THE group of vegetables including lettuce, celery, endive, chicory, cress, parsley, and cornsalad, of which the leaves or stems, or both, are eaten raw, are classed as the salad crops. The production and consumption of these crops, especially lettuce and celery, has increased enormously since their importance as sources of vitamins has become more generally recognized.

The crops of this group are comparatively exacting in their cultural requirements; hence commercial production is limited to areas that, on account of certain environmental conditions, are especially suitable for them. Only the two most important salad crops, lettuce and celery, are grown in large quantity for market.

Most of the cultivated varieties of the salad plants have arisen by selection of individual plants by market and home gardeners. In many cases the parentage and origin are unknown. Only within recent years has an effort been made to improve these crops by scientific methods from stock of known worth.

The salad plants other than lettuce and celery will not be dealt with in the present discussion, as very little work of a scientific nature has been done with the minor crops of this group. The dearth of material on the genetics of the salad plants is no doubt in a large measure due to the difficulties involved in making controlled crosses in many of these species. These plants all produce small flowers that are difficult to handle in securing controlled crosses for genetic studies. Three of them, lettuce, chicory, and endive, are composites, the flowers of which it is difficult, if not impossible, to emasculate, and this makes controlled crossing for genetic studies especially difficult.

The drawings in figure 1 show the structure of a lettuce flower, which is typical of the small-flowered composites. Since the anthers dehisce, or shed pollen, before the stigma appears beyond the sheath, it is necessary to remove the pollen from the stigmas and styles in order to obtain hybrid seed from cross-pollination.

The method of removing the pollen by means of a fine stream of water, first described by Oliver (4), is generally employed. By careful washing with water when the individual florets have reached the stage of development shown in figure 1, D, it is possible to remove the pollen from the stigmas of most of the florets within the head. By applying the desired pollen to heads depollinated with water, a high percentage of hybrid seed may be obtained from the 15 to 20 ovules within a flower head. A knowledge of the inheritance of a number of

1 Italic numbers in parentheses refer to Literature Cited, p. 339.
characters that could be identified in the first generation would greatly simplify germ-plasm studies in this group of plants. Many problems in disease resistance and environmental adaptation in the salad crops are awaiting solution by geneticists and plant breeders, and there is need for extended research in this field. Although limited in extent as compared with that on some other crop plants, noteworthy work in practical plant breeding has been done in the salad group.

LETTUCE

Lettuce is the most important salad plant and one of the most important of the vegetable crops. The present commercial crop has an annual value of about $28,000,000. Lettuce is in demand at all seasons of the year and is probably grown under more varied conditions in greenhouses and in field culture than any other vegetable.

Cultivated lettuce is known to botanists as Lactuca sativa L. This species has never been found in the wild state but is generally supposed to have been derived from the wild species L. scariola L., which is now widely disseminated and is a troublesome weed in many parts of the United States. Lettuce is native to India or central Asia. The time of its introduction into Europe is not known. It is one of the oldest of the vegetable crops. The records of Herodotus, Pliny, Hippocrates, and Aristotle indicate that it was grown as a garden plant in ancient times. It was reported in China as early as the fifth century A. D. Mention of it was made by Chaucer in England in 1340. It was introduced into America from Europe soon after the first colonies were established. Sixteen varieties were listed as being grown in American gardens in 1806.
Lettuce Types and Their Adaptation

Most horticulturists and seedsmen recognize four classes or types of lettuce, namely, crisp-head, distinguished by very firm heads of crisp texture; butter-head, distinguished by soft heads, the inner leaves of which feel oily to the touch; cos, distinguished by elongated heads, stiff leaves, and upright habit of growth; and loose-leaf or bunching, distinguished by loose, nonhead-forming leaves.

The crisp-head and butter-head types, which form round or flattened heads, are often spoken of collectively as "cabbage lettuces" to distinguish them from the "cos lettuces", which form elongated heads. Many good authorities consider that the cabbage and cos lettuces have been derived from two distinct botanical types. However, study of hybrid material from crosses between these two types indicates that they have a common origin.

