Soluble Salt Injury to Gardenia

often traced to excessive use of chemical fertilizers or to salts in the water supply

Stephen Wilhelm and H. T. Pyfrom

Gardenia flower production in greenhouses in the San Francisco Bay area has been seriously affected by a diseased condition brought on by the accumulation of excessive amounts of soluble salts in the soil in the growing benches.

The course of this disease may be quite variable depending upon the concentration of salts and the cultural practices—especially watering practices—employed.

Plants growing with a moderately high concentration of salts in the root zone slowly decline in vigor or may stop growing entirely. They may appear as plants kept too dry or as starved for some nutrient. After long exposure to a high salt concentration, the gardenia plant shows extensive root and crown disintegration accompanied by varying degrees of defoliation and dropping of flower buds.

The outer crown tissues of salt injured gardenia plants are dark brown and punky. Under some conditions considerable cork tissue may be formed at the margins and beneath the salt corroded tissues. However, these are not the extensive corky overgrowths that commonly occur around lesions caused by the Phomopsis canker fungus. Another characteristic which distinguishes salt injury from Phomopsis canker is the absence of yellow coloration in the wood and absence of Phomopsis fruiting bodies—pycnidia.

The larger roots may show injury similar to that at the crown, either in isolated regions or along their entire length. Small roots instead of being white are dark and corroded. Complete failure of the root system results in a collapse of the plant. Under some conditions the collapse may occur so suddenly that the leaves may dry before losing their green color. With a slower decline the lower leaves turn yellow and fall. Environmental factors in the greenhouse such as temperature, light, and humidity influence the rapidity with which plants may collapse.

The root and crown disintegration simulates the type of injury certain of the water-mold fungi are known to cause. Repeated attempts to isolate these fungi from injured gardenia roots and crowns have failed. Isolations have consistently yielded a Fusarium, various species of bacteria, and occasionally a Ceratostomella. It is possible that some of these organisms may have a secondary role, invading salt corroded tissues, and thereby aggravating the root damage. Alone, these organisms have not produced the disease within five months after inoculation of healthy plants.

The approximate soluble salt content of gardenia soils was determined by measuring the electrical conductance of a water extract—usually a 1:2 dilution by weight of air dry soil in distilled water.

In houses where gardenias were failing, the conductance readings varied considerably, even in different parts of the same bench. This is evidence of uneven drainage. Immediately adjacent to injured roots, the conductance was always high, readings ranging between 250 and 500. A few determinations were higher. Soils where no root damage was evident ranged below 150.

Because of its great vegetative vigor, the gardenia plant displays exceptional powers of recovery under saline conditions. Cork cambium activity walls off injured tissue when a high salt concentration occurs only intermittently; and with leaching, a new root system may be produced to replace an almost completely destroyed old one. Badly damaged plants have been salvaged by changing their root environment by leaching and subsequent irrigation with water low in salt content.

Crown portions of plants with severely corroded root systems, when washed and placed in humidity chambers, commonly produce healthy new rootlets and even force long latent vegetative buds to develop. This vegetative vigor makes it difficult to recognize the initial stages of salt injury and plants damaged enough to reduce their yield may not be detected until root failure or girdling produces wilting.

