THE HORTICULTURAL DEVELOPMENT COUNCIL

BULBS AND OUTDOOR FLOWERS PANEL

A REVIEW OF OUTDOOR FLOWER PRODUCTION AND SCOPE FOR R & D

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FOREWARD

The project sets out to review outdoor flower production, including problems and scope for Research and Development.

It contains sections written in consultation with ADAS and HRI colleagues, and includes a literature review on 15 genera covering some 22 species of flower crops. It excludes flowers from bulbs and corms.

It identifies major limitations in crop production and priorities for Research and Development.

SUMMARY

The Review has made full use of the limited statistics on outdoor flower production; of world databases to search literature; of seed and plant sources; and knowledge and experience of specialist ADAS advisers, and HRI colleagues. It identifies major limitations in crop production and priorities for Research and Development.

The number of holdings in England and Wales growing flowers for cutting has increased by 35% over the 5 year period 1985 to 1989, from 723 holdings to 980. Over the four year period to 1989 UK sales of flowers per head of population have also increased although the UK is still a long way behind the majority of European countries.

A world-wide literature search was done on 15 genera encompassing 22 species of flowers. There were very few references to work done in the UK compared with the rest of the world which reflects the relative lack of recent R & D done in this country on outdoor flower crops.

A considerable number of seed and plant catalogues are available, some of which contain very detailed cultural information. However, there are no independant recommendations based on UK trials for seed rates or confirmation of those given in individual seed catalogues.

A wide range of species from different botanical families and genera constitute outdoor flowers which are amongst the smallest of the minor crop sectors in UK horticulture. It is not surprising therefore to find that there are few pesticides with specific label recommendations, especially for weed control, for use in these crops.

Details are given of pesticides with current label recommendations, as are pesticides considered to have potential, but with no label recommendation.

Priority items for research and development have been identified in the areas of weed control, disease control and the use of crop covers and mulches, where the product from relatively simple investigations can have a substantial benefit to growers. The specifications and equipment for the drying of flowers and grasses should also be considered.

The utilisation of this information, some of which may need translation, can be a useful alternative to commissioning unnecessary research and development.

INTRODUCTION

In recent years there has been an expansion in the production of a wide range of flower crops grown outdoors in the whole of the UK.

Cut flowers such as natural season chrysanthemums, hybrid pinks and annual crops from seed are widely grown and provide attractive alternatives to higher cost protected production.

Interest in dried flowers has never been greater; sales in this country have risen steeply in the last few years and are continuing to do so. There is an enormous range of species suitable for drying and 90% of these can be grown successfully in the UK. However, the industry is widely dispersed and will need to concentrate on production aspects and marketing demands.

Whichever crops are grown, techniques to achieve long-season quality production need to be developed and problems identified and solved.

PRODUCTION STATISTICS FOR OUTDOOR FLOWERS

1. Value and area of production in the UK

The lack of detailed statistics makes it difficult to arrive at an accurate value for outdoor flower production in the UK.

1.1 MAFF Basic Horticultural Statistics for the UK. FARM-GATE value of United Kingdom output at current prices; years 1979-1990 (£ million)

	1979-81 average	1986	1987	1988	1989	1990
Flowers in the open including bulbs	13.4	17.2	18.3	21.3	23.3	26.4
Other outdoor flowers excluding bulbs	-	7.9	8.3	11.2	12.9	15.2

Notes: Detailed data not available before 1981.

Separate data are not available for dried flowers. However, in 1990 the British Dried Flowers Association estimated the value of UK dried flowers at £15 m.

Sources: ADAS
Statistics (Agricultural Commodities) Division, Branch B.

1.2 MAFF Basic Horticultural Statistics for the UK

Area in the UK; years 1986-1990 (ha)

	1986	1987	1988	1989	1990
Other outdoor flowers	547	728	864	864	970

Source: MAFF Agricultural Census Branch

1.3 MAFF June Census (England and Wales); number of holdings

	1985	1986	1987	1988	1989
Number of holdings with dahlias	57	60	72	64	65
Number of holdings with chrysanthemums	123	127	154	154	154
Number of holdings with all other flowers for cutting	543	517	638	631	761
Total number of holdings	723	704	864	849	980

Note: The data in this table relate to main holdings, ie they exclude data on minor holdings

N/P = Not published

Source: MAFF Agricultural Census Branch

2. Imports of Cut Flowers to the UK

2.1 Imports into the UK of cut flowers, value for calendar year (trends); (£m)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Roses	3.1	2.7	3.6	3.8	4.8	5.9	7.7	8.5	10.7	12.4
Carnations	11.1	11.1	13.4	15.2	20.0	22.7	28.9	34.0	42.6	50.5
Chrysanthemums	NA	3.3	5.3	7.2	9.7	12.0	16.2	18.0	22.6	24.7
Others	7.6	5.5	7.1	8.0	10.3	14.3	17.8	23.4	31.6	41.7
Foliage, branches etc	1.5	2.1	2.5	3.1	3.4	4.0	4.5	5.4	6.3	8.3
Total value	23.3	24.7	31.9	37.3	48.2	58.9	75.1	89.3	113.8	137.6

Note: Excludes imports from the Channel Islands.

N/A = Not available

Source: HM Customs and Excise

3. Sale Trends

There has been a gradual increase in the purchase of cut flowers in the UK. The largest increase in sales is for home use. Consumer education to get the "best value for money" is very important at this stage in the evolution of a new buying habit.

The 1989 sales of cut flowers per head of population for 11 European countries is given below. Over the past 4 years UK sales have increased - 4.3 times more flowers were bought by the Dutch in 1984 compared with the UK, whereas in 1989 this was reduced to 3.3 times.

3.1 Sales of cut flowers/head of population, 1989. (3.2D.Fl=£1).

	£
Holland	23.44
Italy	21.25
Switzerland	21.25
W. Germany	19.69
Belgium	16.56
Sweden	15.63
Austria	13.13
France	12.50
UK	7.19
Spain	3.75
Norway	3.75

Source: Dutch Flower Council

4. Flower types

The biggest increase in flower types has been the newer range of "summer flowers" or alternative cut flowers. Mostly these are used in mixed bunches known in Holland as a 'Biedermeier' bunch which is a bouquet of mixed summer flowers including chrysanthemums and carnations. Several other colour co-ordinated flowers from a huge range of traditional herbaceous plants are added to extend the variety and range. These flowers can be grown outdoors, as well as under protection to extend the season or can be imported from warmer climates in the northern hemisphere or from southern hemisphere countries out-of-season. The bunches are usually assembled at the flower auctions (in Holland) or by marketing organisations.

4.1 Flowers in Dutch auctions

Total Number of Species: 105
Total value of all cut flowers = £1 billion

No 1. Roses
No 105. Stephanotis

The largest volumes were:

mini-roses	1.4 billion stems
spray chrysanthemums	1.1 billion stems
spray carnations	0.7 billion stems
single tulips	0.7 billion stems
large flowered roses	0.6 billion stems

List of those with over 100% increase in supplies in 1989-1990

Position in volume order	Species	Method of sale or colours
18	Trachelium	(bunches)
19	Delphinium	(perennial)
25	Eustoma	
26	Chamelaucium	(tropical spray)
28	Phlox andresii	
28	Phlox drummondii	
42	Bupleurum	
50	Ranunculus	(red, yellow, white)
51	Zantedeschia	
54	Asclepias tuberosa	
54	Asclepias incarnata	
59	Callistephus	(stem)
63	Hypericum	(stem)
66	Chelone	(bunch)
67	Eupatorium	(white)
71	Cersium	(pink)
82	Symphoricarpus	(bunch)
83	Ananas	(small fruited)
84	Hydrangea	
88	Astrantia	(pink)
89	Atriplex	
91	Ageratum	

93	Leucadendron	
97	Godetia	(stem and bunch)
99	Myosotis	

Source: "Vakblad voor de Bloemisterij", Issue No. 44A, 3 November 1990

It is clear there has been an increase in the production of outdoor flowers in the UK and also a much greater volume of sales for a widening range of flowers on the Dutch auctions.

SOME ASPECTS OF PRODUCTION TECHNOLOGY

A. DATABASE REFERENCES

A literature search was done on 15 genera encompassing 22 species of cut flowers, dried flowers and grasses. The databases consulted were: Agricola; Agris; Biosis; CABI and Update. The following research, development and review reports and articles were identified, mainly published in the period 1980-1990.

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3.1 Bing, A.; 'Post plant pre-emergence weed control in field grown bedding plants 1981'; L.I. Hortic. Res. Lab., Riverhead, NY; Proceedings of the 36th annual meeting of the North-eastern Weed Science Society, New York City, NY, USA, Jan. 5-7, 1982. Proc Northeast Weed Sci Soc 36 (0). 1982 261-265.

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16.2 Agamalian, H.S.; 'Weed Control in field grown and greenhouse flower crops'. Proceedings, 39th annual California Weed Conference. Co-operative Extension Service, Univ. California, Salinas, CA 93901, USA. El Macero, California, USA 1987. 125-127.

16.3 Lamont, G.P.; O'Connell, M.A.; 'An evaluation of pre-emergent herbicides in field-grown cut flowers'. NSW Dep. of Agriculture, Gosford, NSW 2250, Australia. Plant Protection Quarterly 1986. 1 (3): 95-100 (14 ref).

16.4 Gilreath, J.P.; 'Response of gladiolus, statice and gypsophila to residues of pre-emergence herbicides'; Univ. Florida, IFAS, Gulf Coast Res. and Education Cent. 5007 60th Street East, Bradenton, FL 34203, USA. Proceedings of the Florida State Horticultural Society 1986. 99 275-278.

16.5 Paparozzi, E.T.; McCallister, D.E.; 'Glycerol and microwave preservation of annual statice (Limonium sinuatum Mill.).' Nebraska Univ. Lincoln, NE 68583-0724, USA. Scientia Horticulturae 1988. 34 (3/4): 293-299.

