ATO

Prospects of 1-MCP for the flower market

Market study exclusively written for Rohm and Haas

OPD: 01/088/3 juli 2001

Confidential

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Content

1 Foreseeable benefits of 1-MCP for cut flowers

1-Methylcyclopropene (in short MCP) is a unique molecule. It possesses a strained cyclopropene ring structure that is stabilised by a methyl substituent. The unique molecular structure is also reflected in its properties. Its reaction with the ethylene-receptors of plants is promising from a business point of view. It allows ethylene sensitive plants to become much less sensitive to ethylene. This can be used to prolong the vase life of flowers, the distribution time of flowers and plants and the quality of both products.

Many cut flowers are ethylene sensitive, see table 1. Ethylene sensitive flowers start to wilt, to drop petals, etc. after exposure to ethylene gas. Ethylene is a plant hormone that initiates senescence and wilting. Flowers and plants produce ethylene themselves. Additionally, exhaust gases of automobiles contain more than sufficient ethylene to start senescence on sensitive flowers and plants. Hence, product losses due to ethylene in the supply chain have various origins: indigenous ethylene produced by the flower itself, exhaust gases and combined transport or storage with fruits and vegetables.

Table 1: *The major 10 cut flowers and eight ethylene sensitive flowers with small market volumes, trade names, turnover at the VBN in The Netherlands and their ethylene sensitivity. The turnover is given only for the majority of the flowers that is traded via the auctions.*

Trade name	Current package, treatment or method of transportation	Turnover [Mln Euro] in 1995	1998	2000	Ethylene sensitivity, [0-3][C]
Rosa	Buckets and boxes	450.9	570.9	648.6	1[A]
Dendranthema (Chrysant)	Buckets and boxes	245.5	290.5	322.3	0
Tulipa	Buckets	124.5	150.5	177.3	1
Lilium	Buckets, STS-V	102.7	137.3	150.0	2[A]
Gerbera	Boxes	65.9	95.5	100.5	0
Freesia	Buckets, STS-A	59.1	64.1	62.3	2
Dianthus (Carnation, Anjer)	Boxes or Buckets, AOA / STS-V	100.9	87.7	68.2	3
Cymbidium (orchid)	Only boxes with water tubes on each stem	50.0	59.1	65.0	3
Gypsophila (Gipskruid)	Buckets, STS-A	28.2	36.8	42.5	3
Alstroemeria	Buckets, GIB	35.9	41.4	44.0	3[A]
Aconitum[B]	STS-V	4.0		5.4	3
Delphinium[B]	STS-V	6.1	7.3	9.6	3
Aquilegia[B]	STS-V	0.1		0.1	3
Asclepias[B]	STS-V	5.5		10.0	3
Anthirrhinum,[B]	STS-A	4.3		4.4	3
Euphorbia fulgens[B]	STS-V	5.0		4.9	3
Lathyrus[B]	STS-V	1.5		1.3	3
Veronica[B]	STS-V	3.4		7.2	3

A: Ethylene sensitivity is cultivar dependant.
B: Only grown in summer
C: Subjective scale from 0 to 3. Zero means insensitive and three means very sensitive.
STS-V: Treatment with STS (Silver ThioSulfate) is obligatory.
STS-A: Treatment with STS is advised.
AOA: Treatment with AOA (Amino Oxy Acetic acid) is obligatory for flowers grown in The Netherlands
GIB: Treatment with Gibberellic acid is obligatory (bactericide)

Hence, exposure of unprotected ethylene sensitive flowers to ethylene gas causes great product losses. To avoid these financial losses, sensitive flowers are obliged (by VBN) to be treated with protective agents such as Silver

Thiosulfate and Aminooxyacetic acid. Both agents have severe disadvantages in terms of production logistics, environmental and occupational health issues. Hence, there is a market for new alternative agents such as MCP, that can guarantee flower quality and extend vase lives.

