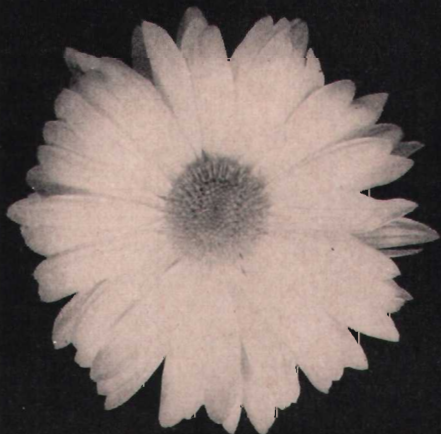
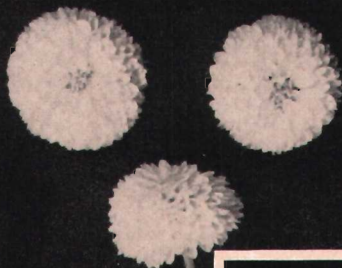
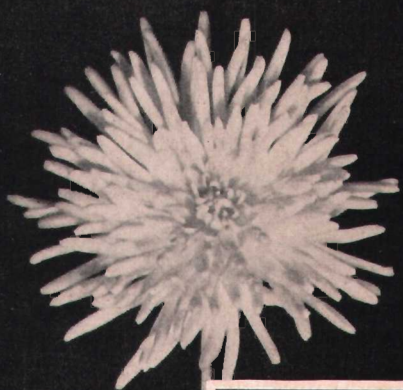


# Chrysanthemums

for the Home  
and Garden

E. J. Kraus and  
Ralph Garren, Jr.



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Oregon State College • Corvallis

## Foreword

This bulletin is the outgrowth of a project in ornamental horticulture initiated in 1949. The work with chrysanthemums is under the recognized leadership of Dr. E. J. Kraus, authority on the breeding and developing of this flower. The many varieties of garden chrysanthemums originated and introduced by Dr. Kraus are well known to gardeners and fanciers throughout the country. The bulletin contains much pertinent information based essentially on the author's long years of experience.

In undertaking research in ornamental horticulture, the Oregon Agricultural Experiment Station complies, in a modest way, with the numerous requests for such research from gardeners and commercial plant growers in Oregon. The work in this field is not yet comprehensive, of course, but many varieties and types of plants comprising azaleas, flowering crab-apples, clematis, lilacs, holly, day lilies, chrysanthemums, etc., have been assembled for trial and improvement. Breeding work has been started with the principal aim of developing types and varieties suitable to Oregon.

While many forms of ornamental plants are now being grown by Oregon gardeners, varieties of these are often not suitable, because they are largely introductions from abroad or from distant parts of the United States. Oregon's wide array of native ornamental plants offers an excellent source of breeding material for the development of new, improved varieties.

A handwritten signature in cursive script, reading "F. E. Price". The signature is written in dark ink and is positioned above the printed name.

Dean and Director

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# *Chrysanthemums for Home and Garden*

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*Department of Horticulture*

The Pacific Northwest provides climatic and soil conditions favorable to the growing of chrysanthemums out-of-doors whether the specific location be near the Pacific Ocean, the valleys between the Coast and Cascade ranges of mountains, or the higher and somewhat drier areas eastward of the Cascades. Only a few locations, such as the highest elevations, exist where they cannot be grown and brought to flower with a minimum expenditure of care and labor when proper varieties are planted. Types are now available which may be brought into flower early enough to escape the frosts of late August or early September and which will tolerate the relatively arid conditions of soil and air. To be sure, some of these extra early varieties do not possess either the size of flower or bush equal to those which require a longer growing season and more humid conditions, but even so some flowering is possible. Within the last twenty years great advances have been made in hybridizing and selecting varieties having a wide range of form and color and resistance to cold and rains. Also, they flower more abundantly and their foliage is less subject to disease attacks.

The chrysanthemum has been cultivated for centuries by man. It is thought by many authorities that all the forms grown today have been derived from small flowered, wild species originally found growing in China. It is definitely known that a form which grows wild in Korea was first used some 30 years ago in hybridizing trials with other types then in cultivation in gardens and greenhouses. All of the first of these hybrids selected were singles. They were introduced into American gardens as Korean hybrids. For many years hybridizing of chrysanthemums has been done and is still being done by many individuals. Great progress has been made in hybridizing these early types of Koreans with other varieties. Today, from among the seedlings, hundreds of varieties ranging in size, season of bloom, degree of doubleness, and scale of colors (except a clear blue), are available to gardeners. At least one major contribution which the Koreans made toward more desirable chrysanthemums was greater resistance to cold and other inclement weather conditions. To be sure other semi-hardy garden varieties existed before

the introduction of the Korean hybrids but many of them were late in flowering and some of them bore small flowers lacking in brilliance and clarity of coloring. A few large flowered types could also be grown in the open garden if given some protection.

## Classes of Chrysanthemums

Various classes of hybrids now are available for garden culture. Some of these are presented below. Their names represent groups of varieties rather than any specific variety or any particular form of flower.

### Exhibition type

In this group are found those varieties which, when a part of their buds have been removed (technically known as disbudding), may produce the huge football type of flower so commonly displayed in shows or exhibitions—hence their name. Here also may be found a wide range of flower forms which will be listed presently. Furthermore, in sections of the United States having severe cold weather early in the autumn, varieties of this group commonly are grown in greenhouses where temperature, soil, and other growing conditions may be kept under close control.

Some of the varieties are much more resistant to cold and other weather conditions than are other varieties. These more hardy types may be cultivated out-of-doors. When so grown some kind of protection from cold weather conditions is provided. Protection is provided by frames of various kinds over which coverings of many types, ranging from glass to blankets, canvas, old carpets, or cast-off garments, may be stretched. In western Oregon there are many amateurs who prefer to grow this class of chrysanthemum, usually disbudding them to secure huge blooms. The plants are tied to stout stakes to hold them upright and to prevent breakage. More details relating to this type of culture are given on the following pages.

### Spray or garden decorative type

As a rule, the flowers of varieties composing this group are smaller than those of the exhibition type, although some of them may develop to considerable size if disbudded. In general, however, extensive or complete disbudding is rarely practiced with this type. The result is that at the ends of shoots or branches of varying length (depending upon the method of training the plants) a terminal cluster or spray of several flowers is permitted to develop rather than a single huge one. This type is grown largely for bedding and

striking landscape effects because of the large number of flowers a well grown plant will produce. Also, the flowers of many of them are of a size convenient for making arrangements, corsages, and other uses where very large flowers are not demanded.

### Early English

This name is applied to a composite group of varieties whose flowers may attain the size of some of the exhibition types when the plants are similarly trained and disbudded or whose plants will produce a number of smaller flowers. The latter are usually larger than most spray varieties when they are trained and not disbudded after the manner of growing the spray varieties. They are common in the Pacific Coast states both with and without special shelter coverings. Uses of the flowers vary with the number and size produced per plant. Being intermediate in size they also serve as both the exhibition and spray types.

The name of the group results from the fact that most of these varieties have been selected for having large flowers and the early flowering habit. Most of them have been selected by several British nurseries. Each year sees many more importations of them; and, after careful testing, some are retained as desirable garden subjects, whereas others soon pass from the lists of American nurserymen. In general, they are not grown so extensively in the Midwest where autumn frosts may be early and severe and winter conditions are not well suited to their survival. They find a more acceptable environment, depending upon personal likes and dislikes, in the Pacific Northwest.

### Japanese

This name was at one time in common use and still is, to some extent, for varieties selected by oriental gardeners. The flowers range from medium size to very large when grown by the disbudding method. The flowers vary greatly in form. Many of them have long to very long often intertwined petals which give the entire flower a tousled or shaggy appearance. Others are very formal in style, and some show all degrees of intermediate and bizarre forms. Importations of seeds are frequently made from Japan by enthusiastic gardeners in other countries. If any of these seedlings have some special traits which appeal to the growers of them, they frequently are given American names and find their way into the catalogues of nurserymen, with, or more likely without, reference to their origins.

## Structure of the Chrysanthemum Flower

Nearly all forms of the flowers listed below may occur in any of the groups just previously discussed. Almost every possible degree of intergrading forms exists between the more or less well marked classes. Before enumerating these classes, therefore, it is necessary to understand the makeup of the flowers of the chrysanthemum.

What is spoken of as a flower is in reality a closely packed cluster of small flowers or florets borne on a base common to all of them. The entire group is surrounded and more or less firmly held together by many small blunt green leaves known as bracts. Botanically this entire cluster of florets is called a head. Furthermore, the florets composing this head are nearly always of two types.

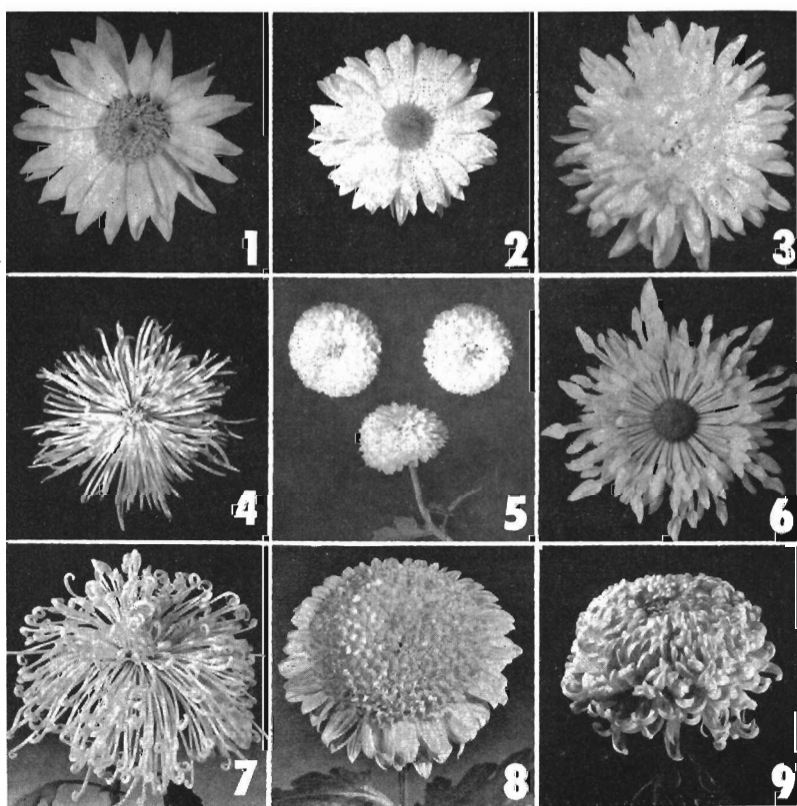


Figure 1. Types of flowers. 1. Single. 2 Duplex, sometimes also called single. 3. Decorative, double. 4. Rayonnante. 5. Pompon. 6. Spoon. 7. Spider. 8. Anemone. 9. Incurve, double.



At the periphery of the group are the ray florets whose five petals are united into a single more or less broadened strap-like structure which points away from the center of the group. Because they radiate outward they are called rays or ray florets. There may be a single ring of such ray flowers or the entire head may consist of them. In the latter case, the flower head is referred to as double. Inward toward the center of the head are the disc florets. Each of these disc florets has five petals, also united with one another, but instead of being elongated and strap-like the petals form an elongated urn shaped tube whose upper rim distinctly shows five lobes or teeth. If conspicuous, the central group of disc florets is sometimes referred to as the eye of the flower. Further details of flower structure are indicated in Figure 20. Some of the common types of flowers are listed below.

### Single

As used in this circular the term single is reserved for those flowers or heads which have but a single row of ray flowers—all of the others are of the tubular disc type. The term is sometimes applied to flowers which have two or even more rings of ray florets, but they have also a relatively large central eye of disc florets. On the other hand such flowers are often referred to as duplex or multiplex—a term which seems preferable so they may be distinguished from the single type which has only a single row of ray florets.

### Decorative

This is a comprehensive group whose members have several forms of flowers. In general, the flowers are nearly double or completely double, that is to say that the major number of the florets are of the ray type. The form of these ray florets may vary considerably. They may be long, narrow, and flat or they may be relatively broad and flat, sometimes overlapping like shingles on a roof. Frequently the edges of the petals are rolled inward especially when young so that they are somewhat boat-shaped. In other types they may be rolled so that the edges are curled toward the back of the petal instead of toward its upper surface. Frequently these rolled petals point strongly upward or outward from the center of the flower with considerable space between them, so that the entire flower has a spiky or starry appearance. Again, the petals of some of the florets near the center of the flower may be curled and twisted in various ways although those of the outer florets are flat. Others have the tips of the petals notched or drawn out into several elongated points giving the entire flower a fringed appearance.

### **Incurves**

This type of flower may range from having all its florets of the ray type or some or many of them may be of the disc type. In any case the petals of the ray florets are strongly curved upward and inward toward the center of the flower, often forming a nearly perfect sphere.

