2.3 Integrated pest management: the case of flower bulb Production in the Netherlands

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1. Introduction

In the second part of this century the bulb-growing industry in the Netherlands and in other bulb-producing countries had to cope with two major societal changes. Between roughly 1950 and 1980 a sharp increase in the costs of labour without a concomitant rise in bulb-selling prices forced farmers to scale up, to intensify and to replace labour by capital-intensive machinery. The concurrent introduction on the market of various groups of pesticides with a then unprecedented efficacy and reliability compensated for the additional risks emanating from intensification, mechanical handling and reduced attention to the crop.

Since the early eighties the bulb-growing industries have to cope with a second major challenge: the society. The markets are becoming increasingly demanding, not only with regard to product quality, but also with regard to the quality of the production process. Application of improved analytical techniques showed that pesticides or their break-down products occur in low but detectable amounts in almost all environmental compartments, e.g., in soil, ground and surface water, and in the air (Faasen, 1992; Van Aartrijk et al., 1995; MJP-G, 1996; Jansma and Linders, 1995; Hopman et al., 1992). Eco-toxicological effects of such contaminations have been shown. To avoid further ecological damage, the regulations set by governments for the registration of existing and new pesticides have been tightened. As a consequence, the number of available, registered active compounds is decreasing and will presumably show a further decline in the future, especially for smaller crops. This development is stimulated further if target organisms become resistant against specifically acting pesticides.

A new concept for crop protection in the future was formulated in the late eighties in The Netherlands. This concept aims at reducing the dominant role of pesticides in crop protection and consists of four strategies:

- a reduction of the dependence on pesticides,
- a reduction of the volume of detrimental pesticides used,
- a reduction of the emissions to environmental compartments, brought about by pesticide applications, and
- a re-evaluation of the registration of the pesticides used.

This article summarises part of the progress and problems in the process of adjustment of the bulb industry in the Netherlands.

2. Characterization of the flower bulb industry

The acreage of flower bulbs in the Netherlands is increasing slowly but steadily, and amounted to 18,650 ha in 1996 on 3000 farms (Voortgangsreportage, 1997). Most of the flower bulbs are still grown in the coastal sandy regions of the provinces of North and South

Holland and Flevoland, but there is a tendency of spreading to heavier soils and other regions (Table 1).

Table 1. Acreage of flower bulbs in different regions in the Netherlands.

Province	Acreage (ha)	Acreage (% of total)
North Holland	11,265	60
South Holland	2,685	14
Flevoland	2,052	11
Brabant/Limburg	1,044	6
Gelderland/Utrecht	339	2
Zeeland	290	2
Other	975	5

With regard to the acreage, tulips and lilies are the most important crops (Voortgangsreportage, 1997), as illustrated in Table 2. Flower bulb culture is a knowledge- and capital- intensive process (planting stock, suited soils, buildings, storage cells, and machinery). Annual yields per ha may amount to Dfl 10,000 - Dfl 100,000. Consequently, growers tend to avoid unnecessary risks as much as possible. Inputs of pesticides have been and are regarded as effective means of reducing production risks. In 1988 (Anonymous, 1991) annual inputs of pesticides were estimated to be 123 kg a.i. per ha. Major changes in the production process, such as required in disease management, increase the grower's perception of production risks. Therefore, changes are generally realised in a step-by-step manner.

Table 2. Acreage of flower bulbs for different crops.

Crop	Acreage (ha)	Acreage (% of total)
Tulip	8,747	47
Lily	3,289	17
Gladiolus	1,569	8
Narcissus	1,473	8
Hyacinth	1,067	6
Iris	677	4
Other	1,828	10
Total	18,650	100

3. Organisation of the turn-around process

Realisation of major changes in the organisation of a single firm with a clear hierarchy generally requires much effort and perseverance. This is the more so for large, diffusely organised structures as the bulb industry, consisting of thousands of private farms. Therefore, at first the Dutch bulb industry has created a broad forum, the so-called 'Milieuplatform', to co-ordinate measures and the policy on pesticide use. Then, the joint bulb industry and various national and local authorities formulated and signed a covenant on reduction of pesticide use and emissions to the environment (Convenant, 1995). In regular consultations of the various organisations (such as ministries, provinces, municipalities, water-boards, 'Milieuplatform') decisions are taken on priorities and measures. This so-called

'Doelgroepoverleg' publishes an Annual Report describing the progress and the problems in the process.

