APPENDIX C. AVERAGE WHOLESALE PRICES: PORK CUTS AND TRIMMINGS, CHICAGO, 1949*

Wholesale cuts	Weights	Prices
	pounds	cents per pound
Fresh skinned hams	10-12	46.39
	12-14	45.76
	14-16	45.47
	16-18	44.68
	18-20	44.12
	20-22	42.69
	22-24	41.72
	24-26	39.14
	25-30	36.51
Fresh loins	8-10	47.06
	10-12	47.06
	12-16	44.74
	16-20	40.36
Fresh bellies	6- 8	33.66
	8-10	33.21
	10-12	31.60
	12-14	29.60
	14-16	27.96
	16-18	26.50
	18-20	25.61
Green fatbacks	6- 8	09.64‡
	8-10	09.75‡
	10-12	09.93‡
	12-14	10.73
	14-16	10.93
	16-18	11.38
	18-20	11.44

Wholesale cuts	Weights	Prices
	pounds	cents per pound
Fresh picnics	4- 6	30.25
	6- 8	28.74
	8-10	26.66
	10-12	25.84
	12-14	25.21
Boston butts	4- 8	38.76
D. S. jowl butts		11.34
Spare ribs (under 3 pounds)		37.99
Neck bones		11.59
Front feet		07.40
Regular pork trim—50 per cent lean		20.49
Sp. pork trim—85 per cent lean		39.64
Ex. pork trim—95 per cent lean		46.66
Refined lard (tierces p.s. lard)		12.03

Conversion of fat to lard (12.03 X conversion factor†)

Cut or trimmings	Weight	Factor	Price
Fat trimmings and fatbacks	Under six pounds	80.00%	09.62
Fatbacks‡	6- 8	81.50%	09.80
	8-10	82.25%	09.89
	10-12	83.50%	10.05
	12-14§	84.50%	10.17
	14-16§	85.50%	10.29
	16-18§	86.25%	10.38

* The average prices for all cuts and trimmings other than loins and Boston butts were calculated from data taken from *The National Provisioner*, the weekly trade magazine of the packing industry. The average prices for loins and Boston butts were calculated from the *Chicago Wholesale Meat Situation*, furnished by the Production and Marketing Administration in the United States Department of Agriculture.

† The factors for converting fat to lard were copied from *The National Provisioner*, May 31, 1947, page 25.

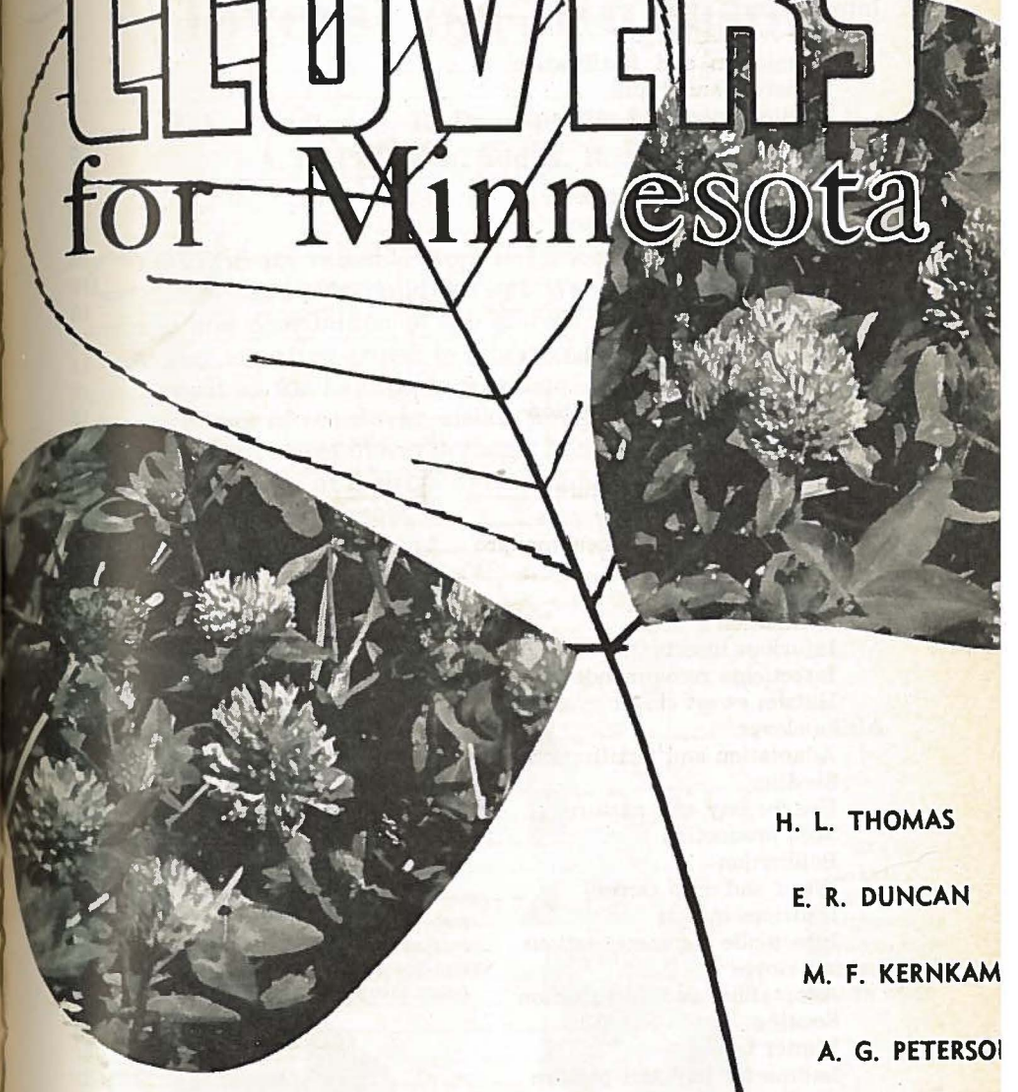
‡ During this year it will be observed that on the average it was profitable to convert fatbacks up to 12 pounds into lard.

§ All fatbacks over 12 pounds could most profitably be merchandised as fatbacks in the wholesale trade.

Bulletin 415

June 1952

CLOVERS for Minnesota



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Contents

Clovers for Minnesota

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CLOVERS are valuable crops in Minnesota. They produce feed cheaply and help build the soil. We are not sure of the exact acreage and distribution of the clovers in Minnesota, partly because they are often grown in mixtures and used for various purposes, such as for hay, pasture, silage, and seed crops. Figure 1 shows acreage of red clover, alsike, timothy, and mixtures in 1950; figure 2 shows sweet clover acreage. Ladino is so new to the state that no estimates of acreage are available, although this acreage must necessarily be small.

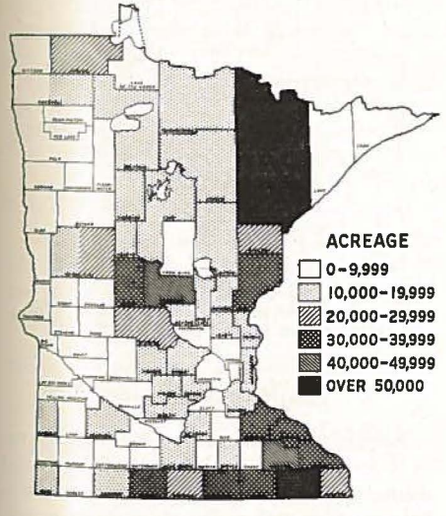

Fig. 1. Estimated red clover, alsike, and timothy acreage, 1950, based on hay acreage reported by the Minnesota State Farm Census and on acreage plowed for green manure reported by the Production and Marketing Administration.

