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Food Production and Inspection Branch
Direction générale, Production et inspection des aliments

Plant Industry Directorate
Direction de l'industrie des prodiuts végétaux

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ORDER - EUBACTERIALES
FAMILY - ENTEROBACTERIACEAE

AGROBACTERIUM RADIOBACTER

(BEIJERINCK AND VAN DELDEN) CONN

PRODUCT MANAGEMENT DIVISION NOVEMBER 6, 1989

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FOREWORD

AGROBACTERIUM RADIOBACTER

As part of the ongoing information initiative, we have provided a summary of the data received and the regulatory action on Agrobacterium radiobacter. This document reflects input from specialists within Agriculture Canada and by interdepartmental advisors. Based on the reviews of all available information and in consideration of its agronomic benefits to Canadian nurseries, a decision has been made to register A. radiobacter (Dygall) for use as a root dip and seed treatment for ornamentals and non-bearing fruit trees.

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November 6, 1989

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AGROBACTERIUM RADIOBACTER (DYGALL)

INTRODUCTION

Dygall (Agrobacterium radiobacter) is a biological pesticide used for control of crown gall in a wide variety of ornamentals and non-bearing fruit crops.

Agrobacterium radiobacter strain 84 has evolved a unique control method which is only active against the crown gall causative agent, Agrobacterium tumefaciens. The biology of this interaction is described in detail elsewhere in this submission, but is specific only to A. tumefaciens at the infection site. No control is exerted until an infection is initiated by A. tumefaciens. Indeed, the two organisms readily co-exist in the soil environment.

A. radiobacter strain 84 has been used for the control of crown gall since the unique properties of the organism were first discovered by Dr. Allen Kerr in the early 1970's. Since then the organism has been tested successfully in England, Scotland, France, Canada, Greece, Hungary and Italy and is known to be available commercially as a registered product in the United States, Australia, Israel, South Africa and New Zealand.

In summary, Agriculture Canada has considered the following in the evaluation of this product:

1) A. radiobacter is a naturally occurring soil/rhizosphere inhabitat, and is found in soils throughout the world.

2) The organism, in the form of several products, is registered in a number of countries including the United States.

3) The product is very cost efficient and has the potential to save losses in the Canadian nursery industry currently running at 10%-80% in susceptible plant species.

4) Canadian nurserymen currently have no cost-effective method to control crown gall.

5) Nurserymen in the United States are currently treating their stock with A. radiobacter providing a competitive edge over Canadian nurserymen for the susceptible species range.

6) Treated American stock is being shipped from the United States to Canada.

7) The product has been tested in Canada and shown to be effective.

8) This naturally occurring organism fulfills the criteria for a Microbial Control Agent as given in the Guidelines for Registration:

- The method of disease control exerted by A. radiobacter strain 84 is specific to A. tumefaciens, the crown gall causative agent. Furthermore, control is only exerted upon the initiation of infection, and not in the general soil environment.

- A. radiobacter strain 84 only eliminates A. tumefaciens at the infection site. The two organisms co-exist in the soil environment.

- Dygall is used as a dip treatment. The formulation is easily converted to a slurry which is further diluted in the dip tank. Large numbers of seeds/plants can be treated quickly by dipping into the suspension for 5 to 10 seconds. The organism is not sprayed into the environment. Upon completion, the remaining dip is allowed to soak into the soil in a shallow trench.

- A. radiobacter is a saprophyte of soil/rhizosphere environment. As such it will persist in the root zone, protecting the plant for a considerable time. As with all soil organisms, an equilibrium population level is reached depending on physical conditions and existing microflora.

- Use of this naturally occurring product as a pre-planting, or seed dip (3-5 years before bearing fruit) mitigates the possibility of residue occurring in foods.

- A. radiobacter can be recovered from soil environments in common soil extractions and isolation methods. Strain 84 can be identified readily by the production of agrocin 84, or by the control exerted by isolates on A. tumefaciens.

