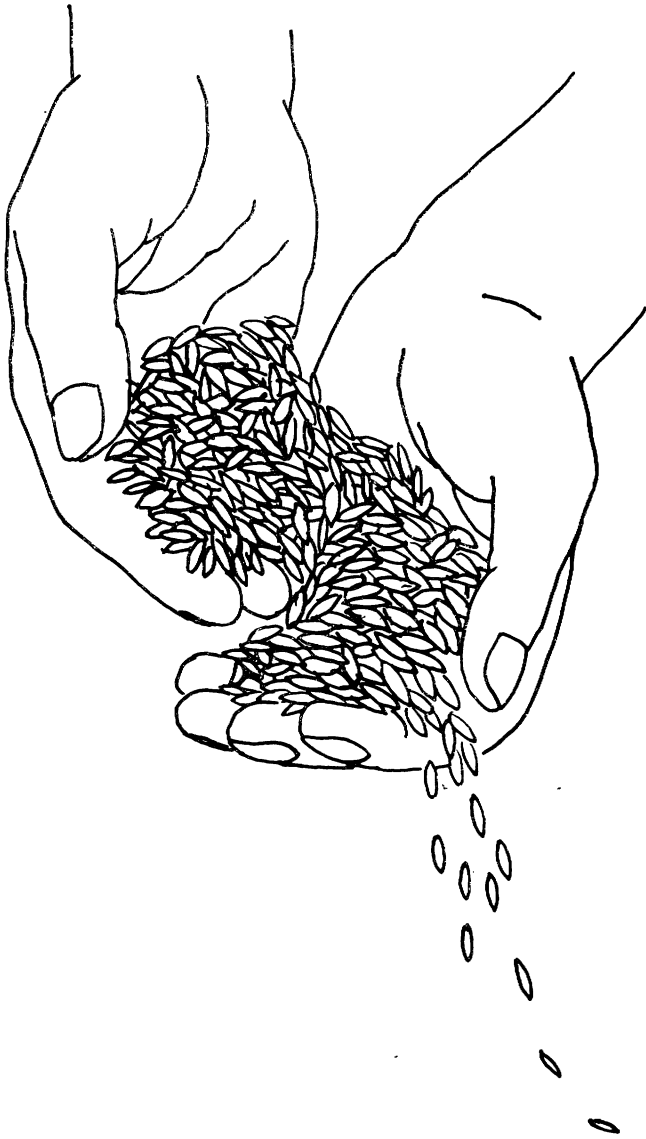


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THE YEARBOOK OF  
AGRICULTURE · 1961



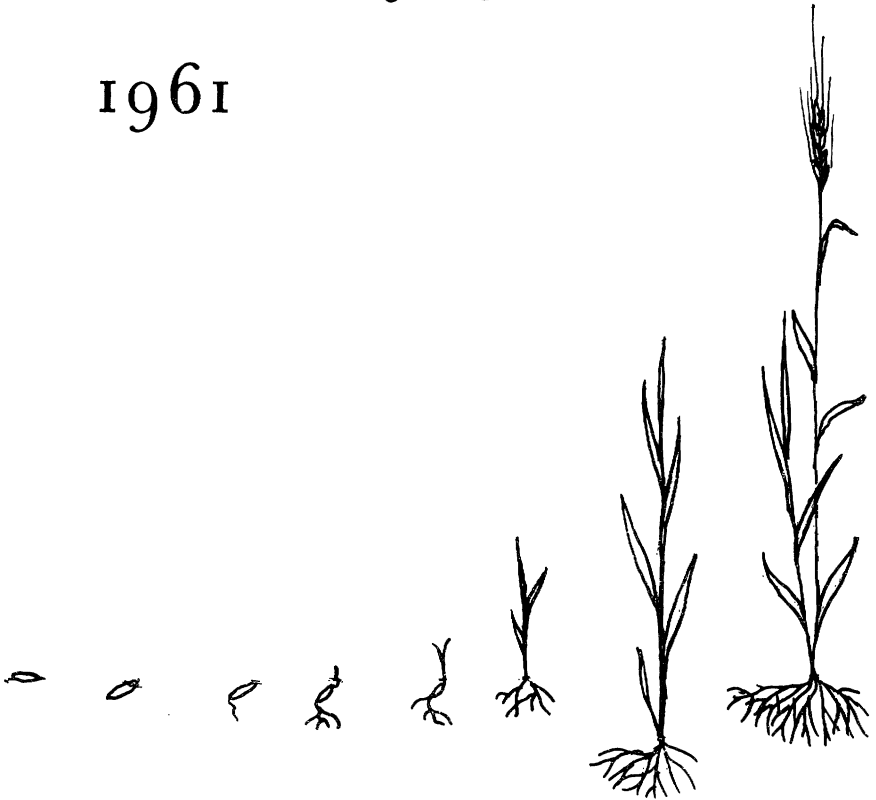
THE UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D.C.

# SEEDS

*The Yearbook of Agriculture*

1961



THE UNITED STATES  
GOVERNMENT PRINTING OFFICE

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# FOREWORD

ORVILLE L. FREEMAN

*Secretary of Agriculture*

GOOD SEEDS ARE both a symbol and a foundation of the good life our people have gained. A basic factor in our realization of mankind's most sought goal, agricultural abundance, good seeds can be a means of our bringing about an Age of Plenty and an Age of Peace and Freedom. We can use our good seeds to help end hunger and fear for the less fortunate half of the human family. So used, our seeds can be more meaningful to a hungry world than can the rocket that first carries man to the moon.

This Yearbook of Agriculture seeks to provide a new and improved basis for understanding the complex order of Nature's forces so that man can better shape them in a positive and creative fashion.

Seeds are ever a positive and creative force. Seeds are the germ of life, a beginning and an end, the fruit of yesterday's harvest and the promise of tomorrow's. Without an ample store of seeds there can be no national treasure, or no future for a Nation.

Finding and developing better seeds is the oldest continuous service our Federal Government has rendered to our farmers—indeed, to all our people. We have collected valuable and curious seeds from all corners of the world. From the founding ninety-nine years ago of this branch of Government, our Department of Agriculture has worked continuously to aid the selection, advance the harvest, and further the development of improved seeds required to produce crops that could better resist drought, heat and cold, the threat of disease, the attacks of insects.

What success we have realized! The seeds we use today enable our farmers to produce a variety of healthy and hardy food and fiber crops that were virtually unknown a few years ago. Our plant breeders and geneticists have accomplished miracles in the development of more useful plants. In our seeds we have a wealth we all enjoy in abundant foods.

This work has concerned all Americans. Now it must concern all members of the human family who fear hunger.

Now, often to the same foreign lands from which we gathered the parent plants, we return more useful seeds. We can do more.

In our seeds we have a wealth we can transmit—without the need of translation—to people of other lands who draw their living from land and forest. The message of seeds that flourish and produce an abundant harvest is one that all the human family can understand. Exported with vigorous purpose and direction, our seeds can be a vital factor in reaching the goals we seek through Food for Peace. Although we cannot feed the entire world, we can supply the technology and the abilities the world can use to feed itself.

This Yearbook of Agriculture, compiling our vast knowledge of seeds for greater application in the United States, also serves well the peoples of the world. By designation of the Food and Agriculture Organization of the United Nations, 1961 is World Seed Year in an international campaign against hunger.

This Yearbook of Agriculture can be regarded as a contribution of the United States and the Department of Agriculture to World Seed Year, and to the continuing search by the peoples of the world for freedom from hunger.

As a contribution to World Seed Year, the Crop Production and Improvement Branch of FAO in Rome undertook to prepare an agricultural study, *Agricultural and Horticultural Seeds—Their Production, Control and Distribution*, in English, French, and Spanish versions.

# PREFACE

ALFRED STEFFERUD

*Editor of the Yearbook*

JOHN CHAPMAN is in this book. He was the near-legendary Johnny Applesseed, who for almost fifty of his seventy-odd years planted apple trees through the pioneer wilderness. The seeds he got from cider presses in Pennsylvania he carried in canoes down the Ohio River and on his back to clearings in Ohio and Indiana. He walked hundreds of miles to tend his orchards and share his dream and the good health he believed was in apples and herbs. He was an original, a doer; he gave no speeches, wrote no books, attended no committee meetings. To the settlers he was a kindly, helpful visitor, who now and then asked a few pennies or old clothes for his efforts. To the Indians he was a welcome medicine man, to whom service was a privilege. To us he is a lesson in greatness, for he who plants a seed plants life.

Wendelin Grimm also is in this book. In 1857, when he was nearly forty years old, he emigrated from his home in Baden, Germany, to Carver County in Minnesota. He brought with him as a prized possession a few pounds of alfalfa seeds, which he planted on some of the 137 acres he bought near Chaska. In the cold Minnesota winter, the first year and later years, some plants winterkilled. Sometimes nearly all died. Each year Grimm saved and planted seeds of the plants that survived. His cattle thrived on the alfalfa, which in time became acclimatized and winterkilled no longer. He let neighbors have some of the seeds. It did not occur to him that his work had scientific importance—he was just being a good farmer—but the value of his “everlasting clover” came to be recognized. Modest, hardworking Wendelin Grimm surely expected no monument, but he has two: A bronze tablet, unveiled in 1924, on a boulder on his old farm and the crop that is grown and prized as Grimm alfalfa. An editorial George W. Kelley wrote about him in the *Northwest Farmstead* said in part: “The world knows not its greatest benefactors. . . . Sometimes, though, it is given

to a few to recognize and pay tribute to a patient man or woman who in obscurity and perhaps in poverty has worked out great benefits to humanity. . . .”

Gregor Johann Mendel, too, is here. He was the gentle, unknown, incurably curious Austrian monk who kept on planting peas in a monastery garden, checking the traits of each generation, and wondering about the reasons for the differences. His report on his records was the beginning of much of our knowledge of heredity and genetics. The horizon of knowledge he pointed to is a limitless one.

Here also are men and women who stand alongside Johnny Appleseed, Wendelin Grimm, and Gregor Johann Mendel in dedication, accomplishment, and vision.

They are the scores of scientists whose work is explained and made into tools for the hands of all. Their efforts helped to make available seeds of superior varieties that have made it possible for Americans to enjoy a bountiful and continuing food supply and to share their good fortune with other people.

They are also the research scientists, plant breeders, seedsmen, economists, production specialists, seedgrowers, and administrators who, drawing on the knowledge of centuries and the notable developments of recent years, have written these chapters. They have written for technicians, because in a day of specialization there is much to be shared and explored; for farmers and gardeners and foresters and others who work in the fields of applied biology; for students and pupils, who some day will discover new things because, despite our big strides forward, there is still much room for improvement; and for the rest of us, who are incurably curious about life and living things. Their subject is as broad as life itself, for seed or seeds (words that we use interchangeably in this book without any special distinction) are life.

The planning of this book began in 1959 and was in charge of the members of the 1961 Yearbook Committee:

*Agricultural Research Service:* Martin G. Weiss, CHAIRMAN;  
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*Federal Extension Service:* John R. Paulling.  
*Forest Service:* H. A. Fowells.  
*Agricultural Marketing Service:* Walter A. Davidson, Thomas J.  
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*Foreign Agriculture Service:* W. H. Youngman.  
*Commodity Stabilization Service:* Wilson E. Westbrook.  
*American Seed Trade Association:* John F. Schiffman.



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## ON A SEED

*This was the goal of the leaf and the root.  
For this did the blossom burn its hour.  
This little grain is the ultimate fruit.  
This is the awesome vessel of power.*

*For this is the source of the root and the bud . . . .  
World unto world unto world remolded.  
This is the seed, compact of God,  
Wherein all mystery is enfolded.*

GEORGIE STARBUCK GALBRAITH.

THE NEW YORK TIMES  
MAY 6, 1960





INSECT-RESISTANT PACKAGING is useful for protecting seed during storage and until it is ready for planting. Even closely woven fabric bags offer little protection against insect invasion. Multiwall paper bags, laminates, and plastic films are somewhat more resistant but fall short of being insectproof. Paper bags treated with synergized pyrethrum or methoxychlor can be highly effective for one season of storage in protecting against invasion or penetration. The bags must be well constructed and have tight closures. DDT could be used on bags for seed that will not be diverted for use as food or feed. None of the treatments is completely effective on fabric bags.

PREVENTING DAMAGE TO SEED by insects and fungi after harvest can be accomplished by the following procedures:

Harvest promptly.

Clean and dry seed before storage.

Clean up the storage structure and apply residual spray before bringing seed in.

Apply a protectant to seed as it is placed in storage.

Keep the seed and the warehouse cool and dry.

Make frequent culture tests to be sure storage fungi are not invading seed.

Apply residual sprays on a periodic preventive maintenance schedule.

Fumigate if and when necessary.

Use protective packaging.

LYMAN S. HENDERSON is Chief of the Stored-Product Insects Branch, Agricultural Marketing Service. He has been with the Department of Agriculture since 1938. He has administered research programs in insect control since 1945.

CLYDE M. CHRISTENSEN is a professor in the Department of Plant Pathology and Botany at the University of Minnesota. He was on special assignment with the Rockefeller Foundation agricultural program in Mexico during 1959. He conducts research on the deterioration of grains caused by storage fungi.

## Questions and Answers

*What proportion of the annual cost of production of the average farmer is spent for seeds?*

About 2 percent—the least of any major element in his cost of operations.

*What is the estimated age of the oldest known viable seed?*

Certain lotus seeds believed to be more than 1 thousand years old have germinated. This is unusual, however, since most agricultural seeds lose their viability in a few years. Weed seeds may remain viable 25, 50, or 100 years.

*What part of plants constitutes the greatest portion of the world's human food supply?*

Seeds.

*From what part of plants are most "vegetable oils" derived for industrial and food uses?*

The seeds.

*Do the characteristics and uniformity of a seed-propagated variety or stock remain constant?*

No. Characteristics and uniformity of varieties and stocks of naturally cross-pollinating crops tend to change to some degree under natural (or artificial) selection pressures. Theoretically at least, varieties of self-pollinated crops should remain constant indefinitely. Accidental mixtures of varieties, however, frequently occur. Mutations of genes also occur infrequently. As a consequence, even varieties of self-pollinated crops may change. Constant and skillful effort is required to keep varieties and stocks in close conformity to the desired standards.

*How many seeds does one parent plant produce?*

Some annual species may produce an average number as low as a dozen; others, 200 thousand or more. Some trees in a lifetime produce many millions.

*What is breeder seed?*

Seed produced by the originator of a new variety that is planted for the production of foundation seed or "stock seed."

*What is "stock" seed?*

To the producers of vegetables and flower seeds, it is the carefully rogued and otherwise "controlled" seed from which seeds are grown for planting crops for ordinary home or commercial use.

*Can all species of crop plants be identified by the appearance of their seeds alone?*

No; although most of them can be. Two or more species within some genera may produce seeds that appear the same.

*Can varieties of crops be identified only by the appearance of the seeds?*

Some varieties of peas, beans, corn, and other relatively large-seeded plants produce seeds so distinctly characteristic of the respective varieties as to constitute a dependable identification of the variety, but this is not generally true. Stem, leaf, flower, fruit, performance, and other characteristics usually must be taken into account to identify a variety.

*Which is richer in vitamins—a dormant seed or a germinating seed?*

The germinating seed—hence the nutritive value of bean sprouts and malted grain.

*How does a true seed differ from a one-seeded fruit?*

A true seed consists of the embryo, endosperm (when present) and integuments (seedcoat or covering) of the ovule from which it developed. A

one-seeded fruit has an additional layer in the covering, which is contributed by the ovary wall. Identification of a one-seeded fruit is certain when it is determined that the ovary of the flower develops a single ovule.

*Which plants produce the largest and the smallest seeds?*

Seeds of some orchids are so small they cannot be seen with the naked eye and look like dust. The largest seed is probably a coconut that is found only in Malagasy and reaches a length of more than 1 foot and may weigh 40 to 50 pounds. The coconut is a dry, one-seeded drupe. The "meat" is the seed. The fibrous and hard shells are part of the ovary walls. The commercial coconut is therefore a fruit and not a seed.

*Is the seed a reproductive structure?*

Functionally, the seed is a reproductive structure in that it serves to increase and multiply the plant species. Structurally, the seed is a young, resting plant waiting for favorable conditions to again start growing. Processes of sexual reproduction are completed in the ovules of the flower long before seed maturity.

*A hickory nut or a walnut that has been kept dry all winter will not germinate in the spring. Why?*

Because at maturity the embryo of the nut enters a period of dormancy or rest as soon as it becomes dry, and the only way to break this deep sleep is to keep the seed moist and cool for a certain period (usually 2 months or more). Then it will sprout and grow.

*How necessary are pollinating insects in the production of seeds?*

Blossoms of some crops are self-sterile, although they contain both pistil and pollen, and to be fruitful need pollen from another plant of the same variety or species. In other crops, the male and female components are borne on separate blossoms on the same plant or different plants.

Some pollens are windborne. Others are heavy, sticky, or spiny and need to be transported by insects. Flowers of certain plants are peculiarly adapted to insect pollination.

*How many seed crops are dependent on bees for yields of seeds?*

More than 35 seed crops are dependent on bees for seed production or yield more abundantly when bees are present. Among the more important are alfalfa, asparagus, beans, cabbage, carrot, celery, cauliflower, cucumber, clovers, muskmelon, onion, radish, squash, sunflower, vetches, and watermelon.

*How many insects are detrimental to seed production?*

In the broad sense that any insect that injures the plant affects seed production, probably a few hundred species are involved. Only a few dozen species directly attack the flowering parts or the seed, however, and only some of them inflict serious damage.

*Where can I get seeds of fast-growing hybrid pines?*

Seeds of hybrid pines are not available commercially. They are being used in research or for forest planting by those who produce them.

*How can I get the seed out of a pine cone?*

Most cones open up and shed their seeds as they dry out naturally. A few, like jack pine, will open readily only when heated up to about 140° F. for about a day.

*How old must a pine tree be before it bears seeds?*

Many pines start to bear seeds when they are 15 to 20 years old, occasionally when only 10. Some, like the sugar pine of the West, seldom bear seeds before they are 40 to 50 years old.

*Is it necessary to identify clearly as a "brand" the brand or trademark each time it is used in a price list with the name of the kind and variety of seed?*

No. We are of the opinion that it is in compliance with the Federal Seed Act to identify clearly in the masthead of a price list the terms used as a brand or trademark without identifying the brand or trademark as such each time it is used on the same page. For example, "The term 'Blank' is our brand (or trademark) and is not a part of the name of the kind or variety."

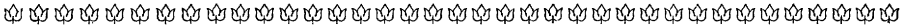
*If I obtain a laboratory report from my supplier, is it necessary for me to have another test made before labeling seeds for interstate shipment?*

The basis for labeling seeds in interstate commerce is left to the interstate shipper to determine. If the seeds are labeled correctly, the basis upon which they were labeled will not be questioned. If, however, the seeds are found to be falsely labeled, the shipper's basis for labeling will be subject to inquiry to determine whether he took proper precautions in labeling the seeds. It would appear that a person who, in good faith, obtains his own representative sample from a properly blended lot of seeds as it is received and has it tested by a qualified seed analyst would normally have taken proper precautions. On the other hand, a person who relies on a laboratory report furnished by his supplier is taking a certain amount of risk, as he cannot know whether the sample reported on properly represents the seeds he has received or that the seed lot is uniformly blended.

*If seeds are held in storage until the date of test expires, is a retest of the original file sample considered a reliable basis for determining the percentage of germination and renewing the date of test shown on the labels?*

No. Seeds stored in a warehouse do not always retain their viability the same as a small sample stored under different conditions. A new sample of the seeds actually in storage should be obtained for the purpose of retesting and relabeling.

# APPENDIX



## A Selected List of Publications

Andersen, Alice M.: *Handbook on Seed-borne Diseases*, 58 pages. Published by the Association of Official Seed Analysts. 1958.

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*Du Pont Seed Treating Manual*, 30 pages; E. I. du Pont de Nemours & Co., Wilmington, Del. 1960.

