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AMERICAN BULBS UNDER GLASS

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INTRODUCTION

Both commercial and private experiences with American-produced bulbous stocks have been varied and often contradictory. This is not surprising when one considers the immensity of the undertaking upon which the growers have but recently ventured and the paucity of experience and information available to guide them.

There has been some confusion owing to a misinterpretation of results obtained under glass. An unsatisfactory experience with domestic stocks has sometimes been interpreted as a demonstration that these stocks could not be produced in America, whereas nothing was really demonstrated but the fact that the particular stocks worked with were unfit, because of various causes which could not be explained.

This bulletin is an effort at a clarification of the situation. It is an effort to determine whether the bulb stocks grown in various portions of this country force satisfactorily, to determine their shortcomings, and to offer suggestions for their improvement.

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The work herein reported was done in a low greenhouse divided into two units, one for lilies and the other for the remainder of the bulbs. The temperatures for the first unit have been kept at 55 to 65° F. at night, and those for the second at 45 to 55°, except in the case of the Regal lily, which was in part handled under special conditions in a house under other control.

The soil used was a heavy clay loam composted for only a few months and having no sand or sod in its composition. In the Dutch-bulb unit about 100 varieties were handled, covering the entire range of commercial tulips and daffodils, besides many which are not considered forcing varieties. On account of the limitation of time available for this line of work and the variable requirements of the varieties used, it was impossible to give to the different items the most favorable conditions, but it was necessary to strike a general average which would give the best results possible with such a wide range of materials. The conditions were particularly trying on tulips, for it was necessary to bring the earliest and the latest varieties together under the same temperatures. Under such circumstances it was not wise or even possible to test earliness of blossoming. That must be left for a future handling. Neither has it been possible thus far to make any serious direct comparisons between the forcing quality of imported and domestic stocks. This very evidently will require more carefully controlled tests with fewer varieties. This point will be particularly forceful to the investigator who has had experience with a mixture of different progenies of the same variety from different fields, different handling, or different localities. Comparisons of the forcing quality of two stocks whose handling the previous year is neither known nor synchronized are of questionable value.

TULIPS

Interesting comparisons have been obtained during the last three years with tulip bulbs produced by various growers. (Pls. 1 and 2.) The greater part of the tulips forced in these experiments were produced under the writer's supervision at Bellingham, Wash. These stocks have been in this country many years. None of them were imported less than three years ago, and the vast majority have been grown by the department continuously for 16 to 20 years. The experiments are summarized in Table 1.

TABLE 1.—*Behavior of American-grown tulip bulbs under glass*

Variety	Where grown [1]	Date of planting	Date put on benches	Date of flowering	Number of bulbs [2]	Number of flowers
Alitz	Wash., 2	Sept. 28	Jan. 26	Feb. 28	50	46
Allard Pierson	do	Sept. 26	Jan. 16	Jan. 30[3]	50	58
Andrea Doria	do	Sept. 28	Jan. 26	Feb. 28	50	48
Antony Roosen	do	Sept. 18	do	do	40	40
Do	do	Sept. 28	do	do	50	40

[1] Numerals following names of States (or Territory) where bulbs were grown indicate as follows: 1, Heeling ground was in an old slat house, under ashes; 2, heeling ground was in a lean-to against the greenhouse, so handled as to keep frost out.

[2] Pans were used for less than 30 bulbs and flats for larger numbers. In most cases 50 bulbs were put in a standard flat.

[3] This variety has been brought into blossom by a commercial grower in Portland, Oreg., from Oregon-grown bulbs, December 12. When well grown it commonly gives a normal and a secondary (smaller) flower from a bulb. (See last figures in Plates 1 and 2 and their accompanying legends.)

TABLE 1.—*Behavior of American-grown tulip bulbs under glass*—Continued

Variety	Where grown	Date of planting	Date put on benches	Date of flowering	Number of bulbs	Number of flowers
Artus	Wash., 1	Sept. 18	Jan. 20	Feb. 9	50	49
Bacchus	do	do	do	do	50	50
Baronne de la Tonnaye	N. J., 2	Nov. 7	Jan. 27	Mar. 3	24	24
Do	Wash., 2	Sept. 18	Feb. 2	Mar. 18	50	50
Bartigon	Idaho, 1	do	Jan. 20	Feb. 23	50	48
Belle Alliance	Wash., 1	do	Jan. 27	Feb. 5	50	46
Cardinals Hat	do	do	Jan. 29	Feb. 16	50	50
Clara Butt	Wash., 2	Sept. 28	Jan. 26	Feb. 28	50	50
Do	Oreg., 2	do	Jan. 27	Mar. 4	50	50
Do	N. J., 2	do	do	do	50	47
Cottage Maid	Wash., 1	Sept. 18	do	Feb. 9	50	50
Do	Alaska	Oct. 14	Feb. 2	Feb. 28	17	17
Couleur Cardinal	Wash., 1	Sept. 18	Jan 20	Feb. 9	50	50
Couleur Cramoisie	do	do	do	Feb. 7	50	50
Crimson King	do	do	do	Feb. 5	50	49
Dream	N. J., 2		Jan. 27	Mar. 4	25	5
Duchesse de Parme	Wash., 1	Sept. 18	Jan. 20	Feb. 6	50	50
Edmee	Wash., 2	Sept. 28	Jan. 26	Feb. 28	50	48
Eugene Delacroix	do	Sept. 18	Jan. 31	Feb. 27	50	50
Do	do	Sept. 28	Jan. 27	Feb. 28	50	50
Fairy Queen	N. J., 2	Sept. 18	Feb. 2	Mar. 20	16	10
Farncombe Sanders	Wash., 2	do	Jan. 27	Feb. 24	50	46
Do	Idaho, 2	do	Jan. 26	Feb. 28	50	48
Faust	Wash., 2	Sept. 26	Jan. 16	Feb. 5	50	50
Fra Angelico	do	Sept. 18	do	do	50	52
Fulgens	Wash., 1	do	Jan. 26	Feb. 16	50	48
General Kohler	Wash., 2	do	do	Feb. 23	50	50
Do	do	do	do	Feb. 28	50	50
Golden Queen	do	do	Jan. 31	Feb. 2	50	50
Gretchen	N. J., 2	do	Jan. 26	Mar. 8	12	8
Do	Wash., 2	do	Feb. 2	Mar. 20	50	49
Hofdyk	do	Sept. 28	Jan. 26	Feb. 28	50	43
Inglescombe Yellow	do	do	Jan. 27	do	50	50
Keizerskroon	Wash., 1	Sept. 18	Jan. 20	Feb. 4	50	50
King Harold	Wash., 2	do	Jan. 26	Feb. 23	50	50
La Citadelle	Wash., 1	Sept. 28	Jan. 27	Mar. 6	50	50
La Reine	do	Sept. 18	do	Feb. 2	50	50
La Tulipe Noire	Wash., 2	do	Jan. 26	Feb. 26	50	50
Leonardo da Vinci	do	do	do	Feb. 28	50	50
Madame Krelage	do	Sept. 28	do	do	50	50
Do			Jan. 27		50	32
Maidens Blush	N. J., 2	Sept. 18	Jan. 26	Mar. 18	16	00
Marconi	Wash., 2	Sept. 26	do	Feb. 16	50	50
McKinley	Wash., 1	Sept. 18	Jan. 20	Feb. 9	50	47
Miss Blugbro	N. J., 2	do	Jan. 26	Mar. 18	16	16
Mon Tresor	Wash., 1	do	Jan. 20	Feb. 2	50	50
Murillo	do	do	Jan. 27	Feb. 7	50	50
Nauticus	Wash., 2	do	Jan. 26	Mar. 18	50	50
Night	do	do	Jan. 28	Feb. 28	50	50
Osmodee	do	do	Jan. 27	Feb. 18	50	50
Painted Lady	do	Sept. 28	Jan. 26	Feb. 28	50	50
Paris	do	Sept. 18	do	Mar. 12	50	46
Philippe de Comines	do	do	do	Feb. 23	50	50
Pierre Loti	do	do	do	do	50	50
Pride of Haarlem	do	do	do	Feb. 28	50	50
Do	N. J., 2	do	do	do	24	24
Do	do	Nov. 7	Jan. 27	Mar. 3	24	24
Psyche	Wash., 2	Sept. 28	Jan. 26	Feb. 28	50	50
Do	do	Sept. 18	do	Mar. 20	50	50
Rembrandt	Wash., 1	do	Jan. 20	Feb. 10	50	50
Remembrance	Wash., 2	do	Jan. 26	Mar. 20	50	[1] 39
Rose Blanche	Wash., 1	do	Jan. 20	Feb. 9	50	50
Rubra Maxima	do	do	Jan. 27	do	50	50
Sieraad van Flora	Wash., 2	do	do	Feb. 24	50	50
The Sultan	do	Sept. 28	Jan. 26	Feb. 28	50	48
Do	N. J., 2	Sept. 18	do	Mar. 8	18	3
Thomas Moore	Wash., 1	do	Jan. 20	Feb. 5	50	50
Do	N. J., 1	do	do	Feb. 9	24	3
Vermillon Brillant	Wash., 1	do	Jan. 27	Feb. 2	50	49
Do	Oreg., 1	do	Jan. 20	Feb. 5	46	46
Von Jehring	Wash., 2	do	Feb. 26	Feb. 18	50	50
Wedding Veil	do	do	Jan. 26	Feb. 26	50	49
Do	do	Sept. 28	do	Feb. 28	50	50
Whistler	do	Sept. 18	Jan. 31	Feb. 24	50	50
William Copland	do	do	Jan. 16	Feb. 9	50	50
Do		do	do	do	50	50
Do	Oreg., 1	do	do	do	50	49

[1] Injured by slugs.

