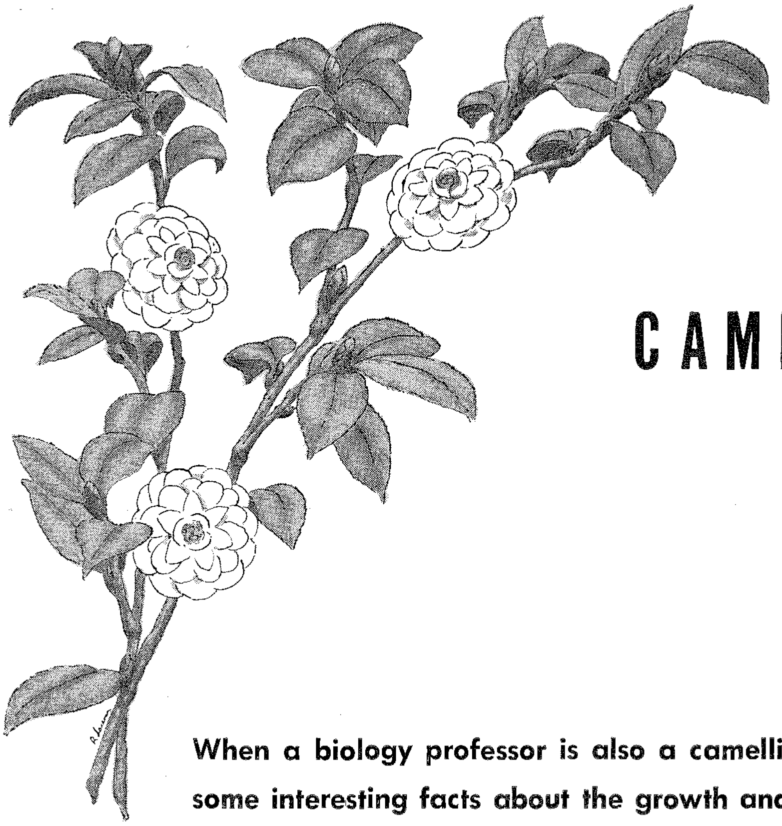

CAMELLIA RESEARCH

by JAMES F. BONNER

When a biology professor is also a camellia lover, he's bound to turn up some interesting facts about the growth and flowering of this popular plant

THE CAMELLIA is one of our most beautiful and most appreciated ornamental plants. Since it is a native of warm temperate regions (southern China), it cannot be grown in all parts of our country, but it does thrive throughout a wide arc, extending from Washington, D.C., south through Georgia and Florida, west along the Gulf Coast and north along the Pacific Coast as far as Seattle.

The large size and sturdiness and freedom from pests of the camellia shrub have combined to make it a favorite of gardeners throughout this region. The enthusiasm of camellia fanciers for the flower of their choice has led them to form societies dedicated to the advancement of camellia lore, as biologists and chemists band together for the advancement of their chosen disciplines.

As it turns out, there is real need for study of the camellia as a plant, since, despite a popularity dating back over a hundred years, there has been but little serious investigation of the factors and conditions which control its growth and flower production. It is only natural, therefore, that when a camellia lover and member of the Southern California Camellia Society happens to be also a member of the biology staff at Caltech, as in the case of the author of this article, some study of camellia problems should ensue.

We have been investigating camellia matters at the Institute as a sort of scientific hobby for the past ten years. Camellias have been grown in the phytotron (the Earhart Plant Research Laboratory) to find out what temperatures they like; they have been grown in nutrient solutions to find out what they need by way of minerals; their flowers have been studied under the microscope to find out about their chromosomes so that we may hybridize them more intelligently.

When we grow a plant, we first want it to grow vegetatively—that is, to produce roots, stems and leaves and to grow to a good thrifty size; then we want it to change its mind, to produce buds which will grow into flowers rather than into more stems and leaves; and finally we want it to become reproductive.

The growth of the camellia, as of any plant, depends upon the carbon dioxide of the air, which is taken up by the plant and reduced to plant material by the process of photosynthesis. Camellia growth depends, too, upon the water which is taken up from the soil, and upon the absorption of a small number of mineral elements which, although they make up only a small part of the plant, are nevertheless essential to its welfare.