### **Japanese**

In flowers of this class, most of the florets are of the ray type. Their petals are usually long and more or less curled, twisted and intertwined with those of the other florets, so that the entire flower has a distinctly shaggy appearance.

### **Button**

These may have florets of the ray type only or may include some of the disc type. The flowers are relatively small—1 to 1½ inches in diameter—and more or less flattened “bun-shaped.” There is considerable variation in the depth of the flower from top to bottom, but they are not spherical nor nearly so. The petals of the florets are relatively short, may be flat or boat shaped when young, and may or may not become flat as the flower ages.

### **Pompon**

This is similar to the button type. It is sometimes classed with it and intergrades are many. It is here limited to those flowers which are nearly spherical as contrasted with the flatter “bun-shape” of the button type. The flower is composed mainly of florets of the ray type having boat-shaped petals when young, which may flatten as the flowers age. The most desirable types are completely double, that is they have only ray florets but they may show four or five disc florets when very old.

### **Spoon**

These may have a single row of ray florets or all the florets may be of this type so the flower is completely double. Most of the varieties, however, have many disc florets at the center. The distinguishing feature is the shape of the petals of the ray florets. These are generally closed tubes near their base but open out flat toward their tips—the whole resembling a spoon or a ladle. Frequently the “handle” portion of the petal is of a color different from that of the bowl. In such cases a striking contrast results. Others are more or less uniformly colored.

**Rayonnante**

Most flowers of this type consist of ray florets only. Their distinguishing characteristic is that the petals are relatively very long, closed tubes except near their tips where there is a small opening. The petals strongly radiate outward from the center of the flower. In some varieties they are straight, in others slightly curved.

**Spider**

In this type there may be ray flowers only, or there may be varying numbers of disc flowers at the center. The petals of the ray flowers are usually relatively long to very long, often pendulous, closed tubes for a greater or lesser part of their length, but there is generally a small opening at the tip. The distinguishing characteristic is that the long petals are curled upward or inward at their tips, sometimes very decidedly so.

**Anemone**

This type may have one or more rows of ray florets at the periphery, but most of the florets are of the disc type. The distinguishing characteristic is that all the five petals of the disc florets are much enlarged and conspicuous, often to the degree that many varieties show a distinct cushion consisting of large ray florets at the center.

## Methods of Propagation

There are two basic methods of propagating chrysanthemums. The most common method is by some form of division of old plants either as cuttings or separation of old clumps. The second method is from seed. Although uncommon, this second method will be discussed first. The division method includes several different procedures.

Chrysanthemum seeds are offered in the catalogues of many seedsmen. Care should be taken, however, to distinguish between the annual chrysanthemum of which there are many varieties and the perennial garden type being discussed here. It is true also that the seeds of perennial types offered by most seedsmen produce plants which are late flowering when propagated from seeds. Almost always a very large percentage of the plants will produce single flowers. Many of these are likely to be of various shades of magenta, although many different colors also may be expected. A few seedsmen offer specially selected seeds or seeds of the early types, but

these types usually produce flowers of small size. A few seedsmen offer seeds of the shasta daisy, which is a chrysanthemum botanically, and a few British seedsmen offer specially selected strains of the ox-eye daisy, which is considered a common white flowered weed growing along roadsides, in meadows and in other neglected spots in many parts of the United States, including Oregon.

### Propagation by Seeds

The seeds of the type of chrysanthemum being discussed in this circular are small, about one-third or one-quarter the size of a lettuce seed. They may be sown in any good garden soil in the same manner that asters, marigolds, zinnias or other common garden flowers are sown. According to this method, fill a flat or shallow wooden box or flower pot with good garden soil. Unmixed clay is too heavy, and sand is too porous. Then make shallow rows or depressions in the soil not more than one-quarter inch deep. Sow the seed thinly in these depressions, then cover the seeds with soil to make the surface level, press down firmly, but do not pack the soil. Next water lightly with a fine sprinkling can or any other means which will moisten the soil to a depth well below the seeds, but will not wash away the soil covering them or render it muddy. Then put the flat or other container where the temperature ranges about 70 to 75 degrees in a window or even out-of-doors, where it is fully exposed to light but not necessarily in bright sunshine. If the soil tends to dry out rapidly, cover the seed container with a pane of clear glass lifting the edges slightly if the container is in full sun to prevent excessively high temperatures or the collection of droplets of water on the underside of the glass. Seeds may be sown anytime from mid March to early April. The seedlings should come through the soil in five or six days or even less time if the seeds are fresh. Once above the soil, the seedlings grow very rapidly. It is well to remove the glass covering from the flat or pot as soon as the seedlings are well out of the ground, otherwise they tend to grow too spindling. By ten days to two weeks the young seedlings will begin to show their first true leaves.

### Transplanting of seedlings

As soon as they can be conveniently handled after this time—which may be another ten days to two weeks—the individual seedlings should be transplanted to provide more room for their growth which is very rapid. The transplanting may be made into flats of loamy soil spacing them about  $1\frac{1}{2}$  inches apart. A very convenient way which saves handling and extra work later is to fill a green-

house flat with  $1\frac{1}{2} \times 1\frac{1}{2} \times 3$ -inch plant bands which are small paper containers that will fit snugly side by side in the flat. Soil is then filled into these bands, wetted down well but not muddy. A young plant is then transplanted directly into each band. After transplanting, the whole flat, box, or other container may be placed where it will have a temperature of about 60 to 70 degrees. It may be in a well lighted window, a cold frame, or even out-of-doors if the weather is warm enough and the plants are protected from excessive rain.

By the middle of May the plants should be large enough to transplant into the open ground—always in a sunny location—because chrysanthemums, small or large, prefer full open sun. It is best, however, to avoid planting them close to the south wall of a building where summer temperatures may become too high for best growth.

Transplanting the seedlings into the open ground is a simple job. First, prepare the soil into which the growing plants are to be set, as one would for setting out any of the common garden vegetables or annuals. An open loamy soil with a moderate amount of manure or other organic matter previously well worked into it is good. If the plants have been grown in a flat or pot, each should be lifted out carefully with a quantity of moist soil clinging to its roots and then set directly into a hole prepared for it— $1\frac{1}{2}$  to 2 feet apart. Set the plants slightly deeper than they were in the seedling flats. After setting, firm the soil around the plants and water them well so that the soil is thoroughly wet but not muddy. If the plants have been grown in plant bands the procedure is the same except that it is somewhat simpler. Each plant band containing a young plant is taken out of the flat in which the plants have been growing. If the band has become fairly well decomposed the entire band containing the plant may be set in place in the open bed, the dirt filled around it, and watered just as if the plants had been dug out of a flat without bands. If the band is not fairly well decomposed, it is best to pull away at least two sides of it and then set the remainder in the soil. The advantage in the use of plant bands lies in the fact that when transplanting is done, the soil is held firmly about the roots of the young plant which thus goes into its new position in the garden with very little disturbance. A disadvantage in their use arises if the band has remained too firm so that when it is transplanted into the field the new roots and also the young shoots—in the case of the chrysanthemum—have difficulty in emerging from it. It should certainly be removed if it has not decomposed partially.

From transplanting forward during the growing season, seedlings are given the same care as new plants grown from cuttings as outlined below. One difference is that seedling plants often grow more vigorously than do those growing from cuttings and hence may need more room when put into the garden; perhaps 2 feet apart for seedlings as compared to 18 inches for cuttings.

### **Production of Seeds**

As already stated chrysanthemum seeds of the type we are discussing can be bought from seedsmen. Sometimes the amateur may wish to secure seeds of his own selection. This is not too difficult a task. The first essential in producing chrysanthemum seed is to understand in a little greater detail than has already been given, the makeup of the chrysanthemum flower and the type of florets which compose it.

The second essential here in the Willamette Valley, if one wishes to work with the later more double varieties, is to have a greenhouse (not necessarily heated) or some other fairly well lighted shelter which will keep the rain from soaking the flowers which have been selected for seed bearing. Heavy rains before the seed has matured tend to bring about moulding or decay. Some of the earlier single varieties may set and mature seeds in the open field before inclement weather arrives, but it is also better to provide shelter for them.

### **Selection of parent plants**

In our own work, plants desired to be used as seed parents are carefully dug from the fields before heavy freezes or rains have injured them, and are brought into well ventilated greenhouses in order to prevent their exposure to excessively high temperatures. The plants are kept well watered and in good growing conditions so far as possible. Any plants which have severely wilted following transplanting are discarded, as well as any broken or severely injured flowers. When all is in readiness the next step may be undertaken.

### **Additional details of structure of chrysanthemum floret**

As already indicated, it is essential to pay attention to the details of floral structure. Usually the ray florets of most varieties of chrysanthemums are incapable of setting seeds unless especially manipulated. As has already been stated, their most conspicuous characteristic is the large apparently single petal they possess. If one pulls on one of these petals firmly or carefully the entire floret is separated from the disc on which it is borne. Further inspection

shows that the broad petal becomes narrowed down to a short tube no larger than a rather fine needle. At the base of this slender portion there is an abrupt thickening which appears as a tiny whitish or greenish wedge. This is the ovary in which the true seed would develop. In many instances, however, the structure which could develop into a seed is abortive and never does so. Again, taking a sharper look at the narrowed tubular portion of the petal, one sees a very tiny greenish spike at its center. This

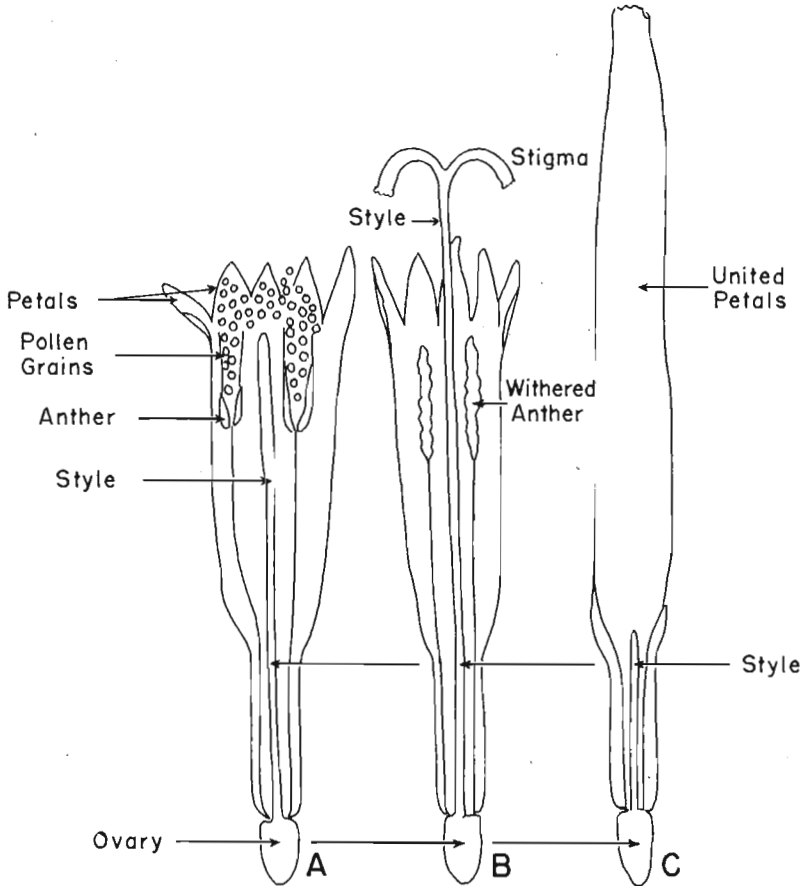


Figure 2. Sketches of chrysanthemum florets: (A) disc floret at the time the pollen is being shed, (B) disc floret which has shed its pollen and whose stigmas are now ready to receive pollen, and (C) ray floret which has been split lengthwise. (Only two of the normally five anthers per floret are shown.)

spike is actually continuous with the wedge-shaped mass just described. It is known as the style whose tip may separate into the two recurving portions resembling a Y. The tips of the branches of this Y are known as the stigmas. All these parts are essential for seed production because it is on these stigmas that the pollen grains germinate and send small tubes down the style to the structure which may later become the seed. It is through these tubes that the true fertilizing elements of the pollen pass to meet other reproductive elements.

Their union results in the formation of a germinable seed. Sometimes the ray florets bear rudimentary stamens which may produce a small amount of pollen. In the case of double flowers having only ray florets, few seeds or none at all are produced. In the case of some varieties, however, if the petals are cut off very close to the disc, and yet not so close as to cut off the styles of the florets, these styles will elongate sufficiently that they may be pollinated with pollen from another flower. The development of germinable seeds may follow. In general, however, the larger number of germinable seeds are produced by the disc florets.