Since lettuce is comparatively exacting in its environmental requirements during certain periods of its development, large-scale commercial production is limited to areas where climatic conditions are favorable during the critical growth periods. These are regions in which the mean temperatures are comparatively low during the heading period.

The commercial producing area of the United States can be roughly divided into three regions: (1) The western, including the Pacific Coast and Rocky Mountain States of California, Arizona, Colorado, Washington, Oregon, and Idaho; (2) the northeastern, including Massachusetts, New York, and New Jersey; and (3) the South Atlantic, which includes North Carolina, South Carolina, and Florida. On the basis of production the regions rank in the order named. The Western States produce approximately 85 percent of the entire crop.

The Western States grow largely the crisp-head type of lettuce, which sells on the eastern markets as "Western Iceberg." This term is confusing, as it does not refer to the Iceberg variety but applies to the numerous strains of crisp-head lettuce shipped to the markets from the West.

One of the notable examples of practical plant breeding was the development of the Imperial strains of lettuce by the United States Department of Agriculture. Some years ago the lettuce industry in parts of the West, the Imperial Valley in particular, was threatened with ruin by the ravages of two diseases, brown blight and powdery mildew. The Imperial strains have remade the industry in these sections. They are resistant to both blight and mildew, and in certain lettuce-growing areas they now constitute 90 percent of the crop. In addition to their resistance to disease, each strain shows special adaptation to definite regional and climatic conditions.
Formerly the western crop consisted almost entirely of strains of the variety New York or Wonderful. Much of the acreage formerly planted to this variety is now devoted to the disease-resistant Imperial strains.

Until recently the eastern lettuce crop consisted almost entirely of the butter-head varieties Big Boston and White Boston, also known as Unrivaled. In New York, New Jersey, and the Carolinas the butter-head varieties are being rapidly replaced by strains of crisp-head New York and the Imperials.

There would no doubt have been a more complete change from butter-head to crisp-head type in the East except for the fact that the California strains of crisp-head lettuce have not proved to be adapted to most parts of the East.

This shift from butter-head varieties such as Big Boston to the harder head type of lettuce has resulted from consumer demand. The consuming public has come to prefer the crisp-textured lettuce, and jobbers and dealers find that it stands handling and shipment better than the more delicate butter-head varieties. It has become difficult for eastern growers to find a market for the Big Boston type when the market can be supplied with the crisp New York or Wonderful type.

Cos or romaine lettuce has never been popular in America, although it has long been prized by European gardeners and is grown in home gardens in this country to some extent. There is a limited market for this type of lettuce among the foreign population of the larger cities. Although cos lettuce is coarse in texture, the best varieties are of high edible quality, lacking the bitterness so often present in other types, especially in some of the crisp-head varieties.

The production of loose-leaf or bunching lettuce is largely confined to the home garden and to greenhouse culture during the winter months, when there is considerable demand for this type of lettuce in some localities.

Greenhouse production of lettuce, which at one time constituted an industry of considerable importance, has declined rapidly as field production in the South and West has expanded. Fresh field-grown lettuce can now be obtained at all seasons of the year. A considerable quantity of lettuce is grown under glass during the winter months in the sections around the southern shores of the Great Lakes and near Boston, Mass. The leaf variety Grand Rapids is the most important variety around Cleveland, Ohio. The butter-head variety Belmay is the leading sort in the Boston section.

History of the Important Lettuce Varieties

When Tracy (6) published his descriptions of American varieties of lettuce in 1904, more than 100 distinct varieties were recognized. Since that time numerous new names have been added to the list.

Until the recent introduction of disease-resistant strains, to be discussed later, the commercial lettuce crop in the United States consisted largely of two or three varieties. Most of the lettuce reaching the markets from the West consisted of the crisp-head variety New York or Wonderful. The eastern crop consisted largely of the butter-head varieties Big Boston and White Boston.
Crisp-Head Varieties

New York or Wonderful is a very large, dark-green, solid, late, crisp-head variety. It is the most widely used of all lettuces and has been used as a parent in many of the recently developed strains. The variety was first named and introduced by Peter Henderson & Co. in 1896. Its parentage is unknown.

