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# Utilisation d'avions pour la protection des plantes au Canada

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Article abstract

Since 1912, Canadians have used aircraft as aids in the protection of field crops, orchards, and forests from the ravages of fungi, insects, frost, and fire. At first, only fixed-wing aircraft could be used, but from 1947 both fixed-wing and rotary-wing aircraft have been employed. This review also relates the involvement of pioneering people and companies that have developed aerial control methods against biotic and abiotic agents damaging to our plants.

# Canadian use of aircraft for plant protection

Ralph H. Estey

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Since 1912, Canadians have used aircraft as aids in the protection of field crops, orchards, and forests from the ravages of fungi, insects, frost, and fire. At first, only fixed-wing aircraft could be used, but from 1947 both fixed-wing and rotary-wing aircraft have been employed. This review also relates the involvement of pioneering people and companies that have developed aerial control methods against biotic and abiotic agents damaging to our plants.

**[Utilisation d'avions pour la protection des plantes au Canada]**

Depuis 1912, les Canadiens ont souvent effectué la protection des cultures agricoles, des vergers et des forêts contre les dommages causés par des agents pathogènes, des insectes, le gel et le feu à l'aide d'avions. On utilisa en premier lieu l'avion à ailes fixes seulement, mais à partir de 1947, celui-ci ainsi que l'aéronef à voilures tournantes ont été utilisés. Cette synthèse retrace de plus l'implication de personnes et de compagnies qui furent des pionniers lors du développement de méthodes de contrôle aériens de plusieurs agents biotiques et abiotiques dommageables pour nos plantes.

## FIXED-WING AIRCRAFT

In the early days of wheat farming in western Canada, it was somewhat of a mystery just how the rust disease of wheat could suddenly appear in many widespread locations at the same time. In their study of this mysterious situation, plant pathologists assumed that spores of the rust fungus (*Puccinia graminis* Pers.:Pers.) were wind-blown, in the spring, from areas in the United States where wheat was already mature and infected with rust. Canadian plant pathologist, Arthur W. Henry (1896-1989) proved this, in 1912-1913, by being part of an aircraft crew that exposed glass microscope-slides, smeared with Vaseline, while the aircraft was flying at various heights. By thus catching rust spores they proved that the disease-inducing fungus came in the form of air-borne spores that were scattered over vast areas at the same time (Stakman *et al.* 1923). That was the earliest use of aircraft as an aid to plant disease control in North America.

Canadian entomologist Eric Hearle used an aeroplane in 1919 to investigate mosquito problems in the lower Fraser Valley of British Columbia. Using his own small camera, Hearle took pictures of mosquito breeding areas. His pictures were so useful that he was able to persuade the Dominion entomologist to endorse his request for the further use of aircraft. Hearle was the first to use an airplane for entomological purposes in Canada (Riegert 1980).

Agricultural aviation, or agro-aeronautics as it is sometimes called, emerged in the USA shortly after the end of World War I when most flying was centered around the military. On 31 August 1921, Lt. John A. Macready, a U.S. Army pilot in a Curtiss JN-6H aircraft, referred to affectionally as the Jenny, with a crude metal hopper bolted to one side of the fuselage and loaded with powdered lead arsenate, took off from a field near Dayton, Ohio. His destination was a grove of trees infested with the catalpa sphinx moth (*Ceratomia catalpae* Boisduval) that regularly defoliated those trees. There, he delivered the first load of an insecticidal dust which practically eliminated the moths, and thus initiated what soon became a crop-dusting industry. J.S. Houser, an experienced American forest entomologist, went to Toronto, December 30, 1922, and enthusiastically related this and other accounts of successful aerial dusting of trees to an annual gathering of the Association of Economic Entomologists (Downs and Lemmer 1935). Entomologists soon found that the use of aircraft was invaluable in their survey of insect damage to farm woodlots and other forest trees, and the only practical method of applying insecticides to the trees.

In 1919, Quebec was being decimated with forest fires and a group of paper mills in the St. Maurice valley formed the St. Maurice Forestry Protective Association. That Association hired Stuart Graham, ex-Royal Naval Air Service pilot and Canada's first recognised bush pilot to fly one of its United States Navy war surplus Curtiss HS-2L flying boats. His primary duty was to fly forest fire patrols over the St. Maurice valley. Thus he initiated the use of aircraft for forest fire control in Canada. The Laurentide Air Services, formed in 1922, evolved from that Association and was active in a variety of operations, including fire spotting. It was taken over by the Ontario Govern-

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ment in 1924, for similar work, and it discontinued operations in June 1925 (Pitt 2002).

