

# GLADIOLUS AS CUTFLOWER IN SUBTROPICAL AND TROPICAL REGIONS



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# **GLADIOLUS AS CUTFLOWER IN SUBTROPICAL AND TROPICAL REGIONS**

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## Preface

The purpose of this book is to provide flower growers with the latest and most detailed information on the flower cultivation of gladioli.

Interest in the cultivation of gladiolus flowers in greenhouses or in the open is growing, particularly in the countries situated in subtropical and tropical regions. Therefore, the information in this book goes more deeply into the specific cultivation conditions and diseases in these regions.

To clarify the main items in this book, a number of illustrations have been added to the text.

We hope that 'Gladiolus as cutflower in subtropical and tropical regions', the result of scientific research and field experience in the Netherlands and other countries, will be a good guide for the many flower growers. May they produce first-rate gladiolus flowers from excellent Dutch corms.

Thanks are due to Mr. N.A. Groen and Mr. P.J. Muller (staff members of the Laboratory for Flowerbulb Research in Lisse) for their contribution to the section of this book dealing with the technique of growing, and to Mr. H.Y. Alkema for the instructive drawings in this book.

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# Chapter I. General

## Introduction

More than 2000 years ago, the Greeks and Romans used gladioli already to brighten up important events. Also today, gladiolus is still quite popular in the Mediterranean region, where it is even the most important cutflower.

The wild species of the genus *Gladiolus*, belonging to the Iridaceae family, are chiefly found in South and Central Africa and around the Mediterranean. Many of the species do not look like the gladioli we now use as cutflowers at all. Many years of hybridization and selection have replaced the old wild species by new varieties forming today's assortment. Varieties which as far as form of flower, colour, flowering time and resistance to disease are

concerned, are an improvement of the old assortment.

Fortunately, the production of new varieties has by no means come to an end yet.

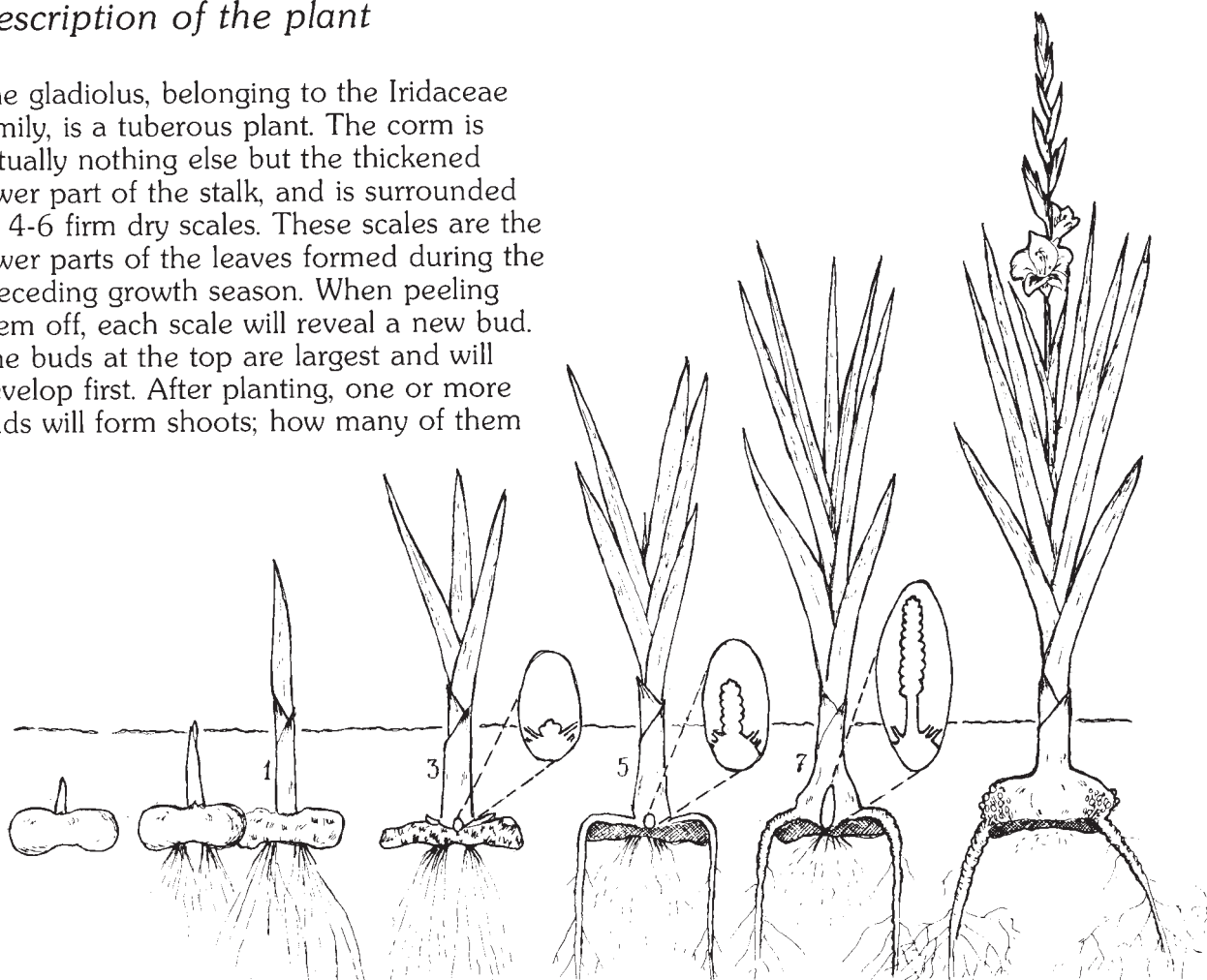
Again and again, new and hopefully better varieties are brought out. This, of course, calls for a continuous adaptation in the technique of the cultivation of gladiolus flowers and in the control of various diseases.

Research in the Netherlands and in several other countries, and a large group of inventive growers see to this adaptation. By means of this cultivation description, we wish to provide you, growers of gladiolus flowers, with information on this matter.

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## *Description of the plant*

The gladiolus, belonging to the Iridaceae family, is a tuberous plant. The corm is actually nothing else but the thickened lower part of the stalk, and is surrounded by 4-6 firm dry scales. These scales are the lower parts of the leaves formed during the preceding growth season. When peeling them off, each scale will reveal a new bud. The buds at the top are largest and will develop first. After planting, one or more buds will form shoots; how many of them



will form shoots is chiefly dependent on cultivar and corm size. After the corms have been planted, 6 to 7 foliage leaves will develop successively.

When the third leaf appears, bud initiation is in full progress. On the old corm, a new corm will be formed, which will develop a number of contractile roots, assuming the

function of the old corm roots. The period in which this happens is a critical period presenting an increased chance of flower desiccation and arrest of growth. Then the flower develops. Not every plant will form a flower, however. This depends on corm size, light intensity and planting density.

## *Economic value*

Gladiolus is very popular as a cutflower, both with the consumer and the florist. There are many forms, colours and colour combinations. Therefore, they can be used to advantage in every floral arrangement. Gladioli picked at the correct stage will keep for a long time. The correct picking

stage is reached when the colour of the bottom flower is just visible. At this stage, the flower can be properly processed and transported. A disadvantage of gladioli is their heavy weight which makes transportation over long distances rather expensive.

## Chapter II. Cultivation directions

### Soil treatment

#### Soil

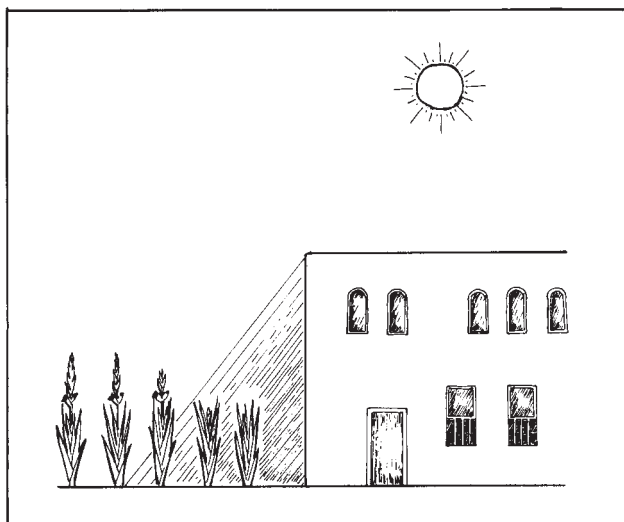
All types of soil are suitable for growing gladiolus flowers, provided that the structure and drainage of the soil are good. A good structure implies a good air and water balance in the soil. A poorer structure, therefore, will impair the flowering percentage and the quality of the gladioli so that correct tillage adapted to the type of soil is always necessary.

When growing on heavier soils, it may be advantageous to work organic matter

through the soil already in the preceding season. Growing on raised beds or on ridges is also recommended in such cases. On lighter soils sensitive to slaking it is desirable to cover the soil with a mulch of peat, straw or other material after planting. This is done to prevent the soil from panning.

Especially during light-deficient periods, moreover, the soils must not be shaded by surrounding objects to avoid flower desiccation as a result of reduced light conditions.

As a rule, it is advisable to have your soils for the different cultures tested yearly. This will give you a reliable impression of the nutrient condition, the salt content and the pH of the soil.



## pH

A pH of the soil between values 6 and 7 is recommended for the cultivation of gladiolus flowers. A pH lower than 5 (a greater chance of fluorine damage) will have to be raised by liming the soil. In that case, see to it that the material is properly mixed with the soil, and that the lime is applied in time, i.e. at least one month before planting. Therefore, have your soil tested on pH well in advance, so that measures can be taken in time.

If the pH is higher than 7.5, this may cause deficiency symptoms in the gladiolus plants. These deficiency symptoms can in many cases be prevented by timely applying a heavy organic dressing.

A well-known deficiency symptom in gladioli is iron deficiency. This can also be controlled by means of an iron-chelate dressing before planting. It is also possible to spray the crop with iron-chelate (5 g of 138 Fe per m<sup>2</sup>). Sprinkle immediately afterwards to avoid black edges and leaf scorch.

## Salt sensitivity

Gladiolus is a plant sensitive to salt. High salt contents, therefore, have a retarding influence on root growth and blooming of the crop.

The chlorine content of the soil must be less than 3 milli-equivalents Cl per litre (extract 1 : 2). At higher chlorine contents, the damage caused thereby can be reduced by ample watering. The total salt content must not be higher than 2 millisiemens per cm. The total salt content is made up by nutritive and other salts. If too much saline organic manure or fertilizer is used, this limit will soon be reached.

Therefore, take a soil sample at least 6 weeks before planting so that sufficient time is left to flood the soil, if necessary.

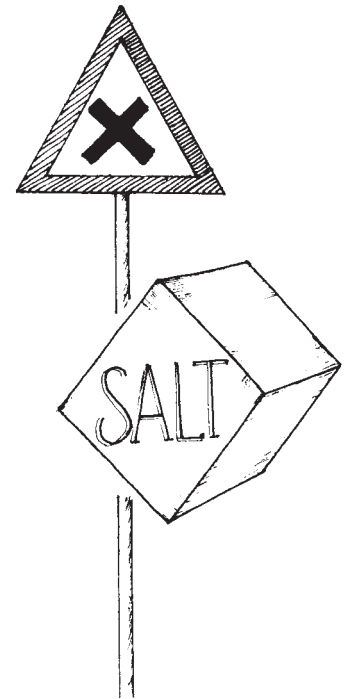
When sprinkling in greenhouses, the chlorine content of the water must preferably not be more than 200 mg per litre, and when sprinkling outdoors not be more than 600 mg per litre.

If water exceeding these norms is used for sprinkling after all, the soil should be kept permanently moist in order to avoid an increased salt concentration occurring when the soil dries out.