The outstanding facts further substantiated are: (1) That bulbs from which a flower has been cut can not be depended on for forcing, and (2) that bulbs improperly handled in storage may not flower at all.

EFFECT OF CUTTING BLOSSOMS

It should be borne in mind that a first-class bulb ought to blossom the second year even when the flower with one or two leaves has been cut, but it will not be standard, and it should not be sold for first-class stock or for forcing until grown under good conditions for one year and left to mature naturally. The better the growing, however, the better the results from such cut plants will be. The fact that the bulb will blossom under glass if properly handled does not make it a forcing bulb or even one fit for the market. To get good results under glass the bulbs must be of prime quality, which is not possible unless the stocks are allowed to mature naturally with no removal of leafage.

CARE NECESSARY IN HANDLING

Growers who handle tulip bulbs carelessly in such a way as to allow them to heat in the containers or in piles on the floors of sheds under and close to tin roofs, or too deep on poorly aerated trays or shelves, can not expect to have their product succeed in competition with stocks properly handled.

Tulip bulbs used for forcing should have their coats preserved as well as possible. To this end the grower must perform every operation in their handling promptly and efficiently, especially with the Darwins, for the coats of many of these varieties come off easily. The bulbs should be dug as soon as mature and usually before the tops are thoroughly dried; they should be dried slowly; and they should then be stored in subdued light in a cool but dry situation where there are no drafts of air. Either light or drafts will crack the coats, after which the bulbs are easily abraded.

It is a little more difficult to preserve the coats and prevent excessive desiccation in a hot region like the Atlantic Coastal Plain than on Puget Sound, but it can be done if the proper conditions are provided. The requirements consist in reducing both light and ventilation, but not allowing the bulbs to mold. Storage on stacked trays in which the bulbs are piled 4 inches high with burlap over them is very satisfactory under the conditions used for sweet-potato storage or in dry half basements. The fact that they need to have ventilation reduced at this period, however, does not mean that they can be safely stored in large heaps, in sacks, or in other bulky, poorly aerated containers.

Besides preserving the coats, particular attention should be given to preventing desiccation, for if once the bulbs are badly wilted they do not again take up moisture readily and plump up as do lily bulbs, for instance. This fact is well brought out in Figure 1, showing a well-preserved bulb (left) and an excessively desiccated one (right) at the time that both were ready to be brought into the greenhouse from the heeling ground. The outer coat is removed in both cases. The dried bulb is decidedly weakened.

The temperature conditions under which tulip and other bulbs are held in storage should receive more than passing notice. It would not be profitable now to enter into a lengthy discussion of the subject, but in order to emphasize its importance the experience of 1924–25 may be briefly mentioned.

Some preliminary tests were made of the effects of storage on tulip bulbs dug green. Such bulbs would be expected to be early, and always are so under field conditions when handled with ordinarily good storage, but when stored in a warm place their forcing quality was depressed; that is, those so handled would not force as early as those held in ordinary storage, or as the same variety allowed to mature before digging and held in ordinary storage. Although heat for a certain preliminary period may accelerate the forcing quality, long-continued heat will actually retard it. What, then, is to be expected of tulips held close to tin roofs for a month or two in lofts and other similar situations in regions like our Atlantic Coastal Plain? The region, although naturally early, may have the forcing quality of its bulbs retarded by the long-continued high heat of storage. The requirements, however, are not so exacting but that they can be compassed without great difficulty. The storage can be accomplished in any moderately cool structure without refrigeration.

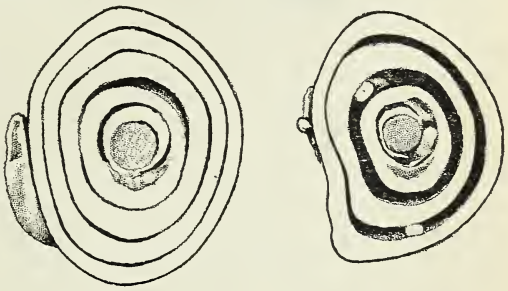


FIG. 1.—Schematic sections of tulip bulbs properly and improperly handled in storage. The one on the right was allowed to dry out too much. The sections were made when the flats were ready to bring into heat from the heeling ground

To produce good blossoms the bulbs must be as uniform in quality as it is possible to make them. Even when no visible differences are detected in the bulbs, there may be vast differences in performance unless the entire purchase is from one growing. In other words, satisfactory results in forcing and bedding demand that the bulbs be from a uniform production and from the same general character of soil. If bulbs from light and heavy soils are mixed, there is likely to be enough difference in the time of flowering to make for lack of perfection in results even when the bulbs themselves are visibly uniform—that is to say, have been carefully sized.

If the demands in the premises are thus exacting, what is to be expected from tulip bulbs which, in the matter of size alone, vary as much as 6 centimeters? It was the writer's privilege during the year to examine a large planting of Darwin tulips in forcing. The buds were above the soil in all the flats, and the earliest were in blossom. Bulbs were pulled out of the flats at random. In Pride of Haarlem alone it was found that bulbs varying from 7 to 13 centimeters had been flatted up together for forcing when forcing size in this variety should run from 12 centimeters upward. Both consumers and producers should avoid attempts to operate upon a basis of this kind, for nothing but disaster can result. Even a casual

glance at the stocks should enable one to anticipate and obviate this kind of failure.

One familiar with tulip bulbs can read a great deal of their history from the bulbs themselves before potting or planting. There is little excuse for mistaking sizes. If the best bulbs in a consignment are mostly long necks, it is more than likely that the flowering bulbs were reduced by a flower cut, that the number of bulbs sold was altogether too great, or that rough handling abraded the mature bulbs.

DATES OF FLOWERING

A cursory study of the dates of flowering of the tulips in Table 1 will show that expectations are sometimes upset owing partly to the conditions under which the operations were necessarily carried on, but more particularly to the variable conditions under which the stocks were produced. The bulk of the material was grown at Bellingham, Wash. Some lots were produced at various points between Bellingham, Wash., and Virginia. Added to this diversity of conditions is a still further variation resulting from the handling of the bulbs in storage, further influencing the manner in which they behaved when forced. These important factors are so complicated and their influence so potent that it is scarcely profitable to do more than call attention to them here.

These observations lead naturally to the consideration of these influences as affecting the florist business. The forcing of American-grown stocks is going to be more complicated, owing to the variable conditions under which they are produced. The florist who has proceeded by the calendar in his different operations will be obliged to forget to a large extent his dates and depend entirely upon what his stocks show they need from week to week. Of course, when the characteristics of the stocks produced in a certain locality have become familiar and production practices are stabilized, dates for handling in forcing may be as stable and dependable as for foreign-grown bulbs; but should the dealer mix stocks from Puget Sound with those from Virginia, for instance, the results from either forcing or bedding are very likely to be unsatisfactory. This feature is not applicable alone to tulips. It applies just as strongly to daffodils, hyacinths, and other forcing bulbs.

MAINTENANCE OF QUALITY IN STOCKS

The tulip stocks produced under the writer's supervision at Bellingham, Wash., were also forced in considerable quantities last year by another branch of the department. The personnel of this branch is well versed in the production of decorative material under glass, and its conclusions may be accepted as carrying authoritative weight. Its observations are interesting. Briefly stated, its report shows that the Bellingham, Wash., tulips forced satisfactorily, but that the flowers were smaller on the average than those of imported stocks of the same varieties.

The writer is satisfied that this criticism of the experimental stocks grown under his direct supervision states the fact. This is exactly the information that was sought, and the criticism that was expected, because for the last five years large tulip bulbs have been disposed

of from most of the Bellingham, Wash., varieties, which were thus tested for the purpose of determining the effect on the stocks. Comparatively few bulbs of greater development than long necks have been planted in these varieties, and many of the largest of these have been turned off also.

Under the practice of marketing all the largest bulbs, a noticeable decrease in size of blossom when the bulbs are forced has occurred. This demonstrates sufficiently that prime commercial quality in tulip stocks will not be maintained when such a large and constant disposal of the largest bulbs is practiced over a period of years. On the other hand, the field display has been constantly satisfactory, although gardeners close by who have grown these same stocks three or four years produce flowers superior to those grown under more nearly commercial conditions and at a sacrifice of all large stocks.

The gist of this whole matter can be put in a sentence which it would be well for all tulip lovers, growers, and producers to ponder: Commercial stocks of tulips and most other bulbs are necessarily of variable and mostly of mediocre quality. The good, honest, intelligent grower will put upon the market stocks produced under average conditions. He will and must avoid the conditions and practices pointed out above as detrimental to quality production, but he can not afford to produce the superb exhibition quality in competition with average market materials. To produce top-notch or what might be called exhibition quality, it is necessary to devote twice as much space as usual to the production of each bulb, and to furnish a higher fertility to that space. Then when these two stocks, the exhibition and the commercial mediocre, are placed on the market in the dormant state, the difference in quality may not be strikingly apparent.