#### **Function of disc florets in production of seed**

If one examines one of the disc florets critically, he will see a conspicuous tube or cup whose upper rim or margin ends in five small teeth arranged in a circle. This tube becomes much narrower toward its base. At its base is a wedge shaped ovary similar to the one seen in the ray floret, except that it is relatively larger. Inside this tube are five anthers which are attached to the sides of the tube near its base by very slender threads or filaments. The anthers are small sacks bearing an abundance of pollen. The top of the ovary is prolonged into a slender style as in the ray flower except that it is much larger and longer. At its top it is divided into two parts which, as it matures, curl back like a ram's horns. The behavior and function of these structures is similar to that described for the ray florets, the principal difference being that all the parts associated with seed production are larger and functional instead of being abortive as may be the case in the ray florets.

#### **Technique of crossing**

The actual operation of cross, or self-pollination, is not difficult. In most varieties of chrysanthemums, the pollen matures and is often shed previous to the maturity of the stigmas. It can be seen as grains of yellow dust at the tips of the ray florets. Sometime after the pollen is shed the styles elongate and push above the rim



of the petals. Soon, thereafter, they are receptive and are ready to receive and retain the pollen grains.

Many varieties of chrysanthemums are self-sterile; that is, they will develop no seeds when fertilized by pollen from the same plant or even another plant of the same variety. In such cases all that is necessary in making crosses is to wait until the stigmas are ready to receive pollen. Then the pollen which is to be used in crossing is taken from a flower of another variety which is to be used and is transferred to the stigmas of the flower being used for crossing. Sometimes it is a bit difficult to remove pollen with a brush, toothpick, or other implement, from the flower producing it. In that case, the two plants to be crossed are placed close together, the flower of one bent over carefully, and the face of it is brushed across the face of the other. Or if there are plenty of flowers to spare, a flower may be picked from one variety and carried to the other for use. As already noted, the pollen of the disc florets is usually shed before the stigmas are ready for pollination, but it is also true that not all the florets in a given flower mature at the same time. Actually, those toward the periphery (away from the center of the disc) mature first, and then maturation occurs progressively inward toward the center. This behavior makes it desirable to pollinate any given flower on several successive days as its florets become progressively mature.

### Self-pollination

While many varieties are self-sterile, this is not universally true. Some will mature viable seeds when self-pollinated.

In such cases, if very precise and accurate work is to be done, care must be taken to prevent any of the flower's own pollen from bringing about fertilization. It is essential, therefore, that all the anthers be removed from the plants before they shed any pollen. Furthermore, the flower being pollinated must be protected from bees, flies, or any other agency which would bring pollen to it from any variety other than the one desired in making the cross.

There are two ways of carrying out these precautions. The first is to observe the flower to be pollinated very carefully. Then, just before the anthers are to shed their pollen, they may be removed entirely with very fine pointed tweezers. (The anthers may be seen better with a hand lens or watchmakers glass.) All the stamens are pulled from the florets and discarded. The whole flower is then covered with a paper sack to keep out insects and the like. Later, when the stigmas are ready to be pollinated, the desired pollen can be applied to them and the sack replaced for several days.

This is an exceedingly trying and tedious process, made more so by the fact that the florets mature over a period of several days so that the entire process must be repeated several times, until all the florets have shed their pollen and have passed the stage where they can respond to the foreign pollen. Hybridizers who use this method often remove a part of the disc florets in order to cut down the magnitude of their task. When that is done, fewer seeds are obtained, because each floret produces but a single seed.

Another method of accomplishing a similar purpose is to cut across the entire flower bud while it is still young, at a level just above the bracts. If this is done precisely, it is possible to cut away the upper portion of the florets just below the level of the anthers and just above the tip of the style which at this stage of development of the flower is very short. After this trimming of the bud, those florets which are not too greatly injured will develop towards maturity. Although no conspicuous flower is formed, the styles may continue to develop without the complicating anthers which were removed by the trimming. When the styles grow up and the stigmas become mature, they may be pollinated with pollen from whatever other flower may be desired. A modification of this latter method (somewhat less severe in trimming) may be used with varieties which have very few disc florets and many ray florets. The petals of the ray florets are trimmed back so that only very short bases of them remain. Many of the flowers trimmed in this manner develop styles and stigmas which can be pollinated. If left untrimmed, the styles either do not elongate or remain so deeply imbedded in the tube of the petal of the ray floret that they are not reached by the pollen and no seeds are developed.

### **Ripening and cleaning seeds**

Whatever method may be used in effecting pollination, after the flowers begin to fade and seed development is proceeding, the old flowers are left in place until they become thoroughly ripe and dry. At the end of that time the seed heads are clipped off and stored in paper sacks for a time until the old florets and any seeds which may have been developed may be easily rubbed off. All this mixture is rubbed thoroughly in one's hands so as to break the seeds away from the chaff. Then the entire lot of material is tossed into a sieve having meshes finer than the size of the seeds. This sieve and its contents are then held above a mild current of air from an electric fan just strong enough to blow out the chaff and leave the seeds behind in the sieve. The seeds are stored in small envelopes and are ready for sowing at the proper time in the spring.

It has been our experience that chrysanthemum seeds retain their capacity for germination for about one year. At the end of a year the percentage of germination and the vigor of the seedlings from the few seeds which do germinate are greatly reduced.

It should be remembered that when chrysanthemums are propagated from seed that very few if any of the seedlings will be worthy of preservation. Scarcely more than one seedling out of a hundred or even a thousand will have as many desirable qualities as either parent. Still, this is the principal method by which new varieties are obtained.

### Propagation by Bud Sports or Mutations

It is possible also to obtain new varieties through mutation or sporting of a portion of the plant of any standard variety. Such sports generally resemble the parent in most characteristics. The most commonly observed sports are changes in color. Thus, a white



Figure 3. Overwintered plant which has made sufficient top growth to furnish good cutting material. Similar plants may be used direct from the garden if they have survived the winter satisfactorily.

variety may produce a branch bearing yellow flowers, or a bronze one may sport to pink or various other colors. Sometimes the sport involves some plant characteristic other than color such as incurved flowers on a plant bearing the decorative type, and so on. Such sports can be perpetuated and maintained by removing the sporting branch and propagating it by means of cuttings. Plants propagated in this way will then bear flowers of the new type instead of those of the parent bush from which it came.

### Propagation by Divisions

Being a perennial—that is, a plant which survives from year to year—a single seedling or rooted shoot put out in the springtime becomes a fairly large clump consisting of several stems by fall. This clump if sufficiently hardy may survive the winter season and begin new growth again the following spring. Such an overwintered plant may be divided into several plants depending upon the number of stems of which it is constituted. The procedure to be followed in making the divisions, or Dutch cuttings as they are sometimes called, is very simple.

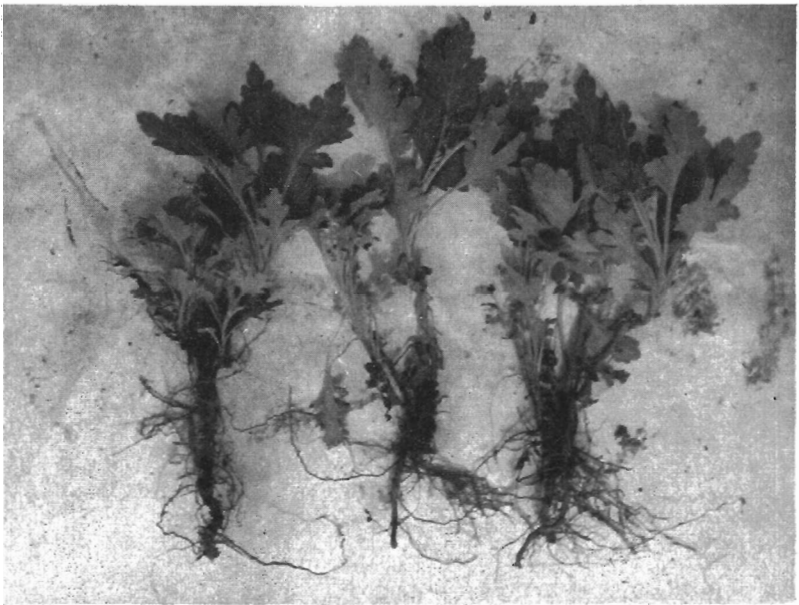


Figure 4. Divisions or "Dutch" cuttings obtained by dividing a plant such as shown in Figure 3. The cuttings as shown could be further divided in case propagation material were scarce.

When new growth has been renewed in the spring, one may dig down around and into the clump and gently pry the shoots or break or cut them apart. Greater survival of plants is possible if these divisions have roots at their bases or, better still, if they have begun to push out new roots near the level of the soil after the winter rest period. It is advantageous, also, to have some soil about these roots, but if the soil contains insects or disease organisms it should be washed away as completely as possible.

After separation the division may be set into a new spot in the garden. By fall it should be as flourishing as the plant from which it was separated—often times it is more so. Of course, if one desires, three or more shoots may be taken up as one small clump and transplanted. One shoot is sufficient, however. Such division may be done in the autumn as well as in the spring, provided the transplanted portions have ample care when first set out and are protected during the winter. Some growers object to this method of propagation because, if any soil which may contain insects or diseases is carried along with the soil which was around the old mother plant, it may be carried along to the new location. Other individuals think that plants resulting from this type of division do not recover and grow as rapidly as do fresh new cuttings made according to the following method.

Plants may be propagated by utilizing the shoots which grow up around the bases of clumps during the summer or autumn. Frequently, it will be found on digging down to the base of such shoots that many young roots are present. These shoots may be treated the same way as divisions of older plants in the spring. Also even though such basal shoots may have no roots at all on them, they may be treated just as are top cuttings.

### **Propagation by Top Cuttings**

Top cuttings are made from the actively growing shoots of a mother plant—either from one which has been carried over from a previous year or from a young plant in an active stage of growth. Usually the upper or top portions of such shoots are used. All that is essential is to wait until the upper portion has matured somewhat, to the extent that it is no longer very tender and soft but has enough firmness so that it will bend with light pressure and not snap off very easily. It should not be overmature, that is the stem has become hard or woody. Although it is possible that such woody cuttings may produce roots, they do so very slowly and frequently decay before rooting. The less mature cuttings root more quickly and vigorously.

# TOP CUTTINGS OF CHRYSANTHEMUMS

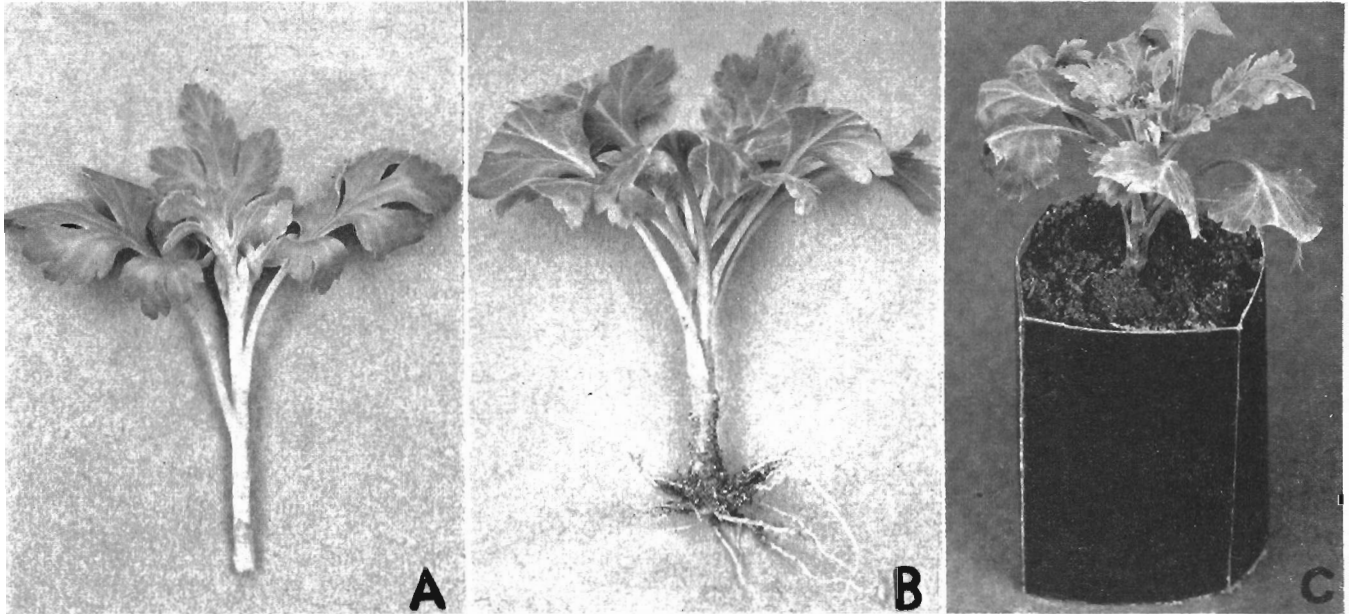


Figure 5. Top cuttings of Chrysanthemum: (A) trimmed and ready to insert in rooting medium; (B) similar cutting rooted and ready to be transplanted to soil; and (C) similar rooted cutting planted in plant band in which it may grow for a time before being transplanted into the garden or a larger container.

