APPLIED PLANT RESEARCH

Alstroemeria literature survey

A review of 10 years of Dutch applied research

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1 Introduction

The cultivation of Alstroemeria in the UK increases only marginally. The production on the holdings does not grow and the quality of the produce is stagnant. The import of alstroemeria from the Netherlands is steadily increasing. In the UK the success of the Dutch alstroemerias and the rise of the yields and of the quality are considered to be due to the excellent material and the implementation of extensive research results.
The assignment consists of the writing of a report in English on the professional Dutch literature published on cultivational aspects of growing alstroemeria.
In 1989 a special report, in Dutch, of the cultivation of Alstroemeria (5) was made. However, for current standards it is obsolete. A lot of techniques are renewed. To give a most up-to-date report a review should be made of the last ten years.
By order of the ADAS a literature search and review of Dutch research work over the last decade was carried out. Most of the sources were found in the Dutch trade journal 'Vakblad voor de Bloemisterij' and about twenty reports of the Glasshouse Crops Research Station in Aalsmeer on the subject of Alstroemeria. One of the references is coming from Belgium, describing the use of artificial lighting and the use of carbon dioxide in practice.
Although the organic cultivation of Alstroemeria is not so important in the Netherlands, one of the references is from of the EKOland magazine, which focuses on organic agriculture.

The cultivars of the Inca lily are developed by means of variety-crossings (38). The wild cultivars are coming from South America with the two most important native countries central Chili and Southeast Brazil. These two areas are different in both geographical and climatological respect. That is why the natural growth circumstances of the different cultivars vary greatly. The varieties from Chili, which are used for breeding show large orchids, look liked cut flowers. Mostly they have narrow leaves and a poor vase life. The crossing parent from Brazil (Alstroemeria pulchella) has broader leaves with a good vase life, but the flowers are smaller and less open.
A lot of new varieties appear each year and the growers purchase these new varieties without a good variety test as was done in the past by The Glasshouse Crops Research Station. The growers buy the new plants from the breeders and hope to get better prices for these varieties with a special shape or colour. That is why there are almost no publications of varieties in the Dutch magazines and as a result there are no references to variety trials in this review.

Special notice is made of subjects such as soil, nutrition and soil temperature. In the period from 1991 to 1996 special attention is given to the culture free from the soil, such as substrate with a recirculated nutrient solution. It was a research program from The Ministry of Agriculture. In the mid-nineties it seemed that the culture of vegetables and floriculture in the soil could stay in Dutch horticulture, so that this special program stopped. In Holland only a limited percentage of the area is covered with substrate.
Glasshouse climate and economic publications are mentioned. One of the modern aspects is the influence of artificial lighting on growth and production and quality of glasshouse cultivations in The Netherlands.

2 Alstroemeria in the Netherlands

In the Netherlands the cultivation of Alstroemeria ranks 7th on the list of most important cut flowers. The acreage increased in the last decade from 83 to 119 ha. In the year 2001 about 40% of the acreage is equipped with an installation of artificial light with a light intensity of 4000 lux. But more and more installations are bought and all the new greenhouses for the cultivation of Alstroemeria get a standard light installation. That means that in the year 2002 more than 50% of the acreage will have an artificial light installation. In the beginning the light intensity was about 2000 lux. But nowadays 4000 lux is more common (29).

Table 1 – Dutch production, turnover (* billion euro) and acreage of Alstroemeria (61)

	1996	**1997**	**1998**	**1999**	**2000**
Production	214	219	231	255	284
Turnover	33	36	37	36	41
Acreage	115	113	116	124	119

More than 60% of the nurseries (= about 90% of the nurseries with a year-round cultivation) has an installation for cooling the soil. The number of nurseries is about 137, so that the average area is 9.000 m^2 per nursery. This is rather low, but that is why there are a lot of nurseries with a mixture of other cut flower cultivations. The last five years the number of nurseries with acreage of more than 3 ha increased. In the Netherlands the cultivars with the large flowers are cultivated, most frequently viz. 94%. Outdoor cultivation is rare. The main varieties are Granada, Virginia and Jamaica. The 'top 10' cultivars of the year 2001 are from two breeders. These firms are Van Zanten and Könst.

In the area of Aalsmeer there is one organic nursery of Alstroemeria (18). The greenhouse acreage is 2000 m^2. In wintertime the crop does not produce shoots, only during summertime there is production of an estimated number of 200 shoots per m^2. The control of aphids, thrips and caterpillars is done biologically. The grower expects that after a cultivation of some years the real problems will come.