Health and Welfare Canada have reviewed the data submitted to date in support of the registration of Dygall with the following comments:

The active ingredient Agrobacterium radiobacter appeared to be non-toxic to rats but its infectivity potential has not been properly assessed.

Agrobacterium radiobacter caused mild ocular irritation in rabbits. Safety precautions on the label reflect this characteristic: Users are to avoid eye contact; if splashed in the eye, the eye should be flushed with clean water immediately. If irritation persists, a physician should be consulted.
The bacterial preparation showed no apparent dermal irritation potential on rabbit skin; however, study results on guinea pigs did not clearly indicate that Agrobacterium radiobacter was not a dermal sensitizer.

The formulated product consists of additional ingredients commonly used in products, processes and foodstuffs. The human health safety concerns related to the formulated product would most probably not differ from that of the active ingredient. However, this has not been confirmed by toxicological investigations.

Environment Canada and Fisheries and Oceans Canada have not reviewed the submission in support of registration of this product.

BENEFIT ASSESSMENT OF DYGALL (AGROBACTERIUM RADIOBACTER) USE IN NURSERY CROP PRODUCTION

1. SUMMARY

Crown gall, a serious disease caused by the soil-borne bacterium Agrobacterium tumefaciens, limits the economical production of fruit and ornamental nursery stock in Canada. The value of this stock was approximately $112 million in 1986. It is estimated that crown gall can cause about 10% loss annually to the Canadian nursery stock industry based on research reports from Ontario and British Columbia and industry estimates. A similar loss is estimated for the west coast of the United States where most of the American nursery stock is located. There were no satisfactory control measures for crown gall until A. radiobacter strain 84 was isolated and its antagonistic properties to crown gall were discovered.

There are a number of commercial products developed for biological control of crown gall which incorporate A. radiobacter strain K-84, a non-sporing gram-negative bacterium. One such product Galltrol-A is produced by AgBiochem of California and registered for use in the United States. Another, Dygall, is produced by a New Zealand company, AgTech Developments. Experimental tests in Canada and several other countries have found this product to be effective against crown gall when seeds, plants and/or cuttings are dipped in the inoculant before planting. This treatment is also relatively cost-effective compared to others.

The potential economic benefits of Dygall are significant. Tests have indicated that it would reduce the level of crown gall infection in nursery stock to insignificant levels of about 1% or 2%. Reductions of this magnitude would have a positive impact on producer and industry income, and the industry's trade balance.

2. PROFILE OF THE PRODUCT AND MARKET SECTOR

2.1 Description and Uses of Dygall

Dygall is a peat-based pure culture of A. radiobacter that, when applied to young root systems, will help prevent the formation of crown gall. A. radiobacter is a non-sporing gram-negative bacterium and a saprophytic soil inhabitant of worldwide distribution. A strain of biovar-2 of this bacterium isolated from Australian soil and labelled K-84 was found to possess biological control potential against crown gall.

There are a number of commercial products incorporating A. radiobacter strain K-84 which have been developed for biological control of crown gall. One, Galltrol-A produced by Ag Biochem of California is an agar plate culture of the same bacterium. In the United States, the Environment Protection Agency (EPA) has allowed registration of Galltrol-A and Norbac 84-C. Dygall is currently registered for use in New Zealand.

Dygall is used as a preventative against crown gall. It is used to treat seeds, cuttings and seedlings of woody plants such as stonefruit, pipfruit and some ornamentals. Usually, these plant materials are dipped in the inoculant before field placement.

2.2 Description of Disease (crown gall)

Crown gall is a disease of many woody and herbaceous plants, but it is most common on members of the rose family (apples, rose, raspberry, peach, etc.). It also affects other field-grown nursery stock such as grapes, willow, chrysanthemums, and many other species.

Symptoms of crown gall are swellings of varying sizes usually at the crown and also on the roots, stems, or shoots. This results from the abnormal increase in cell numbers and size. The gall tissue is not differentiated into productive plant parts, and appears as 'growths' along stems and roots.

The crown gall disease is caused by the soil microorganism A. tumefaciens. These bacteria infect the plants through wounds in roots and stems. Such wounds may be due to normal root growth, insects or from routine production practices such as pruning, grafting and normal handling.

