Neth. J. agric. Sci. 25 (1977): 229-237

Tulip bulb production potentials in Europe[1]

H. G. Kronenberg

Department of Horticulture, Agricultural University, Wageningen, the Netherlands

Accepted: 1 September 1976

Key words: tulip, tulip bulb, potential production, Europe

Summary

Tulips are an important flower bulb crop in Europe. The European climate is very suitable for tulip bulb growing, because large parts of western Europe have a long spring and temperatures do not rise too sharply in this period. Productivity, the percentage weight increase, is determined by the amount of radiation received during the period that plants have leaves above the soil surface. A productivity between 40 and 122 was found, while in the main producing centres productivity was between 100-120. Maps of earliness of spring, earliness of the bulb crop, bulb productivity and relative aberrations were made. It is remarkable that crop statistics show tulip bulb production to be concentrated in certain relatively small parts of the favourable areas meaning that other than the considered growing requirements play an important role in the tulip crop geography.

Introduction

Tulip is a very important flower bulb crop in Europe. The bulbs are used in forcing to get cut flowers early in the year; on the other side they are planted in gardens for ornamental purposes.

At present about 300 cultivars are grown in the Netherlands (Rassenlijst, 1972), which differ to some extent in not well understood cultural requirements, because they are developed from several, partly unknown species.

Crossing started long ago in the Orient and after introduction in the Netherlands (after 1560) free hybridization started; after 1900 hybridization was more purposeful (Dix, 1974). Already in 1618 cultivars were classified as 'early', 'late' and 'between them' (middle late). Tulip cultivars of which the flowers have rather long stems (Darwin, Triumph and Mendel groups) are the most cultivated nowadays.

In cultural requirements the several cultivars differ to some extent; so do the reactions to external influences and the resulting differences in productivity (=

[1] Publication 432, Laboratorium voor Tuinbouwplantenteelt, Landbouwhogeschool, Wageningen, the Netherlands.

Table 1. European production of tulip bulbs (mainly according to Rees (1972) and Vroomen (1973)).

Country	Year	Area (ha)	District
Belgium	(1968)	16	Flandres
Denmark	(1970)	700	Funen, southern Jutland
France	(1971)	100	Ocean coastal regions
East Germany	(1962)	150?	
West Germany	(1969)	370	eastern Friesland
Italy	(1968)	300?	
Netherlands	(1974)	6154	Holland
United Kingdom			
England and Wales	(1971)	1550	Lincolnshire, Cornwall
Scotland	(1968)	22	
USSR	(1968)	150	Esthonia, Lithuania
Total		9512	

weight increase, as a percentage of the planted weight). This percentage varies in the Netherlands between 50-150 with an average range of 95-115 (calculated from Rassenlijst, 1972).

The production of tulips in Europe is concentrated in the Netherlands, England and Denmark (Table 1).

As bulb production is determined by physiological and socio-economic relationships, it is an interesting question whether the above demonstrated distribution must be attributed to only one or to both groups of influences. This study tries to find an answer after investigating some physiological relationships.

Any crop has its own requirements to the environment of which the prevailing conditions of light and temperature together with the availability of water and plant nutrition are the most important; these determine the physiological limits of crop production. In this paper only the reaction to temperature and light will be discussed, presuming that on horticultural holdings water and nutrients, if insufficiently, will always be supplied: in particular a good water supply is of great importance (Schenk, 1969).

Growth cycle of the tulip in the Netherlands

Tulips are normally planted in October, sometimes in November. They start rooting, and low temperatures (9 °C or less) are needed to prepare stem elongation in spring. At least 6 weeks of 5 °C are needed to get a good elongation: at the beginning of January tulips may start this elongation process, if temperatures are high enough (Hartsema, 1961). As a rule tulips show leaf tips in March and open flowers in April-May. Immediately after opening the flowers are taken away. At flowering time leaves are fully developed. Growth of the new bulbs starts about this time.

From the middle to the end of June the leaves die off and the bulbs are harvested a fortnight later.