*Fifty Years of Seed Testing*. 101 pages. Published by the Association of Official Seed Analysts. 1958.

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## SOME CHARACTERISTICS OF SEEDS OF A SELECTED LIST OF CULTIVATED PLANTS

The following table lists in the first column the common and Latin names of some common cultivated plants.

The second column shows the nature of the parent plant—whether it is an annual, a biennial, or a perennial species. (*A*=annual, *B*=biennial, and *P*=perennial.) Plants shown as *A-B* or *B-P* may exhibit either of the two kinds of behavior, depending on cultural conditions and management.

Most seeds germinate over a wide range of temperatures—slowly at the lower part of each respective range and more quickly at the medium to medium-high parts of the range. Relatively high temperature may impede or prevent germination.

The temperatures shown in this table are very favorable for germination of the respective seeds, but are not necessarily the best naturally occurring soil temperatures at which to plant seeds in the spring for the growing of a crop in field or garden. In general, the vegetable seeds shown as tolerant to cool soil must be planted in the spring when soil temperatures are lower than shown, lest the growing crop encounter unfavorably hot weather. Freshly harvested seeds of most of these will germinate better after they are chilled a few days while moist at about 50° F.

The showing of two temperatures for vegetable seeds, as 68°-86°, represents a daily alternation of 16 hours at the first and 8 hours at the second. This alternation roughly simulates the change of night and day temperatures of the soil near the surface. Most species germinate faster and better under such alternating temperatures than under constant temperature. For the seeds of ornamentals the two temperatures indicate a favorable range but not a daily alternation. Exact optimum alternating temperatures have not been determined for these seeds as they have for "farm" and vegetable seeds.

Two figures are shown for the time for germination of vegetable seeds at the specified temperatures. The first figure is the time at which most good seeds in a sample that will germinate will have done so. Seeds that would not germinate at these temperatures by the second time interval are unlikely to have value for planting at the time of such a test. For the seeds of ornamentals, the two figures indicate the normal time within which most seedlings will appear above ground at the temperature shown, following proper planting.

## VEGETABLE PLANTS

Common and Latin names	Plant habit	Approximate seeds per ounce	Germination		Notable characteristic or requirement
			Time	At temperature	
			Days	Degrees F.	
Artichoke— <i>Cynara scolymus</i> .....	P	700	7-21	68-86	Tolerates cool soil.
Asparagus— <i>Asparagus officinalis</i> ....	P	700	7-21	68-86	Do.
Asparagusbean— <i>Vigna sesquipedalis</i> .	A	225	5-8	68-86	Requires warm soil.
Beans:					
Garden— <i>Phaseolus vulgaris</i> ....	A	100-125	5-8	68-86	Do.
Dry edible— <i>Phaseolus vulgaris</i> ..	A	100-125	5-8	68-86	Do.
Lima— <i>Phaseolus lunatus</i> .....	A	25-75	5-9	68-86	Do.
Runner— <i>Phaseolus coccineus</i> ....	A	25-30	5-9	68-86	Do.
Beet— <i>Beta vulgaris</i> .....	B	1,600	3-14	68-86	Tolerates cool soil.
Broadbean— <i>Vicia faba</i> .....	A	20-50	4-14	68-86	Do.
Broccoli— <i>Brassica oleracea</i> var. <i>botrytis</i> .	A-B	9,000	3-10	68-86	Do.
Brussels sprouts— <i>Brassica oleracea</i> var. <i>gemmifera</i> .	B	9,000	3-10	68-86	Do.
Cabbage— <i>Brassica oleracea</i> var. <i>capitata</i> .	B	9,000	3-10	68-86	Do.
Cabbage, Chinese— <i>Brassica pekinensis</i> .	A-B	18,000	3-7	68-86	Do.
Cardoon— <i>Cynara cardunculus</i> .....	P	700	7-21	68-86	Do.
Carrot— <i>Daucus carota</i> .....	B	23,000	6-21	68-86	Do.
Cauliflower— <i>Brassica oleracea</i> var. <i>botrytis</i> .	A-B	9,000	3-10	68-86	Do.
Celery— <i>Apium graveolens</i> var. <i>rapaceum</i> .	B	72,000	10-21	50-68	Requires cool soil.

Celery— <i>Apium graveolens</i> var. <i>dulce</i> . . .	B	72, 000	10-21	50-68	Requires cool soil.
Chard, Swiss— <i>Beta vulgaris</i> var. <i>ciela</i> . . .	B	1, 600	3-14	68-86	Tolerates cool soil.
Chicory— <i>Cichorium intybus</i> . . . . .	P	27, 000	5-14	68-86	Do.
Citron— <i>Citrullus vulgaris</i> . . . . .	A	300	7-14	68-86	Requires warm soil.
Collards— <i>Brassica oleracea</i> var. <i>acephala</i> . . . . .	B	9, 000	3-10	68-86	Tolerates cool soil.
Corn, sweet— <i>Zea mays</i> . . . . .	A	120-180	4-7	68-86	Requires warm soil.
Cornsalad (fetticus)— <i>Valerianella locusta</i> var. <i>olitoria</i> . . . . .	A-B	.....	7-28	68	Tolerates cool soil.
Cowpea (southern pea)— <i>Vigna sinensis</i> . . . . .	A	225	5-8	68-86	Requires warm soil.
Cress:					
Garden— <i>Lepidium sativum</i> . . . . .	A	12, 000	4-10	68	Light sensitive.
Water— <i>Rorippa nasturtium-aquaticum</i> . . . . .	P	150, 000	4-14	68-86	Tolerates cool soil.
Cucumber— <i>Cucumis sativus</i> . . . . .	A	1, 100	3-7	68-86	Requires warm soil.
Dandelion— <i>Taraxacum officinale</i> . . . . .	B-P	35, 000	7-21	68-86	Tolerates cool soil.
Eggplant— <i>Solanum melongena</i> var. <i>esculentum</i> . . . . .	A	6, 500	7-14	68-86	Requires warm soil.
Endive— <i>Cichorium endivia</i> . . . . .	A-B	27, 000	5-14	68-86	Tolerates cool soil.
Kale— <i>Brassica oleracea</i> var. <i>acephala</i> . . . . .	B	9, 000	3-10	68-86	Do.
Kale, Chinese— <i>Brassica oleracea</i> var. <i>alboglabra</i> . . . . .	B	9, 000	3-10	68-86	Do.
Kohlrabi— <i>Brassica oleracea</i> var. <i>gongyloides</i> . . . . .	B	9, 000	3-10	68-86	Do.
Leek— <i>Allium porrum</i> . . . . .	B	11, 000	6-14	68	Requires cool soil.
Lettuce— <i>Lactuca sativa</i> . . . . .	A	25, 000	7	68	Requires cool soil. Some varieties light sensitive.
Muskmelon (including cantaloup)— <i>Cucumis melo</i> . . . . .	A	1, 300	4-10	68-86	Requires warm soil.
Mustard— <i>Brassica juncea</i> . . . . .	A	18, 000	3-7	68-86	Tolerates cool soil.
Mustard, spinach— <i>Brassica perviridis</i> . . . . .	A	15, 000	3-7	68-86	Do.
Okra— <i>Hibiscus esculentus</i> . . . . .	A	500	4-14	68-86	Requires warm soil.
Onion— <i>Allium cepa</i> . . . . .	B	9, 500	6-10	68	Requires cool soil.
Onion, Welsh— <i>Allium fistulosum</i> . . . . .	B	.....	6-12	68	Do.
Pak-choi— <i>Brassica chinensis</i> . . . . .	A-B	18, 000	3-7	68-86	Tolerates cool soil.
Parsley— <i>Petroselinum hortense</i> ( <i>P. crispum</i> ) . . . . .	B	18, 500	11-28	68-86	Do.
Parsnip— <i>Pastinaca sativa</i> . . . . .	B	12, 000	6-28	68-86	Do.
Pea— <i>Pisum sativum</i> . . . . .	A	90-175	5-8	68	Requires cool soil.
Pepper— <i>Capsicum</i> spp. . . . .	A	4, 500	6-14	68-86	Requires warm soil.
Potato— <i>Solanum tuberosum</i> . . . . .	P	.....	.....	68	Tolerates cool soil.
Pumpkin— <i>Cucurbita pepo</i> . . . . .	A	100-300	4-7	68-86	Requires warm soil.
Radish— <i>Raphanus sativus</i> . . . . .	A	2-4, 000	4-6	68	Requires cool soil.
Rhubarb— <i>Rheum rhaponticum</i> . . . . .	P	1, 700	7-21	68-86	Tolerates cool soil.
Rutabaga— <i>Brassica napus</i> var. <i>napobrassica</i> . . . . .	B	12, 000	3-14	68-86	Do.
Salsify— <i>Tragopogon porrifolius</i> . . . . .	B	1, 900	5-10	68	Requires cool soil.
Sorrel— <i>Rumex acetosa</i> . . . . .	P	30, 000	3-14	68-86	Tolerates cool soil.
Soybean— <i>Glycine max</i> . . . . .	A	175-350	5-8	68-86	Requires warm soil.



## VEGETABLE PLANTS—Continued

Common and Latin names	Plant habit	Approximate seeds per ounce	Germination		Notable characteristic or requirement
			Time	At temperature	
		Number	Days	Degrees F.	
Spinach— <i>Spinacea oleracea</i> . . . . .	A	2, 800	7-21	59	Requires cool soil.
Spinach, New Zealand— <i>Tetragonia expansa</i> .	A	350	5-28	50-86	Germinates irregularly.
Sweetpotato— <i>Ipomoea batatas</i> . . . . .	P	.....	.....	77	Break or remove seedcoat.
Squash— <i>Cucurbita moschata</i> and <i>C. maxima</i> .	A	200-400	4-7	68-86	Requires warm soil.
Tomato— <i>Lycopersicon esculentum</i> . . .	A	11, 500	5-14	68-86	Do.
Tomato, husk— <i>Physalis pubescens</i> . . .	A	35, 000	7-28	68-86	Do.
Turnip— <i>Brassica rapa</i> . . . . .	B	15, 000	3-7	68-86	Tolerates cool soil.
Watermelon— <i>Citrullus vulgaris</i> . . . .	A	200-300	4-14	68-86	Requires warm soil.

## ORNAMENTAL PLANTS

Common and Latin names	Plant habit	Approximate seeds per ounce	Emergence		Notable characteristic or requirement
			Time	At temperature	
		Number	Days	Degrees F.	
Achillea— <i>Achillea filipendula</i> . . . . .	P	225, 000	7-14	65-75	
African-violet— <i>Saintpaulia ionantha</i> .	A	750, 000	21-28	65-75	
Ageratum— <i>Ageratum mexicanum</i> . . .	A	200, 000	21	65-75	
Alyssum— <i>Lobularia maritima</i> . . . . .	A	90, 000	14	65-75	
Amaranthus— <i>Amaranthus tricolor</i> . . .	A	28, 000	14-21	65-75	
Asclepias— <i>Asclepias tuberosa</i> . . . . .	P	4, 500	21-28	65-70	Requires cold treatment.
Aster— <i>Callistephus chinensis</i> . . . . .	A	12, 000	14-21	65-75	
Aster Stokes'— <i>Stokesia cyanea</i> . . . . .	P	3, 300	28-42	65-75	
Aubrietia— <i>Aubrietia deltoidea graeca</i> .	P	150, 000	14-21	65-75	
Babysbreath— <i>Gypsophila paniculata</i> .	P	34, 000	7-14	65-75	
Balloon Flower— <i>Platycodon grandiflorum</i> .	P	28, 000	14-21	65-75	
Balsam— <i>Impatiens balsamina</i> . . . . .	A	3, 300	14-21	65-75	
Beard tongue— <i>Pentstemon gloxinioides</i> .	A	55, 000	14-21	65-75	
Begonia— <i>Begonia semperflorens</i> . . . . .	A	1, 000, 000	14-21	65-75	
Bells of Ireland— <i>Molucella laevis</i> . .	A	42, 000	21-35	50	
Bird of Paradise— <i>Strelitzia reginae</i> . .	A	140	21-28	65-75	
Black-eyed-susan— <i>Thunbergia alata</i> .	A	1, 100	14-21	65-75	
Bleedingheart— <i>Dicentra spectabilis</i> . .	P	6, 000	.....	.....	Seed must be frozen.
Browallia— <i>Browallia viscosa</i> . . . . .	A	240, 000	14-21	65-75	
Butterfly Flower— <i>Schizanthus</i> species.	A	60, 000	7-14	65-75	
Calceolaria— <i>Calceolaria herbeahybrida</i> .	A	600, 000	14-21	65-75	Plant on surface.
Calendula— <i>Calendula officinalis</i> . . . .	A	3, 000	14-21	65-75	
Calliopsis— <i>Coreopsis tinctoria</i> . . . . .	A	90, 000	14-28	65-75	
Capc-marigold— <i>Dimorphotheca aurantiaca</i> .	A	9, 500	14-21	65-75	
Candytuft— <i>Iberis coronaria</i> . . . . .	A	9, 500	7-21	65-75	
Candytuft, Hardy— <i>Iberis sempervirens</i>	P	11, 500	14-21	65-75	
Canna— <i>Canna generalis</i> . . . . .	P	100	56	65-75	Soak seeds. Sow on surface of soil with bottom heat.
Canterbury-bells— <i>Campanula medium</i> .	A	50, 000	14-21	65-75	

Carnation— <i>Dianthus caryophyllus</i> . . .	A	14, 000	14-21	65-75	
Castorbean— <i>Ricinus communis</i> . . . . .	A	25	14-21	65-75	
Celosia— <i>Celosia argentea cristata</i> . . . .	A	28, 000	7-14	65-75	
Cerastium— <i>Cerastium tomentosum</i> . . . .	P	19, 000	14-28	65-75	
Christmas-cherry— <i>Solanum pseudo-capsicum</i> .	A	12, 000	21-28	65-75	
Chrysanthemum— <i>Chrysanthemum carinatum</i> .	A	9, 000	14-35	65-75	
Cincreria— <i>Senecio cruentus</i> . . . . .	A	150, 000	14-21	65-75	
Clarkia— <i>Clarkia elegans</i> . . . . .	A	90, 000	7-14	65-75	
Clove Pink— <i>Dianthus plumarius</i> . . . . .	P	25, 000	14-21	65-75	
Colcuz— <i>Coleus blumei</i> . . . . .	A	100, 000	14-21	70-80	
Columbine— <i>Aquilegia species</i> . . . . .	P	15, 500	21-28	65-75	
Coneflower— <i>Rudbeckia hirta</i> . . . . .	A	85, 000	14-21	65-75	
Coralbells— <i>Heuchera sanguinea</i> . . . . .	P	750, 000	14-21	65-75	
Cornflower— <i>Centaura cyanus</i> . . . . .	A	7, 000	14-28	65-75	
Cosmos— <i>Cosmos bipinnatus</i> . . . . .	A	5, 000	14-28	65-75	
Coreopsis— <i>Coreopsis grandiflora</i> . . . . .	P	11, 000	14-21	65-75	
Crossandra— <i>Crossandra infundibuliformis</i> .	A	4, 000	49-84	75-80	
Cup-and-saucer— <i>Campanula calycanthema</i> .	P	120, 000	14-21	65-75	
Cup-and-saucer vinc— <i>Cobaea scandens</i> .	A	375	14-21	65-75	
Cup-flower— <i>Nierembergia frutescens</i> .	A	175, 000	14-21	65-75	
Cuphea— <i>Cuphea llavea miniata</i> . . . . .	A	7, 000	14-21	65-75	
Cyclamen— <i>Cyclamen indicum</i> . . . . .	A	2, 500	21-28	65-75	
Cynoglossum— <i>Cynoglossum amabilis</i> .	A	5, 000	14-21	65-75	
Dahlia— <i>Dahlia pinnata</i> . . . . .	A	2, 800	14-21	65-75	
Daisies:					
English— <i>Bellis perennis</i> . . . . .	P	135, 000	7-14	65-75	
Painted— <i>Pyrethrum roseum</i> . . . . .	P	18, 000	7-14	65-75	
Shasta— <i>Chrysanthemum maximum</i>	P	21, 000	14	65	
Transvaal— <i>Gerbera jamesoni</i> . . . . .	A	8, 000	14-21	65-75	
Datura— <i>Datura suaveolens</i> . . . . .	A	870	14-21	65-75	
Delphinium— <i>Delphinium elatum</i> . . . . .	P	10, 000	21-28	55-65	
Delphinium Chinensis— <i>Delphinium chinensis</i> .	A	20, 000	14-21	60-70	
Didiscus— <i>Trachymene caerulea</i> . . . . .	P	10, 000	14-21	65-75	
Everlasting— <i>Helichrysum bracteatum monstrosum</i> .	A	36, 000	14-21	65-75	
Exacum— <i>Exacum affine</i> . . . . .	A	1, 000, 000	14-21	65-75	
False-indigo— <i>Baptisia australis</i> . . . . .	P	1, 700	21-28	65-75	
Feverfew— <i>Matricaria capensis</i> . . . . .	P	145, 000	14-21	65-75	
Forget-me-not— <i>Anchusa myosotidiflora</i> .	P	10, 500	21-28	65-75	
Foxglove— <i>Digitalis purpurea</i> . . . . .	P	180, 000	14-21	65-75	
Gaillardia— <i>Gaillardia picta</i> . . . . .	A	14, 000	14-21	65-75	
Gayfeather— <i>Liatris scariosa</i> . . . . .	P	9, 500	21-28	65-75	
Geranium— <i>Pelargonium zonale</i> . . . . .	A	6, 000	28-42	55-65	
Globe-amaranth— <i>Gomphrena globosa</i>	A	5, 500	14-21	65-75	
Globethistle— <i>Echinops ritro</i> . . . . .	P	650	14-21	65-75	
Gloxinia— <i>Sinningia speciosa</i> . . . . .	A	800, 000	14-21	65-75	
Golden Cup— <i>Hunnemannia fumariacifolia</i> .	A	8, 000	14-21	65-75	
Golddust— <i>Alyssum saxatile</i> . . . . .	P	30, 000	21-28	65-75	
Gypsophila— <i>Gypsophila elegans</i> . . . . .	A	24, 000	14-21	65-75	
Heliotrope— <i>Valeriana officinalis</i> . . . . .	A	50, 000	21-28	65-75	
Hollyhock— <i>Althaea rosea</i> . . . . .	P	3, 000	14-21	65-75	
Honesty— <i>Lunaria biennis</i> . . . . .	P	1, 500	14-21	65-75	
Impatiens— <i>Impatiens holsti</i> . . . . .	A	66, 000	21-28	70-75	
Incarvillea— <i>Incarvillea grandiflora</i> . . . . .	P	6, 000	14	65-75	
Kalanchoe— <i>Kalanchoe blossfeldiana</i> .	A	2, 500, 000	7-14	65-75	
Lantana— <i>Lantana camara</i> . . . . .	A	1, 300	42-49	65-75	

Freeze seed 72 hrs. before sowing.

Need warmth and moisture.

Sow with bottom heat.