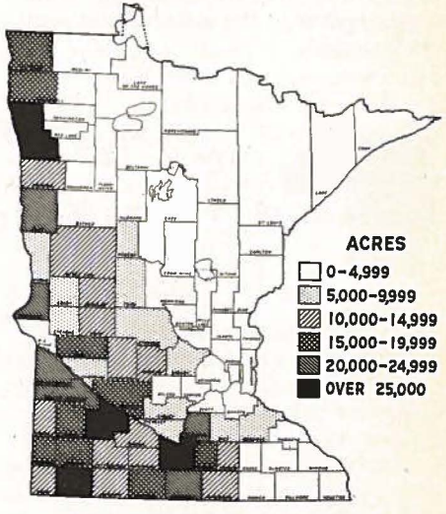

Fig. 2. Estimated sweet clover acreage, 1950, based on acreage which complied for Production and Marketing Administration payments, plus an estimated 25 per cent.

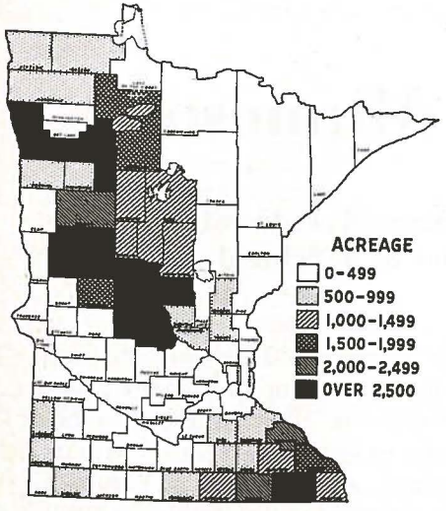

Fig. 3. Red clover cut for seed, 1950. (Information from State Farm Census.)

In general, red clover and alsike—alone or in grass mixtures—are grown mostly in eastern and central Minnesota, while sweet clover acreage is relatively higher in the western and south-central part.

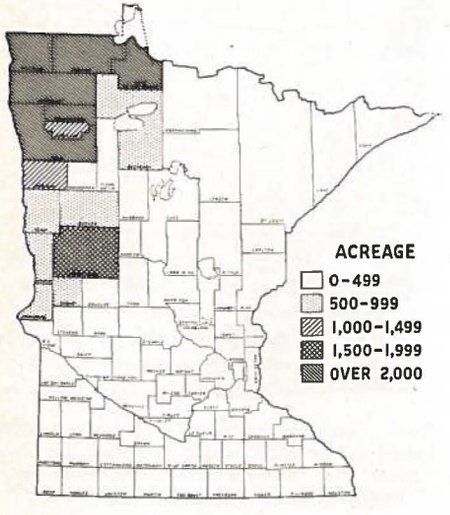

Fig. 4. Sweet clover cut for seed, 1950. (Information from State Farm Census.)

Red clover seed production (figure 3) is centered in central and southeastern Minnesota, and sweet clover (figure 4) and alsike seed (figure 5) production in northwestern Minnesota. Although these acreages vary from year to year, 1950 estimates give a general picture of distribution. The 1.9 million acres represented in figures 1 and 2 together are a little over six per cent of the land in farms and nearly 11 per cent of the cropland when wild hay, permanent pasture, and woodland are excluded.

Table 1 gives some general information about the clovers which will be discussed.

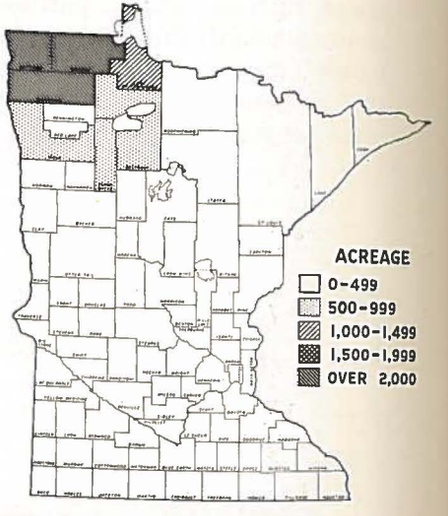

Fig. 5. Alsike clover cut for seed, 1950. (Information from State Farm Census.)

Establishing Stands

Seeding failures are costly. They result in direct loss of seed, labor, and money. They also upset the crop rotation system and cause shortages of hay, pasture, and soil-improving crops. If good seeding methods are followed, less seed per acre is needed to establish good stands, and the chances of failure will be greatly reduced.

Table 1. Seeds Per Pound, Germination, and Growth Habit of Clovers

Common name	Scientific name	Seeds per pound	Germination time in days under good conditions	Growth habit
Red clover	Trifolium pratense L.	260,000	7	short-lived perennial
Sweet clover	Melilotus alba (white) Melilotus officinalis (yellow)	250,000	7	biennial
Alsike	Trifolium hybridum L.	680,000	7	perennial
Ladino	Trifolium repens L.	700,000	10	perennial

Prepare a Good Seedbed

Since clover seed is small and should not be seeded deeper than one-half to three-fourths inch, moisture must be maintained near the soil surface. A firm seedbed will help do this.

For spring seedings, fall plowing is better than spring plowing. If spring plowing is used, do enough work with the harrow, disk, and cultipacker to make a firm seedbed.

If the seed is drilled in, cultipacking before seeding is very helpful. It prevents the drill from sinking too deeply and also puts the seed in contact with firm moist soil.

Table 2 gives clear evidence that shallow seeding is important in small-seeded legumes.

Inoculate Legume Seed

Legumes are able to use free nitrogen from the air. Bacteria in nodules on the roots make it possible for the plants to use this free nitrogen. The bacteria may be present in the soil, or they may have to be supplied artificially.

If the legume has not been grown on the land for several years, it is best to inoculate. Commercial inoculants sold by seed dealers are usually satisfactory. Apply these to the seed according to directions on the container.

Table 2. Percentage of Total Emergence of Clovers at Different Planting Depths*

Crop	Depth of planting (inches)				
	0	½	1	2	3
	per cent				
Red clover	77	82	63	8	0
Sweet clover	64	62	30	4	1
Alsike	65	69	27	0	0
White clover	71	76	34	0	0

* Murphy, R. M., and Arny, A. C. "The emergence of grass and legume seeds planted at different depths in five soil types." *Amer. Soc. Agron. Jour.* 31:17-28. 1939.

Seed at Right Time

Best stands are usually obtained when it is cool and moist after seeding. For this reason, early spring seedings are generally most successful. Summer seedings are successful when properly done and when there is enough moisture. Do not seed clovers later than August 1 in Minnesota because the seedlings must become large enough to survive the winter. Clover seedlings, especially sweet clover, are more susceptible to freezing injury than alfalfa seedlings.