16.6 Lamont, G.; 'Herbicide evaluation trials on cut flowers'; NSW Dep. Agric., Narara Research Station, Gosford, NSW, Australia. Australian Horticulture 1986. 84 (7): 89-91.

16.7 Hatterman, H.M.; Shea, P.J.; Paparozzi, E.T.; 'Weed Control in Statice'; Dep. Hort., Univ. Nebraska, Lincoln, NE 68583, USA. Weed Science 1987. 35 (3): 373-376.

16.8 Gilreath, J.P.; 'Response of Statice to selected herbicides'; Gulf Coast Res. and Education Cent.; IFAS, Florida Univ., Bradenton, FL 34203, USA. Proceedings, Southern Weed Science Society, 38th annual meeting.

16.9 Jones, J.B.; Engelhard, A.W.; 'Crown and leaf rot of statice incited by a bacterium resembling Pseudomonas caryophylli'. 'IFAS, Univ. Florida, Agric. Res. Educ. Cent., Bradenton 34203, USA. Plant Disease 1984. 68 (4): 338-340.

16.10 Engelhard, A.W.; 'Etiology, symptomatology, and economic importance of the diseases of annual statice (Limonium spp); Univ. Florida, Agric. Res. Educ. Cent., Bradenton, USA. Plant Disease Reporter 1975. 59 (7): 551-555.

16.11 Cox, R.S.; 'Sclerotium rolfsii on statice'; 1404 Shirley, Court, Lake Worth, Fla. Plant Disease Reporter 1972. 56 (8): 656-657.

16.12 Healy, W.E.; Espinosa, I.; 'Producing cut flowers - florists statice'; FACT sheet - Co-operative Extension Service, University of Maryland. 1988/1989. (469) 3P.

16.13 Skroch, W.A.; Catanzaro, C.J.; Yonce, M.H.; 'Response of nine herbaceous flowering perennials to selected herbicides'; North Carolina State University, Raleigh, NC. Journal of environmental horticulture. March 1990. v. 8 (1) p 26-28.

16.14 Gilreath, J.P.; 'Pre-emergence weed control in statice'; University of Florida, Bradenton, FL. HortScience. Oct 1989. v. 24 (5) p 794-796.

17.0 Statice tataricum syn. S. dumosa (German Statice)

17.1 Agamalian, H.S.; Elmore, C.L.; Farnham, D.S.; 'Weed control in German Statice'; Progress Report. California University Co-operative Extension, Monterey Counties, California, USA. Flower and Nursery Report 1975 (July/August): 4-5.

17.2 Fischer, H.J.; 'How we grow delphinium, larkspur, liatris, German statice and gypsophila'; Commercial field production of cut and dried flowers: a national symposium, December 6-8, 1988; sponsored by the Center for Alternative Crops and Products, Univ of Minnesota and the American Soc of Horticultural Science. p. 147-151.

B. RESEARCH AND DEVELOPMENT IN EUROPE

A major source of information is work done in Holland at the following research and experimental stations:-

1.0 Glasshouse Crops Research Station, Kruisbroekweg 5, P O Box 8, 2670 AA Naaldwijk, The Netherlands; Tel: (010-31-1740) 36700.

The following publications (in Dutch) include information on outdoor flower crops:

i. Booklet 15 "Production of Summer Flowers Outdoors and Under Glass". Part I; March 1984; Price D Fl 17.50.

ii. Booklet 22 "Production of Summer Flowers Outdoors and Under Glass", Part II; May 1986; Price D Fl 20.00.

2.0 Research Station for Floriculture, 2a Linnaeuslaan, 1431 JV Aalsmeer, The Netherlands; Tel: (010-31-2977) 52525.

3.0 Rijnsburg Experimental Station, Laan van Verhof 1, Rijnsburg, The Netherlands.

An annual report is published which summarises work in progress on outdoor flower crops (in Dutch).

C. SEED AND PLANT SOURCES

1.0 Seed and plant catalogues for cut flowers (fresh) (excluding chrysanthemums, dahlias and hybrid show pinks)

There are no independent recommendations based on UK trials for seed rates or confirmation of those given in individual seed catalogues; seed rates tend to be high, most probably to allow for variation in % germination from year to year.

Not every seed and plant catalogue which lists cut flowers has been included; the following are considered to be a useful selection.

1.1 A. Bartels, Hornweg 53, 1432 GD, Aalsmeer, The Netherlands; Tel: (010 31) 297725364; Fax: (01031) 297726535; (Catalogue in Dutch, with brief descriptions and ordering details in English).

A plant catalogue featuring a wide range of mainly perennial plants suitable for cut flower production. Limited colour illustrations and no cultural details.

1.2 Breeders' Seeds Ltd, 17 Summerwood Lane, Halsall, Ormskirk, Lancs L39 8R0; Tel: (0704) 840775; Fax: (0704) 841099.

A range of species for cut flower production is listed. Propagation details given.

1.3 Clause (UK) Ltd, Charvil Farm, New Bath Road, Charvil, Reading, Berks RG10 9RU; tel: (0734) 340212; Fax: (0734) 342378

Some cut flowers are listed. Very limited cultural details.

1.4 Colegrave Seeds Limited, West Adderbury, Banbury, Oxon OX17 3EY; Tel: (0295) 810632; Fax: (0295) 812135

A wide range of subjects is listed, but with emphasis on bedding and pot plants. Includes cut flowers. Some illustrations.

1.5 Hamer Flower Seeds, Sheraton House Business Centre, Office 29, Castle Park, Cambridge CB3 OAX; Tel: (0223) 327520; Fax: (0223) 462542

A wide range of subjects is listed including annuals, half hardy annuals, biennials and perennial species. Very extensive catalogue, illustrated, and with cultural details. A limited range of cut flower species is available as young plants.

1.6 Kieft Bloemzaden B.V., P O Box 1000-1695 ZG Blokker, The Netherlands; Tel: (010-31-2290) 61723; Fax: (010-31-2290) 61415.

A very comprehensive range of flower seeds is listed, in alphabetical order using latin names throughout. No illustrations in the catalogue, but illustrated 'fact' sheets are issued for a few cut flowers.

Kieft's Growing Manual is issued separately and gives full cultural details for annual, biennial and perennial cut flowers and ornamental grasses grown from seed.

1.7 E W King & Co Ltd, Monks Farm, Pantlings Lane, Coggeshall Road, Kelvedon, Essex CO5 9PG; Tel: (0376) 70000; Fax: (0376) 71189

A good selection of species for cut flower production. Propagation details. Limited illustrations.

1.8 Nutting and Sons Ltd. (incorporating Asmer Flower Seeds), 1500 Melton Road, Queniborough, Leicester LE7 8FN; Tel: (0533) 640777; Fax: (0533) 640887

A wide range of subjects is listed, some illustrated, with emphasis on bedding and pot plants. Technical data given. Cut and dried flower cultural information available on request.

1.9 Royal Sluis Ltd, P O Box 34, Unit 24, Marathon Place, Moss Side Estate, Leyland, Preston, PR5 3QT; Tel: (0772) 454444; Fax: (0772) 456854

A wide range of subjects is listed, including half hardy annuals, biennials and perennials, with emphasis on bedding and pot plants. A good range of cut flowers is included together with cultural information. Some illustrations. Young plants of some species/cultivars are available.

1.10 K Sahin Zaden B.V., Postbus 227, 2400 AA Alphen aan den Rijn, The Netherlands; Tel: (010-31-1720) 91144; Fax: (010-31-1720) 74433.

A comprehensive range of cut flowers is listed, in alphabetical order using latin names throughout. No illustrations, but good, practical cultural details are given.

1.11 A L Tozer Ltd, Pyports, Cobham, Surrey KT11 3EH; Tel: (0932) 62059; Fax: (0932) 68973

Mainly bedding and pot plants, but some flower crops are listed. Cultural details limited to the main lines featured, some illustrations.

1.12 VEGMO Plant B.V., Tuinstraat 5, 2351 SH Leiderdorp, The Netherlands; Tel: (010 71) 899359; Fax: (010 71) 890784; (Catalogue in Dutch and English).

A plant catalogue with a limited range of species/cultivars, mainly for production under protection, but some suitable for outdoors, eg. Statice sinuata, S. tataricum and S. latifolia. A well illustrated 'FACT' sheet for each crop with very good cultural details.

1.13 Samuel Yates Ltd, Withyfold Drive, Macclesfield, Cheshire SK10 2BE; Tel: (0625) 427823; Fax: (0625) 22843

Mainly bedding and pot plants, but some flower crops are listed. Propagation treatments/periods only given. Some illustrations.

1.14 Wm. Zandbergen B.V., Zaadteelt en Zaadhandel, Postbus 262-2230, AG Rijnsburg, The Netherlands; Tel: (010-31-2521) 11666; Fax: (010-31-2521) 18431. (Catalogue in Dutch with separate English translation).

A wide range of subjects is listed, including annuals, half hardy annuals, biennials and perennials. Extensive catalogue with illustrations and cultural details.

2.0 Seed and Plant catalogues for Dried Flowers and Grasses

2.1 The following company only supplies dried flowers and grasses from seed.

Sandeman Seeds, The Croft, Sutton, Pulborough, West Sussex RH20 1PL; Tel: (07987) 315; Fax: (07987) 400.

The only catalogue devoted entirely to dried flowers and grasses; divided into grasses, annuals, perennials and woody plants. The entries are followed by brief cultural details including g/1000 seeds, g/100m^2, height, distance between rows, sowing time. No common names or illustrations.