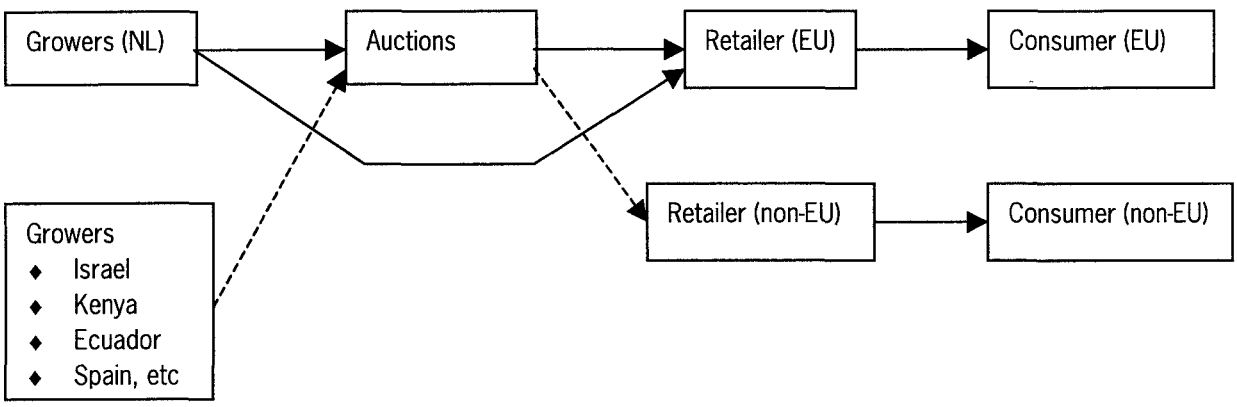
Other mechanisms that cause quality deterioration of flowers, besides exposure to ethylene, are: mechanical damage, dehydration and microbial growth (especially *Botrytis*). Which mechanism is predominant depends on the handling and conditions in the supply chain and on the type of flower.

Summary

The foreseen benefit of MCP for the cut flower market is the extension of the vase life and quality control of Lilies, Carnations, Cymbidium, Gypsophila, Alstroemeria, Freesia and possibly Roses. The rose market is by far the most attractive in terms of market volume. However, the ethylene sensitivity of roses is very cultivar-dependant and the positive effect of 1-MCP on the quality of roses is not established, yet.

2 Supply chain of flowers

The Netherlands is the major flower-producing and trading centre of the world. The world production is estimated to be 3.5 Billion Euro annually, of which 58 % is produced in The Netherlands. Besides the important local production (turnover of 2.03 billion Euro in 2000), flowers produced in all corners of the world are also being flown into The Netherlands, traded and directly flown out of The Netherlands to clients all over the world (foreign grown flowers traded in The Netherlands had a turnover of 0.45 billion Euro in 2000).
The major actor in this complex inter-twined supply chain is VBN (Vereniging van Bloemenveilingen in Nederland, Dutch abbreviation for: Union of Dutch Flower Auctions). This is a very influential non-governmental organisation that represents the majority of the flower industry and sets its own rules. The most important rules are the so-called "veilingvoorschriften" (Dutch for "auction regulations"). These describe precisely how flowers need to be presented at the auction, which treatment they need to have, which package they should be in, and how flower quality is determined and how flowers are classified.
Additionally, the direct supply chain from growers to retailers (without auctions) is a growing part of the business. But, in comparison with the auction-chain, no reliable data exists on the magnitude of this supply chain.[1]



Scheme 1: *Schematic representation of the supply chain for cut flowers. The full lines represent truck transport, the dashed lines represent air transport. For reasons of simplicity, the importers, exporters, wholesalers, etc. have been omitted from the scheme.*

The Dutch part of the supply chain comprises of 6575 growers (in year 2000), which are organised in "Productschap voor de Tuinbouw" or PT (Dutch for Horticultural board), 6 Auctions (organised in VBN) and 1218 flower exporting companies.
The flower market is highly fragmented into products. About 50 different flowers are traded, of which there exist many varieties, hybrids or cultivars. Roses has the largest product turnover, which is annually 649 Mln Euro in 2000 for about 470 different rose cultivars. About 3 million stems were sold in 2000 for an average price of 20 Eurocent/stem; see table 10.

Lead times

In an elaborate Dutch study of the flower supply chain, it was established that 3 to 5 days are required for Dutch grown flowers to reach the consumer (calculated from the moment of harvest until the point of sale). Dutch grown flowers with a foreign destination require 3 – 6 days from harvest to be delivered at the importer. Subsequently, 1 to 5 days are required for these flowers to reach the foreign consumers; see table 2.