Seed Carefully

In seeding clovers and other small seeded legumes and grasses, either of two methods may be used.

1. **Broadcasting,** using the harrow or cultipacker for covering, or **seeding with a cultipacker seeder.** Here seed is mixed with surface dry soil in hope that future rain will bring about germination and growth.

2. **Drilling** into a firm moist seedbed. Preliminary results from experiments conducted at University Farm, St. Paul, indicate that this is the more reliable

method. In states where moisture is more of a problem than in Minnesota, drilling has been definitely more reliable than broadcasting. The one disadvantage of drilling small seeds is the danger of burying them too deeply. This pitfall can be avoided by cultipacking before shallow drilling. This keeps the wheels and disks of the drill from sinking too deeply.

After drilling, leave the field as it is or cultipack it. Harrowing after drilling tends to bury some of the seed too deeply.

When summer seedings are made, cultipacking after drilling is very desirable except where there is danger of wind or water erosion.

Consider Companion Crops

Nurse crops—properly called companion crops—do more harm than good in some respects. They compete vigorously with the legumes and grasses for nutrients, moisture, and light. But these companion crops also have their advantages, for they reduce soil erosion, hold back weeds, and provide a return for the land while the legumes and grasses are becoming established. If a companion crop is used, reduce its seeding rate to two-thirds or one-half the normal rate. (Flax may be seeded at normal rates, however.)

The management of the companion crop may materially affect the stand of the legumes and grasses. Very good stands are usually obtained if the companion crop is grazed off periodically with sheep. Grazing with cattle also gives good results, except that the first grazing in the spring may thin the stand somewhat, particularly if the soil is wet. This may be avoided by mowing the companion crop when about 8 to 10 inches tall and then grazing off the second and third growth. This gives the small legume and grass seedlings a chance to reach a good size before grazing.

Cutting the companion crop for hay will usually encourage stands of the clovers.

Stands are usually poorest if the companion crop is allowed to mature, but this chance must be taken in most cases to get the returns from the grain crop.

Red Clover

RED CLOVER is one of the most important and widely known of all cultivated legumes. It is native to most of Europe and parts of Asia. Red clover was grown in the New England states before 1750 and has spread to all parts of the United States that have sufficient rainfall. It was one of the first cultivated legumes grown in Minnesota. Red clover is actually a short-lived perennial, but under Minnesota conditions usually acts like a biennial.

ADAPTATION AND FERTILIZATION

Red clover is grown throughout Minnesota but has found greatest favor in the southeast, northeast, and north-central sections. When the price of clover seed is low compared with alfalfa seed, the acreage of clover seeded increases rapidly in all of southern Minnesota. This indicates that it is adapted to most of the state and that it is acceptable as a forage crop.

The soil requirements of red clover are not as exacting as those of most other legumes. It is fairly tolerant of acid soils, growing well on soils with a *p*H range of 5.5 to 6.5. It makes better growth, however, on nonacid soils. Red clover stands can be established and some growth made on soils with a low fertility level. Red clover responds well to phosphate and potash fertilizers when needed.

A general fertilizer suggestion would be 250 pounds of 0-20-0 or its equivalent when the seeding is made. If soil tests show that potash is needed, 250 pounds of 0-20-10 or 0-20-20 will be more effective. Soil tests, crop response, and price levels will determine the grade and rate of fertilizer to use. If a complete fertilizer is used the nitrogen will benefit the grain crop primarily.

Soil moisture is important in determining where red clover can be grown successfully. Stands and yields are poor on droughty soils and it is killed out on wet soils with a high water table. Naturally well-drained or tile-drained soils are best suited for maximum yield. Like most other cultivated crops, red clover makes best yields on fertile, well-drained soils and with sufficient rain.

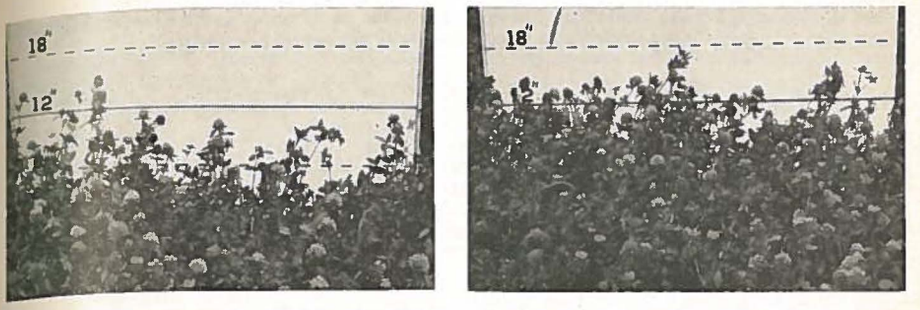

Fig. 6. Second-year growth of red clover at the Agricultural Experiment Station at Rosemount, 1950. Left, no fertilizer; right, 300 pounds per acre of 0-20-20 applied at seeding time.

VARIETIES AND TYPES

Medium red clover

Early tests (late 1920's) showed that native northern-grown seed was superior to foreign strains. Field plot trials conducted by A. C. Arny of the Minnesota Agricultural Experiment Station (table 3)[1] and by workers in Iowa, Wisconsin, and Canada gave similar results.

Beginning in 1945 and continuing up to the present, the Minnesota Agricultural Experiment Station in cooperation with the Soil Conservation Service and the Bureau of Plant Industry of the United States Department of Agriculture has been making replicated yield

[1] Arny, A. C. "The adaptation of medium red clover strains." *Amer. Soc. Agron. Jour.* 20:557-568. 1928.

Table 3. Two-Year Average (1923 and 1927) of the Yield and Percentage of Loss from Winter-killing at University Farm for Medium Red Clover Seed from Various Countries

Source of seed	Loss in stand	Yield per acre on 15 per cent moisture basis		
		First cut	Second cut	Season total
	per cent		tons	
Native strains				
1. Northern grown	18.1	1.34	.56	1.90
2. Central, southern, and western	27.3	1.20	.63	1.83
Foreign strains				
3. Western and central continental Europe	21.3	1.11	.51	1.62
4. South central continental Europe, England, Wales, and Chile	85.4	.24	.13	.37

Table 4. Average Forage Yield from Several Locations in Minnesota for Promising Medium Red Clover Varieties in Comparison with Minnesota Commercial*

Varieties	1945	1946	1947	1948	1949	1950	1951	Over-all average
				tons per acre				
Wegener	3.60	1.85	3.46	3.13	2.63	2.43	1.17	2.61
Midland	3.51	1.94	3.26	3.44	2.67	2.47	1.29	2.65
Dollard	3.39	1.77	3.32	3.45	3.03	2.08	1.10	2.59
Ottawa	3.54	1.79	3.15	3.28	2.77	2.53	1.38	2.63
Minnesota Commercial	3.47	1.55	3.50	3.27	2.73	2.65	1.35	2.64

* Forage yields are at 15 per cent moisture.

trials of named varieties of red clover with seed from various sources (table 4).

Two cuttings were taken in part of the locations and years and in other cases only one, but in every case all varieties were cut and weighed at the same time.

