INSTITUUT VOOR PHYTOPATHOLOGIE

LABORATORIUM VOOR BLOEMBOLLEN-ONDERZOEK TE LISSE

DIRECTEUR
Prof. Dr. E. VAN SLOGTEREN

No. 56 Juni 1936

THE INFLUENCE OF CLIMATE AND STORING-CONDITIONS ON THE FLOWERING OF FLOWER-BULBS

by

PROF. DR. E. VAN SLOGTEREN

DRUK: J. VAN BOEKHOVEN — UTRECHT

Reprinted from the Proceedings of the VIIth International Congress of Refrigeration.
Juni 1936 — Holland

THE INFLUENCE OF CLIMATE AND STORING-CONDITIONS ON THE FLOWERING OF FLOWER-BULBS.

THE INFLUENCE OF CLIMATE AND STORING-CONDITIONS ON THE FLOWERING OF FLOWER-BULBS.

Prof. Dr. E. VAN SLOGTEREN.

Director of the Laboratory for Flowerbulb-research at Lisse.

It is common knowledge that the climate of every country is of great significance for its indigenous flora.

Both the wealth of forms and the quantity of flowers are strongly influenced through this. We also know that the same species and varieties of plants flower much earlier in one climate than in the other and therefore the Hyacinths a.o. will for instance flower in the South of France at a much earlier date than for instance in Holland.

The greatest part of the Dutch bulbs were imported from other countries which have quite a different climate to ours, but through the great care and devotion of the intelligent bulb-growers, they have in many respects acclimatized here wonderfully well.

The striving to lengthen the period of demand and through this increasing the selling possibilities of the product at first induced the Dutch bulb-growers to plant their bulbs for a year in the South of France. By doing so they profited by the natural milder climate there, where the bulbs flowered earlier, could also be lifted earlier and for a great part retained their advantage for the next year over the bulbs grown here.

It was the Dutch bulbgrower Nicolaas Dames, who more than 30 years ago trying to find a more economical solution of the early-flowering problem, proceeded to conquer the difficulties of his own climate by prematurely lifting the hyacinths at an early date and after that by ripening them in artificial climatic conditions.

The application of a special treatment to the flower-bulbs, before they had been planted for forcing for the coming year, through which the less favourable influences of their own climate were obviated,

was in principle already quite the same, as that which now under the name of Jarovisation or vernilisation attracts to such a degree the attention of science and practice for the application for the agriculture and horticulture, and the practical bulb-grower Nicolaas Dames found a solution for a problem here a long time before official science was even aware of the existence of this problem.

He did not have the means of modern technics at his disposal, and had to manage with very primitive aids and appliances but so much the more what he accomplished commands our deep respect, and

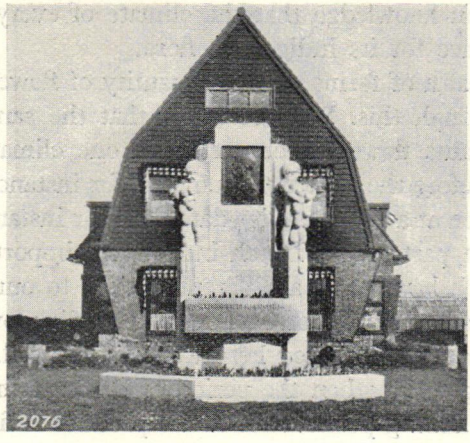

Figure 1.
Statue of Nicolaas Dames, the pioneer of modern flower-bulb culture at Lisse.

that which has still been improved on by scientific researches in this respect, is entirely based on the foundations laid by him. He was able to lengthen the period of demand of the hyacinths by about 4 to 5 weeks and made the hyacinths a favourite Christmas flower.

Besides our culture, our science too is greatly indebted to this insight, and I consider it to be a great honour, that I was allowed to have the monument, erected to him in the flower-bulb district, placed in front of our Laboratory in Lisse. (Fig. 1).

It is self-evident that at this International Congress of Refrigera-

tion stress is primarily laid on the importance of lower temperatures for the flowering capacity of our flower-bulbs. Yet, with regard to the lowness of our temperatures, we make modest demands on the refrigeration experts and for us even the temperatures in the neighbourhood of the freezing-point are of much less importance, than those which are often only a few degrees lower than the average temperatures of our own climate. It is of special importance for us that for the treatment of our bulbs we make ourselves independent of the possible adverse influences of our own climate, of those in the country where our bulbs are used and of those territories which they have to pass through en route to their ultimate destination. Not only do the temperatures however play a prominent part in this case, but especially the humidity of the air too, and in connection with this the ventilation in the sheds where the bulbs have to be stored. It is for that special reason, that the modern technics of the air-conditioning which is also of great importance for this congress, will be able to render us great services. Close co-operation of us biologists with the experts on this domain may therefore bear important fruit both for our flower-bulb culture as well as for this branch of the cooling technics.