## ORNAMENTAL PLANTS—Continued

Common and Latin names	Plant habit	Approximate seeds per ounce	Emergence		Notable characteristic or requirement
			Time	At temperature	
		Number	Days	Degrees F.	
Larkspur— <i>Delphinium ajacis</i> . . . . .	A	8, 000	21-28	55-65	
Lavender— <i>Lavandula vera</i> . . . . .	P	32, 000	14-21	65-75	
Leopards-bane— <i>Doronicum caucasicum</i> . . . . .	P	18, 000	14-21	65-75	
Lily-of-Peru— <i>Alstroemeria chilensis</i> . . . . .	P	1, 600	42-56	55	Germination erratic.
Linaria— <i>Linaria maroccana</i> . . . . .	A	600, 000	14-21	65-75	
Lobelia— <i>Lobelia erinus</i> . . . . .	A	700, 000	14-21	65-75	
Lupine— <i>Lupinus polyphyllus</i> . . . . .	P	1, 000	21-28	65-75	
Marguerite, Hardy— <i>Anthemis kelwayi</i> . . . . .	P	85, 000	21-28	65-75	
Marigold— <i>Tagetes</i> species . . . . .	A	10, 000	7-14	65-75	
Marvel-of-Peru— <i>Mirabilis jalapa</i> . . . . .	A	325	14-21	65-75	
Mignonette— <i>Reseda odorata</i> . . . . .	A	27, 000	14-21	65-75	
Monkshood— <i>Aconitum napellus</i> . . . . .	P	10, 000	.....	.....	Requires cold treatment.
Morning-glory— <i>Convolvulus</i> species . . . . .	A	650	21-28	65-75	Hard seedcoat.
Moss rose— <i>Portulaca grandiflora</i> . . . . .	A	280, 000	14-21	65-75	
Nasturtium— <i>Tropaeolum majus</i> . . . . .	A	175	14-21	65-75	
Pansy— <i>Viola tricolor</i> . . . . .	A	20, 000	14-21	65-75	
Periwinkle— <i>Vinca rosea</i> . . . . .	A	21, 000	14-21	65-75	
Petunia— <i>Petunia hybrida</i> . . . . .	A	285, 000	7-14	65-75	
Phlox— <i>Phlox drummondii</i> . . . . .	A	14, 000	14-21	65-75	
Physalis— <i>Physalis alkekengi</i> . . . . .	P	18, 000	21-28	65-75	
Pincushion-flower— <i>Scabiosa atropurpurea</i> . . . . .	A	4, 500	14-21	65-75	
Plumbago— <i>Plumbago capensis</i> . . . . .	A	2, 000	21-28	65-75	
Poppy, Iceland— <i>Papaver nudicaule</i> . . . . .	A	275, 000	7-14	65-75	
Poppy, Oriental— <i>Papaver orientale</i> . . . . .	P	140, 000	7-14	65-75	
Primrose, Cape— <i>Streptocarpus hybridus</i> . . . . .	A	750, 000	14-21	65-75	
Primula— <i>Primula obconica</i> . . . . .	A	130, 000	21-28	65-75	
Queen-Annes-lace— <i>Daucus carota</i> . . . . .	A	36, 500	14-21	65-75	
Red-hot-poker— <i>Kniphofia uvaria</i> . . . . .	P	20, 000	21-28	65-75	
Rockcress— <i>Arabis alpina</i> . . . . .	P	120, 000	21-28	65-75	
Salpiglossis— <i>Salpiglossis sinuata superbissima</i> . . . . .	A	125, 000	14	65-75	
Sanvitalia— <i>Sanvitalia procumbens</i> . . . . .	A	50, 000	7-14	65-75	
Saponaria— <i>Saponaria ocymoides</i> . . . . .	P	5, 500	14-21	65-75	
Scarlet Sage— <i>Salvia splendens</i> . . . . .	A	7, 500	14-21	65-75	
Siberian Wallflower— <i>Cheiranthus cheiri</i> . . . . .	P	19, 000	14-21	65-75	
Snapdragon— <i>Antirrhinum majus</i> . . . . .	A	125, 000	7-14	65-75	
Snow-on-the-mountain— <i>Euphorbia heterophylla</i> . . . . .	A	5, 000	7-14	65-75	
Spider-plant— <i>Cleome spinosa</i> . . . . .	A	12, 500	7-14	65-75	
Statice— <i>Limonium sinuata</i> . . . . .	A	350	14-21	65-75	
Stock— <i>Mathiola incana</i> . . . . .	A	16, 000	14	65-75	
Summer-cypress— <i>Kochia childsii</i> . . . . .	A	45, 000	7-14	65-75	
Sunflower— <i>Helianthus annuus</i> . . . . .	A	650	14-21	65-75	
Sweetpea— <i>Lathyrus odoratus</i> . . . . .	A	350	14	65-75	
Sweet-william— <i>Dianthus barbatus</i> . . . . .	B	25, 000	14-21	65-75	
Sweet-Wivelsfield— <i>Dianthus chinensis</i> . . . . .	A	25, 000	14-21	65-75	
Thrift— <i>Armeria alpina</i> . . . . .	P	32, 000	21-28	65-70	
Tithonia— <i>Tithonia rotundifolia</i> . . . . .	A	3, 500	14-21	65-75	
Tobacco, flowering— <i>Nicotiana affinis</i> . . . . .	A	400, 000	7-14	65-75	
Verbena— <i>Verbena hortensis</i> . . . . .	A	10, 000	21-28	65-75	
Viola— <i>Viola cornuta</i> . . . . .	P	24, 000	14-21	65-75	
Zinnia— <i>Zinnia elegans</i> . . . . .	A	2, 500	7-14	65-75	

## ESTIMATED COSTS OF PRODUCING COMMON VEGETABLE SEEDS, 1959

Types of costs	Table beet	Broc- coli	Cabbage	Carrot	Cauli- flower	Celery	Lettuce	Melon	Onion	Garden peas	Radish	Sweet corn
VARIABLE CULTURAL:												
Land preparation.....	\$8	\$10	\$10	\$8	\$10	\$10	\$10	\$15	\$18	\$5	\$11	\$8
Fertilization.....	30	17	18	27	18	74	22	16	27	1	10	20
Planting.....	3	2	2	<sup>1</sup> 25	2	3	3	5	<sup>1</sup> 45	8	3	7
Irrigation.....	21	22	24	24	24	31	20	15	29	.....	19	15
Cultivations.....	5	4	5	3	5	8	7	6	6	.....	4	5
Chemical weed control.....	.....	.....	.....	15	.....	.....	.....	.....	.....	2	.....	.....
Thinning.....	.....	20	25	.....	25	.....	22	.....	.....	.....	20	.....
Hoeing and weeding.....	15	10	10	5	10	10	10	13	8	.....	7	15
Dusting and spraying.....	20	8	11	20	11	20	12	5	26	1	6	20
Other cultural labor.....	.....	5	15	3	15	.....	.....	.....	3	.....	.....	35
HARVESTING:												
Cutting.....	.....	.....	.....	.....	.....	.....	.....	.....	65	2	.....	.....
Hand labor.....	35	25	25	.....	23	50	34	.....	22	.....	15	.....
Threshing.....	30	20	20	<sup>2</sup> 50	20	60	30	50	6	5	.....	20
Washing and drying.....	.....	.....	.....	.....	.....	.....	.....	25	.....	.....	.....	.....
OVERHEAD:												
Taxes.....	10	10	10	10	10	10	10	10	10	2	10	6
Miscellaneous.....	12	11	14	12	11	13	14	14	14	1	14	6
Depreciation on equipment.....	7	7	7	7	7	7	7	7	7	5	7	5
Interest on equipment.....	3	3	3	3	3	3	3	3	3	2	3	2
Interest on land.....	36	36	36	36	36	36	36	36	36	16	36	36
Total per acre.....	235	210	235	248	230	335	240	220	325	50	165	200
Yield (pounds).....	1,500	1,000	1,200	1,000	350	1,100	400	400	600	1,200	1,200	2,500
Cost per pound.....	0.16	0.21	0.20	0.25	0.66	0.30	0.60	0.55	0.54	0.04	0.14	0.08

<sup>1</sup> Stecklings or bulbs furnished by seed company.

<sup>2</sup> Where the plants must be pulled by hand because of excess grass in the field, the harvesting costs will be doubled.

SOME CHARACTERISTICS OF SEEDS OF SPECIES USED AS ROOTSTOCKS FOR TREE FRUITS AND NUTS

The following table lists the common name in the first column and the Latin name in the second column.

All tree fruit and nut crops are perennials, producing crops annually. No specific length of life can be indicated since this varies with growing factors in the various geographic localities.

Most deciduous tree fruit and nut seeds require afterripening, which is effected by storage in a damp substrate, such as peat and sand, at temperatures in the neighborhood of 40° F. The length of such afterripening period seems to be related to the length of the natural cold season in which the

fruit was originally native. Some seeds, such as those of citrus, appear to require very short or no chilling. Germination after the chilling requirement has been satisfied is dependent on environment and is variable in optimum temperature. Some species respond more slowly than others.

Longevity of viability of seeds is dependent on storage temperature and moisture. A decrease or increase of the times shown can be effected with conditions. Cherry seeds lose viability rapidly if they become too dry. Citrus seeds are surface dried but cannot stand air drying. Peach and apricot seeds have longer life if kept air dry at moderate temperatures.

Common name	Latin name	Approximate seeds per ounce	Afterripening needed for germination (days)	Speed of germination at optimum temperature (days)	Length of viability (years)
Almond	<i>Prunus amygdalus</i>	12-15	50	15	5
Apple	<i>Malus domestica</i>	600-1,000	75-100	30	2-3
Apple (crab)	<i>Malus pumila</i>	1,000	75	30	2-3
Apricot	<i>Prunus armeniaca</i>	18-20	60	15	5
Cherry (Mahaleb)	<i>Prunus mahaleb</i>	300-350	100	15	1-3 cool-dry.
Cherry (sweet) (Mazzard)	<i>Prunus avium</i>	150-160	100-120	15	1-2 cool-dry.
Cherry (sour)	<i>Prunus cerasus</i>	200-250	100-120	15	1-2 cool-dry.
Citrangens	<i>Poncirus trifoliata</i>	200-300	None	10-15 at 55° F.	Up to 1 year in polyethylene bag at 45°.
	<i>Citrus sinensis</i>		×		
Citrus macrophylla	<i>Citrus macrophylla</i>	200-300	None	do.	Do.
Fig	<i>Ficus carica</i>			Propagated by cuttings.	
Filbert	<i>Corylus maxima</i>			Propagated by cuttings.	
Grapefruit	<i>Citrus paradisi</i>	150-200	None	10-15 at 55° F.	Do.
Lemon (rough)	<i>Citrus limon</i>	200-300	None	do.	Do.
Lime (sweet)	<i>Citrus aurantifolia</i>	300-400	None	do.	Do.
Orange (sweet)	<i>Citrus sinensis</i>	200-300	None	do.	Do.
Orange (sour)	<i>Citrus aurantium</i>	200-300	None	do.	Do.
Orange (trifoliolate)	<i>Poncirus trifoliata</i>	200-300	None	do.	Do.
Peach	<i>Prunus persica</i>	8-10	100	15	5
Peach (David)	<i>Prunus davidiana</i>	10-14	100	15	5
Pear	<i>Pyrus communis</i>	750	60-90	45	2-3 dry.
Pear (Oriental)	<i>Pyrus calleryana</i>	1,000	60-90	45	3
Pear (Oriental)	<i>Pyrus serotina</i>	1,000	60-90	45	3
Pear (Oriental)	<i>Pyrus ussuriensis</i>	1,000	60-90	45	3
Pecan	<i>Carya pecan</i>	8-10	30-90	20	1-3

Plum (American).....	<i>Prunus americana</i> .....	50-55	150	30	4-6
Plum (Bessey).....	<i>Prunus besseyi</i> .....	160-170	80-100	15	4-6
Plum (Damson).....	<i>Prunus insititia</i> .....	100-120	100-120	30	4-6
Plum (Japanese).....	<i>Prunus salicina</i> .....	20-40	60-100	15	4-6
Plum (domestic).....	<i>Prunus domestica</i> .....	26-30	120	30	4-6
Plum (Myrobalan) (cherry plums).....	<i>Prunus cerasifera</i> .....	60-70	80-100	30	4-6
Plum (Marianna).....	<i>Prunus cerasifera</i> .....	50-70	100	30	4-6
Plum (Wild Goose).....	<i>Prunus munsoniana</i> .....	120-140	80-100	15	4-6
Quince.....	<i>Cydonia oblonga</i> .....				
	<i>Citrus reticulata</i> .....	200-300	None	10-15 at 55° F.	Up to 1 year in polyethylene bag at 45°.
Tangelo.....	<i>Citrus paradisi</i> .....	×			
Tangerine (Mandarin).....	<i>Citrus reticulata</i> .....	300-400	None	do.	Do.
Tung.....	<i>Aleurites fordii</i> .....	10-15	30-60	10	1-3
Walnut (Eastern black).....	<i>Juglans nigra</i> .....	3	60-120	30	3-5
Walnut (Northern Calif. black).....	<i>Juglans hindsii</i> .....	2-4	60-120	30	3-5
Walnut (Persian).....	<i>Juglans regia</i> .....	2	30-60	20	1-3
Walnut (Paradox hybrid).....	<i>Juglans hindsii</i> × <i>J. regia</i> .....	3-4	60-80	25	3-5
Walnut (Royal hybrid).....	<i>Juglans hindsii</i> × <i>J. nigra</i> .....	3-5	60-100	25	3-5

## U.S. SEED EXPORTS BY TYPE, QUANTITY AND VALUE, 1946-47 TO 1958-59

Year	Grasses and legumes		Other field seeds		Seed corn		Vegetable seeds		Sugarbeet		Flowers		Total	
	1, 000 pounds	1, 000 dollars	1, 000 pounds	1, 000 dollars	1, 000 pounds	1, 000 dollars	1, 000 pounds	1, 000 dollars	1, 000 pounds	1, 000 dollars	1, 000 pounds	1, 000 dollars	1, 000 pounds	1, 000 dollars
1946-47.....	29, 092	9, 826	12, 482	1, 207	N.A.	N.A.	16, 305	6, 784	8, 992	2, 235	416	598	67, 287	20, 650
1947-48.....	22, 823	3, 506	13, 643	1, 710	N.A.	N.A.	7, 125	4, 886	10, 219	3, 445	213	415	54, 023	13, 962
1948-49.....	23, 177	6, 660	7, 600	655	29, 120	2, 271	4, 871	3, 961	3, 248	690	136	268	68, 152	14, 505
1949-50.....	12, 790	4, 051	3, 210	372	25, 144	1, 905	2, 912	2, 310	766	130	156	235	68, 284	9, 003
1950-51.....	17, 611	4, 967	7, 326	661	13, 552	951	3, 599	1, 701	413	78	175	279	42, 676	8, 637
1951-52.....	13, 945	3, 637	4, 330	459	13, 384	1, 123	3, 465	1, 935	852	142	195	359	36, 171	7, 655
1952-53.....	7, 404	2, 705	1, 079	83	11, 088	926	3, 254	3, 049	849	143	174	324	23, 848	7, 230
1953-54.....	26, 663	6, 491	65, 976	1, 625	13, 272	855	4, 057	2, 688	647	123	158	395	110, 773	12, 177
1954-55.....	49, 953	14, 985	5, 468	420	15, 568	1, 187	4, 030	2, 956	810	173	227	614	76, 056	20, 335
1955-56.....	31, 199	6, 831	6, 837	704	43, 680	3, 672	4, 122	3, 249	100	19	153	410	86, 091	14, 885
1956-57.....	42, 974	13, 476	11, 238	913	21, 484	1, 755	4, 568	3, 494	723	186	250	560	81, 237	20, 384
1957-58.....	45, 927	11, 372	15, 846	782	18, 592	1, 624	4, 996	3, 040	271	56	214	605	85, 846	17, 479
1958-59.....	38, 603	9, 998	10, 112	749	13, 014	1, 697	3, 943	3, 230	473	97	319	650	66, 464	16, 421

N.A.—Not available.

Source: Foreign Agricultural Service. Compiled from records of Department of Commerce.

## SOME SEED CHARACTERISTICS OF COMMERCIALY

Most American forest trees reproduce primarily from seeds. To restore and maintain good and sow seeds either directly on the land or in nurseries to produce seedlings which can be provide food for many birds and small mammals. Many of the berry, fleshy fruit, and nut

Species	Time of—		Commercial seed-bearing age <sup>1</sup>
	Flowering	Seed dispersal	
			Years
1. Alaska-cedar ( <i>Chamaecyparis nootkensis</i> )	Early spring	Fall-spring	20-100
2. Alder, red ( <i>Alnus rubra</i> )	do	Nov.-Dec.	20-100
3. Ash, green ( <i>Fraxinus pennsylvanica</i> )	May	Oct.-May	20-?
4. Ash, white ( <i>F. americana</i> )	Apr.-May	Sept.-Dec.	20-175
5. Aspen, quaking ( <i>Populus tremuloides</i> )	do	May-June	20-70+
6. Baldcypress ( <i>Taxodium distichum</i> )	Mar.-Apr.	Oct.-Dec.	?
7. Basswood ( <i>Tilia americana</i> )	June-July	Fall-spring	15-100+
8. Beech, American ( <i>Fagus grandifolia</i> )	Apr.-May	After first heavy frost	40-?
9. Birch, sweet ( <i>Betula lenta</i> )	do	Sept.-Nov.	40-?
10. Birch, gray ( <i>B. populifolia</i> )	do	Oct.-Jan.	8-50
11. Birch, yellow ( <i>B. alleghaniensis</i> )	do	Nov.-Feb.	15-70+
12. Birch, paper ( <i>B. papyrifera</i> )	Apr.-June	Sept.-Apr.	15-70+
13. Boxelder ( <i>Acer negundo</i> )	Mar.-May	Sept.-Mar.	20-80
14. Butternut ( <i>Juglans cinerea</i> )	Apr.-May	Sept.-Oct.	20-80
15. Catalpa, northern ( <i>Catalpa speciosa</i> )	May-June	Oct.-Mar.	20-?
16. Cherry, black ( <i>Prunus serotina</i> )	Mar.-June	June-Oct.	10-125
17. Chestnut, American ( <i>Castanea dentata</i> )	June-July	Oct.-Nov.	?
18. Coffeetree, Kentucky ( <i>Gymnocladus dioica</i> )	June	Sept.-Mar.	10-death
19. Cottonwood, eastern ( <i>Populus deltoides</i> )	Feb.-May	Apr.-June	9-600
20. Cypress, Arizona ( <i>Cupressus arizonica</i> )	Spring	Sept.-following years	?
21. Douglas-fir ( <i>Pseudotsuga menziesii</i> )	Spring-summer	Aug.-Sept.	9-600
22. Elm, American ( <i>Ulmus americana</i> )	Feb.-Apr.	Mar.-June	15-300
23. Elm, rock ( <i>U. thomasii</i> )	Mar.-May	May-July	20-250
24. Elm, slippery ( <i>U. rubra</i> )	Feb.-Apr.	Apr.-June	15-200
25. Fir, balsam ( <i>Abies balsamea</i> )	May	Sept.-Nov.	20-60+
26. Fir, California red ( <i>A. magnifica</i> )	June	Sept.-Oct.	Middle-age
27. Fir, Fraser ( <i>A. fraseri</i> )	May-June	Oct.-Nov.	20-100+
28. Fir, grand ( <i>A. grandis</i> )	Spring	Sept.-Oct.	20-100+
29. Fir, noble ( <i>A. procera</i> )	?	Oct.	50-100+
30. Fir, Pacific silver ( <i>A. amabilis</i> )	Spring	Oct.	40-100+
31. Fir, white ( <i>A. concolor</i> )	May-June	Sept.-Oct.	20-100+
32. Hackberry ( <i>Celtis occidentalis</i> )	Apr.-May	Oct.-winter	?
33. Hemlock, eastern ( <i>Tsuga canadensis</i> )	May-June	Sept.-winter	30-400+
34. Hemlock, western ( <i>T. heterophylla</i> )	Spring	Sept.	25-200+
35. Hickory, bitternut ( <i>Carya cordiformis</i> )	Apr.-May	Sept.-Dec.	30-175

## IMPORTANT NORTH AMERICAN FOREST TREES

forest stands, it is necessary to provide favorable conditions for natural seeding or to gather planted. This requires an understanding of seed habits and characteristics. Most tree seeds species also are a source of food for larger mammals, including man.