When a shoot has been selected (with the uppermost three or four inches in the proper stage of maturity) the upper three or four inches are cut off carefully with a sharp knife, avoiding crushing any of the leaves or the tip portion. After severing the piece or cutting to be rooted, the lowermost leaves are cut or stripped away. If the lower leaves are stripped off or broken off, care should be taken to avoid tearing away any of the outer portions of the stem. No part of any leaf which has been removed should be left sticking out from the stem. The uppermost three or four leaves should not be removed but left uninjured. Some gardeners prefer to clip off about half of each remaining leaf, but this is neither necessary nor advisable if the cuttings are handled rapidly and precautions are taken to prevent their wilting. This can be accomplished by wrapping them lightly in a damp cloth. Or they may be tossed lightly into a basin of water, a method not recommended because subsequent handling of wet cuttings is more bothersome than those with relatively dry surfaces. The best practice is to work rapidly and come to the next step as quickly as possible.

### Rooting media

Cuttings are planted in a suitable rooting medium in pots, bands, or flats, or a propagating bench and left in the medium for several days to form new roots. Never let the cuttings wilt or dry out either before or after planting them in the rooting medium.

The rooting medium used is somewhat a matter of choice. Several are satisfactory. In days gone by, cuttings properly prepared were placed into tumblers or bottles of water placed in partial sunshine on a window sill. This method may still be used when only two to half a dozen cuttings are to be rooted but is impractical for rooting large numbers of them. For a small number of cuttings, one also may insert the base of each cutting into a small flower pot filled with a mixture of sand and loam. Such cuttings after rooting are left to grow for a considerable time before being transplanted to other pots or locations. In using this method, it should be remembered that the roots will *not* grow as readily or thriftily if the rooting soil contains much nitrogenous fertilizer of any kind.

If large numbers of cuttings are to be rooted, a box, greenhouse flat, or an especially prepared bed in a cold frame or greenhouse may be used. This container, whether large or small, is filled with one of several rooting media, depending in large measure upon the preferences of the individual gardener. Media in common use are: (1) clean sharp river sand free from silt or organic matter,

(2) a mixture of sand and peat moss in varying proportions but never with more peat moss than will permit free drainage of moisture through it, (3) vermiculite which is a specially treated type of mica, (4) a mixture of vermiculite and sand, and (5) various others which are advocated from time to time as being superior to all others. One must decide for himself.

Whatever the medium decided upon, there are a few essential qualities which all must have. The medium should be retentive of moisture and yet be sufficiently porous that any excess of moisture drains away readily, although not so rapidly that the medium dries out. It must be well aerated, because roots of all plants need the oxygen of the air to survive and grow well. The medium can be firmly compacted and pressed down without losing its capacities for aeration and drainage. It must not become soggy. The medium must be free of disease producing organisms of any kind and, as already stated, must not contain much nitrogen from any source.

These conditions are fulfilled well by the media mentioned above. Fresh clean sand of medium texture, neither very coarse nor very fine, is satisfactory without addition of any other material. The grade referred to as mason sand is very suitable. A small amount of clean new peat moss is sometimes added to the sand to increase its capacity for holding moisture over a longer period, but one should avoid adding so much that the mixture becomes soggy. Peat moss alone is likely to become too wet and soggy. It does have the advantage that many disease producing organisms do not grow readily in it. It is less effective in this respect however than fresh sphagnum which is sometimes used alone with water. The latter has a more springy texture than peat moss and is less likely to become soggy wet.

### Containers

When the medium for rooting has been selected, it should be put into containers. Various types of containers are used, varying from ordinary flower pots of various sizes (in which one or more cuttings may be rooted) to wooden boxes, greenhouse flats, and specially devised cutting beds of varying sizes either in a greenhouse or constructed like an out-of-doors cold frame. A heating cable may be placed in the bottom or omitted as one desires. *Chrysanthemums* do not require high temperatures for rooting. In fact, they seem to root most readily when the temperature of the rooting medium ranges from 40° to 50° F. rather than higher. They do resent excess moisture; and, if the rooting beds are out-of-doors during the rainy season, care must be taken to prevent the rooting



medium from having too much moisture. Special cabinets for the rooting of cuttings are now on the market. These are rather large and are provided with pans to catch any excess moisture which may run through the rooting medium. They have hinged covers on which fluorescent lights are fastened for convenient use in any room, basement, or garage.

When container and the rooting medium have been selected, the container is filled with the medium to within an inch or so of its top, so that it may be watered conveniently. Before inserting any cuttings, the medium should be thoroughly moist, but not soggy wet, and firmly compacted by pounding with a brick or any convenient tool. After the rooting medium has been firmly compacted, a thin plant label or a knife may be used to punch a hole about  $1\frac{1}{2}$  to 2 inches deep. A furrow of about the same depth may be made across the cutting bed if many cuttings are to be rooted. Into this depression the leafless bases of the cuttings are stuck to a depth of 1 or  $1\frac{1}{2}$  inches. Then, the rooting medium is spread close around the cutting and again firmly compacted about the cutting. Care must be taken to avoid crushing the cutting, causing other injury to it, or covering over the upper leaves on it. After this compacting process, the cuttings and the medium are watered thoroughly, with due caution to prevent the washing away of the medium from the base of the cutting.

### Rooting

From this time forward, no great amount of attention is needed beyond preventing the medium from drying out unduly. Covering the cuttings with newspaper or other light shade during the period that full sun may fall on them is desirable. Such papers should be removed at night. As already indicated, when rooting large numbers of cuttings in a frame or bench, fluorescent light tubes may be suspended about 18 inches above the tops of the cuttings. This is not necessary, however, except during periods of very dull weather or in the case of some varieties which do not tend to grow readily during the short days of spring. At that season the light period of each day may be extended for 4 or 5 hours by the use of fluorescent lights placed above the cuttings as just indicated. Under average conditions of light, heat and moisture as just suggested, vigorous cuttings should have produced a cluster of new roots at the base in ten days to two weeks.

No great harm will be done if the cuttings are allowed to remain in the cutting medium for several days longer, except that during that time they make longer roots. Long roots on cuttings

are more difficult to transplant than short ones. More root breakage is likely to occur. Of course, if the cutting has been rooted in its own small container there is no point in transplanting until it has made considerable growth and its roots begin to crowd the room in the pot. When such a cutting has made a moderate amount of growth it may be shifted—surrounded by the medium in which it was rooted—to a larger pot containing more soil for additional growth. Shifting should be done whenever the growing plant appears to have exhausted the soil in the pot in which it is growing. Additional fertilizer must be added to the pot in which it is growing if it is not shifted. Instead of shifting to another pot, plants also may be moved from their small containers directly into the garden.

Let us assume that a number of cuttings have been rooted in a flat, cold frame, or cutting bench in a greenhouse with sand as a rooting medium. Ten days or two weeks after having inserted the cuttings in the sand, examine one or two of them by lifting them out carefully. If the cuttings inspected show a number of roots at their base averaging  $\frac{1}{4}$  to  $\frac{1}{2}$  inch long they are ready to be transplanted to a soil medium for continued growth. Such soil may be placed in small flower pots or similar containers. It is better to use a small one at first and then shift to larger ones as required later. A convenient way of handling large numbers of cuttings is to transfer them to plant bands which, again for convenience in handling, may be grouped into larger boxes or flats containing from a dozen to a hundred or more of them depending upon the sizes used. Plant bands are small collapsible boxes that range in size from  $1\frac{1}{2} \times 1\frac{1}{2} \times 3$  inches up to  $3 \times 3 \times 3$  inches. They are made either of thin wood veneer or of paper so treated that they do not immediately disintegrate and yet will do so after a number of days or weeks. They have the advantage of being simple and inexpensive. They may be transplanted along with the young plant into the open ground where they will disintegrate later if the soil is kept moderately moist.

Cuttings may be made at certain times of the year other than spring. They may be taken from older plants and rooted in the open garden if they are carefully watered and properly shaded during bright or hot periods of the day. In fact, Dutch cuttings or divisions, as previously described, usually are planted directly into the garden where they are to continue growth. Occasionally, when such divisions are very small or weak, they may be grown for a time and treated as other cuttings in pots, flats, or whatever type of propagating bed is preferred.

## Establishing the Garden

When cuttings have become well rooted in the containers to which they were transferred from the cutting bed and have made 3 or 4 inches of new top growth, they are ready to be transplanted to the open garden. One qualification to this is in the case of those young plants which may have been kept in a warm and not well illuminated greenhouse. Such plants are likely to be rather soft and succulent and should be hardened for a time before being put directly into the open garden unless one is prepared to give them special protection for a few days from the direct light and heat of the sun and from drying out.

Hardening young plants is a simple process. It consists in gradually accommodating plants from the moist humid conditions of a greenhouse to the more rigorous conditions of the open garden. A simple method to follow is to move the young plants from the conditions where they have grown as tender specimens to an environment where they can be protected for a few days until they have attained greater resistance to out-of-doors conditions. This hardening process is essential only for those plants which have been grown in a greenhouse or under other similar conditions. If they have been rooted in a cold frame or plots out-of-doors, they already are hardened sufficiently to be transplanted to the garden. Even in the case of the cold frame, however, if the glass covering has been such that the conditions inside the frame approximate those of a warm moist greenhouse, this glass covering should be adjusted bit by bit by opening the frame each day until the conditions inside it approximate those of the open garden and the young plants have become hardened.

### Desirable sites and soils and use of fertilizers

Assuming that one has well hardened young plants ready for the garden, the next step is to choose their location. Chrysanthemums need full exposure to sun or only light shade for their best development and flowering, except in a few locations where the sun is apt to sunburn them. They do not grow nor flower well under the shade of trees or buildings. In such an environment they grow tall and spindling and produce very few flowers of inferior quality.

Chrysanthemums do well in a wide range of soil types, ranging from light sandy loam to heavy clay loam. They require more frequent applications of both fertilizers and water on the former than they do on the latter.

If one plans to set the plants in an open garden, the ground must be worked over well to a depth of at least a foot with whatever tool that may be preferred. At the same time, if the soil is low in fertility, it is well to add some fertilizer which will supply nitrogen fairly liberally, but not excessively. Too much nitrogen will slow the development of a large root system. The plants indicate that the supply has been too great by very lush succulent growth, large dark green foliage, weak stems, few flower buds, and dull flowers. To say just how much nitrogen is to be applied initially is not possible because various types of soil vary greatly as to their initial nitrogen content. It is better to supply too little nitrogen at first, because more can be added as the plants grow and develop, while it is nearly impossible to get rid of a large excess readily.

The source of the nitrogen may vary. Stable manure, well decomposed, but not leached by rains is excellent. If it is not well decomposed, it should be applied to the garden in the autumn previous to planting and well dug into the soil at that time. Even though it may be well decomposed it is better to dig it into the soil thoroughly at least 2 weeks before planting time. If needed later in the season, it may be applied to the soil as a mulch around the growing plants. Watering on top of such a mulch will carry the portions used by the plants into the soil about them and prevent the soil from becoming compacted around the plants as well. Partially decomposed alfalfa or clover hay is also a good material to use, if well composted manure is not available. Composted organic matter may be used instead of manure, except that compost out-of-doors over winter with no protection from rains will have much of the valuable fertilizer elements leached out of it.

If none of these organic fertilizers is available, the inorganic ones will do nearly as well as sources of nitrogen. These include ammonium sulfate, ammonium nitrate, and other forms of nitrates. Ammo-phos supplies both phosphorus and nitrogen, and sulfate of potash is a good source of potash.

### **Precautions for fertilizers**

As already stated, it is better to start the growing season with any of these in quantities that may be less than the plant will need throughout the summer and fall. For example, if one plans to use ammonium sulfate a tablespoonful of it may be dug into the soil where a plant is to be set at planting time. Care should be taken to be sure it is well mixed in, however, and that no part of the fertilizer, before it is dissolved, comes into direct contact with the underground portions of the plant. Another good method of applica-

tion is to dissolve a tablespoonful of the ammonium sulfate or one of the nitrates in a gallon of water. Then pour most of this solution over the spot where the plant is to be set, and add the remainder after the plant has been put in place. The objection to this method is that the soil may become too wet for planting in it for a couple of days. This can be avoided by applying most of the water after the plant has been set in place. Of course, it is not necessary to apply an entire gallon to each plant. Just enough should be used to insure that the soil around the roots is well moistened and settled without becoming muddy. It is perhaps a simpler practice, and serves just as well, to dig the fertilizer into the soil in an area larger than that to be occupied by the plant. Then, after planting, water the spot down thoroughly with plain water. It is always well to remember that these fertilizers put in without water or without soil having been mixed with them are relatively very strong and may easily injure young plants very seriously if not applied carefully.