The flowering capacity of our flower-bulbs does not however depend exclusively or mainly either on the temperatures lower than those prevailing in our climate at certain times, but is chiefly determined by a very close interaction between higher and lower temperatures. The effect of the cold-storage is for a very great part determined by higher temperatures, to which the bulbs have been exposed previously, whereas on the other hand the date at which the flower-bulbs were transferred to a lower temperature and the duration of the stay there are of predominant importance both for the flower-quality and for the power of resistance against adverse influences of temperature and humidity of the air to which the bulbs afterwards have to be exposed. However not only the quality of the flowers and the percentage of flowers which are obtained from a certain quantity of bulbs are determined by this, but in no less a degree the appearance of various parasitical as well as physiological diseases are connected with this while especially during the shipment of the

bulbs to distant countries, the appearance of all kinds of secondary rotting organisms is closely allied to this.

The very short time which is at my disposal makes it quite impossible for me to deal fully with the problem facing us.

I can only give you some principal lines along which our investigations went and shall endeavour to give you an idea how very complex the problem is. The fact, that through our working in the centre of the culture itself we are in direct contact with all difficulties which arise at the application of the various treatments guards us from over-estimating our own achievements, in consequence of which we are not lightly to consider a half solution as a whole. I hope to make it clear to you that only through taking into accurate account all difficulties of culture and export we can hope to arrive at a satisfactory solution ultimately.

In the main I shall confine myself to the discussion of two periods, which are very closely allied to each other and, which are of the greatest importance for the flowering of our bulb crops viz.:

1°. the so-called pre-treatment of the bulbs from the time of lifting till the moment when the flower-formation in the bulb is complete, and

2°. the storage of the bulbs after this moment till the time when they are dispatched and then during the journey until they are planted.

Commencing with the hyacinths with which Nicolaas Dames performed his pioneering, we must state that it was possible for him to attain the best results with them because here, through the early and prematurely lifting followed by the application of a higher temperature we can interfere with the normal process of development of the formation of leaves and flower for the coming season.

Through this interference the leaf formation is namely stopped and the flower begins to develop. The temperature applied immediately after lifting is considerably higher than the average outside temperature at this time of the year (± middle of June) but it was easily to be reached, while the temperature, most desirable for the hyacinths later on, could also easily be attained in the cool cellars belonging to Dames.

Thus with regard to the temperature the hyacinths make the

lightest demands, the unripe lifting of these bulbs involves various dangers in connection with the high percentage of moisture of the bulbs in this period and the possibility of the appearance of damage by parasitical bacteria (Pseudomonas hyacinthi), more or less secondary bacteria (Bacterium Hyacinthi scepticus), while also other secondary organisms as the fungi Penicillium glaucum, Aspergillus niger a.o. and the bulbmite (Rhizoglyphus echinopus) can cause all kinds of skin-mould.

We are greatly tempted to remove these obstacles by drying the bulbs rapidly at a high temperature, and this is still more the case because this high initial temperature very favourably affects the precocity of the flowers.

This method however involves great dangers for the size of the flowers as the table I. clearly shows.

Table I.

Hyacinth l'Innocence. Numbers of flowers per cluster.

Size of the bulbs	Date of lifting	Treatment	Number op flowers per cluster
19 cm circumference	21.6.'1933	7 days 34° C + 25½° C	23.9
19 cm circumference	21.6.'1933	10 days 20° C + 25½° C	46.6

This makes a difference of 50 % of the size of the flower and the next picture (fig. 2) of another experiment shows about the same relation in quality of the flowers. We therefore think it better to advise beginning the preparation at a lower temperature (+ 20° C.) which only later on is (30—25° C.) and some weeks later is followed by a lower temperature (15° C.).

We sacrifice a little of the precocity of the flowers, but this is amply recompensed by the much better quality of the flower. The

further dangers of the various forms of skin-mould caused by bacteria and fungi, we combat successfully by disinfecting the bulbs with a $^1/_4$ to $^1/_2$ % solution of Germisan or $^1/_4$ to $^1/_2$ % solution of Aretan for some hours. Especially for hyacinths, which later on are exposed to very abnormal temperatures, both high and very low, this disinfection yields so many advantages as to be considered indispensable. For the application at higher temperatures I refer to publication