These bulbs are stored dry until they are replanted in autumn. All soil temperatures prevailing from planting (end of October) to harvesting (beginning of July) may influence bulb production. From the middle of March to the end of June light should also be considered.

In other places of Europe the above mentioned dates will shift, but the sequence of cultural practices and developmental fases remain the same. This means that the periods of storage, from planting till emergence and from emergence till harvest will differ from area to area.

Effects of temperature and radiation

Information on the quantitative influence of outside temperature and light conditions on growth and development of tulip plants and bulbs is fairly scarce. Kraayenga (1960) presented a statistical analysis of the influences of sunshine, cloudiness, air temperature and rainfall during certain periods (decades) of the year and some hints on the importance of temperature during May and the beginning of June.

Wassink (1965) reported about experiments in which tulips were grown at different levels of shading; plants in these experiments were harvested periodically.

Schenk (1969) surveyed the general possibilities of different geographical areas for flower bulb production.

Broertjes (unpublished, 1970) investigated the influence of soil moisture content on the onset of leaf senescence and bulb weight. These last results were specially suitable for the preparation of this paper because they gave interactions between bulb productivity and several amounts of radiations. To analyse the influence of climate on bulb growth in the Netherlands and adjacent parts of Europe, the above mentioned studies were used.

Kraayenga (1960) stated (Table 6, p. 21) that correlations between the growth of the main and the daughter bulbs with air temperature was rather high and much higher than the correlation with the soil temperature at —10 cm. The first correlation was positive and high till the beginning of May and negative and lower from May till the end of the season. Therefore in the present study the relations with air temperature only were used.

Accepting that in the Netherlands the capability to elongate the sprout is reached at the earliest on 1 January, and that these sprouts in an average reach the soil surface on 15 March a temperature sum for the elapsing period can be calculated. Because detailed information is missing about the minimum temperature for growth all temperatures above 0 °C are considered. This sum has been calculated from the average monthly air temperatures, because of the unavailability of the actual average daily air temperatures from all stations used (temperatures taken from Thran & Broekhuizen, 1965). On 15 March this sum in the Netherlands was 240 ° days. It was used to find the moment of the first possible reaction to radiation all over western Europe, supposing that the date on which elongation may start is 1 January everywhere in Europe. This will not hold true, however, because the saturation of cold requirement for elongation is reached later in more southern areas. The use of pre-cooled bulbs would make it possible to reach the potention for elongation on 1 January.

The time from sprouting till flowering is mainly determined by temperature (Kraayenga, 1960). On the average tulips are flowering in the Netherlands on 1 May. This represents a temperature sum of 360 ° days from the time of sprouting.

From the beginning of May correlations between air temperature and bulb growth are negative (Kraayenga, 1960), while temperatures must not be too high (Schenk, 1969). The results of Broertjes give the possibility to estimate that production of tulip bulbs is optimal when the temperature sum between flowering and leaf senescence is about 800 ° days. The temperature sum from 15 March till this moment of leaf senescence – the end of period of possible reaction to radiation – is 800 + 360 = 1160 ° days. This temperature sum is reached on 25 June as an average in Wageningen.

It was shown that more light during the period of green leaves gives a higher bulb crop (Wassink, 1965; Kraayenga, 1960; Schenk, 1969; Broertjes, unpublished). The result of Wassink and Broertjes were used to estimate the relation between global radiation (as registrated by the Department of Physics, Agricultural University, Wageningen) and bulb production expressed as percentage weight increase. Figures from Kraayenga (1960) showed, in confirmation, a similar relation.

The period for bulb growth, representing 1160 ° days, when the plants have green leaves, has to be divided into two parts. In the first and longest period plants have good, healthy and photosynthetically active leaves, while during a second, much shorter period leaves are yellowing and less active. To find the change-over from healthy to less active leaves, results were used of the experiments of Broertjes, who found that about 14 days before total senescence already ¼ - ½ of the leaf surface is yellow and brown. So it seems acceptable to conclude that the influence of light during the last 14 days of the 1160 ° days period is of less importance. Kraayenga (1960) concluded from several expriments that no bulb weight increases took place during the last 7-10 days of this period. Therefore the radiation available during the period representing a temperature sum of 940 ° days was considered full active in bulb production and only half active during the 220 ° days period.