Excessive accumulations of soluble salts in greenhouse soils can usually be

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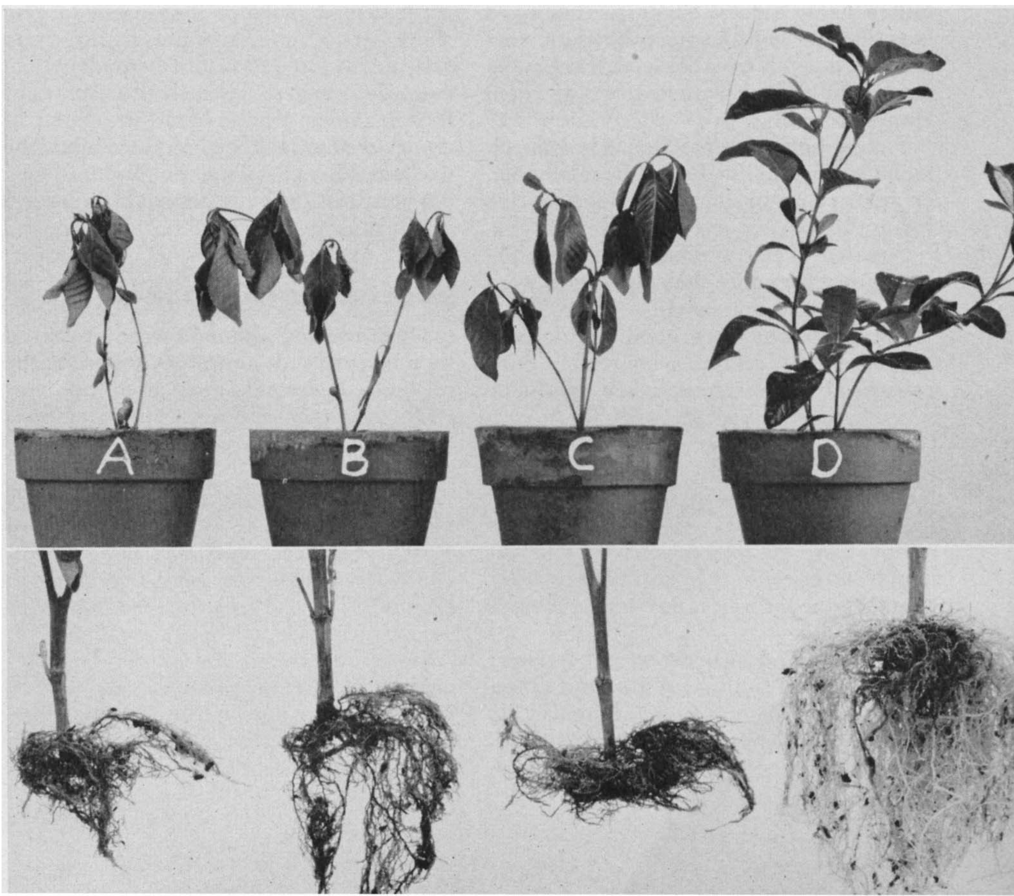

Root disintegration and plant collapse brought on by excess accumulation of soluble salts in greenhouse soils. Four similar gardenia plants with some initial root damage were transplanted into the same commercial gardenia soil. The soil of the plant indicated by D was leached. Its conductance was 137. Note the white, healthy root system completely outgrowing the initial dark corroded root system. Plants A, B, and C have collapsed. They show extensive salt injury to the roots. Soils of the four pots gave conductance readings, beginning at A, of 322, 318, 222, and 137 for the healthy plant.

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traced either to excessive use of chemical fertilizers or to salts in the water supply. In much of central and southern California the use of water containing considerable amounts of soluble salts may be unavoidable. The increased use of underground water during the recent years of below normal rainfall has caused a rise in the salt content of the water of many wells. For example, conductance readings of between 60 and 150 are common for well waters in San Mateo County.

Even though one must use saline water, growing practices can be employed which in most cases will alleviate the danger of salt injury. Benches must be provided with adequate drainage. A layer of porous material should be placed on the bottom of raised benches. Straw is hardly adequate. Ground benches may need additional tile drainage. Plants should be grown in not more than five to six inches of light, porous soil. Clay loams should be avoided. Watering should always be in excess of the plants' needs. An excess of water provides the necessary leaching to remove salts which otherwise would accumulate. Chemical fertilizers should be applied sparingly and frequently.

Growers will find it worth while to determine periodically the salt content of their soil solutions and leachings. On the basis of work done already it appears that a conductance of around 150 to 200 is the upper limit of safety for the gardenia. Growers who have lowered the conductance of their bench soils to less than 100 have completely eliminated the trouble of salt injury to gardenias. It should be remembered that after the plant shows symptoms much of the damage is already done.

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ALMONDS

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plementary feed for cattle and sheep. It was found that the moisture content of the hulls ranged from 5.88% to 10.80%, averaging 7.54%. Total sugar content ranged from 18.3% to 30.56%, with an average of 25.61%.

From 41% to 45% of the weight of the finely ground hulls was soluble in cold water. Thus half the weight of the dry hulls—a high rate—was water soluble. About half was sugars and half carbohydrates, tannin and ash constituents. Crude fiber—roughage—averaged 12.6%. The hemicellulose content—about 10%, is probably digestible for sheep and cattle.

