Forcing Plants by Means of Radium

Treatment Must Be Applied During "Period of Rest"

By Dr. Alfred Gradenwitz

MAN is no longer content with having each plant at its own season. In fact, endeavors have been made for some years to abridge the period of rest of vegetables by different means such as refrigeration, etherizing, hot baths, lesions, and injections.

Four Sprouts Exposed Respectively for 48, 24, 1 and 0 Hours to Radium.

As regards the action of radium on vegetable life the results so far obtained are somewhat contradictory. While growth was generally found to be delayed, some cases are also on record of the germination of grains being accelerated by radium.

Dr. H. Molisch, professor at the University of Vienna, who had for some time been engaged in an investigation of the influence of radium and its emanation on plants, recently tried to ascertain whether radium rays or radium emanation would influence the period of rest so as to accelerate the sprouting of plants. The experiments, of which an account was given to the

Imperial Academy of Science, indeed show the radiation of radium products to possess the striking property of shortening the period of rest of the winter buds of certain plants, causing these buds to sprout prematurely. If, for instance, the terminal buds of *Syringa vulgaris* are exposed to the radiation of strong radium products for one or two days at the end of November or December, these buds, afterward cultivated in the hothouse, are found to sprout very soon, whereas those left untreated only develop much later. While the action of the radiation must be continued for a certain time if this effect is to be produced, it is liable, if prolonged too much, to have effects harmful or even fatal to the plant. In September and October, that is, at a

The Sprouts on the Left Were Kept in Pure Air. Those on the Right Were Exposed for 48 Hours to Radium Emanation.

time of deep rest, the action of radium is quite ineffective. If, on the other hand, the experiment be put off until January or even later, when the period of rest is over, no difference can be observed between buds exposed to radium and those that are not, unless in fact

the former be delayed more or less in their growth. This behavior is quite similar to the influence of ether or warm-water baths.

Radium emanation exerts on the development of buds an even more pronounced action than solid radium products. It is also better adapted for activating the growth of plants, owing to its more uniform action, that of solid radium products being limited to a very small area. At a certain stage of the period of rest (November and December) emanation experiments give particularly good results. The action of emanation otherwise shows about the same behavior as that of solid products.

Apart from *Syringa vulgaris*, Prof. Molisch obtains satisfactory results also with the following trees and shrubs:

Aesculus Hippocastanum, *Siri Liriodendron tulipifera*, *Staphylea pinnata*, and *Acer platanoides*.

Though this forcing process is too expensive to have, at least for the present, any practical importance, the peculiar effects of radium still deserve the attention of biologists, the more so as products of equal intensity generally exert on growing vegetable organs quite different effects from those observed during the period of rest.

Sample (1) Grown in Ordinary Air; (2) Exposed to Emanation for 20 Hours; (3) for 48 Hours; (4) for 72 Hours.

New York's Enormous Annual Coal Consumption*

The Coal Tonnage of New York City

By F. E. Seward

THE coal tonnage of the largest American city has always been a topic of interest to the trade. It has never been an easy matter to ascertain the tonnage used, as precise data are unavailable.

EARLY FIGURES ON THIS TOPIC.

Prior to the expansion of the city limits, it used to be said that 6,000,000 tons would cover requirements; then after Brooklyn, Queens and Richmond were added on, the tonnage was estimated at 12,000,000 tons; and in 1905, when certain Government statistics relative to coal supplied to New York city and harbor points were first made available, the amount sent to destination within the limits of greater New York, so styled, was, in round numbers, 15,500,000 tons.

At that time—seven years ago—there were some 24,000,000 tons of hard and soft coal shipped at loading ports in New York harbor—the city requirements constituting, it will be noted, 65 per cent of the business of the New York loading ports. Nine million tons of the amount shipped to New York city was anthracite—(60 per cent of the 15,000,000 tons of anthracite shipped in the harbor)—and 6,500,000 tons was bituminous, say 72 per cent of the 9,000,000 tons of bituminous handled at the piers in and about New York in the year named.

TONNAGE REQUIREMENTS OF 1908.