If progress is hampered by a lack of knowledge or techniques, projects are formulated and carried out to gather the necessary information. Disease management in the future, which will be less dependent on pesticide use, requires a lot of knowledge to be produced in research programmes carried out by various organisations. In the next chapters an overview will be given of recent developments with regard to the various strategies.

4. Independence of pesticides

Realisation of this strategy is very time-consuming. Various approaches can be distinguished:

4.1 Breeding techniques and resistance breeding

Increased attention is paid to the improvement of breeding techniques - especially in tulip and lily - in order to extend the options for genetic recombination. Transformation and genetic modification were realised for lily (Langeveld et al., 1995; Langeveld, 1996; Van der Leede-Plegt et al., 1995), tulip (Wilmink et al., 1995), and gladiolus (Kamo et al., 1995a; Kamo et al., 1995; Straathof et al., 1997). Crossing barriers between distantly related species of tulip and lily were analysed and *in vitro* techniques were developed to overcome such barriers. As a result, crosses could be made between -until recently- incompatible species (Kerckhoffs and Meyer, 1993). Cultivation *in vitro* of microspores of tulip resulted in the regeneration at low frequency of haploid offspring (Van den Bulk et al.,1994), which offers a perspective for acceleration of breeding programmes in this crop.
Resistance breeding programmes were carried out in lily, gladiolus, and tulip. The main emphasis is on diseases caused by more or less specialised pathogens such as
- formae speciales of *Fusarium oxysporum* in lily (Straathof et al., 1994; Straathof et al., 1994), gladiolus (Straathof et al., 1996; Straathof et al., 1997) and narcissus (Linfield, 1994),
- viruses (tulip breaking virus, lily symptom-less virus), and
- *Botrytis tulipae* in tulip.

4.2 Biological control

A completely different approach, i.e. biological control in its broadest sense, was chosen to control some other, generally less specialised parasites.

The first biological control agent introduced into practical flower bulb culture is the predatory mite *Hypoaspis aculeifer*, which was shown to be very effective against *Rhizoglyphus* mites in lily (Lesna et al., 1996). The gladiolus thrips *Taeniothrips simplex* can be controlled equally well by various predators, such as *Amblyseius barkeri* (Conijn, 1993). Economic barriers have prevented practical application in this crop as yet. Similar approaches offer good perspectives for the control of the dry bulb mite *Aceria tulipae* in tulips.

Polyphagous nematodes such as the tobacco rattle virus (TRV) -transmitting Trichodoridae and the root-lesion nematode Pratylenchus were controlled by preventive soil fumigation in the past. Results in recent years (Asjes et al., 1996) showed that Trichodorids are attracted to roots by root-produced chemical stimuli, the reach of which is dependent on soil type and soil-water flux. Laboratory and field experiments have shown that interception of the stimulus, e.g., by organic matter, prevented nematode migration and, consequently, TRV transmission and plant damage. Inter-cropping of subsequent bulbous crops with specific non-hosts, e.g. easy to grow *Tagetes spp.* against Pratylenchus and black raddish against Trichodorids and TRV, can also considerably reduce risks on bulb yield and quality (Asjes et al., 1996; Conijn, 1994).

Sandy soils used for flower bulb or bulb flower cultivation in the Netherlands appear to be relatively conducive to the soil fungus *Pythium spp.*, especially after soil treatments such as steam sterilisation, fumigation, or flooding and if suitable nutrient sources are available in the soil (Van Os, 1995; Van Bruggen and Duineveld, 1996). In the laboratory, well-timed introduction of a specific antagonist *(Laetisaria arvalis)* or a less-defined mixture of mesofilic organisms in compost could render suppressiveness against Pythium, thus reducing risks on infection. Ongoing experiments will make clear whether these effects can also be realised under greenhouse and field conditions.