Frequency of good seed crops <sup>2</sup>	Weight per 1,000 cleaned seeds <sup>3</sup>		Seed dormancy <sup>4</sup>		Average laboratory germination
	Average	Range	Kind	Occurrence	Percent
<i>Years</i>	<i>Grams</i>	<i>Grams</i>			
Occasional . . .	4.20	2.52-6.87	Embryo? . . . . .	General? . . . . .	1
4 . . . . .	.68	.42-1.25	. . . do . . . . .	General . . . . .	27
1+ . . . . .	26.22	18.44-41.24	Embryo . . . . .	. . . do . . . . .	42
3-5 . . . . .	45.36	24.92-82.47	. . . do . . . . .	. . . do . . . . .	38
4-5 . . . . .	.13	. . . . .	None . . . . .	Quite gen . . . . .	59
3-5 . . . . .	94.50	49.85-348.92	Embryo + resinous seedcoat?	General . . . . .	12
1+ . . . . .	90.72	56.70-151.20	Embryo, impermeable seedcoat, tough pericarp.	. . . do . . . . .	34
2-3 . . . . .	263.50	197.22-348.92	Embryo . . . . .	. . . do . . . . .	85
1-2 . . . . .	.70	.49-.92	Embryo? . . . . .	. . . do . . . . .	43
1+ . . . . .	.11	.09-.13	. . . do . . . . .	. . . do . . . . .	64
1-2 . . . . .	1.01	.50-1.63	. . . do . . . . .	. . . do . . . . .	27
1+ . . . . .	.33	.11-.74	. . . do . . . . .	. . . do . . . . .	34
1+ . . . . .	38.44	30.24-55.32	Embryo . . . . .	. . . do . . . . .	33
2-3 . . . . .	15, 120.00	11, 340.00-30, 240.00	Embryo + hard seedcoat?	. . . do . . . . .	65
2+ . . . . .	21.60	15.12-28.35	None? . . . . .	General? . . . . .	75
+1 . . . . .	94.50	56.00-146.32	Embryo + hard seedcoat?	General . . . . .	63
1+ . . . . .	3, 489.23	2, 835.00-4, 536.00	Embryo . . . . .	. . . do . . . . .	72
1-2 . . . . .	1, 649.45	1, 242.74-2, 160.00	Impermeable seedcoat.	. . . do . . . . .	75
1+ . . . . .	1.30	.77-2.27	None . . . . .	Quite gen . . . . .	88
1+ . . . . .	11.34	7.69-16.80	Embryo? . . . . .	General . . . . .	26
3-7 . . . . .	10.80	6.67-22.68	Embryo + hard seedcoat?	Variable . . . . .	65
1+ . . . . .	6.67	4.77-9.45	Embryo . . . . .	Some, but not all lots.	63
3-4 . . . . .	64.80	50.40-90.72	None . . . . .	General . . . . .	85
2-4 . . . . .	11.06	8.40-12.96	Embryo . . . . .	In northern sources.	17
2-4 . . . . .	7.56	4.80-15.12	. . . do . . . . .	Some, but not all lots.	22
2-3 . . . . .	68.73	41.24-113.40	. . . do . . . . .	. . . do . . . . .	25
. . . . .	8.10	6.57-10.31	. . . do . . . . .	. . . do . . . . .	42
2-3 . . . . .	19.55	10.24-36.00	Embryo? . . . . .	Some, but not all lots?	28
Infrequent . . .	31.07	23.50-40.50	Embryo . . . . .	Some, but not all lots.	24
2-3 . . . . .	40.14	30.44-55.32	. . . do . . . . .	. . . do . . . . .	22
2-4 . . . . .	30.04	16.68-55.32	. . . do . . . . .	. . . do . . . . .	34
1+ . . . . .	105.49	84.00-129.60	Embryo, seedcoat?	General . . . . .	41
2-3 . . . . .	2.43	1.26-3.44	Embryo . . . . .	Variable . . . . .	38
2-5 . . . . .	1.53	.89-2.06	. . . do . . . . .	. . . do . . . . .	56
3-5 . . . . .	2, 907.69	2, 451.89-3, 628.80	. . . do . . . . .	General . . . . .	55



Species	Time of—		Commercial seed-bearing age <sup>1</sup> Years
	Flowering	Seed dispersal	
36. Hickory, mockernut ( <i>C. tomentosa</i> )..	Apr.—May ...	Sept.—Dec. ....	25-200.....
37. Hickory, pignut ( <i>C. glabra</i> ).....	...do.....	...do.....	30-300.....
38. Hickory, shagbark ( <i>C. ovata</i> ).....	Apr.—June ...	...do.....	40-300.....
39. Hickory, shellbark ( <i>C. laciniosa</i> )....	...do.....	...do.....	40-350.....
40. Honeylocust ( <i>Gleditsia triacanthos</i> )..	May—June ...	Sept.—Feb. ....	10-100.....
41. Incense-cedar ( <i>Libocedrus decurrens</i> )..	January.....	Oct.—Nov.....	20-200+.....
42. Juniper, Rocky Mountain ( <i>Juniperus scopulorum</i> ).	Spring.....	Long persistent.	10-300.....
43. Larch, western ( <i>Larix occidentalis</i> )..	...do.....	Aug.—Sept.....	40-60+.....
44. Locust, black ( <i>Robinia pseudoacacia</i> )..	May—June ...	Sept.—Apr.....	6-60.....
45. Maple, red ( <i>Acer rubrum</i> ).....	Feb.—May ...	Apr.—July.....	.....
46. Maple, silver ( <i>A. saccharinum</i> ).....	Feb.—Apr. ...	Apr.—June.....	35-?.....
47. Maple, sugar ( <i>A. saccharum</i> ).....	Mar.—May ...	Oct.—Dec.....	?-200+.....
48. Oak, black ( <i>Quercus velutina</i> ).....	Apr.—May ...	Sept.—Nov.....	20-100.....
49. Oak, bur ( <i>Q. macrocarpa</i> ).....	...do.....	Aug.—Sept.....	35-400.....
50. Oak, chestnut ( <i>Q. prinus</i> ).....	...do.....	Sept.—Nov.....	20-150.....
51. Oak, northern red ( <i>Q. rubra</i> ).....	...do.....	Sept.—Oct.....	25-200.....
52. Oak, scarlet ( <i>Q. coccinea</i> ).....	...do.....	...do.....	20-150.....
53. Oak, southern red ( <i>Q. falcata</i> ).....	...do.....	...do.....	25-125.....
54. Oak, swamp chestnut ( <i>Q. michauxii</i> )..	...do.....	...do.....	.....
55. Oak, white ( <i>Q. alba</i> ).....	...do.....	...do.....	20-300.....
56. Pecan ( <i>Carya illinoensis</i> ).....	Mar.—May ...	Sept.—Dec.....	20-300.....
57. Pine, eastern white ( <i>Pinus strobus</i> )..	Apr.—June ...	Sept.—Oct.....	15-250.....
58. Pine, jack ( <i>P. banksiana</i> ).....	May.....	Fall—several years.	5-80+.....
59. Pine, Jeffrey ( <i>P. jeffreyi</i> ).....	June.....	Fall—spring ...	8-150+.....
60. Pine, loblolly ( <i>P. taeda</i> ).....	Mar.—Apr.....	...do.....	12-60+.....
61. Pine, lodgepole ( <i>P. contorta</i> ).....	June.....	Fall—several years.	5-200+.....
62. Pine, longleaf ( <i>P. palustris</i> ).....	Feb.—Apr. ...	Sept.—Dec.....	20-350+.....
63. Pine, ponderosa ( <i>P. ponderosa</i> ).....	Apr.—June ...	Fall—spring ...	20-150+.....
64. Pine, red ( <i>P. resinosa</i> ).....	...do.....	Fall—summer ...	25-200+.....
65. Pine, shortleaf ( <i>P. echinata</i> ).....	Mar.—Apr.....	Nov.—Dec.....	16-280+.....
66. Pine, slash ( <i>P. elliottii</i> ).....	Jan.—Mar. ...	Sept.—Oct.....	12-150+.....
67. Pine, sugar ( <i>P. lambertiana</i> ).....	May—June ...	Aug.—Oct.....	40-175+.....
68. Pine, western white ( <i>P. monticola</i> )..	Spring.....	Fall—spring ...	10-300+.....

IMPORTANT NORTH AMERICAN FOREST TREES—Continued

Frequency of good seed crops <sup>2</sup>	Weight per 1,000 cleaned seeds <sup>3</sup>		Seed dormancy <sup>4</sup>		Average laboratory germination
	Average	Range	Kind	Occurrence	Percent
Years	Grams	Grams			
2-3.....	5, 040. 00	4, 014. 16-13, 341. 18	Embryo.....	General.....	66
1-2.....	2, 268. 00	2, 016. 00-2, 592. 00	....do.....	....do.....	85
1-3.....	4, 536. 00	3, 024. 00-5, 670. 00	....do.....	....do.....	80
1-2.....	15, 120. 00	12, 960. 00-18, 144. 00	....do.....	....do.....	..
1-2.....	162. 00	112. 00-259. 20	Impermeable seedcoat.	....do.....	50
3.....	30. 24	15. 64-70. 88	Probably embryo.	Variable.....	50
2-5.....	15. 86	10. 77-25. 34	Embryo + seedcoat.	General.....	22
5-6.....	3. 17	2. 30-4. 63	Probably embryo.	Variable.....	27
1-2.....	18. 90	12. 96-28. 35	Impermeable seedcoat.	General.....	68
1+.....	19. 89	11. 87-35. 72	Embryo.....	Some, but not all lots.	46
1+.....	324. 00	238. 74-504. 00	None.....	.....	76
3-7.....	74. 36	49. 85-141. 75	Embryo.....	.....	39
2-3.....	1, 814. 40	1, 134. 00-3, 628. 80	....do.....	General.....	47
2-3.....	6, 048. 00	3, 360. 00-11, 340. 00	....do.....	Variable <sup>5</sup> ...	45
1-2.....	6, 048. 00	4, 536. 00-8, 247. 27	None.....	General.....	82
2-3.....	3, 240. 00	1, 778. 82-5, 670. 00	Embryo.....	....do.....	58
Irregular.....	1, 620. 00	1, 120. 00-2, 926. 45	....do.....	....do.....	62
1-2.....	762. 35	577. 83-1, 163. 08	....do.....	....do.....	91-
.....	4, 536. 00	2, 326. 15-8, 247. 27	None.....	....do.....	87
4-10.....	3, 024. 00	2, 160. 00-6, 480. 00	....do.....	Quite gen...	78
1-2.....	4, 536. 00	2, 835. 00-8, 247. 27	Embryo.....	General.....	50
3-5.....	16. 80	8. 56-22. 68	....do.....	Quite gen...	64
3-4.....	3. 45	1. 81-6. 39	Probably embryo.	Occasional...	68
2-4.....	113. 40	84. 00-146. 32	....do.....	....do.....	68
3-10.....	24. 65	18. 14-28. 35	....do.....	Quite gen...	60
1-3.....	4. 45	2. 84-11. 94	....do.....	Occasional...	64
3-7.....	108. 00	75. 60-119. 37	....do.....	Rare.....	54
2-5.....	37. 80	19. 72-65. 74	....do.....	Occasional...	59
3-7.....	8. 72	6. 39-15. 12	None.....	General.....	75
5-10.....	9. 45	7. 26-12. 43	Probably embryo.	Quite gen...	68
1-10.....	31. 28	28. 35-34. 89	....do.....	Occasional...	61
3-5.....	216. 00	141. 75-302. 40	....do.....	Variable.....	56
4-6.....	16. 80	14. 18-32. 40	Seedcoat, probably embryo.	....do.....	48

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SOME SEED CHARACTERISTICS OF COMMERCIALY

Species	Time of—		Commercial seed-bearing age <sup>1</sup>  Years
	Flowering	Seed dispersal	
69. Port-Orford-cedar ( <i>Chamaecyparis lawsoniana</i> ).	Spring . . . . .	October . . . . .	8-100+ . . . . .
70. Redcedar, eastern ( <i>Juniperus virginiana</i> ).	Mar.-May . . . . .	Feb.-Mar . . . . .	10-175 . . . . .
71. Redcedar, western ( <i>Thuja plicata</i> ) . .	Apr. . . . .	Aug.-Oct. . . . .	16-200+ . . . . .
72. Redwood ( <i>Sequoia sempervirens</i> ) . . . . .	Nov.-Mar . . . . .	Fall . . . . .	20-300+ . . . . .
73. Sequoia, giant ( <i>S. gigantea</i> ) . . . . .	Feb.-Mar . . . . .	. . . do . . . . .	125-300+ . . . . .
74. Spruce, black ( <i>Picea mariana</i> ) . . . . .	May-June . . . . .	Oct. <sup>6</sup> . . . . .	30-250 . . . . .
75. Spruce, Engelmann ( <i>P. engelmannii</i> ) .	June-July . . . . .	Sept.-Oct . . . . .	16-200+ . . . . .
76. Spruce, red ( <i>P. rubens</i> ) . . . . .	Apr.-May . . . . .	Sept. . . . .	30-? . . . . .
77. Spruce, Sitka ( <i>P. sitchensis</i> ) . . . . .	. . . do . . . . .	Early fall . . . . .	35-? . . . . .
78. Spruce, white ( <i>P. glauca</i> ) . . . . .	May . . . . .	Aug.-Nov . . . . .	30-? . . . . .
79. Sweetgum ( <i>Liquidambar styraciflua</i> ) . .	Mar.-May . . . . .	Sept.-Nov . . . . .	20-150 . . . . .
80. Sycamore, American ( <i>Platanus occidentalis</i> ).	May . . . . .	Sept.-May . . . . .	25-250 . . . . .
81. Tamarack ( <i>Larix laricina</i> ) . . . . .	. . . do . . . . .	Sept . . . . .	40-75+ . . . . .
82. Tupelo, black ( <i>Nyssa sylvatica</i> ) . . . . .	Apr.-June . . . . .	Sept.-Oct . . . . .	. . . . .
83. Walnut, black ( <i>Juglans nigra</i> ) . . . . .	May-June . . . . .	Fall . . . . .	12-? . . . . .
84. White-cedar, Atlantic ( <i>Chamaecyparis thyoides</i> ).	Mar.-Apr . . . . .	Oct.-Nov . . . . .	4-100+ . . . . .
85. White-cedar, northern ( <i>Thuja occidentalis</i> ).	Apr.-May . . . . .	Aug.-Oct . . . . .	30-100+ . . . . .
86. Yellow-poplar ( <i>Liriodendron tulipifera</i> ) .	Apr.-June . . . . .	Oct.-Jan . . . . .	15-200+ . . . . .

<sup>1</sup> Most tree species begin to bear seeds several years earlier than indicated and continue almost to death, but the most abundant production normally is between the ages indicated. Open-grown trees usually bear earlier and more abundantly than those in stands.

<sup>2</sup> Most trees bear some seed in the years between good crops, although total failures may occur.

<sup>3</sup> Seeds cleaned for commercial use. Wings, fleshy parts removed in many species.

<sup>4</sup> Seeds of many woody plants contain dormant embryos. Such dormancy usually can be broken by holding the seeds for 1 to 3 months in a moist medium at 0° to 5° C. Some species, chiefly legumes, have hard or impermeable seedcoats which can be overcome by mechanical

## IMPORTANT NORTH AMERICAN FOREST TREES—Continued

Frequency of good seed crops <sup>2</sup>	Weight per 1,000 cleaned seeds <sup>3</sup>		Seed dormancy <sup>4</sup>		Average laboratory germina- tion  Percent
	Average  Grams	Range  Grams	Kind	Occurrence	
Years 4-5 . . . . .	2. 16	. 76-5. 67	Embryo? . . . . .	General? . . . . .	52
2-3 . . . . .	10. 50	7. 69-25. 77	Embryo + seed- coat? . . . . .	General . . . . .	42
2-3 . . . . .	1. 10	. 90-2. 23	Embryo . . . . .	Slight, variable. . . . . do . . . . .	51
1+ . . . . .	3. 72	1. 51-7. 69	Probably embryo. . . . . do . . . . .	. . . . do . . . . .	10
1+ . . . . .	4. 98	3. 44-8. 40	. . . . do . . . . .	. . . . do . . . . .	25
4-5 . . . . .	1. 12	. 89-1. 40	Embryo . . . . .	General . . . . .	64
2-3 . . . . .	3. 36	2. 27-6. 57	. . . . do . . . . .	Occasional . . . . .	69
3-8 . . . . .	3. 24	1. 57-4. 54	. . . . do . . . . .	General . . . . .	60
3-4 . . . . .	2. 16	1. 13-2. 93	. . . . do . . . . .	Variable . . . . .	60
2-6 . . . . .	1. 89	1. 14-3. 19	. . . . do . . . . .	General . . . . .	50
1-3 . . . . .	5. 53	5. 04-6. 98	Probably embryo. . . . . do . . . . .	. . . . do . . . . .	70
1-2 . . . . .	2. 22	1. 99-3. 00	. . . . do . . . . .	Quite gen . . . . .	35
5-6 . . . . .	1. 42	1. 08-2. 16	Embryo . . . . .	General . . . . .	47
. . . . .	137. 45	113. 40-245. 19	. . . . do . . . . .	. . . . do . . . . .	30
Irregular . . . . .	11, 340. 00	4, 536. 00- 22, 680. 00	Embryo + hard seedcoat? . . . . .	. . . . do . . . . .	75
1+ . . . . .	. 99	. 91-1. 08	Embryo? . . . . .	General? . . . . .	84
5 . . . . .	1. 31	. 80-2. 47	Embryo . . . . .	Slight, variable. . . . . do . . . . .	46
Irregular . . . . .	32. 40	18. 90-45. 36	Embryo + seed- coat? . . . . .	General . . . . .	5

scarification or soaking in  $H_2SO_4$ . Several trees have seeds with both types of dormancy. In some species seed dormancy is general; others may have both dormant and nondormant seed in the same lot; and still others may vary between lots, some lots being completely dormant and others completely nondormant. Types of dormancy suspected but not proved experimentally are indicated by question mark.

<sup>5</sup> No embryo dormancy in species proper, but general embryo dormancy in var. *olivaeformis*.

<sup>6</sup> Black spruce cones are retained for 2 or 3 years in a state of active seed dispersal.