On 6 June 1919, the Canadian Air Board Act was passed to control flying in Canada. This required all pilots to be licensed, and all aircraft in Canada to be registered. Prior to that date, aircraft did not have to be registered and aircraft pilots were not required to pass any tests to determine their ability to fly an aeroplane (Fuller *et al.* 1983).

By 1923, so many individuals within the Canada Department of Agriculture were making such heavy demands upon a limited number of aircraft that an Interdepartmental Committee on Air Operations was established to coordinate this activity. In the early days, aerial applicators were known as "crop dusters" because they worked with dry chemicals, mostly insecticides. Today, aerial applicators deliver mostly liquid products for the protection of plants.

In the beginning, aircraft used for aerial application were war surplus. The first company in the world to design planes especially for dusting operations was the Huff-Daland Co. of Ogdensburg, NY, established in 1924 (Isler 1960). That company was later joined by the Keystone Aircraft Corporation, and their crop-dusting aeroplanes were referred to as "Keystone Puffers." The first forest or woodlot dusting in Canada was carried out by F/O C.L. Bath, in a Keystone Puffer seaplane on Cape Breton Island, N.S., on 18 June 1927 (Fuller *et al.* 1983).

Plant pathologist, Frank J. Greaney (1897 – 1976), working from the Research Laboratory in Winnipeg, used sulphur to control stem rust (*Puccinia graminis* Pers.: Pers. f. sp. *tritici* Eriks. & E. Henn.) of wheat in 1927, 1928 and 1930. The feature of his research that caught the attention of plant pathologists everywhere was the successful use of an aeroplane to apply the sulphur to large areas. It was a Keystone Puffer, which could carry about 800 lbs (362.88 kg) of sulphur (Greaney 1934). The results of those trials showed that the cost of the method was too high for profitable returns, except perhaps in yr of severe rust. However they did provide some of the earliest estimates of the amount of injury actually caused by rust diseases under field conditions. The Royal Canadian Air Force (RCAF) provided the aeroplane for Greaney's experiments, and in 1921 it acquired two of these "Puffers" with which they conducted forest and wheat dusting trials on behalf of the Departments of Agriculture and Forestry.

Since 1921, the RCAF has been helping the Department of Agriculture in its investigations into forest and crop disease responses (McAndrew 1985). For example, in 1946, the RCAF carried out an airlift of insecticides from Toronto to Saskatoon to curb a plague of grasshoppers and cutworms. And on 5 August 1971, a Canadian Armed Forces Hercules transport aircraft began the shipment of 14 tonnes of the insecticide Lannate from Houston, Texas, to Saskatoon, where it was distributed for the control of insects that were ravaging field crops. Eventually, nearly 400 000 ha were sprayed in the Prairie Provinces, at a cost of about 3.3 million dollars (Fuller *et al.* 1983).

There was no governmental program to assist Canadian civil aviation in any way up to 1927, either by direct subsidy, contracts, or the building of airports. In September 1927, the federal Government announced a program to assist in the formation of flying clubs, and there have been various forms of assistance to civil aviation in Canada since that time (Molson and Taylor 1982).

There have been times when grasshoppers plagued western farmers and many poisonous baits were devised to kill them. H.L. Seamans and R.M. White stated that the first attempt to equip an aeroplane for spreading grasshopper poison bait in Alberta was made at Lethbridge in 1933 where a small Puss Moth aircraft was fitted with a galvanized hopper in the front cockpit. That experiment was almost a complete failure because the wet bait kept clogging the exit nozzle. The following year an aeroplane was somewhat similarly equipped but with an agitator to keep the bait moving out through the opening. That aircraft crashed, as did a larger machine that was equipped to carry more bait. The idea of having aircraft spreading the poisonous bait was subsequently abandoned, largely because of the ingenuity of farmers who devised various mechanical means of spreading the baits on their own farms (Riegert 1980).