A. tumefaciens carries an extra chromosomal piece of DNA called a plasmid. This plasmid is called Ti plasmid (tumor inducing) and carries the genetic code for virulence. The

Ti plasmid codes for genetic material called tDNA which is integrated into the plant nuclear DNA. The Ti plasmid causes the gall formation with the bacterium acting as a genetic vector.

This plasmid is not detectable within the plant, and may spread systemically within the plant. Hence, healthy-appearing cuttings from infected plants may eventually develop galls, as the Ti-plasmid genetic code is expressed in the host plant cells. Crown gall is mainly considered a nursery crop problem, affecting principally ornamental and fruit nursery stock.

2.3 Description of the Nursery Crop Sector

Nursery crops include a broad range of food, ornamental and utility plant species ranging from turfgrass, to evergreen trees and shrubs, deciduous trees and shrubs, hedges, roses, herbaceous perennials, vines, creepers, fruit trees, small fruits, bulbs and Christmas trees. In Canada, about 31,000 hectares of land are devoted to nursery crop production.

In 1986, nursery crops represented about 42% of the value of ornamental horticulture in Canada, 10% of the value of all horticultural crops, and 0.75% of total farm cash receipts. In the same year, farm cash receipts for nursery crops were $217 million and sales for ornamental and fruit nursery stock were $112 million (Table 1). Based on the sales of ornamental and fruit nursery stock in 1986, Ontario accounted for $61,041 or 54.2% of sales, followed by British Columbia with $26,374 or 23.4%, Quebec with $13,036 or 11.6%, the prairie provinces with $9,254 or 8.2% and the Atlantic provinces with $2,964 or 2.6% (Chart 1).

Ontario dominates the national market in terms of the total value of output of the nursery industry. Ontario's share of output in 1986 was $114.9 million or 53.0%, followed by Quebec with $40.3 million or 18.6%. British Columbia and the prairie provinces had almost identical shares of $27.6 million and $27.3 million or 12.7% and 12.6% respectively. The Atlantic provinces accounted for $6.8 million or 3.1% (Chart 2).

Among the different types of plants grown in nurseries, Ontario produces 85% of all roses, 88% of fruit trees and 89% of the bedding plants. In some categories of plants, British Columbia is virtually the sole producer. For example, B.C. produces more than 90% of azaleas and rhododendrons.

Statistics Canada data indicate that in 1986 the nursery

sector employed over 2,000 people in 281 firms. In the same year, there were 2,284 nurseries operating in Canada with a gross yearly payroll of over $57 million.

In terms of trade, nursery crops produced in Canada are marketed largely within Canada. Ontario, as the major nursery crop producer, leads the way in the volume of plant material imported and exported. Imports of nursery stock represent approximately 60% of the total nursery crop supply in Canada. The principal source of supply is the United States. The major importers of Canadian nursery crops are the United States, West Germany, the United Kingdom, the Netherlands and France (Tables 2 and 3).

In general, Canada is a net importer of nursery crops with the United States as the dominant source of imports and exports. Table 4 illustrates Canada's trade position in ornamental products over the 1984-1987 period. A similar trend could be noted in the fresh fruit sector.

3. AGRONOMIC EVALUATION OF DYGALL AND ALTERNATIVES

3.1 Production Losses Due to Crown Gall

Crown gall is of economic concern to nurseries growing rosaceous plants, Rubus species, grapevines, and various nut-bearing trees. Galled nursery stock are not saleable. Crown gall in the orchard is associated with reduced life span of the tree. In grapes, galls erupt over the whole of the trunk and the affected grape vine seldom survives. Economic losses are not restricted to nurseries, and can be severe in some orchards, vineyards, and landscape plantings. Losses of 13-17% in peach nursery stock and 32% in "vinifera" grapes have been recorded for Ontario. The extent of loss caused by this disease, is estimated to be 10% in Canada, the same figure that has been estimated for the west coast of the United States.