A similar approach was chosen for the control of *Rhizoctonia solani* (Schneider et al., 1996).

4.3 Healthy mother stock

Special attention to disease-free mother stock is a common feature in bulb cultivation and very effective for the control of a broad range of menacing organisms.

In a long-term program, efforts were and are made to improve the virus situation in bulbous crops. In recent years, application of ELISA-tests on dahlia tubers used for the production of cuttings resulted in a sharp decline of tomato spotted wilt virus (TSWV)-incidence in this crop, thus preventing a possible need for intensive crop sprays to prevent spread of this virus by thrips vectors (Asjes and Blom-Barnhoom, 1997; Derks and Lemmers, 1996; Van Schadewijk-Nieuwstadt and Derks, 1995). Virus-free plantlets were produced by meristem culture of hyacinth cultivars bearing hyacinth mosaic virus. An improved technique was developed for meristem culture of bulbous iris (Van Schadewijk-Nieuwstadt M and Derks 1995).

Hot-water treatments are already successfully applied on a large scale to control stem nematodes (*Ditylenchus spp.*) and various insects and mites. Such treatments were optimised in recent years for lily to control root-borne *Pratylenchus penetrans* (Conijn, 1996) and are being developed or modified for a number of special crops, such as *Allium spp.*, Hippeastrum, Colchicum, Fritillaria, Galanthus, Erythronium and various other geophytes (e.g., Aconitum, Hosta, Phlox) (Muller, 1994; Van Leeuwen and Van der Weijden, 1994; Van der Meij, 1998; Van Leeuwen and Van der Weijden, 1993; Van Leeuwen et al., 1993).

4.4 Diagnosis

Reduced availability or use of pesticides also emphasises the need for rapid and discriminative tools for diagnosis. In the past few years a computer-based expert diagnosis system EXSYS was developed for bulbous iris (Kramers et al., 1997). This system is now being tested by potential users. Extension of EXSYS to other crops awaits the results of this testing period.

Improved identification techniques were developed, often on subspecies level, for various viruses (Derks et al., 1994; Derks and Lemmers, 1996; Langeveld et al., 1997), fungi (formae speciales of *Fusarium oxysporum,* AG-groups of *Rhizoctonia solani,* and *Pythium spp.*) (Mes et al., 1994a; 1994b, Schneider et al., 1997), and for *Xanthomonas campestris* pv. *hyacinthi,* the cause of yellow disease in hyacinth (Van Doorn, 1993; Van Doorn, 1995).

5. Reduction of pesticide volume

This strategy is still based on the use of pesticides, be it in dosages and application frequencies as low as possible and with pesticides selected for relative environmentally friendly characteristics. A few approaches can be distinguished. Generally, these approaches are less knowledge-intensive and their development less time-consuming. Major steps can be made and have been made in a relatively short period.

5.1 Guided control

A computer model is developed and tested, that based on a regional 5-day leaf-wetness forecast calculates as to whether the Botrytis-infection risk will exceed a threshold level, taking into account genotype susceptibility and moment of the last pesticide treatment. Additionally, if a crop spray is calculated to be necessary, the related 5-day weather forecast also allows the selection of a suited spraying period. Such a guided control system for 'fire' has been tested for several years in lily, tulip, and gladiolus. Preliminary results indicate that adequate control can be realised using 20-100% less fungicides (Bastiaansen et al., 1997). In 1998, such a warning system for lilies will be introduced on the market. Other examples of guided control relate to Pratylenchus and TRV. A decision as to fumigate soils (or to apply other control measures) is made only when the population density of Pratylenchus or the TRV-infection pressure in the soil exceeds set threshold values. Both control systems show clear perspectives but have to be optimised yet.