The great depression of the 1930s put a damper on virtually all agricultural and forestry research using aeroplanes, and the outbreak of World War II in 1939, put a complete stop to it until near the end of that war. However, in 1936, a Bordeaux dust was applied to potatoes, to control the late blight disease fungus (*Phytophthora infestans* (Mont.) de Bary) in Aroostock county, Maine, just a few km from the New Brunswick border. This naturally sparked the interest of New Brunswick potato growers, who had to wait until after the war before they could use this method to combat late blight of their potatoes (Anderson 1986).

In the spring of 1945, an outbreak of pea aphids (*Acyrthosiphon pisum* Harr.) posed a threat to some pea growers near Essex, Ontario. They had heard about some of the successes of dusting with an aeroplane so they contacted nearby Leavens Brothers Air Services Ltd and asked them to equip their Piper Cub J-5A for applying an insecticidal dust that might rid them of the destructive aphids. This they did, and the results were so satisfactory that Leavens Brothers had two aeroplanes ready for crop dusting the following spring. However, they did not get a contract to do any dusting until August when two tobacco growers hired them to dust their crop. That dusting was so successful that before the season ended they had dusted 30 ha of tobacco and 80 ha of peas. During the following yr Leavens Brothers Air Services were spraying, or dusting, such crops as beans, cabbage, carrots, corn, tobacco, and tomatoes, etc. They learned some of the hazards of flying a relatively large, heavily laden single-engine aircraft at tree top height. This led to the purchase of a Ford Tri-motor aeroplane for its increased reliability, plus an increased hopper capacity. Their Keystone Puffers were declared obsolete late in 1934. Their crop treatment work continued to expand, and by 1952 they were treating 30 000 ha of farmland each yr (Leavens 1977). In 1946, E.J.

Wilkinson commented, without supplying details, that the Stokely-van-Camp Canneries had used an aeroplane several times in its crop-dusting role to combat the pea aphid damages (Wilkinson 1946).

Also in 1946, Westland Dusting Services, based in Edmonton, Alberta, was established by E.S. (Ted) Holmes. He chose the Westland Lysander, a British warplane that had been built under licence in Canada. Those war surplus aircraft were available from War Assets at Swift Current, Saskatchewan, and Suffield, Alberta, at a cost of between $50.00 and $250.00 each. To equip these planes for crop application work required little basic alterations. The 95 gallon (360 L) Lysander fuel tank was used to carry the liquid agricultural spray material, and a new 45 gallon (170 L) tank for the aircraft's fuel was constructed in the centre section behind the pilot's seat. Within one yr, Westland had four of these modified aeroplanes. While applying chemicals to a crop, those aeroplanes commonly flew at a height of between 2 and 3 m, at a speed of 225 km per h. At that time, the Department of Transport required the pilot to wear a parachute, a regulation that was waived soon after that Department was convinced that more than 80% of their flying was done below 10 ft (3 m), thus making parachutes quite useless. Although that company did very good work, there was not enough of it and Holmes sold the company in January 1948 after only 2 yr of service. The new company, calling itself Westland Spraying Service Ltd., of High River, Alberta, bought two more Lysanders, but it too soon found there was not enough demand for their services and the company went out of business in 1950 (Milberry 1979).

Arthur Seller, a pilot instructor in Vancouver, B.C., who had dreamed about having his own aircraft while a prisoner of war in Germany, bought a war-surplus de Havilland Tiger Moth two-seat trainer and founded the Royal City Flying Club at the Vancouver Airport in 1946. He later acquired a second Tiger Moth, one of which was used as a trainer while the other was modified for crop dusting. In 1947, Seller moved to Langley, which at that time had only a grass landing field – an emergency landing field for Trans Canada Airlines. Business was good and the company grew. In August of that yr, the name of the company was changed to Skyway Air Services Ltd. In 1949, Seller acquired a third Tiger Moth; this one for spraying rather than dusting. When it was realized that the tigers were not large enough for profitable crop dusting, Seller acquired several Stearman aircraft, and modified them for crop spraying (Meadows 1998).

A company formed in 1967 to provide aerial tanker services to the Alberta government called itself Air Spray (1967) Ltd., Edmonton. In 1994 that company had three types of aircraft, one of which was a Lockheed Electra Air Tanker, which at that time was the only four-engine heavy fire-retardant tanker operating in Canada. It had a system that could string out a long line of fire-retardant or it could dump it all in under three seconds. By 2002, that company was one of the largest specialty air service operators in Canada and it was providing forest fire protection for the Governments of Alberta and British Columbia (Anonymous 2004).