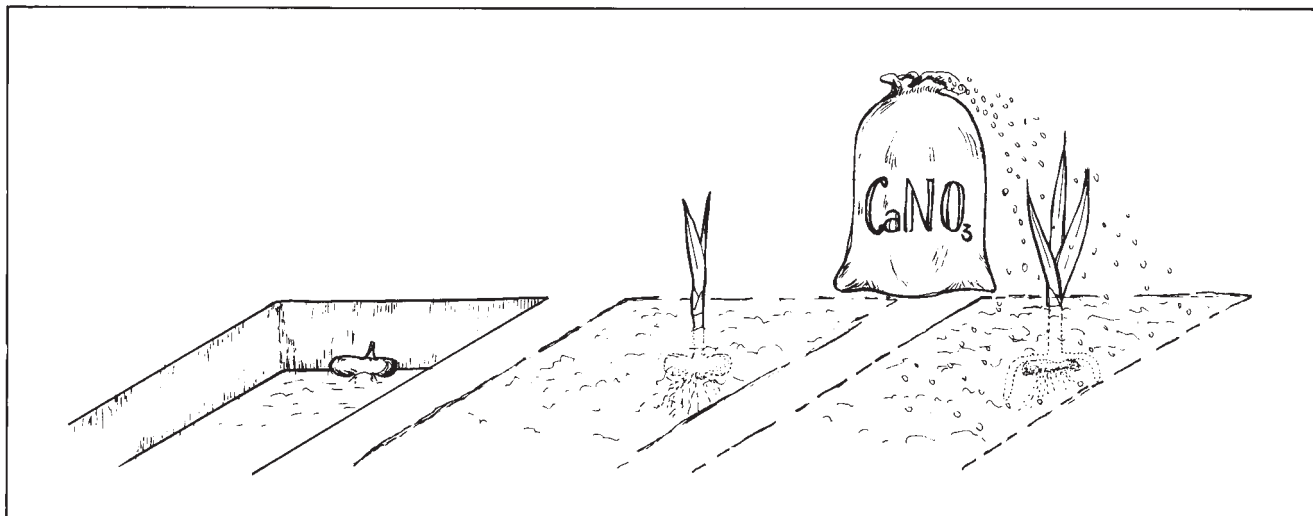
## Fertilizing

It is hardly possible to state exactly what fertilizer gladioli require, as this depends on a number of factors, such as e.g. type of soil, precipitation, fertilizing condition and salt content of the soil.

To improve the structure of the soil, it may advisable to mix an organic fertilizer through the topsoil a considerable time before planting.







The use of fresh farmyard manure is definitely not recommended, however, because of the chance of an unfavorable influence on the growth as a result of decomposition processes.

On heavier and more humic soils, farmyard manure will often have an adverse effect on the structure owing to its cementing action.

On these soils, materials such as garden peat are preferred. Because a gladiolus corm contains sufficient food for a good growth during the first few weeks, and because the roots of newly planted corms are quite sensitive to high salt concentrations, a fertilizer dressing can best be postponed until some weeks after planting. An exception are soils poor in nutrients, where phosphate and potassium may be scattered in the form of straight fertilizers before planting, or where a compound fertilizer in an NPK formulation of 2:2:3 can be used. Since gladioli are damaged by fluorine, no phosphate fertilizers containing fluorine, such as triphosphate, must be used.

Phosphate fertilizers poor in fluorine, therefore, are to be preferred.

When the third or fourth gladiolus leaf is visible, a nitrogen dressing is to be applied, both to soils poor and rich in nutrients. For this purpose, 2-3 kg of prilled calcium nitrate per 100 m<sup>2</sup> can be used. When during the further cultivation a light yellowing of the crop occurs as a result of nitrogen deficiency, it is recommended to apply a topdressing of 1 kg of prilled calcium nitrate per 100 m<sup>2</sup>. This dressing can be applied until two weeks before flowering.

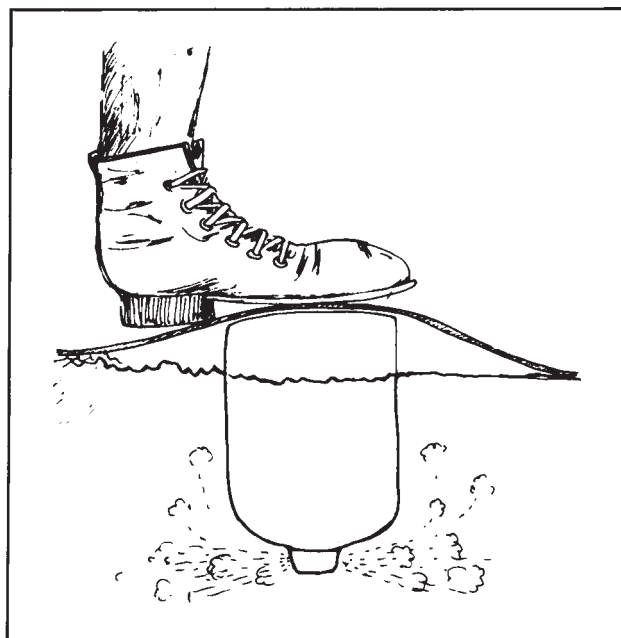
Nitrogen fertilizers can be administered through the sprinkler system or can be

scattered among a dry crop. To avoid leaf scorch and insufficient washing into the soil it is recommended to sprinkle with clean water after applying the fertilizer.

The above shows that a gladiolus crop demands no heavy fertilizing, and that a heavy fertilizer dressing is even inadvisable because of excessive salt concentrations and the occurrence of diseases.

### *Soil disinfection*

Gladiolus corms should be planted in a fresh soil. Soils used in previous years for the cultivation of gladioli or plants related to gladiolus (iris, ixia, freesia and





montbretia) must be disinfected before use. Another possibility is to apply an ample crop rotation of at least 6 years. For disinfecting the soil, different soil disinfectants or steam-sterilizing may be

selected.

In the following table you will find the different possibilities for disinfecting the soil, and their controlling effect on Fusarium, dry rot, eelworms and soil insects.

Agent/method	Control of		Application		
	Fusarium	Dry rot	Eel-worms	Soil insects	Soil temp. (°C) from Waiting time
Steam-sterilizing	good	good	good	good	dry soil from 10°C 2-3 days
Methylbromide + plastic	good	good	good	good	10°C 2-3 weeks
Dichloropropane + methylisothiocyanate (Di-Trapex) + plastic	good	good	good	good	10-15°C 4-5 weeks
Metam-sodium (e.g. Vapam, AAmomam) + plastic	moderate	moderate	good	good	10-15°C 3-4 weeks
Metam-sodium (e.g. Vapam, AAmomam) without plastic	not	not	moderate	moderate	10-15°C 3-4 weeks
Dichloropropene DD (e.g. Shell DD) without plastic	not	not	good	moderate	10-15°C 4-5 weeks

Application and necessary concentrations of the different methods and agents:

1. Steam-sterilizing  
For 1 hour at 70°C to a depth of 30 cm.
2. Methylbromide  
10 kg per 100 m<sup>2</sup>.  
Leave the plastic in place for at least one week. A longer period will produce a better effect.  
Because of the high toxicity of this agent, it should be used with extreme caution.  
Causes which may impair the control results are:
  - plastic is blown up by wind
  - too large clods in the soil
  - compacted layers in the soil.
3. Di-Trapex  
7.5 litres per 100 m<sup>2</sup>  
Cover the soil with plastic immediately after injecting, and leave this plastic in place for at least 14 days.

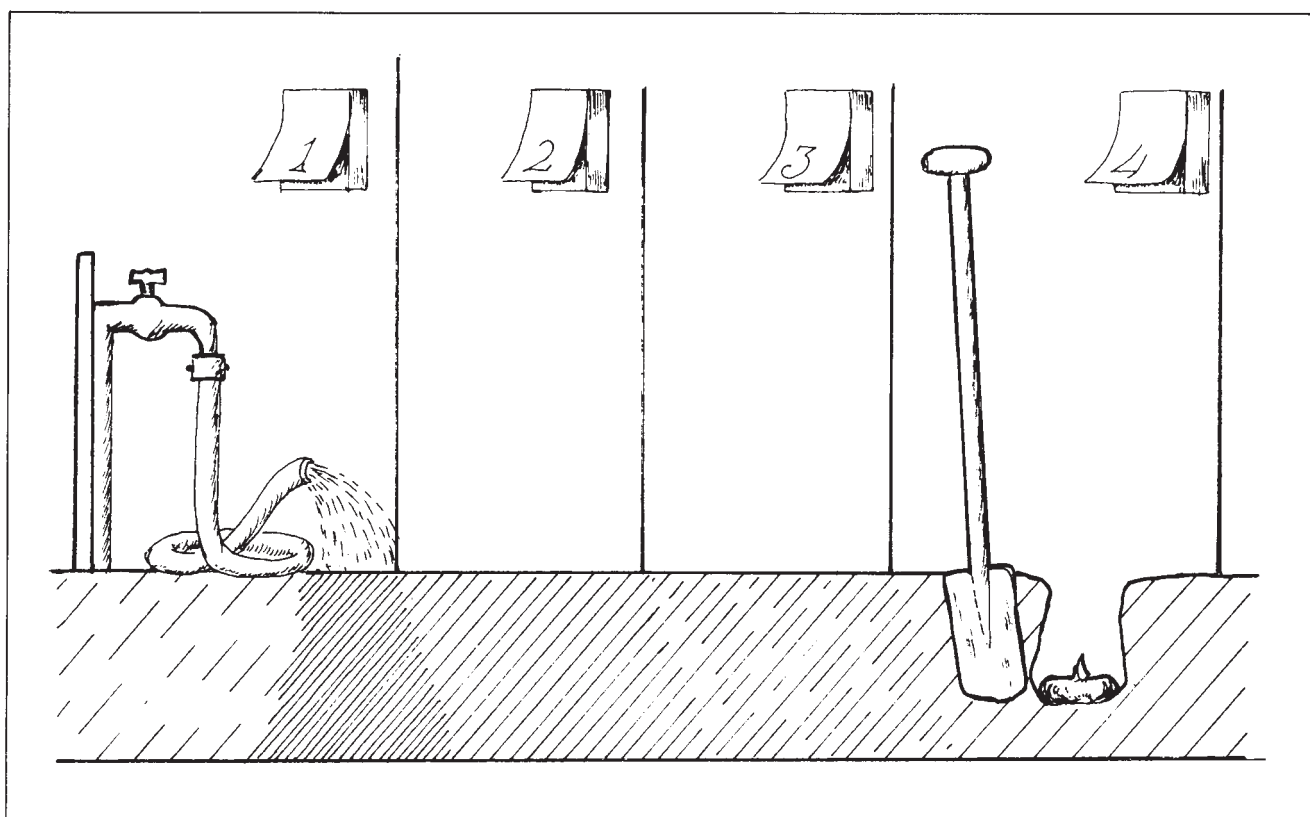
4. Metam-sodium  
10 litres of concentrated metam-sodium per 100 m<sup>2</sup>.  
Cover the soil with plastic immediately after injecting, and leave this plastic in place for at least 2 weeks.  
Without plastic, no good control of Fusarium and dry rot is possible.
5. DD without plastic  
2.8 litres per 100 m<sup>2</sup> when using Shell DD 95, Telone and Vidden D extra.  
4.2 litres per 100 m<sup>2</sup> when using Shell DD, Vidden D and other brands.