While these details of distribution are no longer available, the statistics of 1908 indicated that anthracite shipments at New York harbor points were 15,069,981 tons; the bituminous shipments, 10,247,014 tons. Estimating about the same proportion of distribution

as in 1905 (for which policy there appears to be good authority), would give the result of, say, 10,050,000 tons of anthracite and 7,800,000 tons of bituminous—a total of 17,850,000 tons as the annual coal requirements of the city of New York in 1908, including the steamship or bunker business (the tonnage of which is burned, almost entirely, outside of the city limits).

THE REQUIREMENTS OF TO-DAY.

It seems very probable that the development of New York, particularly in the outlying section—has offset any of the frequently-mentioned reductions arising from economies in the domestic trade, and changes of fuel made by householders, with the more extended introduction of gas and coke. And in the steam trade, so much of the New York tonnage goes to public utilities and other enterprises that operate on a full-time basis the year around, that we do not have to consider locally the variations in coal tonnage requirements that prevail from time to time in manufacturing cities east and west.

Having these circumstances in mind, we give below estimates of hard and soft coal destined for New York use. Proportion of anthracite has been calculated at an increased figure—70 per cent, instead of 60 per cent—as it is probable that more hard coal is going east all-rail, and a larger amount of coal shipped at local ports is for city use. Probably the increase in bituminous coal used locally is in proportion to the increased tonnage used in eastern centers, and no change in percentage thereof seems advisable. Applying these percentages to the figures of harbor loadings appearing in the *Coal Trade Journal* (Manhattan), the local

record stands as follows: Anthracite used, 11,000,000 tons; bituminous used, 3,500,000 tons for miscellaneous purposes, and 4,684,846 tons for bunker tonnage.

WHERE DOES ALL MANHATTAN'S HUGE COAL SUPPLY GO? The distribution of utilization is about as follows:

Anthracite—

Domestic, private houses, and small stores using mostly "egg," "stove," and "nut"—about one fourth of the total.....	25 per cent
Flats and apartment houses, heating, etc., using mostly broken and egg, or pea and buckwheat sizes—under one third of the total	33 per cent
(The two preceding items—some 58 per cent, aggregating a little more than one ton per capita—may be termed the domestic trade.)	
Hotels, clubs, theaters, factories, institutions, etc.—about one tenth of the total	10 per cent
Gas and electric requirements, estimated from annual reports—about one tenth of the total	10 per cent
Department stores, office buildings, etc...	10 per cent
Elevated, subway and surface railroads—about one fourth of their total tonnage	4 per cent
Steamboats, tugs, and shipping, also steam railroad fuel, for heating, etc., within city limits	4 per cent
Municipal requirements (city departments)	4 per cent
Total anthracite (about).....	11,000,000 tons

* The Coal Trade Journal.

Bituminous—

Steam trade, factories, refineries, etc., including gas and electric plants (about) 25 per cent
 Steamship bunkering (official returns)... 50 per cent
 Elevated, subway and surface railroads... 17 per cent
 Heating stores, office buildings, etc. 5 per cent
 Blacksmith trade, including carriage manufacturers 2 per cent
 Municipal requirements, pumping stations, etc. 1 per cent

Total bituminous (about) 8,236,000 tons

Total anthracite and bituminous.. 19,236,000 tons

In addition, there is used an estimated coke tonnage (gas house) amounting to 225,000 loads of 50 bushels each.

Population by the census of 1910 was approximately 4,700,000, exclusive of borough of Richmond, where suburban or rural conditions prevail in the coal trade and otherwise. Manhattan and Bronx may be put down for 2,765,000 population, and are generally considered together in coal trade matters. If division of tonnage is made, as between these boroughs, it should be on the basis of six sevenths and one seventh. Brooklyn may be set down as having 1,635,000 population, borough of Queens 285,000. This trade runs together in the Jamaica and Long Island City territory, where

the heaviest business of the Queens dealers is done. Together the two boroughs have some 1,920,000 population, or, say, two fifths as many as the entire city, and a little over two thirds of the Manhattan and Bronx population.

On this basis we can therefore divide the coal trade by boroughs as follows:

Anthracite—Manhattan and Bronx, 6,550,000 tons; Brooklyn and Queens, 4,350,000 tons.

Bituminous—Manhattan and Bronx, 2,087,000 tons; Brooklyn and Queens, 1,350,000 tons.