There are no significant differences in yield among the varieties. However, since it is not always possible to obtain adapted northern-grown seed when no variety name is attached, the Minnesota Agricultural Experiment Station lists Wegener and Midland as recommended varieties. This makes it possible to have named varieties, which are known to be adapted, available for certification. Seed yield data are not as complete as for forage, but there is nothing to indicate that Wegener and Midland are not satisfactory in that regard.

Wegener, Minnesota No. 2648, is a strain which has been grown for many years by Edward C. Wegener of Bertha, Minnesota. The original seed lot was obtained from the L. L. May Seed Company of Fargo, North Dakota, in 1908, and Mr. Wegener has harvested his own seed practically every year without bringing in any new seed source. Probably natural selection has worked to adapt this variety to Minnesota conditions.

Midland, Minnesota Accession No. 2629, is a blend of equal parts of five old strains: Rahn and Letcher from Illinois, Poland from Ohio, Otten from Indiana, and Emerson from Iowa. Each of these strains had an origin rather similar to Minnesota Wegener in that they were grown on the same farm for a number of years. Midland was developed through cooperative testing work of the United States Department of Agriculture and several midwest experiment stations. According to preliminary reports of recent tests, it appears that Midland has a wider adaptation than Wegener.

Dollard was bred at MacDonald College, Quebec, Canada. This variety has moderate resistance to northern anthracnose. The fact that most leaves are free of the center leaf marking aids in identification.

Ottawa was selected at the Central Experimental Farms, Ottawa, Ontario, Canada.

Several other strains are included in Minnesota yield tests, but no others of promise have been studied as long as have those discussed above.

Kenland, an introduction from the Kentucky Agricultural Experiment Station, seems to be adapted to the southern part of the corn belt, but it is susceptible to northern anthracnose and has shown that characteristic in Minnesota tests.

Wisconsin Mildew Resistant is very resistant to powdery mildew in Minnesota, but it has not as yet shown superiority to Wegener and Midland in other respects.

Mammoth red clover

Mammoth red clover, sometimes called single-cut, is not as desirable for hay as medium red or double-cut in most sections of the state. It generally produces only one crop in a season, and this crop is rank and coarse compared to medium red. In northern Minnesota and Canada the Mammoth type is usually preferred because of the larger yield of the first cutting.

The single-cut types are more likely to live over the third year than medium red varieties. But seed production is dependable only from the first cutting in any one season.

For 1945 to 1947, inclusive, **Altaswede** and **Manhardi,** two single-cut types of Canadian origin, were compared with **Graham's Mammoth** in the same type of variety tests as described in table 3. Mammoth proved to be superior in forage yield.

SEEDING RATES AND MIXTURES

Since red clover behaves like a biennial, it is used primarily in hay and pasture mixtures of one or two years' duration. When red clover is seeded alone, the recommended rate is 8 to 10 pounds per acre. The most common practice is to seed red clover with timothy or other grasses.

A typical mixture for Minnesota is medium red clover, six pounds per acre, and timothy, four pounds per acre. Frequently, alsike clover is added to this mixture or substituted for part of the red clover at about two pounds per acre.

Medium red clover may also be substituted for part of the alfalfa in an alfalfa-grass mixture. A mixture such as alfalfa, five pounds per acre; medium red clover, three pounds per acre; and brome grass, eight pounds per acre, will yield about as well for pasture and hay over a period of two or three years as a mixture of alfalfa, eight pounds per acre, and brome, eight pounds per acre.

RED CLOVER FOR HAY

Red clover and clover-timothy mixtures are popular hay and pasture crops because they fit readily into the crop rotation and because they improve the yields of the crops which follow. Red clover is popular in eastern Minnesota where moisture is usually good and soils tend to be acid. It will tolerate the acid soil condition better than alfalfa. In the Red River Valley and other parts of western Minnesota red clover production is often limited by lack of rainfall.

Red clover hay is readily eaten by all kinds of livestock. Its protein content is about 12.5 per cent—twice that of timothy but slightly less than that of alfalfa. Red clover or red clover-grass mixtures usually yield about the same or slightly less than alfalfa-grass mixtures during the first production year.

WHEN TO HARVEST

Cut the first crop of red clover or red clover-grass mixture for either hay or silage at approximately the half-bloom stage. If red clover is cut at this stage and properly cured, it will contain a high percentage of protein. Early cutting also results in a bigger second crop for hay or seed.

RED CLOVER FOR PASTURE

Red clover makes excellent pasture for all kinds of livestock, although, like sweet clover and alfalfa, it may cause bloat. Red clover-grass mixtures are less likely to cause bloat than pure stands of clover. The exact cause of bloat is at present somewhat debatable. However, bloat is usually associated with the livestock eating too much and too fast when turned into a pasture of succulent legumes.

To avoid bloat, do not put the cattle on pasture when hungry. Keep a handy supply of water and salt available. Do

not turn the cattle on when the legumes are wet with dew. Provide some coarse dry roughage.

RED CLOVER IMPROVES SOIL

Red clover, like other legumes, uses atmospheric nitrogen and converts it to nitrogen compounds which can be used by the growing clover and the grasses associated with it. Approximately two-thirds of the nitrogen in clover is contained in the above-ground parts and one-third in the roots.

If all the top growth is removed, the nitrogen left in the stubble and roots is about equal to the nitrogen taken by the plant from the soil. If a two-ton crop of clover hay (a heavy crop) is plowed under for green manure, about 84 pounds of nitrogen, 20 pounds of phosphorus, and 80 pounds of potassium are retained in the soil. Whatever use is made of the clover crop, its value for fertilizer depends on how much of the crop is returned to the soil either as green manure or as barnyard manure and crop residues.

Whether all or none of the top growth is returned to the soil, a red clover or red clover-grass sod will improve the soil structure and make the soil easier to work.

Many farmers use red clover as a green manure crop in grain, plowing it down in the fall of the first year. This may be beneficial, but biennial sweet clover will usually yield more top and root growth than red clover for this purpose. Mammoth red clover does not yield as well for green manure handled in this way as does medium red clover, according to H. D. Hughes.[2]

SEED PRODUCTION

In the double-cut type, seed is generally taken from the second cutting in the year after seeding. The first cutting is usually used for hay. The second crop is a better seed-producing crop than the first.

Red clover flowers must be cross-pollinated by insects in order to produce a good crop of seed. The weather during the blooming and ripening period of the second crop is usually more favorable for pollination, and there are generally more pollinating insects in July and August than earlier in the season.

Furthermore, the second crop is damaged less by harmful insects such as the clover seed midge and clover seed chalcid than the first crop.

Seed yields from the second crop are best when the first crop is cut at the early hay stage (about one-half bloom). Early cutting allows the second crop to take advantage of the June moisture for rapid, vigorous development.

POLLINATION

Bumblebees are usually considered the principal pollinating agents of red clover. However, other wild bees are possibly important. Dunham[3] in Ohio, Wilsie and Gilbert,[4] and Wilsie[5] in Iowa reported that honeybees contributed greatly to pollination of red clover. It is now generally recognized that honeybees are capable of working red clover for pollen and nectar, although they are not as efficient as bumblebees.

Observations on pollination of red clover have not been made in Minnesota, but it seems likely that effectiveness of honeybees may be influenced by weeds and competing crops.