These differences in quality will account for vast legitimate differences in price. They also offer a fine field for the expert grower to work up first-quality stocks and cater to the most appreciative and discerning clientele at prices which justify such quality production.

DAFFODILS

In general, the daffodils forced in 1925 and in previous years were fully up to expectations in both quality and floriferousness. No difficulty was experienced with them even under dwelling-house conditions where about 20 varieties were handled successfully in previous years in both soil and fiber. (Pls. 3 and 4.)

Here again, as with many other bulb stocks, success is not so much a question of locality in our temperate latitudes as it is of the handling of the bulbs in that locality. When the stocks are produced under proper conditions and grown to normal size their performance is normal, influenced of course by the usual conditions of season, climate, soils, and methods of handling under glass. It seems best to discuss the principal varieties separately.

SIR WATKIN

Sir Watkin (pl. 4, C) proved to be as good a forcer as when grown abroad. Bulbs submitted flowered well, but there was a very

great diversity in the quality of the stocks received. In this variety there is a tendency to grayness, that is, the foliage instead of being a rich glaucous green is likely to be mottled or streaked with yellowish green. This condition has been prevalent in many stocks and in previous years' forcings; when the bulbs were from a wider range of territory the condition seemed to be more prevalent in southern-grown bulbs. However, the stocks at Bellingham, Wash., have never been free from it. Grayness is commonly present also in freshly imported stocks, especially in the cheaper grades.[1]

Although the "gray" bulbs flower well and are but slightly subnormal in size, no grower can afford to work up stocks which are affected in this way. What should be done with them depends largely upon the extent to which they are affected. If the whole stock is in this condition it should be gotten rid of. If only slightly so, the "gray" bulbs can be rogued out early in the spring and the stocks thus trued up. Good cultural conditions should be employed and roguing practiced each year to eliminate the weak plants. The improvement of stocks is accomplished mostly by the elimination of undesirable individuals. It is cheaper in the end to pay a higher price for bulbs which are robust and have a rich glaucous green foliage. The best time to estimate grayness is when the plants are 6 to 8 inches high in the spring.

SPURIUS OR TRUMPET MAJOR

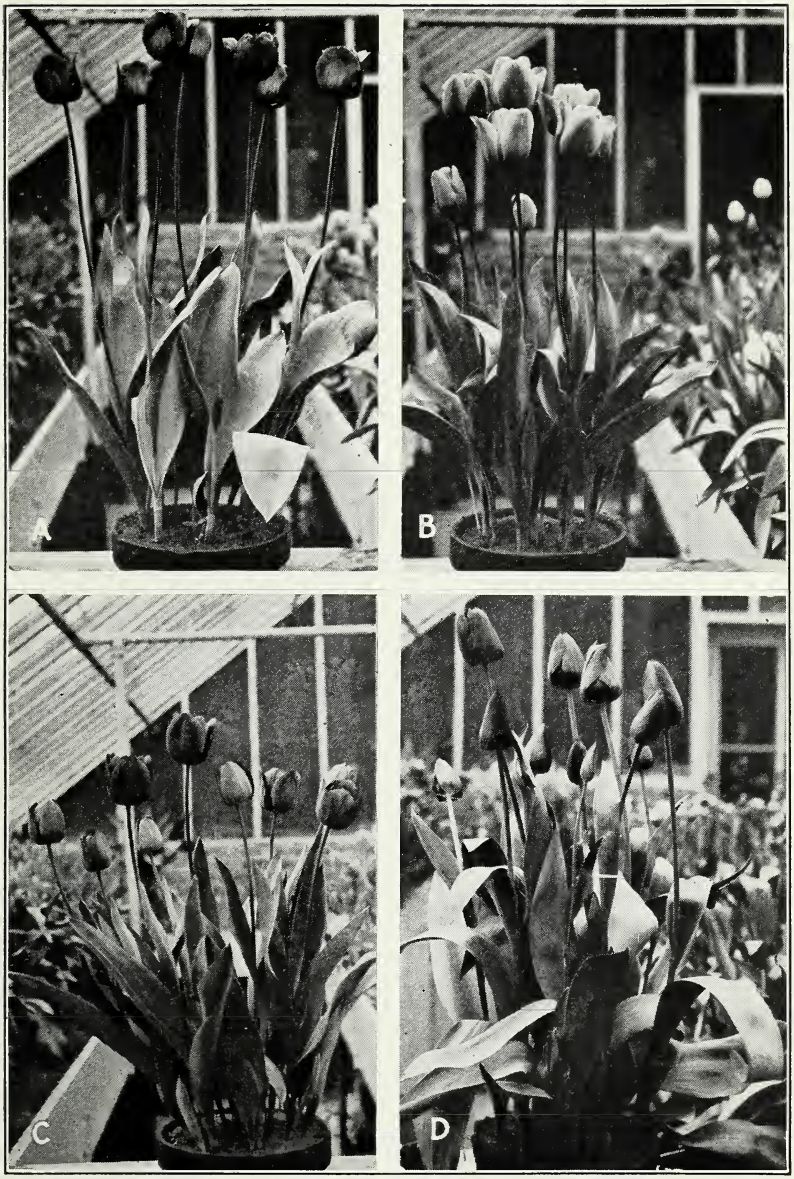
The bulbs of Spurius or Trumpet Major (pl. 3, A, and pl. 4, B) which were forced in this and previous seasons furnish exceedingly instructive information. The experiments recorded in Table 2 indicate a considerable measure of failure compared with the performance as exhibited in the illustration in Plate 3, A, due, it is evident, entirely to the greater success in handling the dormant bulbs in the latter instance.

The bulbs forced in 1923 and 1924 were in prime condition. Those of 1924 and 1925 were of the same stocks but injured in transit. In the latter case stocks in slightly less than bushel quantities were forwarded in burlap sacks, where they remained more than two weeks during warm weather. When the sacks were opened many bulbs were soft and a large percentage showed deterioration at the base, some having the base completely rotted and the bases of the scales starting to discolor, while other bulbs were firm with the base only slightly discolored. Of course, most of the bulbs thus injured finally succumbed, and some in which no injury was observable at the time of planting rotted in the flats and in the field.

That these bulbs were free from any infectious disease is shown (1) by the fact that they were all right the preceding year and (2) by their having been dug from old plantings which had been undisturbed and in perfect health for a score or more of years.

Daffodil bulbs do not ship well in burlap sacks. One commercial shipment made in 1925 in bean hampers went to its destination in perfect condition, but a later shipment in burlap sacks (which, however, was routed differently and suffered a week's delay) had more than 50 per cent loss. Another shipment of gladiolus corms

[1] See p. 20.



TULIPS GROWN UNDER GLASS.—I

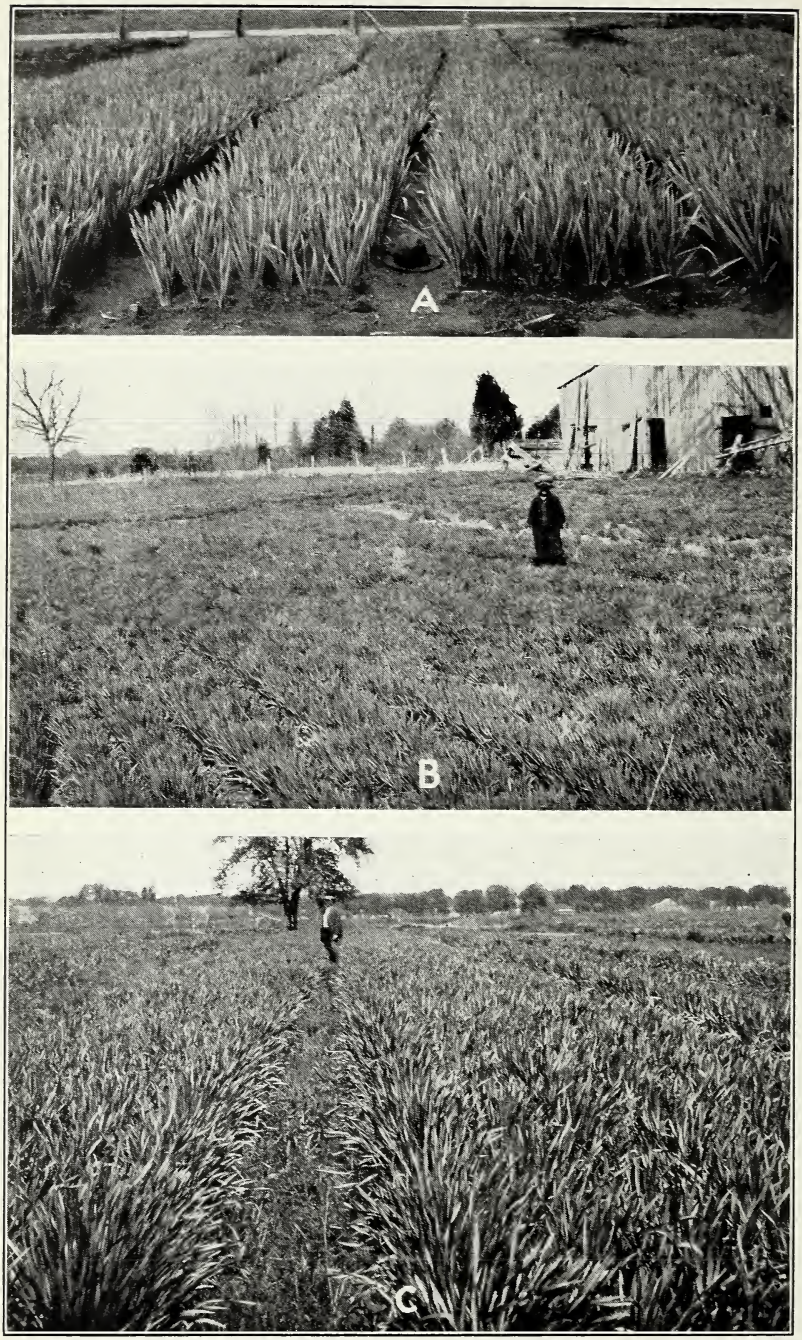
A, Andrea Doria; B, Edouard Andre; C, Whistler; D, Allard Pierson. Potted September 22, 1923; photographed March 9, 1924. All were grown in Virginia

