

frilly, and the midribs protrude slightly more than Great Lakes 118. Because stem elongation is more rapid in Calmar, it may not attain good head solidity in the coastal districts (where it is best adapted) in the early fall harvesting season. The fold and texture of the head leaves are similar to Great Lakes 118 and other popular varieties of this type. Calmar has white seed.

Tipburn resistance

Calmar is more resistant to tipburn than Great Lakes 118 and has a level of resistance similar to Great Lakes R200. It is highly resistant to downy mildew and possesses some tolerance to big vein. Downy mildew-infected wrapper leaves retained at harvest may be invaded during transit to distant markets by rot-producing organisms which result in some quality loss. But since Calmar is resistant to downy mildew, it is not subject to damage from secondary decay-producing organisms that invade tissues through downy mildew lesions.

Calmar has the following parentage: Great Lakes A-36 × F₅ (Great Lakes 6238 × USDA 45325-3-1-M). The Great Lakes 6238 × USDA 45325-3-1-M cross was made in 1950, and the cross involving Great Lakes A-36 and an F₅ generation plant of the above cross was made in 1955. The third generation (59-572-M IV) following the last cross was introduced as Calmar. The first two generations involved single selfed plants, and the last generation was a mass increase. USDA 45325 has a long, complex pedigree that started in 1932 with a cross between USDA Plant Introduction 104854, a wild-type lettuce (*Lactuca serriola* L.) collected in Russia, and a hybrid line involving Imperial D. PI 104854 which was the source of the downy mildew resistance in USDA 45325, and in Calmar. This same plant introduction probably also provided the downy mildew resistance in Imperial 410, a variety released in 1945 by the Arizona Agricultural Experiment Station and the U. S. Department of Agriculture, and did contribute the downy mildew resistance in Valverde, a variety introduced in 1959 by the Texas Agricultural Experiment Station and the U. S. Department of Agriculture. Downy mildew resistance in PI 104854 and in Calmar is conferred by a single dominant gene.

Frequent experimental tests on the PI 104854 source of downy mildew resistance in Calmar show that this resistance continues to be effective in California. Some commercial seed stocks of Calmar

have contained small amounts of seed of downy mildew-susceptible varieties, and consequently produce some infected plants. No evidence has been found to date for the presence in California of a new biological race of the downy mildew fungus that attacks Calmar.

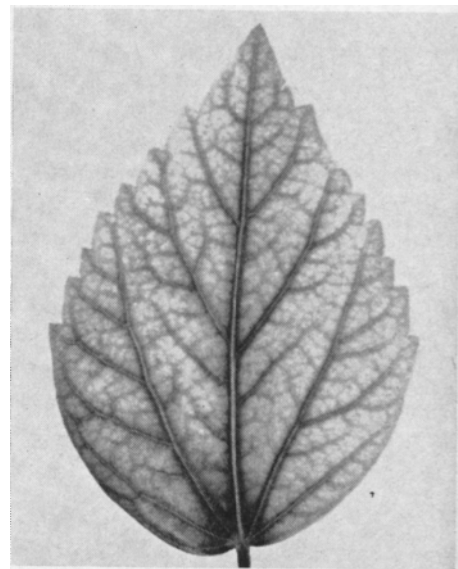
The breeders' seed of Calmar released to commercial lettuce seed-growing firms in 1960 contained 2.4% seed-borne lettuce mosaic virus. This percentage is in the infection range commonly found in ordinary lettuce seed lots. Most lettuce seed planted in California contains very low percentages of seed-borne mosaic infection, and in some districts county ordinances prohibit the planting of lettuce seed that contains more than 1/10 of 1% of seed-borne lettuce mosaic virus. Growers in the Salinas-Watsonville district now plant only seed lots in which a greenhouse-grown, seedling-plant sample showed no seed-borne mosaic in 30,000 seedlings.

The production of lettuce seed possessing no, or extremely low, percentages of seed-borne mosaic, requires special seed-growing techniques. More seed-growing seasons are usually required to rid stock seed of mosaic and obtain mosaic-controlled seed in volume, than merely to increase stock seed without concern for the mosaic content. The 1964 season was the first year that Calmar seed indexed as containing no seed-borne mosaic in 30,000-seedling samples was available in quantities large enough to plant significant acreages. About 10,000 acres of Calmar were estimated to have been planted for harvest in 1964 in the Salinas-Watsonville district, and a larger acreage is predicted for the 1965 season. Calmar seed may now be obtained from all major vegetable seed companies that supply lettuce seed to California growers.

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Financial assistance for lettuce breeding research has been obtained annually from the Grower-Shipper Vegetable Association of Central California, Salinas, and many lettuce growers in the State furnished land for field experiments and assumed other expenses in this program.

IRON



Iron deficiency results in chlorophyll deficiency. Leaves of trifoliate orange are characteristically yellow when insufficient chlorophyll is synthesized.

