Transgenic Rapeseed - Grower Adoption and Consumer Acceptance

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ABSTRACT

Canada=s major canola seed, oil and meal markets have made little or no distinction between GM and non-GM canola. Consumer and grower acceptance has been high and rapid. First introduced in trace amounts in 1995 herbicide tolerant canola use has quickly expanded and now occupies 85% of Canadian canola acres (63% GM, 20% mutant based varieties). Grower surveys 1997 through 2000 have documented the advantages of herbicide tolerant GM canola including improved weed control, providing a cleaning crop within the rotation, higher seed yield, lower costs as well as reduced tillage, herbicide usage and dockage.

The European ban on GM canola imports has had little impact on the Canadian canola industry since European policies have always tended to restrict canola imports. The international inconsistency on the content limits of GM material in foods and the labeling of products as well as the difficulty of accurately measuring GM presence will be discussed as will the co-existence of organic and conventional/GM production.

Key words: Rapeseed, transgenic canola, agronomic benefit, herbicide tolerance, market acceptance.

INTRODUCTION

Canadian rapeseed, with the exception of several thousand contracted acres of high erucic acid producing varieties, is all of canola quality, i.e. less than 2% of the total fatty acids as erucic acid and less than 30 µ moles of total glucosinolates in the whole seed at 8.5% moisture. With the exception of some 20 thousand acres of winter canola production in eastern Canada, all Canadian production is of the spring or summer form with about 95% being *Brassica napus* L. and 5% *B. rapa* L.

Herbicide tolerant (HT) canola varieties have been in use since triazine tolerant varieties were first developed and grown in Canada in 1981. However, product acceptance by growers was limited since the mutation that imparts triazine tolerance also significantly reduces the seed yield and oil content. In 1995 two new classes of HT *B. napus* canolas were commercially introduced, namely the glufosinate tolerant or Liberty Link (LL) hybrid varieties and the induced mutation based Clearfield (CF) varieties, tolerant to the imidazolinone class of herbicides. The following year the first glyphosate tolerant (RR) variety was released. To assure our export markets of the product quality, safety and performance of these new HT materials the initial production of each HT system was limited to 50,000 acres with all production contracted for delivery to domestic processing plants. In subsequent years normal market forces determined which HT system or conventional variety would be grown with little or no segregation practiced at local delivery points.

GROWER ADOPTION OF HT CANOLA SYSTEMS

Canadian growers very quickly adopted the HT canolas, whether they were transgenic or mutant based (Table 1), starting with only 0.5% of the canola acreage in 1995 and expanding to 85% in 2002. Of the total canola acreage in 2002, transgenics occupy the largest proportion at 63% (42% RR, 23% LL).

Table 1. Percentage Canadian canola area sown to various herbicide systems[1] 1995-2002

Year	RR	LL	CF	Suscp.	>000 ha	HT %	Trans %
1995	0.0	0.3	0.2	99.5	5,273	<1	0.3
1996	0.5	3.0	6.6	89.9	3,451	10	3.5
1997	4	8	14	74	4,869	26	12
1998	23	12	16	49	5,560	51	35
1999	33	20	20	27	5,564	73	53
2000	39	14	21	26	4,816	74	53
2001[2]	45	16	20	19	3,765	81	61
2002[2]	42	23	20	15	2,857	85	65

[1]RR=glyphosate, LL=glufosinate, CF=imidazolinone [2]Bromoxynil tolerant varieties <1%

To assess the agronomic and economic impact of the introduction of the transgenic HT canola systems on western Canadian canola growers, the Canola Council of Canada commissioned a study conducted by Serecon Consulting and Koch Paul Associated. The study surveyed 650 canola growers, each growing at least 80 acres of canola. Half the growers grew conventional non-HT varieties (no fields of CF varieties were included) and the other half grew either RR or LL transgenic varieties. In addition, the financial records of 13 transgenic and non-transgenic growers were analyzed for the period 1997 through 2000. The survey identified numerous advantages to growing the HT transgenic varieties including superior weed control, higher seed yield, better returns leading to greater net profit, reduced input costs, reduced tillage and a cleaning crop within the crop rotation. Reasons given by growers of non-HT conventional varieties for not growing transgenic varieties included the cost of Monsanto's "Technology Use Agreement" (TUA), the overall costs for the systems, no need to change, possible reduction in market access and the potential to select herbicide tolerant weeds.