2.2 The following companies, referred to in detail at C 1. include dried flowers and grasses within their catalogue.

2.3 A Bartels: Only achillea and statice (Limonium) are listed.

2.4 Breeders' Seeds Ltd: A limited range of dried flowers is listed.

2.5 Clause (UK) Ltd: A limited range of dried flowers is listed.

2.6 Colegrave Seeds Ltd: A limited range of dried flowers is listed.

2.7 Hamer Flower Seeds: an extensive catalogue of dried flowers and grasses.

2.8 Kieft Bloemzaden B.V.: a wide range of dried flowers and grasses is included.

2.9 E W King & Co Ltd: A reasonable range of flowers and grasses for drying is listed.

2.10 Nutting & Sons Ltd: A limited range of dried flowers is included.

2.11 Royal Sluis Ltd: A limited range of dried flowers is listed; and a good range of grasses.

2.12 K Sahin Zaden B.V.: a wide range of dried flowers and grasses is included.

2.13 VEGMO Plant B.V.: A very limited range of dried flowers is included.

2.14 Wm. Zandbergen B.V: an extensive catalogue, with English translation.

3.0 Plant catalogues for chrysanthemums, dahlias and hybrid pinks

3.1 R Delamore Ltd., Sutton Road, Wisbech, Cambs PE13 5DR; Tel: (0945) 584091; Fax (0945) 584091.

Chrysanthemums including cultivars suitable for outdoor production are listed, together with hybrid pinks. Some illustrations are included, together with limited cultural information. More cultural information can be supplied on request.

3.2 Equinox Plants, Brookside Avenue, Rustington, Littlehampton, West Sussex BN16 3LF; Tel: (0903) 783182; Fax (0903) 776333.

A comprehensive range of hybrid (show) pinks is listed in the catalogue. No illustrations or cultural details are included.

3.3 David W. Panter & Son, Moulton Seas End, Spalding, Lincs PE12 6LF; Tel: (0406) 370212. A list of cultivars and their colour is available.

3.4 Frank Rowe, Rylands Nurseries, Wellington, Somerset TA21 9QB; Tel: (0823) 662462; Fax: (0823) 667991.

The catalogue features natural season chrysanthemums for production outdoors and under protection. It is illustrated and cultural information is provided.

3.5 L Staite & Sons (Evesham) Ltd., Avon Nurseries, Evesham, Worcs WR11 4LE; Tel: (0386) 446212; Fax: (0386) 446213.

Features natural season chrysanthemums and dahlias. Limited cultural information is provided, but no illustrations.

3.6 H R Whetman & Sons, Houndspool, Ashcombe Road, Dawlish, Devon EX7 0QP; Tel: (0626) 863328.

The catalogue features a comprehensive range of hybrid pinks, together with illustrations and cultural details. A newsletter is also issued at intervals.

3.7 Yoder Toddington Ltd., Toddington Lane, Littlehampton, West Sussex BN17 7PL; Tel: (0903) 714139; Fax: (0903) 730497.

A comprehensive range of hybrid pinks is featured. No cultural details or illustrations.

4.0 Dried Flower Sales Catalogues

In Holland, companies marketing dried flowers and grasses produce catalogues with prices included. The size of the bunch is normally determined by the number of stems held in one hand.

4.1 Van Deft de Vink BV, Floralaan ZT-2231 ZV, P O Box 164 - 2230 AD, Rijnsberg, The Netherlands

4.2 Star
Floralaan
PO Box 164 - 2230 AD
Rijnsberg, The Netherlands

4.3 Hogewoning
Floralaan
PO Box 164 - 2230 AD
Rijnsberg, The Netherlands

Note:

Fleuroselect, the international bedding plant selection association is to launch a trials programme for cut flowers in 1991. Final judging of plant material grown on under code number at one of six trials grounds in Europe, will take place by 15 October 1991.

5.0 Plug production

5.1 Introduction

Single-cell plant or plug production has revolutionised the bedding plant industry and is also used widely for the production of flower crops.

5.2 The advantages of plugs:

Decreased production time, more uniform flowering.

There is less risk of disease spread

Plants grow faster in the propagation phase

Less transplant check and quicker establishment in the flowering position

5.3 Buying-in plugs or growing your own

The decision to use "home" produced plugs or to buy-in from a specialist producer must be based on several important factors:

* Availability of species/cultivar from a specialist producer.

* The size of the unit and its production schedule

* The propagation/glasshouse facilities available.

* The ability to use and adopt new technology.

* The financial structure of the business as considerable investment will be necessary.

5.4 Plugs for outdoor flowers

Where low numbers of plugs of each of a wide range of plants are required it is unwise for a unit to invest in machinery for the production of its own plugs. The main reason being too low plant runs from seeders necessitating frequent recalibration or change of heads. Furthermore, more than one type of seeder would be required and this investment would not be economical on a small unit.

Therefore, for the majority of flower producers at the current time it is still more profitable to buy-in plug plants rather than use "home" produced ones.

On larger flower production units, especially those which specialise in a limited number of species requiring long plant runs, there is less need for frequent recalibration of machinery and fewer types of seeders will also be required. Under these circumstances "home" produced plug production may give the grower lower unit costs and greater flexibility compared with bought-in plants.

5.5 In summary, when considering plug production remember:

* It is an economic decision of whether to produce your own plugs or purchase from a specialist producer; it depends on whether the species you require is available from a specialist producer, and if "home" produced plugs can be produced at lower costs than from specialist units.

* Considerable financial investment will be necessary which may include the building of a specialist growth room, equipment, ie seeders, plug poppers, trays, irrigation, germination chambers, lights etc.

* Very accurate environmental control is necessary to germinate, wean and grow the plug crop. Other machinery will be necessary to give adequate humidity control, optimum light levels, precise irrigation and nutrient application.

5.6 Some of the species available in plugs:

Achillea species
Anaphalis margaritacea
Aster
Celosia
Delphinium
Dianthus
Saponaria
Statice caspia }
Statice latifolium } Also listed under
Statice perezii } Limonium
Statice sinuata cultivars }
Statice tataricum (dumosa) }

References

a) Tsurushima, H.; 'Production and utilization of plugs for cut flower varieties in Japan'. Fourth International Floriculture Seminar; Amsterdam; November 1989.

b) Egmond, P., van; 'Speciality Plugs - Holland: Cuts and Perennials'. Fourth International Floriculture Seminar; Amsterdam; November 1989.

D. WEED CONTROL

1.0 Introduction - the use of herbicides

Outdoor flower crops are amongst the smallest of the minor crop sectors in UK horticulture; they can however be of a high value per hectare. It is not surprising therefore to find that there are few herbicides with label recommendations for use in these crops.

It should be remembered that production covers a wide range of species from different botanical families and genera, and it is very unlikely that any one herbicide will be usable on all of them.

In view of the wide range of genera and species it is also more difficult to safely use herbicides pre-emergence of crops grown from seed.

Where such use is possible, safety will probably be limited to only a narrow range of crops in certain families and genera. Use of herbicides post-emergence of the crop will probably be easier for residual herbicides at least, though assessment will be necessary to judge levels of damage that may be acceptable, but still give sufficient weed control.

2.0 Alternatives to chemicals

Alternatives to chemicals should also be considered - stale seedbeds and the hoe can do no real damage if done carefully, and in the long term can often do a better job than herbicides.

3.0 Herbicides with potential use

3.1 Literature searches, and discussion with A J Greenfield, ADAS Horticultural Herbicide Liaison Officer, have identified the following herbicides with potential use on a range of outdoor flower crops.

3.2 Herbicides with current label recommendations

Where agrochemical companies have label recommendations for flowers it is most often for herbaceous plant genera/species and not necessarily for cut flowers. Where more than one agrochemical company markets the same active ingredient different genera/species may be listed on each company's label.

3.3 Current on-label approvals

These include recommendations for use on herbaceous genera, not necessarily cut flowers.

i. Chlorpropham + fenuron + cresylic acid ("Croptex Chrome"). Rates vary between 11 l/ha and 14 l/ha depending on whether the crop is drilled from seed or transplanted.

The following genera may be treated:

Drilled crops pre-weed and crop emergence - calendula, centaurea, delphinium, myosotis and cheiranthus.

Application immediately after planting - dahlia.

Application to the soil 4-5 days before transplanting - delphinium, viola, wallflower.

ii. Chlorthal-dimethyl ("Dacthal W75")

9kg/ha in 450 litres water post-planting. Controls a limited range of weed species and is usually tank mixed with either propachlor or diphenamid.

The following genera may be treated: achillea, aster, chrysanthemum, dahlia, delphinium, gypsophila, helychrysum, paeonia, scabious and wallflower.

Species of the following genera should not be treated: Alchemilla, Dianthus, Myosotis, Phlox, Viola.

iii. Chlorthal-dimethyl + diphenamid ("Dacthal W75" + "Enide 50W") at 7.5kg + 7.5 kg/ha in 300-700 litres water post-planting.

The following genera may be treated: achillea, aster, dahlia, helichrysum, scabious.

Species of the following genera should not be treated: chrysanthemum, myosotis, delphinium, phlox, dianthus, pyrethrum, viola.

iv. Chlorthal-dimethyl + propachlor ("Dacthal W75" + "Albrass") at 9kg + 9 litres/ha in 450 litres water post-planting. A second application of propachlor alone can be applied 6-8 weeks after the first.

The following genera may be treated: chrysanthemum, dahlia, scabious.

Species of the following genera should not be treated: alchemilla, dianthus, myosotis, phlox, viola.

v. Diphenamid ("Enide 50W") at 9.0-13.5kg/ha in 300-700 litres water post-planting. Usually tank-mixed with chlorthal-dimethyl to widen the weed spectrum.

The following genera may be treated: achillea, alchemilla, aster, chrysanthemum, dahlia, delphinium, dianthus, gypsophila, helichrysum, matthiola (stock), paeonia, phlox.

vi. Lenacil ("Venzar") at 2.2-2.8kg/ha in not less than 200 litres water to established crops. Rain or irrigation is required after application to activate the herbicide.

The following genera may be treated: dahlia and "established hardy herbaceous perennials". Also consider for statice to be followed by propyzamide ("Kerb 50W").

vii. Pentanochlor ("Atlas Solan 40", "Croptex Bronze") at 5.6 litres/ha in 220-550 litres water.