New York No. 12 is an early strain of a lighter color than the standard variety. It has been one of the most widely adapted crisp-head strains in the East. It was developed by pure-line selection from New York and introduced by the Pieters-Wheeler Seed Co.

New York Special No. 41 is a strain of the New York variety introduced in 1927 by the Ferry-Morse Seed Co., of San Francisco, Calif. It was obtained by pure-line selection from the New York variety. It is especially adapted to conditions in the Imperial Valley.

Imperial F is one of the best of the strains of the New York type resistant to brown blight and mildew. It was developed by Ivan C. Jagger, of the United States Department of Agriculture, from a cross of New York by a cos variety. It was released in 1930. Imperial F is now an important variety in parts of the West where brown blight and powdery mildew are prevalent.

Imperial 615 is a crisp-head lettuce resistant to brown blight, developed by Ivan C. Jagger from a cross between New York and a cos variety. It was first introduced in 1934 and has met with general favor.

Imperial No. 250 was introduced in 1929 by the Ferry-Morse Seed Co. It was obtained by pure-line selection from Jagger's Imperial No. 3. It is a uniform, widely adapted, disease-resistant strain of Imperial.

Hanson is a yellow-green crisp-head variety, a reliable cabbage-heading sort, apparently introduced by the Henry A. Dreer Co., of Philadelphia, Pa., about 1875. Its parentage is unknown.

Mignonette is a dark-green, reddish-brown, crisp-head variety of high quality but too small for a general market lettuce; it is of unknown origin and was first named and introduced in 1895 by Peter Henderson & Co.

The Iceberg variety (which should not be confused with the New York variety, often marketed as Western Iceberg), is a slightly pigmented, yellow-green, crisp-head variety. It is one of the most reliable of the crisp-head types for summer. Iceberg was introduced from Europe and named by W. Atlee Burpee & Co., of Philadelphia, Pa., about 1894.

Malta or Drumhead is one of the largest of all lettuce varieties. It is a coarse, light-green, crisp-head variety forming a loose head, of unknown foreign origin, introduced about 1850.

Denver Market is a very light green crisp-head variety first introduced by F. Barteldes & Co., of Lawrence, Kans., in 1890. Its popularity has been limited to the Middle West.

Butter-Head Varieties

Big Boston is the leading butter-head variety. It is grown in Europe as Trocadadero. It has glossy, entire-margined leaves tinged with reddish brown. Its parentage is unknown, but it was first
named and introduced by Peter Henderson & Co. in 1890. Until recently Big Boston was the leading variety in the East.

The variety White Boston or Unrivaled may be described as Big Boston lacking the tinge of red anthocyanin pigment and having slightly lighter green leaves. It was first introduced in this country in 1902. It is believed to be identical with the variety listed by Vilmorin-Andrieux & Cie., of Paris, France, as Sans Rival.

White Boston Cornell No. 43 is a large dark-green strain of White Boston developed by the New York College of Agriculture. It seems to be well adapted for conditions in New York State.

The variety Salamander or Black-Seeded Tennis Ball is one of the most popular of the butter-head varieties. It is one of the oldest varieties of lettuce grown in this country. Its parentage is unknown, but it was introduced from Europe about 1856.

Deacon, one of the older of the American varieties of lettuce of the butter-head type, is distinguishable by its peculiar light gray-green color and its very spreading habit of growth. The variety was named and introduced by the Joseph Harris Co., of Coldwater, N. Y., in 1879.

Wayahead, a more recent addition to the list of lettuce varieties, is a small, early, bright-green, butter-head variety said to thrive under extremely adverse conditions. It was named and introduced by the W. Atlee Burpee Co., of Philadelphia, Pa., in 1908.