Fire is a natural component of forest ecosystems and it is common throughout the forested areas of Canada. Canada's forest services use a wide range of forest protection aircraft including light single-engine planes for detection patrol, faster twin-engine types for air attack control, and helicopters for transportation, observation and fire bombing. There are two types of fixed-wing attack aircraft and these are generally referred to as scoopers and tankers. The scoopers are amphibians or float planes capable of scooping water from a lake or river near the fire, adding a foam concentrate to the water, and dropping it on the fire. Scoopers can attack fires for several h at a time, scooping and dropping thousands of litres of water and foam as fast as they can shuttle to and from the nearest suitable body of water. Tankers are usually land-based planes which generally carry fire-retardant chemicals to fires from nearby airports.

Forest fire management is under provincial/territorial jurisdiction but inter-provincial cooperation in this regard is the rule rather than the exception. This cooperation and coordination of resource sharing is provided through the Canadian Interagency Forest Fire Centre (CIFFC) in Winnipeg, Manitoba. That centre was opened 2 June 1982 (Anonymous 2000).

In 1992, about 200 fixed-winged attack aircraft, ranging from 1000 L capacity floatplanes to the mighty 20 000 L capacity Mars flying boat, and a similar number of helicopters, fought forest fires in Canada. The mainstay of the scooper force was a fleet of 48 Canadair CL-215s, each carrying 5350 L, while the major portion of the tanker fleet was divided equally between the 4500-L B-26 and the 3300-L Firecat/Tracker. Improvements to Canada's scooper fleet began with introduction into service of the CL-215T, a turboprop-powered conversion of the piston-engine CL-215 (Picker 1994). Another improvement was the introduction of the CL-415 which has a four-tank, four-door system that can carry 15% more water than the CL-215. The CL-415 came into service in February 2000. It takes only 12 s, travelling at 130 km per h, to scoop up 6137 L of water (Runesson).

Late in the 1940s, the Province of New Brunswick was experiencing a severe attack of the spruce budworm (*Choristoneura fumiferana* Clem.) and was calling for help. Skyway sent a fleet of five Stearmans east each spring for several yr, on a budworm contract. They usually returned to British Columbia before the end of June to be ready for the forest fire season. While they were away one spring there was a budworm infestation on Vancouver Island and Seller called in three Grumman Avenger aircraft from south of the International border. Thus seeing what they could do, he bought 17 war surplus Avengers from the Canadian navy in 1957. At its peak, Skyway Air Services employed nearly 100 people for a fleet of 70 aircraft. The business was thriving, and the company was doing much more than spray or dust crops. They had a pilot training school and a charter service plus an aeroplane overhaul and maintenance service. In 1968, Art Seller suffered a stroke and decided to divest himself of the business. The following year, the spraying and fire-retardant bombing part of the business was sold to a consortium led by Les Kerr who named the new company Conair Aviation. That com-

pany eliminated the crop spraying part of its business and soon became famous for its water/retardant bombing services and techniques (Meadows 1998).

As small farms proved to be more and more uneconomical, and the number of very large farms increased, an interest in the use of aeroplanes for pest control increased. Experienced pilot, Garth Wallace, said the Pawnee aeroplane was ideal for use over vegetable fields as small as 30 acres (12.15 ha), because, he said, they can fly quite slowly and are very manoeuvrable. He flew his Pawnee at 90 mph (145 km per h), and only one foot (0.30 m) above the crop in 60 foot (18.5 m) swaths with a 3-foot (1m) overlap. He estimated that there were more than 100, of what he called agricultural aeroplanes, in Ontario, in 1988 (Wallace 1988).