The hulls contained some tannin, but apparently not enough for production of tannin for leather making. The vitamin C content of a mixed sample was 43 milligrams per 100 grams—nearly as much as in fresh orange juice, and vitamin B_2 content was about 2 milligrams per 100 grams. The ash content was 70% water soluble.

Though the dry hulls keep well and are eaten by sheep and cattle, almond hulls have been converted experimentally into ensilage by filling a 50-gallon barrel with the hulls, heading up the barrel, filling it with hot water, and allowing it to stand for several weeks.

As a fertilizer, almond hull ash is a good source of potassium—which California soils usually do not lack—but is a poor source of phosphorus, a useful fertilizing element for most soils.

Alcohol was made from a mixed lot of the ground hulls by adding water and yeast, fermenting, distilling and redistilling the alcohol. The yield was 39 gallons of pure alcohol—200 proof—per ton of hulls. This, at 30¢ a gallon, would be worth $11.70 at wholesale, but manufacturing costs would be worth at least 15¢ per gallon. The yield would be about $5.85 worth of alcohol in a ton of dry hulls, leaving only $5.85 a ton for hauling and other expenses. The hulls are worth much more than $5.85 for stock feed.

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For a report on the use of almond hulls as a feed for dairy cattle and lambs, see "Almond Hulls," by Robert F. Miller, June, 1949, CALIFORNIA AGRICULTURE.

NEW PUBLICATIONS

—now ready for distribution—

Each month, new publications of the College of Agriculture are listed in this column as they are received from the press.

Single copies of these publications or a catalogue of Agricultural Publications may be obtained without charge from the local office of the Farm Advisor or by addressing a request to: Publications Office, 22 Giannini Hall, University of California, College of Agriculture, Berkeley 4, California.

SELECTIVE WEED KILLERS, by Alden S. Crafts and W. A. Harvey. Ext. Cir. 157, Sept., 1949.

This circular discusses the most important of the compounds, including dinitro selectives; selective oils; 2,4-D; 2,4,5-T; pentachlorophenol and its salts; I.P.C.; T.C.A.; phenyl mercuric acetate; potassium cyanate; and others. A table giving average dosage rates is also included.

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Gifts to the University of California for research by the College of Agriculture accepted in October, 1949

BERKELEY

American Cancer Society	$500.00	Division of Plant Nutrition
DuPont Semesan Laboratory	1 25-lb. drum of Arasan, fungicide	Division of Plant Pathology
Merck & Company, Inc.	50 micrograms crystalline vitamin B_{12}	Division of Poultry Husbandry
San Diego Coöperative Poultry Association	22 lbs. special yeast cultures	Division of Poultry Husbandry
E. R. Squibb & Sons	1 gm. Prolactin No. 71713	Division of Poultry Husbandry

DAVIS

Atlas Powder Company	12 samples of Spans and Tweens	Division of Agronomy
American Cyanamid Company	1 gn. Polvite Powder	Division of Agronomy
Carbide & Carbon Chemicals Corp.	1 lb. Tergitol wetting agent 7	Division of Agronomy
Dow Corning Corporation	Sample of DC Antifoam, and samples of DC 1107 Fluid	Division of Agronomy
Ingram Research Institute, Inc.	Sample of Hesperidin Chalcone, Sodium	Division of Agronomy
Merck & Company, Inc.	50 micrograms crystalline vitamin B_{12}	Division of Poultry Husbandry
Merck & Company, Inc.	1 gm. 4-Amino-5, and 1 gm. 4-Methyl-5	Division of Agronomy
Montana Vegetable Oil & Feed Co.	100 lbs. mustard seed meal and 100 lbs. rape seed meal	Division of Poultry Husbandry
Rohm and Haas Co.	5 lots of assorted amberlite, Resine, 4 oz. Hyamine 1,622, and 4 oz. Pectinal 10-M	Division of Agronomy

LOS ANGELES

California Peat Humus	150 lbs. peat	Division of Ornamental Horticulture
James G. Maxwell Co.	2 gallons liquefied tuna viscera	Division of Ornamental Horticulture