TULIPS GROWN UNDER GLASS.—II

A, Murillo; B, Cottage Maid; C, Keizerskroon; D, Belle Alliance; E, Allard Pierson. A, B, and C were grown in Virginia, D in Oregon, and E at Bellingham, Wash.

DAFFODILS GROWN UNDER GLASS

A, Trumpet Major or Spurius, from Virginia, forced in 1923-24. B, Seagull, from California. C, Golden Spur, from California. D, Victoria, from horse teeth of 1917, forced in 1923-24



DAFFODILS IN THE FIELD

A, Van Waveren's Giant and King Alfred, as grown in Oregon. B, Spurins, naturalized in Virginia. C, Sir Watkin, undisturbed for 12 years, as grown in Illinois

in burlap sacks, in transit but eight days, was practically a complete loss.

Three methods of packing were used in bringing one variety of narcissus to Washington, D. C., from Bellingham, Wash., in the fall of 1925. The stock was healthy. The small quantity of material intended for the experiments reported in Table 2, packed in perforated paper sacks in a crate, came through by freight in perfect condition. Another larger lot intended for another purpose was packed 1½ bushels in a burlap sack in the same kind of crate. There was a sprinkling of rotten bulbs in this consignment. Bulbs in bulk in the same aerated crate came uninjured.

TABLE 2.—*Behavior of American-grown daffodil bulbs under glass*

Variety	Where grown	Date put on bench [1]	Date of flowering	Number of bulbs	Number of flowers
Ariadne	Wash	Jan. 26	Feb. 18	36	92
Do	do	do	Feb. 28	50	70
Aspasia	do	do	Feb. 18	36	99
Campernelle (Double)	do	Jan. 20	Feb. 4	72	128
Conspicuus	do	do	Feb. 13	36	54
Cynosure	do	do	Feb. 10	36	68
Double Van Sion	do	do	Feb. 6	32	63
Do	do	do	Feb. 9	25	47
Emperor	do	Jan. 26	Feb. 18	32	65
Do	do	Jan. 27	Feb. 23	1	2
Do	Ga	Jan. 20	Feb. 20	36	38
Do	Va	Jan. 27	Feb. 25	36	64
Do	Md	Jan. 26	Feb. 28	24	50
Empress	do	do	Feb. 18	24	59
Golden Spur	Wash	Jan. 20	Feb. 2	32	87
Do	do	do	Feb. 4	7	13
Do	Md	Jan. 27	Feb. 6	25	40
Henry Irving	Wash	Jan. 20	Feb. 2	32	81
King Alfred	Ga	do	Feb. 6	32	37
Do	D. C	do	do	12	2
Do	Wash	do	do	6	11
Laurens Koster	Oreg	Jan. 26	Feb. 24	8	12
M. M. de Graaff	Wash	Jan. 20	Feb. 16	32	65
Mrs. Langtry	do	Jan. 26	Feb. 20	36	86
Orange Phoenix	do	Jan. 20	Feb. 4	36	120
Do	do	do	Feb. 5	6	23
Do	do	do	Feb. 6	6	8
Do	do	do	do	8	20
Do	do	do	Feb. 7	55	[2] 56
Princeps	do	Jan. 26	Feb. 5	6	20
Sir Watkin	Calif	Jan. 20	Feb. 4	30	31
Do	Wash	Jan. 26	Feb. 16	32	59
Do	Md	do	do	25	48
Do	Oreg	do	Feb. 20	4	7
Do	Wash	do	do	1	3
Do	Calif	do	do	3	5
Spurius	Va	Jan. 20	Feb. 6	32	34
Do	do	do	do	32	24
Do	do	Jan. 26	Feb. 9	36	43
Victoria	Wash	do	Feb. 12	36	99
Do	do	do	do	32	67
Do	Oreg	do	Feb. 20	1	5
Do	Calif	do	do	3	6
Do	Md	Jan. 27	do	24	52
Do	Oreg	Jan. 26	Feb. 23	3	5
Do	Wash	do	Feb. 28	20	42
Weardale Perfection	do	do	Feb. 20	64	104

[1] All the varieties were planted Sept. 18 except the last Ariadne and the last Victoria, which were planted Sept. 28.
[2] Single-nosed bulbs.

Care must be exercised all along the line in the handling of these stocks. They must not be sunned in warm regions; they must be dried in the shade; they must not be bruised; and they must not be allowed to heat or freeze. The rotting of the bulbs in storage,

starting with the base and proceeding upward through the scales, brought on by some of the above-mentioned agencies, is a familiar phenomenon. Stocks badly rotted have recovered perfectly with no other treatment than the culling out of the injured individuals.

In the old naturalized Virginia stock there is represented a potential asset to the daffodil industry of the country. Although it has been decided to apply to it the name "Spurius," it is well recognized that it is a group of closely related plants that is being dealt with. It is difficult to distinguish between the old *Narcissus pseudonarcissus*, Spurius, Trumpet Major, and Single Van Sion, if, indeed, some of them are really distinct. Whether Trumpet Major, Spurius, or some other name is finally applied to this old naturalized stock matters but little. The important thing to know is that it is a good forcer and that it or a very closely related thing is now used in considerable quantity as French Trumpet Major, on account of its early-forcing quality. This naturalized stock from Virginia will force as early as the Trumpet Major from southern France. The writer is informed that it is not uncommon for the growers in Virginia to have this old variety blossom in tin cans in their homes at Christmas time. As much stock of it is naturalized in Virginia and Maryland as of all other varieties combined in the entire country. It may be advantageously used for forcing after about three years of good culture.

KING ALFRED

The behavior of King Alfred (pl. 4, A) in these tests has been very instructive. Some imported stock of this variety was grown for four years in the District of Columbia in the same location without disturbance. The soil was a heavy clay fill. In planting, a wedge-shaped trench about 6 inches deep was excavated for each row and the soil taken away. These trenches were filled with light soil and the bulbs set flush with the surface, after which the whole bed was covered with similar earth to a depth of 3 or 4 inches. The planting did not suffer for lack of fertility until the last year, when no fertilizer was applied. Under these conditions in a thick planting the bulbs dwindled in size in the four years to 12 centimeters and less in circumference. Two pans of these each containing six bulbs ranging from 10 to 12 centimeters were forced, as shown in Table 2. Only two of the largest bulbs flowered. Twelve centimeters may be taken as about the smallest size at which this variety will flower, and to insure certain flowering no bulbs short of 15 centimeters should be used.

It is an interesting fact that the two flowers produced by this District of Columbia stock were good specimens—fully as good as the Oregon samples, which were from bulbs that were prime in every respect, although somewhat smaller than the mammoth sizes received from abroad. The Georgia sample, however, although handled similarly and flowering over 100 per cent, produced shorter stems and smaller flowers.

King Alfred seems to be better adapted to warm regions than most of the so-called Dutch daffodils. Whether stocks of this variety can be maintained in these warm climates over a long period of years is yet to be determined. So far the plantings have been largely for

cut-flower purposes, and the bulbs in most cases have not been up to best standards in either size or firmness, but they have flowered well.

DOUBLE CAMPERNELLE

The Double Campernelle deserves a much wider use than is made of it. It is large, handsome, double, floriferous, sweet scented, midseason, and has a good shade of yellow. As a commercial bulb it has decided merit, for the space it occupies is small; the bulbs can be set almost solid in the flats. It can be potted nearly twice as thick as Golden Spur and when well grown is fully as floriferous. Although it can be flowered satisfactorily under glass, somewhat greater attention to humidity and temperature is required with it than with Golden Spur, Victoria, or other easily forced varieties.

The Double Campernelle seems better adapted to warmer climates than most of the Dutch varieties. Regions from the Carolinas south seem to be suited for it as well as for the Single Campernelle and the true jonquils. At Bellingham, Wash., it has grown fairly well, but has never fully met expectations.

VICTORIA

Victoria (pl. 3, D) is a splendid daffodil and an easy and early forcer. Its great drawback is the excessive propagation of small naked bulbs which take three years to grow to merchantable size. Even then the bulbs, although flowering well and regularly, are mostly smaller than the purchaser is accustomed to.