Of the many aerial spray operations that began after WW2, by far the largest in Canada was the one to protect the forests in New Brunswick, and those in Gaspe, Quebec, from the spruce budworm (*Choristoneura fumiferana*). The budworm is probably the most destructive insect eating its way through North American softwood forests. By 1951, the losses caused by that insect were enormous and appeared to be getting worse each year. To combat that threat, a consortium of federal and provincial government interests, and members of the forest industries, decided to experiment with an aerial spray program in an effort to stop further losses. A fleet of 20 spray aircraft was assembled, and during a 2-wk operation in June 1951, 192 000 acres (77 703 ha) were treated with pesticides. The results appeared to be worthwhile, and Operation Budworm became an annual event in the region for several yr. In 1957, the operation began on 4 June, with 212 aircraft available. These included at least 190 Stearman sprayers and 22 other aircraft. Twenty-two airstrips were in service, 20 of which were constructed specifically for the budworm fleet. In one month 6.3 million acres (2.55 million ha) of forest were treated (Milberry 1979).

Forest Protection Limited (FPL), a federally licensed aerial operator incorporated in 1952, has offices in Fredericton, and Miramichi, New Brunswick. By 2003, that company could provide such services as fire management, pest management, aerial seeding and fertilising, and aerial photography, etc. Since 1991 they have incorporated the Global Positioning System (GPS) technology into their aircraft. Among their twenty or more aeroplanes, six are Air Tractor 802 units. At that time they were the world's largest single engine, fixed wing air tankers, and they could be quickly converted from fire control to pesticide spraying. FPL became one of Canada's largest air tanker operations.

In the 1950s, dichloro-diphenyl-trichloroethane (DDT) was the insecticide of choice for aerial spraying. From 1952 to 1957, well over half the forested area of New Brunswick was sprayed with DDT. That insecticide was used for the last time in aerial spraying in N.B. in 1968 (Fellows 1987).

In Nova Scotia, insects in lowbush blueberries became such a problem that some of the owners tried aerial spraying, and that type of spraying became increasingly common from the mid 1960s until 1988 from the Parsboro airport. The Nova Scotia Department of Agriculture and Marketing lengthened the runways in Parsboro and Collingwood to make it easier for heavily loaded spray planes to take off and land. Canada Foods Ltd., Kentville, and Bragg Lumber Company, Collingwood, both used aerial spraying for insect control. During the peak yr of the 1970s, nearly 3000 acres (1214 ha) were sprayed by air, mostly for insects. As growers became aware that much of their losses were due to fungal diseases, the emphasis shifted to the control of fungi. In the 1980s, large tractor-mounted mist blowers began to replace the aircraft for spraying blueberries, and the apple trees in the Annapolis Valley (Kinsman 1993).

The first aerial insect control program, to protect the forests of Newfoundland, took place late in the 1960s, to control the hemlock looper (*Lambdina fiscellaria fiscellaria* Gn.). Aerial control programs against the spruce budworm were carried out between 1977 and 1985, and against the hemlock looper again between 1985 and 1990. Those efforts combined with the weather and natural control agents contributed to the collapse of those outbreaks. In 1998 and 1999, the chemical insecticide Dylox was used against sawflies of the genus *Pristiphora*, and the biological insecticide, *Bacillus thuringiensis* (B.t.), was used against the hemlock looper. Since 1988, B.t. has been the product of choice in Newfoundland. It is specific to the larvae of Lepidoptera, and it is safe for the health of humans, animals, plants, and the environment (Newfoundland and Labrador Agrifoods Bulletin 2004).

Dr. M.L. Prebble edited and assembled the contributions of 46 Canadian investigators who experimented with, and used operationally, various chemical and biological insecticides as aerial sprays, from both fixed-wing and rotary-wing aircraft, from 1927 until the end of the 1973 field season (Prebble 1975). The sequel to Prebble's book provides an account of forest insect pest management from 1972 to 1988 (Armstrong and Ives 1995).

## ROTARY-WING AIRCRAFT

Airspray Ltd., a subsidiary of Photographic Survey Company, of Toronto, ordered a Bell 47B-3 rotary-wing aircraft in the spring of 1947. That ship, the first Canadian commercial helicopter, spent late spring and early summer doing crop dusting demonstrations for farmers in southern Ontario. Later that summer it was contracted by the Ontario Department of Lands and Forests to evaluate this rotary-wing aircraft for forest protection. During its first flight the pilot spotted a small forest fire and was instrumental in extinguishing the blaze (Milberry 1979). For reasons unknown, Airspray Ltd. soon went out of business.