Use pre-emergence on larkspur, sweet pea, sweet william and wallflower.

Use as a directed spray only, after transplanting or when established on chrysanthemum and sweet pea.

viii. Propachlor ("Ramrod" granules) at 22.5kg/ha on mineral soils; 34.0kg/ha on organic soils.

The following genera may be treated:

Established - chrysanthemum, dahlia, phlox, pyrethrum and scabious.

Bedded out - antirrhinum, stocks and wallflowers.

ix. Trifluralin ("Treflan") at 2.3 litres/ha in 220-560 litres water incorporated anytime in the 14 day period before planting. Refer to manufacturer's literature for information on methods and timing of incorporation.

The following genera may be transplanted into treated soil: achillea, alchemilla, aster, chrysanthemum, delphinium, dianthus, dahlia, pyrethrum, scabious, wallflower.

3.4 Herbicides considered to have potential but with no label recommendations.

i. Asulam ("Asulox"). Should be considered pre- or post-emergence on nigella and amaranthus; delphinium pre-emergence.

ii. Chlorpropham ("CIPC 40"). As it is used on lettuce it is worth considering for Compositae, ie asters and chrysanthemums.

iii. Isoxaben ("Flexidor"). Should be evaluated on a wide range of species. Post-emergence or planting. However it might be too persistent for annual crops, but useful for perennials. Consider also for grasses cut for drying.

iv. Metamitron ("Goltix"). Consider for use on delphinium pre-emergence.

v. Metazachlor ("Butisan S"). Might be worth considering for stocks and wallflowers.

vi. Napropamide + trifluralin ("Devrinol T"). Should be evaluated on a wide range of species post-emergence or planting. However it might be too persistent in the soil for annual crops but might be considered for perennial ones.

vii. Oxadiazon ("Ronstar Liquid"). Worth considering for Caryophyllaceae - dianthus, hybrid pinks, sweet williams and gypsophila.

viii. Phenmedipham ("Betanal E"). Can be considered for use on amaranthus at the 2 leaf stage.

ix. Propyzamide ("Kerb 50W"). Worth considering for Compositae, ie asters and chrysanthemums, and also statice (preceded by lenacil).

E. CROP COVERS AND MULCHES

1.0 Introduction

The subject has been examined in-depth for field vegetables by D N Antill, and is reported in 'A Review of Crop Covers and Mulches for Field Vegetables', commissioned by The Horticultural Development Council, and dated November 1990.

The above Review has provided the basis for consideration of crop covers and mulches for outdoor flower production in the absence of information resulting from literature searches.

There are two main techniques used in the United Kingdom, these are crop covers and mulches.

2.0 Crop covers

Also known as floating mulches or covers; film covers; floating cloches or direct covers. These terms tend to cause confusion - the material is laid over a crop from drilling or planting and is entirely supported by the crop.

3.0 Mulches

The technique of mulching in this context means laying plastics on the soil surface. The crop grows through slits or holes made at sowing or planting.

4.0 Mulches plus crop covers

Although mulches help the roots, the aerial part of the plant also requires protection to obtain full benefit, especially early in the season. A crop cover in addition to a mulch might have a use to aid early growth of high value crops. Mulches and crop covers are relatively cheap systems for providing earliness, improving establishment and yield, and quality, and achieving better continuity in field vegetables chiefly through higher temperatures and protection from wind. However the degree of success often depends on the experience and management skills of the grower (Antill 1989). The uptake of crop covers for field vegetables has been dramatic from the mid 1980's in the UK and is currently about 9500 ha annually (Antill 1989).

5.0 Types of material

Plastics used for crop covers and mulches are made from the following raw materials. The nature and specification of the finished product depends on the method of manufacture. This can be controlled and specifications can be produced by using different polymers, for various circumstances. For example degradability, thickness, colour and thermal properties.

Polyethylene known as polythene
Polyvinyl chloride known as PVC
Polypropylene eg "Agryl", "Lutrasil" } collectively
Polyamide eg "Agronet" } called
Polyester eg "Reemay" } nonwovens

6.0 Permeability

6.1 Polyethylene

Polyethylene is impermeable to water and air and polyethylene crop covers normally require perforating. The most common size hole is 10mm and the number of perforations/m^2 varies between 200 and 500.

The benefits of perforated materials over solid polyethylene are as follows:-

* prevents ponding of rain or irrigation on the surface
* reduces sucking effect of strong winds
* allows gas exchange
* prevents excessively high temperature build-up
* crops are easier to wean at cover removal
* prevent excess condensation

6.2 Nonwovens

Nonwovens have advantages regarding permeability:

* they allow a free gas exchange
* less temperature build-up
* allow more even distribution of rain or irrigation through the crop cover
* increased ventilation

7.0 Degradability

Photodegradability can be controlled to a certain extent, but because of the vagaries of British weather it is unreliable. The edges buried in the soil to anchor the sheets do not degrade. Biodegradability may eventually be built-in, but requires further investigation.

8.0 Anchorage

The most widely used method is to put soil onto the edge of the material. However soil disturbance at the edges can reduce effectiveness of residual herbicides. The most usual alternative is to weight the covers down with bags of soil.

9.0 Disposal

Careless use of plastics in the field is environmentally unacceptable. Collection of used polyethylene and economic ways of disposal, need to be studied. The possibility of reusing the material on another crop also requires study.

10.0 Nutrition

Plants are able to use nutrients more efficiently under covers due in part to an increase in soil temperature, and that leaching of nitrogen is reduced especially when mulches are used. Further work is needed to establish firm guidelines.

11.0 Temperature

Temperature is one of the most important factors on which crop covers and mulches have influence.

11.1 Mulches

Thermal mulches are able to raise soil temperature as well as controlling weeds. Clear polyethylene gives the highest increase, but also has the greatest extremes.

Black polyethylene acts more as an insulation and its surface can become so hot that plants burn.

11.2 Crop covers

Initially the soil temperature will be similar to mulching with clear polyethylene. However, as the crop grows the canopy shades the soil but the gap between the material and soil widens providing insulation. Air and plant temperatures can become high on sunny, still days.

Standard nonwoven covers generate less accumulated heat units than polyethylene, but more than no cover.

12.0 Moisture

Under perforated polyethylene crop covers distribution of moisture from rain or irrigation is generally uneven. Nonwoven crop covers and mulches allow rain or irrigation through more readily and more evenly making management of watering considerably easier. Because of their permeability there is less condensation.

13.0 Wind

One of the most important aspects is the protection crop covers provide from wind. Mechanical damage is prevented and evaporation reduced from the soil and plants. If crop covers and mulches are laid properly only gales and unusual conditions cause problems.

14.0 Cultural operations

14.1 Crop covers

Experience with leafy transplanted crops such as brassicas and courgettes indicates it is preferable to transplant crops into a small furrow 75-100mm deep, so that initially the ridge of soil in between the rows supports the cover. This prevents the plants being pushed over, and gives frost protection until they touch

the cover. Field drilled crops should be sown into 50mm deep mini furrows. This prevents very young seedlings sticking to the crop cover when condensation freezes on a cold night. The freezing may not kill them, but a slight wind that moves the cover will pull the seedling out of the ground.

A reasonable distance should be left between the outside rows and the edge of the crop cover.

14.2 Mulches

Besides achieving weed control, light inhibiting materials conserve moisture. They only work efficiently when in close contact with the soil surface; they must therefore be laid tightly. The bed needs to be slightly dome shaped to ensure this. Mulches are inefficient if allowed to flap; a loose mulch will also allow plants to slip underneath the mulch in windy conditions and need repositioning by hand as they are unable to do so unaided.

15.0 Weed control

There has never been any approval or formal label recommendations for use of any herbicides on any crops, except carrots, when using crop covers. Problems have arisen ranging from poor weed control, to damage to the crop and not the weeds. At other times weed control has been enhanced by the use of covers. In many crops the lack of suitable herbicides remains one of the most serious limiting factors in the use of covers.

Where herbicides are used results have always been better if the herbicide has been applied to moist soil and laying of the crop cover delayed for up to 72 hours. This prevents the chemical being evaporated or vaporised too quickly.

Further investigations are required to identify suitable herbicides, and their time of application in relation to laying of the crop cover.

16.0 Factors to be taken into account

16.1 Effect on weed species

Because of the rise in soil temperature under cover some weeds germinate quicker and earlier in the season, eg Solanum nigrum L., this could mean it will escape normal timings of herbicide application. There are certain other species that grow particularly well under mulches or covers eg Trifolium spp.

16.2 Soil disturbance at laying

On bed systems where machine laying is used burying the edges of the plastics disturbs the soil and sometimes nulifies the herbicide application.

If the plastic is to be in place for a long time applying a band of herbicide down the wheelings and over the edges may be appropriate.

16.3 Soil moisture at laying

After late March the soil surface becomes dry almost immediately after covering, especially in sunny conditions. Consequently any herbicide applied to the surface immediately prior to covering will also dry out and become inactive. Covering a few days later will be of benefit. A residual pre-emergence or pre-drilling/planting herbicide can be applied before the cover is laid. A one to seven day interval should be allowed after application to ensure movement into the soil before the soil surface dries or the temperature is raised too much under the cover.

17.0 Criteria for successful use of herbicides under low-level plastics

* Allow time between applying pre-emergence residual herbicides and covering with plastics.

* Beware of using herbicides before covering in hot weather.

* If the soil surface is dry after application, apply 5-8 mm of irrigation before covering.

* After removal allow the crop to harden and form wax on the leaves before applying a herbicide.

* Use the stale seedbed technique whenever possible for use with mulches and crop covers.

* Herbicides that have proved successful under covers take longer to disperse.