HARVESTING THE SEED

Red clover should be cut for seed when the heads have turned brown and seeds have become hard but before they begin to shatter. To avoid excessive handling, the usual procedure is to cut with a mower with a windrowing or bunching attachment. If the weather is very dry, cut in the morning when the plants are damp and tough.

A good job of threshing can be done when the plants are thoroughly dry. Several types of machines are used for this purpose. A special machine, the "clover huller," does a thorough job of removing the seed from the hulls. Grain separators with hulling attachments are also used. The combine is rapidly taking the place of these machines and is used either as a stationary or pick-up machine in the field.

[2] Hughes, H. D. "Mammoth or medium red clover." *Iowa Farm Science* 1: No. 5. 1946.

[3] Dunham, W. E. "Collecting red clover pollen by honey bees." *Jour. Econ. Ent.* 32:668-670. 1939.

[4] Wilsie, C. P., and Gilbert, N. W. "Preliminary results on seed setting in red clover strains." *Amer. Soc. Agron. Jour.* 32:231-234. 1940.

[5] Wilsie, C. P. "More alfalfa red clover seed." *Iowa Farm Science* 3(10):8-9. 1949.

INJURIOUS INSECTS

Insects Affecting Forage Production

TARNISHED PLANT BUG, *Lygus oblineatus* (Say), is frequently abundant on red clover. Adult bugs are brownish, oval, flattened, and about three-sixteenths of an inch long. Nymphs, or young bugs, are greenish with five black dots on the back. Feeding injury consists of dead or deformed areas in the leaves, stems, and flower heads, and general stunting of the plant.

PEA APHID, *Macrosiphum pisi* (Kltb.), and other species of plant lice occasionally cause severe curling of leaves and stunting of new growth.

GRASSHOPPERS are important during periods of grasshopper abundance. The ALFALFA PLANT BUG, *Adelphocoris lineolatus* (Goeze), and the POTATO LEAFHOPPER, *Empoasca fabae* (Harris), appear to be of minor importance on red clover.

Insects Affecting Seed Production

CLOVER SEED CHALCID, *Bruchophagus gibbus* (Boh.), is one of the most important injurious insects affecting seed production. The chalcid is a very small, black, wasplike insect that lays its eggs in the maturing seeds. The larvae eat the contents of the seeds and leave round emergence holes in the seed coats.

CLOVER SEED MIDGE, *Dasyneura leguminicola* (Lint.), is a small fly. The pink larvae of the midge destroy the ovules in the flower heads and prevent the formation of seed. Infested flower heads open unevenly and appear to be deformed.

When the second crop is to be left for seed, early cutting of the first crop before the half-bloom stage gives some control of both the midge and the chalcid.

LESSER CLOVER LEAF WEEVIL, *Hypera nigrirostris* (F.), was abundant in Minnesota during 1951. This striking blue-to-green snout beetle or weevil is about one-eighth of an inch long. The larvae cut through the bases of the florets in the flower head, and the injured florets fall from the head.

RED CLOVER THRIPS, *Haplothrips niger* (Osb.), frequently becomes abundant in the heads of red clover, but the extent of injury has not been determined. Adults are very small, slender, black insects, while the young are red.

CLOVER HEAD WEEVIL, *Tychius stephensi* (Schonh.), is a minute snout beetle or weevil, whose larvae destroy the maturing seeds. They are present in Minnesota, but their importance is not yet known.

INSECTICIDE RECOMMENDATIONS

Applications of toxaphene or aldrin may be desirable for control of grasshoppers. Formulations and rates are the same as for alsike (see table 7). If the crop is to be used for forage, apply when plants are two to four inches tall in order to avoid a residue problem. Aldrin has a shorter residual effect than either toxaphene or chlordane. Nevertheless, plants treated during later stages of growth have an insecticide residue, and forage from these plants

should not be fed to dairy cattle or animals being finished for slaughter.

The use of insecticides on red clover grown for seed in other states has given inconclusive results. Except for control of grasshoppers, insecticides cannot be recommended on red clover in Minnesota until more information is available.

Sweet Clover

THE HISTORY of sweet clover goes back to 2,000 years ago, when it was reported to have been used as a green manure and "honey" plant in early Mediterranean agriculture. It is supposed to have originated in the Bakhara region of Asiatic Russia.

Sweet clover was first reported growing in the United States in Virginia in 1739. Today it is found in all parts of this country where there are 17 or more inches of rainfall and nonacid or limed soils.

The value of sweet clover for soil improvement in corn-belt agriculture was recognized by experiment stations as early as 1905. It was generally considered a weed until about 1918, but at that time its value became generally recognized and its use spread rapidly in the heavy soils of the Red River Valley. It was not until 1930 that it became important in southwestern and south central Minnesota.

ADAPTATION AND FERTILIZATION

Sweet clover requires nonacid soils which are reasonably well drained. It is among the most winter hardy of the legumes and is tolerant to drought and heat. It is more tolerant to alkali and high-lime conditions than most cultivated crops. It requires a relatively high level of available phosphorus, but it apparently can utilize forms of soil phosphorus not readily used by other crops. While sweet clover grows well on light, well-drained soils it makes maximum growth on heavy soils which show no need for lime and are well supplied with nutrients.

In the parts of Minnesota where sweet clover is grown, phosphorus is the nutrient most likely to limit growth of inoculated sweet clover on nonacid or limed soils. A general suggestion for fertilization on the normal soils is 250 to 300 pounds of 0-20-0 or 0-20-10 or

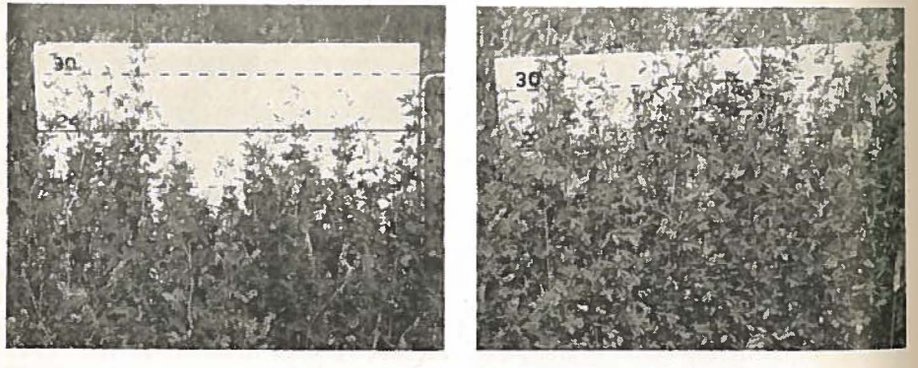

Fig. 7. Second-year growth of sweet clover at the Agricultural Experiment Station at Rosemount, 1950. Left, no fertilizer; right, 300 pounds per acre of 0-20-20 applied at seeding time.

Table 5. Comparative Yields of Sweet Clover Varieties, 1945 to 1951 Inclusive, at Several Locations in Minnesota

Variety	Forage yield as hay*		Maturity rating
	Fall seeding year	Second year	
	tons per acre		
Commercial Yellow	1.84	1.98	Early
Commercial White	1.84	1.96	Early
Evergreen	1.93	2.16	Very late
Madrid	2.11	2.12	Early

* Forage yields are in tons per acre at 15 per cent moisture.

their equivalent. Heavy, high-lime soils may require a similar amount of 0-20-20. Apply these fertilizers before seeding and work into the seedbed or apply with a fertilizer attachment on the grain drill. Soil testing and crop response will determine the grades and rates of fertilizer.