Losses to the nursery industry caused by crown gall could be substantial when one considers that untreated plant material bears high risk of contracting the disease. Normally, crown gall is not detected until after the plants have been put in the ground. By that time a producer would have expended 85% of his labour cost and all of his pesticide spray cost. Research has indicated that these loss factors could be anywhere between 10% and 60% of the crop.

3.2 Available Control Alternatives and Relative Efficacy/Yield Effects

A number of alternative control measures have been employed to cure and/or control the spread of crown gall. Excluding A. radiobacter strain K-84, these measures have included hygiene, crop rotation and chemical protection.

Strict hygienic practices are normally very difficult to implement because growers are required to stabilize all open soil and maintain windbreaks, wash off equipment between nursery blocks, clean boots and hand tools, avoid contaminated water runoff between nursery plots with the use of ditches and culverts, use germicidal soaps at entrances and keep work areas clean and free of soil and debris. Good hygiene can help to 1imit 1osses to crown gall, but this is an insufficient means to control the disease. Avoiding wounds and planting clean stock, although desirable, would have serious drawbacks as well. Most nursery practices result in wounding through which crown gall bacteria can enter. Symptomless nursery stock may be carrying the bacteria which may lead to gall development later on. Indexing "mother" plants for freedom from internal infection and using cuttings from screened plants for nursery stock production has been found useful for controlling crown gall in grapes.

Strategies based upon therapy for curing infected plants are not economically suitable for nursery stock production. This method involves cutting the galls from the plants and painting a chemical (metacresol and/or 4-Xylenol mixtures) onto the wounds. This method is not cost effective. While valuable individual landscape specimens may warrant this treatment, it is not feasible for large volume nursery operations with significant numbers of affected plants. Because the plasmid may be systemic within the plant, galls may continue to develop elsewhere on the plant. This procedure may remove current signs of the disease, with no promise of curative action.

Chemical protection involves the use of sodium hypochlorite and antibiotics. Sodium hypochlorite (household bleach solution) could be used as a general disinfectant. Plant stock is normally immersed in 0.5% solution of this chemical. However, the treatment only kills bacteria on the surface of the stock. Antibiotics such as streptomycin sulfate have been recommended as general bacteriacides. To date, control by antibiotics has not proven practical.

3.3 Efficacy Trials of Dygall

Attempts to control crown gall by soil fumigation in apple

nurseries in British Columbia have been inconclusive. An increase in the incidence of crown gall following preplanting treatments with several fumigants was observed in cherries. It has been suggested that fumigation with methyl bromide and chloropicrin reduce the effectiveness of competitors (often disease/pests) and allows an increase in the number of crown gall bacteria or surviving bacteria to be more effective in causing infections.

Successful control of crown gall has been achieved through treatment with A. radiobacter strain K-84. The treatment has been found to be effective in controlling crown gall on plant stock in many countries including New Zealand, Australia, the United States and Israel. Experimental field tests done by Dr. B.N. Dharvantari of the Harrow Research Station showed the efficacy of Dygall in biological control
of crown gall on peach, plum and cherry in Ontario in 1976. Aldergrove Nursery of Aldergrove, British Columbia, reported that out of a yearly cultivation of 160,000 rose bushes, as many as 24% were affected by crown gall. However, their use of Dygall on a test basis several years ago reduced the rate of infection to under 2%.

Trials completed in New Zealand on roses have also shown encouraging results. In one trial, 23.4% of the untreated plants were found to be infected with crown gall after being exposed for one year in infected soil. The galls ranged in size from 1 cm to 5 cm in diameter. However, only 0.9% of the treated plants showed any signs of the disease in the infected soil; the galls were very small on the infected set with few of them exceeding 1 cm in diameter.

4. POTENTIAL ECONOMIC BENEFITS TO PRODUCERS FROM DYGALL USE

Based on the available information, it is reasonable to assume that producers will benefit from the registration and use of Dygall. These benefits are most likely to occur as a result of economic factors and safety of product use. In monetary terms, benefits will accrue to producers from a decrease in losses caused by crown gall, reduced treatment costs and a bigger market share.