In the stocks of Victoria forced there was usually an abundance of the small ring splits (horse teeth), although the blossoming, as will be seen, has been very satisfactory and up to the standard for normal bulbs. The writer is not prepared to recommend definitely what should be done eventually with these small bulbs, but for the present it may be profitable to grow them up to flowering size, which can be done in three years under good cultural conditions. The job can be accomplished most profitably on an intensive cultural basis. With good fertility, about 800,000 may be grown on an acre for two years and about 225,000 the third year if the Dutch method of culture is followed. The 3-year period of culture gives a firm, round bulb which will produce a single flower of good quality. The advantage of a maximum-sized bulb may not be so obvious, especially if bulbs are destroyed after forcing. It is probable that Victoria will eventually be discarded on account of this characteristic, but it can not be dispensed with for some years if we are to depend upon our own production. There is a probability that Victoria may eventually give way to Spring Glory, Glory of Sassenheim, or some similar variety.

It is, of course, possible to true up the variety by selection and thus in a measure get rid of the small splits. The tendency to their formation is in the variety, however, and constant watchfulness is necessary in order to keep the stock free. But good results are accomplished by maintaining the best of cultural conditions and culling out and destroying undesirable individuals whenever they occur.

Under Atlantic Coastal Plain conditions this variety has proved to be a rather poor keeper. Complaints are made that it rots badly when

handled. The same characteristic attaches to the imported bulbs. The remedy seems to be quick drying in thin layers and a thoroughly aerated pack.

GOLDEN SPUR

Golden Spur (pl. 3, C) may be considered one of the most important items in the Dutch daffodil list, but it is usually considered exacting in its cultural requirements. There are many failures with imported stocks. In this country experience with it has been varied and often unsatisfactory, but when sound bulbs of suitable size are produced they behave normally under glass.

In these experiments the forcing trials of Golden Spur have, on the whole, averaged as good as those of any bulb handled. There will be no difficulty with the forcing of any sound and sizable Golden Spur bulbs. The difficulty, if any, lies in the growing of the stocks to normal size and firmness.

To produce good stock may be a little more difficult with this than with the more robust varieties. When, however, the required conditions are provided, success usually follows. The writer has seen some eminently successful cultures of Golden Spur in the Pacific Northwest on low-lying, moist, well-drained, fertile, deep, sandy loam soil. The experience of the department with this variety on a silt loam underlain with clay at a depth of 14 inches has been unsatisfactory. The bases have gone out of the bulbs, causing a great deal of rotting. But the same deteriorated stocks have recovered when culled and planted in a better drained situation. It is believed that the conditions for the culture of this variety must be more carefully considered than for most others. When suitable conditions are provided, as good success follows as with the hardier forms, except that Golden Spur is slower in reproduction. There is also a greater difference in stocks than with almost any other variety. Some importations behave much more satisfactorily than others under both field and greenhouse culture.

A sandy loam soil seems advisable for the production of this variety on account of greater ease in handling and the more certain drainage, but it is by no means proved that heavier soils will not produce good stocks if the climatic and drainage factors are suitable. One instance is known of good results on a rather stiff clay soil through which water passes readily. There is still much to learn regarding culture of this variety.

PAPERWHITE GRANDIFLORA

As may be seen from Table 3, the quality of the bulbs of Paperwhite Grandiflora (pl. 5) which were received was very variable. This was easily predicted from the appearance of the bulbs at potting time and was made a matter of record in the case of No. 18. This grower sent in five bulbs as samples of stocks grown in 1925. Two of the bulbs were pronounced planting stock, two others commercial, and one very large one was of entirely different appearance. The two "commercial" ones blossomed, and the large one threw up a flowering stalk but its florets blasted. It was not a Paperwhite. The two "commercial" bulbs were 13 to 14 and 14 to 15 centimeters and gave 10 and 18 florets, respectively.

It is unnecessary to comment on the other bulbs. The character and behavior of this one will illustrate very definitely the causes of some complaints regarding the Paperwhite Grandiflora grown in this country and forced under glass. There is too great a tendency to put large split bulbs on the market, whereas the bulbs that give the best results are those which are round, firm, single nosed, and ranging in size from 12 to 16 centimeters. When these and these only are forced they are successful. All others should be planted to increase the stock.

TABLE 3.—*Behavior of American-grown polyanthus narcissus bulbs under glass*

No.	Variety	Date of planting	Date of flowering	State where grown	Number of bulbs	Number of flower stems	Number of flowers to the stem	Remarks
9	Chinese sacred lily	Sept. 18	Dec. 13	Fla.	10	9	2 to 5	One seemed to be a double Chinese lily.
10	do	do	Nov. 26	Calif.	24	24	2 to 6	Bulbs too small.
4	Grand Monarch	do	Nov. 17	do	42	42	9 to 15	Fine and strong.
9	Paperwhite Grandiflora.	do	Dec. 13	Fla.	7	5	9 to 15	Two bulbs did not flower. One 4-flowered Chinese lily besides the above.
10	do	do	Nov. 26	Calif.	21	24	7 to 15	As good as any imported stock.
16	do	do	Nov. 12	do	32	28	4 to 9	Mostly 4 to 6 flowered. One Chinese lily produced a stalk with 4 flowers.
18	do	Sept. 26	Dec. 17	S. C.	5	2	10 to 18	Samples showing different types of growth.
4	do	Sept. 18	Nov. 12	Calif.	44	46	7 to 14	Five are Chinese lilies, 4 to 9 flowered. Variable in type of flower. Not all of the Paperwhite Grandiflora type.

It may not be amiss here to say a word about the production of such bulbs. It is evident that the best time to begin the selection of marketable bulbs is before they are planted instead of after they are dug; in other words, the bulbs should be sized into different categories before planting. There will be three or possibly four sizes: One consisting of big bulbs in which the divisions are laid down but not separated enough to be pulled apart; the others of two or three sizes of slabs, the largest of which will grow to 12 to 15 centimeter round bulbs in one year and the others a year later. When this sizing occurs at planting time and the growing is well done, the largest splits should practically all be turned off after one year's culture. If the bulbs are mixed and all sizes are grown together, it is something of a task to pick out by hand the bulbs which should go on the market. Besides this, sizing the stocks gives an opportunity for a better distribution of plant material on the land.

The production of stocks of Paperwhite Grandiflora is being attempted on the California coast from Humboldt County south, in southern Texas, and generally along the coast of the Gulf States. The greatest activity just now is in Florida and as far north on the Atlantic coast as southeastern South Carolina. Both the Paperwhite

and the Chinese sacred lily, together with the Grand Soleil d'Or, were frozen down in the last-named State in the winter of 1923–24. The cold occurred at the close of the blossoming season and cut the flowering stems and foliage to the ground. In spite of this the best picked bulbs blossomed well under glass the following winter.

The above-named localities were very well represented in the department's forcing tests in 1925 and previous seasons. The bulbs from all localities behaved true to form, all single-nosed round bulbs more than 12 centimeters in circumference having given good blossom, although there was a wide variation in the proportion of such bulbs received. In some cases bulbs appeared to be single nosed when in reality several splits were already laid down, as was seen when the bulbs were cut open. Such a condition is likely to occur when stocks are left undug and allowed to get crowded or are grown with poor fertility. It can not be too often impressed upon the grower that the best Paperwhite bulb for forcing is a single-nosed round one grown from a split under good conditions of culture and fertility and in the shortest possible time, one or at most two years.

During the last two years there has been a good opportunity to observe and study the methods and conditions suited to the production of the Paperwhite crop. The formula for the best conditions is the same as that for the production of Golden Spur except as to climate. For the culture of Paperwhite Grandiflora and Grand Soleil d'Or the temperatures from September to June should not go much below 28° F., and even that temperature should be of short duration and infrequent. The most advantageous soil is a low, deep, moist, well-drained sandy loam of good fertility or well and suitably fertilized. What is considered good potato land in Florida is suitable for Paperwhites. Although the specification given here is for sandy soil, this does not correspond with what is actually employed for the production in Europe, where a heavy, refractory clay obtains. In one of the largest ventures in this country a heavy, black, rice-swamp clay is also employed with success. The greater number of cultures, though, are on sandy loams. On these the expense of culture is very much lower.

As to fertilizer, there is little reliable information based on controlled experiments. Until this is obtained, the grower can not go far wrong by using a liberal application of a good potato fertilizer, making one application at planting time and the other shortly before blossoming.

CHINESE SACRED LILY

Generally speaking, the Chinese sacred lily bulbs produced in this country simulate very closely those of Paperwhite. This seems to be caused by the conditions under which the culture has been attempted.

On sandy loam soils, especially where the fertility is low, it is a firm, round bulb of this narcissus that is produced. These bulbs are so different from the large, flabby clumps imported from the Amoy region of China as to make the market skeptical of their identification, or to insist that this variety can not be produced satisfactorily in this country. The fact is that the Chinese cultivate this narcissus on a heavily-fertilized muck soil with an abundant supply of water.

Bulbs indistinguishable from the imported stocks have recently been produced on rather wet peat soil in Florida, solving conclusively the riddle connected with the production of these bulbs. There seems to be no question now that the peat and muck soils of both Florida and California will produce the oriental form of this popular narcissus.

