Temperature and Bud Rest Period

effect of temperature and exposure on the rest period of deciduous plant leaf buds investigated

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Breaking the rest period of leaf buds of deciduous plants is generally admitted to be brought about mainly by the low temperatures of late fall, winter and early spring.

The amount of exposure required to fully break the rest varies with different plants and with the temperature. If the exposure is too short or the temperature not low enough—or both—incomplete breaking occurs; fewer buds grow, and growth is relatively less vigorous than on normal plants.

The rest of many plants may be effectively broken by cold storage. The requirements are a temperature between freezing and about 45° F and a period of continuous exposure of two to three months.

If plants which have clearly recognizable rest periods and are in the resting state are held continuously at temperatures of 60° F to 80° F, the rest may be prolonged for many months and sometimes for a year or more.

In the intermediate temperature range —45° F to 60° F—the results of continuous exposure vary with the kind of plant, but in general, an incomplete ending of the rest occurs.

A relatively short exposure to excessively high temperature—a few hours or days at 110° F to 130° F—will often start resting buds into growth. How the different temperature levels prolong or bring about the ending of the rest condition is still unknown.

The relation of exposure for varying periods to a temperature very effective in breaking the rest is shown in the larger illustration.

The plants shown in the photograph are one-year-old Hardy pear trees bearing only leaf buds. They were transplanted in November from an outdoor nursery to a greenhouse with a temperature range from 60° F to about 90° F, where they remained completely dormant for many months. No buds grew until the following August, and then only a portion of the terminal buds.

At intervals of several days, beginning in April, a few of the dormant trees were transplanted into peat moss and placed in a cold storage room at 37° F. At the end of 81 days, the ten lots were removed to the greenhouse. Two months later one tree from each lot was photographed with one which had remained continuously in the greenhouse.

The picture shows that trees which had been stored at 37° F continuously for 56 to 81 days opened most of their buds, as they do after a normal winter outdoors. With decreasing length of cold treatment below 56 days, an increasing proportion of buds remained inactive until at no exposure and at 10 days exposure only two injured buds grew feebly.

The trees which were in the cold room from 19 to 42 days resemble typical examples of delayed foliation found in the orchard after a too warm winter.

The results described above were obtained with continuous storage at 37° F.

Trees outdoors are subjected to widely varying climatic conditions.

The temperatures to which they are exposed are, part of the time, favorable for breaking the rest, part favorable for prolonging it, and part in the intermediate range. It is difficult to estimate how large an influence each temperature level may have upon the subsequent behavior of resting buds.

To get a basis for judging the possible effect of daily temperature changes, the following experiment was carried out, based upon some results obtained in Europe with water plants.

The trees used were essentially the same as used in the previous work, one-year-old Hardy pears bearing only leaf buds, brought into the warm greenhouse in November and used while still in the resting condition the following spring.

On April 1st three lots of ten trees were transplanted into peat moss and placed in cold storage at 37° F. Lot 1 was held continuously in the cold room for 71 days. Lot 2 was daily removed from the cold room and placed in a dimly lighted room at a mean temperature of 73° F for about six hours, then returned to the cold room. Lot 3 was likewise daily removed from the cold room and placed outdoors where the mean temperature was 64° F and it received direct daylight for about six hours before return to the cold room.

Of the total outdoor exposure 76% was recorded by the United States Weather Bureau as sunshine, 24% as cloudy.

On April 20th a fourth lot of ten trees was placed in the cold room and held there continuously for 52 days.

On June 11th all trees were planted in the greenhouse. On June 20th a few

Continued on page 12

Hardy pear trees held at 37° F: *Lot 1*, 71 days continuously; *Lot 4*, 52 days continuously; *Lot 2*, 71 days, 18 hours per day at 37° F, 6 hours per day at 23° F in dimly lighted rooms; *Lot 3*, 71 days, 18 hours per day at 37° F in unlighted room, 6 hours per day outdoors in daylight, of which 76% was direct sunlight. Photographed one month after return to greenhouse.

SWINE

Continued from page 5

was run with three 240 pound hogs at a room temperature of 100° F.

All were distressed, with an average body temperature of 106.8° F and an average respiratory rate of 150 breaths per minute. When four liters of water at 100° F were poured on the floor to make a wet area, the hogs began to roll in the water immediately. In twenty minutes the body temperatures were lowered an average of 1.0° F and the respiratory rate lowered by 50%. In 90 minutes the body temperature was lowered by 2.0° F and the respiratory rate by 80%.

Air Motion

In another experiment three hogs weighing around 250 pounds were on a wet floor at approximately 119° F. Air motion in the chamber varied from 20 to 30 feet per minute at hog level. A fan was turned on, which increased the air motion to an estimated average of 175 feet per minute, but varying from 100 to 250 feet. In 30 minutes, the respiration was lowered by about 60%, and the body temperature was reduced on the average about 2.5° F. In 80 minutes, the body temperature was reduced an average of 3.0° F, when the hogs were on the wet floor with an accelerated rate of air motion.