18.0 References

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F. DISEASES AND THEIR CONTROL

1.0 Introduction

1.1 Legality of Pesticide Use on Outdoor Cut Flowers

Lists of pesticides registered for use in the UK and guiding information on their use is available in Pesticides 1991 (Anon, 1991) and in The UK Pesticide Guide (Ivens, 1991). Changes in pesticide provisional approvals, full approvals and specific off-label approvals are reported in The Pesticide Register.

Under the Long Term Off-Label Arrangements, valid until 31 December 1994 (MAFF News Release 546/89), commercial growers are permitted to use on outdoor cut flowers any pesticide provisionally or fully approved for use on any growing crop. A number of restrictions must be satisfield.

While these arrangements remain in force there is no need for specific off-label approvals for outdoor cut flowers. The long-term off-label arrangements will be reviewed by the Advisory Committee on Pesticides by 31 December 1994.

2.0 Diseases and their control on a range of cut flowers

2.1. Chrysanthemums

(a) White rust (Puccinia horiana)

The fungus is potentially a major disease of the crop, both under protection and outdoors. It is weather sensitive and crops are most at risk in the autumn following a combination of warm day and cool night temperatures, or other weather conditions leading to prolonged leaf wetness.

Fungicide spray programmes should aim for good preventative control using:

- benodanil ("Calirus")
- oxycarboxin ("Plantvax")
- mancozeb ("Karamate Dry Flo")
- triforine ("Saprol")

and fungicides which eradicate the disease

- propiconazole ("Tilt", "Radar")

There is some varietal resistance but it is generally only transient as the fungus continues to adapt and new races evolve. Some cultivars are notably more susceptible than others, eg Margarets, and warrant particular attention. Use of "Tilt" and/or "Radar" to

eradicate the fungus is recommended when the disease is confirmed. Use of these products as preventative sprays should be discouraged in order to minimise the risk of fungicide resistance developing. Dickens (1990) has recently reported on studies on the chemical control of white rust.

(b) Tomato spotted wilt virus (TSWV)

Tomato spotted wilt virus spread principally by western flower thrips (WFT) is now a major concern to the industry. Although there is less risk of rapid spread in outdoor cultivars, compared with those grown under protection, growers need to be aware of the potential severe problems. Most of the recent outbreaks of TSWV have been in protected crops of cv Snowdon and other susceptible varieties, particularly in the autumn and winter months; symptoms tend to be more severe at cool temperatures.

(c) Damping, Petal Blight and Stem Rot

Damping (Botrytis cinerea), and less frequently petal blight (Itersonilia perplexans), are found when bad weather occurs. Stem rot (Sclerotinia sclerotiorum) is found occasionally in outdoor crops; it is being reported more frequently than in the past in glasshouse crops. Fungicides are available for all 3 diseases. Control of damping and petal blight is difficult in persistent wet weather.

(d) Pythium and Phytophthora Root Rots

Root rots caused by these soil-borne fungi are more severe under poor soil/cultural conditions and are affected by moisture regimes and planting depth. There is more risk of pythium and/or phytophthora root rot in outdoor crops compared to protected crops because of the lack of soil sterilisation. Particular attention should be paid to soil structure and drainage. However, once soil is contaminated, disease can occur in the absence of soil structure problems.

Fungicides are available both for module (block) incorporation and border soil treatment and no specific R & D has been identified.

2.2 Hybrid pinks

Successful disease control is an essential pre-requisite for production of high quality crops as hybrid pinks are affected by a number of potentially debilitating diseases. The shiny, smooth leaves are not very receptive to fungicides and therefore wetters need to be added to products that do not already contain them.

(a) Stub rot (Fusarium culmorum and F. avenaceum)

Stub rot is a major problem as the causal fungi are wound pathogens which readily enter the plant through wounds caused by continual harvesting, and growth cracks. As the plant ages the risk of infection increases as the plant canopy is much denser and slower to dry out and harvesting creates an increasing number of wound sites.

The intensity of production both on holdings and in districts also presents problems. Rotation and isolation are desirable to separate new, healthy plantations from old, affected ones. Cultivars also differ in their susceptibility to the disease - "Doris", still the major cultivar, is particularly susceptible.

It is believed that stub rot can be carried as a latent infection in symptomless cuttings. The first few weeks after planting out are critical for regular inspection, roguing out of unthrifty, suspect diseased plants, and application of a suitable fungicide treatment.

In the last 2 years - both having hot, dry summers - stub rot has occurred in some crops at a high incidence at unseasonal times, notably during the summers.

A routine fungicide programme is needed, starting with drenches of benomyl immediately after planting and 3 weeks later, to be followed with routine foliar sprays of captan. Carbendazim plus maneb ("Delsene M Flowable") will also give some control.

(b) Fusarium wilt (F. oxysporum f sp dianthi)

This disease is occasionally a problem in outdoor crops, particularly if soil temperatures are high. As with stub rot, the disease can be carried as a latent infection in symptomless cuttings; inspection, roguing and fungicide treatment in the first few weeks after planting is again crucial.

(c) Rust (Uromyces dianthi)

The fungus requires leaf wetness and damp, humid conditions to establish and flourish and it is therefore potentially a major problem throughout autumn and winter. It is extremely difficult to control once it is established on the leaves and strict attention must be paid to preventative treatments and immediate action when the disease is first seen. Freedom from infection of bought-in stock is crucial. Varieties differ in susceptibility with cv Haytor White being very susceptible, cv Doris less so.

Timeliness of fungicide applications and coverage are important considerations in operating the programme. The two fungicides "Tilt" and "Radar" are very effective and have been used successfully in conjunction with "Calirus" and "Plantvax", by some growers.

(d) Ring spot (Mycosphaerella dianthi)

This disease occurs under similar conditions to that of rust although it is more of a problem in the south-west of England than in the drier east; in some years it is a major problem. A fungicide spray programme applied during autumn and winter is needed, based on the fungicides chlorothalonil (eg "Bravo 500"), maneb + carbendazim (eg "Delsene M") and mancozeb + carbendazim (eg "Kombat").

The question of alternative hosts needs to be examined.

(e) Alternaria leaf spot (A. dianthi)

This disease has occurred on a few crops under protection in the south west and is a potential problem of outdoor crops, particularly in warm, wet weather.

(f) Leaf rot - (Heteropterella valtellinensis)

Although once common, this disease is now relatively rare.

(g) Virus Diseases

Viruses which may affect pinks include carnation mottle virus, carnation vein mottle virus, carnation etched ring virus, carnation ringspot virus, carnation Italian ringspot virus, carnation latent virus and carnation necrotic fleck virus.

Most cuttings are now produced from virus-tested stock and these diseases are rarely a serious problem. The best control is to plant only clean stock.

Tomato spotted wilt virus has been recorded in one crop of carnations since the arrival of western flower thrips in the UK; experience in Hawaii indicates that carnations (and pinks?) are not a favoured host and widespread outbreaks are unlikely.

2.3 Sweet Williams

The crop is affected principally by rust Puccinia arenariae and ring spot Mycosphaerella dianthi. The crop has soft leaves and is prone to leaf scorch which can seriously disfigure the flower stems. Rust in protected crops is very difficult to control. The author is not aware of any experimental work on control of these diseases.

2.4 Gypsophila

The major disease in the crop is Botrytis cinerea which largely attacks the flowers at or during flowering. In severe attacks it may progress to the shoots.

Application of "Rovral" or equivalent botrytis fungicide at the end of the cropping flush to prevent stem dieback is advised.

Sclerotinia stem rot has been recorded occasionally.

2.5 Asters

The main diseases of aster are aster yellows disease, fusarium wilt and phytophthora foot rot. Aster yellows disease is the most difficult to control with rotation the only option. A long rotation also delays build-up of fusarium wilt and phytophthora foot rot.

2.6 Stocks

Downy mildew (Peronospora parasitica)) is the main disease of the crop; pythium root rot and rhizoctonia stem base rot have also been recorded.

Downy mildew is controlled by a routine spray programme, the fungicide metalaxyl + thiram ("Favour 600 FW") being effective and widely used.

2.7 Statice

(a) Botrytis cinerea (grey mould) is a major problem during the flowering period, especially under wet conditions. Preventative spray programmes are advised using the following fungicides: dicarboximides (eg "Rovral", "Ronilan") and chlorothalonil (eg "Bravo 500").

(b) Powdery mildew (Erysiphe polygoni) can also be a problem but is easily controlled. A rust (Uromyces limonii) has also been recorded, but it is considered incidental.

(c) Statice tataricum (dumosa) (perennial statice) is affected by Rhizoctonia solani and crop losses from a stem base rot have been recorded from the young plant stage to mature plants one to two years after transplanting.

2.8 Helichrysum

The most serious disease is caused by the soil-borne fungus Verticillium dahliae which also attacks potatoes and strawberries. It is known to be a problem in Holland. Drenches of benlate ("Benomyl") are the only recognised means of treatment of this disease in potatoes and strawberries.

2.9 Peony

The following diseases have been recorded:

- Ring spot virus
- Phytophthora root rot
- Leaf blight (Botrytis paeoniae)

2.10 Dahlia

Tomato-spotted wilt virus is known. It may become more of a problem now that western flower thrips (WFT) is established in the UK.

3.0 References

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G. PESTS AND THEIR CONTROL

The term "cut flower" encompasses a wide range of species from many families, some more familiar than others. Each may have its own pest complex. To write comprehensively about every potential pest on each species would take a book; comments here have therefore been confined to general comments about each major pest group.

1.0 Aphids

1.1 Species and damage

Many species of aphid have been found in cut flower crops. Some of these, such as the peach-potato aphid Myzus persicae, are common and widespread. Others such as the chrysanthemum aphid Macrosiphoniella sanborni and the lupin aphid Macrosiphum albifrons may be restricted to a single host. Direct damage is greatest when colonies form in growing points, on stems or in flower buds. Attacks may result in distortion of flowers or stems, and in severe cases the aphid's waste product, honeydew, acts as a food source for unsightly sooty moulds. Skins of aphids, cast during moulting, may reduce marketability. Aphids can also cause indirect damage by transmitting viruses to plants.