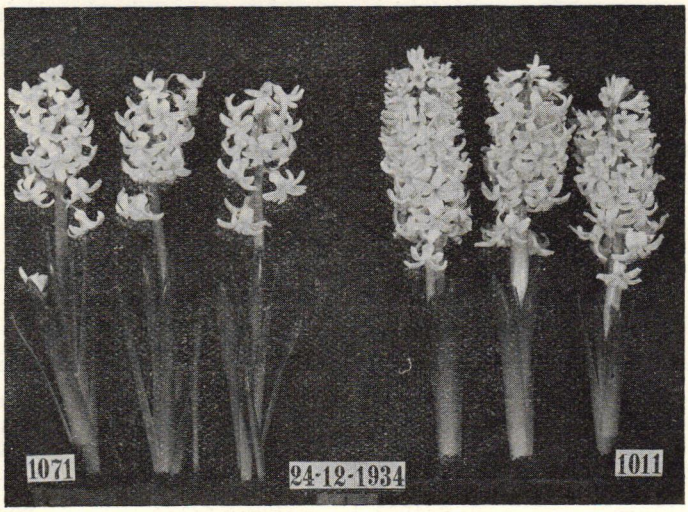

Figure 2.
(2002) Hyacinth L'Innocence: A high temperature immediately after lifting for preparing of hyacinths unfavourably influences the numbers of flowers of the cluster.
No. 1071 : 3 weeks 35° C. — 20° C. No. 1011 : 10 days 20° C. — 10 days 25½° C. — 7 days 30° C. — 25½° C.

No. 39 of the Laboratory for flower-bulb research, but especially too, for the preparation of hyacinths for the Southern Hemisphere (about which Miss Luyten has spoken to you) it has been essential for us to remove the very serious obstacles.

Table II shows an example of the percentage of loss of two lots of hyacinths at a number of our experiments in 1933. The number of bulbs, lost during the experiments by rotting of the bulbs during

their stay in the cold storage at $3^1/_2°$ C. or shortly afterwards, was no less than 29.1 % for the variety of l'Innocence, which as prescribed by Blaauw had been taken air-dried to the cold storage. This loss was reduced to $2^1/_2$ % after a treatment in a $^1/_2$ % solution of Aretan for the duration of 8 hours.

With one lot of Hyacinths Arentine Arendse, a part of which had been put in a temperature of 35° C. for a week in order to diminish this loss, the percentage of loss was still 17.2 %, which by disinfection with Aretan could be decreased to 6 %.

Table II.

	Treatment before cold storage	Loss in cold storage
Hyac. L'Innocence	air dry	29.1 %
	8 hours ½ % Aretan	2.5 %
Hyac. Arentine Arendse	1 week 35° C	17.2 %
	8 hours ½ % Aretan	6.0 %

For judging the value of any method of treatment, it is not only sufficient to mention the ultimate flowering results of the flower bulbs which give satisfaction, but it is primarely essential to mention the percentage of loss every time, whereas the intrinsic value of the method can after all only be judged by the application on a large scale in conditions as the export demands them.

In contrast to the hyacinths, which to a certain extent can be forced to commence the flower development at any time, is the other extreme: the Daffodils, the flower development of which, as stated in our publication No. 42 in 1931, commences very early, about the beginning of May, a long time before the Narcissi can be lifted.

Whereas till then nothing had been achieved with these bulb

crops with regard to the acceleration of the flowering for our climate, we succeeded, by applying temperatures of 8 to 9° C. immediately or shortly after the lifting, in lengthening the period of demand of these bulbcrops considerably.

This revolutionized our flowermarkets in December and January and whereas till then the Narcissi were the last on the market, they have now for some years past been among the harbingers of spring on the flowermarkets too.

As the photos No. 3 and 4 show we could already obtain large quantities of Narcissi in bloom in the middle of December which till then could not be got in bloom until the end of January.

Some varieties are even to be had early in December through cold-storage with good results, as figure No. 5 shows.

Too early lifting or even too long a stay in the cold storage is also dangerous for the flower-quality as the flowers are dwarfed. (Fig. 6).

Finally the tulips which with regard to the planted area are of the greatest importance for our export.

With them the flower formation takes place later than with the Narcissus, but the earlier lifting here too has not such an after-effect as with the hyacinths, because this interference does not either lead to an immediate beginning of the flower development. The tulip first develops its leaves and only then does it commence forming its flower. Nicolaas Dames already knew, that he could obtain an improvement of the early flowering, by exposing the tulips immediately after lifting to a higher temperature and by placing them in a cool place later on.

As the lower temperatures, which are desirable here, were however not by far attained by him, he could not achieve much.

Blaauw c.s. studied the morphological development of the flower under the influence of different temperatures. They enumerated the different stages of the flower development and advised a treatment at 20° C. from the time of lifting and followed by a storage at 9° C. (48° F.). Through this a very important improvement was obtained, which was also a basis for our researches on this subject.