Information about radiation received in Europe is scarce. Black (1956) gives monthly world maps of received radiation. From these data radiation sums were calculated for the above mentioned temperature sum periods. These calculated radiation sums made it possible to estimate bulb productions elswere in Europe as related to the production in the Netherlands.

Apart from the temperature sum, rapidity of temperature rise during the period of bulb growth is also important. Kraayenga (1960) mentioned the period from 10 May until 10 June of particular importance because bulb growth is then most rapidly. These dates represent 473 ° days and 919 ° days, respectively, from sprout emergence in the Netherlands. Because differences in the length of this period occur between the several places in Europe, this aspect should be considered in the evaluation of the productivity. If temperature rise is more rapid than in the Netherlands conditions for bulb growth are considered less favourable. The temperature rises were plotted against the duration of this critical period and the thus found swarm of points was divided into three regions by lines through the orgin. The following annotations were used: less favourable than the Netherlands (Valkenburg) —, about equally favourable ±, more favourable +.

However, the data compiled from literature did not allow to determine, or even estimate, of how much importance these annotations are.

Mapping the results

To plot maps of Europe which show the above discussed items, informations gathered by Thran & Broekhuizen (1965) were used. From the meteorological stations referred only those below +200 m altitude were chosen. For some areas averaged data of 2 or 3 stations were used to give the best impression of temperature conditions. Thus 70 places of information were used for all the above mentioned calculations. The results were represented in four maps.

1. Map of sprout emergence (earliness of spring)

Of all meteorological stations dates for reaching 240 ° days temperature sums starting 1 January were determined and plotted on a map (Fig. 1.) Tulip sprouts appear above the soil from before 30 January in Portugal and Cornwall to after

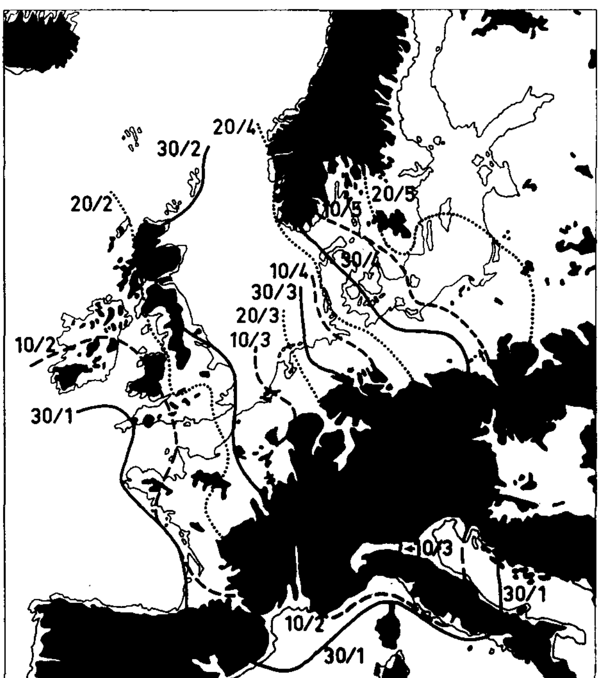

Fig. 1. Dates of tulip sprout emergence: earliness of spring. Dark areas: above 200 m altitude.