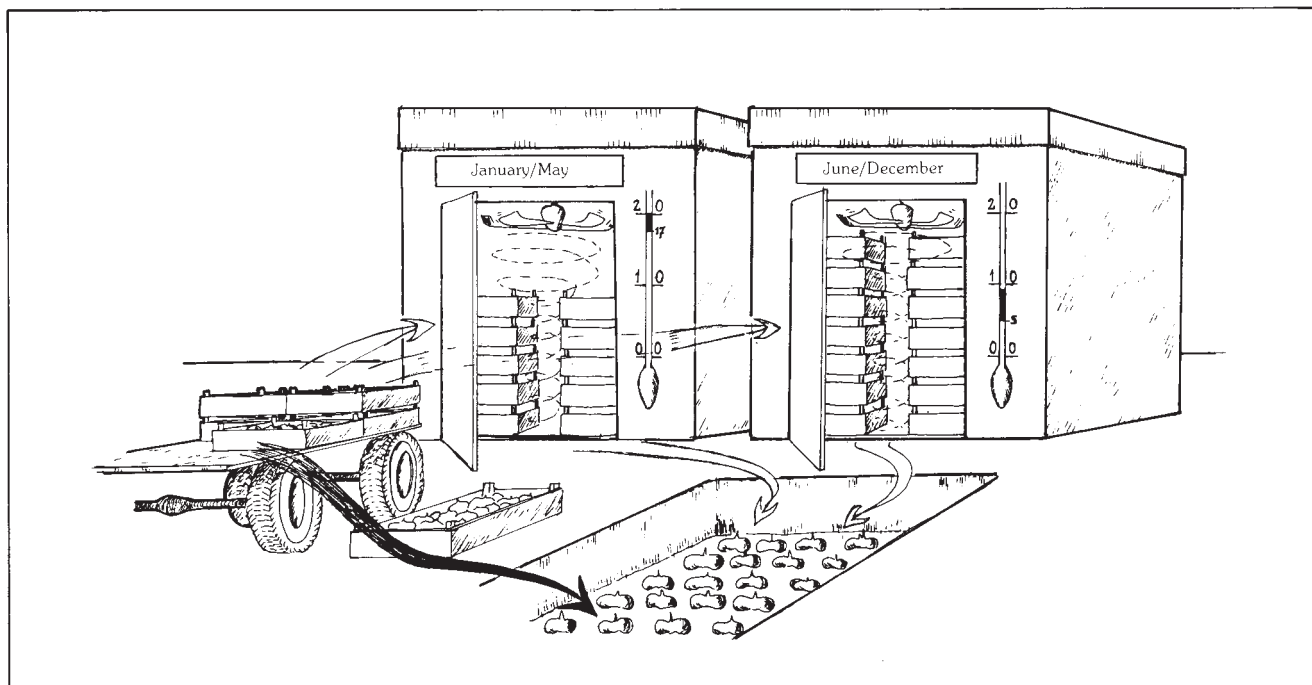
Before starting the different treatments, see to it that neighbouring crops, as well as houses, cannot be reached by vapours. In view of the risk of root rot, no nitrogen shall be applied within three or four weeks after using a fungicide.

### *Watering before planting*

Moisten the soil already a few days before planting the gladiolus corms so that the corms can be planted in a sufficiently moist but not too wet soil. Watering during the first and second week after planting can then be reduced to a minimum or even omitted.

The soil retains its structure so that rooting of the corms planted can proceed undisturbedly.





## Planting

### *Corm treatment on arrival*

Gladiolus corms should be unpacked immediately after arrival at the nursery. This is done to avoid fungus formation and the development of sprouts and roots as a result of the rising temperature and humidity in the packaging material. This will greatly restrict damage to sprouts and roots during handling and planting of the corms. Also the quality of the flowers will be improved. Plant the corms as soon as possible after unpacking. If this is not possible at all, store the corms in a well-ventilated place and as dry as possible for

a short period at the following temperatures:

For storage in the period January through May 17-20°C

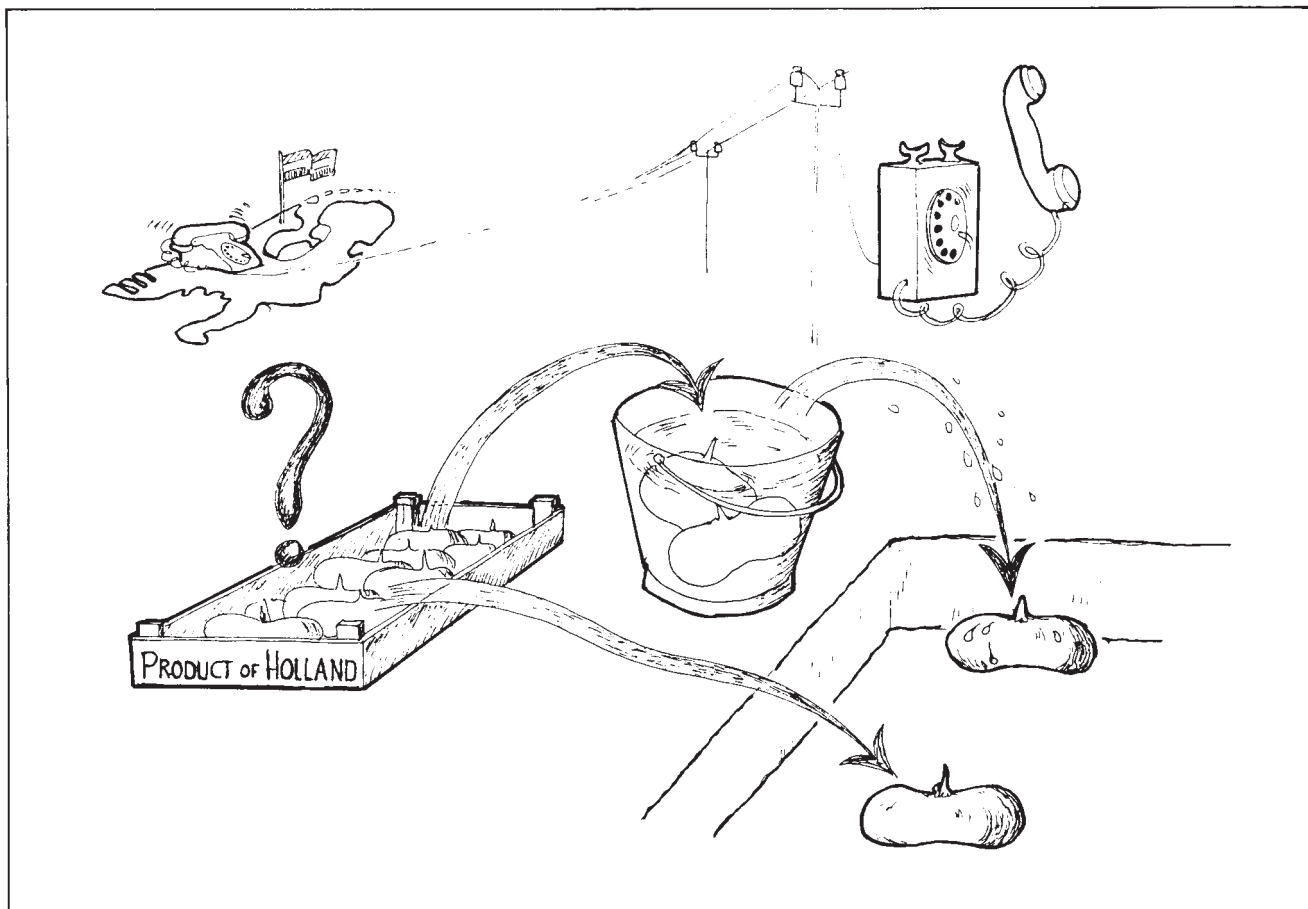
For storage in the period June through December 5-9°C up to max. 17°C.

Corms to be stored for longer periods should preferably be delivered to your nursery before the end of January.

Thereupon, the corms should dry properly at sufficient ventilation for a week, after which they can be stored in a cold room with a good air circulation at 5°C.

To keep the risk of rejects after planting as small as possible, the bulbs should be disinfected just before planting.

It may be possible, however, that your supplier has already carried out this disinfection, so that it can be omitted at



your nursery. Therefore, always consult your supplier on this matter.

Should you have to disinfect the corms yourself, however, this should be done as precisely and carefully as possible.

This disinfection consists of submerging the corms for 1 to 15 minutes in a bath of water to which the following disinfectants have been added:

prochloraz (0.4% Sportak\* 450 g per litre) + captafol (e.g. 1% Ortho-Difolatan 4F, 480 g per litre) + procymidon (e.g. 0.2% Sumisclex 500 g per kg).

If prochloraz is not available, you should disinfect the corms only in captafol (e.g. 2% Ortho-Difolatan 4F, 480 g per litre) + procymidon (e.g. 0.2% Sumisclex, 500 g per kg).

\* Indicating behind the brand names is the part of the agents consisting of active matter.

If agents of a different composition are used, more or less agent should be used dependent on difference in composition.

As the agents used may precipitate on the bottom of the bath, the solution should regularly be stirred thoroughly.

To clarify the above: 0.4% Sportak means use 400 g of Sportak per 100 litres of water, 0.2% = 200 g per 100 litres of water and 1% = 1000 g per 100 litres of water.

## Place of cultivation

Gladiolus flowers can be grown direct in the soil of glass or plastic greenhouses, as well as outdoors. A combination of outdoor planting and plastic greenhouse is also possible.

When choosing the best place for planting the corms, the planting time and the anticipated climatic conditions during the period of cultivation should be taken into consideration.

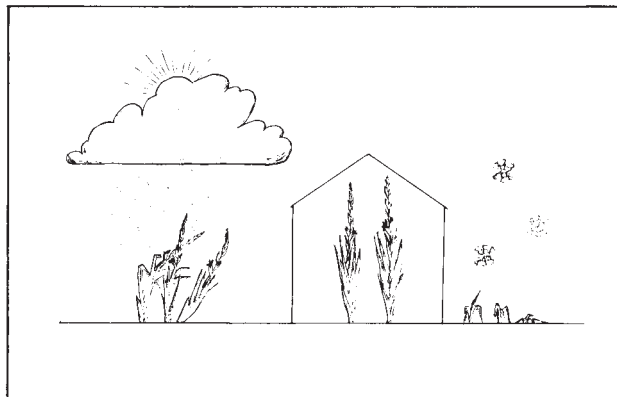
Of course, also the cultivation directions as described in the section 'Soil treatment' should be followed.

It may be observed that greenhouse planting as compared with outdoor planting has the advantage of being less dependent on unfavourable weather influences. Thus the gladiolus crop will be affected less by any night frost that may occur. Such low temperatures below freezing point may destroy the gladiolus crop.

Disadvantages of greenhouse planting as compared with outdoor planting are that the soil and crop temperatures may run high during the summer months, and an earlier occurring light-deficiency during the winter months.

## Planting time

Dependent on planting time, the gladiolus crop will receive a certain amount of light per plant. Especially during the winter months, this amount of light may be insufficient, despite the lower cultivation temperature and even despite a lower planting density. The result may be flower

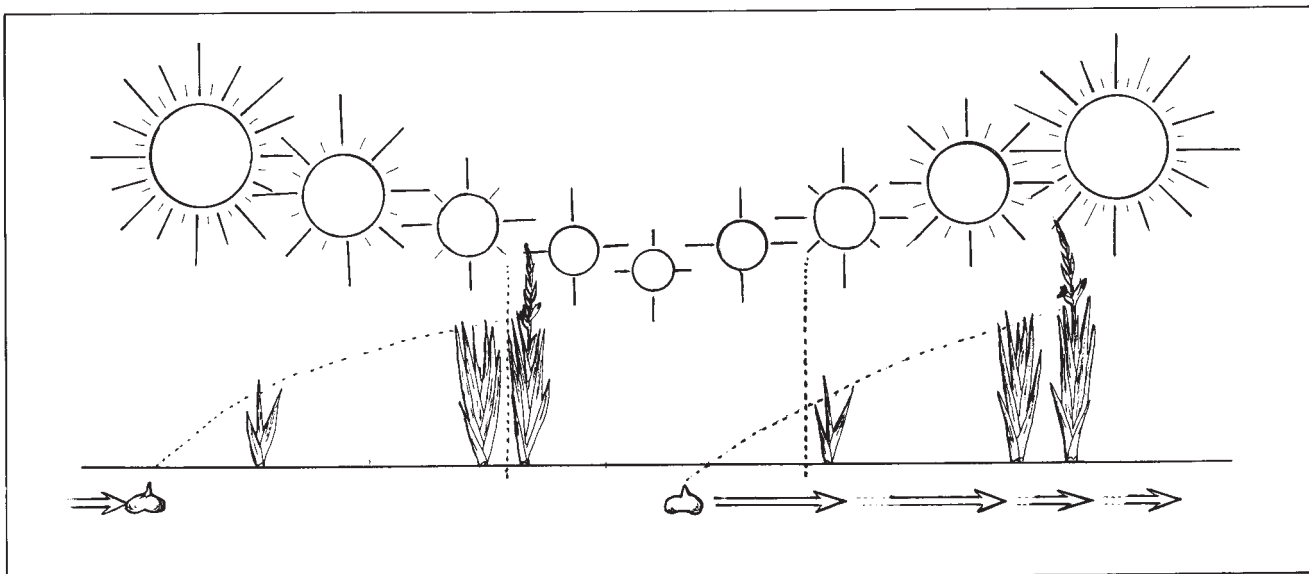


desiccation but also too short spikes and a limp crop.