Before long however it was evident to us that many disappointments also arose here, principally due to the fact, that the tulips at too

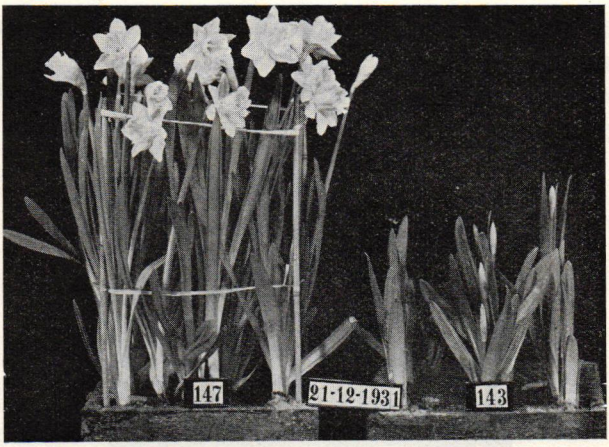

Figure 3.
Narcis Bicolor Victoria.
No. 147: stored at 9° C. No. 143: stored for 3 weeks at 17° C. — 9° C.

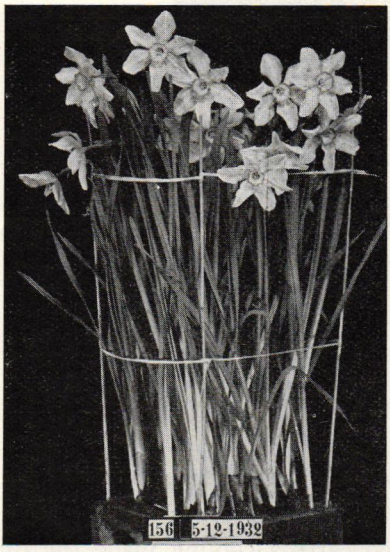

Figure 5.
Narcis Brillancy: Stored at 9° C.

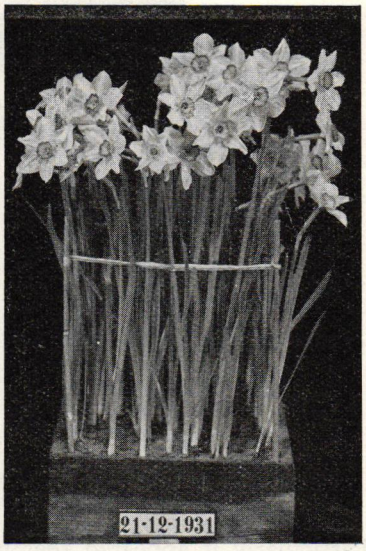

Figure 4.
Narcis Early Surprise:
Stored for two weeks at 17° C.
and furtheron at 9° C.

early a stage of development were placed in cold storage at 48° F. and that an optimal treatment for the most rapid flowering involved very many dangers both for the quality of the flowers and for the percentage of blind flowerbuds.

Figure 6.
Flowers of Narcis Springglory.
under: Dwarfing of the flowers by a too early lifting of the bulbs.

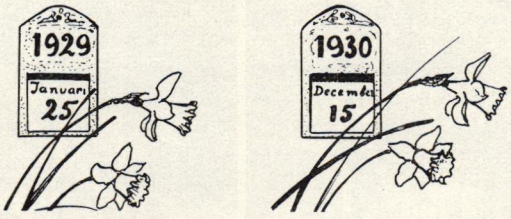

Figure 7.
Progress in precocity attained in the Laboratory for flowerbulb-research by cool-storage of Daffodils.

Particularly it appeared that too early a cooling made the tulips very susceptible to the physiological disease "the tumbling over" of the tulips, a disease that has been described in publication No. 33 of our laboratory by Miss Pinkhoff. Photo No. 8 shows the symptoms

of the disease and the earliest lot of the experiment was entirely lost through this disease.

It soon appeared that the morphological stage of development was not at all a reliable test for the judging of the date when the tulips had to be put into the cold storage. The morphological development-stage is more of a secondary importance, of much more importance is the studying of the biochemical processes which take place in the bulbs. For these reasons in 1927 I therefore commissioned Miss Pinkhoff to study these biochemical processes further. A part of this research was published in the dissertation of Miss Pinkhoff