According to research reports and industry survey data, losses can range from 10% to 80% per farm. Based on this information, a typical nursery cultivating 160,000 rose bushes with a unit price of $1.50 can earn a revenue of $240,000 (160,000 x $1.50) when there is a healthy crop. However, a 10% loss could reduce farm revenue by $24,000 (10% of $240,000). The use of Dygall would, most likely reduce the incidence of crown gall from 10% to

about 1%. This would result in a $21,600 ($24,000-$2,400) yearly saving in crop loss to the firm.

In order to have a relatively healthy crop, the farm would have to spend some money to protect these 160,000 rose bushes from the possibility of infection.

Since each plant would have to be dipped in the inoculant, the firm would incur costs for treatment, labour and material. These costs have been estimated at 1.8Ç per cutting. For 160,000 rose bush cuttings the total costs would be approximately $2,880 (160,000 x 1.8Ç). Hence, the net benefit to a farm using Dygall would be approximately $18,720 ($21,600 - $2,880) or a benefit to cost ratio of 7.5 to 1.

Depending on the plant variety, a farm can experience far more significant losses than the above example illustrates. For instance, one farm in Ontario indicated that its crop of Pyrus, Malus, Cydonia, Populus, Rosa, Salix and Prunus were all infected with crown gall which resulted in a 24% loss or $50,000 to $60,000 in revenue. This farm anticipates that treatment with Dygall would reduce the losses to 2%, thereby cutting its revenue losses by more than $50,000. Another farm in British Columbia indicated that its Euonymus crop is very susceptible to crown gall. This farm produces 80,000 plants/annum and has experienced yearly losses of 10% or 8,000 plants. Each plant is worth $5.00 and this translates into $40,000 per year in revenue losses. The availability of Dygall could reduce these losses to 2% or less, resulting in savings of over $30,000 per year.

Apart from being able to produce top grade plant stock, these examples indicate that production costs will be reduced significantly because less time will be required for grading and culling and less space will be required for plant material that is not suitable for sale.

As well, additional costs will accrue to the farm as a result of the time and labour-consuming aspects of the treatment procedure. It costs between $2.00 and $4.00 to treat a single infection site with gallex. Dygall, on the other hand, will reduce the incidence of the disease from 10% to about 1% or $2,400 in lost sales, with treatment costs of less than 2% per cutting.

5. AGGREGATE ECONOMIC IMPACTS

In general terms, the availability of Dygall would have a positive impact on the nursery industry. An increase in production of healthy nursery crops, including fresh fruit, would allow producers across Canada to be more competitive,particularly against imports. In 1987 Canadian imports of rose bushes, trees, fruit trees, vines, bushes, pot plants, stocks and import

cuttings totalled $74.3 million, a 32.5% increase over the 1984 sales value of $55.4 million (Table\4). Agriculture Canada forecasts indicate a continuation of the strong demand for these nursery products. Sales of these products are largely influenced by the level of housing starts which is expected to be strong in the coming years.

Canada's principal competitor, the United States, exports nursery products whose producers have access to the use of A. radiobacter strain K-84. These products are certified as acceptable for import into Canada. With the availability of Dygall, Canadian nurserymen will be able to produce a healthier crop which may enable them to displace some American exports, thereby increasing their domestic sales. The use of Dygall would also give Canadian producers a greater opportunity to augment their income. Using the American example, one can accept 10% as a reasonable approximation of industry loss due to crown gall. Based on ornamental and fruit nursery stock sales of $112 million in 1986, these losses could translate into more than $11 million to producers. However, not all nurseries are affected by the disease. Some estimates have put industry loss due to crown gall at $3.5 million per year. The use of Dygall would cut these losses substantially to about 1%, thereby increasing the revenue of producers.

Because most nursery crops are produced in Ontario and British Columbia, producers and consumers in these regions stand to benefit more than those in other regions.