The Bell Aircraft Corporation had started in the rotary-wing business in September, 1941, and after a few trials of demonstration models they settled on one they labelled the Bell 47. Over time, the Bell 47 became one of the most popular of the early helicopters in use in Canada. By the mid 1960s, more than 60% of all helicopters on the Canadian Civil Aviation

Registrar were Bell 47s. More than 5000 commercial and military versions were built before the Model 47 was discontinued in 1973. In January 1976, the company name was changed to Bell Helicopter Textron. They built a plant at Mirabel, Quebec, Canada, in 1985, and in the yr 2000 they built their 2500$^{th}$ helicopter (Petite 1999).

Skyways Services Ltd. of Winnipeg, Manitoba, founded in 1947, purchased three Bell 47B-3 helicopters in a deal that included the teaching of two ex-RCAF pilots in a helicopter training school operated by Bell in the USA. Although those two pilots were the first Canadians to be trained for crop dusting using helicopters, they did as much, or more, timber cruising, power line surveying, etc. as they did crop dusting. In June, one helicopter was lost in a lake, due to an accident. It was Canada's first civilian helicopter accident. The second occurred in July of that yr while crop dusting on farms a few miles from Regina, Saskatchewan. The main rotor struck a telephone pole and lost a small end-section of the blade. This produced such a vibration that the pilot lost control and the helicopter struck the ground wrecking the machine, but the pilot was not seriously hurt. Plagued by accidents and a lack of contracts, Skyways Services went bankrupt (Anonymous 1963).

It was around this time that a group of ex-RCAF pilots in the Southern Okanagan British Columbia Flying Club became interested in the possible advantages of the use of helicopters for fruit-tree spraying in the Okanagan Valley. They formed a company, Okanagan Air Services, in April of 1947, and purchased a Bell 47B-3 helicopter. In their first test to dust an orchard, the powerful downdraft of the rotor produced such an up-swirl of ground dust and insecticide dust that the aircraft was completely enveloped. As a result of that experience liquids were used after that. It was soon learned that the helicopter had to be almost completely dismantled, and re-lubricated after about 25 flying h, and it took an inordinate amount of time just to keep the spray nozzles unclogged for efficient spraying. On 12 September 1947, while spraying an orchard near Kelowna, B.C., the helicopter came in contact with a power line, broke two wires and crashed to the ground. The pilot managed to escape without being electrocuted, but the helicopter required major repairs. Early in the 1950s Okanagan Air Services owned three helicopters but they ceased their orchard spraying because they could not compete with the efficient mobile, ground-based sprayers that had recently come into use (Corley-Smith 1985).

In a unique form of plant protection, helicopters have been used for what became known as "frost flying". This involves flying over tender fruit trees in the pre-dawn light of frosty mornings in May to break up the cold inversion layer formed during calm spring nights (Wallace 1988).

Helicopters are very versatile aircraft for use in plant protection. They can take off and land near the treatment area, they can manoeuvre around obstacles, including irregular terrain, they can make sorter turns than fixed wing aircraft, and they can move slowly or hover over a treatment area. Nevertheless, the use of helicopters generally remains limited to applications where their unique features are required, such as small fields, orchards, etc.

There are several companies across Canada specializing in the use of helicopters but there are more in British Columbia than in any other province. For example, there are Aberdeen Helicopters of Prince Rupert, and E & B Helicopters of Campbell River, to name only two. Those two are mentioned because they each use helicopters that have quick access to Bambi Buckets, which are patented fire-fighting buckets. A helicopter with a Bambi Bucket is a very efficient firefighting vehicle, one that is said to be able to put more water on a fire than any other system, and at less cost.

Rotary-wing aircraft are commonly used to transport men and equipment to and from forest fires and to drop water or foam directly on a fire perimeter to control and aid in extinguishing a fire.

The Canadian Aerial Applicators Association (CAAA) was formed in 1986 to promote professionalism among aerial applicators and others associated with aerial application of seeds and chemical compounds. In September 2002, there were almost 300 members, consisting largely of aerial applicator companies and their pilots.

Because individuals involved in aerial applications may work in a number of provinces or territories in Canada, to ensure consistency of training, and to increase flexibility in obtaining certification or licensing, a *National Aerial Pesticide Application Manual* has been developed. This Manual provides information pertaining to most types of aerial application throughout Canada, using either fixed-wing or rotary-wing aircraft.

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