Equally precise lead times are not available for foreign grown flowers. Interviews with foreign producers have revealed large differences. Flowers from Israel require about 2 - 3 days to travel to the auction under almost optimal conditions, whereas flowers from Kenya and Thailand are about 3 - 5 days on route under mostly non-cooled conditions.

Table 2: *Modal lead times in the various phases of the distribution chain per country of destination, [days].*

Phase	Destination							
	NL	D	F	GB	I	USA	S	CH
Grower	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Auction	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Exporter	-	1.4	1.5	1.5	3.0	1.9	1.2	1.8
Importer	-	1.1	1.1	1.5	2.1	2.6	2.5	1.2
Retailer	1.7	2.4	1.7	2.2	3.2	2.9	2.7	2.0
Total	4.6	6.6	5.9	8.3	8.3	8.8	8.6	6.1

Conditions

The optimal temperature for storing most flowers is close to the freezing point (0-5°C). Chilling causes all major quality deterioration mechanisms to slow down; senescence, ethylene sensitivity and microbial growth rate. However, flowers cannot be frozen and some flowers experience chill damage at temperatures near the freezing point; discoloration of the stem or glassyness of the stem, etc. For instance, roses and carnations should not be stored at 0°C for more than 3 days.
The optimal relative humidity for storing flowers is high (ca. 90%RH). Flowers transpire. The rate of transpiration is lower at higher levels of relative humidity. Too much transpiration causes the flower to become limp and soft. Too high levels of relative humidity enlarge the chance of condensation on the flowers. Condensation most often results in fungal growth (Botrytis). Hence, the relative humidity should be kept high, but not too high and large temperature fluctuations (that cause condensation) should be avoided.
Additionally flowers benefit from light and from an atmosphere that does not contain ethylene (< 50 ppb) and Botrytis spores.

The temperature in the flower supply chain has been measured intensively, see table 3. Optimal temperatures are hardly ever attained.

Table 3: *Measured temperatures [°C] in various rooms and at different stages of postharvest handling in The Netherlands (NL) and France (F).*

Phase	Temperature					
	Mean	SD	Min.	Max.	Modal	n
Grower cold room	4.9	4.1	0.0	29.0	2.0	271
Auction cold store	6.2	2.9	0.0	14.7	8.0	165
Auction hall	14.7	3.9	3.0	26.6	17.0	264
Wholesale F	7.3	4.0	3.0	12.2	3.0	58
Wholesale NL	4.9	2.7	1.0	15.0	4.0	213
Retailer cold store F	9.8	2.7	6.5	16.0	7.5	33
Retailer cold store NL	9.7	3.3	5.0	17.0	10.0	50
Retailer shop F	17.3	3.2	11.0	24.5	21.0	30
Retailer shop NL	16.2	4.0	5.2	26.1	14.0	60

Temperatures during truck-transport are mostly properly set, but hardly ever attained inside the truck. Flowers are often packed so densely in pallet stacks of containers or boxes that the air is no longer able to penetrate the pallet stacks and cool the interior.
Temperatures during air transport in the cargo room are mostly between 10 and 20°C, but sub-zero temperatures also occur. Due to the dense packing of flowers in boxes and the heat generation of flowers, the real temperatures are moderate and no large chill-damage is done due to low freight room temperatures. The largest bottle-necks of

air-transport are the long unconditioned waiting times. The packed pallets of flowers are mostly left waiting outside at the airport, experiencing ambient temperatures for 1-4 hours.
In summary, the quality loss due to temperature abuse is considerable. The reason for this mis-management is mostly lack of knowledge.

The relative humidity in the supply chain is generally high. The relative humidity that the flowers experience depends strongly on the used packages. Most boxes are fairly closed with small ventilation holes on the far sides, allowing the relative humidity to reach levels of 90-100 %. Aqua-boxes (bucket in cardboard box) obviously possess internal relative humidity close to 100 %. Hence, condensation occurs very often and Botrytis growth is a serious problem. Exceptions are sometimes air-transports, with levels of relative humidity of < 20 % inside the freight room. However, due to the well-isolated nature of the flower boxes and pallets, this hardly causes any problems.