## DATA ON SOME FOREST TREES

Common name <sup>1</sup>	Scientific name	Number seed/oz.		Treatment recommended for germination <sup>2</sup>
		Average	Range	
Alder, red.....	<i>Alnus rubra</i> .....	41, 500	22, 600- 67, 500	(a)
Ash, black.....	<i>Fraxinus nigra</i> .....	510	380- 590	(a)
Ash, green.....	<i>F. pennsylvanica</i> .....	790	580- 1, 180	(a)
Ash, white.....	<i>F. americana</i> .....	625	340- 1, 140	(a)
Aspen, bigtooth.....	<i>Populus grandidentata</i> .....	190, 000	.....	None
Aspen, quaking.....	<i>P. tremuloides</i> .....	225, 000	.....	None
Basswood, American.....	<i>Tilia americana</i> .....	310	190- 500	(b)
Beech, American.....	<i>Fagus grandifolia</i> .....	100	80- 140	(a)
Sugarberry.....	<i>Celtis laevigata</i> .....	270	230- 360	(a)
Birch, paper.....	<i>Betula papyrifera</i> .....	86, 000	38, 000-260, 000	(a)
Birch, sweet.....	<i>B. lenta</i> .....	40, 400	30, 800- 58, 300	(a)
Birch, yellow.....	<i>B. alleghaniensis</i> .....	27, 900	17, 400- 56, 600	(a)
Boxelder.....	<i>Acer negundo</i> .....	740	510- 940	(a)
Buckeye, Ohio.....	<i>Aesculus glabra</i> .....	.....	3- 4	(c)
Buckeye, yellow.....	<i>A. octandra</i> .....	.....	2- 3	(c)
Butternut.....	<i>Juglans cinerea</i> .....	2	1- 4	(c)
Cedar (Alaska-cedar).....	<i>Chamaecyparis nootkatensis</i> .....	7, 400	4, 100- 11, 200	None
Cedar (Atlantic white-cedar).....	<i>C. thyoides</i> .....	28, 700	26, 200- 31, 200	None
Cedar (eastern redcedar).....	<i>Juniperus virginiana</i> .....	2, 700	1, 100- 3, 700	(c)
Cedar (incense-cedar).....	<i>Libocedrus decurrens</i> .....	900	400- 1, 800	(a)
Cedar (northern white-cedar).....	<i>Thuja occidentalis</i> .....	21, 600	11, 500- 35, 500	None
Cedar (Port-Orford-cedar).....	<i>Chamaecyparis lawsoniana</i> .....	13, 200	5, 000- 37, 500	None
Cedar (western redcedar).....	<i>Thuja plicata</i> .....	25, 800	12, 700- 31, 500	None
Cherry, black.....	<i>Prunus serotina</i> .....	190	300- 500	(c)
Cottonwood, eastern.....	<i>Populus deltoides</i> .....	21, 800	12, 500- 36, 800	None
Cypress (baldcypress).....	<i>Taxodium distichum</i> .....	300	80- 500	(a)
Dogwood, flowering.....	<i>Cornus florida</i> .....	280	200- 390	(c)
Elm, American.....	<i>Ulmus americana</i> .....	4, 200	3, 000- 5, 900	(a)
Elm, rock.....	<i>U. thomasii</i> .....	440	310- 560	(a)
Elm, slippery.....	<i>U. rubra</i> .....	2, 560	2, 180- 3, 370	(a)
Fir, balsam.....	<i>Abies balsamea</i> .....	3, 720	1, 870- 5, 900	(a)
Fir, California red.....	<i>A. magnifica</i> .....	410	250- 680	(a)
Fir (Douglas-fir).....	<i>Pseudotsuga menziesii</i> .....	2, 610	1, 250- 4, 250	(a)
Fir, grand.....	<i>Abies grandis</i> .....	1, 450	740- 2, 780	(a)
Fir, noble.....	<i>A. procera</i> .....	910	700- 1, 200	(a)
Fir, Pacific silver.....	<i>A. amabilis</i> .....	700	500- 930	(a)
Fir, subalpine.....	<i>A. lasiocarpa</i> .....	2, 340	1, 490- 3, 200	(a)

Fir, white. . . . .	A. concolor . . . . .	940	520-	1, 710	(a)
Gum (sweetgum). . . . .	Liquidambar styraciflua . . . . .	5, 100	4, 050-	5, 650	(a)
Hackberry. . . . .	Celtis occidentalis. . . . .	270	220-	340	(a)
Hemlock, eastern. . . . .	Tsuga canadensis . . . . .	11, 700	8, 300-	22, 400	(a)
Hemlock, mountain. . . . .	T. mertensiana . . . . .	7, 150	3, 750-	12, 900	(a)
Hemlock, western. . . . .	T. heterophylla . . . . .	13, 700	18, 500-	31, 800	(a)
Hickory, bitternut. . . . .	Carya cordiformis. . . . .	10	8-	12	(c)
Hickory, mockernut. . . . .	C. tomentosa. . . . .	6	2-	7	(c)
Hickory, pignut . . . . .	C. glabra . . . . .	12	11-	14	(c)
Hickory, shagbark. . . . .	C. ovata. . . . .	6	5-	9	(c)
Hickory, shellbark. . . . .	C. laciniosa . . . . .	2	.....	.....	(c)
Juniper, Rocky Mountain. . . . .	Juniperus scopulorum . . . . .	1, 790	1, 120-	2, 610	(d)
Juniper, western. . . . .	J. occidentalis . . . . .	650	500-	810	(d)
Larch, western. . . . .	Larix occidentalis . . . . .	8, 900	6, 100-	12, 300	None
Locust, black . . . . .	Robinia pseudoacacia . . . . .	1, 500	1, 000-	2, 200	(e)
Locust (honeylocust). . . . .	Gleditsia triacanthos . . . . .	175	110-	250	(e)
Madrone, Pacific. . . . .	Arbutus menziesii . . . . .	125	.....	.....	(a)
Magnolia, southern. . . . .	Magnolia grandiflora. . . . .	360	.....	.....	(c)
Maple, bigleaf. . . . .	Acer macrophyllum. . . . .	190	175-	210	(a)
Maple, red . . . . .	A. rubrum . . . . .	1, 420	800-	2, 490	(a)
Maple, silver . . . . .	A. saccharinum . . . . .	90	60-	120	(a)
Maple, sugar . . . . .	A. saccharum . . . . .	380	200-	570	(a)
Oak, black . . . . .	Quercus velutina . . . . .	16	8-	25	(a)
Oak, bur . . . . .	Q. macrocarpa . . . . .	3	2-	5	(a)
Oak, California black. . . . .	Q. kelloggii . . . . .	7	.....	.....	(a)
Oak, cherrybark. . . . .	Q. falcata var. pagodaefolia . . . . .	47	.....	.....	(a)
Oak, chestnut. . . . .	Q. prinus . . . . .	6	3-	12	None
Oak, live. . . . .	Q. virginiana . . . . .	24	21-	32	None
Oak, northern red. . . . .	Q. rubra . . . . .	9	5-	16	(a)
Oak, Oregon white. . . . .	Q. garryana . . . . .	6	.....	.....	None
Oak, pin. . . . .	Q. palustris . . . . .	25	20-	34	(a)
Oak, post. . . . .	Q. stellata . . . . .	25	15-	40	None
Oak, scarlet. . . . .	Q. coccinea. . . . .	17	10-	25	(a)
Oak, southern red. . . . .	Q. falcata . . . . .	37	24-	49	(a)
Oak, white . . . . .	Q. alba . . . . .	9	4-	13	None
Oak, willow . . . . .	Q. phellos . . . . .	40	37-	43	(a)
Pecan. . . . .	Carya illinoensis. . . . .	6	3-	10	(a)
Persimmon, common. . . . .	Diospyros virginiana . . . . .	74	41-	110	(a)
Pine, eastern white. . . . .	Pinus strobus. . . . .	1, 680	1, 250-	3, 400	(a)
Pine, jack . . . . .	P. banksiana . . . . .	8, 200	4, 430-	15, 600	(f)
Pine, loblolly. . . . .	P. taeda . . . . .	1, 150	1, 000-	1, 560	(a)
Pine, lodgepole. . . . .	P. contorta . . . . .	8, 450	6, 900-	10, 300	(a)

## DATA ON SOME FOREST TREES—Continued

Common name <sup>1</sup>	Scientific name	Number seed/oz.		Treatment recommended for germination <sup>2</sup>
		Average	Range	
Pine, longleaf.....	<i>P. palustris</i> .....	260	240- 370	(f)
Pine, Monterey.....	<i>P. radiata</i> .....	1, 000	810- 1, 440	None
Pine, pinyon.....	<i>P. edulis</i> .....	120	95- 155	None
Pine, pitch.....	<i>P. rigida</i> .....	3, 900	2, 250- 5, 200	(f)
Pine, ponderosa.....	<i>P. ponderosa</i> .....	750	430- 1, 440	(a)
Pine, red.....	<i>P. resinosa</i> .....	3, 250	1, 870- 4, 400	None
Pine, shortleaf.....	<i>P. echinata</i> .....	3, 000	2, 280- 3, 900	(f)
Pine, slash.....	<i>P. elliottii</i> .....	910	810- 1, 000	(f)
Pine, sugar.....	<i>P. lambertiana</i> .....	130	95- 200	(a)
Pine, Virginia.....	<i>P. virginiana</i> .....	3, 300	2, 500- 4, 700	None
Pine, western white.....	<i>P. monticola</i> .....	1, 690	880- 2, 000	(a)
Poplar (yellow-poplar).....	<i>Liriodendron tulipifera</i> .....	875	625- 1, 500	(a)
Redwood.....	<i>Sequoia sempervirens</i> .....	7, 600	3, 680- 18, 600	(a)
Sequoia, giant.....	<i>Sequoia gigantea</i> .....	5, 650	3, 360- 8, 200	(a)
Spruce, black.....	<i>Picea mariana</i> .....	25, 000	21, 000- 31, 900	(a)
Spruce, Engelmann.....	<i>P. engelmannii</i> .....	8, 500	4, 300- 12, 500	None
Spruce, red.....	<i>P. rubens</i> .....	8, 700	6, 200- 18, 000	(a)
Spruce, Sitka.....	<i>P. sitchensis</i> .....	13, 100	9, 700- 25, 000	(a)
Spruce, white.....	<i>P. glauca</i> .....	15, 000	8, 900- 24, 800	(a)
Sycamore, American.....	<i>Platanus occidentalis</i> .....	12, 700	9, 400- 14, 400	(f)
Tamarack.....	<i>Larix laricina</i> .....	19, 800	13, 100- 26, 200	None
Tupelo, black.....	<i>Nyssa sylvatica</i> .....	200	115- 250	(a)
Walnut, black.....	<i>Juglans nigra</i> .....	2	1- 6	(c)
Willow, black.....	<i>Salix nigra</i> .....	<sup>3</sup> 150, 000	.....	None

<sup>1</sup> Common names shown in parentheses are the preferred common names but are listed alphabetically according to usual usage. Thus "Alaska cedar" is listed under "cedar" although this tree is not a cedar, which name is reserved for trees of the genus *Cedrus*.

<sup>2</sup> Most tree seeds, except those requiring severe treatment, germinate in the spring if sown the fall before. For seed sown in the spring, stratification may be necessary or will hasten or improve germination. The stratification process, mixing seed with moist sand or sand and peat moss and storing at cool temperatures, is a substitute for the conditions of overwintering. The following treatments are recommended to improve germination:

(a) Stratify for 2-3 months at 33°-41° F.

(b) Soak in concentrated nitric acid for ½-2 hours, then stratify for 3-5 months at 33°-41° F.

(c) Stratify for 4 months at 33°-41° F.

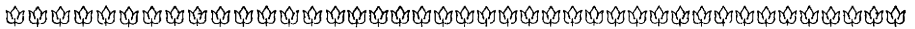
(d) Stratify for 2-4 months at 68°-80° F., then stratify for 2-4 months at 33°-41° F.

(e) Scarify the seedcoat or soak the seed in concentrated sulfuric acid for 20-120 minutes.

(f) Stratify for 1-2 months at 33°-41° F.

<sup>3</sup> Approximate.

# GLOSSARY



**ABERRATION** (ab-burr-ay-shun) A non-typical form or function. A straying from the normal. Some abnormality of an individual organism or part of a biological happening.

**ABNORMAL** Unusual; away from the natural pattern.

**ABORT** (uh-bort) To fail in the early stages of formation. The development of the young seed may be stopped early in its growth; its cells collapse and largely disappear.

**ABSCISSION** (ab-sizh-un) Separation of plant parts from the main body of the plant, such as the dropping of leaves, flowers, fruits, or buds. Generally associated with the formation of a special layer of thin-walled cells called the abscission layer or zone.

**ACCESSORY ORGANS** Attached structures that may or may not contribute to the main function of the organ.

**ACHENE** (ay-keen) A small, dry, one-seeded fruit with a thin distinct wall that does not split open.

**ACORN** The nonsplitting, one-seeded fruit of the oak.

**ACREABLE** In terms of an acre, or per acre.

**ADAPTATION** (add-ap-ay-shun) The reaction of plants to environmental conditions. One kind may respond to some conditions of soil, site, or climate favorably while another kind does not.

**ADVENTITIOUS** (add-ven-tish-us) A descriptive term for a structure that arises in an unusual place, such as a bud that develops from areas of a plant other than the base of a leaf or a leaf scar.

**ADVENTITIOUS EMBRYONY** (add-ven-tish-us em-brec-ah-nec) The embryo origin from a somatic diploid cell of the nucellus or integuments by a series of somatic cell divisions.

**AERATION** (ay-er-ay-shun) Bringing air into a substance or tissue. Making air, and therefore oxygen, available to a material.

**AGAR** A gelatinous substance extracted from a seaweed such as certain red algae. It is an ingredient used in making culture media to study the growth characteristics of micro-organisms.

**AGGREGATE FRUIT** (ag-gre-gate) Fruit developed from several pistils in one flower, as in strawberry or blackberry.

**ALBINO** (al-by-no) An organism that lacks normal color; plants that are white because of a lack of chlorophyll and other colored substances.

**ALKALOID** (al-kah-loid) An organic, nitrogenous, basic substance derived from vegetable or animal sources. Some are now synthesized. Morphine, codeine, strychnine, and quinine are alkaloidal compounds important in medicine to relieve pain or to stimulate the central nervous system.

**ALLOTETRAPLOID** (al-lo-tek-trah-ploid) A plant of hybrid origin with two sets of chromosomes from one parent and two sets from the other parent. Although four sets of chromosomes are present, associations of three or four chromosomes are rarely found at meiosis since the chromosomes contributed by the two parents are dissimilar.

**AMINO ACIDS** (a-me-no) Organic acids containing one or more amino groups ( $-\text{NH}_2$ ) and at least one carboxyl group ( $-\text{COOH}$ ). In addition, some amino acids (cystine and



methionine) contain sulfur. Many amino acids linked together in some definite pattern form a molecule of protein.

**AMYLOSE** (*am-il-los*) The straight chain fraction of normal starch. The starch of normal corn is made up of two molecular types; amylose (straight chain) and amylopectin (branched chain). In both starch types the basic units consist of the sugar glucose.

**ANAEROBIC** (*an-air-oh-bick*) Living or functioning in the absence of air or free oxygen. The opposite of aerobic.

**ANDROGENESIS** (*an-dro-jen-ch-sis*) Development in which the embryo contains only paternal chromosomes.

**ANGIOSPERM** (*an-gee-oh-sperm*) A kind of plant the seeds of which are formed within a fruit.

**ANNUAL** The kind of plant that normally starts from seed, produces its crop of flowers and fruits, or seeds, and then dies within one growing season.

**ANTERIOR** A position that is forward, before, or toward the front of an object.

**ANTHER** (*an-ther*) The saclike structure in which the pollen is formed in the flower. Anthers commonly have two lobes or cavities, which open by longitudinal slits or by terminal pores and release the pollen.

**ANTHOCYANIN** (*an-tho-sigh-ah-nin*) A water-soluble plant pigment that produces many of the red and blue colors of plants; for example, the red color of apples and the red and blue colors of many flowers.

**ANTIPODAL NUCLEI** (*an-tip-o-dal new-klce-eye*) Three of the eight nuclei that result from meiosis or sexual cell division in the female organ of seed-bearing plants. They are usually in the base of the embryo sac, contain one member of each pair of chromosomes, and in most plants have no known function.

**APEX** Extreme point or distal end.

**ARCHESPORIAL** (*ahr-kch-spo-ree-ul*) Refers to the differentiated cell situated in the nucellar tissue of the ovule which is destined to undergo meiosis and give rise to the haploid generation.

**ARIL** A loose, fleshy bag that encloses the seed, as in the white waterlily and yew.

**ASEXUAL** (*a-sex-shu-al*) Nonsexual; denotes reproduction by purely vegetative means, or without the function of the two sexes.

**AUTOTETRAPLOID** (*aw-to-leh-trah-ployd*) A plant with double the usual number of chromosomes. Each specific chromosome is present four times and multiple associations are found at meiosis.

**AUXINS** (*awk-sins*) Any of several substances found in plants that may stimulate cell growth, root development, and so on.

**AWN** A slender bristle, such as the "beards" of wheat or rye.

**AXILLARY** (*ax-sill-a-ree*) Pertaining to the angle between the leaf and the stem.

**BACKCROSS** A plant obtained by crossing two plants that have different characters is a hybrid. Pollen of the hybrid used on either parent, or pollen from either parent used on the hybrid, produces a backcross generation.

**BACTERIOPHAGE** A viral agent that produces a dissolution of specific bacterial cells. Bacteriophage agents will only multiply in actively multiplying cells. Cells parasitized by phage seem to swell, burst, and disintegrate, liberating large numbers of phage particles.

**BERRY** A simple, fleshy, or pulpy and usually many-seeded fruit, that has two or more compartments and does not burst open to release its seeds when ripe.

**BIENNIAL** The kind of plant that produces vegetative growth during the first year or growing season. After a period of storage or overwintering out of doors, flowers, fruits, and seeds are produced during the second year, and the plant dies.

**BIOCHEMISTRY** The chemistry of life; the branch of chemistry that is concerned with biological organisms and processes.

**BOLT** Formation of an elongated stem or seedstalk. In the case of biennial plants, this generally occurs the second season of growth.

**BROADLEAF** Used in weed terminology to designate a broad group of nongrasslike plants.

**BUD** A plant structure that contains an undeveloped shoot or flower.

**BUDDING** The process of transferring a live bud from one plant to another, usually by insertion under the bark. Also, the plant process of forming buds.

**BULB** An enlarged, fleshy, thick, underground part of a stem surrounded by a mass of leafy scales. Scales of a bulb are actually thickened and shortened leaves. Roots de-

velop from the base of a bulb. The lily is an example.

**BULBEL** A small bulb produced above ground usually in the axil of a leaf. Sometimes spelled "bulbel."

**BULBLET** Usually refers to a small underground bulb formed on a parent stem.

**CALLUS** A hard or thickened layer at the base of certain grass seeds (florets).

**CALLUS TISSUE** A shapeless, noncorky mass of cell growth that develops from a wounded or cut surface of a stem or root.

**CALYX** (*kay-licks*) All of the sepals of the flower; forms part of the covering of some seed.

**CAMBIAL TISSUE** (*cam-bce-ul*) The layer of cells found between the bark and the wood that gives rise to new growth. It consists of a very thin layer of cells, which normally may give rise later to either bark or wood.

**CAMBIUM** (*cam-bce-um*) A layer of cells in a stem between the bark and the wood in which cell division (resulting in lateral growth) occurs.

**CARBON DIOXIDE** A gaseous compound that is formed when carbon combines with oxygen. It leaves the body chiefly when air is exhaled from the lung.

**CARBON-14** One of several isotopes of the chemical element carbon. (See Isotope.) It is somewhat radioactive; this activity decreases very slowly with time. Carbon-14 occurs in very small, and varying, amounts in all organisms and in all organic material containing carbon. In a complicated chemical and electronic apparatus, the carbon-14 content can be used to date approximately ancient organic materials. The common isotope of carbon, carbon-12, which accounts for about 99 percent of the carbon in nature, emits no radiation.

**CAROTENE** A yellow compound of carbon and hydrogen that occurs in plants, a precursor of vitamin A. Alpha, beta, and gamma carotenes may be converted into vitamin A in the body.

**CARPEL** (*car-pell*) The ovule-containing receptacle of a pistil.

**CARUNCLE** (*care-unk-l*) An outgrowth or thick appendage of the testa or outer seed-coat, as in the seed of the castor-oil plant.

**CARYOPSIS** (*care-e-op-sis*) A one-seeded fruit with the pericarp and seedcoat fused into one covering, as in corn and other grains.

**CATABOLISM** (*ka-tab-o-lism*) The breaking down in the body of chemical compounds into simpler ones, usually accompanied by the production of heat.

**CATALYZE** (*kal-ah-lies*) To induce or accelerate a chemical reaction by a substance that remains unchanged in the process.

**CELL** The basic structural unit of living organisms. It is comprised of protoplasm enclosed, in plants, in a cell wall. The protoplasm consists of a nucleus and a semifluid matrix, the cytoplasm, which contains plastids and many other smaller bodies. Mature plant cells usually contain a large cavity or vacuole filled with a water solution of sugars, salts, acids, and other substances.

**CENTRIFUGE** (*sen-tri-fewj*) An apparatus that is used to spin liquids in a circular motion at high rates of speed. Particles that are suspended in a liquid medium can be separated according to their density, the heavier particles collecting at the outer rim of the circle and the less dense ones collecting in layers toward the center.

**CENTROMERE** (*sen-tro-mere*) A short segment or region of the chromosome to which the spindle fiber appears to be attached when the chromosomes are separating during cell division. In stained preparations, this region is unstained. It is the last portion of the chromosome to divide during the process of chromatids formation; however, it precedes the remainder of the new chromosome during its migration to the spindle pole.

**CEREALS** Members of the grass family in which the seed is the most important part used for food and feed.

**CHARACTER** An identifiable hereditary property, such as a specific component of color, a structural detail, a color pattern, or resistance to disease.

**CHLOROPHYLL** (*klor-oh-fill*) The light-absorbing pigment in plants that gives them a green color. The absorption of light by chlorophyll is the first step in the manufacture of carbohydrates from carbon dioxide and water.