3 Soil, nutrition and irrigation

In 1992 a large project was launched called: Development and testing of closed systems. The aim of this project was to investigate whether a closed system could be an alternative for the culture in the soil. Special attention should be paid to the reduction of the emission of nutrients and diseases and pest control to the water and the soil. Alstroemeria was one of the pilot crops (42, 45), other crops included radish, lettuce and freesia. The research started with the choice of substrate and watering systems. Special attention was given to the balance of air and water in the different substrates (35, 52). The results of the research showed that in a substrate the total shoot production increased. The average was 10% more shoots (33).
One of the researches in this large project was the trial with treatments of two water supply frequencies and three different substrates it was found that, although there were large differences in treatment, the crop responded in the same way. There were no differences in production or fresh weight per shoot (34, 44).
Although a lot of research was done to the culture of alstroemeria on substrate with the various items the culture of alstroemeria in practice is not used nowadays. One grower started with a substrate system (27) on 8,000 m^2. In a bed of 80-cm width and 15 cm height he planted two rows of plants in sand. On the bottom of the bed a drain tube was placed. The walls consisted of foil. In the substrate 6 tubes for soil cooling were placed. The costs of the system were about 10 guilders per m^2, including material and labour. The grower expects to harvest 5% more shoots with a higher fresh weight. The substrate is still there, but the area of substrate does not increase not even on the nursery of this grower.

The standard nutrient solution for an open system and the target values for the root environment were used. In an open system the standard nutrient solution gives the target values in the root environment assuming a leaching fraction of 30% of the volume of the water. These target values are been found to give the optimal production and quality in standard situation. For Alstroemeria the composition of the standard nutrient solution for an open system and the target value in the root environment are given in table 2. The target values in the root environment are given for a certain EC-comparison. This EC is calculated on the macro elements with Na and Cl.
The analysis of the root environment should be corrected to compare the actual EC with the EC-comparison and also the individual element concentration should to be corrected for the actual EC. Therefore the EC from the nutrients has been calculated from the actual EC and the concentrations of Na and Cl.
In the different physiological stages of Alstroemeria the standard solution was not changed.
In many cases the EC of the desired nutrient solution is different from the standard nutrient solution. Therefore the solution to be made has to be recalculated from the standard to the desired EC. After the adaptations of the standard solution the cation and anion sum may not be equal. In that case the cations and anions are changed so that the sum becomes equal. In these calculations NH_4 and H_2PO_4 are not taken into account and the ratios of cations and anions are not changed.
In a closed system a principle 'drip solution minus drain water' is used. In this system the standard nutrient solution for the open system has been used. The solution to be calculated is corrected for the extra input of drain water. The solution to be calculated is added to the total stream of water, i.e. the raw water mixed with the drain water.

Depending on the water content of the soil the amount of fertilisers is different.
In the cultivation of Alstroemeria on substrate a more delicate target value of the concentration of the mineral is used (19). Substrate culture of Alstroemeria in the Netherlands covers an estimated area of only 1.5 ha.

Table 2 - Standard nutrient solution for closed and open system and target values in the root environment of Alstroemeria

Element	Target value	Minimum value	Maximum value	Standard nutrient Solution Closed system	Drip solution Open system
EC, mS/cm	2.0	1.3	3.0	1.1	1.6
pH	5.5	5	6		
NH_4, mmol/l	0.1	0	0.5	0.7	0.7
K	5.0	3.3	6.7	4.3	5.8
Na	<5.0	0.1	5.0		
Ca	5.0	3.3	6.7	2.0	3.5
Mg	2.0	1.3	2.7	0.7	1.3
NO_3	13.0	8.6	17.3	7.3	11.2
Cl	<5.0	0.1	5.0		
SO_4	2.5	1.7	3.3	1.2	1.95
HCO_3	<1.0	0.1	1.0		
P	1.0	0.7	1.3	0.7	1.0
Fe, umol/l	30	15	45	25	25
Mn	5	2	8	5	5
Zn	5	2	8	4	4
B	40	20	80	20	30
Cu	1.0	0.5	1.5	0.75	0.75
Mo	0.5	0.3	0.8	0.5	0.5

