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Alsike clover

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Cover photo

A field of alsike clover in bloom.

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CONTENTS

Note: This publication is intended to be used as a guide for farmers and extension workers interested in the culture and management of alsike clover in Canada. Information in this publication has been obtained from a number of research publications and text books.

Recommendations for licensed cultivars, mixtures, management practices, and fertilizer requirements and for chemical control of diseases, insects, and weeds have not been listed in detail because they change periodically. Updated general recommendations, as well as special regional recommendations, can be obtained from Agriculture Canada research stations, provincial departments of agriculture, and universities.

Alsike clover

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DISTRIBUTION AND ADAPTATION

Alsike clover, *Trifolium hybridum* L., is a true species, in spite of its specific name, which originally implied that it was a hybrid of red (*T. pratense* L.) and white (*T. repens* L.) clovers. This crop is not native to Canada. The common name is derived from the village of Alsike in central Sweden, the area in which it is believed to have originated. Alsike clover has been grown extensively in Europe since 1832 and was introduced into Canada around 1839.

Alsike clover is a short-lived perennial, but it is often used as a biennial in short rotations for improving the structure and fertility of poor soils. It is adapted to a wide range of soil types and grows well in northern latitudes and at high altitudes. It survives severe winters and thrives best where the summers are cool. Generally, alsike clover is suitable for the same purposes as red clover, but it is usually lower yielding. However, it thrives on soils too acid for red clover and can also tolerate more alkalinity than most clovers. Unlike red clover, it is resistant to clover rot and has been known to survive and grow for extended periods in water-soaked and flooded soils.

Cultivars of alsike clover are either diploid or tetraploid. Diploids have 16 chromosomes, and tetraploids are artificially produced by using chemical means to double the chromosome number to 32. Tetraploids are usually taller, have larger leaves and blossoms, and flower later than the diploids. In some regions tetraploid cultivars have higher forage yields than diploid cultivars. Diploid and tetraploid cultivars must be separated when grown for seed. Seed yields of tetraploids are severely reduced if they are pollinated by diploid pollen.

MORPHOLOGY

Alsike clover is a noncreeping, short-lived perennial with a growth habit similar to red clover. It may be distinguished from red clover by the absence of crescent-shaped marks on each leaflet and more conspicuously toothed leaves. Tillers grow profusely from the crown. Leaves are glabrous, and stipules are long with a tapering point. Stems are semi-erect, long, thin, and usually hollow with very short, almost spherical axillary racemes about 2–3.5 cm in diameter (Fig. 1). Each raceme has about 30–50 white or pale pink flowers. Individual flowers are about 6–11 mm long. Flowers become reflexed or bent downwards after pollination and turn brown at maturity (Fig. 2). Each seed pod is about 1 cm long and contains 3–5 seeds. The seeds are one-third the size of those of red clover and vary in color from dull green to nearly

Fig. 1 Leaves of alsike clover are glabrous, without leafmarks; the raceme has white and pale pink flowers.

black, often with tinges of yellow. There are about 1.5 million seeds per kilogram.

Alsike clover has a branched taproot. Small lateral outgrowths (or root nodules) are usually present on the root. The nodules develop in the presence of particular *Rhizobium* bacteria, which enter the plant through the root hairs. The bacteria multiply in the root hair and form an "infection-thread"—a filament of bacterial cells surrounded by a tubelike sheath secreted by the root cells. The infection thread penetrates into the root cells and releases the bacteria into the root. Once inside the root cells, the bacteria multiply, thus causing the development of small lateral protrusions referred to as nodules.

SOIL FERTILITY, INOCULATION, AND SEEDING

Soil tests are required for proper assessment of the availability of soil nutrients. All nutrients should be replenished on the basis of soil tests. Liming is essential on soils with a pH below 5.0. Lime makes the soil less acid and promotes the nitrogen-fixing activity of nodule bacteria.