**CHROMATID** (*kro-ma-tid*) A half chromosome during early stages of cell division when it is still joined to its sister chromatid. After the half chromosomes separate, the chromatids are known as daughter chromosomes. Subdivisions of chromatids are called chromonemata. They are the forerunners of chromosomes in the succeeding cell division.

**CHROMATIN** (*kro-ma-tin*) The chemical carrier of inheritance. It is the complex protein material within a cell which functions in cell

multiplication to reproduce identical "daughter" cells. The material readily absorbs some dyes. In prepared microscope slides of multiplying cells, chromatin is commonly the most deeply stained portion of the protoplasm within the nucleus.

**CHROMATOGRAPHY** (*kro-ma-tog-ra-fe*) A method for the separation of compounds from one another. Separation is accomplished as a result of the movement of compounds at different rates in a solvent allowed to flow very slowly through a porous medium, such as paper.

**CHROMOMERES** (*kro-mo-merc*) Granules of protoplasm occurring along the chromosome thread. They are visible during early stages of cell division and are frequently thought of as the beads on a string that comprises the chromosome. The granules may be accumulations of nucleic acids and, in this event, actually comprise the gene. On the other hand, they may be expressions of different patterns of coiling along the chromosome thread.

**CHROMOSOME** (*kro-mo-soam*) A rodlike body contained in the nucleus of the plant cell; the bearer of the hereditary material. (Adjective: chromosomal.)

**CLIMAX** The final stage and condition of equilibrium of vegetation after a series of progressional stages which have developed, without serious interruption, under the influence of a given complex of environmental factors.

**CLONE** A group of individuals of common ancestry which have been propagated vegetatively, usually by cuttings or natural multiplication of bulbs or tubers.

**COLCHICINE** (*kol-chi-seen*) An alkaloid produced by the autumn crocus. It is commonly used to induce doubling of the number of chromosomes in the nuclei of plant cells.

**COLEOPTILE** (*koh-lee-op-tile*) A sheathlike leaf of grasses and other monocotyledons that protects the delicate growing point as it emerges from the soil.

**COLUMELLA** (*col-yew-mell-a*) An elongated floral axis that supports the carpels in certain plants.

**COMA** (*koh-mah*) A tuft of hairs attached to a seed.

**COMPANION CROP** A crop grown with another to secure an earlier or larger return than from one crop alone.

**COMPOSITE MIXTURE** Breeder seed obtained by mechanically combining seed from two or

more strains. The mixture is increased through successive steps in a certified seed program and distributed as a synthetic variety.

**CONIFER** (*konn-i-fur*) A species of plant that bears its seeds in cones, such as a pine tree.

**CORM** Similar to a bulb, but the stem part is much thicker and broader and the scales form only a thin layer and represent a small part of the bulk. *Gladiolus* is an example.

**CORN** In American terminology, *Zea mays*, or Indian corn; includes sweet corn, popcorn, and field types. The word is so used in this book. In Old World terminology, "corn" may mean almost any of the Old World cereal grains.

**COTYLEDON** (*kol-e-lee-donc*) Seed leaves of the embryo. Usually they are thickened for storage of reserve food. They may serve as true foliage leaves.

**CROSS-FERTILIZE** To fertilize the ovule or ovules of one flower with the pollen from another flower; commonly refers to the fertilizing of ovules of flowers of one plant by pollen from another plant.

**CROSSOVER UNIT** A measurement of the degree of linkage between two genes. It is expressed in percentages. Crossing over is the interchange of corresponding segments between two homologous chromosomes before the formation of sex cells. When the terminal portion of a segmental interchange occurs between linked genes, the association between them is broken. The frequency of such occurrence is a function of nearness of the genes. The crossover units separating two genes is equivalent to the percentage of sex cells in which the association has been broken through segmental interchange.

**CROSS-POLLINATE** To apply pollen of one flower to the stigma of another; commonly refers to the pollinating of the flowers of one plant by pollen from another plant.

**CRUCIFEROUS** (*croos-if-er-us*) Pertaining to plants in the family Cruciferae. These are tap-rooted plants with four sepals and four petals arranged in crosses. They include such crop plants as radish, turnip, mustard, rape, and the many cabbagelike crops.

**CRYPTOXANTHIN** (*crip-toc-zan-thin*)  $C_{40}H_{56}O$ , a yellow carotenoid pigment in plant parts similar to xanthophyll. It functions as a provitamin A to some extent.

**CUTINIZE** (*kew-tin-ize*) To impregnate a cell or a cell wall with cutin—a complex fatty or waxy substance—which makes the cell more or less impervious to air and moisture.

**CYTOPLASM** (*sie-toe-plasm*) The contents of a cell outside the nucleus or chromosome-bearing portion. In reproduction, the male parent normally contributes only chromosomes, whereas both nuclear and cytoplasmic constituents from the female parent become a part of the offspring.

**CYTOPLASMIC MALE STERILITY** A type of male sterility conditioned by the cytoplasm rather than by nuclear genes and transmitted only through the female parent.

**DAMPING-OFF** A disease of seeds or young seedlings caused by fungi. The disease is most evident in young seedlings that topple over and die just after they emerge from the soil (postemergence damping-off). Two other types of damping-off are often mistaken for poor seed rather than disease: Germination failure, in which a seed is invaded in the early stages of germination and fails to sprout; and preemergence damping-off, in which the young seedling is attacked before it pushes its way through the surface of the soil.

**DAYLENGTH** The number of hours of light in each 24-hour cycle.

**DECORTICATION** Removal of the pith and bark from fibrous other tissues. Generally, this is a mechanical process.

**DEFOLIANT** (*dee-foe-lee-ant*) A chemical or method of treatment that causes only the leaves of a plant to fall off or abscise. The fruits remain attached.

**DEGENERATION** The progressive decrease in vigor of successive generations of plants, usually caused by unfavorable growing conditions or diseases. Virus diseases cause great loss of vigor.

**DEHISCENCE** (*dee-hiss-cents*) The bursting open at maturity of a pod or capsule along a definite line or lines.

**DESICCATE (DESICCATOR)** (*des-ik-kate, des-ik-kat-er*) To dry thoroughly; to remove moisture from an object definitely below the normal level. A desiccator is a laboratory apparatus for thoroughly drying substances. It commonly consists of a glass container with an airtight lid. The drying agent, a desiccant, is placed in the container with the material to be desiccated. The desiccant absorbs water and water vapor very strongly and literally takes most of the water away from the material being dried.

**DETASSEL** To remove the tassel or pollen-producing organ at the top of a corn plant before pollen is released.

**DIAPAUSE** (*die-a-pause*) In insects, a state during which growth and development is

temporarily arrested. Exposure to low temperature is frequently but not always required to permit the resumption of these processes.

**DICOT** (*dyc-kot*) A short synonym of dicotyledonous plant, the term refers to plants which have two seed leaves in the seed. Dicot stems always have definite wood and bark layers, and the leaf veins are branched.

**DIFFERENTIATION OF CELLS** (*dif-er-en-shi-ay-shun*) The development of specialized kinds of cells from nonspecialized cells in a growing tissue.

**DIFFUSIBLE** (*dih-fu-ze-ih-bul*) Able to spread through a system.

**DIMER ACID** (*die-mer*) A chemical compound in which two fatty acid molecules are combined to form a single molecule.

**DIOECIOUS** (*dic-ee-sh-us*) Having stamens and pistils on different plants. The plants are unisexual; therefore both sexes must be grown near each other to produce fruit, as in American holly.

**DIPLOID** (*dip-loid*) A plant with two sets of chromosomes.

**DIPLOSPORY** (*dip-plo-spo-ree*) The formation of a diploid egg cell as a result of failure of the egg mother cell to undergo normal reduction division.

**DISPERSAL** (*diss-per-sal*) Spreading or scattering.

**DISTAL END** The part of a fruit, leaf, tuber, or root farthest from its connection with the plant bearing it.

**DOMESTICATE** To convert a wild plant species into a cultivated crop by selection and adaptation.

**DOMINANT FACTOR** A hereditary factor or gene possessed by one parent of a hybrid which causes a character to be manifested in the hybrid to the apparent or near exclusion of the contrasted (recessive) character in the other parent.

**DORMANCY** An internal condition of the chemistry or stage of development of a viable seed that prevents its germination although good growing temperature and moisture are provided; also applied to buds.

**DORMANT** In a state of dormancy, a resting state that must be "broken" by time or special conditions before a seed will germinate at temperatures and moisture levels suitable for growth; applies also to buds.

**DOUBLE CROSS** The type of hybrid corn most commonly grown. It is the result of

mating two pairs of inbred lines to produce two single crosses which are then mated to produce a double cross.

**DRUPE** One-seeded stone fruit, as cherry, plum, and peach.

**DRY MATTER** The substance in a plant or plant material remaining after oven drying to a constant weight at a temperature slightly above the boiling point of water.

**ECOLOGY** (*ek-ol-o-gee*) The study of living organisms in relation to environment and their effects upon one another. The major classes of environmental factors relate to climate, physiography, soil, and associated organisms. Autecology is the study of the ecology of a single species. Synecology is the study of communities and associations of organisms.

**ECOTYPE** (*ek-oh-tyc*) A variety or strain within a given species adapted to a particular environment.

**ELECTRON MICROSCOPE** An instrument that permits magnification of particles up to 200,000 diameters. Instead of having the specimen exposed to a light source, as with the standard light microscope, a stream of electrons is directed on the object. The higher resolving power of the electron microscope is largely the result of the shorter wavelength associated with electrons. The electrons are accelerated in a high vacuum through electromagnetic lenses and focused on the specimen. They are then projected on a fluorescent screen where the image of the particle may be viewed or onto a photographic plate.

**EMBRYO** (*em-bry-oh*) The rudimentary plant within the seed.

**EMBRYONIC** (*em-bry-ahn-ik*) Relating to, or like, an embryo; also used to denote an early or incomplete stage of development of anything.

**EMERGENCE** (*ih-mer-gents*) Issuing from a place or state.

**ENDOCARP** (*en-do-carp*) Inner layer of the fruit wall.

**ENDOSPERM** (*en-do-sperm*) The tissue of seeds, developing from fertilization of the polar nuclei of the ovule by the second male nucleus, that nourishes the embryo.

**ENERGY** The capacity to do work. The energy stored in living cells as food material is released by respiration for use in growth.

**ENVIRONMENT** (*cnn-vie-ron-ment*) Surroundings. A plant's environment includes the air, soil, amount of moisture, light, and temperature.

**ENZYME** (*en-zim*) A catalyst produced in living matter. It is a specialized protein capable of aiding in bringing about chemical changes. It promotes a reaction without itself being changed or destroyed.

**EPICOTYL** (*epi-c-cott-l*) The growing point of the embryo, which gives rise to the shoot, or aboveground part of the plant.

**EPIDERMAL** (*epi-c-derm-l*) Relating to the epidermis, or outer layer of cells. Epidermal cells usually have thickened outer walls to protect plants against drying and mechanical injury.

**EVOLUTIONARY** Orderly, developmental change, usually in a definite direction.

**EXOCARP** (*ex-o-karp*) Outermost layer of the fruit wall.

**EXOGENOUS** (*ex-odge-jcn-us*) Refers to a characteristic circular arrangement of plant stem parts including cambium, bark, and wood. All dicots have this arrangement of tissues.

**F<sub>1</sub>** Denotes the first generation offspring coming from the mating of two parents.

**F<sub>1</sub> HYBRID** The first generation resulting from a cross mating of distinctly different parental types.

**FAR-RED LIGHT** The radiant energy near the long wavelength side of the visible spectrum between 7,000 Å and 7,500 Å or 700 and 750  $\mu$ . This is the place in the spectrum where the average eye begins to fail to detect radiation.

**FASCIATED** (*flash-ec-a-ted*) The condition whereby two or more stem growing points develop to form one broad flat stem rather than two or more single rounded stems.

**FASCICLE** (*fas-ih-kul*) A bundle of needles on a tree, as on pine or larch.

**FAT** A glyceryl ester of fatty acids. Fats generally are substances of plant and animal origin. Fat may be in solid form, as butter, margarine, lard, or other shortening, or in liquid form, as the vegetable oils.

**FATTY ACID** Organic compound of carbon, hydrogen, and oxygen, which combines with glycerol to make a fat.

**FERMENTATION** (*fer-men-ta-shun*) Chemical transformation induced by the activity of the enzyme systems of micro-organisms. Yeast enzymes produce carbon dioxide and alcohol from sugar. In breadmaking, the carbon dioxide causes dough to rise. Organic substances are fermented by bacteria, molds,

and yeasts to a wide variety of products such as antibiotics, vitamins, food, and feeds.

**FIBRIL** (*fie-bril*) A small thread or very fine fiber. Normally a fiber is constituted of a bundle of fibrils.

**FILAMENT** The stalk that supports the anther in the flower. The filament and anther together make up the stamen.

**FIRST-GENERATION HYBRID** Same as  $F_1$  hybrid.

**FLORET** (*flor-et*) A little flower. In grasses the floret consists of the small, inconspicuous flower with its small greenish bracts, the lemma and palea.

**FLORIGEN** (*flo-ri-jen*) The hormone or hormones produced by plants that causes them to change from the vegetative to the flowering or reproductive state.

**FLUORESCENT** (*flew-oh-rehs-sent*) A substance is fluorescent when upon receiving radiation it emits radiation of its own of a wavelength either the same as or different from the incident light.

**FORAGE** Feed from plants for livestock, such as hay, pasturage, straw, silage, and browse.

**FOUNDATION PLANTING** The first seed increase from the initial seed stock (breeder seed) provided by the originating agency in a recognized seed-certification program.

**FOUNDATION SEED** A primary source of seed of a genetically identified variety from which all increases are made.

**FREESTONE** A descriptive term used in relation to drupaceous fruits such as peaches, cherries, and plums to indicate that the fruit flesh does not adhere to the stone or pit containing the seed at maturity.

**FRUIT (FRUITS)** A fruit is a ripened (matured) ovary of a plant, together with any intimately attached parts that developed with it from the flower.

**FUNGICIDE** A chemical that kills or inhibits fungi. Bordeaux mixtures, ferbam, and zineb are fungicides.

**FUNICULUS** (*few-nick-you-luss*) The stalk by which a seed or ovule is attached to the ovary.

**GAMETOPHYTE** (*ga-meet-o-fite*) The part of the plant that produces gametes, or sex cells.

**GEL (jel)** A solid form of colloidal suspension. The process of changing certain liquid colloidal systems to a jellylike state can be achieved by cooking, like the white of an egg, or by cooling, like gelatin desserts.

**GELATINOUS** Thick, jellylike, somewhat sticky.

**GENERA** (*jenn-er-ah*) Plural of *genus*.

**GENE** (*jeen*) The unit of inheritance. The physical basis of heredity. It governs, controls, affects or conditions the transmission and development of one or more hereditary characters or traits. Its effect on a character is frequently conditioned by its interaction with other genes, the cytoplasm, and environmental factors. Genes are arranged in linear order in the chromosome. Chemically, the gene is thought to be composed of deoxyribonucleic acid, a highly complex, giant, organic, double helix molecule. Structurally this molecule is thought to consist of two spirally rising chains of linked atomic groups (five-carbon sugar molecules, called deoxyribose, alternating with phosphate groups) and a series of horizontal members or links (pairs of basic molecules) connecting the two spirals. Many viruses, which may be closely related to genes, also seem to be comprised of bundles of such molecules.

**GENETICS** The science that deals with the mechanisms of heredity.

**GENIC BALANCE** The numerical ratio of the different kinds of chromosomes and hence of genes. If each specific chromosome is present in the same number as the rest of the chromosome set, the plant is called a euploid, while plants with numerical differences are called aneuploids.

**GENIC STERILITY** A type of male sterility conditioned by nuclear genes. In contrast to cytoplasmic sterility it may be transmitted by either the male or female parent.

**GENOMIC** (*jee-no-mick*) Pertains to genome that refers to chromosome set.

**GENOTYPE** (*jen-oh-tipe*) The hereditary makeup of an individual plant or animal, which, with the environment, controls the individual's characteristics, such as type of flower or bony structure or shape of leaf or color of hair.

**GERM PLASM** The living stuff of the cell nucleus that determines the hereditary properties of organisms and that transmits these properties from parent to progeny. The expression is also used in a broad sense in referring to the total hereditary makeup of organisms. For example, geneticists and plant

breeders often refer to the seeds and plants used in their research and breeding as their "collections of germ plasm."

**GERMINATION** The resumption of growth by the embryo and development of a young plant from the seed.

**GERMINATIVE** (*ger-min-a-tive*) Having the ability to grow and develop.

**GIBBERELLINS** (**GIBBERELIC ACID**) (*jib-cr-ell-ens*) Plant growth-stimulating chemicals produced by a fungus, *Gibberella fujikuroi*, that attacks rice, causing the stems to elongate so rapidly that they become spindly and the plants fall down. Japanese scientists found that the fungus would produce gibberellins when grown in nutrient culture. Their chemists isolated three compounds and designated them as gibberellin A<sub>1</sub>, A<sub>2</sub> and A<sub>3</sub>. British scientists later produced plant responses. Commercial preparations are available and may consist of a mixture of gibberellin A<sub>1</sub> and A<sub>3</sub> or pure gibberellic acid (A<sub>3</sub>). The gibberellins induce many different plant effects, such as rapid stem growth, overcoming of dormancy, production of seedless (parthenocarpic) fruits, and other responses.

**GIRDLING** (**GIRDLE**) Removing a band of or cutting through the outside bark and the thin layer of cambium just underneath the bark.

**GLAND** Organs or swellings that usually secrete a watery or characteristic substance. Many oily and aromatic products are glandular in origin.

**GLOMERATE** (*glahm-cr-ate*) A compact cluster forming a round mass.

**GRAFT** The act of transferring a piece of stem, with buds attached, to another plant, placing cambium layers adjacent so that union will occur.

**GYMNOSPERM** (*jim-no-sperm*) A kind of plant that produces seeds but no fruits. Since the seeds are not borne within an ovary, they are said to be naked—hence the name.

**HARD SEEDS** Seeds that have a seedcoat impervious to water or oxygen required for germination. Sometimes overcome by scratching or scarifying the coat or removal by brief immersion in concentrated sulfuric acid and thorough washing.

**HEAT UNIT** A calculated amount of heat. It consists of one degree of temperature above an arbitrary level for a duration of an hour or other time interval. The day-degree above a daily mean of 50° F. is commonly used as a heat unit in studying response of certain plants to temperature. The base level above which units are computed differs for different kinds of plants.

**HEMICELLULOSE** (*hem-eh-sell-you-lohsc*) Cell wall compounds similar in appearance to cellulose, but more easily broken down to simple sugars. Common forms contain galactose and arabinose or glucose and xylose as well as other substances.

**HERBACEOUS** (*her-bay-shus*) Nonwoody, as applied to kinds of plant growth.

**HERBICIDE** (*herb-i-side*) A chemical or mixture of chemicals for killing plants by application to the plants or to the soil.

**HEREDITARY** (*heh-red-ih-tare-y*) Transmissible from parent to offspring or progeny.

**HERITABLE** Capable of being passed by inheritance.

**HETEROFERTILIZATION** (*hett-ur-oh-fur-til-izay-shun*) The fertilization of the egg and polar nuclei by sperm cells from different pollen tubes.

**HETEROPLASTIC** (*hett-ur-oh-blass-tick*) Refers to grafting or transplanting of tissue between two unrelated plants, especially plants of a different genus or species.

**HETEROZYGOUS** (*hett-ur-oh-zie-gus*) Not true-breeding for a specific hereditary character. A plant that does not breed true for flower color is called heterozygous for this character. Plants may be heterozygous for some characters and homozygous for others.

**HIGH-AMYLOSE CORN** A special type of corn that has starch with a greater than normal percentage of the straight chain starch component, amylose.

**HILUM** (*high-lum*) The scar left on the seed at the place of detachment from its base or seed stalk.

**HOMOLOGOUS CHROMOSOMES** (*ho-mol-o-gus kro-mo-soms*) The members of a pair of chromosomes that occur in all but the sex cells of the higher plants. Such members are structurally similar but may vary greatly as to the hereditary potential of genes carried in the chromosomes. When the embryo was formed, one member was contributed by the male and the other by the female sex cells.