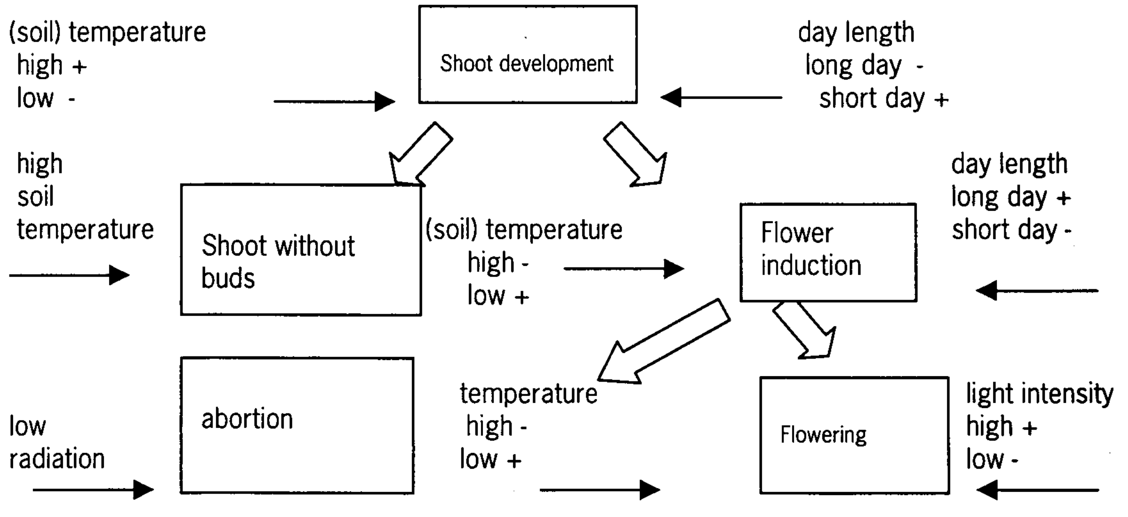
The EC given is the value at 25 °C.

A regularly wet soil is very important in the culture of alstroemeria to get a good and regular growth (20, 57). In 1996 a project was started to supply as much water as the plants need. Via electronic tensiometers the water concentration of the soil was measured at 10, 20, 35 and 55 cm depth.
The water supply was done via the DAC-system. The Denar Aqua Control (DAC) is a system to supply water to the soil or substrate so that there will be no wash out of water and nutrients. The supply of water must be in a low volume and very regular. The wetness of the soil is controlled with electronic tensiometers. The project should give a deeper understanding of wetness of the soil at various depths and experiences in guiding the wetness of the soil with a computer guide system. Based on figures of the tensiometers from the computer, the starts and stops of the supply of water are done. The aim is to get a soil with a constant wet level. Particularly at the start of the culture, increased attention should be given tot the system, for the supply with a drip system or a small sprinkle installation is completely different from the old system.
On the internetsite: www.alstroemeria.tv growers discuss the system for in the alstroemeria beds there are a lot of very wet spots on the lowest levels in the greenhouse if the growers use the DAC system (50) as water supply. In practice there are differences in opening times of the valves. Varying from twenty seconds to one minute. If there is a water supply a dozen times a day, the difference is from exactly right or completely wet. Maybe the technical equipment such as the drippers of the tubes gives different amounts of water. The tubes were sent back to the company in Israel.

4 Soil temperature

To get a high production it is necessary that a lot of shoots are made. The shoots are made in the soil by splitting the rhizome (60, 63). The number of side rhizomes determines the number of visible shoots above the soil, the number of growing points and the velocity of splitting and development of the shoots.
Factors that influence the growth of the shoots are soil temperature and daylength. High soil temperatures introduce the total shoot production and low soil temperatures decrease the number of shoots. With 5 °C the plants become dormant (40, 63).
Short days, less than 12 hours, increase the growth of the young shoots and days with a length of 14 hours or more decrease the shoot growth.

Figure 1 - Schematic representation of shoot development till flowering of Alstroemeria



+ = positive influence
- = negative influence

A good view of the flower induction of Alstroemeria is very complicated because there is a great variation in response between the cultivars. With flower induction (38, 39) the temperature or light condition causes the vegetative to the generative reaction. Figure 1 shows the path from shoot induction to inflorescence. Long days and low soil temperatures increase flower induction. Induction takes place in the young shoot and not in the rhizome. A lower number of internodes below the flower head shows an induction at a young stage. Of course the development velocity of flowering depends on temperature. The lower the temperature the slower and if the temperature is above 20 °C there is no or hardly any induction of buds (22, 31).
Cv. Jubilee is a very good winter flowering cultivar. Cv. Flamingo responds better to soil cooling than Jubilee and is not a real winter variety.
High greenhouse temperature (25 °C) stimulates the flower development i.e. the growth of buds to open flowers.
A shoot without buds shows shorter internodes and a thinner stem. The shoot is not induced or the buds are primarily aborted. It costs a lot of assimilates to make a stem, so it is very important to avoid stems without buds (38).