1.2 Aphicides

Currently there is a reasonable choice of aphicides from several different chemical groups to control aphids in cut flower crops outdoors. Resistance is not yet a major problem although some strains of Myzus persicae, particularly those found under glass, are resistant to organophosphates, pyrethroids and even carbamates.

2.0 Caterpillars

2.1 Species and damage

Caterpillars of several species may attack cut flower crops. These can be divided into three types.

(a) The first type feeds only on the aerial parts of plants. These subdivide into the larger Noctuid types (eg dot moth, silver Y moth and angleshades moth) and the smaller tortrix moths that frequently web leaves together. Feeding is often nocturnal so that the culprit may be difficult to find.

(b) The second type, known as cutworms, feed on the foliage for the first two instars (ie larval stages) and then go underground to complete their development. Whilst feeding on the aerial parts of the plant they are prone to mortality caused by rainfall. They therefore tend to be a problem mainly in dry summers.

(c) The third type, the swift moths, live entirely underground. Adult moths lay eggs in grassy or weedy places and the caterpillars that hatch feed entirely on the subterranean parts of plants.

Control of swift moth caterpillars in an established crop is virtually impossible, so that keeping land weed-free before sowing or planting the flower crop is the most important control measure.

2.2 Chemical control

The other caterpillars can be satisfactorily controlled using a range of chemicals, those from the synthetic pyrethroid group, eg cypermethrin, deltamethrin, being particularly effective, although once cutworms have gone underground they, like swift moth caterpillars, become difficult to deal with.

3.0 Thrips

3.1 Species and damage

Thrips ("thunderflies") are small, narrow-bodied insects that feed by stabbing surface cells of plant tissue and ingesting the exuding cell contents. Air often enters the damaged cells giving them a bleached or silver appearance. Damage to petals is most important, but damage to foliage can also be disfiguring.

i. Several species may be involved in causing damage to flower crops outdoors. These range from the very common polyphagous onion thrips (Thrips tabaci) to those with a more restricted host range. A recently introduced species, the western flower thrips Frankliniella occidentalis, has caused a great deal of damage, particularly on protected crops. It is a vector of tomato spotted wilt virus and is difficult to control. As it becomes even more widespread the incidence of damage on outdoor flower crops may increase, particularly in hotter summers.

4.0 Leaf miners

4.1 Damage

Leaf miners damage crops in two ways. The adults feed by puncturing the leaf and drinking the sap that exudes. This feeding leaves behind a series of discrete spots. More important is the damage caused by the larvae, feeding in between the two leaf surfaces and leaving behind a mine which may be linear or a blotch, depending on the species involved.

4.2 Chemical control

There are many native leaf miners, most of which do not attack flower crops, though a few will. These can be relatively easily controlled with penetrating insecticides such as diazinon. Two other leaf miners have recently occurred in the UK and may become established here. These are both Liriomyza species, L. trifolii (the American serpentine leaf miner) and L. huidobrensis (the South American leaf miner). They are difficult to control because of insecticide resistance.

5.0 Capsids

Capsid bugs are relatively large, active insects, moving away rapidly if disturbed. They feed by piercing and sucking, injecting as they do so a toxic saliva which causes symptoms such as leaf distortion and tearing, or even blindness if the growing point is attacked. They have a wide host range.

They have only two generations a year. Most contact insecticides will deal satisfactorily with capsids.

6.0 Cabbage root fly

Cut flowers of the Cruciferae such as stocks and wallflowers may be damaged by cabbage root fly maggots feeding on the roots. The first sign of attack is when plants wilt under drought stress. Digging up affected plants reveals white maggots feeding on the roots.

Peaks of egg-laying activity of cabbage root fly occur in late April and May and again in July and August. Sowing or planting at the right time can reduce the risk of damage.

7.0 Mites

7.1 Species and damage

Mites such as the two-spotted spider mite (Tetranychus urticae) and tarsonemid mites (eg the broad mite, Polyphagotarsonemus latus) can damage flower crops, particularly if these are propagated under glass and the summer is hot. Severe damage however would be unusual.

7.2 Acaricides

Acaricides such as amitraz and dicofol/tetradifon mixtures are permissible for use in controlling mites on ornamentals under off-label arrangements. ('The Pesticides Register'; Issue 11, Dec 1989.)

8.0 Nematodes

Leaf and bud nematodes (Aphelenchoides spp), stem nematode (Ditylenchus dipsaci) and potato tuber nematode (Ditylenchus destructor) have all been recorded in cut flowers. Infestations normally result from contamination via the soil or by the use of infested stock plants.

The nematodes live either within the host plant tissue or, in the case of leaf and bud nematodes inside buds, unfurled leaves etc. Infested plants may display several symptoms. Leaf and bud nematodes may kill leaf tissue, leaving behind necrotic areas or patches. Where the leaf veins are strong these may confine the nematodes so that the damage symptoms are sharply defined by the veins. Stem nematodes often damage the cell structure of plants so that they grow soft and bloated. Both types of nematode may however cause only distortion of the foliage in less severe cases.

Destruction of infested plants is advised, although it may be possible to "clean up" valuable infested stock plants using nematicides such as aldicarb.

9.0 Slugs

Slugs sometimes cause damage to cut flower crops, particularly if conditions are damp. Slug pellets can be used if problems arise.

10.0 References

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(b) Ivens, G.W. (1991); 'The UK Pesticide Guide 1991'. CAB International and the British Crop Protection Council. 518 pp.

(c) Scopes, N. and Stables, L. (1989); 'Pest and Disease Control Handbook'. The British Crop Protection Council. 732 pp.

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H. FERTILISERS

The nutrition of outdoor cut flowers is not well represented in the literature for United Kingdom conditions. MAFF Bulletin No. 190 Outdoor Flowers for Cutting published in 1962 gives some guidelines.

"There is little experimental evidence as to the manurial requirements of cut flowers but it seems safe to say that in order to obtain the desired length and strength of the flower stem, suitable size and form of flower and to maintain healthy stock a high state of soil fertility is required".

Studies at the Glasshouse Crops Research Institute, by Winsor (1968) suggested that outdoor chrysanthemums needed 190 kg/ha N, 250 kg/ha P_2O_5 and K_2O to produce the largest number of blooms. Anon 1961 suggested applications of 130 kg/ha N, 190 kg/ha P_2O_5 and 130 kg/ha K_2O. At Stockbridge House EHS chrysanthemums responded to 240 kg/ha N (Jubb & Johnson 1966).

In order to maintain a "high state of soil fertility" for cut flowers the following fertiliser recommendations should be tested:-

For vigorous species such as chrysanthemums and pinks give P_2O_5 and K_2O base dressings similar to those applied to potato crops. (MAFF Bulletin 209 'Fertiliser Recommendation' Pub 1988 HMSO).

For less vigorous species fertilise with P_2O_5 and K_2O as for outdoor lettuce.

Nitrogen application will depend on previous crop and the flower to be marketed but for crops following low residue crops such as cereals 175 kg/ha N could be applied to chrysanthemums and 125 kg/ha N to flowers to be dried.

The pH is also important and should be checked by species.

References

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Anon., (1961); 'Chrysanthemums'. Bulletin No. 92. MAFF/HMSO.

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I. MECHANISATION

1.1 Bed systems

Crop production is generally based on the bed system, the main needs of which are fully understood. See details at Appendix I, page 63

1.2 Sowing and transplanting

Sowing and transplanting operations for a wide range of seed types and transplant material are readily met by commercially available equipment. See details at Appendix I, pages 63 and 64.

1.3 Crop covers/mulches - mechanised handling

Considerable research and development has been done worldwide on the production of field vegetables under crop covers and mulches.

This has been the subject of a Horticultural Development Council Research Report, "A Review of Crop Covers and Mulches for Field Vebetables", by D N Antill, Horticulture Research International, Stockbridge House, dated November 1990.

There are opportunities for the use of crop covers and mulches to advance the season for outdoor flower crops and the subject is considered fully in Section E Crop Covers and Mulches, page 32.

Removal and disposal are major problems that need to be addressed. Manual and powered re-rollers can be used, but it is doubtful if the crop cover can be re-used. See detail at Appendix I, page 65.

1.4 Mechanical weed control

The use of equipment for inter-row hoeing or flaming is limited to early stages of growth. See detail at Appendix I, page 64.

1.5 Irrigation

The performance of different types of equipment is well documented. Equipment suitable for use in crops with soft plant tissue is essential. See detail at Appendix I, pages 64 and 65.

1.6 Harvesting

The lack of uniformity at maturity severely limits mechanical harvesting, but mechanical aids such as boom conveyors and simple pedestrian gantries should be considered. See detail at Appendix I, page 65.

1.7 Post-harvest storage

a) Cut flowers - fresh

i. Storage

The principles of removal of field heat, and optimum storage temperatures for a wide range of cut flowers are well documented. Various types of store can be used, each having different performance characteristics. See detail at Appendix I, page 66.

ii. Bunching and packing aids

Good ergonomic design is essential. See detail at Appendix I, page 66.

b) Dried flowers and grasses

The specifications are generally well understood although the Dutch usually adopt higher temperature regimes than in the UK.

Fuel efficient systems, combined with good air circulation are essential. See details at Appendix 1, pages 66 and 67.

J. POST-HARVEST MANAGEMENT

1.0 Cut flowers

The principles of post-harvest management are well understood and documented. Success in the cut flower trade depends on a regular supply of high-quality, fresh blooms with a long vase life. Cut flowers are fragile and perishable and must be handled with skill by growers and the marketing organisations alike. For each flower type, there is an optimum cutting stage for maximum vase life and quality. The correct handling and cool storage procedures should be adopted.

1.1 Flower conditioners

The use of flower conditioners has been a major recent development which has considerable application to enhance the quality and vase life of outdoor cut flowers.