6. CONCLUSION

Agriculture Canada has considered the following regulatory options for A. radiobacter:

1. Refuse to grant registration of A. radiobacter for control of crown gall in ornamentals and non-bearing fruit trees. This option would tend to create substantive adverse economic impact.

2. Grant unlimited registration of A. radiobacter. This approach would fail to recognize the weaknesses/gaps in the supporting data package and the need to update the data.

3. Grant temporary registration status under the following conditions:

   a. Warning on the label: "Mild eye irritant. Avoid contact with eyes."

   b. Warning on the label: "this product has not been tested for infectivity. Wear protective clothing."

c. Label statement: "to be used by trained nursery personnel only."

d. An infectivity study to be generated and submitted in 1991.

Regulatory option 3 represents, in our view, a sound approach to risk management which takes into consideration the benefits from use of A. radiobacter on horticultural crops, in the absence of an appropriate alternative.

Based on the input received, the benefits of registering A. radiobacter are considered to outweigh the potential risks. As a result Dygall has been registered under the conditions outlined in option 3 (PCP No. 21106).

TABLE 1

Economic Indicators of Canadian Nursery Trades

	Economic Indicators	1984	1986	% Increase
	Total Land (ha)	26,572	30,548	15.0
	Gross Yearly Payroll ($)	54,422,060	57,465,300	5.6
	Total Nursery Stock Purchases ($)	28,968,336	40,964,950	41.4
	Total Sod Purchases ($)	1,364,059	1,825,061	33.8
*	Nursery Stock Sales ($)	70,135,974	112,668,681	60.6
	Sales of Stock Purchased and Resold ($)	31,502,677	53,408,073	69.5
*	Contract Services ($)	28,910,673	N/A	
*	Sales of Related Materials ($)	20,114,076	N/A	
*	Value of Sod Sold ($)	41,101,221	50,773,436	23.5
	Advertising Expenditure ($)	3,848,407	N/A	
*	Total Industry Revenue ($)	191,764,621	216,850,190	

SOURCE: Statistics Canada Factsheet,
Survey of Canadian Nursery Trades Industry.

TABLE 2

Regional Exports of Nursery Crops (1982-83 to 1986-87)

CROP year	MARITIMES [Halifax]	QUEBEC [Montreal]	ONTARIO [Niagara Falls]	MANITOBA [Winnipeg]	SASKATCHEWAN [Regina]	ALBERTA [Calgary]	B.C. [Vancouver]	TOTAL
	REGIONAL AREAS OF ORIGIN							
	- UNITS -							
1982-83	4,634,136	88,738	17,637,931	43,672	211,450	15,898	1,713,790	24,345,615
(%)	(19.0)	(0.4)	(72.4)	(0.2)	(0.9)	(0.1)	(7.0)	(100.0)
1983-84	9,307,940	1,865,218	15,782,225	5,842	37,985	78,449	2,796,389	29,874,048
(%)	(31.2)	(6.2)	(52.8)	(0.0)	(0.1)	(0.3)	(9.4)	(100.0)
1984-85	9,098,153	4,114,465	21,085,780	12,829	4,805	15,770	9,034,681	43,366,483
(%)	(21.0)	(9.5)	(48.6)	(0.0)	(0.0)	(0.0)	(20.8)	(100.0)
1985-86	10,473,789	7,335,291	26,214,829	21,877	22,784	14,870	12,722,221	56,805,661
(%)	(18.4)	(12.9)	(46.1)	(0.0)	(0.0)	(0.0)	(22.4)	(100.0)
1986-87	13,475,147	21,781,998	42,012,587	133,510	178.845	15,452	9,795,444	87,392,983
(%)	(15.4)	(24.9)	(48.1)	(0.2)	(0.2)	(0.0)	(11.2)	(100.0)

N.B.: [ ] indicates largest exporting location and units include all plants or their parts and small fruit trees.

Source: Plant Protection Division, Agriculture Canada.