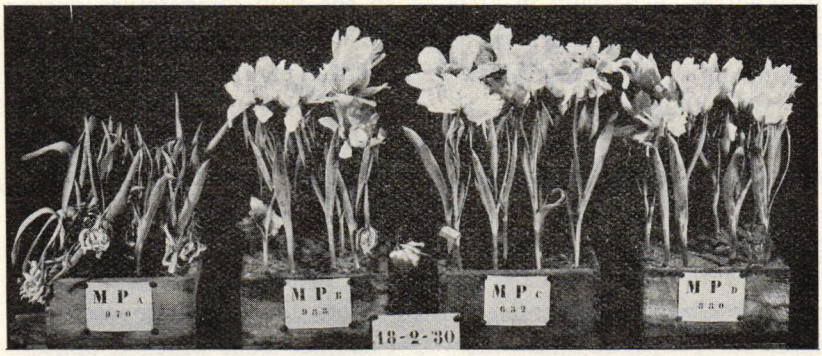

Figure 8.
D. V. T. Murillo: The earliest lot entirely lost by „tumbling over".

and these researches were later continued by Dr. Algera; two publications of Dr. Algera on this research will shortly appear.

The effect of the cold-storage is entirely dependent on the temperatures which these bulbs have had beforehand and if, at a certain date we examine a tulip, then the stage in which this tulip is at that moment is not of primary importance, but the conditions in which this stage has been reached are of all the greater importance. In any case we prefer to wait until the tulip has reached stage VI when all parts of the flower, except the pistil can be seen in the flowerebud and this stage is generally reached quickest by storing at temperatures between 17 to 20° C.

Both at higher and lower temperatures the morphological development will take place slower and a retarding in the development stage at a certain date can consequently both be due to a high as well as to a low pre-treatment temperature.

In the former case the result at flowering will exceed one's expectations and in many cases will be better than that of the much further developed tulips, whereas in the latter case a total failure is almost certain.

Consequently tulips which in the correct morphological development stage have been put in cold-storage, but had attained this stage at too low a temperature, have already in practice frequently caused great losses. Especially in 1935 when the field temperature during the latter part of the growing period had been abnormally low, the growers were already speaking of a cold-storage disease, when they remarked that many of their lots failed in consequence of these influences. The disease was wrongly attributed to cold-storage and was indeed primarely due to too low a pretreatment temperature.

On the ground of very extensive experiments we have come to the conclusion that in many cases it is desirable to raise the initial temperatures to at least 25° C. after the lifting and sometimes even considerably higher. I cannot go further into details of these researches here, but I wish to show you one example, from which it appears that a short pre-treatment of 24 hours at a temperature of 40° C. immediately applied after lifting, may cause a very important improvement of the forcing results fig. 9.

The bulbs out of the two boxes were stored at 20° C. until they had attained stage VI—VII on 10 August 1935. Then they were both kept at 9° C. and the only difference was that the left box (859) had been treated at 40° C. for 24 hours on the first day after lifting. Already on 10th August there was no longer any difference in the morphological stage of development whereas the difference at the forcing had been exceptionally great.

Furthermore I must point out two dangers in the application of cold storage on a commercial basis.

a. Firstly the influence of the relative humidity of the air in the refrigerated room. With a high percentage of moisture there is a

danger of the tulips contracting a skin-mould, which especially with tulips which have been lifted very early, may cause decay. In the above case too a disinfection will at least effect some improvement.

Moreover a high percentage of moisture leads to early root-development, which especially if the tulips have to be shipped to distant countries, may be the cause of a failure. Yet on the other hand with a very dry storage we have seen considerable damage owing to the fact that the flowerquality becomes inferior, and many more blind

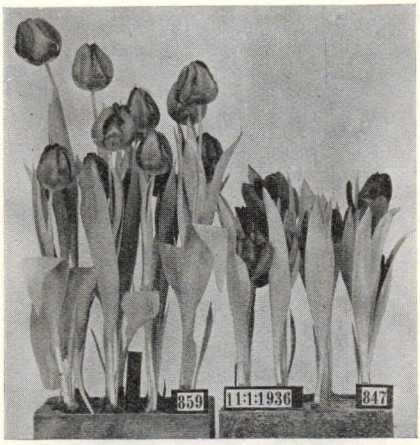

Figure 9.
E. V. T. Prince of Austria.
Precocity of No. 859 attained by storing at 40° C. for 24 hours.

buds occur in the lots and the root development is checked too much. Especially when the boxes with the planted bulbs are kept in cold storage it is necessary to guard against excessive drying.