When the plant is well into its growth period—for example, late June or early July—the growth may lessen and the stems tend to become hard or the leaves yellowish. In such instances, they need another application of fertilizer. This may be applied in the same amounts and in the same ways as at planting time. Care should be taken, however, to avoid digging very deeply around the plant, because the feeding roots and new shoots around the base of the plant are likely to be near the surface and may be severely injured. In similar fashion a third or even a fourth application of fertilizer may be needed, but it is not advisable to apply any considerable amount of nitrogenous fertilizer nearer than two weeks before blooming time. An excess of nitrogen delays the proper opening of the flowers and is likely also to reduce the intensity of their coloring, especially the darker colored varieties.

If compost has been added to the soil during the autumn previous to spring planting or if it has been applied in the spring (either dug into the soil or as a surface mulch) it is seldom necessary to apply more than two supplemental applications of fertilizer. More often one is sufficient, and frequently none is required. One must realize that requirements vary according to the type of soil. Open sandy soils may require fertilizing each week, using small amounts at a time, whereas heavier clay soils seldom require more than one, if any, application during the entire growing season when a liberal amount of stable compost, alfalfa, clover hay, or even grass clippings have been dug into the soil or used as a surface mulch.

### Foliar feeding or fertilizing through the leaves

Recently, garden supply stores have begun to sell fertilizers which may be sprayed on the foliage of plants. One of these consists principally of urea, is readily soluble in water, and may be sprayed in dilute solution. It principally supplies nitrogen. There are also one or two other types available. At least one consists mainly of fish residues from canneries and such sources and is prepared so that it may be sprayed onto plants easily. These latter types supply other fertilizing elements, such as phosphorus and potash, as well as nitrogen. Whatever fertilizer may drip from the leaves is used through the soil.

There are also several fertilizer mixtures on the market which are reputed usable either for spraying on foliage or applying to the soil. One of these is a so-called complete or balanced fertilizer, which means that it should supply all the elements essential for growing plants. Reports from those who have used one or more of these foliar spray types of fertilizer, as they are called as a group, have been variable. Some have found them highly effective, others have claimed little response by the plants to their use. They are mentioned here only to inform the gardener that they are available and might be useful. If they were as effective or more effective than the conventional types of fertilizer they would be of real use, because they are easy to apply and save the time and trouble needed to loosen the soil around the plants after using fertilizers which require watering into the soil. On the other hand, if there are disease producing organisms on the foliage, because of the water applied, such organisms might be more readily spread over the plant.

### Watering and Use of Mulches

Proper watering of the garden is as essential as is proper use of fertilizers. It is best to keep the soil moderately moist, never very dry and by all means never soggy wet. When to apply water, and how much, is dependent upon the type of soil in the garden and the decomposed organic matter in it. A few very sandy soils may require watering every day, while heavy clays need water only once in each week or even less frequently, depending on weather conditions. The main point is to do a thorough job. A light sprinkling over the soil from a nozzle or a 10 to 15 minute use of a soil sprinkler or soil soaker does not get the moisture deep enough, especially if the soil is a non-porous one and water tends to enter it slowly. Only a half inch or so of the surface is penetrated by brief or superficial waterings, and this means quick drying out and wilting

of the plants. If such light waterings are given they must be more frequent.

A good mulch of straw, lawn clippings, sawdust, or peat moss around the plants will help both to maintain satisfactory moisture and to serve as a fertilizer regulator. Such mulches should not be kept soaking wet nor allowed to become heavy or soggy. Lack of moisture is likely to cause a loss of the lower leaves from the stems. Excess watering is likely to have the same effect but also causes a blackening of the foliage. It is always best to apply water to the soil beneath the plants—over the mulch if one is used—than to spray the foliage excessively. If the foliage is left wet, it becomes more subject to disease, may turn yellow, or will frequently develop yellow spots which may become dead dry areas. The edges of the leaves also may become dead and dry. Varieties differ greatly in this respect. Some can tolerate adverse conditions better than others. It is better to avoid such conditions in any case.

### Cultivation of the Soil

Contrary to much that has been said it is *not* necessary to cultivate the soil after each watering, especially if such watering has been thorough. It is necessary to hoe or cultivate to eliminate competing weeds. Beyond that, excessive cultivation or deep stirring of the soil may tend to cause a loss of water from the soil. Avoiding excessive cultivation reduces injury to the roots, young basal shoots, and even the upper branches. Few gardeners are likely to object to a reduction in the amount of hoeing or hand cultivating (so often stated as being essential), but one should not gather the idea that it is not necessary to remove weeds. Weeds remove large quantities of water from the soil. In fact, they rob the soil of as much moisture as is lost by direct evaporation.

### Planting

To plant, one should dig a hole three or four inches deep—slightly larger than the ball of earth around the roots of the plant—and set the plant in with three or four of the lowermost buds below the level of the soil without covering the upper leaves. If leaves are present near the base of the cutting, they should be removed to make planting easier. They serve no useful purpose when covered with soil in any case.

This relatively deep setting helps, because additional roots readily form on the portion of the stem below the soil level. Often, the buried buds grow out into sturdy shoots which, when they come above the soil, help to form a more dense and compact bush.

The plants should be spaced one and one-half to two feet apart. After the soil has been firmed about the base of each plant, one or two cupfuls of water may be applied near the stem to settle the soil in more completely around the roots and to dilute any soluble fertilizer which may have been applied as already suggested. If the soil is a clay loam, it should not be stirred as long as it remains wet, or it is likely to bake badly and become very hard. A better plan is to wait until the water has completely entered the soil, then draw some dry soil over the wet surface up to the stem of the young plant, being careful not to cover its top.

If the weather is mild and the soil has had a chance to warm up somewhat before planting, the newly set plants should show the beginning of renewed growth within four days to a week. At the end of such time, one may apply one or two teaspoonsful of ammonium sulfate, ammo-phos, or some complete fertilizer over an area with a radius of 6 inches from the plant stalk, making certain that no fertilizer comes in contact with either the leaves or stem. Some gardeners prefer to add bone meal to the soil before setting the plants and later to apply some form of potash fertilizer to obtain sturdier plants with stiffer stems. On soils lacking these fertilizer elements, they may well do so. Any late applications of fertilizer should be dug or chopped lightly into the soil and watered amply



Figure 6. At the left, a cutting grown in the open garden, ready to be pruned back. The stake is 12 inches tall. At the right, the same plant a few days after pruning shows new shoots in the axils of the leaves beginning to grow.



unless one is fortunate enough to do this job just before a penetrating rain. As soon as the soil surface has dried (within a day or two) the surface should be loosened close to the plants, if it has become compacted. It should not be stirred while wet.

### Pruning or Training the Plant

Following the application of fertilizer discussed above, a young plant which was in need of fertilizer should show a lush, green, rapid growth. When such growth has attained a height of about one foot, it should be cut or pinched back just above a leaf to about six inches. This seems a drastic treatment, but the result amply repays the effort. The removed tops may be rooted as additional cuttings if desired, and they may be expected to give some bloom even if not rooted and set into the garden until the end of June. The portion of the plant below the point at which the top was removed will soon show the beginnings of new shoots in many of the angles of the remaining leaves, especially if the young plants have been making as vigorous



Figure 7. Same plants as shown in Figure 6. The new shoots of the plant at left have now attained a length of 12 to 14 inches and are ready to be cut back about half their length. At the right, the same plant several days after second pruning shows new shoots again starting to develop in the axils of the leaves. These may be left to grow on to flowering or, if their growth is very rapid, they may be cut back to about half their length. It is best to avoid a third pruning after the first week in August. A similarly pruned plant in flower is shown in Figure 12.

growth as they should be at the time of cutting them back. If this lower portion of the stem has become very hard and woody before the topping is done, frequently only one or two of the topmost buds break out into shoots. This latter condition results in sparse and spindling plants and brittle branches which are easily broken off.

Let us assume, however, that four to six buds have started into shoots, as they should do on well grown plants. These new shoots are allowed to attain a length of a foot or slightly more and then cut back until only about six inches of the lower portion of each remains. In the same manner as the buds on the main stem grew out into shoots so the buds of these cut-back branches will break, each branch giving rise to several sturdy side shoots. Another light application of fertilizer may well be applied at this time. In general, if the plants were set out early and have been making good growth, this second set of side shoots will attain sufficient length that they in turn may be cut back to about six inches in length, and each of these shoots will likewise in turn, give rise to several strong branches. Thus, the plants will have been cut back two or three times, including the pruning back of the stems of the original single stemmed cutting. In some cases even four cuttings may be needed but usually by early August the cutting back should cease since blossom bud formation should be expected to take place about then. This much cutting back may seem somewhat drastic, but with good soil and moisture conditions the result will be much-branched dense bushes, often two feet or more across, consisting of many branches fourteen to eighteen inches or more in length, later to be laden heavily with clusters of bloom at their tips. The longer ones of these terminal blossom clusters are well suited for use as cut flowers, the making of arrangements, or profuse display of bloom in the garden. Usually also, additional shoots will spring from the soil around the base of the original cutting. The earliest formed of such shoots may need to be cut back at least once, as the rest of the plant has been. Bushes developed in this way are low, broad, compact, sturdy, require no staking unless broken down by rains and provide an enormous wealth of bloom. Generally, no disbudding is done when plants are grown in this manner.

Of course, one may omit these prunings back if desired. When little or no pruning is done, upright, slender, taller plants result. Under such circumstances the plants must be tied to a stake to prevent falling over and spreading too much. Some of the low growing cushion types do not require staking. Plants grown in the manner outlined above should be liberally watered throughout the summer. If they show the need of it, fertilizer applications may be made also.



Figure 8. At the left, the shoots in the axils of the leaves on the stem are vegetative branches as indicated by their leaves which are folded together flatwise. At the right, the shoots on the stem are branches which are preparing to flower, as indicated by the leaves at their tips which are strongly curved inwardly.

A few of the earliest flowering varieties should not be pruned in this manner nor do they require it. For example, the varieties *Amelia*, *Early Harvest*, and some of the cushions, if not cut back will show an abundance of flower buds and some flowers by early August or late July. In the case of the varieties *Early Harvest* and *Zantha* new shoots usually come up in profusion from the base of the plants. Such shoots grow somewhat taller than the portion of the bush already in bloom. Often they produce flower stems and flowers which top the older ones. There may even be a third crop of such blooms. The entire bush seldom attains a height of more than eighteen inches or two feet even though not cut back at all. Of course, earlier blooming is sometimes thus obtained. Some varieties may be grown in partial shade. If they receive abundant fertilizer and water, they may attain a height of more than five feet and be a mass of bloom from top to bottom by the end of September. Such tall plants must be staked to hold them upright.

To do their best, chrysanthemums should be kept in vigorous growth throughout the summer. How to use fertilizers and water has already been indicated. If fertilizer applications are continued much

after the time flower buds show color, both the plants and flowers are much more likely to suffer from rain and frost damage.

Generally, the spray types of chrysanthemums are not disbudded. In the case of two varieties, however, such a practice may prove desirable. The variety Olive Longland has many buds in the terminal cluster at the end of the branches. If one-third of these are removed by the time they have become as large as small peas, the blooms from the remaining buds will not only be somewhat larger, but more distinctive in character. The same treatment gives even more satisfactory results with the variety Charles Nye, whose principal fault is the production of a very large number of buds close together in the terminal cluster. If all these buds are permitted to develop, the entire cluster is very compact and the mass frequently resembles a single large flower. If some of the buds are removed, the remaining blooms have slightly larger size, are of finer quality, and the clusters are much more open and distinctive.

### Care Following Blooming (Overwintering)

After the period of bloom has passed, it is good practice to let the plants dry off naturally and not remove the tops from them until fully ripened or not before the following spring. In cold regions having much snow, the dead tops catch falling leaves and snow which serve as a natural mulch which can be supplemented with other *loose* cover such as cornstalks, evergreen boughs, or coarse straw. Anything which packs down firmly such as tree leaves, manure or lawn clippings should be avoided as winter coverings because the plants are readily smothered by such cover. Here in Oregon where winter cold is a lesser problem, the plants may well be left in place without a mulch if in a well drained area. If water is likely to stand over or around them, clumps should be lifted with the soil which clings naturally to the roots and, without replanting, placed under the eaves of a building or on the drier side of a building, the floor of a barn or shed, or within a covered frame on well drained ground. They may remain thus until spring. Clumps have been wintered successfully by digging them and placing them on top of the ground with no supplementary protection. In such instance, if the soil is loose and likely to be washed out by winter rains, some sort of light protection to keep off excessive moisture may be placed over them. The important thing is to avoid excessive moisture around the plants. Yet, if the clumps are placed in a wholly dry situation, they should not be permitted to dry out completely. A sprinkling or two with a watering pot, avoiding washing the soil off

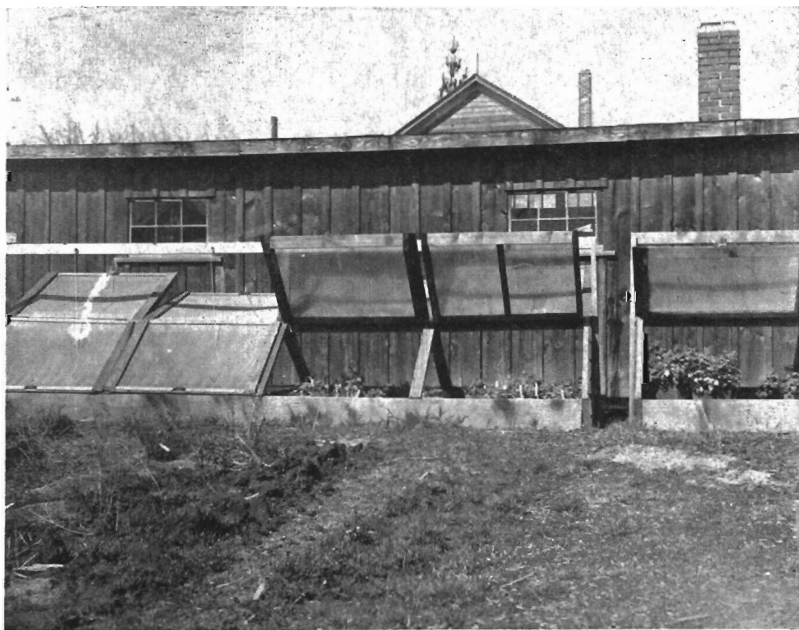


Figure 9. Serviceable, inexpensive cases in which plants may be wintered. The covers are hinged and are covered with plastic. Those shown are being used for the fourth successive season and have deteriorated only slightly. These cases are also used for housing flats of cuttings after they have been transplanted either into soil only or into soil held in plant bands, pots, or other containers.

the roots and shoots at the bases of the stems, will be ample until spring arrives. It is then time to divide the clumps or make cuttings for the ensuing year.