Soil cooling decreases the number of shoots without buds of the cultivars Jubilee, Flamengo and Wilhelmina. (23, 24) The total number of shoots was reduced only with the cultivar Jubilee. With Flamengo and Wilhelmina the number of shoots increased with soil cooling.
A higher light intensity also reduces the number of shoots without buds, but a long daylength reduces the growth of the shoots.

Some varieties must have rhizome temperatures between 14 to 16 °C for flowering. Other cultivars are neutral in temperature reaction or even respond positively to high soil temperatures (26). Normally when the plants are making more shoots or shoots without buds the soil temperature must be lowered to get an increase of flowering stems.
A cooling of the soil between 14 and 16 °C introduces a better winter production.
Cultivars, such as Diamond and King Cardinal stop the production of flowers with a soil temperature of 20 °C or higher. For some cultivars, such as Butterfly-types the soil temperature setpoint will be 13 °C. Most of the standard varieties such as Virginia, Jamaica grow with a soil temperature between 14 and 16 °C.
In a research with cv. Victoria (55, 56) it was found that with a root temperature of 11°C the number of shoots without buds almost decreased to zero. But the number of shoots even decreased deeply.
In summertime shoots were harvestable within 4 weeks, but in winter there was a growing period of 14 weeks.
A soil temperature of 11 and 14 °C results with cv. Flamingo in fewer shoots without buds and a higher production of shoots with three and more flowers and a stem length of more than 60 cm. The induction of shoots is with 11 °C year-round. With 14 °C there is a year-round induction, but on a lower level.. With 10 °C and not cooled the induction stops in week 34. From visible growingpoint, just above the soil, till flowering it takes on average 35 days.

In 1993 (36) one of the first calculations of the costs of soil cooling was carried out. The costs were calculated at 10.20 guilders per m2 and the increasing production of cv. Jubilee was 6.24 guilders. For Flamengo and Wilhelmina the extra production figures were 27.90 and 11.52 Dutch guilders respectively. The author recommends the growers before the investment of cooling to calculate and to wait for further research.

5 Glasshouse climate

The production of Alstroemeria is found in countries with a rather cool climate (54). Not only in the Netherlands, but also in the mountains of Kenya and Colombia this culture is found. That means that the average day temperature in the greenhouses must be low too. De Groot (13) gives some tips for the summer culture to make a good basis for autumn and winter.
Take away the shoot without buds and remove the dead shoots, so new shoots can arise. The soil temperature in that period must go to a realised value of 14 to 15 °C. That is important to get sufficient vegetative growth. Fluctuations of the soil temperature and too high levels can give too many shoots without buds. In a uncooled soil, cover the soil with styromull or wood (mot) in May or June, so that the soil temperature does not increase too much. Notice that it is not the thickness of the layer, but the reflection and insulation aspects of the material. If a cooling system is available regular service control of the technical equipment is necessary.

In 1995 some growers conducted an experiment with lighting with candelas lamps starting from July or August during the winter months. The vegetative varieties responded positively and quicker flowering was obtained in comparison with supplemental photoperiod lighting. But if the soil temperature stays low the effect of lighting was negligible.
Problems with extreme vegetative growth and shoots without buds can be expected after a warm period, such as the summer of 1992 (11). The advice will be either to use a roof sprinkler installation or to use lime shading of the greenhouse. Both factors decrease the air temperature of the greenhouse and the soil temperature. The relative humidity in summer is considered to be a little bit higher than without covering the greenhouse, so the vegetative and generative growth of alstroemeria will be better. To equalise the air temperature in the greenhouse, fans are increasingly used in practice.