We therefor advise keeping the percentage of moisture as high as possible without stimulating the root formation too strongly and as not only the different varieties make various demands on this, but also different lots of the same varieties, according to the pre-treatment which they have had, will react differently the careful supervision of someone, who has a profound knowledge of the flowerbulbculture, is always necessary. Special attention has to be paid to the fact, that

the bulbs are not piled up too closely to each other and a moderate airmovement in the storingroom is very desirable.

b. Further more one should especially bear in mind, that a treatment which makes the tulips most suitable for early flowering, makes them less fit for a somewhat later period and makes them worthless for later flowering. This demonstrates clearer than anything else how complex the problem facing us is, and how dangerous it is, to give a general advice for application on a large scale based on a few labor-

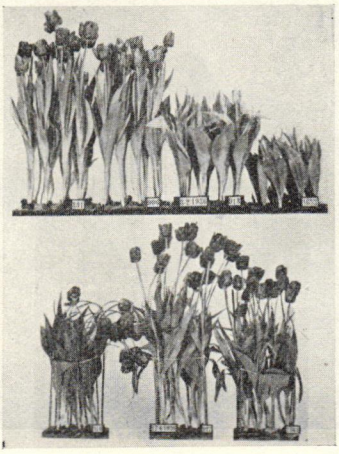

Figure 10.
Darwin tulip Bartigon:
891—916: treated for early flowering.
1653—1661: treated for late forcing.

atory experiments, no matter how well they may seem to have succeeded. It is apparant that exterpolating is very dangerous in this case too! I only show you one example here, which can make it clearer to you than many words would.

Photo 10. shows two series of Darwin tulips Bartigon which were placed in the hot-house on January 17th and on 23 March respectively. No. 891 and 906 of the first series were good, both the others failed. No. 1661 of the second series was the best and No. 916 entirely worthless. The pretreatment of 891 and 916 had been the same and

likewise that of 1653 and 1661. A treatment favourable for early flowering may at the same time be a maltreatment for use at a later date!

For the future of our flowerbulb export as well as for the cool-technics, which can render us great services for the extension of the period of demand, an accurate insight in the difficulties connected with this is absolutely necessary. Otherwise there is a great danger of defeating one's own end.

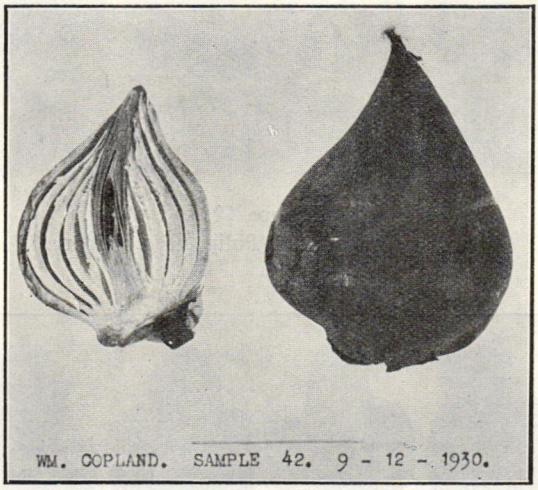

Figure 11.
Flowerbud of tulip destroyed by „heating in transit".

Finally something concerning the shipping of our flower-bulbs. I have already said that we are not only concerned with our own climate and its influence on the flowering capacity of our bulbs, but in no less a degree with the climates of the countries, which they have to pass through, and of the countries where they have to be forced into bloom.

When once we know which temperatures, in the course of the whole period of development from bulb to flower, are most desirable, then theoretically it is very easy to solve the matter by continually

making use of storage-rooms, where the desired artificial climate prevails, firstly for the storage, and during the dispatch in train or boat later on.

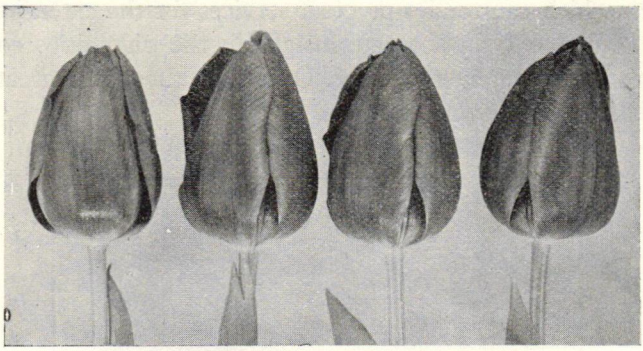

Figure 12.
Normal flowers of Tulip Fred. Moore.

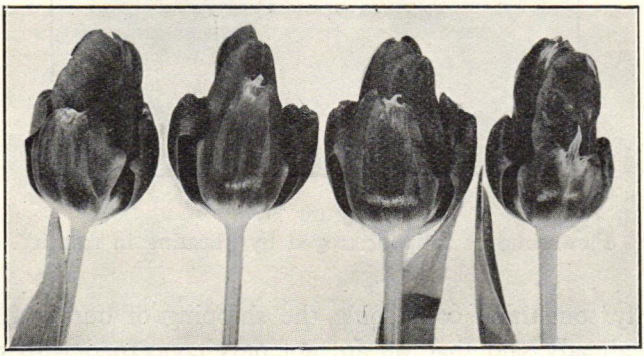

Figure 13.
Flowers of Tulip Fred. Moore demaged by „heating in transit".