1.2 Cut flower foods

Cut flower foods used by wholesalers, retailers and consumers may include proprietory products such as "Chrysal Ltd " which is recommended for a wide range of crops.

Sufficient information exists in trade literature, and experience indicates no further immediate research and development is justified.

2.0 Dried flowers and grasses

The drying and storing temperatures and regimes are critical. The Dutch use a fast drying technique at 60°C compared with slower drying at a range of lower temperatures in the UK. Woody stems take long to dry, especially the area under the rubber band. If the banded area is dried to the harvest stage the flower will be over-dried and will need to be "relaxed" afterwards.

It is important that bunches are allowed to "relax" after drying, normally in another building.

In Holland foliage is not removed, apart of course from where single flower heads are dried.

All flowers are dried and stored in the dark to conserve the colour.

SCOPE FOR FURTHER RESEARCH AND DEVELOPMENT

Priority items for research and development are in the areas of weed control, disease control and use of crop covers and mulches. Work on specifications for drying flowers and grasses is also considered worthwhile.

1.0 Weed control

1.1 Asulam ("Asulox")

A post-emergence translocated herbicide for control of grass weed species, annual meadow grass and perennial weeds, especially docks.

Action

i) Evaluate "Asulox" at 2.8 l/ha in 200 l/ha of water (2pt in 18gal/ac water).

ii) Crops to be considered for trial - grasses for drying.

Also pre-emergence: delphinium, nigella (Pre- or post-emergence), amaranthus (pre- or post-emergence).

1.2 Isoxaben ("Flexidor")

A soil-acting herbicide which can be safely applied to sand, light, medium and heavy soils. The activity of "Flexidor" is reduced in soils with high levels of organic matter and is not therefore recommended for use on soils with organic matter of 10% or more.

Moisture is needed for activation; 5-10mm of rain within 14 days after application is normally sufficient to carry the herbicide to a depth of 20mm in the soil profile where most of the principal broad-leaved weeds germinate.

Apply to well prepared firm, moist seedbeds free of clods.

Weeds controlled include:-

Common chickweed, common field speedwell, fumitory, red dead nettle, hempnettle, poppy, shepherd's-purse, fat-hen, small nettle, pansy, volunteer rape, groundsel, knotgrass, matricaria, mayweed.

Moderately resistant weeds include cleavers. "Flexidor" will not control grass weeds.

Apply pre- and post-crop emergence up to 31 March; used alone for broad-leaved weed control it should be applied before weed emergence.

Action

i. Evaluate "Flexidor" at 0.3 l/ha in 100-400 l/ha of water (4.3fl oz/ac in 10-40 gal/ac water) after seedbed preparation and drilling.

ii. Crops to be considered for trial - grasses for drying;

Also post-emergence on a wide range of broad-leaved species, but not members of the Cruciferae family including stocks and wallflowers

Note

a) Use between 1 November and 31 March when soil moisture is sufficient to activate "Flexidor". At other times irrigation is desirable.

b) "Flexidor" has residual activity which may influence husbandry prior to the next crop in the rotation; oilseed rape, brassicas, sugar and fodder beet are particularly sensitive. Land must be mould board ploughed to at least 20cm following use of "Flexidor" before drilling succeeding crops other than cereals, grass leys, potatoes or maize.

1.3 Oxadiazon ("Ronstar Liquid")

A residual and contact pre- and post-emergence herbicide which is particularly active against all bindweeds and many annual broad-leaved weeds, including those such as cleavers and knotgrass which are resistant to simazine.

"Ronstar Liquid" is active in moist soil conditions and persists for 4-6 months.

Irrigation will give optimum activity. In dry soil pre-emergence activity will be reduced.

Weeds controlled pre-emergence to the young plant stage - cleavers, knotgrass, orache.

Weeds controlled pre-emergence only - speedwell, annual nettle, annual sowthistle, black bindweed, charlock, dead nettles, fat hen, fumitory, groundsel, mayweeds, redshank, shepherd's purse, spurrey.

Action

i. Evaluate "Ronstar Liquid" at 4 or 8 l/ha in 300-1000 l/ha of water (2.9 or 5.8pt/ac in 30-100gal/ac water). If weeds are present complete wetting of the foliage is essential.

ii. Crops to be considered for trial -

Transplanted: aster, dahlia, Dianthus allwoodii and cultivars; Dianthus barbatus, (sweet william), Gypsophila elegans and G. paniculata, Statice sinuatum, S. tataricum.

Note

a) Annual meadow-grass is only controlled by "Ronstar Liquid" at 8 l/ha pre-emergence.

1.4. Napropamide ("Devrinol") and napropamide and trifluralin ("Devrinol T")

A. "Devrinol"

A pre-planting or soil applied herbicide for control of annual grass weeds, and broad leaved weeds including cleavers. Gives long weed control from a single application. Weeds controlled by 'Devrinol' include - annual meadow-grass, cleavers, chickweed, speedwell, fumitory, hempnettle, orache, poppy, spurrey, fat hen, field pansy, groundsel, knotgrass, mayweeds, red dead nettle, redshank, shepherd's purse, small nettle, volunteer cereals.

Moderately susceptible species include black bindweed, pansy, knotgrass, redshank, shepherd's purse and volunteer cereals.

Action

i. Evaluate "Devrinol" at 5 or 7 l/ha (3.5pt-5pt/ac) depending on soil type.

ii. Crops to be considered for trial -

Transplanted: aster, Dianthus barbatus (sweet william), Gypsophila elegans and G. paniculata, Matthiola (stocks), Statice sp.

Direct-sown: aster, matthiola, wallflower.

Note

a) If land previously treated with "Devrinol" is used for arable cropping only grow brassicas, swedes, potatoes or oilseed rape as the first crop.

B. "Devrinol T"

A soil incorporated residual herbicide for the control of certain annual grasses and a range of broad-leaved weeds. Weeds controlled include those listed above and black bindweed, knotgrass and redshank, with the following moderately susceptible - cleavers, fumitory, hempnettle, pansy, groundsel, red deadnettle, small nettle and volunteer cereals.

Action

i. Evaluate "Devrinol T" at 7 l/ha in 200-550 l/ha of water (5pt/ac in 18-50gal/ac water).

ii. Crops to be considered for trial - wallflowers, stocks.

Note

a) Apply "Devrinol T" during the later stages of seedbed preparation and use only a light set of harrows to blend the herbicide into the top 25mm (1") of soil.

b) "Devrinol T" can be used on a wide range of soils, but should not be applied to sands, or to soils with more than 10% organic matter. On very light and light soils germination and early growth of treated crops may be reduced under adverse conditions such as dry and/or cold weather. The seedbed should be free from clods and weeds and in a good tilth.

c) Only oilseed rape, swedes, brassicas or potatoes can be sown within 12 months of application.

1.5 Alachlor and monochlorobenzene solvent ("Lasso")

A soil-acting residual herbicide which is applied to the soil surface without incorporation.

Rainfall in needed after application to give optimum weed control. It must be applied before emergence of both crop and weed. The length of the effective residual life is about 8 weeks.

Best results are obtained when the soil has a fine tilth.

Weeds controlled include:- annual meadow grass, black nightshade, cleavers, common chickweed, common field speedwell, common hemp nettle, groundsel, red dead nettle, mayweed, shepherd's purse, small nettle.

The following weeds are moderately susceptible:- fat hen, field pennycress, scarlet pimpernel.

Resistant weeds include:- black bindweed, charlock, knotgrass and wild radish.

Action

i. Evaluate "Lasso" at 4.0l/ha in a minimum of 225l/ha of water (2.8pt/ac in 20 gal/ac of water).

ii. Crops to be considered for trial:-

Direct-sown: Dianthus barbatus (sweet william), Gypsophila elegans (annual gypsophila).

Transplanted: aster, Dianthus barbatus (sweet william), Gypsophila elegans, Helichrysum bracteatum, Statice sinuatum.

Notes

a) Emerged weeds are not susceptible.

b) Do not apply to cloddy seed beds.

c) Do not apply under cold, adverse growing conditions.

2.0 Diseases and their control

2.1 Chrysanthemums

(a) Tomato spotted wilt virus (TSWV)

Action

Cultivars exhibit marked differences in susceptibility to TSWV. Screening for susceptibility should be undertaken and only those new cultivars that show resistance should be released to commerce.

2.2 Hybrid Pinks

(a) Stub Rot (*Fusarium culmorum* and *F. avenaceum*)

Action

R & D is proposed on the following:-

i. Evaluation of fungicide programmes with the aim of minimising summer losses. Investigations would include (1) drenches and dips at planting, (2) timing of subseqent drenches and sprays, (3) efficacy of alternative products (eg. prochloraz Mn ["Octave"]) and (4) minimising fungicide use.

ii. Investigation of the effect of drought, soil acidity and other stress factors on susceptibility to stub rot.

iii. Evaluation of new cultivars by objective screening for susceptibility to the causal fungi.

iv. *Fusarium* species isolated from some other crops (eg cereals) have been found in some instances to be resistant to benomyl and related MBC fungicides. The status of *Fusarium* spp isolated from pinks should be monitored.

In addition: Plant propagators should be encouraged to develop quality assurance/quality control schemes.

(b) Rust (Uromyces dianthi)

Action

An objective comparison of the efficacy of rust fungicides and their suitability for use on hybrid pinks is recommended.

(c) Alternaria leaf spot (A. dianthi)

Action

i. Monitor outdoor crops for Alternaria leaf spot.

ii. Investigate effectiveness of "Rovral" against this disease.

2.3 Sweet Williams

(a) Rust

Action

Evaluate fungicides for efficacy against rust and phytotoxicity on sweet william.

2.4 Stocks

(a) Downy Mildew (Peronospora parasitica)

Action

Investigate the use of fosetyl-aluminium ("Aliette") as a block incorporation and propamocarb hydrochloride (Fisons "Filex") as a drench, as alternative treatments for control of downy mildew. Should they be found to be effective and safe, their use should be encouraged, in alternation with "Fubol 58" or "Favour 600", in order to reduce the risk of fungicide resistance developing.