The fresh weight of alstroemeria per m2 can increase by 26% if there will be an extra supply of CO_2. The increase is found in more stems and a higher fresh weight of the stems. In an experiment in the research station in Klazienaveen (2) four varieties, viz. Fantasy, Granada, Rebecca and Virginia gave the same reaction. There were no differences in the number of flowers per stem. Between unsupplied and 500 ppm the increase of the stem weight was between 2 and 5% and between unsupplied and 1000 ppm the increase was between 4 and 9%. The increase of the number of shoots was between 10 and 20% in the treatment of 1000 ppm CO_2. The supply of CO_2 was done with a crop, which was planted in week 6, and the results were found from week 21 till week 44. The extra costs for CO_2 supply were calculated at 5,50 Dutch florins with 500 ppm and about 12 guilders with 1000 ppm.

6 Assimilation lighting

Irradiation is a very important factor of growth and Alstroemeria is very sensitive to irradiation. The photosynthesis of the crop is saturated in high values (37). That means that the greenhouses must intercept light as little as possible. In wintertime the flower and bud abortion is caused by too low light intensities. In summer, however, the greenhouses must be lime-shaded to protect the soil from high temperatures.
The Alstroemeria is a quantitative long day plant with a critical daylength of 12 to 14 hours. The rudimentary flowers are caused to low temperature and long days. Under these conditions the vegetative shoots start flower induction earlier. The number of internodes below the inflorescence decreases.
Most flowers appear in spring because daylength, temperature and total radiation are optimum. That is why there is a production peak from April to June.
Daylengths longer than 14 to 16 hours are not recommended. In the past Vonk Noordegraaf found that the shoot production and the number of flowers per shoot decrease with increasing daylength. Nowadays several varieties are cultivated year round with daylength of 20 hours and a high total irradiation (32). It has been calculated (8) that normally the plants will make good shoots and flowers in February. In February the intake of light into the greenhouse is 135 J/cm^2/day. In December this is 60 J/cm^2/day. The supply is 75 J/cm^2/day and this amount of light can be compared with 4000 lux during 20 hours.
In 1996 in research at the PBG (46,48) it was found that with 5000 lux the rhizomes during the winter from week 37 till week 4, continue to develop shoots with a better quality. A sudden decrease of the light gives an abortion of the second or third ring of flowers after two weeks.
Artificial light introduces a higher production and a faster development of the buds and gives an increase of the number of shoots. The shoots got a higher fresh weight with less flower abortion. In a Research Station in Belgium (21) the results of assimilation lighting were increased with carbon dioxide supply. In the period November to February an extra increase of 30% of the number of stems was found with 900 ppm CO_2 in the treatment of assimilation lightning.
In practice for the artificial light SON-T plus lamps of 440 W are used. One lamp per 9 m^2 greenhouse gives 11.6 W per m^2 PAR or 58 umol per m^2 per s or 4930 lux.

In 1996, 1997 van Noort (30) found that with the varieties Flamengo, Rebecca and Diamond in a short day treatment, organised with a black screen, the number of shoots decreased and the number of shoots without buds increased.
The long day treatment, 14 hours per day, done with incandescent lamps, does not increase the production of the three varieties (51). Cv's Rebecca and Flamengo decrease the production of the first class flowers and also the number of shoots without buds. Only cv. Rebecca shows a production increase after stopping the long day treatment. The combination of daylength and cooling does not increase the production, only cooling had a very positive effect.
On a nursery Alstroemeria Virginia (29) was cultivated during a year under two assimilation regimes, viz. 20 hours and 7000 lux compared to 14 hours and 3220 lux. The production increased with 18 shoots per m^2 and the fresh weight per shoot increased with 3.5 grams. The auction price per shoot was an average of 45 cents, so in total it means 8.10 guilders per m^2. That is too low to pay the extra costs of assimilation lighting of 7000 lux per 20 hours.
Gemert (10) calculated the costs of assimilation lighting (4500 lux and 3300 lamp burning hours) for a nursery of 1 ha. The investment costs are 65 guilders per m^2 and the year costs are 24 guilders per m^2. The calculation is that there should be a yearly increase of the production of 86 shoots or the average price per shoot should increase with 5.5 cents.
It is quite understandable that the combination substrate, such as wheeled benches with a layer of substrate, and assimilation lighting (6) is much too expensive compare to the production increase.