A final example of a guided control system is in weed control. Instead of preventive treatments with soil herbicides crop sprays with very low herbicide concentrations are applied when a 'flux' of tiny germinated weeds can be observed. In gladiolus and iris, some of the crops for which the technique has been developed already, a reduction of roughly 50% in herbicide use is possible (Koster et al., 1996; Koster et al., 1994). Except for tulip and hyacinth, the technical prospects for other crops are good.

5.2 Reconsideration of existing recommendations and techniques

Considerable reduction of pesticide volumes and emissions were also achieved by critical reconsideration and fine-tuning of existing recommendations. To give some examples:

- adjustments of the recommended crop treatments for the control of Botrytis allowed a lower crop-spraying frequency and a 50% or more reduction in active compounds sprayed (Koster and Van der Meer, 1992; Koster et al., 1994).
- decreased susceptibility for viruses after flowering of lily allowed a 50% lower frequency of sprays against aphid-transmitted viruses after flowering (Asjes, 1993).
- changing from specific to more or less uniform bulb disinfection treatments for the various bulb crops reduced the amount of fungicides required and of immersion-bath remnants.
- Site-specific application of pesticides. Examples are in furrow treatments instead of field applications of soil fungicides against *Rhizoctonia spp.* (Koster and Van der Meer, 1988) and plant row instead of field treatments with herbicides. The latter system is being investigated now in combination with mechanical weed control in between the plant rows and in the paths.

6. Reduction of emissions

This strategy aim at the reduction of emissions of pesticides to environmental compartments in addition to the reductions brought about by the decrease in pesticide use. Extensive field experiments revealed that the most important emission pathways to surface water are related to spray-drift and to farm buildings. Leakage of pesticides to soil and surface water is of minor or no importance for most pesticides (Van Aartrijk et al., 1995). Various studies are carried out to reduce these sources for emissions (Van IJzendoorn et al., 1995; Beltman and Boesten, 1996; Wondergem, 1995; Porschkamp et al., 1997).

7. (Re)evaluation of pesticides

Based on criteria that are uniform in all countries of the European Union ('uniform principles') all existing and new pesticides will be reregistered resp. registered. In the Netherlands, applications of registered compounds will not be allowed to exceed threshold levels in various compartments. It is yet unclear for many applications what the consequences of this policy will be. It may well be that (applications of) certain registered compounds will be prohibited.
Moreover, the number of applicable compounds may also be limited by a purely commercial development: the registration of pesticides for application in minor crops becomes unprofitable for phyto-pharmaceutical industries. Probably, a system of 'off-label use' may contribute to solving this problem.

8. Evaluation and perspectives

The applied volume of pesticides in the bulb industry in the Netherlands decreased ever since 1988. In 1996 a reduction was realised of 43% compared to 1988 (after correction for changes in the acreage of various crops (Voortgangsrapportage, 1997)).

In experimental 'integrated farming' systems the actual reductions amount to 80 - 95%, depending on the crops grown, and new improvements are regularly introduced (Wondergem et al., 1997). At present, priorities are in control of virus diseases of lily, in weed control and in bulb disinfecting treatments.

Most of the bulb growers have invested in improved equipment for bulb disinfecting and in spray-drift reduction in order to reduce emissions to surface water. A large and rapidly increasing number of farms have received a so-called 'WVO-license' from water-boards to conduce their farms. Compulsory registration of pesticide use has given a clear insight in the application of pesticides. On the other hand, in 1996 and based on data from 'monitoring studies' no improvement of surface water quality could yet be established. These studies will be continued in coming years.

The process of reducing pesticide inputs by the bulb industry has shown to be slow and stubborn, due to its complexity, to risk perception and to resistance of vested interests. However, substantial progress has been made in the last 5 years and there is an increasing willingness for further adjustments. To realise further reductions, the economic situation of the farms must be adequate and emphasis should be given to demonstration and extension of new techniques and recently obtained knowledge. In 1998, in a large project called 'Bollenteelt 2000', a number of bulb farms will be intensively trained and guided in order to introduce principles of 'integrated farming' systems on these farms.