Major elements are required in large quantities for optimum growth and yield. Nitrogen is essential for seedling establishment, and a minimum of 11 kg/ha is recommended. Atmospheric nitrogen is fixed by well-nodulated plants after stand establishment. However, if excess nitrogen fertilizer is applied, nodulation will be reduced. The applied nitrogen substitutes for atmospheric nitrogen that would otherwise have been fixed by the nodule bacteria *Rhizobium trifolii*. Nitrogen fertilizer should be applied only to established stands growing on soils where nodulation is suppressed, i.e., acid

Fig. 2 Flower heads of alsike clover before (*left*) and after (*right*) pollination and seed set.

soils. A soil is considered deficient in phosphorus if tests show that less than 22 kg/ha are available. Since phosphorus is tied up readily in the soil and is released very slowly, phosphorus fertilizer should be worked in before seeding for optimum benefit or should be banded near the seeds, to increase the phosphorus level to about 45 kg/ha. Deficiencies in potassium and sulfur are often found only in certain regions and can usually be detected by soil tests. Some luvisolic (Gray Luvisol) soils are deficient in sulfur. Fertilizers such as 16-20-0 will provide the necessary sulfur along with nitrogen and phosphorus.

A number of other elements, referred to as trace elements, are essential in extremely small quantities for plant growth. These trace elements play just as important a part in plant nutrition as do the major elements. For example, copper is required for respiration and reproductive growth and molybdenum is essential for nitrogen fixation. Boron is used in protein synthesis and is associated with increased seed set. Occasionally, when moisture is limiting, symptoms of boron deficiency occur in alsike fields. Reduced levels of moisture can curtail the uptake of boron that is present in the soil. The leaf margins or tips of alsike plants turn reddish brown when the soil is deficient in boron. The tips usually split and whole leaves gradually die. Unlike the major elements, the availability of trace elements is largely dependent on soil conditions, e.g., pH, moisture, and the ratio of other nutrients. The optimum range in concentration of trace elements is usually quite narrow. Small increases above the optimum usually have toxic effects.

The nodules on the roots of alsike clover, like those of other legume crops, are miniature nitrogen factories. Specific bacteria (*R. trifolii*) in the nodules are capable of utilizing nitrogen from the air and converting it to a form usable by the plant, thus providing a free source of nitrogen for plant growth. The alsike clover plant, in turn, provides the bacteria with carbohydrates for growth and survival. Inoculation of the seed of alsike clover with inoculum containing *R. trifolii* ensures that the correct species of bacteria are present in the root nodules. For example, bacteria that are effective for fixing nitrogen in alfalfa are not effective for this purpose in alsike clover. The inoculum is a culture of living *Rhizobium* bacteria and should be applied to the seed just before seeding. Preinoculated seed should be kept in a cool, dark place. Exposure to sunlight or fertilizers will kill the *Rhizobium* bacteria.

Alsike clover should be seeded as early as possible in the spring. The seed should be placed in a warm, moist, firm seedbed at a depth of 1–2 cm. Seeding rates vary depending on the area of cultivation, cultivar used, soil type, and intended use of crop, e.g., for forage or seed production. This is discussed in some detail in the sections that follow.

HERBAGE PRODUCTION, STORAGE, AND UTILIZATION

Alsike clover is a nutritious livestock feed. It is used predominantly in mixtures for pasture, hay, or silage in areas where other higher yielding legumes do poorly. Pure stands of alsike are best harvested for hay when in full bloom, but because alsike blooms irregularly, there may be many heads with ripe seed when a whole stand is in full bloom. Fortunately, despite the presence of a few mature heads, the fine stems of alsike keep on growing and do not harden quickly. Consequently, nutritious hay can be made over an extended period of time. However, alsike clover should not be allowed to become too ripe. The presence of ripe seed in hay often causes slobbering in horses. Straw, either from a seed crop or from a hay crop that is cut too late for good hay, makes fair winter feed for sheep, foals, and young cattle. Herbage production in some alsike cultivars is presented in Table 1.

Alsike clover herbage has a tendency to cause bloat and should therefore be fed to livestock with care. Also, alsike-induced photosensitization (or trifoliosis) has been reported among animals grazing alsike clover, particularly in bright, sunny weather. In horses this condition is characterized by reddening of the skin and swelling of the affected areas.