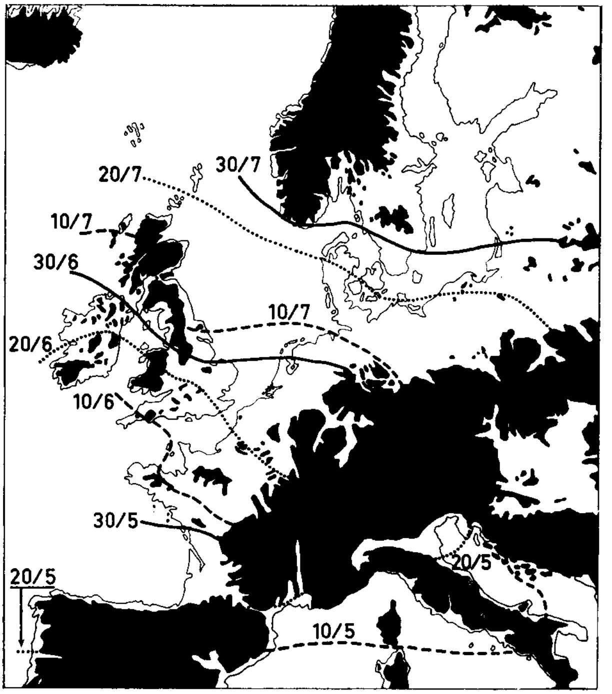

Fig. 2. Dates of leaf senescence: earliness of the bulb crop. Dark areas: above 200 m altitude.

20 May in Scandinavia – a difference of about 100 days. The calculated dates for the main bulb growing area of England (Lincolnshire) and the Netherlands (Valkenburg) are 25 February and 15 March, respectively.

2. Maps of leaf senescence (earliness of the bulb crop)

The temperature sums of 1160 ° days are plotted on a map represented in Fig. 2. Time of leaf senescence varies from before 20 May in Portugal, the south of France and Italy to after 30 July in Scandinavia. In Lincolnshire as well as in Holland this calculated date is 25 June. Combining the data of Fig. 1 and 2 shows that the duration of the growing season is 107 days in Portugal and 84 days in southern Scandinavia. However, in eastern England this period is 119 days, while in the western parts of the Netherlands the plants have leaves during 103 days.

3. Maps of production potentials

Knowing the dates of emergence and senescence total global radiation for this period was determined and related to bulb productivity (Fig. 3). Productivity of bulbs, which was expressed as weight increase as a percentage of the planted weight, has been found to vary between 40 and 122. Five different productivity areas were marked of: above 120; 120-100; 100-80; 80-60; under 60. The existing main tulip bulb producing areas are situated on the map in the areas with productivities between 120-100, which is in fair agreement with the productivity mentioned earlier for the Netherlands. Productivity here was calculated 102. In the small area with a potential production above 120 no tulip bulbs are grown. The further estimated distribution is:

Productivity area	Percentage of acreage
120-100	86
100- 80	12
80- 60	2

4. Map of relative aberrations

Aberrations due to a more rapid or slower rise of temperature are represented in map 4. In a large area, of roughly elliptic shape with a main axis NW-SE, aberrations are of no importance. This area comprises about 20 meteorological stations. Around the former ± area a + area is located, while only in the south of France, the eastern part of the Po valley and the east coast of Italy (about 10 stations) a — area is located indicating that actual productions will be lower than calculated. Borders of these areas, however, are arbitrary because the position of the lines through the origin can be chosen very subjectively. The position of these lines is chosen in such a way that stations which were situated in a certain area were getting the same annotation (+, ± or —).

Fig. 3. Tulip bulb production potentials. Dark areas: above 200 m altitude.

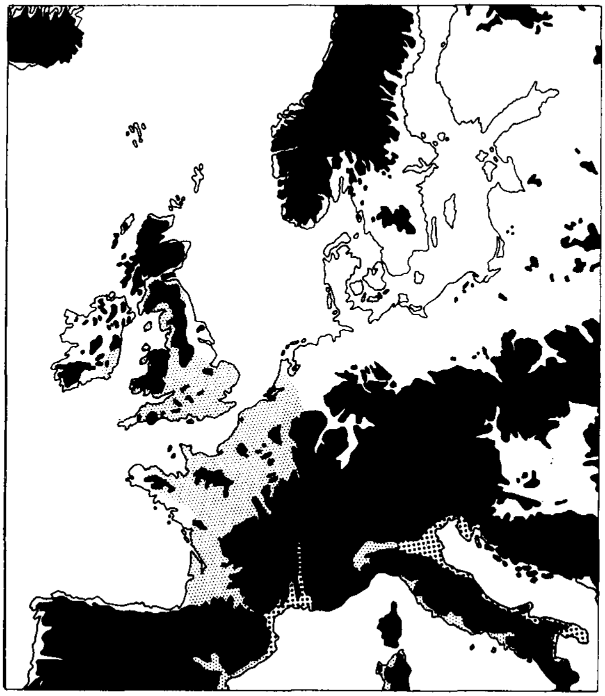

Fig. 4. Map of relative aberrations. Finely dotted areas : ±; coarsely dotted areas : — white areas : + (see text). Dark areas: above 200 m altitude.