Besides the fact that this would in many cases be too expensive for the vast majority of our products to maintain their competition struggle against the foreign product, we must however take into account too, that even on shipment in ships specially equipped for

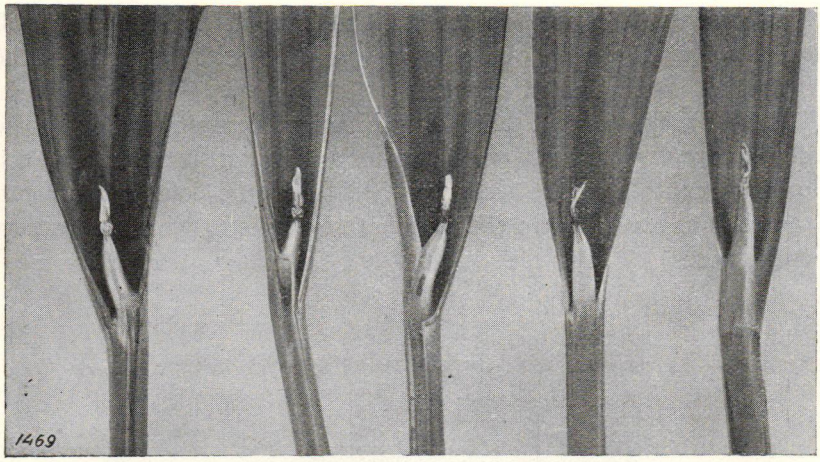

Figure 14.
Damage by „Heating in transit".

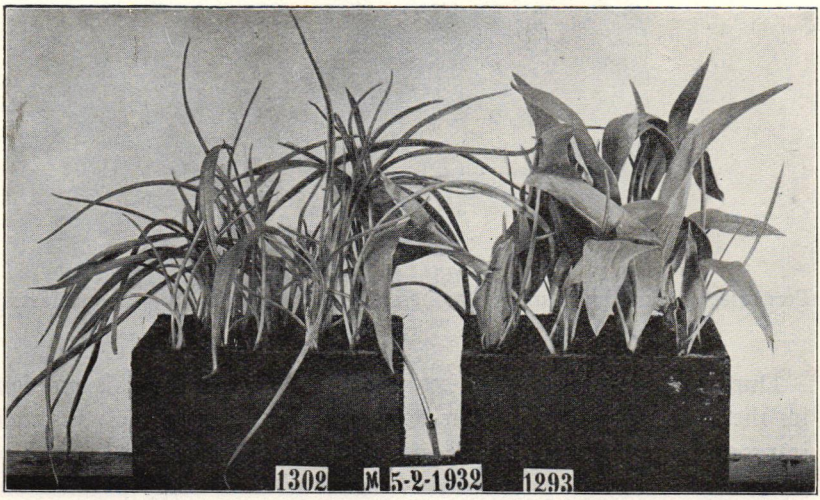

Figure 15.
Results of forcing after damage by „heating in transit". No. flowers, abnormal foliage.

that purpose, the necessity of transhipment at the harbours still exists, and the bulbs cannot continually be withdrawn from the influence of the natural climate.

In this respect much can and will have to be improved on in the near future, but we can already now for a great part meet the dangers, by taking into accurate account, when fixing the date of shipment, the climate prevailing in the different countries to which we export our bulbs.

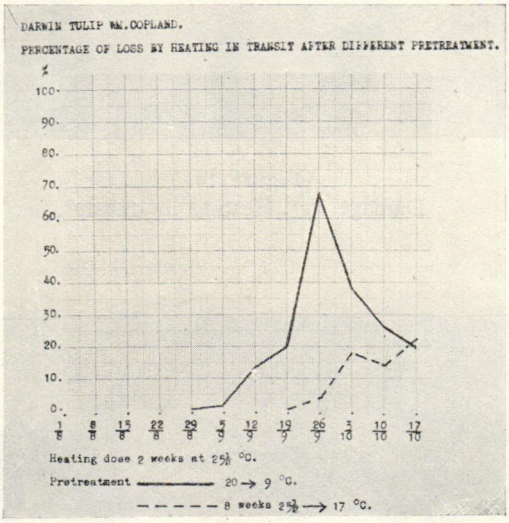

Figure 16.
Darwin tulip Wm. Copland:
Percentage of loss by heating in transit after different pre-treatment. Heating dose 2 weeks at 25½° C.

During the last years much attention has been paid to this problem in the Laboratory for flower-bulb research, and already a great improvement has been attained in many respects with a later shipment e.g. to various parts of America. I refer to some publications of our laboratory concerning this matter.