By adapting the planting time to the light conditions during the cultivation period from the third leaf, flower desiccation can be avoided or restricted to an acceptable percentage.

The following points may also be useful in this respect:

- use cultivars which are less light-sensitive during the more light-deficient periods.
- in these periods, also use larger corm sizes (12-14 and 14-16). These have more reserve food and, therefore, will flower somewhat better. Any side shoots should be removed then.
- apply a low planting density so that more light will be available per plant.
- do not plant gladioli in the vicinity of shading objects.
- use no greenhouses with dirty or old glass or plastic, transmitting less light.
- see to a good root system.



## Planting method

Corms can be planted in two ways, viz:

- on beds
- on ridges.

If the crop is watered by means of irrigation, planting in beds is definitely not recommended. Soil panning would occur, which greatly impairs the soil structure. As a result, the flower quality and flowering percentage will decline too.

In this case, the corms should be planted on ridges.

If the crop is sprinkled, however, it is possible to plant on beds and on ridges.

The system of planting on ridges is illustrated by the following diagram.

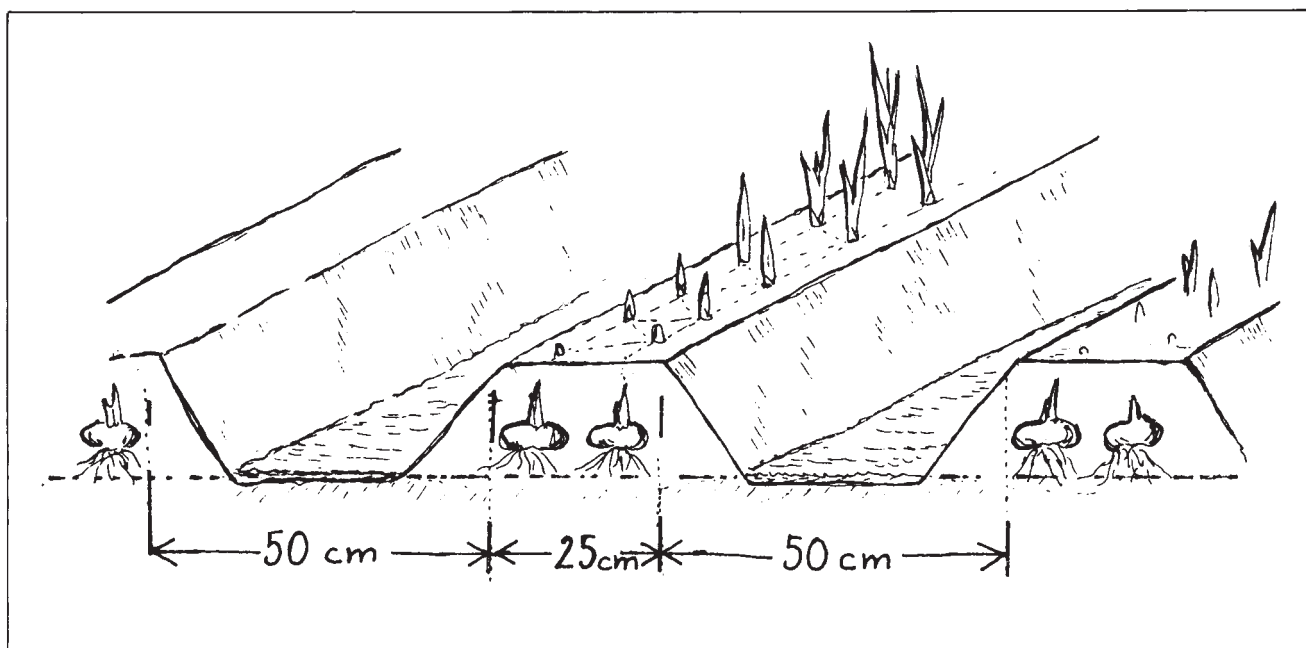
In case of ridge culture, some of the plants will sometimes topple if there is not enough soil on the shoulders of the ridge or if the corms were not planted deep enough.

Toppling may be avoided by building wide and flat-topped ridges, having sufficient soil between the corms and the shoulders of the ridge.

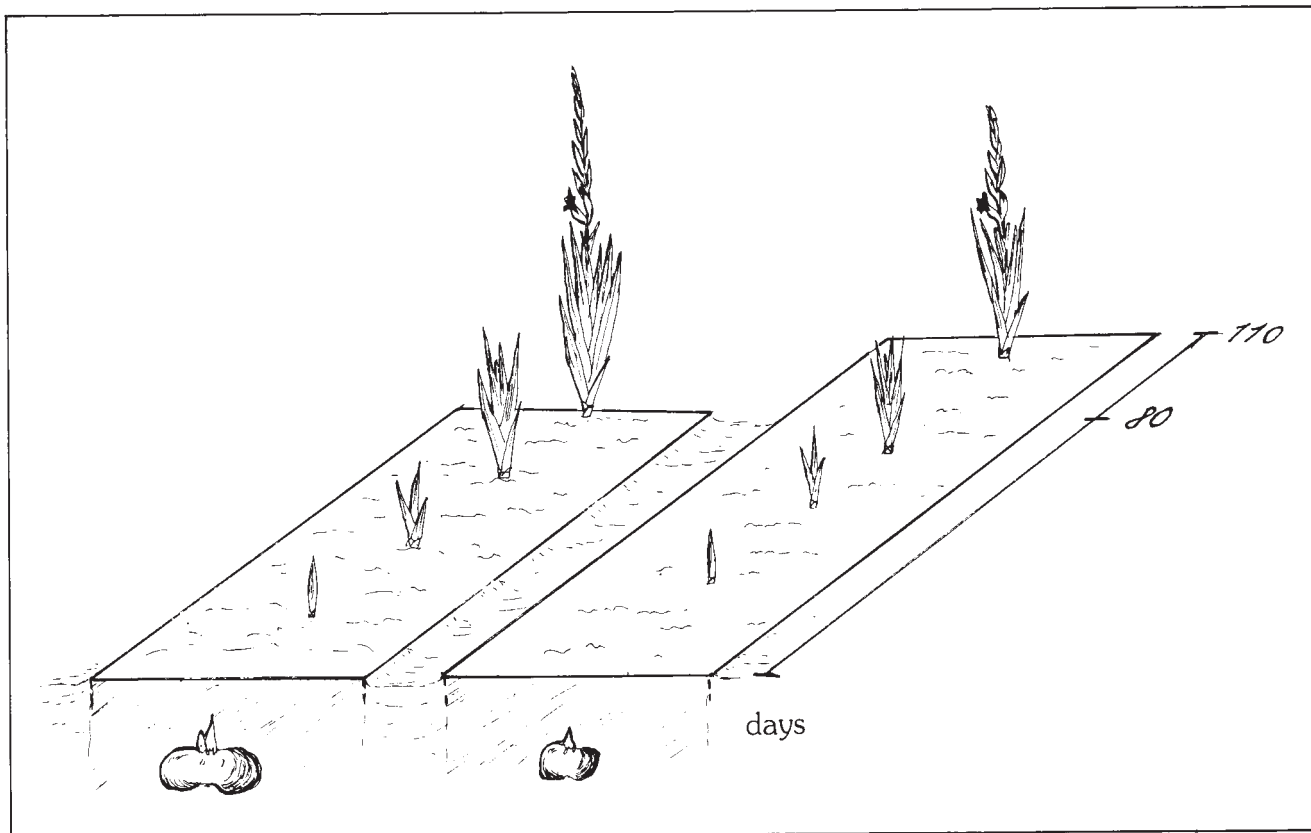
When planting on beds, chrysanthemum netting can be used during planting to determine the distance between corms.

During the growth of the crop, the same netting may serve to support the plants.

When planting mechanically, the planting density should be watched closely.



Cross section



### *Corm size*

When selecting the corm size, the planting time and the anticipated climatic conditions in the place of cultivation during the subsequent cultivation period should be taken into account.

As far as the climatic conditions are concerned, such as light, temperature and wind, especially the light plays an important part in the choice of corm size.

Moreover, the corm size should be adapted to the required quality of the end product. A number of points may be helpful in making your choice:

- a larger corm size, as compared with a smaller corm size, will produce taller and firmer plants, a heavier spike, more uniform flowering and a shorter cultivation period.
- under light-deficient conditions, the larger corm sizes will generally give a better flowering percentage, because of their greater growing power.
- large corm sizes (12 cm and upwards) will often produce several, although smaller spikes. If this is undesirable, the side shoots should be removed at an early stage.

### *Planting density*

The correct planting density for the different corm sizes depends on the planting date and the properties of the cultivar concerned.

The planting density is very important as it is largely decisive for the firmness of the plants and the flower quality. If the number of corms per m<sup>2</sup> is too large, for example, the crop will often be long and limp. Too short spikes or even flower desiccation may

occur as a result of light-deficiency.

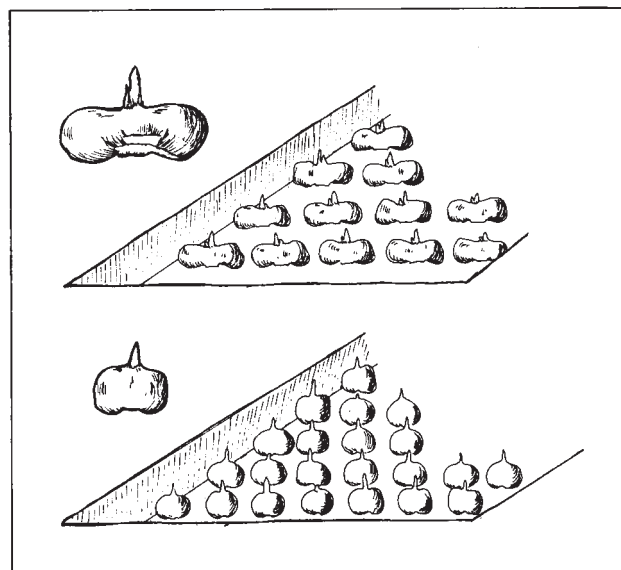
As to the influence of the cultivar properties on the planting density, the growth rate and the crop development of every cultivar should be taken into consideration. Thus in early spring, the rapidly growing cultivars *Hunting Song* and *Nova Lux*, for example, will reach the critical point, at which flower desiccation may occur, earlier. If at that moment the



amount of light is still too small or the planting density is too high, flower desiccation will take place.

The following table indicates the margins per corm size between which the planting density can be chosen. The choice, therefore, will depend on the planting time, the cultivar and the desired quality.