**HOMOZYGOUS** (*ho-mo-zi-gus*) True-breeding for a specific hereditary character. A plant that breeds true for a character such as flower color is called homozygous for this character. Plants may be true breeding (homozygous) for some characters and not for others.

**HORMONE** (*hor-moan*) A chemical substance that is produced in one part of a

plant and induces a growth response in another part, generally at extremely low concentration of the chemical.

**HOST** An organism, as a plant, that harbors a parasite such as a disease-producing fungus or an insect that feeds upon it.

**HUMECTANT** (*hu-mek-tant*) A material with a high water-attracting capacity. When added to other materials that lose water too readily, it retards loss of moisture and retains freshness. Humectants are used in tobacco, cosmetics, and some foods to stabilize moisture content.

**HURL** The straight, fine, smooth broom-corn structures used for the outer covering of a structure.

**HYBRID VIGOR** The increase in vigor over the parental types exhibited by hybrids. This increase is at a maximum in the first generation and decreases by approximately one-half in each succeeding generation of inbreeding.

**HYGROSCOPIC** (*high-grow-scah-pick*) Easily takes up moisture, even from water vapor in the air.

**HYPHAE** (*high-fee*) Threadlike strands, or filaments, that constitute the body (mycelia) of fungi. They may be divided into cells by crosswalls (septate) or be one elongated cell with several nuclei (nonseptate), coarse or fine, aerial or submerged, stiff or flexible, and exhibit different types of branching. Some hyphae are specialized for producing spores or for penetrating host tissues.

**HYPOCOTYL** (*high-po-cot-l*) The part of the axis of the embryo that gives rise to the root system of the young plant.

**IMBIBE** (*im-bibe*) To take up water by absorption.

**IMBIBITION** (*im-bi-bih-shun*) The taking up of liquid by absorption. In seed germination, the taking up of water by the seed from a moist medium in preparation for germination.

**IMPERMEABLE** (*im-per-me-uh-bull*) Impenetrable, as when a seedcoat allows no passage through of water or gases.

**INBRED** Successively self-fertilized; also, a plant or progeny resulting from successive self-fertilization.

**INBREEDING** Successively self-fertilizing a breeding line or stock through a number of generations.

**INCREASE** To multiply a quantity of seed by planting it, rearing the plants that grow

from it, and harvesting the seeds they produce. The seeds resulting from this process also are called an increase.

**INDEHISCENT** (*in-dee-hiss-cent*) Not splitting open when ripe.

**INDEXING** Refers to the process used to test vegetatively reproduced plants for freedom from virus diseases before multiplying them.

**INFLORESCENCE** (*in-flow-res-enz*) The flowering axis or other specialized flowering structure of a plant, such as an umbel, raceme, spike, tassel, and panicle.

**INHERITABLE** Capable of being transmitted from parents to offspring.

**INHIBIT** (*in-hib-it*) To prevent or restrain.

**INHIBITOR** (*in-hib-i-tor*) A chemical substance that acts to prevent a process from occurring. Many chemicals, both natural and artificial, can act to prevent seed germination.

**INHIBITORY** (*in-hib-i-tor-ee*) Property of blocking or checking a process or reaction.

**INOCULUM** (*inn-okk-you-lum*) Material, as spores, bacteria, etc., used for infecting a plant with a disease or for propagating microorganisms in controlled cultures.

**INTEGUMENT** (*in-eg-you-ment*) The tissue covering and surrounding the ovule. When the ovule matures, it becomes part of the seedcoat.

**INTERNODE** (*in-ter-node*) The portion of a plant stem between the places (nodes) from which the leaves grow.

**INTERVARIETAL** (*in-ter-vah-rye-e-tal*) Between two varieties.

**IRRADIANCE** (*car-ray-dec-ants*) Radiation (usually meaning light) received by an object.

**ISOLATE** (*i-so-late*) To remove from the plant in pure form.

**ISOTOPE** (*eye-soh-tope*) Elemental substances having identical chemical properties, but somewhat differing atomic weights. Most of the common chemical elements have been shown to consist of a mixture of two or more isotopes. Isotopes of any one element have the same number of extra-nuclear electrons, and the same nuclear charge, but have differing nuclear masses. Today there is major interest in radioisotopes. These are basic elements that emit radioactive particles or radiations that can be detected by electronic apparatus or photographic-type film. Radio-



isotopes of carbon, iodine, cobalt, phosphorus, and others are now widely used in plant and animal research to study translocation of chemicals and how they react in the tissue systems.

**LANOLIN** (*lann-o-lin*) The fatty substance removed from sheep wool when it is scoured and cleaned. When refined, it is used extensively in cosmetics and provides a nontoxic carrier for applying plant regulators or other chemicals to the surface of plants.

**LARVA** The wormlike immature form of certain insects. Some are commonly called caterpillars, grubs, or maggots.

**LATERAL** (*lat-cr-ul*) Located on or developing from the side, as a bud located on the side of a shoot.

**LEAFSTALK** A petiole; the footstalk or supporting stalk of a leaf.

**LEGUME** A plant which is a member of the Leguminosae family. These plants have the characteristic of forming nitrogen-fixing nodules. Beans and peas are examples. Also the characteristic dry, dehiscent multiseeded pod or fruit of members of this family.

**LEGUMINOUS** (*le-gev-mi-nuss*) Pertaining to the pea family.

**LEMMA** (*lem-muh*) The small greenish bract that is part of the floret in grasses.

**LETHAL** (*lee-thul*) So detrimental as to cause death.

**LIGNIFY** (**LIGNIFICATION**) (*lig-ni-fie, lig-ni-fi-cay-shun*) To make woody. The thickening, hardening, and strengthening of plant cells by the deposition of lignin on and in the walls of plant cells. Lignin is a complex strengthening material which chemically shows both phenolic and alcoholic characteristics.

**LINEAR** (*lin-e-er*) Narrow and long. Genes are said to have a linear arrangement as they are thought to occur as in a line along the chromosome.

**LINKAGE** Association of genes (hereditary factors) in inheritance because they are located in the same chromosome.

**LOCUS** (*lo-kus*) The fixed position or location of a gene on or in the chromosome.

**LONGEVITY** (*lon-jev-eh-tec*) Length of life. In a strict sense, the length or period of lifespan, but commonly applied only to longer-than-average duration of life for the organism or material being considered.

**LYSE** To destroy or disorganize cells by enzymes, viruses, or certain other means.

**MACERATE** (*mass-cr-ayt*) To finely divide and separate, as to separate seeds from fruits, either fleshy or dry, by softening and wearing away the nonseed parts.

**MACROBIOTIC** (*mak-roh-bie-aht-ic*) *Macro-*: long or large; and *biotic*: relating to life. Therefore, that which is long lived.

**MAIZE** (*mayze*) Indian corn, *Zea mays*; in America, more commonly called corn.

**MALE STERILE** Producing no functional pollen.

**MALPIGHIAN LAYER** (*mal-pig-i-an*) A protective layer or layers of cells present in the coats of many seeds. It is characteristically made up of close-packed, radially placed, heavy-walled, columnar cells without intercellular spaces. The cells often are heavily cutinized or lignified and are relatively impervious to moisture and gases.

**MEDIUM** (**MEDIA**) The supporting substance on or in which plants, fungi, and bacteria are cultured or grown. The term usually includes the nutrients as well.

**MEGASPORE** (*meg-a-spor*) One of the four cells that are formed in the ovule of higher plants as a result of meiosis, or sexual cell division. Megaspores contain only one member of each pair of homologous chromosomes. The enlarged cell which gives rise to the megaspores is known as the megaspore mother cell.

**MEIOSIS** (*myc-oh-sis*) Cell division, in which whole chromosomes pair; the members of each pair separate and pass to daughter cells, resulting in halving the chromosome number.

**MEMBRANE** (*mem-brain*) A thin, soft, pliable sheet or layer or the outer surface of a body of protoplasm.

**MERISTEM** (*mer-i-stem*) Undifferentiated tissue comprised of cells capable of undergoing cell division.

**MERISTEMATIC CELLS** (*mer-i-ste-mat-ik*) Plant cells that have not undergone differentiation to fit a pattern of special uses. In most cases, such cells are young cells that later develop into highly specialized tissues, such as the epidermis, transporting vessels, or sex cells.

**MESOBOTIC** (*meh-zoh-beyc-aht-ic*) *Meso-*: middle; and *biotic*: relating to life. Sometimes used in a series of longevity terms, between macrobiotic and microbiotic, to designate an average or intermediate age.

**MESOCARP** (*mez-oh-karp*) Middle layer of the fruit wall.

**METABOLISM** (*me-tab-o-liz'm*) The chemical changes within a cell that provide the energy required by a plant or animal. It embraces both constructive and destructive changes—the processes involved in the building up of protoplasm and its destruction as required for the processes that generate life.

**MICROBIOTIC** (*my-crow-by-ah-ic*) *Micro-*: small; and *biotic*: relating to life. Therefore, that which is short lived.

**MICROPYLE** (*my-crow-pilc*) The pore or opening through which the pollen tube enters the embryo sac during the fertilization process.

**MICROSOME** (*my-crow-some*) A submicroscopic particle, approximately 0.05–0.2 micron (1/500,000–1/125,000 inch) in diameter, which can be isolated from living cells. Present knowledge suggests that these particles contain the enzymes that synthesize proteins.

**MICROSPORE** (*my-crow-spor*) The cells that develop into pollen grains. They arise through sexual cell division (meiosis) from the microspore mother cell in the anther of higher plants. Microspores contain only one member of each pair of homologous chromosomes.

**MITOCHONDRIA** (*my-toe-chon-dria*) Microscopic structures, which may be spherical or rod-shaped, approximately 0.5–2.0 microns (1/50,000–1/12,500 inch) in diameter, present in living cells. These particles contain organized groups of enzymes, which carry on the respiration and possibly other processes of cells.

**MITOSIS** (*my-toe-sis*) The division of a cell in which each chromosome splits longitudinally; the halves pass to daughter cells, each of which is identical to the original.

**MITOTIC** (*my-lot-ick*) Pertaining to mitosis.

**MOLECULE** (*mol-c-kule*) The building block of matter. The smallest portion of a compound or element that is of the same chemical identity as the mass. The molecule usually consists of two or more atoms and organic molecules, such as make up protoplasm, often contain hundreds of atoms.

**MONOCOT** (*mon-o-kot*) A short synonym of "monocotyledon"; it refers to plants that have single seed leaves. These plants have parallel veins in their leaves and no distinct bark and wood layers. Examples are bamboo and corn.

**MONOEIOUS** (*moe-neesch-us*) Having stamens and pistils in different flowers on the same plant, as in the watermelon.

**MORPHOLOGY** (*mor-fahl-oh-gee*) Form, structure, and development. Study of the form and structure of organisms, as opposed to the study of their chemistry and function.

**MOTHER CELLS** Special cells in anther and ovule that give rise to pollen and egg, the structures of sexual reproduction.

**M $\mu$**  An abbreviation for millimicrons, a unit of length used to denote the wavelength of light. The visible spectrum extends from about 400 to 700  $\mu$ .

**MUCILAGINOUS** (*myu-sill-laj-i-nuss*) Sticky.

**MULTIPLE FRUIT** Developed from a cluster of flowers on a common base, as in the fig.

**MUTANT** (*myoo-tant*) A plant or animal that differs from its normal or parent strain by virtue of an altered genetic characteristic.

**MUTATE** To change suddenly in genetic constitution.

**MUTATIONS** New properties or characters that suddenly appear in an organism and that are not inherited from its parent; under some conditions they are transmissible to the progeny.

**MYCELIUM** (*my-see-lce-um*) The vegetative threadlike growth, which in fungi acts as food-taking structures for the fruiting body. (Adjective: mycelial.)

**NECTAR** A sweet liquid secreted by flowers attractive to insects. Bees make honey from the nectar of many flowers, and carry pollen to the pistil, thus aiding in seed formation.

**NIAGIN** (*nye-a-sin*) One of the water-soluble vitamins of the B complex group. It is also known as nicotinic acid (C<sub>6</sub>H<sub>5</sub>O<sub>2</sub>N) and is the precursor of the pellegra-preventing factor.

**NICK** The two parents for producing hybrid seed are said to nick when they produce high yields of seed of a highly productive and desirable hybrid.

**NOBILIZATION** A term used in the breeding of sugarcane to indicate repeated matings (backcrossing) to the "noble" canes, *Saccharum officinarum*.

**NONALLELIC** Two contrasting genes (hereditary factors) that occupy different corresponding positions on the two members of paired chromosomes.

**NONSPECIFIC** A substance or process with a number, instead of a single, of functions or actions.

**NOXIOUS** (*nok-shuss*) Injurious. A noxious weed is one that crowds out desirable crops, robs them of plant food and moisture, and causes extra labor in cultivation.

**NUCELLUS** (*new-cell-us*) Tissue in the central part of the ovule in which the embryo sac is embedded.

**NUCLEIC ACID** (*new-klee-ik*) Highly complex organic molecules found in the nucleus of cells. Deoxyribonucleic acid, for instance, is a giant molecule that is the chief component of chromosomes and many viruses. It is believed to be the substance that determines heredity and governs the behavior of all cells.

**NUCLEUS** (*new-kle-us*) The part of the plant cell bearing the chromosomes, carriers of hereditary units.

**NUT** A nonsplitting, one-seeded fruit, with a hard, woody shell.

**NYMPH** The immature stage of certain insects whose growing young resemble the parents in body form.

**OCTOPLIOD** (*okk-toe-ploid*) A type possessing 8 repetitions of the basic haploid chromosome complement. Thus if the haploid number for a species were 10, the diploid number would be 20 and the octoploid number 80.

**OFFSET** A scaly bud or fleshy rosette of leaves borne on a short stem as an offshoot from the parent plant.

**OFFTYPE** Offtype plants in a seed field deviate in one or more characteristics from that which is usual in the strain being grown.

**OPTIMAL** (**OPTIMUM**) The most favorable.

**ORGANIC ACID** Contains only carbon, hydrogen, and oxygen. Among the best known organic acids are citric acid (in grapefruit, lemon, and orange juice) and acetic acid in vinegar.

**ORGANISM** A body or individual (a member of the animal or vegetable kingdom) exhibiting organization and organic life. The individual is composed of a number of essential and mutually dependent parts all of which partake of a common life. Bacteria and fungi are examples of micro-organisms.

**OSMOTIC** (*ahs-mot-ick*) Pertaining to the diffusion of substances through a membranec.

**OUTCROSS** The mating of a hybrid with a third parent; also an offtype plant resulting from pollen of a different sort contaminating a seed field.

**OVARY** The part of the pistil that contains the ovule or ovules; it ripens to form the fruit.

**OVOID** (*oh-voyd*) Egg-shaped.

**OVULE** The body within the ovary of the flower that becomes the seed after fertilization and development.

**OXIDATIVE** (*ox-ih-day-tive*) Refers to the processes of oxidation.

**PALEA** (*pay-lee-uh*) One of the greenish bracts that enclose the floret in grasses.

**PALISADE LAYER** (*pal-i-sayd lay-er*) In leaves, a somewhat compacted layer of elongated cells which underlie the upper epidermis with the long axis perpendicular to the leaf surface. In seeds, the term is used interchangeably with Malpighian layer. The term presumably derived originally from the resemblance of the palisade layer to a fence of stakes.

**PAPPUS** A tuft of delicate fibers or bristles at the tip of a tiny fruit, such as the feathery structure of the ripe dandelion seed that is easily blown from the head.

**PARASITE** One organism living on or within another (the host) and at the expense of the host. The host may or may not be destroyed in the process.

**PARTHENOCARPIC** (*par-the-no-karp-ik*) The production of fruit or a fruiting body without seeds. Examples are banana fruits, seedless grapefruit or oranges, and seedless grapes. This condition can sometimes be induced chemically by the use of plant growth regulators.

**PARTS PER MILLION** (Abbreviated p.p.m.) Designates the quantity of a substance contained in a million parts of a mixture or solution in a carrier, such as air or water.

**PASMO** (*pazz-moc*) A fungus disease of flax first observed as spots on any part of the plant above ground except the flowers. The spots may increase in size until several join together to form large irregular brownish areas. The causal organism is *Septoria lini-cola*.

**PATHOGEN** Any organism capable of causing disease in a particular host or range of hosts. It obtains its nutrients wholly or in part from another living organism.

**PEDICEL** (*ped-ih-sell*) Flower stalk.

**PENTAPLOID** (*pen-tah-ploid*) Having five chromosome sets.

**PERENNIAL** A plant that produces vegetative growth year after year without the necessity of replanting.

**PERIGARP** (*per-i-karp*) The covering of a seed that is derived from the ovary wall. It may be thin and intimately attached to the seedcoat, as in a kernel of corn; fleshy, as in berries; or hard and dry, as in pods and capsules.

**PETIOLE** (*pett-e-ohl*) The stem of a leaf.

**PHAGE-PLAQUE** A clear area caused by a bacteriophage in a bacterial colony. The bacteriophage dissolves specific bacterial cells.

**PHASE CONTRAST MICROSCOPE** Permits the examination of living, transparent materials without resort to the usual staining procedures. Structural details, which often vary only slightly in thickness and refractive index, become visible by transformation of the phase changes of light passing through the object into corresponding variations of brightness.

**PHENOMENON** A fact, event, or experience that is sensed or observed.

**PHLOEM** (*flow-em*) Conductive tissue in higher plants through which food materials largely are transported from the leaves to the roots. The vessels through which the materials are actually conducted are called sieve tubes and are components of the phloem tissue.

**PHOTOCHEMICAL** Pertaining to a chemical reaction activated by light.

**PHOTOPERIODISM** (*foh-toh-peer-ce-oh-dizm*) The response of plants and animals to the relative lengths of the daily periods of light and darkness. (Adjective: photoperiodic.)

**PHOTOREACTION** A reaction that is initiated or hastened by light. (Adjective: photoreactive.)

**PHOTORESPONSIVE** Responds to or is affected by light.

**PHOTOTHERMAL** Pertaining to the combined effects of light and temperature.

**PHYSIOLOGIC RACE** Within certain groups of fungi, notably the rusts, smuts, and mildews, strains have originated which can attack or parasitize only certain specific host varieties. Individuals having the same parasitization pattern are said to belong to the same physiologic race. More than 200 physiologic races of stem rust of wheat have been described.

**PHYTO-** (*fi-toe*) A prefix meaning plant.

**PHYTOTOXIC** (*fi-toe-tox-ik*) Injurious to plant life or life processes.

**PIGMENT** (*pig-ment*) Substances that appear colored by virtue of differential absorption of radiant energy. These substances impart color to tissue of plants. Green color is a result of chlorophyll; orange and some red colors are due to many carotenoids; many red to blue colors are anthocyanins; light-yellow colors are flavones.

**PISTIL** (*pis-till*) The seed-bearing organ of the flower, composed of stigma, style, and ovary.

**PLANT REGULATORS** (growth regulators) Synthetic compounds prepared in the laboratory that induce growth responses in plants. Sometimes these responses are similar to those induced by chemicals produced by the plant itself which are true plant hormones. Plant-regulating chemicals have sometimes been mistakenly called plant hormones.

**PLASTID** (*plas-tid*) Small bodies or granules suspended in the cytoplasm of plant cells. Some contain pigments such as those of the chloroplasts which give the green color to plant leaves. Others contain starch or oil.

**PLATED** Placed on or in special media in a culture dish, usually in a petri dish, for study.

**PLUMOSE** (*ploo-mohs*) Feathery.

**PLUMULE** (*ploo-mule*) The major young bud of the embryo within a seed or seedling from which will develop the aerial portions of the plant. It usually occurs at the tip of a stemlike structure called the epicotyl, that part of the embryonic plant axis above the cotyledons.

**POD** A fruit that is dry and nonfleshy when ripe and splits open to release its seeds.

**POLAR NUCLEI** Two nuclei that fuse with a sperm cell to give rise to the endosperm, a nutritive tissue, of the seed.

**POLLEN** The more or less microscopic, usually yellow, bodies that are borne in the anthers of flowers and contain the male generative cells.