Bunker business cannot be divided by boroughs. Odd amount of hard and soft coal not covered in the above distribution may be set aside as tonnage used on Staten Island.

The following distribution of tonnage in the borough of Brooklyn is furnished to us:

To steam users, including all sizes and grades of anthracite and bituminous, 2,000,000 tons.

To apartment houses, hotels, stores, etc.—all anthracite, in sizes from pea up to broken, with small percentage of No. 1 buckwheat—1,500,000 tons.

To families—all anthracite, in sizes egg, stove and nut principally, with a very small percentage of broken and pea—1,000,000 tons.

The borough of Queens will take a greater proportion-

ate amount of coal than Brooklyn, on a per capita basis, because of manufacturing interests in the Long Island City section and the tonnage of coal used for railroad purposes. There is practically no coal used for railroad purposes, on locomotives, in Brooklyn, and very little in Manhattan. A moderate tonnage is delivered to engines in the borough of the Bronx.

The amount indicated as requirements of the local railroad interests, may be sub-divided in general as follows: Brooklyn Rapid Transit Co., 500,000 tons hard coal, 150,000 tons soft coal; the former Metropolitan Street Railroad lines, 350,000 tons in all, of which about 200,000 tons is buckwheat coal. The balance of the tonnage is used by the subway and elevated power houses in the several boroughs, and is about equally divided between hard and soft coal.

Probably the largest industrial consumers—if they may be so called—are the breweries, of which there are about thirty-five in Manhattan alone. In the Bronx, Brooklyn, Queens, and Richmond there are about as many more. The largest concerns in this class are Ehret and Ruppert, each of which uses about 20,000 tons of broken coal per annum. The others use between 5,000 and 6,000 tons each, as an average, so that in all about 250,000 tons are sold to trade in Manhattan and about half a million in the entire city.

Experiments on Durability of Tool Steel*

Cutting Tests at Different Cutting Speeds and With Different Cooling Mediums

By Edward G. Herbert

THE durability of a tool is measured by the length of tube it will turn away before attaining a measured degree of bluntness. Tests made at a succession of cutting speeds from 20 feet per minute upward were reported in a former paper by the author and showed a very low durability at the lower cutting speeds; an increase of durability as the cutting speed increased; a maximum durability at cutting speeds of 50 to 80 feet per minute; and a decline of durability to a very low value as the speed was further increased. The theory was put forward that the observed changes in the durability of cutting tools are mainly caused by changes in the temperature of the cutting edge, due to varying quantities of heat generated at different cutting speeds. The heat theory was confirmed by experiments showing that changes of durability corresponding to those which occur under varying cutting speeds can be produced by varying the temperature of the tool in other ways while the cutting speed remains constant, viz., by varying the temperature of the water with which the tool is flooded; by varying the depth of cut (a heavy cut generating more heat than a light one), or by dispensing with the cooling water.

LOW DURABILITY AT LOW SPEEDS AND FINE CUTS.

It has been found by experiments on the tool steel testing machine that all tool steels, without exception, have a very low durability and are very quickly blunted when cutting under water at low speeds and fine cuts under conditions which preclude any considerable heating of the cutting edge; and it has been found that any alteration in the cutting conditions which tends to increase the temperature of the cutting edge, results in an increased durability of the tool.

All varieties of tool steel have been found to be capable, when suitably hardened, of producing double-peaked speed-durability curves, the characteristics of such steels being that at a certain speed they are less durable than at higher and lower speeds.

The principal action to which a tool is subjected in cutting is one of friction under heavy pressure. This tends to rub the surface of the steel away, by causing the particles of steel to slide over one another. To resist blunting by this action a tool must possess hardness. But the stress on the tool point is not constant;

as the chip is detached it breaks up into a series of short segments (more or less completely separated), and this process subjects the tool to a succession of changes of pressure, amounting almost to blows, and tending to chip off portions of the cutting edge. To withstand this action the tool must possess toughness.