Iron-deficient avocado leaves.



and chlorophyll synthesis

D. VAN NOORT • A. WALLACE

Iron deficiency in plants, characterized by yellowing of the leaves, indicates that chlorophyll, the green coloring matter, is not being produced. While iron is not a constituent of chlorophyll, studies with algae indicate that iron functions in the synthesis of a specific kind of ribonucleic acid, which in turn regulates chlorophyll synthesis through a chain of reactions which as yet are largely unknown.

IRON DEFICIENCY probably follows nitrogen and zinc deficiencies in order of importance of mineral nutrient problems—at least with fruit trees in California and other Western states. Since iron deficiency is the most difficult of all micronutrient deficiencies to correct in plants, exact information on how iron regulates chlorophyll synthesis is urgently needed.

Iron deficiency in plants is readily recognized by the characteristic yellow leaves that result when they are not producing green chlorophyll. Iron is not a constituent of chlorophyll, however, and why a deficiency of iron results in chlorophyll deficiency has long been a mystery.

Iron deficiency in plants is generally called iron chlorosis. It is usually partly or completely induced by factors other than a low iron supply. No matter what factors induce the chlorosis, the biochemical disturbance in leaves seems to be the same. Iron deficiency results in an increase in the level of free amino acids which indicates a disturbance in protein synthesis. Organic acids of the dicarboxylic and tricarboxylic variety are also

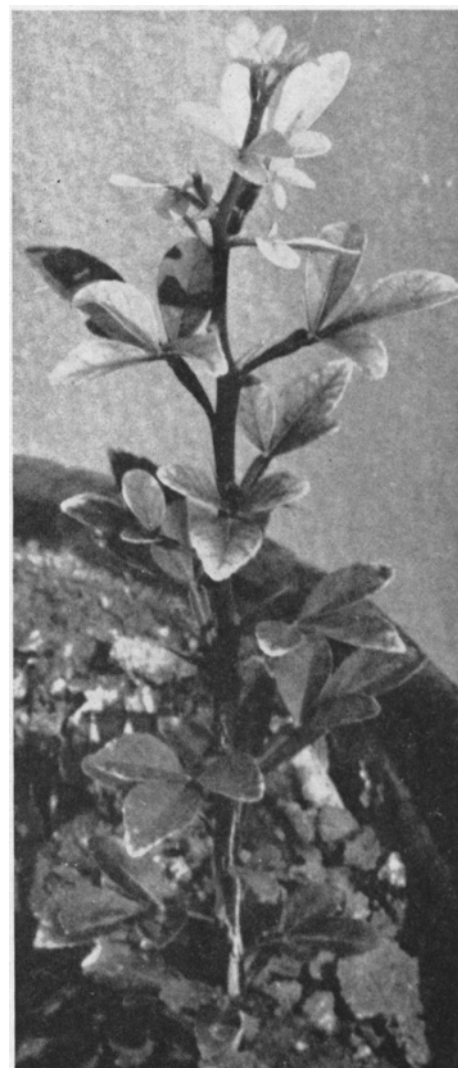
different. Decreased synthesis of protein and ribonucleic acid has been observed. Progress toward understanding the nature of iron chlorosis was made when the site of decreased protein synthesis was identified as the chloroplast. Chlorophyll is also synthesized in the chloroplast.

The algae *Chlorella* was chosen for this study because its behavior can be followed under controlled conditions. The algae were first allowed to grow and divide in the near absence of iron. Iron was then added to subcultures, and the rates of development of ribonucleic acid, protein, and chlorophyll were followed.

New ribonucleic acid was synthesized almost immediately upon the addition of iron. Protein and chlorophyll synthesis also resulted, but the development of these substances definitely lagged behind that of the ribonucleic acid.

Evidence was obtained that the ribonucleic acid that was synthesized upon the addition of iron was not the same as that already present in the cells, since when the ribonucleic acid was hydrolyzed to yield its constituent bases, different ratios of the bases were obtained. This was further confirmed when radioactive phosphorus was incorporated into the new ribonucleic acid, and base ratios were determined.

These results lead to a hypothesis that iron deficiency results in a reduction in one of the types of ribonucleic acid. Recent findings indicate that each of the types of ribonucleic acid has a special function in protein synthesis. Iron deficiency, therefore, results in failure of synthesis of a ribonucleic acid, which regulates synthesis of a protein (enzyme)—which, in turn, functions in



Iron-deficient hibiscus leaves.

chlorophyll synthesis. Further work may indicate that this hypothesis is too simple. It can, however, be used for additional investigations.

The antimetabolite, fluorouracil, was used with radioactive tracers to further investigate the effect of iron on synthesis of ribonucleic acid. This chemical blocks the synthesis of ribonucleic acid. The addition of the fluorouracil to iron-deficient *Chlorella* and to iron-deficient bush beans resulted in blockage of chlorophyll synthesis. The inhibition was reversed by the pyrimidine base, uracil. These results add strength to the hypothesis that iron regulates the synthesis of a ribonucleic acid that is involved in a sequence of reactions resulting in chlorophyll synthesis.

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