Ethylene concentrations have been measured intensively at various supply chain elements; see table 4. These results show that in 60-90 % of the cases, the level of ethylene is not harmful for ethylene sensitive flowers. However, in 10-40 % of the cases, ethylene-abuse situations occur. Due to the longer lead times at the retailer, the abuse situations at the retailer are especially important. Besides the locations given in table 4, high ethylene concentrations are also expected at airports, although data on ethylene concentrations at airports is lacking.

Table 4: Ethylene concentrations in various types of rooms in the various phases of the distribution chain

Phase / room	Percentage of ethylene concentration class, [%]			
	< 50 ppb	50-100 ppb	>100 ppb	N
Grower cold store	86	11	3	87
Auction cold store	61	33	6	85
Auction hall	71	25	4	211
Wholesale, cold store	83	16	1	201
Wholesale storage room	67	30	3	64
Retailer, cold store	86	13	2	128
Retailer, shop	71	26	3	258
Retailer, processing room	75	19	6	164

Hence, the chances are great that ethylene sensitive flowers experience ethylene concentrations that affect their quality negatively. Therefore, VBN requires growers to treat these flowers with agents such as STS or AOA to render them less sensitive. Consequently, few flowers show ethylene-damage at the point of sale. The reason for the VBN to implement the use of these agents is that ethylene is the only parameter they can control; temperature-control, moisture-control and hygiene cannot be enforced by VBN further on in the supply chain.

Intensive measurements of the air quality of all rooms in the flower supply chains have shown that about 70 % of these rooms do not contain Botrytis spores, about 25 % contain 1-100 spores /m^3 and about 5 % contain more than 100 spores/m^3. This implies that most flowers will get infected with Botrytis spores. Damage due to fungal growth will occur in case condensation occurs and sufficient time is available (long lead times) for the micro-organism to grow.

Mechanically damaged flowers (crushing, brushing) are most common in the large boxes (1-3 m^3) used in air transport from tropical origins. These boxes are commonly overfilled, compressed and closed.

Losses in the supply chain

The losses in the flower supply chain are large. Experts estimate the direct loss to be 5-10 %. This is the value of flowers that never reach the consumer, because the quality has fallen below the acceptance limit. On top of that, there are the indirect losses. These are roughly estimated to be higher than 10 %. These are losses due to unsatisfied consumers, which stop buying the same type of flower or will buy from another florist in the future.

Attempts have been made to quantify the losses more precisely with the help of predictive model calculations. These calculations show that losses can be attributed to all partners in the chain, but the vase life loss increases gradually for the later phases of the supply chain. Some results of these predictive calculations with model supply chains are given in table 5. The loss is expressed as the loss in vase life.

Table 5: *Total loss in quality over all phases in the supply chain in percentages as calculated by predictive models.*

Flower	Total loss, [%]	Maximal vase life, [days]	Remaining vase life, [days]
Gerbera	33	17	11.4
Rose	29	15	10.7
Carnation	15	11	9.4
Tulip	47	10	5.3
Chrysant	25	17	12.8
Lily	33	11	7.4
Iris	46	6	3.2
Freesia	27	13	9.5

Summary

The overall supply chain of cut-flowers is complex. VBN is by far the most powerful chain element. Cut flowers with a total value of about 2.2 billion Euro are traded via Dutch auctions annually. Highly ethylene sensitive flowers equal a total market value of about 450 million Euro.
The conditions in the flower supply chain are not ideal; lead times are still reasonable, temperatures and humidties could be controlled better, ethylene concentrations are often too high and Botrytis contamination is too common. Consequently, the losses in the supply chain are large (5-10 %). In case MCP replaces STS and AOA as protective agents, it is expected that this loss is reduced as a consequence of a better protection under sub-optimal conditions (read: temperature abuse conditions).

3 Market description for ethylene sensitive flowers

This chapter describes the flower specific details of the supply chain for the four ethylene sensitive flowers with the largest market volume and for roses.

Lilium

Four hybrids of Lilium -(lilies) are grown and traded in The Netherlands, see table 6. Roughly one-third of all lilies has to be pre-treated with STS, this applies to most of the Asiatic hybrids and all of the Longiflorum Asiatic hybrids.