Belmay is the leading greenhouse variety in the Boston area. It is a downy mildew-resistant butter-head variety carrying a tinge of reddish brown. It was developed by the Massachusetts Agricultural Experiment Station from a cross between May King and the old reliable forcing variety, Hittinger Belmont. It was introduced in 1928. The variety is discussed later in this article.

**Loose-Leaf or Bunching Varieties**

Grand Rapids is the most popular of the so-called loose-leaf or nonheading type. It is quite hardy and well adapted for greenhouse culture, but not so well suited for growing out of doors. Grand Rapids was originated and named by Eugene Davis, a market gardener of Grand Rapids, Mich. It resulted from selection from the variety Black-Seeded Simpson. The variety was first introduced into the seed trade in 1890 by D. M. Ferry & Co., of Detroit, Mich.

Early Curled Simpson is a curly, yellow-green, nonheading variety, one of the best of the nonheading sorts for out-of-door culture. It is supposed to have originated about 1865 with a market gardener named Simpson, near Brooklyn, N. Y.

Black-Seeded Simpson is a nonheading variety similar to Early Curled Simpson, but larger and lighter green. Peter Henderson & Co. are said to have introduced the variety about 1880.

Prize Head is probably the best of the loose-leaf or nonheading varieties as regards quality, but is not liked by many on account of its reddish color, which develops especially during cool weather. Its origin is unknown, but apparently it was named and introduced by D. M. Ferry & Co., of Detroit, Mich., about 1868.
Cos or Romaine Varieties

Paris White Cos is the most popular of the cos or romaine type. As a salad lettuce for the home garden it has no superior. It is among the older varieties grown in this country, having been introduced from Europe about 75 years ago, and is considered to be a good variety for warm weather.

Dark Green Cos is similar to Paris White except that the leaves are a darker green. Its parentage and origin are unknown.

Lettuce Breeding

The different producing regions have had their specific problems for the plant breeder. The lettuce industry in some parts of the West, the Imperial Valley of California in particular, was at one time threatened with ruin by the ravages of two diseases, brown blight and powdery mildew. A notable example of practical plant breeding is the development of the mildew and brown blight resistant Imperial strains of lettuce by Ivan C. Jagger, of the United States Department of Agriculture, cooperating with the California growers and shippers. These strains have remade the industry in some sections of the West. They are of the general type of the popular and widely grown variety New York or Wonderful, and in addition to their resistance to disease, each shows special adaptation to certain regional and climatic conditions in the West. The breeding work was started in 1923 at Chula Vista, Calif. A lettuce-breeding plot in the Imperial Valley is illustrated in figure 2.

The strains resistant to both mildew and brown blight were given a letter in addition to the name Imperial. Jagger's other strains have been identified by numbers. The first brown blight-resistant strains released were obtained by selection from the variety New York.
The mildew-resistant strains were obtained by selection from material resulting from crosses between the New York variety and European varieties found by severe tests to be resistant to mildew. In some of the most important lettuce-growing sections of California, these strains now constitute 90 percent of the crop.

Imperial F has already been described. Imperial 13, introduced in 1932, was selected from hybrid material from a cross of New York with the French variety White Chavigne. Imperial 152 and Imperial 615, introduced in 1934, and Imperial 847, released in 1936, were all derived from a cross between New York and a cos variety.

One of the serious problems of eastern lettuce growers is the lack of crisp-head varieties of the New York or Wonderful type that will thrive under eastern soil and climatic conditions. The lack of varieties adapted for the East is explained by the fact that California not only grows more of the commercial lettuce crop than any other State but produces almost the entire seed supply for the United States. This concentration of the production of lettuce seed in California has resulted in the building up, through a long period of selection, of seed stocks especially adapted to western conditions but not to other sections of the country. Western crisp-head varieties almost always fail when tested in the East.