One of the most dangerous rocks which we have to steer clear of is the notorious "heating in transit", to which great quantities of

flowerbulbs fall victims every year. The bulbs apparently arrive abroad in a very sound condition, but on cutting the bulbs open it appears that the flowerbud is entirely destroyed. The figures 11 + 15 give an impression of these symptoms of injury in the bulbs and the floweringresults obtained through this, which jeopardizes our markets abroad.

By means of experiments we have studied the sensitiveness of the flowerbulbs, especially of tulips, during the entire shipping season,

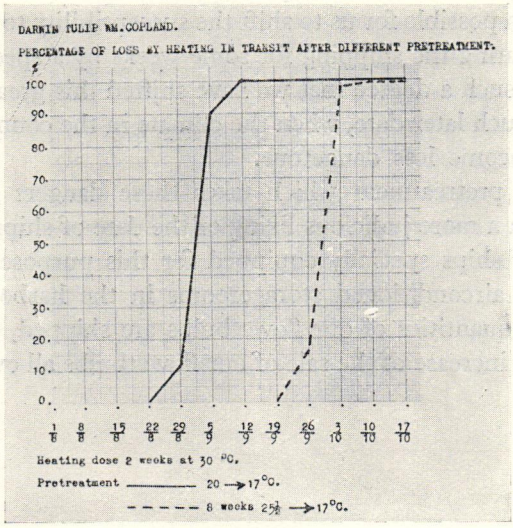

Figure 17.
Darwin tulip Wm. Copland:
Percentage of lose by heating in transit after different pre-treatment. Heating dose 2 weeks at 30° C.

and here too, we found that the pretreatment of the bulbs is of great importance. In connection with the application of lower temperatures promoting the early flowering, it is very important to know, that it is again this lower temperature which makes the tulips more sensitive to this heating in transit.

Fig. 16. gives a graph of the percentage of damage done to various lots of the same stock of Darwintulips Wm. Copland in the period

between 1 August and 17 October by every week exposing a lot for two weeks to the very moderate dose of heat of $25^1/_2^\circ$ C. In this case the great difference in sensitiveness of the cooled tulips is very clear in contrast to the other series of lots of the same variety, which had previously been put at a higher temperature.

Fig. 17 shows similar differences between a series, which had been treated a little warmer than was desirable for early flowering, and another series, which had also been pretreated for very late flowering, at a higher dose of heat namely two weeks: 30° C.

It has been possible for us to shift the susceptibility to these adverse influences during the shipping for some weeks by a special treatment and even to such a degree that we have shifted this greatest susceptibility to a much later date, when the climate in the country of destination has become less dangerous.

A correct pretreatment which takes these dangers into account, coupled with a more judicious fixing of the date of shipment, making more use of ships specially equipped for this purpose and also installation of airconditioned storagerooms in the harbours to which the greatest quantities of our flowerbulbs are shipped, will lead to a considerable increase of the sale of our flowerbulbs all over the world.

REFERENCES:

M. Pinkhof: Untersuchungen über die Umfallkrankheit der Tulpen. Rec. d. Travaux Bot. Neerland. Jan. 1930.

J. J. Beijer and E. van Slogteren: Vroegbroei van onze bolgewassen. Weekblad v. Bloembollencultuur 1930.

H. E. Dolk and E. van Slogteren: Ueber die Atmung und die Absterbeerscheinungen bei Hyazinthen-Zwiebeln bei höheren Temperaturen im Zusammenhang mit der Bekämpfung der Gelbkrankheit. (Gartenbauwissenschaft Band 4, 1933).

J. J. Beijer and E. van Slogteren: Vroegbroei en verzending van onze bolgewassen, Weekbl. v. Bloembollencult. 1931.

J. J. Beijer and E. van Slogteren: Vroegbroei van Narcissen. Weekbl. v. Bloembollencult. 1932.

E. van Slogteren: The early-forcing of Daffodils. (R. H. S. Daffodil-Yearbook 1933).

E. van Slogteren: Influence of climate and shippingconditions in the early forcing of daffodils (R.H.S. Daffodil-Yearbook 1935).

E. van Slogteren: De beteekenis van Klimaat- en transport-invloeden voor de verbruikswaarde van tuinbouw-producten, in het bijzonder van Bloembollen. Tijdschrift voor Plantenziekten 1936.

J. J. Beijer: De invloed van de schuur-behandeling op de bloemkwaliteit van de Hyacinth. Weekblad v. Bloembollencult. 1936.

L. Algera: Concerning the influence of temperature treatment on the carbohydrate metabolism, the respiration and the morphological development of the tulip. I—III. Proc. Kon. Akad. van Wetenschappen, Amsterdam. Vol. 39. No. 7, 8 and 9, 1936.