Corm size, cm	Number of corms per gross m <sup>2</sup>
6 - 8	60 - 80
8 - 10	50 - 70
10 - 12	50 - 70
12 - 14	30 - 60
14 and upwards	30 - 60



### Planting depth

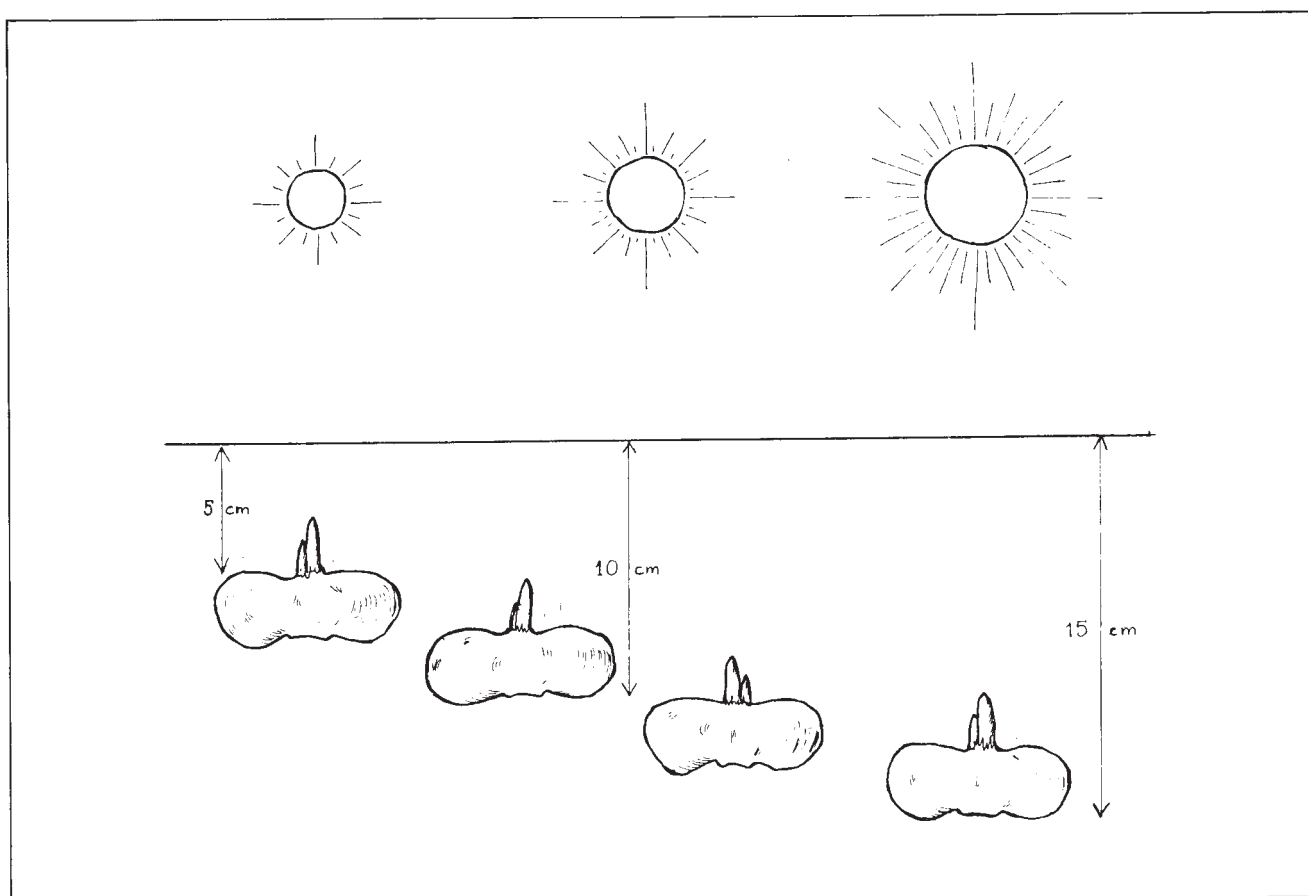
The planting depth of the corms depends on type of soil and planting time.

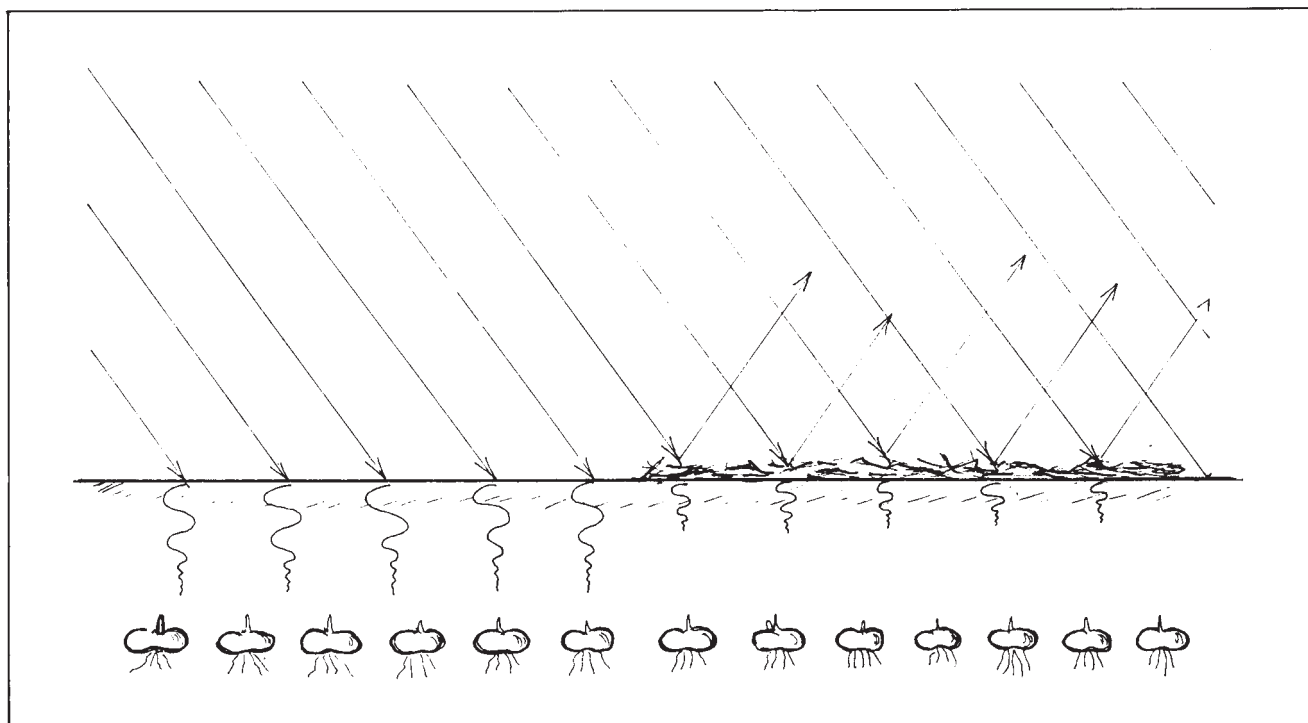
As a rule, the planting depth will be slightly shallower on heavy soils than on lighter soils.

With regard to the planting time, the following planting depths (cm of soil on the corm) can be adopted:

spring planting      5 - 10 cm  
summer planting    10 - 15 cm.

Planting the corms more deeply in the summer is done because it is desirable to plant the corms at as low a soil temperature as possible, in view of any disease problems. Flowering, however, will be a few days later then. Furthermore, it is to be observed that shallow planting, particularly in sandy soils, will encourage toppling of the gladiolus plants. Deeper planting, using supporting wire (e.g. chrysanthemum netting) and placing windbreaks can protect the plants against it.





### *Mulching*

Although mulching is hardly used yet in the cultivation of gladiolus flowers, it nevertheless has some positive effects.

By applying a mulch consisting of straw, pine needles, etc., the soil temperature can be kept at a lower level. This will especially hold for spring and summer planting. At falling temperatures, such a mulch will keep the soil temperature higher.

In periods when night frost may occur, the use of a heavy mulch will enhance the risk of frost damage to the crop.

A mulch does have a highly positive effect on the maintenance of the soil structure. It prevents the topsoil from panning caused by rain and sprinkling. It will improve rooting and, consequently, the quality and percentage of flowers.

A mulch, moreover, will reduce drying out of the topsoil.

Especially during the first period of growth, planted gladiolus corms may then dispose of more moisture.

## Cultivation conditions

### Light

From the reserves of the planted corm, but especially through the assimilation process during the cultivation period, the gladiolus can dispose of a certain amount of nutrients.

Substances necessary for a good growth and flowering of the gladiolus.

Non-optimum growth conditions during the cultivation will cause a deficiency of assimilation products (the produced nutrients). If this happens in the period when the gladiolus develops its flower, it will in particular affect the flower.

The period of flower initiation starts at the moment the 3rd leaf becomes visible and ends approximately when the 6th and 7th leaf appears.

From the appearance of the third leaf until the time of flowering, the light will have to be as optimum as possible. Especially in the winter months, but also during the whole year, light-deficiency may occur as a result of e.g. high planting density and too dark a place of cultivation.

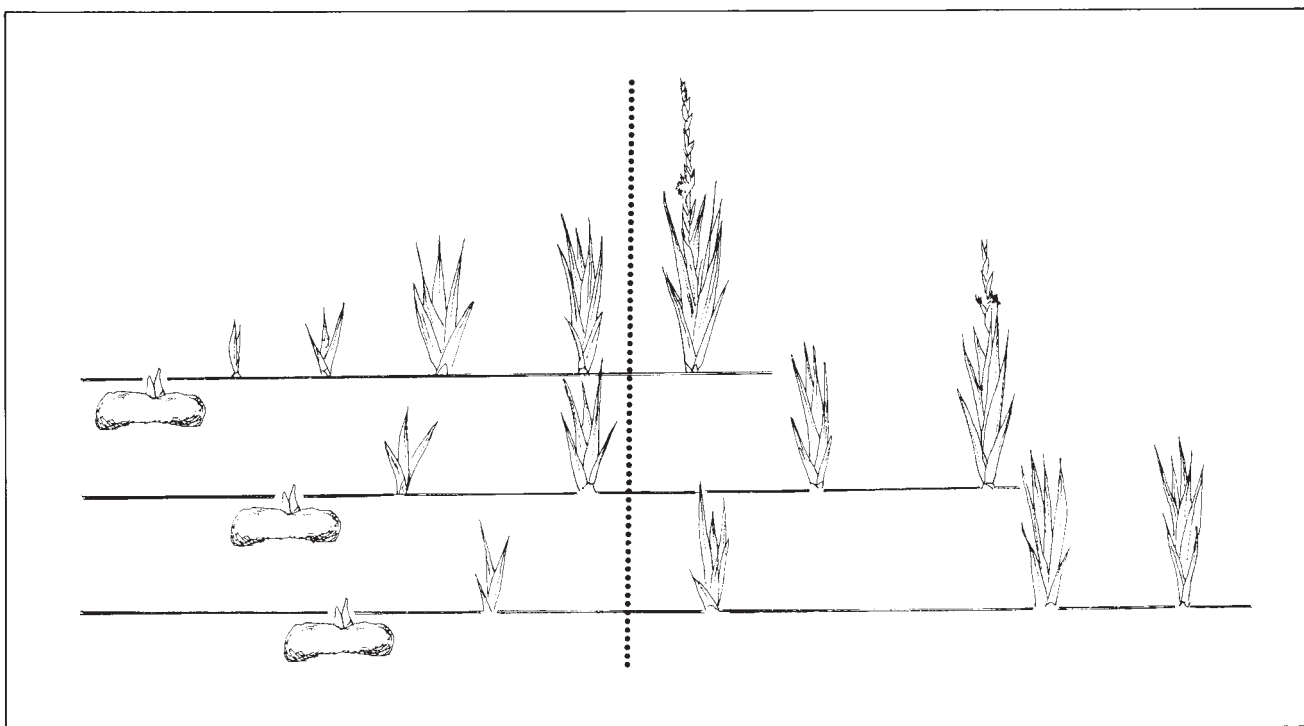
If this light-deficiency takes place during the first phase of the critical period, the spike will fully desiccate and 'flower blindness' occurs. If this deficiency should be later, however, when the 5th, 6th and 7th leaf appears, only the individual flower-

buds will desiccate. The spike will develop then, but will have a smaller number of flower-buds.

The gladiolus experiences a light-deficiency if the total amount of light during the above-mentioned critical period stays under 1000 joules per m<sup>2</sup> per day for a number of days. This situation will especially present itself in the winter months, but depends strongly on the location of the nursery (cultivation place) in respect of the equator. The farther removed from the equator, the sooner and also the longer the period will be in which the cultivation of gladiolus flowers will present light-deficiency problems. Besides the location in respect of the equator, the amount of available light will also be dependent on the local climate (clouds) and the selection of the place of cultivation, i.e. outdoors or in the greenhouse.

If the light conditions are critical, so that flower desiccation just may or may not occur, other measures will also play a part. Especially the moisture supply is very important then.

The root system must be in a good condition so that the absorption of moisture through the roots will not be impeded. This means that the structure of



the soil must be and continue to be good. Lesion nematodes may also cause a poor root system. Apart from a good moisture supply and a good root system, the average temperature is also important. If this average temperature is higher than 27°C, the risk of flower desiccation is much greater.

If you wish to obtain good flowering results with the cultivation of gladiolus flowers

during the winter months, these points must be given proper attention. The removal of any side shoots and a correct selection from the assortment of gladioli may also be helpful. A number of cultivars such as e.g. Eurovision, Peter Pears, Friendship, White Friendship, Jessica and Mascagni are less light-sensitive than the others.

## Temperature

Gladioli present optimum growth at temperatures between 10 and 25°C. During the period the gladiolus develops its flower, there is a clear relation between the available light and favourable temperature. The period of flower development of gladiolus lies between the time the third leaf becomes visible and the time the sixth or seventh leaf appears.