When the actual input costs, herbicide use and crop returns for transgenics and non-transgenics were compared it was found that although the seed cost of the transgenic varieties was $11.17/ha CAN more than for seed of conventional varieties, the higher seed cost was more than offset by a 40% lower cost for herbicides and any summerfallow costs from the previous year. When the reduced level of herbicide use was applied to the total transgenic acreage in the year 2000, it was estimated that transgenic growers applied some 2,000 tonnes less herbicide than if they had grown a conventional variety.

Reduced herbicide use was not the only environmental advantage documented by the survey. Transgenic growers found less need to work or till their fields to obtain a cleaner crop, thus conserving their soil resources to a greater degree. Of the transgenic growers surveyed, 50% reported sowing their canola crop into standing stubble (direct seeding) as opposed to only 36% for conventional growers. Similarly, only 18% of transgenic growers sowed their canola crop on summerfallow as opposed to 36% for conventional growers. The reduction in tillage operations reported by transgenic growers, when applied to the total transgenic acres grown in 2000, amounted to some 2.6 million acres with at least one less tillage operation. The reduced tillage translated to a significant 31.2 million litre fuel saving with a monetary value of about $31.1 million CAN.

When the harvest results were compared, transgenic growers had an average yield advantage of 10% (1639 kg/ha transgenic vs 1427 kg/ha conventional). In addition, the transgenic systems resulted in a lower level of dockage (the presence of weed seeds and inert matter) that is deducted from the grower's seed delivery. The reduction in dockage was significant, with dockage for conventional growers at 5.14% but only 3.77% for transgenic HT systems. When gross margins were compared over the 1997 to 2000 period, the growers recorded a $26.24/ha CAN average profit advantage for transgenic canola over conventional growers. In the year 2000, growers estimated their net returns, calculated as yield x price - inputs, labour etc., for transgenic canola at a $14.33/ha CAN advantage over conventional canola. Thus the Canola Council's commissioned survey clearly demonstrated the underlying reasons why growers have so quickly embraced the technology.

THE ISSUES

Several issues concerning HT canola have arisen during and since their introduction which have been either misinterpreted or exaggerated by the media. The potential for gene transfer to weedy relatives has been extensively studied by researchers in Canada and abroad both before and since the release of HT transgenics. The conclusion is that such transfer is of very low probability (see review by Salisbury, 2003). This is particularly true for western Canada where *B. rapa* is a crop, not a weed, wild radish (*Raphanus raphanistrum* L) is rare and hoary mustard [*Hirschfeldia incana* (L) Lagréze-Fossat] is absent.

Gene flow via pollen dissemination has attracted the attention of both researchers and the media. Under field conditions *B. napus* plants are largely self-pollinating but about 20% outcrossing does occur, primarily with neighbouring plants. Studies have shown that 90% of canola pollen falls to the ground within 10 m but a small proportion, because of the pollen's small size, can be carried by wind, as well as bees, over long distances. The canola pollen distribution and the level of outcrossing between fields and/or plots follows a liptokurtic curve where pollen counts and outcrossing decline steeply with distance, but exhibit a long tail (Fig.1 from Salisbury, 2003). Note that the long distance outcrosses reported in the Australian study (Rieger et.al., 2002) are open to question since the seed sown in the recipient field was not tested for the presence of the maker gene. However, when such a pattern is applied to the major Canadian canola growing area, where 65% of the canola acreage is transgenic, the possibility of producing a crop that is 100% pure non-transgenic is, at best, uncertain. The pollen distribution pattern also produces a very small percentage of plants with more than one HT system gene. However, pollen flow is not the only source of unwanted HT genes. Recent studies of conventional, HT hybrid and CF certified seed lots have shown that some varieties carry additional HT genes (Downey and Beckie, 2001, Friesen, et.al., 2002). The data indicate that the contamination occurred during the development of the varieties and not during the pedigree seed production process. The seed industry is working hard to correct this situation. Part of the problem is the lack of a fast, accurate test that will detect minute amounts of transgenic seeds. In a recent ring test conducted by ISTA using a 1% GM corn sample, involving 41 laboratories and 43 tests, 30.2% of the results were incorrect. False negatives were reported by 8 labs, 3 reported false positives and 2 reported both false negatives and positives.