### Care After Wintering

As discussed above, clumps of chrysanthemums may be overwintered either by leaving them in the open ground with or without a loose mulch as the case may be or they may be placed under shelters against both rain and cold during the winter season. One should be certain, in all cases, however, that the plants receive sufficient light to prevent them from producing long, spindling, weak, and light green or yellow shoots. If they have been wintered under shelter, growth should begin actively by early-April, mid-March, or even February if there have been several weeks of warm weather.

Whatever the date, the time to handle the new planting is best determined by the kind and amount of growth of new shoots on the clump. When these shoots or the new growths have attained a height of two or three inches and are sturdy and green, a heavy knife or a fairly sharp garden trowel is used to pry the clump apart. The extent of division made may vary as desired from separation of individual shoots to three or four shoots in clusters. In any event, each shoot should have several new sturdy roots near its base and part way up the sides. A dozen or more of such roots per shoot is desirable.

After separation, these shoots or small clumps are planted just as are new rooted cuttings (described in the discussion for the making of divisions or cuttings).

Because of the earliness of the season when divisions may be made, special care should be taken to avoid handling or working the soil while it is very wet. If this is done in the case of the heavier clay loam soils, they are apt to become much compacted and hard and cementlike later in the season. This is less likely for sandy soils or soils which contain a large amount of well composted organic matter. If the soil is very wet, it is better to delay shifting until it has had opportunity to dry out somewhat.

If the weather is cold and damp after transplanting, the shoots may be somewhat slow in starting to grow; but, as soon as a few warm days have passed, growth will be strong and rapid. Throughout the summer, these plants are handled with respect to heading back, spraying, cultivation, etc., as already suggested for new cuttings. If the weather is warm, growth is likely to be more advanced at any given date for these transplants than for new cuttings. Hence, heading back may be commenced at an earlier date than previously suggested, but at about the same stage of development.

### Care of overwintered clumps the following spring

If the clumps have been wintered in the soil at the same spot where they grew the previous season and it is desired to divide and spread them, the same method of dividing the clumps as just described may be followed—prying out such individual shoots or clumps as it may be desired to move. To do this, the trowel or knife used for division should be inserted sufficiently deep so that in prying out the young divisions some soil and a good supply of roots will be left attached to each. Such a division may then be transplanted and handled as described above. The old clump should be thinned out in any case; otherwise many shoots will grow up in a small area, far too many for the production of large full flowers later in the season. For most varieties not more than three shoots should

be left in place, the rest should be dug out and either thrown away or disposed of as desired. It is a good plan to add some new soil or well rotted manure around the remaining sprouts and to cover their bases also with a little extra soil.

Use a liberal dressing of well rotted compost together with a light dressing of any good fertilizer fairly high in its nitrogen content. Be somewhat more liberal than in the case of a small plant just being started from a cutting, because these older plants should have a better established root system, capable of absorbing and utilizing more fertilizer at an earlier date. Care should be taken, however, to avoid very large applications near the plants, because the young leaves are easily injured by concentrated fertilizers and are likely to wither and die. When the weather of spring is cold, the new shoots are not capable of using as much nitrogen as when the weather is warm. Instead they may turn decidedly yellow and be severely injured. Exact amounts of fertilizers to apply cannot be specified, because soils, seasonable temperatures, and rainfall vary so greatly from year to year. As suggested previously, it is better to make several smaller applications of fertilizer than one heavy one, adding small quantities as the plants develop and have increasing root and leaf growth capable of utilizing it.

A few varieties tend to grow up and away from the soil level and produce their new roots in the air above the soil. The entire clumps in such types should be lifted and replanted two or three inches deeper in the soil than they stood previously. If this is not done when dry weather arrives, many of the roots die, the bases of the stems become hard and dry and many of the lower leaves will blacken and fall. A very small crop of inferior flowers will appear. On the other hand, some varieties, with a little thinning out, may remain in the same spot for six or seven years and continue to produce as excellent bloom, as if fresh new cuttings were used each year.

### Precocious Flowering

It has been observed over a period of years that some varieties, especially those inclined to flower early in the autumn or in late summer—when not transplanted or cut back early in the spring—, tend to produce many flower buds during May, especially if the weather is cool. Sometimes nearly a full crop of flowers may be produced by the end of May or the early weeks of June. Generally, however, such flowers are small and of inferior quality. Often too, if the buds have not opened when warm weather arrives, they do not open all summer or will blast or open in a lopsided manner.

With the advent of warm weather, weak leaf and shoot growth begins. The effect of the dying buds, half opened flowers, and rather indifferently growing shoots is very messy indeed. It is much better practice, when such early budding takes place, to cut all top growth back completely, to the soil level. Directly following such cutting back, if the weather is warm, the plants will put up sturdy, husky, vegetative shoots which should be given the same cutting back and other treatment during the summer as a plant which had not produced these early flower stems. The cultivation and fertilization practices to be followed during the spring and summer are much the same as when new cuttings are used.

By following out these simple suggestions it is possible to have enormous clumps of the finest possible bloom from older established plants. The plants of many varieties will improve with the passing years. They certainly will be as good as plants established each year through the use of new cuttings. The procedures suggested avoid the crowding together of too many stalks. There are fewer of them, but each is developed well and will give far more satisfactory returns than many crowded weaklings.

## **Old Clumps as Sources of Cuttings**

It is a common practice to make the terminal type of cuttings from the upper portions of the shoots produced by older clumps. Such clumps are the principal source of cutting material. Of the very successful amateurs who grow chrysanthemums, some use top cuttings and others use divisions or Dutch cuttings. Those who argue for the top cuttings state that it is often more desirable to take them as far away from the center of the old clump as possible, because in that way stronger shoots can be selected and they are less likely to carry over insects or diseases than are divisions. On the contrary those who favor divisions contend that such plants grow more rapidly, come into flower somewhat earlier, and that the whole job of starting new plantings of whatever sort is more simple and easy. Thus, as already suggested, the type used depends upon the preferences and experience of each individual who grows chrysanthemums.

## **Large Flowered Early English or Other Exhibition Types**

As stated above, the Early English type of chrysanthemum is a strain or collection of strains which when disbudded may be made to bear very large flowers which often rival in size those of



the exhibition types. Most of them are selections made by a few British nurserymen. Under favorable environmental conditions these large flowered types may be grown out-of-doors. Many of them bloom early in the season, or, if they do bloom late, they may be brought to perfection under some type of shelter to protect them from rain and moderately severe conditions of cold.

Much of what has been said about the culture of garden spray types applies equally to the large flowered types. One of the principal differences is that they are not cut back so severely as the former during the growing season. They are usually disbudded, if huge flowers are desired, and they are tied or trained to stakes to hold them upright. Some of the varieties, however, will produce an abundance of medium to large size flowers when not disbudded if pruned and trained according to the methods described for the spray types. Under such circumstances, they may require staking to prevent them from sprawling over the ground. Some of them, however, do grow sturdily upright and produce excellent flowers suitable for arrangements and general use.

The Early English and Exhibition types are grown by many individuals in Oregon. Practices and details of method of culture vary with the individual grower. What is set down here is based on observation of the methods used by several individuals rather than any single one. Perhaps every individual who reads these pages will say, "that's not the way I do it," and be correct.

The methods of taking, making, and rooting the cuttings are similar in principal to those for the non-disbudded spray varieties. The shoots selected for the making of cuttings are somewhat sturdier and larger in the case of the English or Exhibition types. Many of these varieties naturally produce sturdier cutting material, but there may be fewer shoots produced. A few varieties are very noticeably weak, making the securing of strong cuttings a difficult task. Some advanced amateurs prefer divisions rather than top cuttings.

There are varied preferences as to the rooting medium used in the hands of a careful gardener. Any of the types of medium and container previously mentioned may be employed. Some growers prefer to fill a 3-inch flower pot with a mixture of  $\frac{2}{3}$  loam and  $\frac{1}{3}$  leaf mold. A hole is made at the center and this hole is filled with sand. The base of the cutting is inserted in the core of sand. When the roots form they penetrate directly into the soil-leaf mold mixture and do not require transplanting for a considerable period. If soil only is used the inserted bases of the cuttings may rot before rooting. Other growers prefer to root the cuttings in the open garden bed where the plants are to be grown. In such cases one must make

certain that wet soggy soil does not lie in contact with the base of the cutting. This condition can be avoided by making a hole in the soil and filling it with sand into which the cutting is inserted, as in the pot method. If rooting is done after the soil has dried out and warmed up somewhat in the spring, the precautions against rotting are not necessary. The same is true if divisions or Dutch cuttings are used for propagation, especially if they already have good roots on them.

The vigor and condition of the cuttings is as important as the particular method employed in rooting them. Strong shoots will be found at the edges of a clump, as a rule, although they may be scattered through it. Procedures are similar to those already given for making and rooting cuttings and their subsequent handling. If the cuttings have been rooted in 3-inch pots, they may remain there until they have made considerable growth or until additional volume for root growth is needed. Such need is readily ascertained in either of two ways. One, there is an indication of yellowing of the foliage or it begins to appear dull, which means there is a probability of lack of sufficient fertilizer in the pot. Two, when the soil is moistened and the pot is turned upside down, the soil and rootmass come away readily when the pot is tapped. If there is a mass of roots which fill the ball of soil and they are massed abundantly over its surface, it has become root-bound. Under such circumstances, the plant should be set into the soil bed, which has been prepared in the same manner as for the spray type.

## System of Development of Shoots and Buds

If one wishes to grow a plant as a single stem, the cutting (whether grown as a pot specimen or in the open ground) may be permitted in the case of some varieties to continue growth until a flower bud develops at its tip. Such buds, however, very rarely develop into satisfactory flowers, often they do not bloom at all. Before going into further details, one must know the growth and flowering behavior of the chrysanthemum.

### Plant growth habits

If a plant were allowed to develop by itself without the intervention of man, the following sequence of development would take place. After a cutting or a seedling has been planted in the garden and has grown vigorously for a time, a flower bud forms at its top and stops any further production of leaves or elongation of the original stem. This bud is referred to as the *break bud*, because below it the small buds in the angles of the upper leaves of the main

stem begin to break or grow into side shoots. After the side shoots have grown and produced leaves for a time, each shoot forms a bud at its tip which stops the elongation or production of more leaves by that particular shoot in a manner similar to what took place in the case of the main stem. The bud at the end of each of these shoots is called a *first crown bud*.

After the formation of the first crown bud, elongation of the shoot ceases, and new shoots develop in the angles or axils of its leaves. These new side shoots elongate and produce leaves for a time, and then at the end of each shoot a flower bud develops. These buds are called *second crown buds*. A second crown bud ends the growth in length of the shoot on which it occurs. Below this bud, however, side shoots will again form in the axils of the leaves. As in previous cases, each of these shoots is terminated by a flower bud which is referred to as the *terminal bud*, because it is the last bud the plant will form at the tip of a shoot. Such additional growths as do occur in the axils of the leaves immediately below the terminal bud, do not develop into leafy branches, but as flower buds lateral to the terminal bud. This final terminal bud together with the flower buds which develop in the axils of the leaves just below it are referred to as a *terminal flower cluster*. After the terminal bud cluster is formed, the production of side shoots on the main stem is finished except for such as may develop near or at its base. The training of chrysanthemums for various uses depends upon this habit of growth.