TABLE 3

Nursery Crops - The Top Seven Importing Countries by Year

	1982-83		1983-84		1984-85		1985-86		1986-87
COUNTRY	VOLUME (Plant Units)	COUNTRY	VOLUME (Plant Units)	COUNTRY	VOLUME (Plant Units)	COUNTRY	VOLUME (Plant Units)	COUNTRY	VOLUME (Plant Units)
*UNITED STATES	23,980,812	U.S.A.	29,739,525	U.S.A.	40,144,178	U.S.A.	50,381,347	U.S.A.	86,343,048
*WEST GERMANY	239,980	W. Germany	9,836	W. Germany	2,852,678	W. Germany	5,911,973	W. Germany	351,651
*UNITED KINGDOM	64,700	U.K.	41,978	U.K.	71,495	U.K.	63,958	U.K.	167,020
*NETHERLANDS	33,591	Netherlands	15,324	Netherlands	19,738	Netherlands	43,277	Netherlands	11,337
MEXICO	6,512	France	31,882	France	63,163	France	91,217	France	46,280
USSR	5,315	Czechoslovakia	3,251	Japan	104,016	Japan	210,314	Spain	120,040
CHINA	2,066	India	3,097	Mexico	79,405	Australia	56,097	Colombia	200,000
TOTAL	24,332,976		29,844,893		43,334,673		56,758,183		87,239,376

* Consistent importers over the last five years.

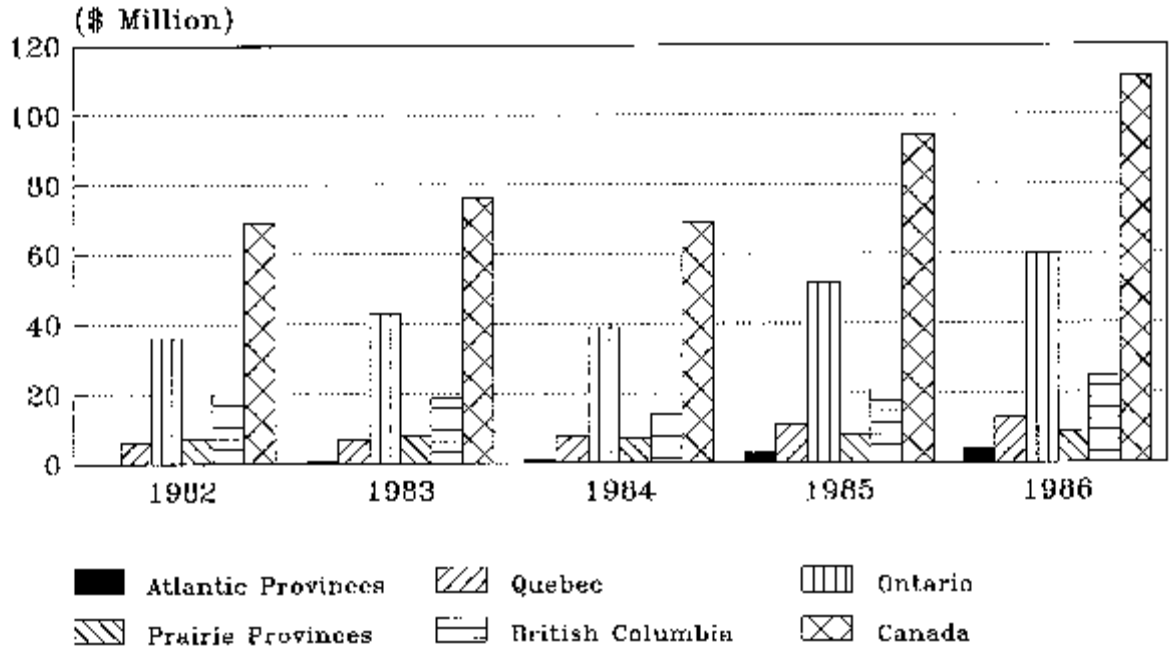
SOURCE: Plant Protection Division, Agriculture Canada

TABLE 4: Ornamental Products: Value of Exports and Imports, Canada, 1984-1987 (by calendar year)