Breeding investigations for the purpose of developing strains of head lettuce of the New York type adapted for eastern conditions was begun by the writer in 1928. The work was begun at the Arlington Experiment Farm, Arlington, Va., and was moved to the United States Horticultural Station at the National Agricultural Research Center, Beltsville, Md., in the spring of 1935. The first strain resulting from this project was released under the name of Columbia No. 1 in the spring of 1936. A similar but earlier strain was introduced in the fall of 1936 as Columbia No. 2. These two varieties were selected from material obtained from a cross made in 1928 between the varieties New York and Hanson. Their chief merit is their adaptability to soil and climatic conditions in some parts of the East.

A third strain introduced in the fall of 1936 as Cosberg is a distinctly new type of head lettuce resulting from a cross of the varieties Iceberg and Paris White Cos. Trial tests of Cosberg show it to be capable of producing solid heads comparatively free of tipburn under conditions that result in severe tipburn in most varieties that will head at a high temperature.

As the breeding work at the Arlington Experiment Farm and the United States Horticultural Station has progressed it has become increasingly evident that the wide range of soils and climate existing in the producing centers of the East will require the development of strains especially adapted to local conditions. For example, it is evident that strains adapted for the muck soils of northern New York State are not likely to prove suitable for the soil and climate of the Carolinas, and that strains adapted for the lettuce section of Florida are not likely to meet the needs of growers in Massachusetts.

Within the last 2 years the Division of Fruit and Vegetable Crops and Diseases, in cooperation with the State experiment stations in New York, Massachusetts, New Jersey, and North Carolina, has undertaken the development of lettuce strains of the crisp-head type.
adapted for the particular conditions prevailing in these different sections. The plan is to make available to the State experiment stations the breeding stocks developed at the United States Horticultural Station. In this way it is believed that the large amount of hybrid material now on hand can be used more effectively in securing strains to meet the needs of the several lettuce-growing centers in the East.

Plant breeders are becoming more conscious of the importance of local adaptation of varieties in their crop-improvement work. The needs of widely separated production centers cannot be met by one or two strains of a variety. No one strain is so cosmopolitan that it can adjust itself to such extremes of soil and climate.

Growers of greenhouse lettuce also have problems that have required the attention of the breeder. One of these is the loss from tip-burn. This is a physiological break-down of the tissues at the margins of the actively growing leaves. The first appearance of the trouble is characterized by a breaking down of the marginal tissue between the larger veins. The affected area becomes somewhat transparent, loses its green color, and finally becomes brown or blackish. The disease is widespread, occurring wherever lettuce is grown, both under greenhouse and field culture, but it is usually most destructive in greenhouses. It is most likely to appear if high temperature prevails when the plant is in an active stage of growth and especially at the time the plant nears maturity. Much loss is caused by infection of the tip-burned tissues by fungus diseases.

The Ohio Agricultural Experiment Station has contributed to the solution of this problem by the development of a strain of Grand Rapids lettuce resistant to tipburn. This is a dark-green, rapidly growing strain, selected from the standard leaf variety, Grand Rapids, and adapted for greenhouse culture.

One of the aims of the breeding work being carried on at the United States Horticultural Station by the Division of Fruit and Vegetable Crops and Diseases is the development of tipburn-resistant strains for field production. The Cosberg variety already released is a step toward the solution of this problem.

Mildew is also a serious problem in the production of lettuce under glass. It has been met by the downy mildew-resistant strain of Grand Rapids developed by Ivan C. Jagger in California, and by the powdery mildew-resistant variety Belmay developed by the Massachusetts Agricultural Experiment Station at Waltham, Mass.

The Jagger strain of Grand Rapids, developed from a cross between Grand Rapids and a cos variety, is a heavier, stalkier strain than the standard variety. It was released in 1936 as Grand Rapids U.S. No. 1.