In order to measure, throughout a range of temperatures, those physical properties of a steel which constitute its durability, it is necessary to test it at each temperature for hardness and for toughness. The method finally adopted was that of breaking the specimen, supported at the ends on knife edges, by a load applied transversely at the center. The apparatus employed is illustrated in Fig. 1. The specimen *A* was in all cases 3 inches long, $\frac{1}{4}$ -inch deep and $\frac{1}{2}$ -inch wide. It was supported on knife edges *BB*, $2\frac{1}{2}$ inches apart. A third knife edge *C* was affixed to a plate *F*, and guided by pins *DD* sliding freely in holes in *F*. The whole was placed in a bath containing water, oil or salt, according to the temperature under investigation, the specimen being completely immersed in the liquid. The bath was rested on iron blocks *GG*, with gas burners or blow pipes between them, and the whole was placed under the cross-head of a 100,000-pound autographic testing machine.

Some of the resulting diagrams are reproduced in Fig. 2. The height of each curve represents the maximum load applied to the specimen to break or bend it, and this maximum load is taken as a measure of toughness. Curve *a* is from a specimen broken cold; being brittle, a small load sufficed to break it. Curve *b* is from a similar specimen broken at 238 deg. Cent. (460 deg. Fahr.). It was tougher, and broke at a higher load. Curve *c* is from a specimen tested at 278 deg. Cent. In this case the specimen was very tough. It supported a heavy load, and bent with breaking. Specimen *a* was very hard; it gave only a small deflection for each increment of load, and the resulting diagram is nearly vertical. Specimen *b* was softer, and *c* very soft, and the slope of the diagram was greater as the hardness diminished. Numerically the hardness may be expressed as the load required to produce 1/10-inch deflection, and the hardness number is obtained by dividing the maximum load in pounds by the deflection in tenths of an inch.

EXPERIMENT WITH CRUCIBLE STEEL TOOLS.

Experiments were first made on a crucible steel containing about 1.3 per cent carbon. A bar $\frac{1}{2} \times \frac{1}{4}$ -inch in section was cut into pieces 3 inches long, which were heated to 800 deg. Cent. and quenched in water. Some of the specimens were left in the dead-hard state, others were tempered by being placed for 15 minutes in an oil bath at 136 deg. Cent. Others were tempered in like manner at 145 degrees and 175 degrees, respectively.

The results of the breaking tests are plotted out in diagrams *A*, *B*, *C*, *D*, Fig. 3. The full lines in these diagrams represent maximum loads at which the specimens were broken or bent (toughness), and the dotted lines represent the hardness, or maximum load divided by deflection. We have here, according to our theory, two of the elements for determining the variations of durability with temperature; but it is very difficult to say, from inspection of the curves, which tempera-

tures might be expected to give the highest durability to the steel. The durability will be high when both the hardness and toughness are high. The durability will be low when either the toughness or hardness, or both, are low.

It is evident that if we multiply the hardness number by the corresponding toughness number for each temperature, we shall obtain a new series of numbers fulfilling the conditions just stated—they will be high when the hardness and toughness are both high; they will be low when either hardness or toughness, or both, are low. These numbers should therefore be in some degree proportional to the durability of the steel. We cannot say that they will be strictly proportional to durability unless we assume that hardness and toughness are the only qualities constituting durability, and that they are equally important factors in durability, but these are assumptions we have no right to make. Either hardness or toughness may be the more important factor, according to the nature of the material the tool is required to cut.

It is an established fact that the steel which is best for cutting hard materials such as tire steel is not necessarily the best for cutting soft materials such as mild steel or brass, and this may be because a harder tool is required for one class of material and a tougher for the other. Nor can we safely assume that hardness and toughness are the only factors in durability. Some steels (notably the tungsten steels) possess a property of resisting abrasion which does not appear to depend directly on hardness or toughness, and can only be measured by an abrasive test—preferably an actual cutting test. It is certain that a tool which is very soft or very brittle will not be durable. It is almost certain that a given tool will gain in durability as it becomes harder and tougher; but it by no means follows that the specimen of steel which carries the heaviest load with the least deflection will make the most durable cutting tool.

Recognizing, then, that the product of hardness and toughness may bear only an approximately proportional relation to durability, let us examine the curves produced by plotting these products on a temperature basis. The curves are shown in Fig. 4. and the durability-

Fig. 1.—Scheme for Breaking Steel at Different Temperatures.

Fig. 2.—Autographic Record of Steel Broken: *a*, cold; *b*, at 460 deg. Fahr.; *c*, at 530 deg. Fahr.