VARIETIES

The two varieties of sweet clover recommended by the University of Minnesota Agricultural Experiment Station are **Evergreen** and **Madrid.** Data from yield tests comparing these two varieties with commercial white and yellow are shown in table 5.

Evergreen. Minnesota Accession No. 1806, is an introduction from Ohio. It is a white-blossom variety making a tall, rank growth the second year and maturing two weeks later than commercial. This later maturity increases the summer grazing season. The stems of Evergreen are very coarse but since animals graze mostly on the new growth at the ends of the branches, the coarse stems may not be a drawback.

Most of the yields shown in table 5 were obtained by cutting the whole experimental field when the commercial strains were in full bloom. Therefore, if Evergreen had been left to make its complete growth the forage yield undoubtedly would have been larger than shown.

Although Evergreen is very late in blossoming, satisfactory seed yields have been obtained in the plot tests at Morris and Grand Rapids in 1948, University Farm, Waseca, Morris, and Crookston in 1949, and Rosemount, Crookston, and Morris in 1950.

Both Evergreen and Madrid have made considerably more top growth the fall of the seeding year than have the commercial types. This is an advantage for green manure, fall pasture, or fall hay.

Madrid. Minnesota Accession No. 1807, is a yellow-blossom type imported from Spain a number of years ago by the United States Department of Agriculture. It is well adapted to Minnesota. In addition to its outstanding yield the fall of the first year, it has made good forage and seed yields during the second year in variety tests.

SEEDING

Sweet clover for pasture, green manure, or hay is usually seeded along with a small-grain companion crop. It is generally seeded at about 10 pounds per acre.

Sweet clover is also used in mixtures with other legumes and grasses for pasture—especially renovated pasture. A desirable mixture for pasture renovation sites is alfalfa, 5 pounds; biennial sweet clover, 3 pounds; alsike clover, 1 pound; and brome grass, 8 pounds per acre. Do not seed sweet clover in flax because it grows higher than the flax and thus interferes with harvesting.

Sweet clover contains many hard seeds which may live in the soil for

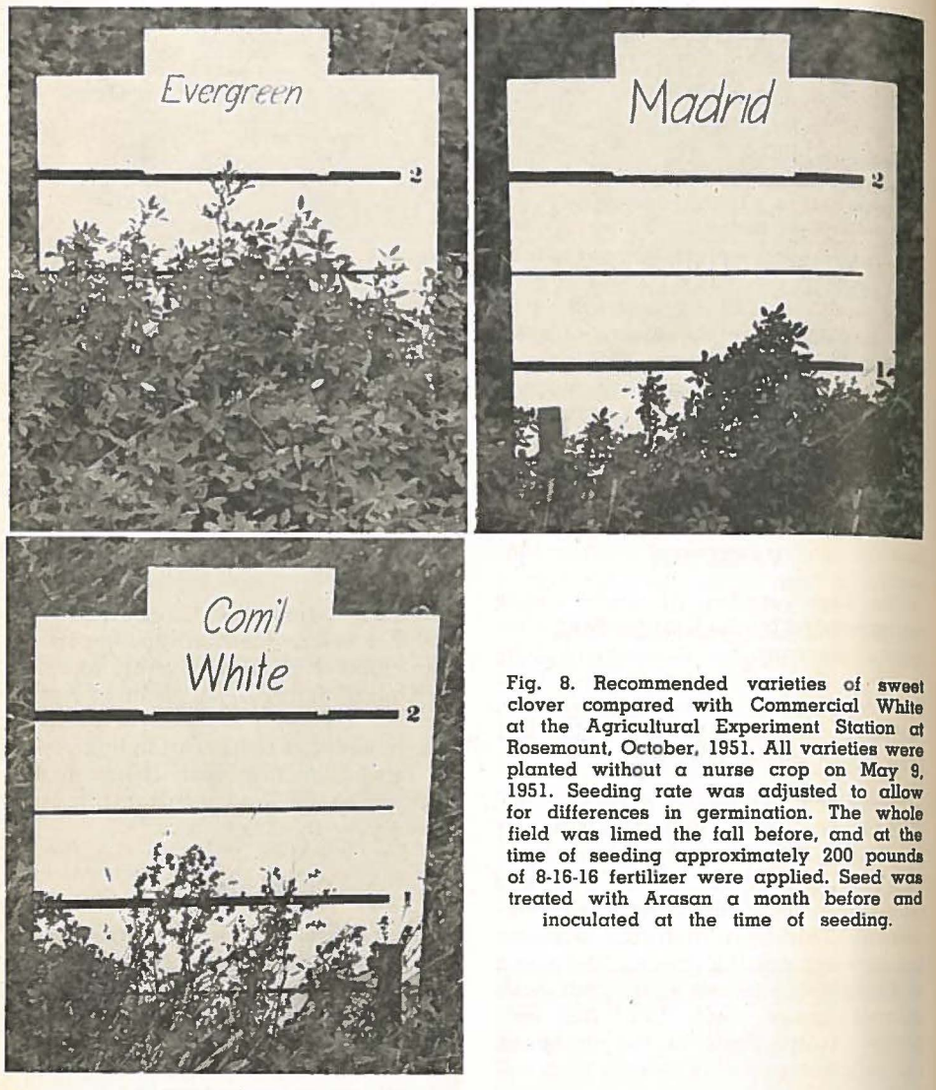

Fig. 8. Recommended varieties of sweet clover compared with Commercial White at the Agricultural Experiment Station at Rosemount, October, 1951. All varieties were planted without a nurse crop on May 9, 1951. Seeding rate was adjusted to allow for differences in germination. The whole field was limed the fall before, and at the time of seeding approximately 200 pounds of 8-16-16 fertilizer were applied. Seed was treated with Arasan a month before and inoculated at the time of seeding.

many years. Use only scarified seed for field plantings. Seed from reliable seed companies is usually scarified.

SWEET CLOVER FOR PASTURE

If seeded in early spring without a companion crop, sweet clover will furnish some pasture during August. However, its main use for pasture comes in the second year. During the second year it will provide pasture for approximately two cows per acre until about July 15. Then it becomes woody and unproductive. Graze sweet clover heavily during the heavy production period to prevent it from becoming woody.

Sweet clover is low in palatability because of its coumarin content, and livestock will tend to eat other vegetation before eating sweet clover. Once they become accustomed to it, however, they will eat it and produce meat and milk satisfactorily.

On pasture renovation sites sweet clover also serves as a snow catch. The trashy, woody growth left in the fall will hold the snow, and this is particularly important on high ground where snow tends to blow away.

Since sweet clover may cause bloat, take the usual precautions to avoid this trouble. Do not turn the livestock on sweet clover when they are very hungry. Have a readily accessible supply of salt and water available. And feed hay or other dry feed along with pasture.

Sweet clover pasture may taint the milk. To prevent this remove the cows from pasture a few hours before milking.