Belmay is a butter-head type of lettuce adapted for greenhouse forcing. This is a mildew-resistant variety developed by selection from material obtained from a cross between the May King and the old reliable forcing variety Hittinger Belmont, or Hothouse. The cross and preliminary selection work was done by V. A. Tiedjens while he was a member of the staff of the Massachusetts Agricultural Field Station at Waltham. Its resistance to powdery mildew and its adaptation for forcing has made it the leading variety for greenhouse production in the Boston area.
Celery ranks next to lettuce in importance as a salad crop. It was one time considered a luxury but is now a common item in the diet of many people.

The production of celery has increased rapidly during the last 10 years. The commercial crop now has an annual value of about $15,000,000. California, Florida, Michigan, New York, New Jersey, Colorado, and Oregon produce almost the entire celery crop of the country.

Celery (Apium graveolens L.) is a biennial plant native to the low marshlands of southern Europe, northern Africa, and southwestern Asia. A wild form is native in the southwestern United States. Although the plant was known to ancient peoples, recorded history indicates that it was not used as an article of food until modern times. Its development as a garden plant began among the gardeners on the lowlands of Italy and spread to France and England. By selection the undesirable wild plant, long considered poisonous, has been transformed into a crisp, sweet, appetizing, and wholesome item of food.

The commercial producing areas are even more limited than in the case of lettuce. The production of the early yellow type of celery is centered in the Sacramento district of California, the Sanford district of Florida, and the Kalamazoo district of Michigan.

Winter or green celery is produced in the market-garden sections around Great Salt Lake, Utah, Denver, Colo., Boston, Mass., and the trucking sections of New York, New Jersey, Michigan, and Pennsylvania.

History of Celery Varieties

There are two distinct types of celery—(1) yellow or summer celery, of which the variety Golden Self-Blanching is typical, characterized by its early maturity and ease of blanching, and (2) green or winter celery, of which Giant Pascal is typical, maturing later and having greater weight and better quality than the early yellow type. The yellow type can be blanched in the field as it stands in the row by excluding light merely by means of paper or boards. The green or winter varieties are more difficult to blanch. The plants must be either banked with soil as they stand in the row so that only the tips of the leaves are exposed to light or they must be dug and placed in light-proof pits to destroy the green coloring of the petioles.

Most of the old standard celery varieties—such as Golden Self-Blanching, Giant Pascal, White Plume, and Winter Queen—are of unknown parentage and origin.

Yellow Varieties

Golden Self-Blanching is one of the oldest of the yellow celery varieties. It has long been a standard variety in France and was very likely introduced to the United States from Europe. Its parentage is unknown. For many years French-grown seed of this variety was considered to be superior to American-grown stocks. Good strains of American-grown seed are now available. There are both tall and dwarf strains of this popular variety.

Easy-Blanching is a tall yellow celery resembling Golden Self-Blanching but a little later in maturing and having bright rich green
foliage. It is claimed that Easy-Blanching is hardier and more resistant to blight than Golden Self-Blanching.

White Plume is the earliest and most easily blanched of all celery varieties. The blanched petioles are snowy white. Most strains of this variety have the weakness of not keeping well after digging.

Golden Plume is one of the best of the early varieties. It is somewhat resistant to blight and keeps well in storage. The plants are medium in size, compact, and stocky. It is earlier, stalkier, and more vigorous than Golden Self-Blanching.

Some of the more recently developed yellow varieties include the yellows-resistant Michigan Golden and Curly Leaf Easy-Blanching, introduced by the Michigan Agricultural Experiment Station in 1933 and 1936, respectively; Non-Bolting Golden Plume, Golden Pascal, Crispheart, and Golden Supreme, developed and introduced by the Ferry-Morse Seed Co.

**Green Varieties**

Giant Pascal is one of the oldest of the green varieties. It is considered the standard of excellence in celery. The plants are tall and have rich dark-green foliage. The large thick petioles when blanched in soil are tender and crisp and have a rich nutty flavor. It is probably of European origin.

Winter Queen is a dark-green dwarf celery resembling Golden Self-Blanching in habit of growth. It matures earlier and is more easily blanched than Giant Pascal. It is probably an American variety, although its parentage is not known.