A mixture of alsike and red clovers makes good hay. Although alsike clover is lower yielding than red clover, it has certain advantages over the latter—it withstands excessive soil moisture and is more tolerant of acid soils. Alsike clover is therefore usually sown with red clover when problems of waterlogging and soil acidity are likely to occur. This practice ensures that some clover is present if the red clover fails to become established. In a mixture of red and alsike clovers, the latter improves the quality of hay, thickens up the lower parts of the stand, and adds materially to the yield, which is often greater than that of either species alone. For best quality, the hay should be cut when the red clover approaches full bloom.

Table 1. Herbage production in some alsike cultivars.*

					Herbage yield					
					Dry matter t/ha			% of Aurora		
		Production year †			Herbage production year					
Cultivar	Origin	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Aldan Trifolium	Denmark	7	4	4	4.35	0.34	0.41	110	57	87
Alpo	Norway	7	1	–	3.77	0	–	95	0	–
Aurora‡	Canada	8	5	5	3.99	0.60	0.47	100	100	100
Dawn‡	Canada	8	5	5	4.51	0.40	0.42	113	67	89
Ermo Otofte	Denmark	6	4	4	3.14	0	0.44	78	0	94
Hogsta	Sweden	9	6	4	4.03	0.43	0.26	100	72	55
Iso Tetra	Finland	9	7	4	4.55	0.36	0.47	113	60	100
Jeno Daehnfeldt	Denmark	6	3	2	4.17	0	0.28	105	0	60
Odenwalder	Germany	8	6	5	4.25	0.27	0.37	105	45	79
Otofte	Denmark	4	1	–	2.85	0	–	73	0	–
Otofte 4N	Denmark	8	6	5	3.91	0.22	0.43	98	37	91
Stena 4N	Sweden	9	5	3	4.18	0.16	0	105	27	0
Strain II	Canada	7	5	5	5.02	0.36	0.43	125	60	91
Tetra‡	Sweden	9	7	5	4.36	0.38	0.49	110	63	104
Mean					4.08	0.32	0.37			
L.S.D. (P = 0.05)					1.44	0.27	0.29			

* Source: Adapted from Northern Research Group Publication 81-16B-1981, Agriculture Canada Research Station, Beaverlodge, Alta.
† Stand survival: 1 = poor; 9 = good.
‡ Cultivars licensed in Canada.

Alsike clover is often used in mixtures with red clover and grasses, e.g., timothy. Timothy in the mixture appears to minimize lodging of the alsike and is beneficial because it helps keep the clover from packing when cut. Swaths are airy, resulting in an improved, more rapid curing than in stands of pure alsike clover. In low-cost projects, e.g., the conversion of wooded areas to pasture with minimum tillage, alsike clover is useful as a legume in mixtures seeded by aircraft into ash left after forest fires.

SEED PRODUCTION

For optimum seed production, alsike clover must be seeded as early as possible in the spring. Seeding rates should be lower than those used for herbage stands and should vary from 1 to 7 kg/ha in solid stands or in rows. Row seeding and a row spacing of 15 cm are recommended. The use of a companion crop is not recommended because alsike clover is a nonaggressive species and is often unable to compete (e.g., for light or nutrients) with other crops during its establishment phase. Seeding of alsike clover with a companion crop often results in poor establishment and reduced first-year seed yield. However, companion crops do provide a cash crop in the establishment year, may help weed control, and prevent crusting in some soils. Therefore, when a companion crop is used, competition with the legume can be alleviated by seeding the companion at half the recommended rate in alternate rows or by cross-seeding.

Alsike clover must be cross-pollinated to produce seed because it is predominantly self-incompatible, i.e., pollen is unable to successfully fertilize the ovules of the plant on which it is produced. Cross-pollination is the transfer of pollen from the anthers of one plant to the stigma of another and is done primarily by bees. A bee that is collecting pollen or nectar forces its proboscis down the corolla tube causing the stamens and pistil to protrude from the interior of the floret. The body of the pollinator is then brought in close contact with the upper ends of the stamens and pistil, thus becoming covered with pollen. Since the pistil protrudes a little beyond the stamens, it is more likely to come in contact with the pollen from other plants already deposited on the body of the pollinator than to come in contact with the pollen of its own flower. Cross-pollination is thus effected. Unlike other legumes, the flower structure of alsike clover provides a greater opportunity for cross-pollination. After each visit by a pollinator, the pistil and stamens move back to their original position. A second or third visit by a pollinator has the same effect, and the pistil can be properly fertilized as long as it remains in a condition to receive pollen.