The study of the uptake of minerals by plant roots and the effect of variations in mineral uptake on plant growth is perhaps the most active aspect of plant science. The mineral nutrition of the camellia is something that we know a lot about. The general method of studying the mineral nutrition of the camellia, as of any plant, consists of growing the plant in some inert substratum; for example, sand or gravel, which supplies only mechanical support. The plant is then watered with a nutrient solution.

By growing many plants with many different nutrient solutions, we can determine how well our plant grows in the presence or absence of each, and can determine what constitutes an optimum nutrient mixture for the camellia.

We have done experiments of this kind, in which we have systematically varied the levels and ratios of all the principal mineral nutrients—nitrogen, phosphorus, sulfur, potassium, calcium and magnesium—and have grown camellia plants with these varied solutions over a period of two years. It has been shown that the camellia grows well and is tolerant to a wide range of concentrations of these elements.

Nitrogen, which is the mineral nutrient used in greatest amount by all plants, is most critical. The camellia needs to have continuously available to its roots some ten parts per million of nitrogen in the soil solution. Nitrogen concentrations of ten times this level are, however, quite acceptable to our plant.

Nitrogen deficiency is fortunately easy to detect, since characteristic yellowing of the lower leaves and restricted growth of the plant result from a deficiency of this element. In our experiments, too, it was shown that for supporting the growth of the camellia, nitrate nitrogen, the usual form found in soil, is as good as or better than ammonium nitrogen or urea nitrogen. It was shown, too, that conditions which favor optimal vegetative growth, which favor rapid growth of stems and leaves, are also the conditions which favor abundant bud set and abundant flower production.

The results of these experiments are, then, reassuring to us in that they suggest that we need not worry very much about feeding our camellia plants with any critically balanced nutrient diet. Provided only that we supply enough minerals to the soil in which our camellias are growing, they will not suffer nutritionally.

Soil acidity

Perhaps the most important cultural factors influencing camellia growth and those which have been least understood in the past are the twin matters of soil acidity and soil salinity.

Soil acidity refers to the hydrogen ion concentration in a soil—to its pH. When hydrogen ions are present in low concentration in a soil, it is said to be alkaline.

Most of our ordinary crop plants are not too demanding as to the exact hydrogen ion concentration of the soil in which they grow, and will grow well with hydrogen ion concentrations over a range of at least a hundred thousand fold. Particular plants, as the pines and others, do, however, prefer an acid soil and it has been widely held that the same is true of the camellia. We have grown camellias in soils of a wide range of hydrogen ion concentrations and have found that they grow well even in soils which we would ordinarily consider alkaline.

The camellia is not truly an acid-loving plant. What is true however, is that the camellia grows well under damp, well-drained conditions. Soils which are damp and well-drained are ordinarily acid. So the camellia likes damp, well-drained places, but not on account of their acidity. The camellia likes damp, well-drained places because it is very sensitive to what is called salinity.

Soil salinity

The concept of salinity has to do with the saltiness of the soil solution. When a soil contains a high concentration of soluble mineral salt, it is said to be saline. A saline soil may be either acid or alkaline. It so happens that saline soils are most frequently also alkaline. This is because a part of the salt which is ordinarily supplied to soil in irrigation water is commonly in the form of calcium or sodium carbonates which react with acid in the soil and neutralize it. But alkalinity in itself does no harm; it is the salt which does the harm to plant growth.

We were fortunate in being able to enlist the assistance of Harold Pearson of the Metropolitan Water District in studying the response of camellia plants to varied conditions of soil salinity. He grew plants at different levels of added salt and with different kinds of salt.

It was shown that camellia plants grown in the presence of 2700 parts per million of salt suffer from a tip burn of the leaves, a typical salt damage symptom. Plants grown in solutions containing 4300 parts per million of salt produced no growth at all. It was concluded that probably not over 1500 parts per million of salt should be present in the nutrient or soil solution if all salt damage to the camellia is to be avoided.

Now, our irrigation water in southern California contains some 800 parts per million of solids, of which about 600 parts per million contribute to soil salinity. If we water a plant with such water, then, of course, we supply the plant with salt as well as with water. The water is taken up by the plant and evaporated through the leaves, especially during the day. The salts do not evaporate and are left behind in the soil and in the plant.