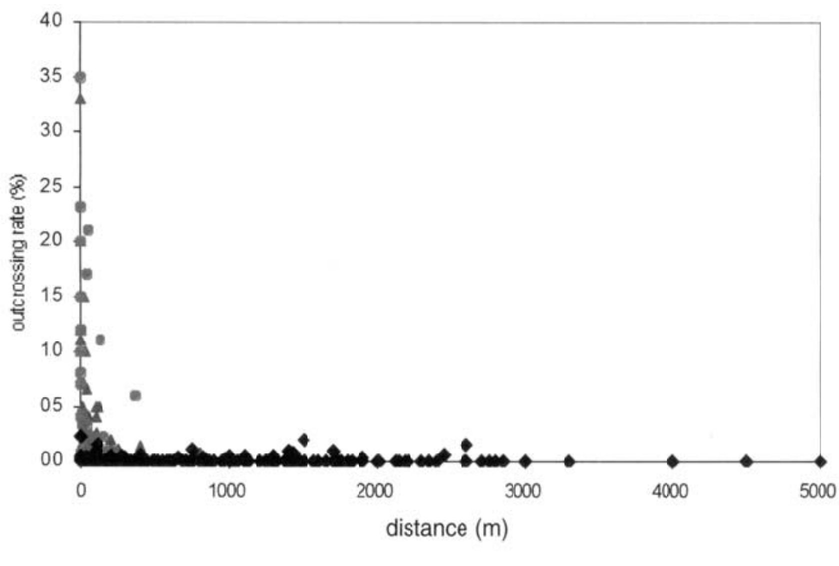

Fig. 1. Comparison of outcrossing levels from Canada, Europe and Australia

Such adventitious presence of HT genes and the occurrence of plants with multiple tolerances were anticipated in the initial environmental assessment but not fully understood or appreciated by growers. Initially some growers chose not to grow RR varieties so they could continue to use glyphosate as a broad spectrum herbicide, rather than the selective herbicide it has become. Other growers decided against the imidazolinone tolerant varieties as the CF herbicide system did not fit well with their other rotational crops. Of the three HT systems only the glufosinate (LL) system is herbicide management neutral, since glufosinate herbicide is only used with canola. For the vast majority of canola growers the adventitious presence of HT plants in their fields is not a problem provided the necessary adjustments are made in their herbicide management operations. Canola is almost always followed in the crop rotation by a cereal crop where the presence of any HT canola, with single or multiple tolerance, is readily controlled by herbicides traditionally applied to cereal grains. It is in subsequent non-cereal rotational crops, minimum tillage, pre-plant weed control and chemical fallow that changes in the glyphosate based management of canola volunteers have had to be made. Unfortunately, not all growers understood or accepted that glyphosate is now a selective herbicide and no longer kills almost everything green. For growers who practice chem fallow or use a pre-plant burn off spray to control all weeds present in their fields, an additional herbicide now needs to be added to the standard glyphosate application (Table 2).

Table 2. Herbicide group options for stacked tolerances

Herbicide system combos	In crop cereals	Pre-plant burn-off
RR x LL	2 or 4	9 + 4
RR x CF	4	9 + 4
LL x CF	4	9
LL x CF x RR	4	9 + 4

The media has characterized HT canola as a so called “superweed” that can only be killed by uprooting them. Nothing could be further from the truth. Plants with multiple HT are no more difficult to control than plants with glyphosate tolerance alone, as is clear from the herbicide options available to control canola volunteers with single or multiple tolerances (Table 3).