In contrast, four pigs averaging about 100 pounds were on a dry floor at 113° F. The fan was turned on, increasing the air velocity as before. At first the respiratory rate and body temperature decreased slightly, since it was not possible to have the floor completely dry and the hogs were slightly damp. As the floor and hogs dried, the respiratory rate and body temperature increased again to that at the start.

After five hours with the accelerated air motion and a dry floor, there was no apparent benefit to the comfort of the animals. This type of experiment has been repeated with four hogs averaging 187 pounds at 99° F and another four hogs averaging 236 pounds at 100° F, with no apparent effects.

As the air temperature rose above 80° F the animals became increasingly lazy and lay flat on the floor. The light weight pigs weighing around 100 pounds were still fairly active at 80° F.

Under the conditions of these experiments, with constant temperatures, swine weighing around 100 pounds utilized feed to a greater degree and gained weight more rapidly in the neighborhood of 75° F, whereas heavier weight hogs weighing approximately 200 pounds did better in the neighborhood of 60° F.

As the air temperature was increased or decreased beyond these averages, rate of gain declined and utilization of food was lowered.

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BUDS

Continued from page 9

buds were growing on lots 1 and 4 but none on lots 2 and 3. Visible growth of a few buds on the latter two lots did not occur until June 27th. In the succeeding days the number of growing buds increased on all lots of trees, but many more grew on lots 1 and 4 than on lots 2 and 3. The maximum numbers of growing buds were reached on July 3d on lots 1 and 4, but not until July 15th on lots 2 and 3. The final number of buds which grew were as follows: lot 1, 84%; lot 2, 29%; lot 3, 50%; lot 4, 72%; of the total buds present.

It is clear that the treatments applied to lots 2 and 3 both retarded the rest breaking process in comparison with those applied to lots 1 and 4. The retardation expressed itself in two ways: in the smaller numbers of buds growing and in the slowness with which they started growth. In the smaller illustration are shown two trees from each lot, the one with least and the other with most buds growing. The trees in lots 2 and 3 resemble those in the larger photograph which had received too short cold treatment—less than 50 days.

Lots 2 and 3 received a cumulative exposure at 37° F of 52 days, the same as lot 4 received without interruption.

It is apparent that a few hours daily warm treatment partly offset the effect of 18 hours daily cold treatment.

Although lots 2 and 3 were both strongly retarded in comparison with lots 1 and 4, nearly twice as many buds grew on lot 3 as on lot 2.

The average temperature outdoors during the daily warm treatment of lot 3 was 9° F lower than that to which lot 2 was subjected. This difference in temperature may have caused the difference in behavior, but there is also the possibility that the strong summer sunlight may have stimulated growth of buds on lot 3. Strong radiation such as X rays in suitable dosage has been shown to break the rest of buds, and some evidence exists that ordinary light shortens the rest of certain buds. In the orchard it has been generally believed that much direct sunlight during the winter days tends to prolong the rest because it raises the temperature of twigs and buds somewhat. The part that light of varying intensity may play in retarding or hastening the ending of the rest is still not very clear. It may at winter intensities and duration be a retarding influence and become a stimulating influence at the higher intensities and longer duration of spring and summer.

The gardner and orchardist in regions of mild winters is thus confronted with a rather complicated situation involving temperature, light, variation of response of different kinds of plants, and possibly other factors, all of which affect spring growth. It appears clear from experience, however, that shade in winter is beneficial for plants with strong rest periods. It seems a reasonable deduction from the experimental results described above that plants subjected to fluctuating outdoor conditions may require a longer exposure to break the rest of buds than would be required under continuous low temperature.

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CITRUS

Continued from page 10

The range of values and the average for each of the constituents in a group of high performance California orange orchards are shown in the table. A section—columns six to 17 inclusive—shows the effect of a deficiency of any given element in the direction of change in other elements, insofar as information is available. These standards are tentative and may need to be shifted in one direction or another as more information develops.

Use of Table on Page 10

As an example of the use of this table: suppose a sample of orange leaves has been collected, cleaned, and analyzed.

If the total nitrogen turns out to be 2% or less, this would suggest that nitrogen may be limiting—deficient—in the orchard sampled. With nitrogen levels of 2% or less, it could be expected to find that other elements—columns six to 17—shifted in the directions indicated. Thus phosphorus likely would be increased, and values greater than 0.13% might be expected.

Total sulfur would be slightly increased, and values greater than 0.25% might be slightly decreased from the average values shown in column four, while potassium would be increased.

Though no actual values for other elements can be stated with certainty when

Continued on page 14