The honey bee, *Apis mellifera*, is the most important pollinator of alsike clover. The use of two to three colonies per hectare for fields of 20 ha or more and up to eight colonies per hectare for smaller fields, distributed in groups of 10–20 colonies, is recommended. Two economically important products are obtained—alsike clover seed and honey. Bumble bees, *Bombus* spp., also pollinate alsike clover, but because of fluctuations in the population of these bees from year to year, they cannot be relied on as the sole pollinators of this legume. However, bumble bees should be encouraged to build colonies in the vicinity of alsike seed fields. This can be accomplished by providing patches of bush for nesting and, wherever possible, by seeding plants that flower in the early spring. The alfalfa leafcutter bee, *Megachile rotundata*, has been known to successfully pollinate experimental plots of alsike clover, but to date, these bees have not been used successfully on a field scale.

For seed production, diploid and tetraploid cultivars must not be mixed, and each must be grown in isolation from the other. Seed yields of tetraploid cultivars can be reduced up to 50% if they are fertilized by diploid pollen. Also, under similar conditions, tetraploid cultivars generally produce lower seed yields than do diploid cultivars.

Alsike clover should be cut and swathed when 90% of the heads are brown (Fig. 3). Unless the stand has been defoliated by chemicals or severe frosts, the crop is usually swathed with a grain swather or a mower that has a swather attachment. The swaths should be allowed to dry for 7–10 days before threshing. Heavy swaths may require turning, but this operation tends to shatter the seed. For threshing under normal conditions, a fairly high cylinder speed should be maintained with the concaves set close. A slow forward speed should be used because overloading the machine can cause serious seed losses. Chemical defoliation and straight combining 5–7 days later are often the preferred method for harvesting seed. This technique keeps the alsike clover from producing fresh growth after most of the seed heads

Fig. 3 Seed field of alsike clover with recently cut swaths (*left*) and swaths that were cut about a week earlier (*right*).

are ready to be harvested. Defoliation also reduces losses caused by wind damage in cut swaths. The seed should be dried if the moisture content exceeds 13–14%. Further processing with specialized machines at a seed-cleaning plant is usually required.

Growers who wish to produce pedigreed alsike clover seed should contact the Canadian Seed Growers' Association.[1] The *Canada Seeds Act* and regulations have designated the association as the official pedigreeing agency responsible for prescribing standards and issuing crop certificates for Canadian-produced pedigreed seed. Seed that has pedigree status meets the grade requirements (genetic identity, purity, germination) of the *Canada Seeds Act*. There are specific requirements that have to be met to produce pedigreed seed, such as isolation distances and previous cropping history of land. Further details can be obtained from the association.

A limited opportunity exists for the production of seed of foreign cultivars. The seed is grown under contract for a particular member country of the Organization for Economic Cooperation and Development (OECD). Such contracts are negotiated between the individual producer and the particular seed firm responsible for delivery of the seed to the country involved. A number of countries participate in this scheme, and prospective producers should make all arrangements and negotiate contracts with the seed firms of their choice before starting production of foreign unlicensed cultivars. Seed production of Canadian and foreign cultivars is presented in Table 2.

ALSIKE CLOVER FOR SOIL CONSERVATION

Alsike clover, like all members of the legume family, is of outstanding agricultural value because of its ability to fix nitrogen from the air (Table 3) and produce a high dry-matter yield with little or no requirement for nitrogen fertilizer. Some of the nitrogen may become available to nonleguminous plants by decay and sloughing off of the nodules or from the dung and urine of grazing livestock. However, much of the fixed nitrogen can be used as a replacement for nonrenewable nitrogenous fertilizer for succeeding crops if the legume is returned to the soil as green manure. This practice is sometimes referred to as plow-down. The crop is allowed to grow to the blossom stage and is then incorporated into the soil with either a moldboard plow or a disc. Single or double-disc harrows followed or preceded by heavy-duty cultivators can effectively incorporate the green crop into the soil. It should be remembered that the amount of nitrogen from the alsike crop incorporated into the soil during plow-down depends on the quantity of alsike crop residues returned to the soil, the proportion of nitrogen in the crop residue, and the rate at which nitrogen in the crop residue becomes available to the succeeding nonlegume crop. For best results, make sure that the nitrogen-rich, leafy top growth is returned to the soil at about 10–20% bloom. Alsike clover fixes more nitrogen earlier in its development compared with other legumes such as red clover.