SWEET CLOVER FOR HAY

Sweet clover is not generally favored for hay production. If cut at the proper time and cured well, it compares quite well with alfalfa in feeding value. However, because of its high moisture content at the hay stage and its rank growth, curing is difficult.

Sweet clover hay or pasture may cause a lack of normal blood clotting in animals, particularly when it is the principal part of the feed ration. Internal hemorrhages or excessive loss of blood from dehorning, castrating, or other operations may result. The best policy is not to feed sweet clover for at least three weeks before such operations.

The best stage at which to cut sweet clover if used for hay is at the late bud or early (beginning-to-) blossom stage. If a second crop is desired, the first crop must be cut high enough to leave live buds on the stubble. The older the plants become, the higher the first crop must be cut. At the hay stage a stubble of 8 to 12 inches is necessary.

To determine the proper height, examine the buds and new branches at the base of the stem. In order to cut at the proper height, the usual procedure is to cut with a binder or swather. If the clover is tied into bundles, they should be tied loosely to prevent spoilage under the bands.

Good-quality hay or pasture may often be obtained the fall of the seedling year.

SWEET CLOVER FOR GREEN MANURE

Biennial sweet clover is an outstanding soil-improving legume. Its thick fleshy roots decay rapidly, and crops that follow are benefited markedly. For loosening and penetrating heavy soils it is unexcelled.

Sweet clover is used in several ways for green manure. In corn-growing areas it is seeded with the small grain in the spring and plowed under in late fall or early the next spring. Less volunteer growth of sweet clover will appear when it is spring plowed than when it is fall plowed. Volunteer sweet clover is not a serious problem when a good job of plowing and spring cultivating is done.

A field cultivator is excellent for removing volunteer plants in the spring. Both biennial sweet clover and Hubam, the white-blossomed annual sweet clover, are used for green manure preceding corn (table 6). Biennial sweet clover yields more total dry matter per acre, when roots and tops are considered, than Hubam.

Under farm conditions the growth of Hubam clover is not very vigorous. Being an annual legume, it does not produce the heavy root system that biennial sweet clover does. Although Hubam may produce more top growth than biennial sweet clover in some years, the total weight of tops and roots produced is less.

Table 6 summarizes the effect of various legume and green-manure crops

Table 6. Yields of Corn in a Two-Year Corn-Oats Rotation on Clarion Loam at Ames, Iowa, with Different Legumes Seeded in Oats, 1923-39*

Legume	Yield of corn (16-year average)	
	Bushels per acre	Percentage of check yield
Biennial sweet clover	60.1	113.8
Hubam	57.1	108.1
Red clover	55.7	105.4
None (check)	52.8	100.0

* Johnson, I. J., Wilsie, C. P., and Leffler, A. T. "Sweetclover on Iowa Farms." *Iowa Farm Science Reporter.* 6(1):17-20.

on later crops of corn. These data, although representing results only from central Iowa, show the relative value of biennial sweet clover, Hubam, and red clover in increasing the yields of corn. Experiments at other stations have shown even greater increases in yield of corn following sweet clover than are shown in this table.

In northwestern Minnesota a common practice is to plow down sweet clover at the hay stage in the second year and fallow the land for the rest of the season. By following this system, the maximum use is made of the sweet clover plant's soil-improving property. Trials at the University of Minnesota Northwest Experiment Station at Crookston showed that the largest amount of nitrogen from sweet clover sown with a grain crop is obtained at the hay stage of the second year. These experiments also showed that in northwestern Minnesota, where moisture is a limiting factor in crop production, fallow following plowing helps restore the soil moisture and control weeds.

Plow down a hay crop before the growth becomes too rank and before any seed is formed because rank growth may leave the soil so loose that yields of crops which follow will be greatly reduced. In addition, the seed will cause trouble in succeeding years.

USE FOR BEE PASTURE

Sweet clover is an excellent source of high-quality honey. It produces an abundance of nectar, and the honey derived from it is light colored and mild flavored. One acre of sweet clover is considered sufficient for one hive of bees. Northwestern Minnesota is an important honey-producing area.

SEED PRODUCTION

Minnesota is the United States' leading state in the production of sweet clover seed. Seed yields in the Red River Valley range from 3 to 9 bushels per acre.

Thin stands are usually better for seed production, and the second crop is the best because of its shorter growth. The usual practice is to clip the first crop high at the very early hay stage and then take the second growth for seed.

The proper time to cut sweet clover for seed is when three-fourths of the pods are brown. Sweet clover shatters very easily, so it may be necessary to cut at an earlier stage in some years. Cut when the plants are damp or wet to avoid excessive shattering. The common harvesting procedure is to cut with a swather or similar machine to lay the sweet clover in a windrow without excessive handling. When dry, it is threshed from the windrow with a combine.

POLLINATION

Honeybees and wild bees are effective pollinators of sweet clover. Sweet clover is very attractive to bees as a source of nectar and pollen. Observations during the past two years indicate that honeybees could be used to advantage in some areas of Minnesota to increase production of sweet clover seed. However, research is needed on number of colonies to be used per acre and the effect of fertilizer practices and competing crops.

INJURIOUS INSECTS

Sweet Clover Weevil, *Sitona cylindricollis* (Fahr.), is one of the most important injurious insects of sweet clover. The adult weevils eat crescent-shaped areas out of the young leaves soon after the leaves appear in the spring (figure 9). The most serious injury is the reduction in stand of new seedings following attacks by the adult insects in early spring. The adults consume the new seedlings as soon as they emerge, and the casual observer might blame the trouble to faulty germination of the seed. Larvae also injure the plants by attacking the roots.

Alfalfa Plant Bug and Pea Aphid are common on sweet clover but appear to be of secondary importance.

INSECTICIDE RECOMMENDATIONS

Applications of toxaphene or aldrin may be necessary for control of grasshoppers (table 7). If the sweet clover weevil is causing extensive injury, it can be controlled by an early application of DDT, toxaphene, or aldrin. Apply DDT or toxaphene at two pounds actual insecticide per acre and aldrin at one pound per acre.

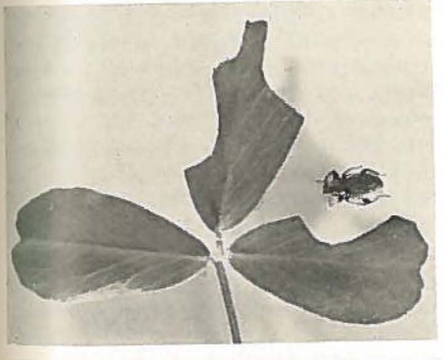

FIG. 9. Sweet clover weevil and the type of injury it causes.

Time of application is important for effective results. Apply insecticides early in the spring soon after growth begins.

HUBAM SWEET CLOVER

Hubam clover is the annual form of white sweet clover. Since it is an annual, it has the advantage over the biennial in that it can be plowed safely the fall of the year seeded with less danger of volunteer plants.

Adaptation

Hubam clover has the same soil and climatic requirements as other sweet clovers. It has never been grown continuously over wide areas although certain communities have grown large acreages for several years. When seeded with a small grain companion crop, Hubam clover does not always mature seed in Minnesota. It has found most favor in southwestern Minnesota when the heavy soils need to be fall plowed. Most of the seed supply comes from Texas.