**POLLEN PARENT** The parent that furnishes the pollen which fertilizes the ovules of the other parent in the production of seed.

**POLLEN TUBE** A microscopic tube by which the sperm cells move to the embryo sac of the ovule.

**POLLINATION** (*pol-lin-a-shun*) The process by which pollen is transferred from an anther to the stigmatic surface of the pistil of a flower.

**POLYAMIDE** (*pol-i-am-id*) A polymer the units of which are linked together through bonds between carbon and nitrogen atoms. Nylon is a typical polyamide.

**POLYMER** (*pol-i-mer*) A large molecule formed by joining together small identical molecules. Polyethylene, the familiar squeeze-bottle plastic, is a polymer composed of linked units of ethylene, a gas.

**POLYPLOIDY** (*pol-ly-ploid-dee*) The condition in which more than two sets of homologous chromosomes are carried by the cells of a plant.

**POSTERIOR** (*pos-tear-i-cr*) A position which is behind or to the back of an object.

**PREEMERGENCE** (*pree-ee-murj-ence*) Before emergence. Often refers to the treatment of the soil with weed-control chemicals after planting before the crop plants appear above ground.

**PRIMITIVE** Of simple derivation, or first in order of development.

**PRIMORDIA** (*pry-mor-di-a*) Organs in their earliest stage of development. The primordia that will develop into flowers, leaves, and stems are first visible as a dense group of cells in meristematic tissue. Later they assume the form characteristic of the organ.

**PRIMORDIAL TISSUE** Refers to the earliest or primary growth of a very young plant. In many plants the structure of primary growth differs from subsequent or secondary growth.

**PROEMBRYO** (*pro-em-bree-o*) The young embryo in the first stages of development.

**PROGENY** (*pro-j-e-ny*) Offspring. Plants grown from the seeds produced by parent plants.

**PROTEIN** (*pro-te-in*) An essential constituent of all living cells. Proteins occur naturally and are complex combinations of amino acids. Proteins always contain the elements carbon, hydrogen, oxygen, and nitrogen and sometimes sulfur and phosphorus.

**PROTOPLASM** (*pro-to-plas-em*) The essential, complex, living substance of cells, upon which all the vital functions of nutrition, secretion, growth, and reproduction depend.

**PROTOTYPE** (*pro-toc-type*) A pattern or original after which other objects are copies or are developed.

**PROXIMAL END** The end of a leaf, fruit, root, or shoot that grows closest to the stem that bears it.

**PRUNE** Remove vegetative parts of a plant to trim or shape it.

**PSEUDOGAMOUS** (*soo-dah-gum-muss*) Pertaining to pseudogamy or the type of apomixis where the diploid egg cell develops into the embryo without uniting with a sperm and fertilization of the polar nuclei is necessary for endosperm development and normal seed production.

**PUBESCENCE** (*pyu-hess-cents*) A hairy covering, usually of short, soft hairs.

**PYCNIDIA** (*pik-nid-i-a*) Globose or flasklike fungus fruiting bodies containing nonsexual spores (pycnidiospores). They are formed on the surface or more or less embedded in the tissue of the host and often open by a pore. The pycnidiospores are commonly extruded in mass or in whorls through the pore.

**QUIESCENCE** (*kwce-es-ents*) A state of no growth, of dormancy.

**RACEME** (*ray-seem*) A type of flower cluster in which single-flowered pedicels are arranged along the sides of a flower shoot terminus. There is more or less space along the shoot between the pedicels.

**RADICLE** (*rad-i-kl*) A rudimentary root, the lower end of the hypocotyl of the embryo. It forms the primary root of the young seedling.

**RADIOACTIVE** (*ray-di-oh-ak-tiv*) A substance is radioactive when a constituent chemical element is undergoing the process of changing into another element through the emission of radiant energy. Radioactivity is used as a tool in research to tag or trace the movement of compounds of interest. The presence of a compound containing a radioactive element is revealed by instruments that measure the radiant energy emitted.

**RADIOISOTOPES** (*ray-dee-o-ice-o-topes*) See Isotopes.

**RECEPTACLE** The structure to which the flower parts are attached. The receptacle may become modified in different ways, even to forming part of the fruit, as in apple and pear.

**RECESSIVE GENE** See Dominant factor.

**RECESSIVENESS** The condition of being recessive when a character controlled by one member of an allelic pair can be masked by the other member; the masked character is designated as recessive.

**RECIPROCAL CROSSES** Crosses in which two parents are used as female and male, and also as male and female, respectively.

For example, if plant A (female)  $\times$  plant B (male) represents the original cross, the mating of plant B (female)  $\times$  plant A (male) would be the reciprocal cross.

**REGENERATION** The development of new, noncorky growth from more or less mature tissue.

**RELEASE** Varieties or inbred lines of crop plants are subjected to repeated evaluations. Those of proved merit are made available to the public. The making available of such material is designated as release.

**RENOVATION** The process of restoring the productivity of plants in solid stands or rows by cultivation, fertilization, reseeding, or by other methods.

**REPELLANT** A material that animals try to avoid.

**REPLICATE (REPLICATION) (rehp-li-kayt)** A more or less exact duplication or repetition of a test or of an experiment to assure, or to increase, confidence in the resulting data. Five identical tests, for example, could be called five replications. Results from the five tests taken together would be more reliable than results from any one of the tests.

**RESIDUAL ACTION** The continued action of a material. The effect of an insecticide on insects that come in contact with it for some time after its application.

**RESIN (res-in)** Any of a large group of natural and synthetic materials similar in appearance and general characteristics to rosin, shellac, and amber.

**RESISTANT** A plant that is able to grow and produce a crop even though heavily inoculated or actually infected with a disease. There are various degrees of resistance; complete resistance is called immunity. A plant that is killed is classed as completely susceptible; one that grows in spite of the disease is also called tolerant.

**RESPIRATION (res-pir-ay-shun)** The metabolic processes by which a plant or animal oxidizes its food materials. Respiration provides the living system with the energy it needs for the synthesis of new material and growth.

**REST** A condition of a plant in which growth cannot occur, even though temperatures and other environment are favorable for growth.

**RESTORER LINE** An inbred line that, when crossed on a male-sterile strain, causes the resulting hybrid to be male fertile and produce pollen.

**REVERSIBLE** Capable of proceeding in either direction. Used to indicate a chemical reaction that can change its product back to the original substance from which it came.

**RHIZOMATOUS (ryc-zohm-uh-tus)** Plants with rhizomes (creeping stems or rootstocks) below the soil surface, usually horizontally elongated. Rhizomes of grasses bear scales at the nodes and usually are slender and creeping.

**RHIZOME (rye-zohm)** A nonfleshy, more or less horizontal, underground stem.

**ROGUE (roag)** An off-type plant; to remove such plants.

**ROOT** The mineral- and water-absorbing underground part of a plant. Roots do not bear leaves, scales, flowers, or true buds.

**ROOTSTOCK** The bottom or supporting root used to receive a scion in grafting.

**RUDIMENTARY** Incompletely developed.

**RUNNERS** Trailing stems or branches that take root and produce new plants at the joints or ends.

**SAG (EMBRYO)** The sexual part of the ovule, usually in the center, which bears the egg and polar nuclei.

**SAMARA (sah-mare-a)** A nonsplitting, winged fruit, as in maple or ash. (Adjective: samaroid.)

**SAPROPHYTIC (sap-roe-fit-ik)** Subsisting on dead organic matter and commonly causing its decay.

**SCARIFICATION (scare-i-fi-cation)** The process of mechanically scarring a seedcoat to make it more permeable to water.

**SCHIZOCARP (skiz-o-karp)** Dry, two-seeded fruit of the carrot family. The fruit separates at maturity along the midline into two nonsplitting one-seeded mericarps.

**SCION (sie-un)** A portion of the shoot of a plant, such as a small branch or part of a branch, which is grafted upon a plant having a root system.

**SCUTELLUM (sku-tell-um)** A shield-shaped organ of the developing embryo within a seed. The embryo absorbs food from the scutellum, much of which is in turn obtained from the endosperm. In certain plants, like corn, it is a specially developed cotyledon.

**SEED (SEEDS)** A mature ovule, consisting of an embryonic plant together with a store of food, all surrounded by a protective coat. It

usually develops after the fertilization of an egg cell by a male generative cell from a pollen grain. Seeds of some species develop without the intervention of the male cell; formed entirely of "mother" tissue, such seeds are called apogamic seeds.

**SEED PARENT** The strain from which seed is harvested in the hybrid seed field. Also commonly used to designate the female parent in any cross-fertilization.

**SEEDBORNE** Carried on seeds.

**SEEDCOAT** The outermost tissues or "skin" of a seed. Sometimes this coat is extremely hard and waterproof, preventing entrance of water to initiate germination unless it is broken, scratched, or eroded away.

**SEEDLING** A young plant; a plant grown from seed.

**SEEDPIECE** The term applied to the pieces cut from stem tissue for the purpose of vegetative multiplication. Seedpieces are not true seed and the use of the term seedpiece (occasionally abbreviated to seed) is confusing.

**SEEDSTALK** The erect stalk on a plant that produces flowers and seed. Applied particularly to root crops and leafy vegetable crops that produce seed after the desired product (root, head, or leaves) has fully developed.

**SELECTION** The practice of permitting certain individuals to reproduce and of preventing other individuals from so doing. In plant breeding, this involves the retention of apparently superior individuals and the discarding of the less desirable individuals.

**SELF-FERTILIZE (SELF-FERTILE)** To fertilize the ovule of a flower with the pollen of the same flower (or plant).

**SELF-INCOMPATIBILITY** Inability to set seed from application of pollen produced on the same plant.

**SELFED** Said of a pistil that is fertilized with pollen from the same plant that bears the pistil; also applied to seed resulting from such fertilization.

**SEMINAL (sem-i-nal)** Pertaining to the seed or germ. Seminal organs are those already developed in the embryo within the seed.

**SEPALS (see-puls)** The lowermost set of leaflike bracts making up the flower cup. The sepals together are called the calyx.

**SET (OF SEED)** Formation of seeds.

**SIBBED** Mated individuals having the same parentage.

**SILK (CORN)** The stigma and style of the female corn flower, through which the pollen tube grows to reach the embryo sac.

**SIMPLE FRUIT** Developed from a single pistil or ovary, which may be simple or compound.

**SINGLE-CROSS PARENT** The  $F_1$  offspring of two inbred parents, which in turn is used as a parent—usually with another single-cross parent to produce a double-cross hybrid, as in corn.

**SOMATIC (so-mat-ik)** Pertaining to cells of the soma or body as contrasted to cells of the germinal or reproductive tissues.

**SP. (SP.)** Abbreviation of "species." The expression follows the name of a genus when the single species indicated is unknown or for any other reason not specified. (Spp. is the plural.)

**SPAWN** A common term applied to a mixture of fungal mycelium and a nutritive organic material for the artificial propagation of mushrooms.

**SPECIES (spee-sheez)** A group of closely related organisms; for example, *Medicago sativa* is the botanical name for alfalfa. *Medicago* is the genus, and *sativa* is the species. Several species belong to the genus *Medicago*.

**SPECIES HYBRIDIZATION** The mating of two different species. Several wild species are represented in the ancestry of the cultivated rose and of many of our crop plants as well.

**SPECTROMETRY (spec-trom-eh-tree)** The measurement of the absorption or emission of light by a substance at specific wavelengths.

**SPECTROPHOTOMETER (spek-troh-foh-tom-eh-ter)** An instrument for determining the relative intensity of two colors or spectral regions.

**SPERM** The male generative cell that fertilizes the egg cell. Carried to the stigmatic surface of the pistil within the pollen grain, it travels down the style of the pistil within the penetrating pollen tube and near its tip. It finds its way to the egg cell within the ovule, via the micropyle, a microscopic opening.

**SPERMATOPHYTE (sper-matt-o-fite)** A seed-bearing plant.

**SPHAGNUM MOSS (sfag-num)** A bog moss belonging to the genus *Sphagnum*. It is frequently used as a rooting medium for plants.

**SPORE** In seed plants, the spore is the first cell of the gametophyte generation. The

two kinds, microspore and megaspore, produce male and female gametes, respectively.

**SPOROPHYTE** (*spor-o-fite*) The asexual or vegetative part of the plant, as opposed to the gametophyte or sexual portion.

**SPOROPHYTIC** (*spo-ro-fi-tick*) Pertaining to the sporophyte or diploid generation which has cells with twice the gametic number of chromosomes.

**STALK** (*stawk*) A stemlike supporting structure, such as a peduncle or pedicel.

**STAMEN** (*stay-men*) The part of the flower bearing the male reproductive cells, the pollen. Each stamen is composed of a stalk (the filament) and pollen sac (the anther).

**STEM** The part of a plant that bears leaves, flowers, and true buds. Stems grow either in a direction opposite to the pull of gravity or in a horizontal direction—uncommonly downward.

**STERILE** (*stair-ill*) A plant that fails to set seed even though compatible pollen is applied to the stigma of the flower. Cross-sterile plants fail to set seed with pollen from other plants. Self-sterile plants produce no seed from their own pollen.

**STIGMA** (*stig-ma*) The part of the pistil that receives the pollen.

**STIMULUS** (*stim-u-lus*) A chemical or other treatment that excites an organ or tissue to a specific activity, such as the application of a plant regulator to a stem to induce root formation.

**STOLONIFEROUS** (*stow-lahn-if-er-ous*) Plants with stolons—creeping stems above or below the soil surface.

**STOLONS** (*stow-lons*) Laterally creeping stems at or below the soil surface, from the buds of which new plants may arise. Some stolons bear tubers at their ends (potato).

**STYLE** The stalk of the pistil between stigma and ovary.

**SUBERIZATION** (*soob-er-ih-za-shun*) The process by which the cut surface of a stem forms a protective, corky layer, especially in conditions of high temperature and high humidity.

**SUBERIZE** To heal or form a corky protective layer over a cut or wounded surface.

**SUBSTRATE** (*sub-strate*) A substance that is acted upon, as by an enzyme. Also, a culture medium.

**SUCKER** An offshoot that develops from an adventitious bud located on the roots or lower stem of a plant.

**SYMBIOSIS** (*sim-be-o-sis*) Living together in more or less intimate association of two dissimilar organisms, in which the association is advantageous to one or both organisms.

**SYNERGID NUCLEI** (*si-nur-jid new-klee-eye*) Two of the eight nuclei that result from meiosis or sexual cell division in seed-bearing plants. The synergid nuclei are closely associated with the egg nucleus and are usually located in the tip end of the embryo sac. Like the egg, they contain only one member of each chromosome pair. They are usually nonfunctional.

**SYNTHETIC** (*sin-thet-ik*) Artificially produced material as distinguished from that made by living organisms. Also applied to interbreeding population derived from the propagation of multiple hybrids.

**SYNTHETIC GROWTH SUBSTANCES** Chemically synthesized compounds which affect the growth of a plant. These may be the same or similar to natural growth substances which are synthesized by the plant.

**SYSTEMIC** (*sis-tem-ick*) Absorbed into the sap stream and passed to other parts of the plant.

**TAILINGS** Partly threshed material, that has passed through the coarse shakers, or "straw walkers," of a threshing machine and has passed over the fine sieve.

**TASSEL (CORN)** The flower cluster at the tip of a corn plant comprised of pollen-bearing flowers. The staminate inflorescence of maize.

**TAXONOMY** (*tax-ahn-oh-mee*) The science of classification as applied to living organisms.

**TERMINAL** End, as the tip of a plant shoot.

**TESTA** The outer covering of the seed.

**TETRAPLOID** (*tet-ra-ploid*) A plant with four sets of identical or similar chromosomes.

**THERMAL INDUCTION** The change in growth and development of plants brought about by a given temperature exposure; usually applied to the process resulting in flowering of biennial plants.

**TILLER** A branch arising from the base of a monocot plant, especially in the grass family.

**TRAIT** A synonym of character with re-



spect to function and performance but less so with respect to form.

**TRANSLUCENT** (*trans-loo-sent*) The quality of a substance that permits transmission of light but diffused so that objects are not clearly visible when viewed through it.

**TREFOIL** A group of plants composed primarily of two species—birdsfoot trefoil (*Lotus corniculatus*) and big trefoil (*L. uliginosus* or *L. major*).

**TRISOMIC** (*tri-so-mik*) An otherwise diploid individual having one chromosome present in triplicate.

**TUBER** A much thickened underground branch or stem structure, filled with stored reserves of food and so modified as to serve as a vegetative reproductive structure. A potato is an example.

**TUBEROUS** (*too-bur-us*) Tuber-producing; like a tuber.

**TURGID** (*ter-jid*) Refers to the crisp, fresh condition found when the cells of the plant are amply supplied with water to the extent that they are fully extended. It is the opposite to wilted.

**UMBELLIFEROUS** (*um-bell-if-er-us*) Pertaining to plants in the family Umbelliferae. These are tap-rooted plants with minute flowers aggregated into flat or umbrella-shaped heads, and include such crop plants as carrot, parsnip, celery, dill, and parsley.

**UNDERSTOCK** The bottom or supporting part of a graft composed of either root or stem tissue or both.

**UNSATURATED FATTY ACID** A fatty acid that has a double bond between two carbon atoms at one or more places in the carbon chain. Hydrogen can be added at the site of the double bond.

**UTRICLE** (*you-trick-l*) A small, thin-walled, one-seeded fruit.

**VACUOLE** (*vak-u-ol*) A "cavity" in the protoplasm of most plant cells filled with a water solution of sugars, salts, acids, and other substances. Certain plant pigments, such as the anthocyanins, occur in the vacuole.

**VARIETAL** (*vah-rye-e-tal*) Pertaining to, or involving varieties.

**VARIETAL HYBRID** The product resulting from the mating of two varieties. The production of such hybrids was used in corn breeding to some extent in earlier years.

**VEGETATIVE** A descriptive term referring to stem and leaf development in contrast to

flower and seed development; commonly used as a synonym of nonsexual in contrast to the sexual type of development and reproduction in plants.

**VERMICULITE** (*ver-mick-you-light*) is a form of mica, a mineral. Certain altered forms make ideal rooting mediums because they are light in weight, easily penetrated by air, and retain moisture.

**VIABLE, VIABILITY** (*veye-uh-bul, veye-uh-bil-i-tee*) Alive. Capable of living and developing normally. A viable seed is one which is capable of germinating under the proper circumstances. Such a viable seed may, or may not, be readily or immediately germinable. Dormant viable seeds may require lengthy specific treatments before they become immediately germinable.

**VISCID** (*viss-sid*) Sticky.

**VIVIPAROUS** (*vi-vip-arus*) As applied to plants, a relatively rare condition in which seeds germinate while still attached to the parent plant.

**VOLUNTEER PLANTS** Unwanted plants growing from seed that remains on the field from a previous crop.

**WAVELENGTH** The distance between two corresponding points on any two consecutive waves. For light it is very small and is measured in Angstrom units (A), which equal about 0.04 millionths of an inch.

**WEED** Any plant in a place where it is a nuisance might be considered a weed. The term is most often applied to noncultivated plants that arise unwanted in cultivated areas, lawns, pastures, or other areas used by man. Most weeds are prolific and persistent.

**WINDROW** (*wind-roe*) A loose, continuous row of cut or uprooted plants placed on the surface of the ground for drying to facilitate harvest.

**WING** A membranous or thin and dry expansion or appendage of a seed or fruit.

**XANTHOPHYLL** (*zann-thoc-fill*) ( $C_{40}H_{56}O_2$ ) A yellow pigment in plant and animal products which is related to carotene and also is a precursor of vitamin A.

**XENIA** (*ze-ni-a*) The direct visible effects of the pollen on the endosperm and related tissues in the formation of a seed.

**XYLEM** (*zi-lcm*) Conductive tissues in higher plants through which water and solutes move from the roots to the leaves. The conducting vessels are often called tracheae.

**ZYGOTE** (*zie-goat*) The fertilized egg.

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