LILIES

The writer considers that the lilies yield in attractiveness and prospective success to no other in the entire group of bulbous plants. Some lilies are satisfactorily produced in this country, and there are likely to be others shortly. None, however, are yet produced in sufficient quantity to supply more than a small portion of the demand.

THE REGAL LILY

The commercial status of the Regal lily (*Lilium regale*, pl. 6), after 12 or more years of study and handling, much advertising, and unstinted praise, is still somewhat chaotic. The greater part of the bulbs put on the market are small, ranging from 10 to 14 centimeters in circumference, and usually give only one to three flowers whether grown under glass or outside. Some growers market bulbs as early as the end of the first growing season from the seed bed. This has created a prejudice in some quarters against the species for florists' use, because of its so-called "shy" blossoming.

The real trouble is with the size and age of the bulbs put on the market. It is believed that commercial sizes of this lily will prove to be above 18 centimeters. To make this character of bulb will require the best of culture for three years, although there will usually be plenty of blossoms the second year, many plants giving as high as five or six. The Department of Agriculture has produced 20-centimeter bulbs the second year, but only from seedlings started inside in late fall, repotted from the field before frost, and handled without loss of roots.

The writer's seven years of experience in the culture of this lily seems to indicate that this is a long-lived one and that its proper reproduction is from seed and not from bulblets. There is a serious question whether the lily produces bulblets to any appreciable extent when the situation and conditions under which it is grown are congenial to it. Pinching off the flowers, it is asserted, has a tendency to produce bulblets, but this has not been evident in the cultures of the department. Heavy clay soils with bad drainage or the presence of too much decaying organic matter (particularly raw manure) in contact with the bulbs have always induced an abundant production of bulblets on the stem, but in every case which has come under observation this has been accompanied with either a lack of proper development or, more commonly, an actual imperfection in the main bulb. It is more than likely that an abundant formation of bulblets is inimical to the production of good forcing stocks and that the grower has here a very good barometer of the suitability of his situation to the production of commercial stocks of this lily. These facts are well portrayed in Plate 6 and the accompanying legend. The Department of Agriculture stocks have been grown

from a single bulb which was undisturbed in a good border situation for six years. When dug it had split into three double-nosed bulbs, none of which produced bulblets. Seedlings of this lily on heavy clay produced an abundance of bulblets on the stems, but the bulbs have been uniformly poor. On sandy loam with good drainage the bulbs are good, but no bulblets are produced.

The handling of this lily under glass seems to be predicated upon three main factors: (1) It should not be forced before January 1; (2) it should be left outdoors to take the weather until that time; (3) it should go on the benches and into a full heat of 55 to 65° F. at night without the removal of roots and without a rooting period such as is usually given to the longiflorum group. With bulbs measuring 18 centimeters or more in circumference handled in this way good results are to be expected. Flowering will occur in 80 to 100 days, depending upon the usual factors governing greenhouse culture.

Bulbs of this lily potted both from the field and from cold storage late in September have failed miserably, the vast majority of the bulbs decaying in the pots. Bulbs from the same sources potted early in January and put at once into heat started growing promptly and blossomed in March. An important corollary of these facts is the desirability of handling stocks of this lily at the beginning rather than the close of the growing period.

For forcing purposes the bulbs can be dug and stored if necessary, but in the climate of Washington, D. C., it is preferable to dig them from the field in January and put them directly into heat. For field handling the same principle seems to govern. The stocks seem to be much better off if moved when growth starts in the spring. The reason for this is very patent from the discussion in the previous paragraphs. When the bulbs are moved in the fall they lie dormant without a hold on the ground all winter. In severe climates this is dangerous. Even in the climate of Washington, D. C., much better results have been attained with spring transplanting.

THE EASTER LILY

American-grown bulbs of the Easter lily (*Lilium longiflorum*, pls. 7, 8, and 9) have forced in a way very comparable with the commercial Formosum and the seedling Harrisii, which are uneven in height and behavior and develop under glass more slowly than the Giganteum variety. (Pl. 7.) Uniformity can be obtained here by growing up progenies vegetatively from single seedlings, as is done with tulips and daffodils, and this will doubtless eventually be accomplished. One grower has already made a mass selection of seedlings and has trued up his stock by a culling-out process in the field until his lilies appear as uniform as imported "gigs."

When the time comes for selection the grower must be governed by his own ideas as to the most desirable types. The market now seems to favor black-stemmed plants, but experience seems to indicate that some of the green-stemmed seedlings are more floriferous and stronger growers. There is abundant opportunity for the selection of superior plants from any progeny of seedlings one may raise. The selection can be most successfully made about the time the buds are showing and a reselection later when the flowers open. The timing of these stocks is no more difficult than that of imported Formosums.

PAPERWHITE GRANDIFLORA GROWN AT WALDO, FLA.

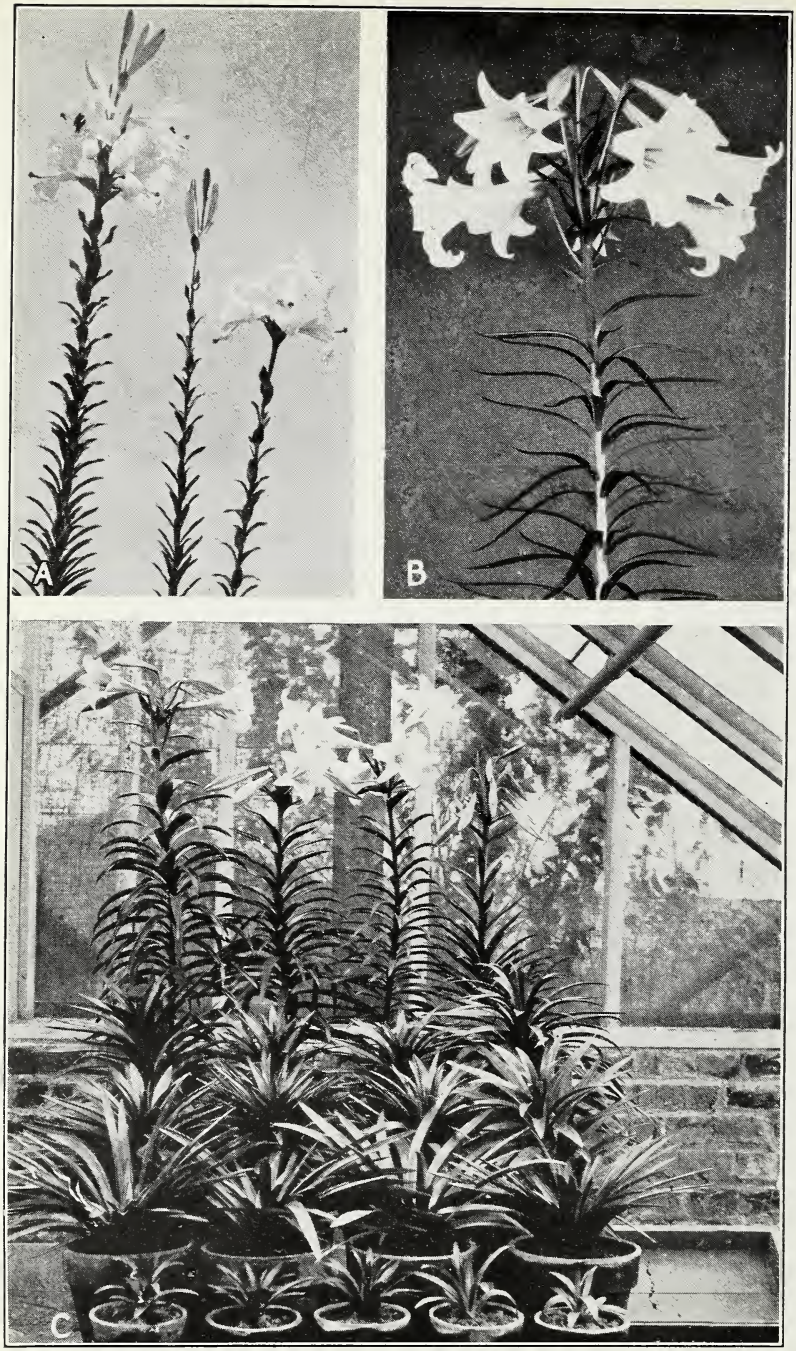
This was potted September 25 and photographed December 22. There are four spikes with 8 to 13 flowers from four 12 to 13 centimeter single-nosed bulbs

REGAL LILY, SHOWING NORMALLY GOOD BULBS GROWN UNDER PROPER CONDITIONS

The insert is the underground portion of a stem of another plant improperly grown, showing excessive development of bulblets