### Control of growth

The skilled gardener seldom allows his plants, especially those destined for the production of large blooms, to form the break bud, but "stops" them, that is, pinches out the tip, so as to cause them to produce side shoots at an earlier stage of development. Directly following such pinching or "stopping", the growing plant sends out new shoots in the angles of several of the uppermost leaves which it bears. From among these laterals, the grower may select one or even up to four or more of them for continued growth or train a single stem if but a single shoot is chosen. In any case, before many days have passed, these lateral shoots develop flower buds at their tips. These are the first crown buds. On some varieties these are not removed. If they are not, eventually they may come into flower. In many cases, however, these "first crown" buds are nipped off or disbudded. Following such disbudding, new lateral shoots are developed on the branch or stem below them. The grower selects as many of these branches (often one only) as he may wish to allow to continue growth.

Whether one or more shoots are selected, each develops the "second crown" bud at its tip. Below these second crown buds, shoots will in turn, start out in the leaf axils. If the grower wishes this second crown bud to come into flower, then all the new shoots below it are pinched out or rubbed off. If however, it is desired to select a terminal bud to produce the flower, then at least one of the shoots below the second crown bud must be permitted to continue growth. Such a shoot will produce not only one, but a cluster of flower buds at its tip—the terminal bud cluster already referred to. The grower must select from among them the particular bud which he intends to allow to come into flower. Generally, the center or true terminal bud is selected or "taken." The remainder are removed, that is, disbudded. Sometimes it may be desirable to "take" or select more than one bud of the terminal cluster. This is done mainly as a matter of insurance in case the bud intended for flowering is misshapen or injured. It may be removed, and the second one which has been held in reserve produces the flower. In general, the earlier in their stage of development the more desirable it is to remove the buds not desired for flowering. With less competition among the buds, the bud which has been selected to remain will become stronger.

### Types of buds

It is a well recognized fact that there may be considerable difference in the size and doubleness of flowers which mature, dependent upon whether they mature from the first crown buds, the second crown buds, or from terminal buds. It is thought by some that flowers from the first crown buds are likely to be more double than those from terminal buds. Others contend the reverse is true. In fact, which bud to take is a matter of individual experience. Lists of some nurserymen are explicit, however, in suggesting which type of bud to "take" and on what date it should be taken to secure flowering at some specific time.

It is beyond the scope of this bulletin to provide even a short list from among the hundreds of varieties of chrysanthemums now available through one source or another. Exchange of information with other growers or, better still, one's own experience are the safest guides to follow. The growing of prize winning blooms for show purposes is work for the specialist.

With reference to general principles of culture, there seems to be fairly common agreement on a few points. Plants starved for lack of water, fertilizer, or proper conditions of light will not yield large blooms. Therefore, the soil should be prepared deeply and well before planting, usually working into it some well composted animal

manures which will provide a plentiful supply of nitrogen but not so much that during the early stages of growth the roots may be injured by it, or that the leaf growth made is not so excessively lush and soft that it breaks readily when the leaves are bent slightly by the fingers. The leaves of plants should be flexible when bent lightly. They should not crack or break across readily. The advantages of animal composts are that they aid in making a soil more open and porous, supply nitrogen over a considerable period as the compost continues to disintegrate, and furnish potash and phosphorus which the growing plant requires. The same is true for alfalfa hay. As said previously, it is better to provide a slight undersupply than an oversupply of plant foods while the plants are in active growth. More fertilizers may be added as the plants grow larger. This can be done by applications of mineral or animal fertilizers to the soil, around the plants or to the foliage as a spray. The same principles should be followed of course, for the spray types of chrysanthemum. The only difference is that more detailed care and attention are focused on individual plants and blooms in the case of the large flowered types.



Figure 10. Good sturdy type of shelter under which exhibition types are being grown. Note the canvas sides which may be raised or lowered at will depending on weather conditions.

## Shelters

Many of the individuals who grow chrysanthemums of the exhibition type out-of-doors prefer to provide some sort of shelter for them. A large flower is prized so highly that it seems desirable to provide protection for it from intense sunlight, wind, and other elements of weather during the summer. Many of the varieties bloom so late in the season that protection from rain and cold is needed during the autumn.

The type and method of construction and materials used in making these shelters vary with the number of individuals who use them. There are a few principles common to all of them, however. A stout framework is essential. This may be of wood or metal. Over the top of, and often on the sides as well, is spread material sufficiently transparent to permit light enough to strike the plants beneath the covering so they will not grow spindling and yet dense enough to prevent the plants from becoming sunburned. Some growers omit all top covering during the summer but supply one in the autumn. At that time, after the plants have made their seasonal



Figure 11. Same shelter as shown in Figure 10 with a collection of Early English and Exhibition types which have been grown with one to three or four main stems. They have been disbudded in order to achieve especially large blooms for exhibition. Note roof of shelter is sufficiently high to permit working conveniently beneath it.

growth and need little light or sunshine, opaque coverings such as heavy cloth, blankets, and old carpets are sometimes used.

Such shelters should range up to 8 feet or more in height from the soil level to the roof. The height necessary depends upon the height of any given variety when in bloom—some grow 8 feet high, others scarcely more than 4 feet. In the better built shelters, protection at the sides may be provided against prevailing winds or rains. Canvas is often used for the sides but, as in the case of the top covering, sufficient light must be admitted to provide for good growth. In certain regions these side protectors are provided only in the autumn. If the entire shelter is a large one, they may be left in place on the north or west sides provided enough light can be allowed to enter from the south and east sides. If one desires to grow only the earlier flowering varieties, excellent large flowers may be had on plants grown entirely in the open with no artificial shelter provided that the plants are started early in the spring, and if a system of training, fertilizing, and disbudding which does not delay blooming is followed.



Figure 12. Plant in flower. Note the low bushy habit and large number of flowers resulting from pruning back two or three times during the growing season. Compare with the larger individual flowers on individual stems as grown under shelter in Figures 10 and 11.

## Growing Chrysanthemums in Pots

All the details discussed in raising chrysanthemums in the open ground or in beds are equally pertinent to growing plants in pots. They differ only because of the restrictions in pots of the soil and water supplied to any given plant. Starting with a cutting which has been rooted in sand the following procedures are desirable. Lift the cutting from the sand when its roots have attained a length of about 1 or  $1\frac{1}{2}$  inches or root the cutting directly in a small pot as already described. Long roots are more subject to injury during transplanting. Use a good potting soil of open texture— $\frac{1}{2}$  part decayed sod compost which has a considerable amount of soil in it,  $\frac{1}{4}$  part leaf mold or other well composted organic matter, and  $\frac{1}{4}$  part well rotted stable manure, if available. Some growers prefer to add a handful of bone meal to each gallon of this mixture.

### Fertilizers

If the well decomposed stable manure is not available, a soil may be made up by adding to each gallon of the compost and leaf mold mixture one-half teaspoonful of a complete inorganic fertilizer. The entire lot of material should then be well mixed together. If such inorganic fertilizer is used, it is best to prepare the soil several months in advance if possible, moistening it well but not soaking wet at the time of preparation, and storing it in a place protected from rain. It needs to be watered lightly from time to time to keep it moist but not wet. It should be moist at the time it is used for potting the plants.

At the first potting up of a rooted cutting, a 3- or 4-inch pot is filled half full of this soil mixture; then the cutting is set gently down upon the soil so as to avoid breaking the roots. A couple of tablespoonsful of water are added. The remainder of the pot is filled to within  $\frac{3}{4}$  inch of the rim and the soil pressed down gently around the cutting. Sufficient water to moisten the soil well but not make it soggy wet is applied. The plants should then be placed in a well lighted frame or spot where they may be allowed to grow for a time. If they are to be exposed to bright sun, they need shade with newspapers or other light cover during the heat of the day, but remove such cover at night.

When the plants have made some growth and the roots are beginning to show at the outside of the soil mass (when tapped gently and removed from the pots), they are repotted in a 5- or 6-inch pot using a procedure similar to the original potting up.

The plants having made more root and top growth at the time of the repotting, they are then capable of using more nitrogen and



other fertilizers in the potting mixture. Hence, after the plants have been replanted and are ready for water, it would be advantageous to use water in which ammonium sulfate or ammonium nitrate or a complete fertilizer has been dissolved at the rate of 1 tablespoonful for each gallon of water. Do not add an excess of fertilizer and be certain before applying this water that all fertilizer in it has been completely dissolved so that no sediment remains. A similar solution of fertilizer is useful to apply at subsequent periods during the summer as the plants develop, using not more than 2 teacupful at any single period of application. If more water is needed, supply it without the fertilizer in it. This solution, if a complete fertilizer has been used in preparing it, is recommended for use as a substitute for the liquid manure so generally suggested. Liquid manure is indeed a valuable fertilizer, but at the present time the manure which is used in preparing it is often difficult to obtain, its odor is offensive, and containers for it take up storage space of value for other things.

### Growth in pots

In the 6-inch pots the plants should make rapid and sturdy growth and, if of a medium sized variety and trained to a single stem, may often be brought to satisfactory flowering without shifting to a larger size. If the plants have been cut back so as to develop 3 to 5 stems, they will need another shifting, to an 8-inch or even a 10-inch pot, in the manner suggested for the earlier shifts. As the plants continue to grow and develop to the flowering stage more fertilizer should be added from time to time, using the complete fertilizer solution already suggested. It may be applied more frequently but not of stronger concentration at any one time. One may mulch the surface of the pots with a well decomposed and sifted mixture of leaf mold to which a cupful of dried sheep manure at the rate of 1 cup per gallon of leaf mold has been added and well mixed. If this method is used, less watering with water containing fertilizer will be needed.

Throughout this entire period of growth the plants should be carefully watched. If they are not receiving plenty of nutrients, as indicated by slow growth and grayish yellow foliage, then more frequent applications of fertilizer may be added, but always a very dilute solution. A common error and fault is not too little fertilizer but lack of careful watering. The pots must not be allowed to dry out at any time nor on the other hand should they be kept continuously very wet, a condition which is as harmful as any other single thing. Plants which have been overfed on inorganic nitrogen, com-

posts, or any other fertilizer, until they have become excessively lush with heavy, watery, green leaves will produce poor flowers of inferior quality and color.

## Transplanting Mature Plants

As has already been pointed out, chrysanthemums do best when exposed to full sun during all or a major portion of the day. This fact might prevent their use under trees or other shaded spots. This need not be the case, however, because it is a very simple matter to grow the smaller flowered types in a location where they do receive ample sun for excellent growth and flower production. When the flower buds show color, as autumn approaches, entire plants may be taken up and transplanted to other locations including those under trees and the like, where they will come into full satisfactory bloom and color.

The method of accomplishing this transplanting is as follows. After low, husky plants have been developed in the manner already outlined for the spray types and the plants are about to come into bloom, they should first be well watered. After the water has soaked into the soil around the plants and there is no longer likelihood of puddling the soil, it is best to dig deeply around each plant at least 5 inches out from the center on all sides with a spade to a depth of about one foot or slightly more. Then lift out the plant completely with a good ball of moist soil adhering to the roots. Next, dig, or have already prepared, a suitable hole at the spot where the plant is to be reset. Place the plant in the hole at about the depth it has been grown previously and fill around the plant until the hole is about one-half full. Water it very thoroughly to settle the soil around the roots and prevent air pockets below them. After the water has soaked in well, fill in the soil around the plant and firm it down. Draw some dry soil up around the plant and then leave it alone except to supply additional water from time to time if the soil is sandy.

The plant may wilt slightly in very bright sun. If temporary shade is provided, it will recover completely in three or four days and bloom as well as if it had not been transplanted. By all means, avoid pulling on it or lifting it. To disturb it after transplanting means nearly certain failure whereas leaving it undisturbed leads to success.

In similar manner, plants may be dug and transplanted with great success into pots, planter boxes, tubs, or wherever it is desirable to have them. In this way continuous bloom may be had for weeks following transplanting. In some localities these full grown,



Figure 13. A plant which was grown to the flowering stage in the garden, then transferred to a flower pot in which it has come to full bloom. Plants handled in the same manner may be transferred to planter's boxes, borders, or other locations in the open ground—wherever it may be desired to have a show of autumnal color.

ready to bloom plants may be purchased from local nurserymen at very reasonable prices either in pots or cans or with suitable balls of earth on them. In such areas one may have a splendid show of fall flowers with a minimum of personal effort and cost. When such potted plants have finished blooming, the plants may either be removed from the containers and planted in the garden where they are more than likely to survive the winter or they may be overwintered in the containers in which they were purchased and then

set into the garden the following spring. If they are left in the containers out-of-doors during the winter, care should be taken to see that they do not become soggy wet because of exposure to excess rains. On the other hand if they are kept under cover they should be watered sparingly from time to time to prevent drying out.

## Insects, Pests, and Diseases

Although the chrysanthemum is relatively free from the attack of many different kinds of insects, the total number of any given type may reach enormous numbers. In total the list of serious pests of the chrysanthemum is not a long one and it is very rare indeed that any one gardener has to contend with more than a few of them. The following are among the more common ones.