Fordhook is one of the best of the winter celery varieties, having good keeping qualities. The plants are somewhat dwarf in habit of growth, and the petioles are thick and heavy. It was named and introduced by the W. Atlee Burpee Co., of Philadelphia, Pa., in 1915.

A recent addition to the list of green varieties of celery is Utah. This is a strain of winter celery developed by the Chinese gardeners around the Great Salt Lake in Utah. The strain has also been called Chinese celery. It is a green celery of high quality, a week to 10 days later than Giant Pascal. The variety seems to be well adapted for some of the irrigated sections of the West.

**Recent Celery Improvement**

Celery growers look to the plant breeder for the solution of some of their most serious problems. Among these are the celery yellows disease, premature seedstalk development, pithiness, and obtaining earlier maturity.

Some of these problems have already been attacked by plant breeders and much has been accomplished in reducing losses.

Celery yellows first became a serious disease in Michigan. It was first observed there in 1914 and has since been found in Ohio, Pennsylvania, New York, New Jersey, Massachusetts, and Connecticut. Only the yellow celery varieties are susceptible, the green varieties being immune. Plants having the disease lose their normal color and become stunted; the tissues are brittle and have a bitter taste. The disease is caused by a species of *Fusarium* which remains in the soil and gradually becomes more abundant as celery is grown on the same land year after year.
The first attempt to solve the yellows problem by breeding methods was initiated by G. H. Coons and Ray Nelson, of the Michigan Agricultural Experiment Station. The work was later carried on by Ray Nelson and L. C. Cochran. The first strains released were resistant to yellows but were found to be too green to blanch easily. In 1933 the Michigan Golden Yellows Resistant strain was introduced. It was obtained by selection of yellows-resistant plants from a tall strain of Golden Self-Blanching.

The Michigan station has also introduced a yellows-resistant selection from the Newark Market variety. It was released in 1936 as Curly Leaf Easy-Blanching.

Some strains of celery shoot to seed prematurely if the plants are subjected to low temperature during the early growth period. In seasons when cold weather prevails after the plants have been set in the field or in cases where the seedlings in the plant-growing beds are subjected to low temperature, a heavy loss results from premature seeding. Emsweller (3) demonstrated the possibility of avoiding this trouble by breeding nonbolting strains.

The new Non-Bolting Golden Plume variety, developed by the Ferry-Morse Seed Co., and introduced in 1936, is a step toward the solution of this problem. The new strain was obtained by pure-line selection from the variety White Plume. The chief merit of the strain is its resistance to premature seedstalk formation under conditions that induce early seeding in many of the commercial varieties of early celery.

Pithiness in celery, a condition in which the parenchyma cells collapse, resulting in hollow, spongy petioles or stalks, has been shown by Emsweller (2) to be an inherited character. The establishment of the genetic basis of pithiness paves the way for the development by scientific breeding of strains free from this undesirable character.

The superior quality of green celery of the Giant Pascal type has long been recognized. On the other hand, the early yellow celery has the distinct advantage of being much more easily blanched than the green type. A celery combining the high quality and heavier stalks of the green celery with the early maturity and easy blanching characters of the yellow type would be a worth-while breeding accomplishment. The Ferry-Morse Seed Co. claim to have approached this in their new strain of Golden Pascal. It is a dark-green selection from Golden Plume.

The New York State College of Agriculture has investigations on celery breeding and genetics in progress but has as yet released no new strains.

GENETICS OF SALAD CROP PLANTS

Very little is yet known of the inheritance of characters in the salad crop plants. Some investigations have been made on the inheritance of certain characters in lettuce and in celery, but the genetics of only a few of these is known as yet.

2 This section is written primarily for students and others professionally interested in breeding or genetics.
**Lettuce**

The most comprehensive study of the germ plasm of a salad crop plant is that made on lettuce by Durst (1). His investigations included the inheritance of plant height, time required for flower production, habit of growth, anthocyanin in the leaves and ray flowers, prickles on stems and leaves, seed color, leaf length, leaf width, and leaf area. Both cultivated varieties of *Lactuca sativa* and the wild form, *L. scariola*, were used in his studies.