Suppose that our plant evaporates two-thirds of the water which we have supplied, so that one-third of the original water is left behind. The salts carried in with the original water are now concentrated three times as compared with the original water. If the original water had been Metropolitan Water District water, the concentration of salts in the soil solution in our hypothetical experiment would now be 1800 parts per million. This would be a salt solution high enough in concentration to yield some restriction of growth in the camellia and almost high enough to cause real damage to the plant.

In order to avoid concentration of salts in the soil solution, we must always supply enough water to the camellias, or any other plant, to leach these salts down out of the root zone. This is easily achieved with plants in tubs or pots, where we can always supply enough water to cause visible leaching of water through the container. With plants growing in soil and not in tubs, we must irrigate heavily enough so that the salts accumulated from the previous irrigation are rinsed or leached down below the root zone.

All camellia growers know that, by and large, camellias do better in the shade. This behavior is probably related to the sensitivity of the camellia to the accumulation of salt. When a plant is in the sun, it evaporates more water than it does if it is in the shade. Light does more to increase rate of water loss from a plant than any other single factor except, perhaps, the temperature. The more light, the more water loss; the more water loss, the more rapid the depletion of the water after irrigation and the more concentration of salt in the soil solution.

The more light the camellia receives, the more difficult it will be to be sure that the salinity of the soil solution is kept at all times below the level which causes damage to the plant. The conclusion is, then, that the camellia is sensitive to high salt concentrations.

It is not so particular about the hydrogen ion concentration—the acidity of the soil solution. We should distinguish between these two difficulties. We cannot cure soil salinity by making the soil more acid through the application of sulfur or other acidifying agents; we can only cure the condition of soil salinity by leaching. And for myself, I would favor abolition of the term soil alkalinity. It is a term which confuses the concept of soil salinity with the secondary fact that saline soils are often alkaline.

Climatic control

Now let us turn to the production of flower buds and flowers. In Caltech's phytotron we can grow plants under conditions which simulate different climatic conditions. We can, for example, grow plants under conditions of temperature and humidity which simulate summer in Pasadena, and simultaneously under other conditions which simulate winter in Pasadena.

We have applied this facility to the study of the flowering of the camellia. It has turned out that the flowering of our plant is controlled by two principal climatic factors; namely, the night temperature and the relative length of day and night. Many plants are controlled in their flowering by relative length of day and night and this matter has been much studied.

With the camellia, as with other species, it is in fact the absolute length of the night period which controls the flowering response. Only when the night is shorter than a certain critical length does the production of flower buds take place. Superimposed upon this response to length of night is an effect of temperature. It has been shown that camellia plants of several varieties studied produce flower buds only if the days are longer than about 15 hours and the nights correspondingly shorter than about nine hours. And in addition, the nights must be warmer than about 65° for abundant flower bud formation to occur.

If we maintain a plant under these summer conditions of relatively warm, short nights, flower buds are formed but they do not open into flowers; they fall off. In order to get our flower buds to open and produce flowers, we must supplant the short warm nights with a regime of long cold nights. The optimum opening of flower buds and production of flowers has been shown to take place when the nights are 60° or colder, and longer than about nine hours.

Summer camellias

If, for example, we want to produce camellia flowers in the middle of our Pasadena summer, then what we will do is to take a camellia plant, say on January 1, and put it in a greenhouse with warm nights and with artificial illumination at night to persuade the plant that the days are long and the nights short. After two months of such treatment flower buds will have been formed and we can then move the plant to conditions of colder nights. We should also mask the plants with dark cloths from say 6 p.m. to 8 a.m. to maintain a day length of ten hours. Under these conditions our plant will open normal flowers sometime between May 1 and June 1.

The temperature relations of flower opening in the camellia as determined in the laboratory have an interesting connection with the normal time of flowering for our different varieties. Our night temperatures during the winter in Pasadena and in southern California generally are sufficiently low to greatly slow down the rate of flower opening. We have found by collection of temperature data from a series of growers in different spots in southern California that the earliness of flowering of each camellia is correlated with the temperature of the locality. The warmer the minimum night temperature, the earlier the flowering of each variety. If, for example, our climate should warm up and the winter nights become warmer, we would observe a correspondingly earlier date of flowering for each of our varieties.

We have reviewed some of the factors which are most important in controlling the vegetative growth of the camellia and in determining flowering behavior. We should not get the impression, however, that all of the science of the camellia is already known. As with the study of any plant or any living thing, a great deal remains to be discovered about the camellia.