### Slugs

Several kinds of slugs attack the plants, especially during rainy spells in the fall, winter, and spring. Two common types of injury occur. One of these is to young plants in propagating beds, where plants are kept in pots or plant bands, or even in open beds or pots to which they have been transplanted if such locations are very moist. Another likely time and place of injury is to the overwintering or overwintered clumps. Slugs often invade these clumps and eat completely away the young shoots as they begin to make their growth in the springtime or during the winter. A reasonably effective means of control is the scattering of poisoned baits containing 3 per cent metaldehyde made especially for the control of slugs. This can be purchased at plant supply stores. There are several trade brands.

### Aphis or plant lice

There are several types of aphis or lice which find the chrysanthemum attractive food. Although small, this pest may multiply to almost incredible numbers, sucking the juices from the plant. They cause small and distorted leaves and dwarf plants.

An effective aphicide is a liquid preparation of tobacco containing 40 per cent nicotine sulfate, which is readily miscible with water and which may be sprayed onto the plants without injuring them when the manufacturer's directions are followed. Sometimes aphis persist despite this treatment. Then 1 per cent parathion dust or preferably 5 per cent malathion dust may be used. **Parathion is very poisonous to people if taken into the lungs, eyes, or mouth.**

Persons using parathion dust or spray in greenhouses should walk backward as the chemical is applied and treat one section at a time. The doors and ventilators of the greenhouse should be open

during application. A gas mask protecting against organic vapors should be worn by applicators who cannot avoid getting into parathion spray or dust. (See Station Circular 436). During warm weather out-of-doors, aphids are not a serious problem as a rule, because their natural enemies and parasites keep them under control, but during the cool days of spring and fall these parasites are generally less active than are the aphids so that the latter may increase to enormous numbers in a relatively short period.

### Red spider

These are very tiny spider-like pests which usually live on the undersides of leaves and extract the natural sap and juices from them. They cause a curling downward of the edges of the leaf, the loss of bright green color, a very fine yellow speckling, and a drying of the foliage. Sometimes a very fine and delicate network, much finer than any average spider web, may be noted over the surfaces of the leaves and on the upper portions of the stems. Red spiders are so very small that they are difficult to see with the unaided eye, but a hand lens will help to reveal them. They usually do not appear distinctly red but rather have a yellowish green color and dark spots on their backs. They are likely to multiply in greatest numbers and to be most destructive during warm dry weather or in the warm dry conditions of a greenhouse. One fairly effective method of control is to spray the foliage, especially the under surfaces of it, with a fine but forceful spray of water. This treatment needs frequent repeating to rid the plants of all of the spiders. Another remedy is to dust the infected plants with 1 per cent parathion dust or 5 per cent malathion dust, available at plant supply stores. **Because parathion dust is very poisonous to human beings, the precautions suggested under control of aphids should be strictly observed.**

### Tarnished plant bug

These are small (about  $\frac{1}{8}$  inch long), flat, gray bugs which tend to fly away rather promptly when one approaches a bush they are on. In a manner similar to that of aphids, they pierce the leaves and stems, suck out their juices, and leave small grayish dead or dying areas where they have been feeding. Their most severe injury, however, is to the flower buds. If one of these insects pierces a flower bud, it will not develop properly and often fails to bloom. The portion of the bud that the insect has pierced fails to grow as rapidly as the uninjured portion, and the bud becomes lopsided and valueless. One good control for these bugs is the use of DDT either in the form of a 5 per cent dust or as a liquid preparation. Either form is available at plant supply stores.

### Leafhopper

These are tiny yellowish green insects which generally remain on the under surfaces of the leaves and suck out their juices, leaving a tiny yellow spot on the upper surface of a leaf above the place where they have fed on the lower surface. They are destructive in themselves but their most serious effect is that they may carry a serious disease called virus from plant to plant. Viruses are extremely destructive. Leafhoppers can be fairly well controlled, if not eliminated completely, by the use of DDT preparations as suggested for tarnished plant bugs. Several applications may be needed during a growing season, because this pest may migrate into the garden from nearby sources where it is not being kept in check.

### Twelve spotted cucumber beetle

These beetles are large compared to the pests just previously discussed. The mature beetles are somewhat more than  $\frac{1}{8}$  inch in length and of stocky dimensions and can be most readily recognized by their color which is light greenish yellow with 12 black spots on their backs. They crawl about the plants and fly from one part to another rather actively. They may cause very serious damage by eating the foliage and stems but are most active in eating the petals of the flowers, especially those of the lighter colored varieties, particularly yellow. They may be held in check by the use of 5 per cent DDT dust. The operation of dusting must be repeated several times, because the beetles occur throughout the entire summer. They are most numerous in the autumn, especially on warm days following rain. Weed patches are favorite haunts for them, and from these they migrate in great numbers to the plants in the garden.

### Blister beetle

These insects are large, jet black beetles,  $\frac{3}{4}$  inch to one inch long, with a voracious appetite which matches their size. In late summer the adults migrate into the chrysanthemum plantings where they devour the petals of the flowers. Often they completely ruin a flower in a single day. Although not as numerous as the twelve spotted cucumber beetle, they are nearly as destructive when present. Their period of infestation generally does not extend beyond a three or four week period. They may be destroyed by an application of 5 per cent DDT dust. In using this preparation, care should be taken to see that it is evenly distributed, especially to avoid splotches of it on the petals, because most varieties of chrysanthemums are sensitive to it and may show severe discoloration and withering of the petals if too much is applied. Caution is to be taken in this respect because

many commercial hand dusting-machines fail to distribute dusts evenly. A serviceable and efficient duster should be a part of the equipment of every gardener and well managed garden.

### **Eel worm or nematode**

These are not insects but very small worms, which may be present in soils or even in the leaves of plants as received from some nurseries. If once thus introduced into the garden, they persist for several years in the dead leaves of old plants or in the soil. The injury resulting from this pest is most severe during wet growing seasons or in areas where there is much rainfall. This is because the pest is splashed by the rain from the soil onto the leaves or from leaf to leaf, each of which it enters and eventually kills. Injury to the foliage first appears as yellow areas near the tips of the leaves. These yellowish areas enlarge rather rapidly. In the early stages they appear as yellow wedge shaped spots extending backward from the tip or edges of the leaf until the entire leaf may finally become black and withered.

Once inside the leaves, this pest is very difficult to reach so the best way of dealing with it is to avoid splashing water from the soil onto the leaves or from one infested leaf to another leaf. The dead leaves may be removed and burned before they fall onto the ground. Branches bearing a number of infested leaves should be removed and burned. All trash should be cleaned up scrupulously in the autumn. In propagating from old plants, select only portions which show no trace of injury. The pest is particularly likely to be carried over on divisions of old plants if these have become infested. Also, care should be taken to secure clean plants from nurserymen. **There is a chemical which can be applied to the soil which will kill the pest within the plants infested but after application the chemical persists in the soil for long periods of time and is so extremely poisonous to animals and man that its use in the garden is not recommended.** Nurserymen sometimes use this chemical to treat all their stock plants from which propagating material is to be taken. Cuttings from such propagating material will be free from the nematodes. Fortunately this nematode does not yet appear to be a serious menace in most Oregon plantings. Dry summer weather and care in watering will help to preserve this fortunate situation.

### **Grasshopper**

Grasshoppers become a menace to chrysanthemums only when the plantings are located near fields where other farm crops are grown or where weed patches exist in nearby vacant lots in cities.

As the season advances and their usual food supply dries up the grasshoppers often migrate into the chrysanthemum garden where they feed on the foliage, young stems, and flowers. They are a difficult pest to control, but some of the newer insecticides such as aldrin, chlordane, or toxaphene may be employed in the flower garden. The directions supplied on the package of any particular preparation should be followed carefully. If the grasshoppers are present in small numbers only, the simplest control is to pick them off by hand and destroy them.

### Spittle bug

The presence of this insect may be noted in the spring after the plants have begun their early growth from bits resembling saliva adhering here and there to the stems of the plant. The leaves curl at the tips of the shoots where these masses are present. The shoots are often stunted in growth. If one of these masses is pulled apart, in its center will be found a yellowish or greenish insect which is the immature form of the spittle bug.

At times this insect is abundant, at other times it is not so common. It may be controlled rather readily by dusting the plants with 1 per cent Rotenone dust, making certain that some of the powder falls on the foamy white mass in which the insect lives. Later in the summer the spittle bug, in the adult stage, may be present, but at that time it seems to do little damage. The foamy masses are not present.

### Mildew

Mildew is caused by a fungus which occurs principally on the surfaces of the leaves but may also occur on the tender stems when plants are severely affected. The edges of a leaf turn downward slightly and the whole leaf appears coarsely pebbled or corrugated. A whitish dust-like coating covers all or part of the surface. It spreads most actively during spells of cold, damp, cloudy weather. When the weather is dry and sunny, it is not frequently encountered except on very susceptible varieties grown under shelter. The spray type varieties in general are less susceptible than some of the exhibition types, especially when the latter are given large quantities of nitrogenous fertilizer and are over vigorous. The occurrence of the disease may be prevented by exposure of the plants to ample light and air and avoiding over-fertilization. Once the disease has appeared, plants need a thorough dusting with sulfur in some of the specially prepared dusting forms. A spraying with Bordeaux mixture, or thorough dusting with dry Bordeaux in a powder form, will



aid in control. Dry Bordeaux mixture is similar to other fine dusts and may be put in a muslin bag and applied by shaking small quantities into the plants.

### **Wilt**

Wilt is caused by a fungus sometimes present in soil. It enters the roots of a plant and may penetrate other parts as well—growing mainly in those portions of the stems that supply water to the leaves. It causes the entire plant to wilt and die. Once the symptoms of this disease become apparent, there is no effective remedy. The entire infested plant should be removed and burned and never used for compost nor for propagation. All dead plant parts likely to contain the fungus should be burned. As an added precaution the area where the plant grew should be thoroughly dusted with dry Bordeaux or some other fungicide in an attempt to destroy any of the fungus which might be present in the soil or stray plant parts.

### **Leaf spot**

This disease shows up first as yellow green dots scattered on the lower leaves of a plant. Later, the spots may grow to much larger size and turn gray. The gray area is dead plant tissue. Severely infected leaves may show many of these gray spots. Each affected leaf may turn red, beginning at its tip, and finally gray, dry up, and fall from the plant. Once the disease symptoms have appeared, the most one can do is protect the unaffected areas of a given leaf or those leaves which do not show any infection. A spray of Bordeaux mixture or a light spraying of the plants with water followed at once by a dusting with dry Bordeaux, so that it will stick to the surface, prevents the spread of the infection. Picking off and burning badly infected leaves also helps.

### **Aster yellow**

This malady usually involves the entire plant. It first gives the leaves a yellowish instead of green color. The plant may produce a few flowers. Infected plants have characteristic flowers which can be recognized at once by their small and narrow, almost spiny, petals and their yellowish green color, sometimes with a faint indication of normal color. The cause of the disease is a virus which is transmitted from one plant to another by leafhoppers. Hence, any method of control must attempt to prevent the spread of leafhoppers as already discussed by the application of 5 per cent DDT dust. Also, any plant which shows any symptoms of the disease should be destroyed as promptly as possible, so that the virus which it contains cannot be transmitted to other plants. A suspected plant should be

pulled up and burned immediately. Fortunately the disease is not widespread on chrysanthemums in Oregon, but a few cases of its occurrence are known.\* It is to the interest of all chrysanthemum growers to prevent the spread of the disease. No matter how choice a plant may be, it should be destroyed as soon as it is infected.

### Red foliage

Whether to call this a disease or not may be open to question, but it is certain that plants showing the following symptoms neither grow nor flower so well as do those which do not show them. At first a gradual development of a dark purplish red color appears along the veins on the underside of the leaves. As the season progresses, a similar purplish red color spreads from the veins until the entire leaf (both upper and lower surfaces) is involved. Cuttings taken from such red plants will invariably develop similar symptoms. These symptoms resemble slightly, and may be confused with, the coloration which healthy foliage may assume when nitrogen supply is too low or if the plants get a sunburn from brilliant sunshine. In such cases, the red coloration is less purple in hue than that in the disease. The disease is a serious one. All affected plants should be pulled up and destroyed. Some varieties show these symptoms when received from those who supply plants. Such plants should be destroyed as soon as received and *not* planted into the garden. If the nurserymen or the individual from whom they were obtained, cannot supply healthy stock, another source of supply should be used or another variety planted instead. This difficulty is being encountered more and more frequently in chrysanthemum plantings to the extent that, unless growers and nurserymen will cooperate in eliminating all plants which show it, the time may come when the growing of healthy vigorous chrysanthemums may be an impossibility.

Fortunately, as stated previously, the number of pests on chrysanthemums is not very great. With reasonable care it is possible to enjoy abundant crops of this finest and most gorgeous of all autumn flowers.

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\* Does occur on a variety of other plants in Oregon.