Thus excessive average temperatures in combination with light-deficient periods may cause flower desiccation in this period of flower development. In the last part of this period, this may also adversely affect the number of flower-buds per spike.

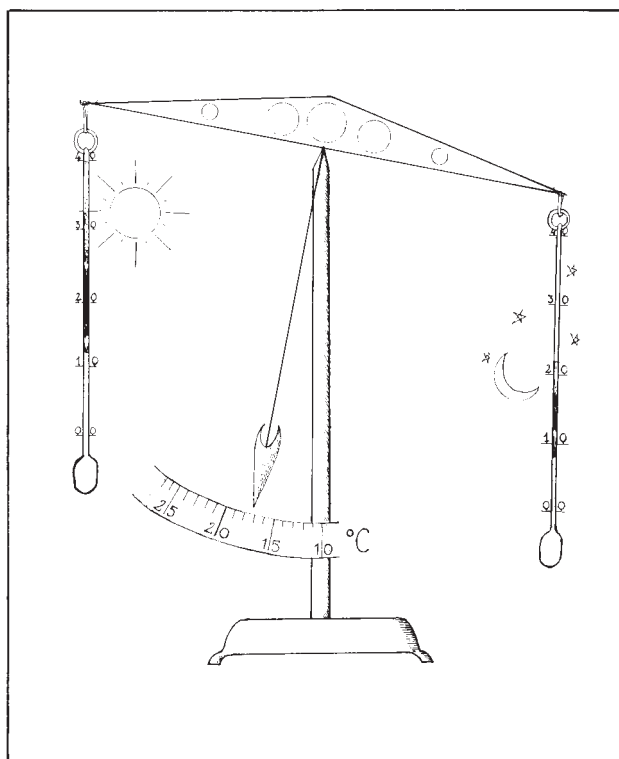
Average temperatures lower than 10°C cause an arrest in growth and development of the plant.

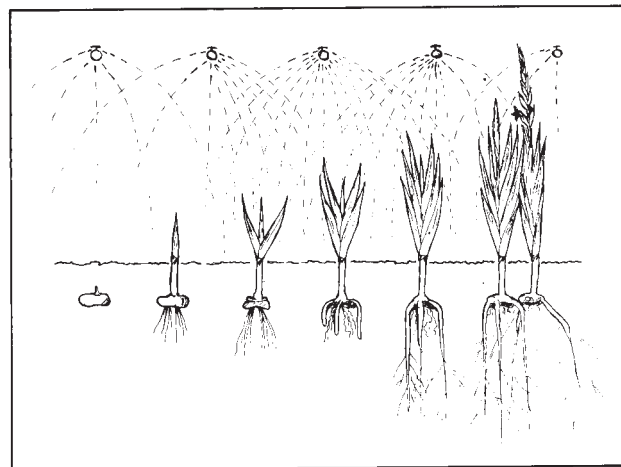
If this cold period continues for too long a time, all kinds of interruptions in growth may occur. Temperatures below freezing point are not tolerated by gladioli and cause frost damage and even perishing of the crop.

At average temperatures below 10°C and when night frost is expected, it is recommended, therefore, to plant the gladioli in a greenhouse (glass or plastic). If necessary, it must be possible to heat these greenhouses in order to avoid extremely low temperatures. A reduction in light conditions when growing in greenhouses, however, is to be allowed for.

The maximum temperature for growing gladioli will be an average temperature of about 27°C. For this purpose, however, only a limited assortment is suitable.

Gladioli can temporarily tolerate temperatures over 25° (up to about 40°C), but only if in such cases the relative humidity is high and the moisture condition of the soil is optimum.





## Moisture supply

After planting, the gladiolus corms must be able to root quickly and undisturbedly. They will do so easily if the soil around the corm is moist enough. Therefore, it is recommended to moisten the soil liberally already before planting. If the soil is too dry after planting, however, immediate sprinkling is urgently required. A mulch to avoid deterioration of the soil is sometimes desired then.

Thereafter, a gladiolus must have amply sufficient water at its disposal during the entire growth period. The most critical period for a deficiency of water begins, just as with the light, at the moment the third leaf becomes visible and ends when the seventh leaf appears.

Flower initiation is in full progress then, but also in this period the roots of the old corm will die and the contractile roots of the new corm are initiated. A sturdy crop is already available, however, losing rather much moisture through evaporation during sunny weather. In this period, therefore, the moisture supply requires extra attention.

The amount of water to be administered is dependent on the type of soil, the climate and the stage of development of the crop. This water can be supplied by means of irrigation or sprinkling.

Sprinkling is preferred to irrigation, because the structure of the soil will stay much better when applying sprinkling instead of irrigation. Sprinkling should, of course, be carried out so that no surface panning occurs.

If irrigation is needed at all, ridge culture, in which the gladioli are in the ridge, is preferred.

Sprinkling also makes it possible to reduce the crop temperature during periods with high daytime temperatures, and to raise the

relative humidity in case of extremely dry air.

In all other cases, sprinkling is preferably done early in the morning. The crop will then be dry at night, which will reduce the chance of infection by the *Botrytis* fungus.

## Ventilating and screening

From a viewpoint of temperature control, the possibility of ventilating in greenhouses is very important. Large fluctuations in temperature and the resulting fluctuations in relative humidities must be avoided then. This precludes the risk of dried brown leaf tips. Ventilating can also be an important means to get the crop dry again after sprinkling.

Screening is hardly applied in the cultivation of gladiolus flowers. Only in times of a high light intensity, screening may be a remedy to avoid highly rising crop temperatures.

In case of little light, however, the screen is to be removed again.

## Weed control

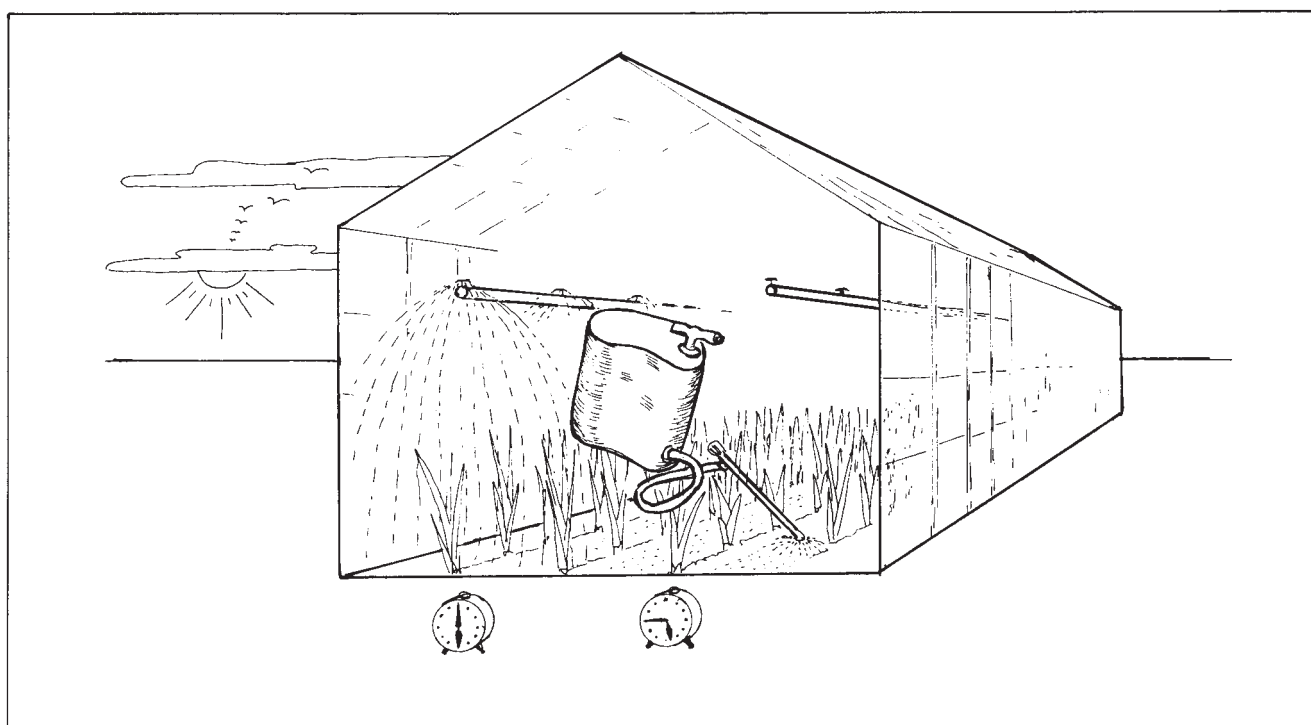
If no general soil disinfection takes place before planting, the agent glyphosate (Round up, 6 litres/ha) can be sprayed a considerable time before planting when perennial weeds are found. Before or just after planting (but well before the gladioli come up), the agent paraquat (e.g. Gramoxone, 6 litres/ha) may be successful when annual weeds are found.

If you wish to keep the soil free from weeds during the further greenhouse or outdoor cultivation, a weed control before the crop comes up is to be preferred. The agent metoxuron (Dosanex, 3 kg/ha) is suitable for this purpose. An exception is made for light sandy soils, where the agent linuron (e.g. Linuron 50WP) is preferred. When metoxuron is not available, this agent can also be used on the other soils. Dependent on type of soil, 1 (sandy soils) to 2 kg (clay soils) per ha is used.

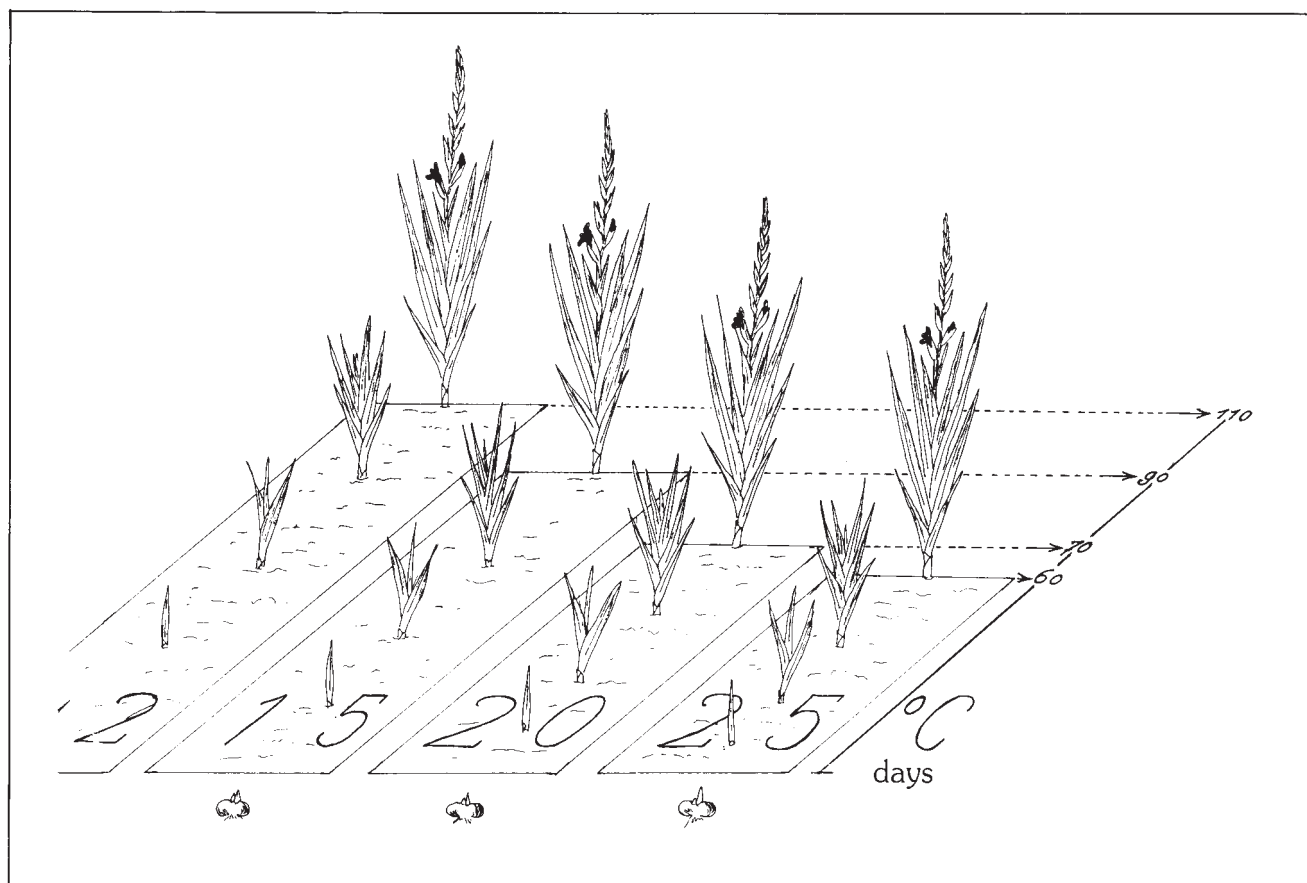
After the crop has come up, only the agent metoxuron (Dosanex) can be sprayed. Dependent on type of soil 2 to 3 kg per ha.