7 Post-harvest

Alstroemeria is one of the crops that are very sensitive to ethylene. The plant itself produces ethylene. High concentrations of C_2H_4 cause a rapid senescence, which is shown as yellow leaves. Yellowing of the leaves reduces the vase life of Alstroemeria. It can be postponed with a treatment of gibberellins (16). A low concentration of GA_4 (0.035 mg per litre) increased the vase life with 34%. Other gibberellins, such as GA_8 or GA_{13}, don't have good results. Two years later in a new research the best results were obtained with a concentration of 0.0035 mg per litre. It is commercially available in CIRO Alstroemeria VB or Chrysal SVB2. This new method to increase vase life is tested at the auction with positive results and it must be used since September 8, 1994 for all the Alstroemeria varieties that were brought to the flower auctions.
Via an ELISA test (9) it can be shown that the grower used the correct concentration of the pre-treated compound.
The shoots were taken to the auction in a rather early stage. But from time to time there was a suggestion to deliver the flowers more open to the auctions, because it was noticed that in that stage the second and third bud opens better. Via a market research of the auction it is shown that it is desirable for the export to deliver alstroemeria with buds in a coloured stage, like the growers do now.

8 Diseases

In the cultivation of alstroemeria the integrated pest management is a common factor. Of all the insects whitefly is an increasing problem. A biological control agent is Encarsia formosa; chemical control agents include Admiral and Applaud. Both chemicals work against eggs and young larvae and are safe to Encarsia formosa.
With a starting red spider problem the use of Phytoseiulus persimilis is a good solution. If the attack of red spider is severe Vertimec or Nissorun can be used. Note that Vertimec is dangerous for the natural enemies (7) and there is a waiting time of two weeks after the treatment.

Another aspect is the integrated plant health care. During three years two Alstroemeria nurseries are followed intensively in scouting of the integrated fight against pest and diseases (17). The best distributors of pests and diseases are human bodies, working in the crop. Especially red spider mite and thrips are examples. New pests are coming in the nurseries via ventilators, doors or new plant material. In the neighbourhood of holes in the glasshouse and with open doors the first attacks of aphids, red spider mite and whitefly are found.
On a nursery in the north of the Netherlands (28) chemical and biological treatments were used. Together with his adviser the grower discussed every week what to do that week. Last year, in 2001, he put on the biological control once against aphids and whitefly and three times against thrips. The financial balance was € 0.15 and he liked to go to a maximum of € 0.25, because a chemical alternative is still available. At the end of the cultivation he uses Pirimor and Vertimec against insects and with the beginning of the new crop he starts again with a biological control.

In alstroemeria plants several viruses occur (59 and 62). In the year 1962 in Denmark, in 1981 in the UK and in 1985 In the Netherlands virus was officially found. The most important viruses are:
- alstroemeria- mosaic virus
- alstroemeria streak virus
- alstroemeria carla virus
- cucumber mosaic virus
- tomato spotted wilt virus

In the course of years other viruses were found, but there were incidental occurrences. To identify and characterise the viruses of alstroemeria an EU-project started in 1994. Researchers of 4 countries worked in this project and changed the results. Via the virus-free breeding of in vitro culture and adequate pest and disease control alstroemeria virus is hardly found in the culture in the greenhouses.

In 1994 there were two publications (12 and 58) related to soil fungicides. With the introduction of soil cooling more and more varieties were planted from March to June. In this period the radiation is rather high and the just planted crop is not yet covered, the soil temperature can easily increase and fluctuate. Especially in wet substrate such as peat it is recommended to spray Rizolex against rhizoctonia. Nowadays with soil cooling Rhizoctonia is not really a problem

In combination with nematodes pythium is found, in the summer period, in the cultivation of alstroemeria. The remedy (58) is to use in spring Nemacure against nematodes, so pythium can be prevented in summer. The nematode Pratylenchus bolivianus can be a serious problem in the cultivation (10). Alstroemeria is a sensitive host plant of this nematode. The start concentration of 24 P. bolivianus can cause damage. Growers have to be attentive to the presence of pythium and rhizoctonia. These can use the lesions as a gate. By sterilising the soil before planting infection can be prevented.

9 Mechanisation

Alstroemeria growers are looking for labour saving techniques. Trolleys on the heating pipes with a container filled with styromull to strew the reflection material regularly (26) are used. One man can do 1,0 ha per day. The strewer costs about 2000 guilders (= € 1000).
In the barn, just after the grading machine the bunches with shoots must be placed in a container with water and pre-treatment material (or plantnutrition). In the old-fashioned way it was done by hand. Now-a-days it is done with an automatic container filler. This machine saves 160 man hours per year. The machine is delivered by Schijf Tuinbouwtechniek and costs about 6000 guilders (= € 3000).