[1] Canadian Seed Growers' Association, P.O. Box 8455, Ottawa, Ont. K1G 3T1.

Table 2. Seed production in some alsike cultivars.*

					Seed yield					
					Yield (kg/ha)			% of Aurora		
		Production year †			Seed production year					
Cultivar	Origin	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Aldan Trifolium	Denmark	7	4	4	460	86	16	83	90	38
Alpo	Norway	7	0	-	556	0	-	100	0	-
Aurora‡	Canada	8	5	5	556	96	42	100	100	100
Dawn‡	Canada	8	5	5	624	128	34	112	133	81
Ermo Otofte	Denmark	6	4	4	450	104	44	81	108	105
Hogsta	Sweden	9	6	4	484	109	30	87	114	71
Iso Tetra	Finland	9	7	4	524	100	32	94	104	76
Jeno Daehnfeldt	Denmark	6	3	2	353	54	24	63	56	57
Odenwalder	Germany	8	6	5	487	187	18	88	195	43
Otofte	Denmark	4	1	-	506	43	-	91	45	-
Otofte 4N	Denmark	8	6	5	516	104	33	93	108	79
Stena 4N	Sweden	9	5	3	413	36	0	74	38	0
Strain II	Canada	7	5	5	492	139	31	88	145	74
Tetra‡	Sweden	9	7	5	569	139	48	102	145	114
Mean					499	95	29			
L.S.D. (P = 0.05)					116.18	63.13	31.03			

* Source: Adapted from Northern Research Group Publication 81-16B-1981, Agriculture Canada Research Station, Beaverlodge, Alta.

† Stand survival: 1 = poor; 9 = good.

‡ Cultivars licensed in Canada.

Table 3. Total annual estimates of nitrogen fixation and nitrogen removed (each in kilograms of nitrogen per hectare) in forage and seed of alsike clover and red clover grown on Orthic Gray Luvisol and Black Solod soils.*

	Orthic Gray Luvisol				Black Solod			
	Seed		Forage		Seed		Forage	
	fixed	removed	fixed	removed	fixed	removed	fixed	removed
Alsike clover	75.6 b†	22.8	86.2 a	80.2	33.8 d	8.6	34.8 d	55.2
Red clover	40.2 d	23.7	50.4 c	136.0	18.3 e	10.0	19.1 e	84.5

* Source: Adapted from W.A. Rice, 1980, Seasonal patterns of nitrogen fixation and dry-matter production by clovers grown in the Peace River region, Can. J. Plant Sci. 60:847-858.

† a–e: Means (nitrogen-fixed) designated by the same letter are not significantly different at $P = 0.05$ (Duncan's multiple range test).

Alsike clover is a nonaggressive species and is used successfully as a cover crop in rotation with annual cash crops like cereals or corn. It can be undersown with a cash crop in the early spring, and after this crop is harvested, the alsike is allowed to grow without any competition until it is plowed down either in the late fall of the same year or spring of the following year, depending on the length of the growing season. The amount of commercial nitrogen fertilizer added to the succeeding crop can be decreased. For example, in some regions the amount of nitrogen in fertilizer required by succeeding crops can be greatly reduced in soils containing plowed-down legumes (Table 4).

Alsike clover in rotation helps to conserve the soil and in most instances is preferable to summerfallow because it prevents wind and water erosion and increases the content of organic matter in the soil. In addition, decomposition of organic matter helps to improve soil structure, moisture-holding capacity, aeration, and root penetration of succeeding crops in the rotation.