9. References

Anonymous (1991) Meerjarenplan Gewasbescherming. Staatsdrukkerij The Hague
Asjes CJ (1993) Virusverspreiding en -bestrijding in lelies: Complex van factoren bepaalt virusverspreiding. Bloembollencultuur 104 (12): 26-27
Asjes CJ and Blom-Barnhoorn GJ (1997) Incidence and control of thrips-borne tomato spotted wilt virus in dahlia in the Netherlands. Acta Hortic 430: 625-632
Asjes CJ, Zoon FC, de Hey A, de Boer FA and Maas PWTh (1996) Geïntegreerde beheersing van trichodoride aaltjes en tabaksratelvirus via tussengewassen en organische toevoegingen. Gewasbescherming 27: 17-18
Bastiaansen C, Koster AThJ, Van de Meer LJ, Van de Ende E, Pennock I, Groen NPA and Buurman FPM (1997) Vuurbestrijding: waarschuwingssysteem klaar voor praktijktest. Bloembollencultuur 108 (7), 26-27
Beltman WMJ and Boesten JJTI (1996) Emissies van bestrijdingsmiddelen bij het spoelen van bloembollen. Report 429 SC-DLO Wageningen The Netherlands
Conijn CGM (1993) Biological control of the gladiolus thrips Taeniothrips simplex on gladiolus corms in storage rooms with Amblyseius barkeri and Orius insidiosus. Med Fac Landbouww Univ Gent 58 (2a): 391-396
Conijn CGM (1994) Cultivation of *Tagetes patula* to control root rot in narcissus and lily caused by *Pratylenchus penetrans*. Med Fac Landbouww Univ Gent 59 (26): 807-811
Conijn CGM (1996) Lelieplantgoed: warmwaterbehandeling en invriezen doden veel wortellesie-aaltjes. Bloembollencultuur 108 (1), 36-37
Convenant ' Overeenkomst uitvoering milieubeleid bloembollensector' (1995). Doelgroepoverleg Bloembollensector Hillegom The Netherlands
Derks AFLM and Lemmers MEC (1996) Detection of tospoviruses in bulbous crops and their transmissibility by vegetative propagation. Acta Hortic 432: 132-139
Derks AFLM, Lemmers MEC and Van Gemen BA (1994). Lily mottle virus in lilies: characterization, strains, and its differentiation from tulip breaking virus in tulips. Acta Hortic 377: 281-288
Faasen R (1992) Landbouwbestrijdingsmiddelen in oppervlaktewater een situatieschets. H_2O 25(2): 30-33
Hopman R, Janssen HMJ, Van Beek CGEM and Puijker LM (1992) Speurtocht naar bestrijdingsmiddelen in de bronnen voor de drinkwaterbereiding. H_2O 25(7): 176-185
Jansma JW and Linders JBHJ (1995) Volatilization of pesticides from soil and plants after spraying. Repno 67910203. National Institute of Public Health and Environmental Protection Bilthoven The Netherlands
Kamo K, Blowers AD, Smith F and Van Eck J (1995a). Stable transformation of Gladiolus by particle gun bombardement of cormels. Plant Science 110: 105-111
Kamo K, Blowers AD, Smith F, Van Eck J and Lawson R (1995a) Stable transformation of Gladiolus using suspension cells and callus. J Amer Soc Hort Sci 120: 347-352
Kerckhoffs DMFJ and Meijer B (1993) New genetic variation in Lilium and tulip by wide hybridization. Proc XVIIth Eucarpia Congress San Remo Italy pp141-149
Koster AThJ and Van de Meer LJ (1988) Veurbehandeling tegen Rhizoctonia kan nog efficiënter. Bloembollencultuur 99 (20): 26-27
Koster AThJ and Van de Meer LJ (1992). Control of Botrytis spp. in tulip with reduced input of chemical crop protectants. In: Recent advances in Botrytis research. Proceedings Xth Int Botrytis Symp Heraklion Greece pp277-281
Koster AThJ, Brooymans EACM, Bastiaansen C, Van de Meer LJ, Buurman FPM and