Investigate the above fungicides for phytotoxicity on stocks and make recommendations for appropriate rates of use.

2.5 Statice tataricum

(a) Rhizoctonia solani

Action

The need for a preventative fungicide programme to achieve long-term protection both at the young plant stage, in modules, and after transplanting in the field, needs to be evaluated: tolclofos-methyl ("Basilex") and iprodione ("Rovral") are suggested.

2.6 Helichrysum

(a) Verticillium dahliae

Action

The efficacy, timing and economics of applying benomyl drenches for control of verticillium in helichrysum need to be evaluated.

3.0 The evaluation of crop covers and mulches

3.1 To consider the following herbicides for use on outdoor flowers applied in conjunction with crop covers.

(a) Chlorthal-dimethyl ("Dacthal W75") + diphenamid ("Enide 50W") at 7.5 kg/ha plus 7.5 l/ha respectively.

(b) Chlorthal-dimethyl ("Dacthal W75") + propachlor ("Albrass") at 9 kg/ha + 9 l/ha respectively.

(c) Trifluralin ("Treflan") at 2.3 l/ha + propachlor ("Albrass") at 9 kg/ha or trifluralin alone.

3.2 To evaluate the following crop covers and mulches

(a) Covers

Material		Product
Polyethylene (polythene):		A range of products
Polyethylene degradable:		"Degradall"
Polyethylene perforated:		"Polycrop Coverall 200" "Polycrop Coverall 500"
Polypropylene) Polyester)	non-wovens	"Agryl P17", "Base UV17", "Growshield", "Covertan", "Lutrasil", "Environfleece".

(b) Mulches

Black polyethylene:	A range of products and thicknesses.
Black non-woven:	"Black Agryl"
Black mulch paper (creped):	"Mulch paper type 909 black"

3.3 Outdoor flower crops which may benefit from covers or mulches

Covers or mulches may have an application to spring sown or transplanted crops such as:-

Covers

Centaurea cyanus; Delphinium ajacis, Gypsophila elegans, Gypsophila paniculata, Nigella damascena, Saponaria vaccaria, Statice spp.

Mulches

Chrysanthemums, Gypsophila paniculata, Statice spp.

4.0 The evaluation of drying specifications for flowers and grasses

4.1 Evaluate optimal drying temperatures and durations, and identify fuel efficient systems.

CONCLUSIONS

The Review describes a small, but expanding sector of horticulture. In reviewing this subject area several useful sources of trade, cultural and economic information have been identified. The ultilisation of existing information, some of which may need translation, can be a useful alternative to commissioning unnecessary research and development.

Essential research and development has however been suggested where the product from relatively simple investigations can have a substantial benefit to growers.

Priority items for research and development are in the areas of weed control, disease control and use of crop covers and mulches.

The specifications and equipment for the drying of flowers and grasses should also be considered.

SOME ASPECTS OF MECHANISTION

1.0 Bed systems

1.1 Bed width

Maximum width cropped bed 1.2m to allow for 0.6m comfortable reach of people.

Aim for tractor wheelings of 1.5m.

1.2 Bed formation

One bed formed at a time on 1.5m wheelings; around 1ha worked per day using a small farm tractor or a compact tractor.

1.3 Cultivations

Plough and deep loosen the soil to create rooting zone depth. The bed should be made directly on the ploughed land to prevent compaction due to wheelings in the cropped area.

2.0 Sowing operations

2.1 Field

(a) "Stanhay" belt precision seed drill.

2 and 3 line belts available to give double and triple rows.

Also available is a wide coulter with a 'spreader' to distribute seed in bands with maximum width 76-100mm.

Belts and chokes have very specific hole to seed size/shape.

(b) "Nibex" precision drill with spoon wheel mechanism. This has the advantage of greater flexibility in the extremeties of the range of seed types that can be drilled. It can take time to set as it requires detailed calibration for each seed shape or size to ensure the best plant spacing.

Any precision drill can be tested in the shed using a sticky band to determine spacing performance and seed damage. However, this 'dry' test is not fully representative of field conditions because of the interaction of soil movement around the coulter.

2.2 Modules (see also C. Seed and Plant Sources, section 5.0, pages 25-27).

Vacuum seeders eg Hamilton

Rotary drum seeders - cell trays/module trays.

3.0 Transplanting

3.1 Simple

(a) Furrow opening and hand placement. This is not specific to shape or growing method of transplant for example from dahlia tubers to plugs. Typically plants can be handled at 1200 units/operator/hour.

3.2 Mechanised

(a) Hand fed transplanting equipment eg "Accord". It is more limited on the maximum size of transplants such as chrysanthemums and dahlia. Typically 2,000 plants/operator/hour can be handled.

(b) Semi-automatic type eg "Pelican" or "Lannen".

Require module-grown transplants but are quite rapid at 2,500-4,000 plants/operator/hour.

3.3 Row centres

On a single tool bar there will be a minimum row width restriction of about 0.5m to accommodate operators shoulder to shoulder.

This can be overcome by use of a tandem tool bar, but this is cumbersome and could make the planter difficult to lift with compact tractors.

A further option is to plant alternate rows from a single tool bar and split back in the opposite direction. This though halves total output.

4.0 Equipment for mechanical weed control

4.1 Inter-row hoeing using fixed or powered blades or flexible finger tines such as "Reekie weeders". For early stages of growth only.

4.2 Inter-row flaming or total herbicides can be used, but there is a risk of damage to plants. With flame weeding the aim is to "heat-up" the weeds to achieve kill, not to desiccate them.

5.0 Irrigation

5.1 Propagation stages under protection

As fixed sprinklers give uneven distribution, moving boom equipment is essential to achieve even watering especially if nutrients/pesticides are included.

5.2 In the field

Small droplet sprinklers are advised; nozzles larger than 10mm should be avoided as damage to soft plant tissue and soil structure can result, as well as splash onto foliage.

(a) Solid set: totally moved or with fixed pipe and movable sprinklers. This could be expensive in initial costs and labour needed to move it regularly.

(b) Towed sprinkler boon is the ideal system.

(c) Rain guns: either as a solid set, single nozzle or as a towed carriage, are relatively cheap but limited in wetting area with a 10mm nozzle.

6.0 Spraying equipment

Conventional hydraulic boom sprayers, if well set and operated should give good results in all types of crop canopy.

7.0 Harvesting

Very few species can be harvested mechanically because of the lack of crop selection, difficulty of trash and weed separation, and damage. Mainly hand labour used for selection and harvesting, but increasingly using mechanical aids to assist handling such as boom conveyors and simple pedestrian gantries.

8.0 Crop covers/mulches

8.1 Crop covers

The crop cover is laid over the bed in advance of sowing/planting to help raise soil temperature. The ADAS polythene lifter/re-layer ("Polyflow") [Windle Agro Tech] has been designed to raise the cover during drilling/transplanting and then immediately relay it.

The bed shape can be formed to allow 'head space' to give more crop height so that it does not need to be removed so early. Mini-ridges are formed each side of the bed across which the crop cover is tightly stretched.

8.2 Removal and disposal are a major problem; manual and powered re-rollers can be employed, but it is doubtful if the crop cover can be re-used.

9.0 Post-harvest management

9.1 Removal of field heat

(a) General purpose cold stores

A limited quantity of flowers can be cooled in a conventional cold store. However, if any large quantity is put into a cooler the cooling will be slow and there will be the risk of severe desiccation and freezing damage.

(b) High humidity cold stores (ice bank stores)

Cooling can be relatively rapid, alternatively the flowers can be held for several days, depending on species, without desiccation or fear of freezing damage. It is essential that they are stored unwrapped and not in cellophane, in shallow layers in trays.

After cooling, grading and wrapping, the bunches can be put into a conventional cold store for one to two days prior to collection.

Condensation on the film might be detrimental and limit cooling temperature in warm weather.

9.2 Bunching

(a) Line design

It is essential to have good ergonomic design of the bunching line. It is seldom appreciated the need for selection of operators because of factors like dexterity and colour blindness. Factors such as operator position, light and crop flow need to be carefully planned to avoid operator fatigue and loss of performance.

(b) Packing aids

Bunching machines with elasticated string tying and end or length trimming can be used to good effect. Also, some automation of wrapping and sleeving will be justified on large operations.

10.0 Drying flowers and grasses

10.1 Air movement/temperature

Rapid drying for two to three days at temperatures up to 60°C has been found best to preserve colour and quality. However care is need to avoid overdrying.

Good air movement is essential and bunches need to be hung on racks to allow air to circulate all round.

Full control of air conditions is needed preferably with re-circulation in the later stages of drying to avoid heavy energy use.

10.2 Dehumidifiers

Dehumidifiers have been used successfully to create the correct drying atmosphere. However, raising the air temperature further increases rate of moisture release from the flowers.

Where the species might be damaged by drying at very high temperatures, dehumidifiers have the advantage that they can remove moisture reasonably efficiently at lower temperatures.

10.3 Microwaves

Microwave heating will produce very rapid drying with negligible loss of colour. However, results might be uneven and careful monitoring will be essential to prevent over-drying or even charring of parts which dry the most rapidly.

APPENDIX II

TRADE JOURNALS

The following publications are useful sources of production and marketing information.

1.0 "Flower Trades Journal"; The International Monthly Marketing Journal for the entire Horticultural Industry; Yewtree Publishing Co Ltd., 17 Wickham Road, Beckenham, Kent BR3 2JS.

2.0 "The International Floriculture Quarterly Report"; Pathfast Publications, 31 Second Avenue, Frinton on Sea, Essex CO13 9ER.

3.0 "Vakblad voor de Bloemisterij"; Dutch Weekly Journal for protected and outdoor flower crop; Schipholweg 1, Postbus 9324, 2300 PH Leiden, The Netherlands.