Table 4. Adjustment of nitrogen requirement where sod that contains legumes is plowed down.*

Type of sod	For all crops deduct from nitrogen requirement (kilograms of nitrogen per hectare)
Less than one-third legume	0
One-third to one-half legume	55
One-half or more legume	110
Perennial legumes seeded and plowed in the same year	20†

* Source: Ontario Ministry of Agriculture and Food, 1984 Field crop recommendations, Publication 296, p. 77.

† Applies where the legume stand is thick and over 15 cm high.

WEEDS

Weed competition in the seeding year may affect the establishment of alsike clover. It is therefore important either to select a clean field on which to seed the alsike clover or to reduce weed infestations before seeding the crop. Controlling perennial weeds before seeding is particularly important because many species are impossible to remove from the growing crop. The use of pedigreed seed with careful attention to the seed-testing certificate can prevent the introduction of new weed species in the stand.

Crop rotation plays an important role in controlling weeds in alsike clover. Seeding competitive annual crops before seeding the clover can be useful in reducing weed populations. In seedling stands, clipping fast-growing weeds with a flail chopper can often be used effectively for weed control. Alsike clover regrows from crown buds and is usually not injured by infrequent clipping. A limited number of herbicides can be used in seedling stands of alsike clover to control weeds. Refer to provincial recommendations for proper use and application of herbicides.

In established stands used for herbage, weeds generally constitute a limited problem. However, in established stands grown for seed, contamination by weed seeds presents a serious problem. Many weed seeds are similar in size, shape, and density to alsike clover. They are often difficult and costly to separate from alsike clover and can result in reduced grades and prices. Roguing before harvest is often the best procedure for handling the problem. Seeds of some weeds and most forage legumes remain viable in the soil for many years. Therefore, fields known to be infested with weeds that cannot be removed with herbicides without damaging the alsike crop, or fields with a history of seed production of other clovers, should be avoided.

DISEASES

Alsike clover is resistant to many diseases, such as bacterial wilt, bacterial blight, mildew, and northern anthracnose, which cause heavy losses in other forage legumes. Crop losses caused by most diseases can be reduced by using management procedures that maintain a vigorous stand. Yield losses to disease are usually higher in older stands. The use of clean seed of recommended cultivars and rotation with nonlegume crops are the most effective measures for controlling most diseases of alsike clover (Table 5). Avoid contaminating healthy fields by farming diseased fields last and by disinfecting farm machinery after it is used on infected areas.

The importance of viral diseases in alsike clover is not completely understood. Also, losses in yield caused by virus infection have not been extensively documented. Clover yellow mosaic virus, bean yellow mosaic virus (BYMV), and pea streak virus (PSV) have been identified in stands of alsike clover. Bean yellow mosaic virus is transmitted through infected seed, and both BYMV and PSV can be transmitted by several species of aphids. Mycoplasmalike organisms (MLO) are a relatively newly recognized group of causal agents for plant diseases. A number of diseases previously associated with viruses, e.g., phyllody, witches' broom, and proliferation are now attributed to MLO. These diseases are transmitted by leafhoppers. Some symptoms of phyllody include the reversion of floral parts to leaflike organs, slight deformations in newly emerged leaves, and the bronzing of older leaves. Plants infected with witches' broom are severely dwarfed, with small chlorotic leaves. Numerous spindly shoots originate in the crown and the axillary buds along the stem. Proliferation in alsike clovers has been found in Alberta, from Lacombe north to the Peace River region. The symptoms of this disease are similar to those of witches' broom. Infected plants are mildly chlorotic, with profuse foliar growth from the crown. Each flower head becomes a cluster of green leaflike structures and does not produce seed.

Table 5. Diseases of alsike clover.