Grading of the shoots is a matter of 'eye' and 'hand'. Of course later on the shoots are automatically bunched. But two manufactures of grading machines, Olimex and Aweta, try to construct a special alstroemeria grading machine based on a rose grading machine (49). It is possible to measure not only the thickness of the stems, but also the firmness of the stems. In the Applied Research Station (PPO) in Naaldwijk Verkerke (53) developed a test to measure the firmness of the stem of alstroemeria carefully and objectively. This test is able to characterise the shoot firmness and to measure the differences between varieties and nurseries. It seems that the growers cause the border value of the firmness between first and second class of the different varieties. The measurement seems to be able to be built in a grading machine. The results of the research are given to the grading machine builders.

10 Economic aspects

Setting up an up-to-date, new alstroemeria nursery in The Netherlands requires an investment of €118/m^2 with a glasshouse area of 15,000 m^2. This investment is rather high because growing is done with soil cooling and mostly with a recirculating water supply system. In addition lighting of the crop is necessary, partly on business-economic grounds, partly from the point of view of competition, to be able to realise the desired quality and yield in winter. Flue gas purification and heat storage, particularly with respect to efficient energy use when generating one's own electricity, make light an expensive investment. The annual costs of the investment amount to more than € 18, -/m^2, taking all aspects mentioned above into account. The general business costs for contributions, insurance and tax result in an additional € 2.40.

The balance is the difference between yield and the direct costs, the costs directly associated with the production in a certain year. It is an important economic index relating to the financial affairs around the crop and nursery. Both for comparing crops and for comparing nurseries, and for determining the position of the nursery the balance sheet offers good possibilities. The information on balance calculation and the standard to be retained for the various crops can be found in the Quantitative Information for Glasshouse Horticulture (61). The balance calculation is presented in table 3, 4, 5 and 6. The data recorded in KWIN set the standard for a modern business situation and as a result are not representative for the average nursery. For yield determination not only the production is relevant but also the distribution of the production per year. The auction price for Dutch supply, which is used for yield calculation, fluctuates in the course of the year. Therefore, both yield and price are presented per 4- week period. The labour required is associated closely with the production, in which both total production and distribution over the year are important. It is known from labour studies (14) that the labour requirement per harvest is determined by both the number of stems to be harvested and the number of alstroemerias to be harvested per linear meter bed.

In the balance calculation a distinction is made between a one-year old crop and a multi-year crop. During the year the yield is slightly lower, and in addition the costs for plant material and soil cooling are only in the first year of cultivation. In the accounts, the reduced balance is regarded as an investment, which is written off in subsequent years.

Table 3- Balance budget for perennial cut flowers per gross m2 excl. VAT

Cultivation : Alstroemeria Rebecca, cooled
Component : Initial year
Planting period : early May
harvest period ; year-round

Yields

period	number stems	price	Monet. Yields.	gas cons.	gr. labour / 1000 m2
5				1.7	35
6				0.5	5
7	4	0.12	0.48	0.8	15
8	15	0.09	1.35	0.5	45
9	33	0.12	3.96	0.6	80
10	14	0.13	1.82	1.2	50
11	27	0.17	4.59	1.8	80
12	18	0.18	3.24	4.2	60
13	15	0.18	2.70	5.6	50
1	11	0.20	2.20	5.8	40
2	8	0.19	1.52	5.6	35
3	11	0.18	1.98	3.9	40
4	14	0.13	1.82	2.9	45
total (A)	**170.0**	**0.15**	**25.66**	**35.0**	**580**

Attributed costs

balance entry	Quantity	price	Amount
plant material	3.1	8.05	24.97
gas (heating) (m^3)	35.0	0.184	6.44
gas (CO_2) (m^3)		0.184	
gas (sterilisation) (m^3)	6.0	0.184	1.10
lightning (kWh)		0.068	
crop protection			0.34
fertilization			0.27
source cooling electra			0.50
packing			0.59
auction costs	25.66	9.5%	2.44
interest circul. capital.	24.97	3.5%	0.87
Total (B)			**37.53**
balance (A-B)		**€**	**-11.87**

Starting points:

- source cooling
- costs plant material include licences for 5 years
- cultivation period 5 years
- incl. CO_2

Table 4 - Balance budget for perennial cut flowers per gross m2 excl. VAT

Cultivation : Alstroemeria Rebecca, cooled
Component : Fully productive
Planting period :
harvest period ; year-round