### Notes:

- Apply herbicides in principle on moist and somewhat solid soil.
- When using Dosanex on sandy soil, there is a chance of damage caused by absorption through the roots after washing in the herbicide.
- When using Dosanex after the crop comes up, do not spray the agent at temperatures over 20°C, as the foliage may be damaged then. Spraying between the rows and preferably in the evening will reduce the chance of damage. A light sprinkling after spraying also reduces the risk of damage.
- After steam-sterilizing the soil, or after a treatment with methyl bromide etc., weed control is usually not required.







### *Duration of cultivation*

The duration of cultivation of a cultivar is understood to be the total number of days from planting until flowering, needed for the cultivation of flowers of the cultivar concerned.

The cultivars can be divided into three groups according to the length of the duration of cultivation. Thus we speak of cultivars with a short, medium and long duration of cultivation.

At an average, you may allow for a difference of about 20 days between a cultivar with a short and one with a long duration of cultivation. Besides this variation in the duration of cultivation, also the temperature during the cultivation period causes a difference in the number of days as follows:

Average cultivation temperature	Duration of cultivation, days
12°C	110-120
15°C	90-100
20°C	70- 80
25°C	60- 70

As a last factor influencing the duration of cultivation, the corm size may be mentioned. As already indicated above, the use of the larger corm sizes will reduce the duration of cultivation.

Thus the flowering of corm size 12-14 cm will be two or three weeks earlier than of corm size 8-10 cm. This period of two to three weeks is dependent on temperature and cultivar.



## Picking and processing

### *Picking*

The flowers can be picked as soon as the bottom flower-bud of the spike starts colouring. When the flower-bud is allowed to open too far, damage may be caused during the further processing and during transport.

When picked too early, i.e. when the bottom flower-bud shows no colour yet, the flower is likely to develop insufficiently.

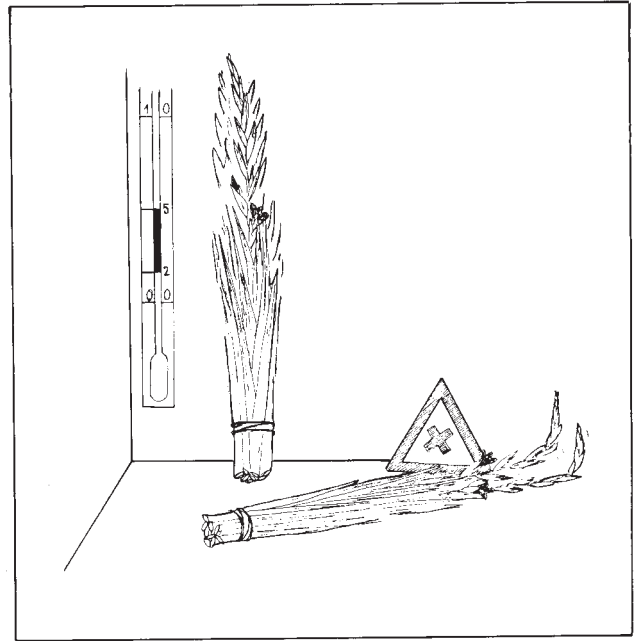


## Storage

After picking, the flowers should be processed, stored and transported in an upright position. This will prevent the tops of the spikes from getting crooked.

When storing the flowers, this can best be done dry at a temperature of 2 to 5°C. To keep the durability of the flowers for the consumer as optimum as possible, storage should be as short as possible.

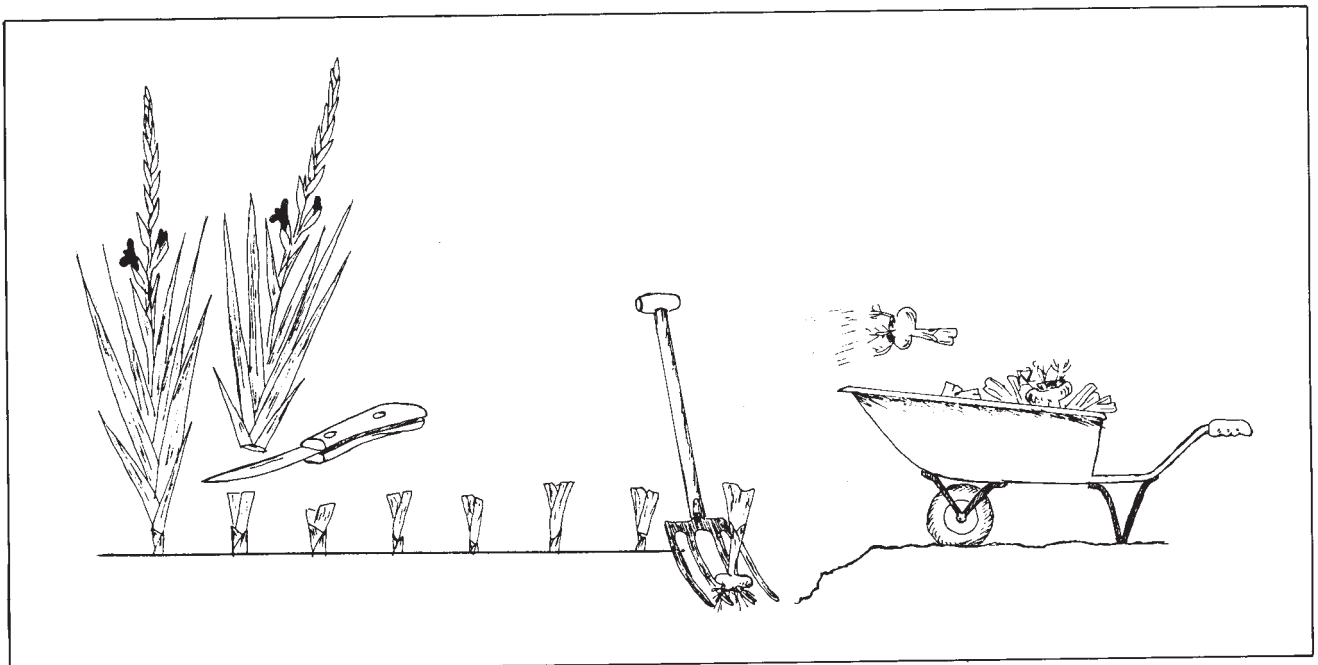
Storage for more than a few days is not recommended; if the flowers should be stored longer after all, they must be placed in water instead of stored dry.



## Clearing the crop

In spite of the fact the corms are pulled out during picking, it is often necessary to dig up any corms left.

Especially with lots which were affected by *Fusarium* or dry rot, it is essential that the crop is immediately cleared after picking the flowers. If this is not done, the lot will spread the disease so that the soil may be seriously infected.



## Chapter III.

# Diseases and disorders

### Diseases caused by fungi

#### *Botrytis*

This fungus causes corm as well as leaf inflections. The lightest symptoms on the corm consist of little black-brown spots ('spot-botrytis'), which as a rule are found mainly at the top of the corm around the stalk base. Brown stains of variable shape and size may also occur on the surface. In case of severe infection, the corms become soft all over and reddish brown in colour.

Sometimes, the outside shows white fungus threads (mould) and black sclerotia. When the corms dry up, they will shrivel and become hard. The infection of the parts above the ground can occur at soil level, where the tissue is brown and wettish rotted so that the plant becomes yellow and sometimes topple. The disease below-ground tissue reveals large black sclerotia. Otherwise, the corm will be sound and well-rooted.

The symptoms on the leaves consist initially of light, afterwards dark brown round spots. Later in the season, large and dead gray-brown patches appear on the tissue. Germinating spores may cause colourless watery spots ('pocks') on the flowers.

#### *Cause*

Both the corm and the leaf infection is caused by the fungus '*Botrytis gladiolorum*'. Sclerotia can be formed on all parts of the plant, as well as on the corms. They have a dark colour, are flat and of variable size (1 - 9 mm), and can play a part in spreading the disease in a following season. Under moist conditions and above the ground, they can produce spores, which are spread by the wind. The corm infections arise especially under too moist conditions during storage of the corms.

Infection of leaf and stalk at soil level is chiefly caused under cool (about 10°C) and moist conditions. The other leaf infections manifest themselves after prolonged wet periods in which the crop remains moist too long. Such conditions can especially prevail in a dense crop and in stuffy greenhouses.

#### *Control*

- Keep the relative humidity low (max. 80%) and maintain a good air circulation during storage of the corms.
- Apply an ample crop rotation.
- If the corms have not yet been disinfected, disinfect them just before planting for 1 to 15 minutes in prochloraz (e.g. 0.4% Sportak 45%) + captafol (e.g. 1% Ortho-Difolatan 4F, 480 grams/litre) + procymidon (e.g. 0.2% Sumisclex 50%).
- Do not plant too densely.
- Keep the topsoil dry, and when the first symptoms of infection appear at soil level, spray low under the crop with vinchlozolin (e.g. 5 grams of Rozilan 50% per 100 m<sup>2</sup>) or procymidon (e.g. 5 grams of Sumisclex 50% per 100 m<sup>2</sup>).
- Remove clearly infected plants with their corms.
- When growing in greenhouses, ventilate well and, if necessary, dry the crop by heating. Water in the morning so that the crop will be dry before nightfall.
- Spray regularly from the time the crop comes up, during wet weather at least weekly, with 25 grams of maneb 80% per 100 m<sup>2</sup>.  
During the growing season, vinchlozolin (e.g. 5 grams of Ronilan 50% per 100 m<sup>2</sup>) or procymidon (e.g. 5 grams of Sumisclex 50% per 100 m<sup>2</sup>) can be added three times.
- When greenhouses can be closed, fumigate, if necessary, with vinchlozolin or chlorothalonil (Ronilan or Termil H tablets, respectively, 1 tablet/100 m<sup>3</sup>), by the time of flowering.
- After harvesting the flowers, remove the remaining plants and corms as soon as possible.

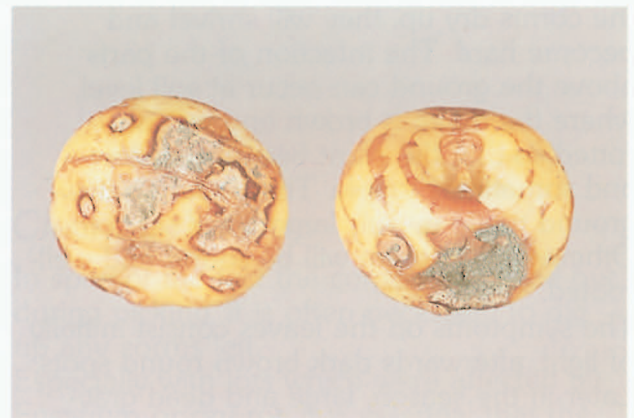
Botrytis: Leaf infection at a later stage.



Botrytis:  
Infection by the fungus at soil level.



Dry rot: Yellowing of the outer leaves.



Green mould: Mechanical injuries followed by a  
Penicillium attack.

Fusarium rot: Crooked plants as a result  
of Fusarium infection.



Dry rot: Sclerotia on the spathe leaves.