Table 3. Herbicide products controlling volunteer canola with nil, single or multiple tolerances.*

Herbicide system	No. of products	Herbicide system	No. of products
Conv. B Susceptible	27	RR x LL	24
Liberty Link (LL)	26	RR x CF	17
Roundup Ready (RR)	25	LL x CF	18
Clearfield (CF)	19	RR x LL x CF	16

*2002 Saskatchewan Guide to Crop Protection

MARKET ACCEPTANCE OF TRANSGENIC CANOLA

Canada’s major markets for canola seed, oil and meal are North America, Japan, Mexico and China. No change in market acceptance or utilization could be detected in any of these markets with the introduction and expanded use of transgenic canola. Indeed the demand for Canada’s canola, in terms of oil equivalents, has been increasing (Fig. 2). The only potential export market to be affected has been European Union (EU) countries. However, with the exception of a short period in the 1990's, Europe has been a net exporter of canola and canola oil. As a result the continuing EU embargo on transgenic canola has had no effect on Canada’s canola production and exports.

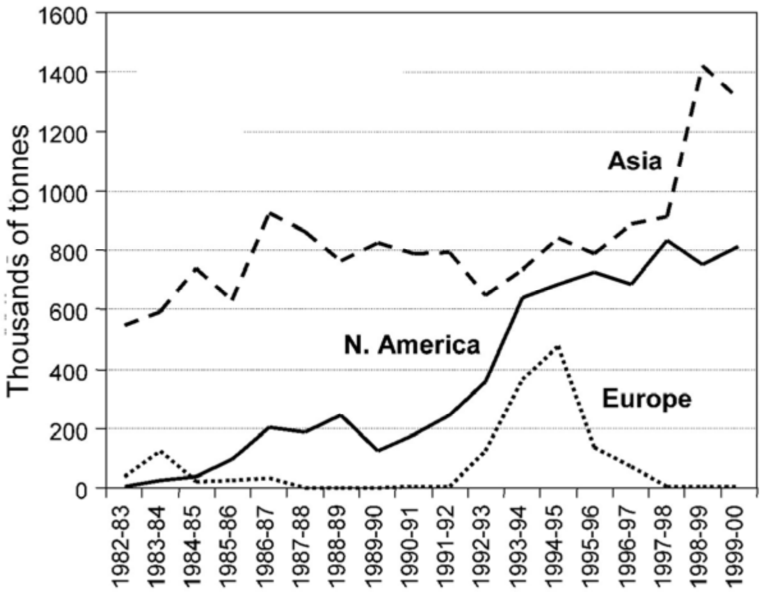

Fig. 2. Canadian canola demand in oil equivalents by Continent

ORGANIC CANOLA PRODUCTION IN CANADA

A group of Canadian organic canola growers have claimed that the introduction and growing of transgenic canola has excluded them from participating in an expanding market for organic products. When evaluating such a claim several facts need to be kept in mind. First, it was not until 1997, two years after the introduction of transgenic canola, that the organic industry, by way of the International Federation of Organic Agricultural Movements, resolved that GMOs and products derived from them were not compatible with the organic production method. This was later unilaterally interpreted to mean organic products had to be 100% non-transgenic, an untenable condition since to prove absolute absence the entire production would need to be destroyed in the testing. Clearly zero tolerance is not a commercial option. Thus to achieve co-existence of conventional and organic production some level of transgenic tolerance is required. Secondly, it has always been difficult to grow canola without the help of herbicides and/or insecticides. As a consequence, the acreage of organically produced canola has always been very small. According to a survey by Saskatchewan organic growers, the province with the largest number of organic farmers and the largest acreage of canola, they estimated that only 810 ha of organic canola were grown in 2000, compared to over 1.62 million ha of non-organic canola.

On the positive side Canadian organic growers do have the option of growing the non-transgenic *B. rapa* canola species that, before the introduction of the herbicide trifluralin, occupied over 85% of Canada's canola acres. From an agronomic perspective this species, with its short growing season, would be a much better choice for organic growers than *B. napus* since no HT varieties of *B. rapa* are now commercially grown. Thus, if the organic industry would accept a small but realistic adventitious presence of transgenic seeds and draw from an available, transgenic-free *B. rapa* source, co-existence could be a reality.

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