Schouten CAM (1994) Vuurbestrijding lelie: Allure goede vervanger voor zineb/maneb. Bloembollencultuur 105 (11): 34-35
Koster AThJ, Van de Meer LJ, Buurman FPM and Schouten CAM (1994) Onkruidbestrijding in gladiool: minder middel nodig met lage-dosering-systeem. Bloembollencultuur 105 (8): 44-45
Koster AthJ, Van de Meer LJ, Kok H and Van Aanholt H (1996) Besparing op middelen mogelijk: lage-dosering-systeem biedt perspectief bij onkruidbestrijding iris. Bloembollencultuur 107 (5): 44-45
Kramers M, Conijn CGM and Bastiaansen C (1997) EXSYS, an expert system for diagnosing flowerbulb diseases. Acta Hortic 430, 651-656
Langeveld SA (1996) Introductie van virusresistentie in lelie door middel van genetische modificatie. Report Bulb Research Centre The Netherlands
Langeveld SA, Derks AFLM, Konicheva V, Munoz D, Zhinnan C, Denkova ST, Lemmers MEC, Boonekamp PM (1997) Molecular identification of potyviruses in Dutch stocks of Onarcissus. Acta Hortic 430 641-648
Langeveld SA, Marinova S, Gerrits MM, Derks AFLM and Boonekamp PM (1995) Genetic transformation of lily. Acta Hortic: 430, 290
Lesna I, Sabelis MW and Conijn CGM (1996) Biological control of the bulb mite *Rhizoglyphus robini* by the predatory mite *Hypoaspis aculeifer* in lilies: predator-prey interactions at various spatial scales. J Appl Ecology 33: 369-376
Linfield CA (1994). An investigation into the detection, identification, differentiation and pathogenicity of *Fusarium oxysporum* f sp *narcissi*. PhD Thesis University of Reading UK 227 pp
Mes JJ, Van Doorn J, Roebroeck EJA, Boonekamp PM (1994a) Detection and identification of Fusarium oxysporum f sp gladioli by RFLP and RAPD analysis. In: Schots A Dewey FM and Oliver R Modern Assays for plant pathogenic fungi Identification detection and quantification. CAB International Oxford UK
Mes JJ, Van Doorn J, Roebroeck EJA, Van Aartrijk J and Boonekamp PM (1994b) Restriction fragment length polymorphisms, races, and vegetative compatibility groups within a world-wide collection of Fusarium oxysporum f sp gladioli Plant Pathology 43: 362-370
MJP-G Emissie-evaluatie (1996) Report IKC-LNV Ede The Netherlands
Muller PJ (1994) Aconitum napellus, bladaaltjes goed te bestrijden met warmwater-behandeling. Bloembollencultuur 105 (22): 11
Porskamp HAJ, Michielsen JMGP and Van de Zande J (1997) Driftbeperkende spuittechnieken voor de bloembollen. Report 97-08, IMAG-DLO Wageningen The Netherlands
Schneider JHM, Dijst G and Schilder MT (1996) Rhizoctonia solani in tulp en iris in relatie tot de bodemreceptiviteit. Report 96-05. IPO-DLO Wageningen The Netherlands 42pp
Schneider JHM, Salazar O, Keijer RV and Keijer J (1997) Identification of Rhizoctonia solani associated with field-grown tulips using ITS rDNA polymorphism and pectic zymograms. Eur J Plant Pathol 103, 607-622
Straathof ThP and Van Tuyl JM (1994) Genetic variation in resistance to Fusarium oxysporum f sp lilii in the genus Lilium. Ann appl Biol 125, 61-72
Straathof ThP, Jansen J, Roebroeck EJA and Löffler HJM (1996) Fusarium resistance in gladiolus:selection in seedling populations. Plant Breeding 116: 283-286
Straathof ThP, Löffler HJM, Linfield CA, Roebroeck EJA (1997) Breeding for resistance to Fusarium oxysporum in flowerbulbs Acta Hortic 430 477-486
Straathof ThP, Roebroeck EJA and Löffler HJM (1994). Screening for Fusarium resistance in seedling populations of Asiatic Hybrid lily. Euphytica 78: 43-51