Table 6: Economic figures of the Lilium hybrids in 2000 at VBN.

Hybrid	Turnover, [Mln Euro]	Part of turnover that has to be pre-treated.	Number of stems produced	Average price, [Euro]
Asiatic	37.996	35.536	148063	0.26
Longiflorum Asiatic	10.910	10.910	33202	0.33
Oriental	73.588	0	126566	0.58
Longiflorum	27.412	0	74363	0.37
Other	151	0	508	0.30
Total	300.906	46.446	382702	0.44*

*: overall average of the price per stem

Lilies are harvested by cutting them from the bulb. They are transported dry on a harvest carriage to the cool processing room at the grower, at which they are sorted, grouped and cut to the same length per bunch. Subsequently, they are sleeved and placed in large buckets. These buckets contain aqueous solutions of STS in the cases where the VBN has required the growers to do so. This treatment takes about 4-8 hours. The lilies have to stand in the growers' processing room for this period of time and take up valuable space. Hence, most growers now harvest these lilies in the evening and place them in STS-solution overnight. Subsequently, the lilies are taken out of the STS solution, rinsed and placed in buckets containing water, since the VBN does not accept flowers with STS-solution in the buckets. Alternatively, the lilies are taken out of the STS-solution and transported in a dry box to the auction. The auction accepts three types of boxes for lilies. Very early in the morning, the grower transports the lilies to the auction. They are sold to the highest bidder and transported to this exporter or wholesaler. At this stage, the lilies are usually re-packed in either aqua-boxes or boxes. The aqua-boxes are buckets with a card-board over-package and are used for truck transport in Europe. The dry boxes are used for air-transport to faraway destinations and for truck-transport in Europe.

Freesia

Freesia is harvested by cutting branches from the plant. The branches are grouped in bunches, cut to equal length, placed in containers (read: large buckets) and transported. Nearly 180 different cultivars of Freesia are grown and traded. These can be divided in large groups of single Freesias and small groups of single Freesia; see table 7. VBN advises growers to treat Freesias with STS. In practice, most growers do not take this advice because, the STS treatment requires much time and space. Furthermore, chemicals cause hassles and their disposal is costly.

Table 7: Economic figures of the two types of Freesia in 2000 at VBN.

Type	Turnover, [Mln Euro]	Number of stems produced	Average price, [Euro]
Double	18.965	126442	0.15
Single	43.386	318333	0.14
Total	62.350	444775	0.14

Dianthus, Carnation

Carnations are cut and placed in buckets on the harvest carriage. Inside the cold processing room, the grower will sort the carnations, group them into bunches, cut them into equal lengths, sleeve them and place them in buckets with either AOA or STS. VBN requires the growers to treat with either AOA or STS. Most growers use AOA, since it does not cause delay. Carnations in buckets with AOA solutions are allowed inside the auction, whereas carnations in buckets with STS solutions are not. Most Dutch-grown carnations are transported and presented in buckets, whereas most imported carnations are transported and presented in dry boxes.
AOA is only allowed forcCarnations by the VBN. The Dutch authorities do not officially allow AOA, it is merely tolerated. It will probably be forbidden in the near future, depending on the introduction of better alternatives. The main advantage of AOA is that it does not cause delay at the grower. Disadvantages are the small effective concentration window; the concentrations at which AOA starts to be effective and at which AOA becomes phytotoxic are close. Therefore, solutions should be made with care and this is not always possible at the grower.

Table 8: Economic figures of the types of Carnation in 2000 at VBN.

Type	Turnover, [Mln Euro]	Number of stems produced	Average price, [Euro]
Geplozen Anjers	38.605	282190	0.14
Trosanjers	28.852	296747	0.10
Misc. Carnation	618	6687	0.09
Total	68.075	585624	0.12

Table 8 shows an overview of the economic figures of the Carnation production in the Netherlands. The two most important types are the standard or "geplozen" (fluffy) carnations and the "trosanjers" that have many flowers on one stem.