Discussion

When comparing the four maps it is striking that Fig. 1 and 2 follow the progress of the season, whereas Fig. 3 shows high productivity in more or less elliptically shaped areas, because an optimum in the required temperature sum exists. The rapidity of temperature rise during summer depends mainly on the influence of the Ocean. It seems quite reasonable that the direction of the elliptical areas in Fig. 3, running SW - NE, may be caused by the dominating SW and W winds, which enlarge the oceanic influences. In the other hand the direction of the finely dotted area on Fig. 4, running SE - NW, could illustrate the decreasing influences of the Ocean.

Tulips can be grown for bulbs only and for both cut flowers and bulbs. In the latter case bulb productivity may be of less importance, and therefore it is understandable that part of tulip growing area given in Table 1 is outside the best productivity areas. The very soft winters in south-west England, for instance, make a very early, profitable cut flower crop attractive.

Another reason for accepting a lower production may be a political one. In eastern Europe (East Germany, Esthonia and Lithuania) production may be stimulated for political reasons.

A third reason to accept a lower productivity may be the production of bulbs suitable for very early flowering: in the main producing areas bulbs are harvested not earlier than the end of June, which puts a limit to the earliest possible flowering.

In most cases prices of cut flowers are higher early in any season – and this holds true for tulip – and therefore tulip forcers are willing to pay (much) higher prices for their bulbs, meaning that a lower productivity can be accepted. This is the reason why tulip bulbs are produced in France (and even in Italy and Portugal).

It is remarkable, however, that the tulip producing areas are not scattered evenly over the area indicated as highly productive. They are more or less concentrated in eastern England and the western part of the Netherlands. This indicates that other factors than the considered growing requirements are decisive in the tulip crop geography. Suggested are: a good water supply, soils, control of pests and diseases, craftmanship and marketing facilities.

References

Anonymous, 1969. Tulpenareaal in Rusland. *Weekbl. Bloembollencultuur* 79: 862.

Black, J. N., 1956. The distribution of solar radiation over the earth's surface. *Arch. Met. Geophys. Bioklim.* 7: 177-189.

Dix, J. F. Ch., 1974. De veredeling van tulpen. In: De veredeling van tulpen, hyacinten, narcissen en irissen, Hillegom, Centraal Bloembollen Comitee, Haarlem: 3-16.

Hartsema, A. M. G., 1961. Influence of temperature on flower formation and flowering of bulbous and tuberous plants. *Encycl. Pl. Physiol.* 16: 123-167. Springer, Berlin.

Kraayenga, D. A., 1960. Growth measurements on the tulip bulb. *Meded. LandbHogesch.* 60 (8): 9-21.

Rassenlijst van tulpen, 1972. Instituut Veredeling Tuinbouwgewassen, Wageningen.

Rees, A. R., 1972. The growth of bulbs. Academic Press, London.

Schenk, P. K., 1969. Geschiktheid van de verschillende geografische gebieden voor de bloembollencultuur. *Weekbl. Bloembollencultuur* 79: 1191-1193; 1204-1205.

Thran, P. & S. Broekhuizen, 1965. Agroclimatic atlas of Europe. Pudoc, Wageningen.

Tuinbouwcijfers, 1975. Landbouweconomisch Instituut, Den Haag.

Vroomen, C. O. N. de, 1973. De positie van de Nederlandse bloembollenteelt in de vergrote EEG. *Bedrijfsontwikkeling* 4: 1039-1042.

Wassink, E. C., 1965. Light intensity effects in growth and development of tulips in comparison with those in *Gladiolus. Meded. LandbHogesch.* 65 (15).