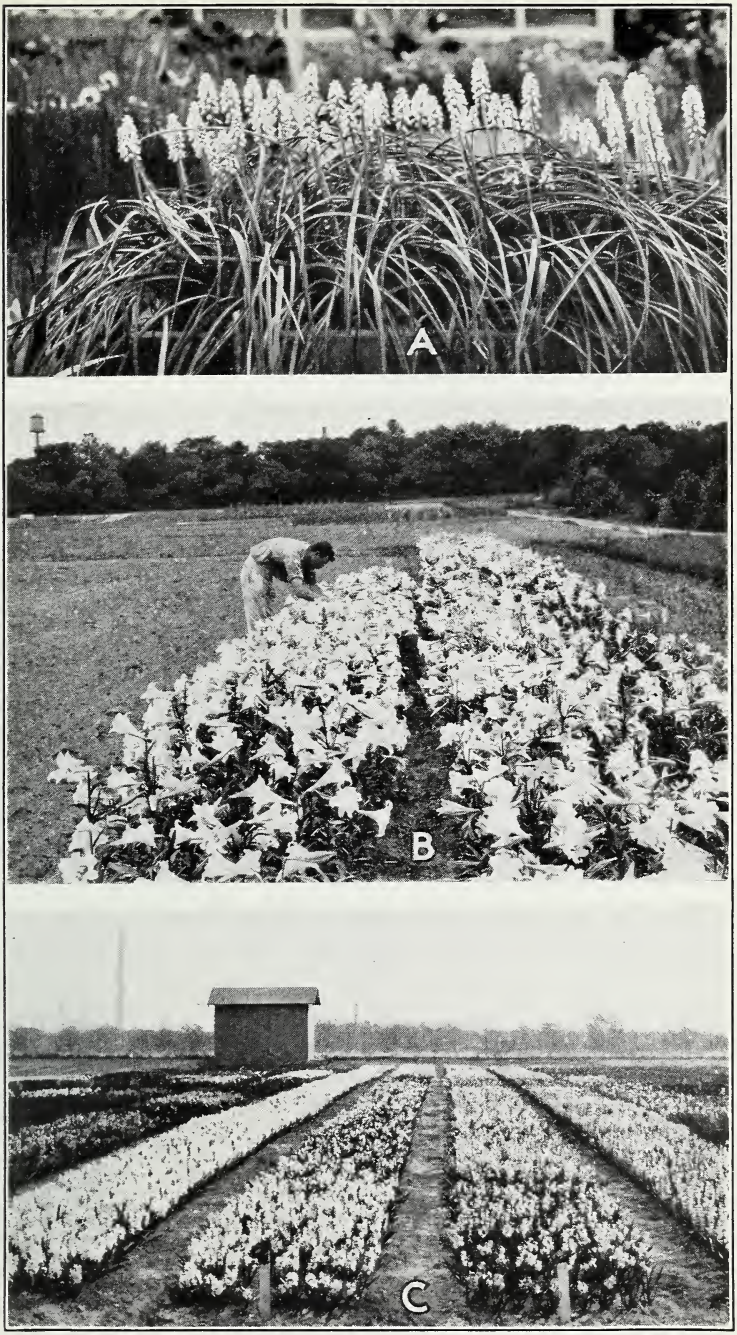
LILIUM LONGIFLORUM, GROWN AND FORCED AT ARLINGTON EXPERIMENT FARM, ROSSLYN, VA.

The seed was sown November 1 in the greenhouse, pricked off in January, set in the field May 1, repotted in a vegetative condition from the field in October, and photographed the middle of March



MADONNA AND EASTER LILIES

A, Madonna lily from bulbs grown at Bellingham, Wash., two years from a closely scaled bulb. B, *Lilium longiflorum*, showing 12 flowers at 15 months from seed. C, *Lilium longiflorum* on November 15, showing the current year's seedlings grouped to show variation in development. Seed sown November 1, pricked off in January, transferred to the field in late April, and repotted from the field October 6. These will come along in a cool house at various dates to Easter and later if desired



GRAPE HYACINTHS, EASTER LILIES, AND HYACINTHS

A, *Muscari botryoides conicum* grown at Bellingham, Wash. B, *Lilium longiflorum* seedlings grown at Arlington Experiment Farm. C, Hyacinths at Arlington Experiment Farm

L'INNOCENCE HYACINTH

Fourth year from scooped bulbs, Arlington Experiment Farm

HYACINTHS GROWN AT ARLINGTON EXPERIMENT FARM

A, Grandeur à Merveille; B, "Tennessee Native"; C, Marie, three years from scored bulbs

Instead of growing bulbs and forcing them the grower may plant seed annually about November 1, prick off the seedlings into 2-inch pots, transfer to the field when danger of frost is past, and transplant from the field to pots for forcing before winter sets in. This sort of handling can be done in the very cold North, for the plants are not out during the winter. A house for this kind of culture is shown in Plate 7, and a batch of plants sized to come in at different times during the winter in Plate 8, B and C. A more complete discussion of this subject will be found in Department Bulletin No. 962.[2]

THE MADONNA LILY

The Madonna lily (*Lilium candidum*, pl. 8, A) has been forced from bulbs grown on Puget Sound three or four seasons. The results have always been commensurate with the quality of the stocks forced. Bulbs for forcing should be firm, symmetrical, single nosed, and preferably above 20 centimeters in circumference. The practice has been to keep the pots in a cool house until January and then put them in a temperature of 55 to 60° F. at night. In 1924 they blossomed the middle of March.

As brought out in Department Bulletin No. 1331,[3] the Madonna lily must be grown on a well-drained soil in order to produce bulbs suitable for forcing. On heavy soils, especially with an impervious clay subsoil, the autumnal growth and the central scales are broken off, decidedly weakening the bulbs. When properly grown, the American bulbs force as well as the imported.

LILIUM UMBELLATUM

Forms of *Lilium umbellatum* are comparatively easily forced and very easily produced, but it is not the purpose to pass judgment upon this lily as a florist flower. The lily should be potted in the fall and left in the heeling ground until late in December or early in January. Some freezing seems to be desirable. In 1923 and 1924 bulbs grown at Bellingham, Wash., were potted in September and left in an uncovered frame until the middle of December. They blossomed very satisfactorily by the middle of March.

This lily should not be brought into heat early, because if it is it will not start until January, and the bulbs are almost certain to be materially injured by two or three months in heat before growth starts. The only safe course is to leave them outside until the first of the year. They will then take a temperature of 50 to 60° F. at night very well.

MUSCARI (GRAPE HYACINTH)

When brought along slowly for late February flowering with good lighting, the Muscari varieties Heavenly Blue, Conicum (pl. 9, A), and Azurea make especially fine subjects for either pots or cut flowers. Their worst character is the long leaf so difficult to keep in good condition. However, these leaves are an asset when

[2] GRIFFITHS, D. THE PRODUCTION OF THE EASTER LILY IN NORTHERN CLIMATES. U. S. Dept. Agr. Bul. 962, 31 pp., illus. 1921.

[3] GRIFFITHS, D. THE MADONNA LILY. U. S. Dept. Agr. Bul. 1331, 18 pp., illus. 1925.

injury can be avoided. The bulbs should not be forced, and no attempt should be made to bring them in too early. The date at which Conicum may be flowered depends, as with other stocks, upon its date of maturity. Bulbs grown one year at Bandon, Oreg., came into flower in 1922 and 1923 much earlier than the same stock grown at Bellingham, Wash.

The stocks seem to be benefited by being left outside to receive some freezing, but too severe cold injures the leaf tips and should be avoided. All bulbs forced in these experiments were grown either at Bellingham, Wash., or at Bandon, Oreg. One commercial grower at Portland, Oreg., has forced and marketed locally grown *Muscari botryoides conicum* flowers for the last two years with a great deal of satisfaction.

The group is commonly flowered under glass in Europe, but this is seldom done in this country, although the bulbs grown here may be made fully up to quality, as has been shown by the results obtained both in the department's forcing tests and in at least one commercial establishment.

CROCUS

The production of crocus bulbs has received little attention in this country. Up to 1918 the Department of Agriculture grew a few varieties at Bellingham, Wash., and in 1922 began again to work up experimental stocks. Enough of these have been forced in past seasons to demonstrate that the American-grown article runs true to form. It can not be forced, but when brought along slowly and kept cool until the buds show color the flowers will open in a few days at a temperature of 45 to 55° F. There are few varieties of bulbs more attractive as pot plants than the crocus. Under dwelling-house conditions and with no effort at earliness of flowering, King of the Blues, Baron von Bruno, and Mont Blanc were flowered very successfully early in March, 1918, in both soil and fiber.

ANTHOLYZA AND WATSONIA

On account of the size of the plants, requiring a large amount of space in the house, it is doubtful if Antholyza or Watsonia will ever be used extensively under glass. They do, however, make an appeal and are particularly adapted to ornamental effect in private conservatories, where a large proportion of cut flowers compared with the attractive vegetative growth may not be demanded. The flower spikes are decidedly graceful, and if cut when the lower flowers are opening both last a long time in water.

The material forced in 1924 and 1925 was from California-grown corms which had been handled the previous year in pots under forcing conditions and allowed to mature naturally. It would seem that these corms can be forced year after year, as is done with freesias, provided the leafage is preserved and the plants are allowed to mature naturally.

HYACINTHS

Contrary to general opinion, the hyacinth (pl. 9, C, and pls. 10 and 11) is not particularly difficult to produce in good quality.

Given firm, healthy bulbs to start with, a knowledge of the method of propagation, a loose, friable soil with good porosity, and an abundant moisture supply during the growing season, there is no more difficulty in producing good bulbs than with the daffodil.

In spite of this fact, there seems to be a feeling that there is something mysterious and difficult about the production of these stocks, and few indeed have had the courage to attempt to grow them. There is really but one firm in this country that is attempting their commercial production on an extensive scale.