Yields

period	number stems	price	monet. yields.	gas cons.	gr. labour / 1000 m2
5	31	0.10	3.10	1.7	75
6	21	0.11	2.31	0.5	55
7	21	0.12	2.46	0.8	55
8	21	0.09	1.89	0.5	55
9	22	0.12	2.64	0.6	60
10	21	0.13	2.73	1.2	70
11	15	0.17	2.55	1.8	55
12	16	0.18	2.88	4.2	55
13	12	0.18	2.21	5.6	45
1	5	0.20	1.04	5.8	25
2	10	0.19	1.90	5.6	40
3	15	0.18	2.70	3.9	45
4	20	0.13	2.60	2.9	55
total (A)	**230.0**	**0.13**	**31.01**	**35.0**	**690**

Attributed costs

balance entry	quantity	price	Amount
plant material			
gas (heating) (m^3)	35.0	0.184	6.44
gas (C02) (m^3)		0.184	
gas (sterilisation) (m^3)		0.184	
lightning (kWh)		0.068	
crop protection			0.34
fertilization			0.32
source cooling electra			0.61
packing			1.13
auction costs	31.01	9.5%	2.95
interest circul. capital.			
Total (B)			**12.51**
balance (A-B)		€	**18.50**

Starting points:
- source cooling
- costs plant material include licences for 5 years
- cultivation period 5 years
- incl. CO_2

Table 5- Balance budget for perennial cut flowers per gross m2 excl. VAT

Cultivation : Alstroemeria Rebecca, cooled
Component : last year
Planting period :
harvest period ; year-round

Yields

period	number stems	price	monet. yields.	gas cons.	gr. labour / 1000 m2
5	31	0.10	3.10	1.7	75
6	21	0.11	2.31	0.5	55
7	21	0.12	2.46	0.8	55
8	21	0.09	1.89	0.5	55
9	22	0.12	2.64	0.6	60
10	21	0.13	2.73	1.2	70
11	15	0.17	2.55	1.8	55
12	16	0.18	2.88	4.2	55
13	12	0.18	2.21	5.6	45
1	5	0.20	1.04	5.8	25
2	10	0.19	1.90	5.6	40
3	15	0.18	2.70	3.9	45
4	20	0.13	2.60	2.9	155
total (A)	**230.0**	**0.13**	**31.01**	**35.0**	**790**

Attributed costs

balance entry	quantity	price	Amount
plant material			
gas (heating) (m^3)	35.0	0.184	6.44
gas (CO2) (m^3)		0.184	
gas (sterilisation) (m^3)		0.184	
lightning (kWh)		0.068	
crop protection			0.34
fertilization			0.32
source cooling electra			0.61
packing			1.13
auction costs	31.01	9.5%	2.95
interest circul. capital.			
Total (B)			**12.51**
balance (A-B)		**€**	**18.50**

Starting points:

- source cooling
- costs plant material include licences for 5 years
- cultivation period 5 years
- incl. CO_2

Table 6 –Calculation average year balance (per gross m^2)

Balance calculation of an average year-m^2
Cultivation : Alstroemeria Rebecca, cooled
Cultivation period : 5 years

cultivation year	phase	costs	Yield	part	balance
initial year	1	37.53	25.66	20.0%	- 2.37
first FP year	2	12.51	31.01	20.0%	3.70
second FP year	3	12.51	31.01	20.0%	3.70
third FP year	4	12.51	31.01	20.0%	3.70
last year	5	12.51	31.01	20.0%	3.70
Total					**12.43**
Balance per average year-m^2				**€**	**12.43**

The average balance that can be realised over a 5-year cropping period appears to be insufficient to cover the costs of labour, depreciation and interest of the investment and the general business costs on a modern Dutch alstroemeria nursery.
The average alstroemeria nursery does not seem to be capable of a profitable exploitation either, but the height of the various costs may sometimes be slightly different.
Standard figures on the capital demand, the labour requirements and the height of the balance posts are thus not a guideline to be followed, but an indication to compare one's own situation with.

In 1998 a group of growers, who like to give a certain quality brand to there product made a co-operation together with seven alstroemeria growers and three zantedeschia growers, called Alpha 1 (41). The quality of the product is factor one. The members have the duty to deliver their product in the package what the buyer wants. Regularly samples are taken for the products in the auction to check whether the product has the desired quality . The Alpha members take care of the prescription of the environment demands and labour processes.

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