year before the defoliation rather than the year after. It seems logical that if the trees are going to be severely defoliated in the next few months, it would be better not to take sap out of the trees because they will need that sap and all the energy sources they have built up to refoliate. Therefore prior to a defoliation it is probably better not to tap.

Comment: I think you must be cautious in taking that approach because we only take out about 3% of the tree's total carbohydrate stores during tapping. Therefore a minimal amount of the stored carbohydrates is removed by tapping prior to defoliation. It is hard to believe that is going to significantly impact the tree.

Comment: The impact to the tree of tapping is not necessarily how much carbohydrate is removed but how much available energy there is for healing the tap hole wound. The biggest problem is that the more discolored wood there is in a tree, the less clean, clear sap there will be in future years. If the tree responds ten times as much in one year because of low energy reserves then ten times more wood is lost for tapping. So the problem lies not necessarily in what has been taken out of the tree, but what is being done to the internal tree system and how that affects the quality of the product you will be getting out in future years. All of this depends on genetics, available energy and the combination of those factors.

Question: What is the effect of vacuum systems on tree health?

Comment: Vacuum systems have not been in use long enough to make complete judgments on its long-term effects on trees. Based on anecdotal information, the areas that appeared to be suffering in terms of tree health were those areas in which the vacuum system was used. Critical studies need to be done on the long-term effects of vacuum systems on sugar maple trees. I am not sure that there is no effect.

Comment: So far we haven't seen any effect of vacuum on trees. In fact on steep slopes there seems to be about the same amount of suction pressure in a non-vacuum closed system as there is in a vacuum system. I agree there haven't been many years of experience with vacuum systems to state conclusively that there is no effect, but I haven't seen evidence or published results indicating that low amounts of vacuum pressure are harmful to sugar maple trees. Of course, if you destroy cell walls with high pressure, the effect could be very different.

Question: Has any testing of starch been done on branches or tree trunks rather than the roots; why can't you do that?

Answer: You can; starch is stored in the stems as well as the roots. The problem is that the period of time in which starch testing can be done in the stems is reduced because of diurnal fluctuations in temperature. These fluctuations can cause the starch in the stem

tissue to convert to sugar making the timing of testing critical. Temperature fluctuations are not such a problem in the roots. In addition, the starch concentration in the root system is much greater than that in branches or twigs, which increases the ability to distinguish among the different starch level categories and makes the test results more accurate.