Disease	Symptoms
Brown root rot (*Phoma sclerotioides*)	Plants become yellow and stunted in early spring and sometimes die after beginning growth. Circular brown areas appear in roots and crowns.
Fusarium root and crown rot (*Fusarium* spp.)	Plants are gradually weakened by rotting of roots and crowns. These diseases can cause major economic losses. Good cultural practices, e.g., proper fertilization and cutting schedules, reduce severity of disease.
Rust (*Uromyces trifolii*)	The disease causes minor economic damage in most seasons and is favored by cool, wet weather.
Sclerotinia crown and stem rot (*Sclerotinia trifoliorum*)	Plants of all ages are susceptible. The disease occurs in patches where infected leaves and stems become yellowish and collapse. A white mass of mycelium grows over the dead plants, and hard black sclerotia are produced in the plant tissue. Plow deeply to bury sclerotia, and plant sclerotia-free seed.
Seedling blight (*Pythium* spp., *Fusarium* spp., *Rhizoctonia solani*)	The disease is responsible for much of the stand reduction in new seedings. Little damage is done after the plants reach the four- or five-leaf stage. Shallow seeding helps prevent the disease.
Sooty blotch (*Cymadothea trifolii*)	Conspicuous dark brown to black pustules are formed on the underside of the leaves. Severely infected foliage may be toxic to livestock, causing ulcers of the mouth. Cut and burn stubble as control measures.
Spring black stem (*Phoma trifolii*)	The fungus causes black or dark brown lesions on stems, petioles, and leaves. Early cuttings reduce leaf loss. Burning stubble in spring before growth begins may be effective in seed fields.
Stagonospora leaf spot (*Leptosphaeria pratensis*)	The disease is characterized by large leaf lesions. Leaves gradually die off but tend to remain attached to stems. Early cutting reduces leaf loss and inoculum. Burning stubble in spring helps curtail the disease.
Winter crown rot or snow mold (*Coprinus psychromorbidus*, LTB phase)	The fungus causes severe damage in central and northern areas of western Canada. The pathogen is active only at near-freezing temperatures, and damage occurs in late winter in the form of irregular patches of dead plants.

INJURIOUS INSECTS

Many species of insects damage alsike clover. They can prevent or reduce plant growth, destroy plant tissue, and damage the inflorescence and seed. Lygus bugs (*Lygus* spp.) suck plant juices, wither individual flowers, and shrivel the seeds. The tarnished plant bug, *Lygus lineolaris*, is one of the most common lygus bugs infesting fields of alsike clover. Aphids and leafhoppers are vectors for diseases caused by viruses and mycoplasmalike organisms.

Insecticides are available for control of these insects. Some insecticides are extremely toxic or may persist on sprayed foliage for extended periods. In fields of alsike clover grown for seed, small residues of long-lasting insecticides can effectively decimate useful pollinating insects and bees. Sweeps should be made before bloom, preferably in the early- to mid-bud stage, and if insect populations warrant it, the recommended insecticide should then be applied. To avoid injury to introduced and native pollinators, spraying should be done before pollinators are introduced into the crop and before bloom. Refer to provincial recommendations for proper use and application of insecticides.

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CONVERSION FACTORS

Metric units	Approximate conversion factors	Results in:
LINEAR		
millimetre (mm)	x 0.04	inch
centimetre (cm)	x 0.39	inch
metre (m)	x 3.28	feet
kilometre (km)	x 0.62	mile
AREA		
square centimetre (cm^2)	x 0.15	square inch
square metre (m^2)	x 1.2	square yard
square kilometre (km^2)	x 0.39	square mile
hectare (ha)	x 2.5	acres
VOLUME		
cubic centimetre (cm^3)	x 0.06	cubic inch
cubic metre (m^3)	x 35.31	cubic feet
	x 1.31	cubic yard
CAPACITY		
litre (L)	x 0.035	cubic feet
hectolitre (hL)	x 22	gallons
	x 2.5	bushels
WEIGHT		
gram (g)	x 0.04	oz avdp
kilogram (kg)	x 2.2	lb avdp
tonne (t)	x 1.1	short ton
AGRICULTURAL		
litres per hectare (L/ha)	x 0.089	gallons per acre
	x 0.357	quarts per acre
	x 0.71	pints per acre
millilitres per hectare (mL/ha)	x 0.014	fl. oz per acre
tonnes per hectare (t/ha)	x 0.45	tons per acre
kilograms per hectare (kg/ha)	x 0.89	lb per acre
grams per hectare (g/ha)	x 0.014	oz avdp per acre
plants per hectare (plants/ha)	x 0.405	plants per acre