Cymbidium

Cymbidium is a type of orchid and has a growing popularity. It is handled similar to ethylene sensitive lilies, except for the package. After the STS-treatment in buckets, every stem is given a small water tube. A limited amount of stems (usual 10) are packed per box. Since Cymbidium is especially popular in South and East Europe (as funeral flower), it is mostly transported by air-planes or long truck rides. Two main types can be discerned: "grootbloemig" (large one single flower) and "mini" having several small flowers on the stem; see table 9.

Table 9: Economic figures of the types of Cymbidium in 2000 at VBN.

Type	Turnover, [Mln Euro]	Number of stems produced	Average price, [Euro]
Grootbloemig	31.208	10184	3.06
Mini	14.286	10341	1.38
Misc. Cymbidium	19.955	14765	1.35
Total	65.450	35290	1.85

ATO has positive experiences in treating Cymbidium with MCP. Vase lives can be extended greatly. A continuous exposure to MCP was found to perform better than a one-shot treatment. Additionally, large extensions of vase life were established under sub-optimal conditions (read: temperature abuse situations).

Roses

Roses are cut and placed on the harvest carriage. In the cooled processing room of the grower, the roses are sorted, grouped into bunches, cut into equal lengths, sleeved and placed in buckets or boxes. Three types of roses are discerned; roses with small flowers (kleinbloemig), roses with large flowers (grootbloemig) and one stem with many small flowers (trosrozen); see table 10.

Table 10: *Economic figures of the three types of roses in 2000 at VBN. The three most important cultivars are given as well.*

Type	Turnover, [Mln Euro]	Number of stems produced	Average price, [Euro]
Grootbloemig (Large)	381.678	1,379,179	0.28
• *First Red*	*65.706*	*230,042*	*0.29*
• *Red Berlin*	*34.385*	*91,053*	*0.38*
• *Grand Prix*	*23.464*	*49,631*	*0.47*
Kleinbloemig (Small)	236.858	1,675,461	0.14
Trosrozen (on the stem)	30.202	165,125	0.19
Total	648.738	3,219,765	0.20

Roses are currently not treated with STS, AOA or other agents, since it is not established that these agents have a positive influence on the rose quality. VBN, PT and rose growers are very interested in new treatment agents that can retain the rose quality longer.
Should MCP have a positive effect on the quality of roses, a very interesting market would open up for Rohm & Haas. On the internet-site of Rohm & Haas, results are presented that suggest that the quality of the most important cultivar (First Red) can be retained much better after a treatment with MCP. Since this cultivar has a market-share of about one-tenth of the total rose business, this could be very interesting.

4 Methods of application

Protective agents can be applied at different stages in the supply chain;

- directly after harvest or
- continuously in the supply chain.

Both strategies have advantages and disadvantages; see table 11.

Table 11: Advantages and disadvantages of two strategies of flower treatment

Strategy	Advantages	Disadvantages
Treatment direct after harvest	+ Concentration of agents in the supply chain on one place	- Growers do not have the space and experience for complex treatments.
	+ Consumers are not exposed to the agent	- Growers have to pay for the extra treatment but do not necessarily get something in return.
		- Protective action of the agent might be lost in time.
		- Treatments can cause delays (STS).
Continuous treatment	+ No delays for long treatments	- Safety of workers and consumers in all stages in the supply chain has to be assured.
	+ Continuous protection	- Due to the international nature of the supply chain, this system has to comply with many various legislations and regulations.
	+ Potential simple solution	- Development of dedicated release systems is necessary.
	+ Easily integrated in the complex supply chains	

Currently, only the first strategy is used because the properties of the current agents are not suited for the second strategy. STS is only applied at the grower, because the auction does not accept STS solutions in the buckets. AOA is used up to the wholesaler or exporter, where re-packing occurs.

MCP is a very volatile vapour and is best applied in a close system (closed chamber, closed package, etc.) at low concentrations. Hence, MCP could be used directly after the harvest at the grower in a treatment tank or chamber. The disadvantage is that the grower has to invest in equipment and knowledge. As a compromise, the treatment could be postponed to the cooling cells of the auction. However, this must not result in reduced lead times. Moreover, this system is less robust, since ethylene exposure can already damage the flowers prior to the auction.