	1984	1985	1986	1987
		- $000's -		
EXPORTS				
Plants, bulbs and roots of flowers	27,839	34,193	40,879	42,092
Trees, small fruit plants and stocks	3,082	3,331	7,849	8,287
Other nursery and greenhouse stocks (includes cut flowers)	8,728	11,862	12,312	17,294
Total Exports	39,649	49,386	61,040	67,673
IMPORTS				
Gladiolus bulbs	336	419	550	647
Tulip bulbs	2,542	3,575	4,355	4,700
Bulbs, tubers, roots of flowers N.S.E.*	7,297	9,002	9,523	12,080
Rose bushes	4,465	5,031	5,132	6,459
Fruit trees, trees, plant stocks and cuttings	50,970	56,340	61,505	67,900
Cut flowers and decorative materials	47,381	40,580	46,775	48,710
Total Imports	109,391	114,947	127,840	140,496
NET TRADE	-69,742	-65,561	-66,800	-72,823

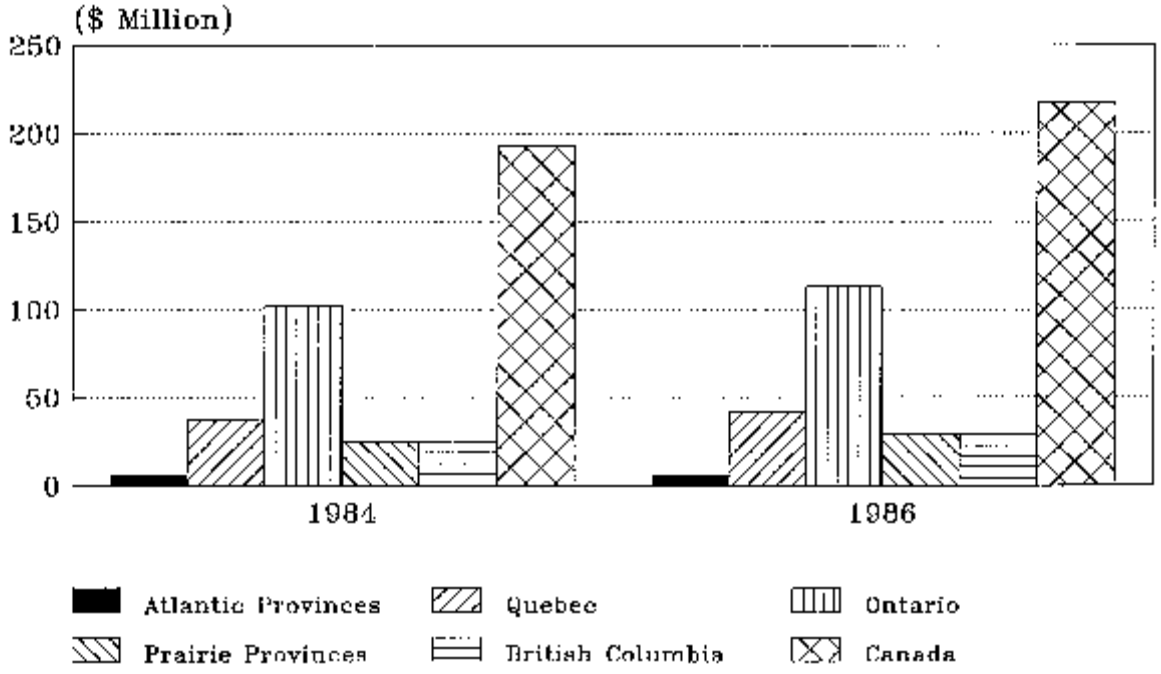
*Not specified elsewhere

CHART 1: TOTAL SALES OF ORNAMENTAL AND FRUIT NURSERY STOCK BY REGION IN CANADA (1982-1986)



SOURCE:
STATISTICS CANADA, CATALOGUE 22-203

CHART 2: TOTAL INDUSTRY REVENUE BY REGION



REVENUE/OUTPUT VALUES PRORATED FOR 1986 ARE UNDERESTIMATED DUE TO LACK OF DATA FOR RELATED MATERIALS