Durst found anthocyanin in the leaves and ray flowers to be inherited as a single factor dominant to the absence of the pigment. Black seed behaved as if inherited via a single factor dominant to white seed. Prickles on the midrib of the leaves and on the stems are also inherited as a single factor dominant to the absence of prickles.

The inheritance of lobed leaves characteristic of some forms of the wild species *Lactuca scariola* is apparently controlled by complementary factors. The F₂ progenies from crosses of lobed with entire-margined leaf types gave approximately nine lobed to seven entire-margined.

Leaf length, leaf width, leaf area, time required for flower production, plant height, and habit of growth behaved as quantitative characters, and their inheritance is controlled by many factors.

Thompson (3) has determined the inheritance of certain color characters in lettuce. A report is made on the inheritance of three distinguishable anthocyanin pigment types in the leaves, of dark-green and yellow-green chlorophyll color, of seed color, and of a chlorophyll deficiency that does not follow Mendelian inheritance.

The three anthocyanin pigment types in the leaves of lettuce studied by Thompson were the full red type characteristic of the variety Mignonette, the spotted type characteristic of the variety California Cream Butter, and the tinged type characteristic of the variety Iceberg.

The inheritance of these three anthocyanin types was found to be controlled by a multiple allelomorphic series of three genes and two pairs of complementary genes. The presence or absence of the pigment is controlled by the complementary genes and the intensity and pattern by the multiple allelomorphic series.

Dark-green chlorophyll color, characteristic of the variety New York, was found to behave as a single factor dominant to the gene for yellow-green characteristic of the variety Hanson.

Studies on seed color confirm the results obtained by Durst that black seed is due to a single gene dominant to the gene for white seed.

The chlorophyll deficiency in the leaves of lettuce studied by Thompson was found to be non-Mendelian in inheritance. The deficiency was inherited only through the deficient portions of the mother plant, and its inheritance was not affected by the type of pollen applied.

**Celery**

The inheritance of pithiness in celery has been studied by Emsweller (2) in the variety Utah. Emsweller isolated inbred lines from this variety that were homozygous for solid petioles free from pithiness.

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Progenies from heterozygous lines segregated approximately three pithy to one nonpithy. The results obtained indicate that pithiness in celery is controlled by a single factor, dominant to the recessive condition of solid or nonpithy petioles.

It should be noted here that the problem of pithiness in celery was practically solved by Sandsten and White (5) in 1900. They observed that certain stocks of plants of the variety Golden Self-Blanching from different sources varied greatly in the percentage of pithy plants produced. Strains of both American- and French-grown stocks were tested. Lots from the French-grown seed showed much less pithiness on the average than lots from the American-grown seed. Some of the French stocks were entirely free of pithiness, which White and Sandsten, who reported the work, attributed to more careful selection of seed stocks by French growers. Although Sandsten and White's results strongly indicated an inherited difference in strains in respect to pithiness, they failed to carry their investigations far enough to show a definite genetic relationship.

Premature seedstalk development in celery has also been studied by Emsweller (3). The varieties Golden Plume and Golden Self-Blanching were used. Emsweller was able to isolate strains homozygous for the nonbolting habit, which would not bolt under conditions causing a high percentage of bolting in other strains. He was able to isolate some lines that were strongly annual in their seeding habit, some plants of which seed prematurely even under favorable conditions for vegetative growth. It is evident from his results that premature seedstalk development in celery is inherited. He concluded that nonbolting is a quantitative recessive character. The influence of environment on the expression of the bolting character makes genetic analysis of it difficult.

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(1) **Durst, C. E.**


(2) **Emsweller, S. L.**


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(4) **Oliver, G. W.**


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(6) **Tracy, W. W.**


See footnote 3, p. 338.