Alternatively, the MCP could be released inside a box, either a dry box or an aquabox. This offers the advantages of continuous protection and short lead times. With a limited amount of systems (for instance: one for dry boxes, one for aqua-boxes), the complete market could be served. The grower could add such a system to the box / aquabox and transport the flowers, without delay, to the auction. The flowers are protected from the moment of system-activation and all through the supply chain.
Such a system needs to comply to all regulations for occupational health, air transport, truck transport, consumer protection, etc. Hence, only small concentrations of MCP could be tolerated. This seems feasible with MCP, since already very low concentrations protect the flowers.

Summary

Flowers could be treated with MCP directly after harvest, in the growers processing room. This will require large investments in equipment (closed treatment chambers) and knowledge. Moreover, most growers will not have the required space for such machinery.
Flowers could also be treated continuously in their packages (either dry boxes or aqua-boxes) from the moment of harvest onwards. These systems would be integrated more easily in the current complex supply chains of various flower products.

5 Legal aspects and competitive agents

Two competitive agents currently in the market that protect flowers against ethylene are: STS and AOA. There are many more agents in the market, but none of these protect against ethylene; these are usually mixtures of glucose (plant feed) and sodium hypochlorite (bactericide). Additionally, there are many ethylene absorbing mixtures on the market (based on potassium permanganate), but these do not offer any form of protection. Intensive research at ATO in the past has shown that ethylene is still produced by the flower and still causes damage due to the lack of air circulation.
STS is officially allowed for ethylene-sensitive flowers, as it is certified as "gewasbeschermingsmiddel" (Dutch for protective agent for plants) according to the "gewasbeschermingsbesluit".
AOA is not officially allowed, but merely tolerated. According to the VBN, it is expected that the policy of the Dutch government will be more strict on flower treatment agents and "AOA will no longer be available in the near future".

MCP will have to comply with the following law and regulations:
- Gewasbeschermingsbesluit, (Dutch law on crop protecting agents)
- Warenwetbesluit algemene productveiligheid, (Dutch law on general product safety for workers and consumers)

Rohm & Haas will have to position MCP on the market as a new alternative for STS and AOA. Important sales-arguments will be:
- MCP saves time and handling at the grower, and hence reduces lead times and improves quality,
- MCP is more environment-friendly than STS and AOA,
- MCP saves costs, because no chemicals have to be disposed of,
- MCP protects flowers better,
- MCP is simple, it does not involve difficult hassles with chemicals (precise dilutions, disposal)
- MCP complies with national, European and international legislations.

A successful Introduction of MCP in the market implies that STS and AOA will be replaced. Defensive responses from STS manufacturers (Pokon Chrysal) can be expected. Rohm & Haas could consider strategic alliances with such companies.

A successful market-introduction will require the assistance of VBN. VBN will have to be convinced of the positive effect of MCP on flowers. Once they are convinced, they can require growers to use this agent. In order to get commitment of VBN, they could be involved as advisors in flower projects.
Other important stake-holders are the horticultural board "Productschap voor Tuinbouw" and the Dutch ministry for environmental affairs (VROM).

Recommendations

The following opinions are those of the author and presented for the benefit of Rohm & Haas:

- Develop two standard release systems for MCP, one for boxes and one for aqua-boxes to cover the market for all ethylene-sensitive flowers (Lily, Carnation, Freesia, Cymbidium, Gypsophila, Alstroemeria, etc.).
- Involve VBN as advisor in these developments.
- Establish that MCP protects the above-mentioned flowers for ethylene damage under sub-optimal conditions.
- Consider the use of MCP-release systems for plants as well.
- Prepare yourself for defensive responses of STS and AOA manufacturers. Consider strategic alliances with companies such as Pokon-Chrysal, to reduce these responses and to make use of their sales-network.

Concise calculation of added value

The added value of MCP is an economic loss reduction of more than 45 mln Euro/year (about 10 % of the turnover) for all ethylene-sensitive flowers. To calculate the maximum price for the MCP-system, we need to take the amount of flowers per transport-unit into account. This varies from 10 for Cymbidiums to 100-300 for roses and carnations. Hence, for a box of 10 Cymbidiums, the maximum price for a MCP-system would be 1.85 Euro and for a box of 300 roses, the maximum price would be 6.00 Euro.

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Notes

[1] This information is most likely present at VBN, but is not disclosed for political reasons.