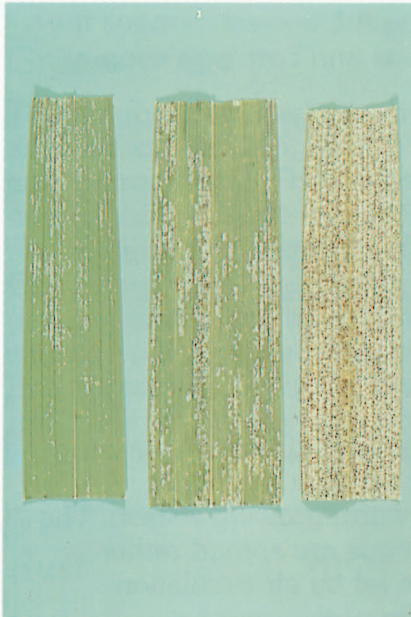
Rust: Spore pustules and partly spread  
orange-yellow rust spores.







Root rot:  
Right: Corm with healthy root system.  
Left: Corm with a *Pythium*-infected  
root system.



Thrips: Symptoms of the leaves.

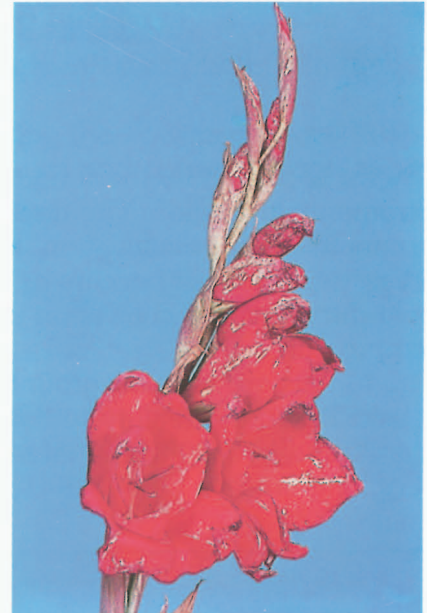


Root-knot nematode:  
Root thickenings as a result of  
*Meloidogyne* nematode attack.

Corn borer: The larva of the corn borer,  
removed from the inside of the stalk.



Corn borer:  
Stalk damage caused by fretting.



Thrips: Symptoms on the flowers.

Leaf chlorosis:  
Yellow-green leaf tissue and green veins.



## Dry rot

At first, the plants show a good growth, but after some time the foliage will turn yellow and brown, starting at the outer leaves. The lower parts of these leaves are already badly affected at that moment. The spathe leaves of such plants are brown to black, and are covered with many very small round black sclerotia.

The corm is not rotted but brown spots are found on the roots, becoming larger later on. Also on these spots, sclerotia will develop.

Initially, the infection occurs in random plants, afterwards in patches or expanding to the whole parcel.

## Cause

Dry rot is caused by the fungus *Stromantinia gladioli*. The disease chiefly occurs in outdoor cultivation. In warmer areas, dry rot hardly occurs or plays a part only during winter cultivation at lower temperatures.

The fungus grows belowground from an infected plant to healthy surrounding plants, and keeps the soil infected for a very long time.

## Control

- Treat severely infected soils with 7.5 to 10 kg of methylbromide or 7.5 litres of Di-Trapex per 100 m<sup>2</sup>. Metam-sodium (e.g. 10 litres of Vapam or Monam per 100 m<sup>2</sup>) offers a somewhat poorer control. After using any of these three agents, the soil should be covered with plastic (see Soil disinfection).
- Treat lightly infected or suspected soils by sprinkling with procymidon (e.g. 35 grams of Sumisclex 50% per 100 m<sup>2</sup>).
- If the corms have not yet been disinfected, dip them for 1 to 15 minutes in prochloraz (e.g. 0.4% Sportak 45%) + captafol (e.g. 1% Ortho-Difolatan 4F, 480 grams/litre) + procymidon (e.g. 0.2% Sumisclex 50%).
- Remove clearly affected plants and their surrounding plants with the corms.
- After harvesting the flowers, remove the remaining plants and corms as soon as possible.

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## Fusarium rot

Seriously affected corms do not come up. Lightly affected corms produce weak and somewhat crooked plants. Initially, only the leaf tips of these plants are yellow.

Afterwards, almost the whole plant will turn brownish yellow all over. In serious cases, the whole plant will die down.

The young corm can be infected from the contractile roots, but also from the mother corm. The corm base will turn gray to dark brown. This discoloration continues in the central part of the corm and spreads to the sides.

## Cause

The fungus *Fusarium oxysporum*, causing this disease, can damage the plants particularly in a warm growing season. The spores of this fungus are spread rather easily among the lot by air circulation during the storage of the corms. Gladiolus corms, therefore, must not be planted before being disinfected.

Infection from the soil is also possible. Above Fusarium strain also attacks Iris, Freesia, Ixis and Tritonia.

## Control

- Unpack the corms immediately after receipt, and plant them as soon as possible, or put them in an airy and cool place (preferably 5°C).
- Apply ample crop rotation.
- Never plant in soil already infected, but disinfect such soils before planting with 10 kg of methylbromide or 7.5 litres of Di-Trapex per 100 m<sup>2</sup> or metam-sodium (e.g. 10 litres of Vapam or Monam per



100 m<sup>2</sup>). Apply these agents under plastic foil, and leave this foil in place for at least 14 days (see Soil disinfection).

- Disinfect the corms just before planting for 1 to 15 minutes in a bath to which the following agents have been added: prochloraz (e.g. 0.4% Sportak 45%) + captafol (e.g. 1% Ortho-Difolatan 4F, 480 g/litre or 0.5 Ortho-Difolatan 80%). Stir the bath at regular intervals. Plant the corms immediately after disinfecting.

Note 1. If the corms have already been disinfected by your supplier, disinfection at your nursery can be omitted.

Note 2. If the corms have not been disinfected by your supplier, and the agent Sportak cannot be obtained by you, disinfect

the corms only in captafol (e.g. 2% Ortho-Difolatan 4F, 480 g/litre or 1% Ortho-Difolatan 80%).

Note 3. Disinfecting in B.C.M. agents such as benomyl (e.g. Benlate), carbendazim (e.g. Bavistin, Delsene, Derosal), thiofanat-methyl (e.g. Topsin M) and thiabendazole (e.g. Lirotect 60 and Tebuzate) must be **strongly** dissuaded. These agents **no** longer control the *Fusarium* fungus.

- Always take the correct cultivation measures (see Chapter II).
- Remove clearly affected plants with their corms.
- After harvesting the flowers, remove the remaining plants and corms as soon as possible.

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## Green mould

The fungus produces grayish-green mould as a 'fur' on the skin, desiccated root tips and injured tissue. The corms may become entirely covered with mould, but this does not impair the final quality of the corms.

On severely damaged corms, slowly growing brown and afterwards strongly sunken spots, covered with green mould, may sometimes be found. Such corms will not come up or will produce weak plants.

### Cause

The *Penicillium* fungus, causing this attack, develops chiefly during transportation or storage of the corms under too moist conditions.

### Control

- Keep the relative humidity low during storage of the corms, and see to a good air circulation among the corms.

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## Rust

On both sides of the leaf, yellowish, somewhat swollen spots will develop. After some time, they burst and an orange-yellow powder appears. These spots are circular at first, but enlarge in width afterwards, so that eventually they are elliptical across the width of the leaf. The infection is often very sincere and gives the plant a rust-brown appearance.

### Cause

The disease is caused by the fungus *Uromyces transversalis*. The orange-yellow spores are responsible for spreading the disease during the growing season. The disease occurs in subtropical (summer months) and tropical regions, and can spread on a large scale.

### Control

- Preferably from the moment the crop comes up or when finding the first symptoms, spray weekly, alternately with oxycarboxin (e.g. 5 grams of Plantvax 75% per 100 m<sup>2</sup>) or benodanil (e.g. 10 grams of Calirus 50% per 100 m<sup>2</sup>) or triadimefon (e.g. 5 grams of Bayleton 25% per 100 m<sup>2</sup>).



## Root rot

From shortly after coming up until flowering, the plants will be retarded in patches, will flower later or not at all, and sometimes die down prematurely. The roots of such plants are for the greater part rotted, and no sclerotia are found. At an early stage, narrow and short light-brown stripes are sometimes visible on the roots, caused by the root lesion nematode *Pratylenchus penetrans*.

### Cause

The rot is caused as a result of infection by the *Pythium* fungus, the root lesion nematode or other non-identified fungi and bacteria. Apart from some characteristic symptoms, a

distinction is hard to make, and the affected parts will have to be sent to laboratories for identification.

### Control

- See to a good soil structure. This should not be too compact so that it stays wet too long.
- Apply a complete soil disinfection (see Soil disinfection).
- On problematic soils, in case of an anticipated *Pythium* infestation, additionally rotavate fenamino-sulf (e.g. 500 grams of Bayer 5072 70% per 100 m<sup>2</sup>) or etridiazole (e.g. 500 grams of Aaterra 35% per 100 m<sup>2</sup>) into the soil just before planting.

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## Diseases caused by animal organisms

### Root-knot nematode

The above-ground symptoms consist of a retarded growth of the crop in patches. During warm weather, the foliage is limp, followed by yellowing, as also observed on the above-ground crop of corms attacked by *Fusarium*. These corms are sound, however, in contrast to *Fusarium*-infected corms.

The roots show thickenings of different size, and a number of these thickenings together give the roots a swollen appearance.

### Cause

The attack is caused by the heat-loving root-knot nematode *Meloidogyne incognita*. This parasite is indigenous to warmer regions and also attacks a large number of other plants (e.g. tomatoes, cucumbers and various weeds).

### Control

- Apply a complete soil disinfection (see Soil disinfection), especially after a diseased preceding crop (e.g. tomatoes, cucumbers, weeds, etc.),
- or work aldicarb (e.g. 300 grams of Temik per 100 m<sup>2</sup>) through the soil.

### Thrips damage

The leaves show scattered silver-white spots. When a serious attack occurs, these spots will merge to form large grayish to light-brown coloured stains. These stains appear first in places where leaves overlap and between the bracts of the spike. Also the flowers can be affected, and show spots. Such flowers usually open poorly. The insects can also find their way to the corms. Especially under loose skins, dark brown spots will appear, often sharply defined by 'rings'. At these spots, the corm feels somewhat sticky.

### Cause

The damage is caused by the *Gladiolus* thrips *Taeniothrips simplex*. The insect quickly multiplies at higher temperatures, and is very lively under these conditions.

### Control

- During planting, work aldicarb (e.g. 300 grams of Temik per 100 m<sup>2</sup>) through the soil,
- or spray the crop biweekly, alternately with acefate (e.g. 10 grams of Orthene 80% per 100 m<sup>2</sup>) or deltamethrin (e.g. 5 cc Decis 25 grams/litre per 100 m<sup>2</sup>).
- Corms can be given a room treatment, in accordance with instructions for use, with pirimifos-methyl (e.g. Actellic 50%) or dichlorfos (e.g. Dedevap 50%).

## *Corn borer*

The inner leaves of the plant turn yellow. These leaves and the flower spike will subsequently die down. A first symptom at a somewhat later stage of growth of the crop is the wilting of the flower spike.

### *Cause*

The attack is caused by an insect, *Pyrausta nubilalis*, which can cause considerable damage to the crop especially in warm regions. The butterflies lay their eggs on the leaves of the gladiolus, which hatch after some time. The larvae eat their way inside where they feed on the central part of the stalk.

### *Control*

- Do not plant gladioli for autumn flowering near cornfields.
- Check the plants on the presence of eggs. When more than 50 eggs per 100 plants are found, the crop is to be sprayed with an insecticide in accordance with instructions for use, such as perniethrin (e.g. 5 cc Ambush per 100 m<sup>2</sup>) or deltamethrin (e.g. 5 cc Decis per 100 m<sup>2</sup>). Continue spraying weekly as long as eggs or larvae of the corn borer are found on the plants.
- Remove and destroy all affected plants, as corn borers hibernate as pupae in the stalks.

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## **Non-parasitic disorders**

### *Leaf chlorosis*

The foliage of the plants is yellowish-green with green veins or yellowish white all over. This may occur in patches or even in the whole field. The inner leaves are lightest in colour.

### *Cause*

This deficiency symptom is caused by iron deficiency, and mostly occurs in soils with a high pH (over pH 7).

### *Control*

- Spray and sprinkle the crop with iron chelate, such as Fe-EDDHA (e.g. 500 grams of Chel 138 Fe or Librel Fe Hi, or Sequestrene per 100 m<sup>2</sup>).