Van Aartrijk J, Groenendijk P, Boesten JJTI, Schoumans OF and Gerritsen R (1995) Emissies van bestrijdingsmiddelen en nutriënten in de bloembollenteelt Report 387 SC-DLO Wageningen The Netherlands

Van Bruggen AS and Duineveld TLJ (1996) The effects of Laetisaria arvalis and compost on *Pythium ultimum* root rot in a tulip forcing system. Proc 4th 10BC/EFPP Workshop Dijon France. IOBC Bulletin 19(6)

Van den Bulk RW, De Vries-Van Hulten HPJ, Custers JBM and Dons JJM (1994) Induction of embryogenesis in isolated microspores of tulip. Plant Science 104: 101-111

Van der Leede-Plegt LM, Kronenburg-Van de Ven BCE and Franken J (1995) Pollentransformatie: een methode voor de produktie van transgene lelies. Report CPRO-DLO Wageningen The Netherlands

Van der Meij J (1998) Warmwaterbehandeling van vaste planten ter bestrijding van wortelaaltjes. Report Bulb Research Centre Lisse The Netherlands

Van Doorn J (1993) LBO ontwikkelt nieuwe monoklonalen: verbeterde toetsing op geelziek in hyacinteblad. Vakwerk 67 (12): 10-11

Van Doorn J (1995) Detectie van geelziek: van sera naar DNA. Bloembollencultuur 106 (9): 24-25

Van IJzendoorn MT, Van Koster AThJ, Schouten JAM (19??) Spuiten: evenveel middel, minder drift. Bloembollencultuur 106 (13): 38-39

Van Leeuwen PJ and Van der Weijden JA (1993) Galanthus, warmwaterbehandeling effectief tegen stengelaaltje. Bloembollencultuur 104 (9): 29

Van Leeuwen PJ and Van der Weijden JA (1994) Allium giganteum and A. aflatunense zonder schade koken, voorwarmte noodzakelijk. Bloembollencultuur 105 (12), 23

Van Leeuwen PJ, Van der Weijden JA and Muller PJ (1993) Fritillaria imperialis: bladaaltjes zijn met een warmwaterbehandeling goed te bestrijden. Bloembollencultuur 104 (11), 36-37

Van Os GJ (1995) Pythium-aantasting: het gevolg van een verstoord biologisch evenwicht. Report Bulb Research Centre, Lisse The Netherlands 38 pp

Van Schadewijk AR (1996) Detection of tomato spotted wilt virus in dahlia. Acta Hortic 432: 384-391

Van Schadewijk-Nieuwstadt M and Derks AFLM (1995) Virusvrij maken iris: meristeem en bolbewaring bepalen rendement. Bloembollencultuur 106 (12): 22-23

Voortgangsrapportage Doelgroepoverleg Bloembollencultuur 1996-1997 (1997) Hillegom, The Netherlands

Wilmink A, Van deVen BCE, Custers JBM, Van Tuyl JM, Eikelboom W and Dons JJM (1995) Investigations on the genetic modification of tulip. In: Bajaj UPS (ed) Biotechnology in agriculture and forestry, Vol. 34 'Plant Protoplasts and genetic engineering VI', 296-303

Wondergem MJ (1995) Gewasbeschermingsmiddelen en nutriënten in compost en percolaatwater. Report 95 Bulb Research Centre Lisse The Netherlands

Wondergem MJ, Jansma JE and Snoek AJ (1997) Geïntegreerde bedrijfssystemen Bloembollenteelt. Jaarverslag 1995/1996 Bulb Research Centre, Lisse The Netherlands