For these reasons, the only hyacinths forced in the tests reported in this bulletin have been those produced on the Government gardens at Bellingham, Wash., and Arlington Experiment Farm, Va. It is not necessary to report now in detail on the behavior of these, any further than to say that size for size they have been as satisfactory as the imported bulbs. Some illustrations are submitted to substantiate this point, which will undoubtedly be treated more fully in a future publication. (See pls. 10 and 11.)

IRIS

But few samples of iris bulbs aside from those produced on the Department of Agriculture grounds at Bellingham, Wash., have been handled under glass. For the last four years the four varieties of the Dutch group which have been forced have been uniformly satisfactory. The few samples from other growers which have been handled have also forced satisfactorily when received in good condition. There has been, however, a great variation in quality. Some bulbs, especially those of *Iris tingitana*, have been undersized, and some of the others have been injured in handling.

There are a number of considerations to which attention should be directed. It has been proved to the writer's satisfaction that good stocks of the Spanish and Dutch groups have been produced in the Pacific Northwest, in California, Virginia, North Carolina, and New York. This is a wide enough range of conditions to satisfy the most exacting demands.

To produce iris bulbs successfully, moisture must not fail during the growing season from September to June; the soil must contain good fertility without rawness in the manures; the bulbs must be handled with care in storage and must not be allowed to mold or dry out too much; the gray bulb aphis, if present, must be kept in check by a liberal application of tobacco dust on the shelves; and above all things the pack must be prevented from sweating by good aeration and the breaking up of large bulb masses. If these requirements are complied with, these desirable florist bulbs so much in demand can be produced over a very wide range of conditions. Here, as with so many other bulbous crops, the watchword must be care and attention to detail in cultivation, keeping down weeds, and watchfulness during the dormant season.

The complaint is made that the bulbs "do not keep." Doubtless many stocks have not kept on the dealers' shelves, but this is due to an error somewhere along the line of travel from the field to the consumer. The writer is positive of this because he has kept these stocks perfectly from the middle of June to the middle of October, which is certainly long enough to allow for merchandising.

DISEASES, PESTS, AND UNFAVORABLE CONDITIONS

During the season of 1924 special attention was paid to the possible appearance of diseases in the stocks received from different sections. Some daffodil bulbs were submitted with the request that this attention be given, the nematode disease being specifically mentioned. In the last three years stocks of daffodils from 13 States have been forced. None of them was infested with this malady, although the disease is known to exist in some localities from which bulbs were forced.

A few daffodil bulbs were gray, but not many. A discussion of this malady is found under the consideration of Sir Watkin, on page 8, and a more complete treatment in United States Department of Agriculture Bulletin 1270, The Production of Narcissus Bulbs.[4]

The large daffodil fly (*Merodon equestris*) was received from two sources and the lesser fly (*Eumerus strigatus*) from one source in tulip bulbs.

On the whole, the most serious and destructive maladies of daffodils are those brought about by untoward conditions of culture or handling. It is useless to attempt to produce good daffodils over an impervious subsoil which keeps the roots in stagnant moisture during the wet season. Raw manures are also inimical to healthfulness of the stocks. Either of these conditions will produce basal rots and "ring diseases," which are sure to cause alarm and are likely to be interpreted as caused by parasitism, when in reality they are a reaction to improper environment and disappear when these conditions are rectified.

Another very potent cause of trouble is improper storage conditions, resulting in heating, bruising, or overexposure of the bulbs. Some growers dig the bulbs before the tops die and throw the daffodils into piles, turning these over as the tops decay to prevent "too much heating." Such stock will not keep on the merchants' shelves any more than will daffodil stocks burned in the sun or those bruised in handling. The writer has seen a 75 per cent loss in daffodil bulbs caused by rough screening at harvesting time. About 25 per cent of the rotted bulbs were literally filled with the larvæ of the lesser narcissus fly, and the remainder were free of it.

The economical handling of large quantities of daffodil bulbs in storage is difficult to direct, for the reason that the crop is very bulky and furthermore because improper storage leads to alarming disease. The writer has previously stated that it may be seriously questioned whether it is economically practical to shelve a mass production of daffodil stocks, because they must be handled so that they are neither heated, bruised, sunned, nor dried out too much. Any of these excesses leads to "diseased" conditions which impair the stocks. Excessive drying, however, is much less dangerous than poor aeration with danger of heating.

The Department of Agriculture has been able to dry and keep successfully Emperor and King Alfred daffodils in slatted crates holding 1 bushel each, in the climate of Washington, D. C. The bulbs were dug after the tops were well dried, and were put directly

[4] GRIFFITHS, D. THE PRODUCTION OF NARCISSUS BULBS. U. S. Dept. Agr. Bul. 1270, 32 pp., illus. 1924.

into the crates, which were stacked in a well-aerated place. After the bulbs were properly dried out the aeration was reduced. When dug before the bases of the leaves and stems were dry the bulbs were left in the windrow in the field, covered with the hoed-off tops for a day or two, and then handled the same way as the others. A grower in North Carolina handled his daffodils successfully last season in storage in some old Dutch-bulb crates through the centers of which some ventilation had been put to break up the bulb mass. These crates were piled in a shed open to the south.

Another factor which affects the healthfulness and vigor of daffodil stocks and one which is at present of somewhat controversial nature relates to frequency of digging. In spite of the fact that daffodils are rejuvenated by being left several years undug or even in a seminaturalized condition, and a general biennial digging practice may be advisable when possible, there are conditions under which annual digging may be imperative. There is yet much which must be learned by experience and experiment, but it seems probable that daffodil stocks will keep better in storage than in our southern shallow soils during the very hot and very wet dormant season from mid-June to mid-September.

The very trying season of 1924–25 in the Northwest affected seriously the condition of several daffodil plantings. Some plantings were killed in large measure, and it will take some time for other stocks to recover. Some growers in this region have planted too shallow. Deeper planting or a mulch is necessary in occasional winters. It is believed that there should be not less than 4 inches of soil over the bulbs and in exposed situations more than that. Deeper planting on the very light soils of this region is advised.

Freezing results in dwarfed plants with leaves prematurely yellowed at the tips, and in discoloration of the bases of the bulbs, which gives rise eventually to a rot producing rotten bases, rotten scale bases, a ring-diseased appearance, and finally a completely rotted bulb.

Broken tulips appeared in two instances in the forcing tests of the winter of 1924–25. The occurrence was rather peculiar in that both cases occurred in recently imported stock. No broken forms have been found in the hundred or more varieties of the Department of Agriculture which have been grown continuously for 15 years or more in this country at Bellingham, Wash.

Recently imported stocks of the cottage tulip Fulgens, grown one year at Bellingham after being used for bedding on the Department of Agriculture grounds at Washington, D. C., showed 10 per cent of broken plants when forced this season. The breaking was not noticed on the department grounds nor in the field at Bellingham. The stocks of one grower, also recently imported, showed nearly 25 per cent broken plants in both Farncombe Sanders and Bartigon. This breaking is of great importance to our growers, as the value of tulip stocks is tremendously reduced when any considerable percentage of the bulbs become broken. When this occurs the varieties can be disposed of as mixed stocks only. Observations seem to indicate that the breaking is more likely to take place in the warmer sections of the country. It is there also that aphids are most prevalent.

It is well to note that there are several classes of tulips in commerce based upon this broken character. The most important are the Rembrandts or broken Darwins and the broken forms of several other self-colored groups. The time was when these were highly prized. Indeed, they have been considered not only the ultimate state but the acme of perfection of every self-colored tulip (all seedlings are self-colored) from time immemorial. Since the history of the tulip began to be written this characteristic has been recognized, and as long ago as the fifteenth century, before the tulip was introduced into Europe, these flamed and feathered forms were the most prized. It is felt that growers should treat the broken bulbs as diseased forms and grow them, if at all, at safe distances from regular stocks and also exercise the same precautions with reference to the bulbs in storage.

CONCLUSIONS

The production of these bulb crops is a task requiring the care inherent in intensive culture.

The occasional imperfections brought out in these tests are a demonstration not of lack of adaptability of the stocks to American conditions but of a lack of information relative to the requirements of the crops and, often, of a failure to recognize the necessary quality in the commercial article.

Tulips from which one or two leaves have been cut do not make forcing stock.

It is not true that the coats of tulips "amount to nothing." They should be preserved to protect the delicate tissues from abrasion and, what is often just as important, from excessive desiccation.

American-grown bulb stocks on the whole, owing to the diversity of the conditions under which they are produced, are likely to be less uniform in their performance than foreign stocks, but are just as productive and responsive under glass when suitably handled. On this account stocks from widely separated localities should not be mixed.

Storage should receive more careful attention. Overexposure is common, and sometimes heating is evident.

Injury in the pack is not uncommon. It is imperative that the large pack be well aerated.

A large part of the so-called disease troubles of bulbs, especially daffodils, is due not to parasitic organisms but to improper cultural, storage, or handling conditions.

It is considered that, in spite of shortcomings in some of the varieties, the outlook for American production of bulbs is decidedly bright. The progress made is rather remarkable, considering the short time that our growers have devoted to the industry.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

November 12, 1926

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