General Use

The primary use of Hubam clover is green manure, but it is used occasionally for an emergency hay crop. Under favorable growing conditions the recovery growth of Hubam clover after removing the grain crop is generally greater than that of biennial sweet clovers. From this standpoint it appears desirable.

Since it is an annual, however, the root system is not an extensive one. Actually under average conditions, the roots make up only about 10 per cent of the total weight of the plant. In biennial sweet clover at the same time of year the roots may make up 50 to

60 per cent of the total weight of the plant. Heavy soils need the penetrating roots of the biennial sweet clover as much or more than top growth. Hubam clover for green manure might have a place on well-drained soils.

It has been difficult to maintain satisfactory stands of Hubam clover. This is undoubtedly due in part to the height of cutting grain. There is considerable evidence that there will be satisfactory stands and growth when the grain crop is cut 8 to 10 inches high. This will assure some side branches on the plant from which the recovery growth is made. When the grain is cut low, many of the taller plants are killed.

The seed cost of Hubam has been generally a little higher than that of other sweet clovers and this may have limited its use. It does not appear likely that Hubam clover will become important to Minnesota agriculture judging from the evidence available.

Alsike Clover

ALSIKE CLOVER is native to Sweden where it is known as Swedish or Hybrid clover. The last name originated because it was thought to be a cross between red and white clover.

Alsike clover has had a place in our agriculture which could not be filled by any other legume. It has at times been considered perennial, but under cultivated conditions it sometimes acts like a biennial. At present it is used most intensively north of a line through Aitkin, Brainerd, and Wadena. Clearwater, Roseau, and Beltrami Counties are the western boundry of the alsike clover-growing area.

ADAPTATION AND FERTILIZATION

Alsike grows under a wider range of soil conditions than any other cultivated legume. It is least adapted to droughty soils but will grow under rather wet conditions and on acid soils. Alsike clover will tolerate acid soils with a *p*H as low as 5.2, but like other legumes does best on nonacid or limed soils. It is possible to obtain stands on poor, run-down soils which are both wet and in need of lime. While alsike clover will produce some yield under such unfavorable conditions, the growth is increased under favorable growing conditions.

Alsike clover responds well to fertilizers. The suggested fertilizer application is 200 to 300 pounds of 0-20-20 where alsike clover is to be seeded. Again, soil tests and crop response should determine the grade and rate of fertilizer application.

The ability of alsike clover to make a stand and some growth under unfavorable conditions has made it popular in mixtures with red clover on good soils and alone on wet and acid soils.

SEEDING

Alsike clover is most commonly grown in mixtures with red clover and timothy. The seeding rate in such mixtures is usually about two pounds per acre. In mixtures it serves about the same purpose as Ladino clover in that its contribution is primarily in areas of the field where the soil is heavy and moist.

In the corn belt and in northeastern United States, Ladino clover is replacing alsike clover to a large extent. In Minnesota a small amount of alsike clover may well be included in alfalfa-grass and red clover-grass mixtures to supply a legume for heavy, moist soils. In favorable years alsike will contribute considerably to the forage—even on high ground.

In north-central and northern Minnesota, alsike clover is frequently seeded alone for hay and seed production. A seeding rate of 6 pounds per acre is usually enough for this purpose.

USE FOR HAY AND PASTURE

Because of the nature and habit of growth of the alsike clover plant, it makes excellent quality hay. The stems are fine and free from hairs and this results in a palatable hay, free from dust. The crude protein content of alsike clover hay in bloom is about 13.4 per cent, as compared to 12.6 per cent for red clover in bloom.

In addition, because of its indefinite habit of growth—seeds form at bottom while the plant is still blossoming on top—the quality of the hay does not fall off rapidly as it reaches the blossoming stage as is the case with red clover. In other words, a longer period of time is available for cutting the hay without losing much in quality. However, too much delay in cutting may result in excessive lodging due to weak stems. For this reason, many farmers prefer to grow alsike with a grass such as timothy to hold the plants upright.

One disadvantage of growing alsike clover alone for hay production is its lower total yield per acre as compared to alfalfa and red clover. Alsike clover normally produces only one crop of hay per season. Although it generally behaves like a biennial in Minnesota, many alsike fields in northern Minnesota are maintained for several years by reseeding themselves. In pastures, too, alsike clover will maintain itself for many years by natural reseeding. When pastured, it produces a short rosette type of growth and blossoms on short stems.

SEED PRODUCTION

Alsike clover is a good seed producer. Seed yields of 3 to 6 bushels per acre are common. In Minnesota one crop of seed is obtained in a season from the first growth. The crop is cut when about three-fourths of the heads have turned brown.

Be careful to avoid excessive shattering of seed. The usual practice is to cut with a mower equipped with a windrowing or bunching attachment. Cut in the morning when the plants are damp or wet, but thresh when the material is dry—either with a combine or stationary thresher.

POLLINATION

Alsike clover requires insects for cross-pollination. Honeybees and several species of bumblebees are important to this pollination, but the value of other wild bees has not yet been found.

The producer of alsike clover seed will benefit greatly from locating honeybees near his alsike clover fields. However, there is no evidence to indicate how many colonies per acre might be desirable under Minnesota conditions or how much the presence of weeds and competing crops might affect the number of colonies to be used. In Michigan one or two hives of bees per acre in the vicinity of alsike clover fields insured a good supply of pollinators.

WEED AND CROP CONTROL

One serious disadvantage to successful seed production in Minnesota has been the problem of controlling weed and crop mixtures. Many weed and crop seeds are the same size as alsike clover and are difficult to separate from the alsike clover.

The most troublesome crops and weeds are timothy, white clover, white cockle, pepper grass, sheep sorrel, dock, buckhorn, black seed plantain, night flowering catchfly, Canada thistle, frenchweed, and hoary alyssum. Modern seed-cleaning machinery can separate many of these from alsike clover,

but contaminated seed is discriminated against by seed buyers.

INJURIOUS INSECTS

Insects Affecting Forage Production

The alfalfa plant bug, the tarnished plant bug, and grasshoppers may all cut forage yields of alsike clover. The pea aphid is usually present in moderate numbers, but occasionally it becomes so abundant that plants become unthrifty and growth is retarded.

Insects Affecting Seed Production

ALFALFA PLANT BUG, which is an active, flattened, grayish-green insect about three-sixteenths of an inch long, and the somewhat smaller, darker TARNISHED PLANT BUG both inject a poison into the plant during their feeding. This results in floret blasting and deformed flower heads.

ALSIKE CLOVER SEED WEEVIL, *Miccotrogus picirostris* (Fab.), which is an important pest of alsike clover, is a small, dark-colored snout beetle or weevil (figure 10). The seed weevil was first collected in Minnesota in 1947. Since that time it has become abundant on white clover, on alsike clover, and to a lesser extent on red clover. Adult weevils emerge from hibernation and feed on clover heads. Eggs are deposited in the developing seed pods and the larvae feed on the maturing seeds.

FIG. 10. Adult of the alsike clover seed weevil on a head of alsike clover.

LESSER CLOVER LEAF WEEVIL, *Hypera nigrirostris* (F.), was abundant enough during 1951 to cause much injury. Larvae damage the flower heads by cutting through the bases of the florets.

RED CLOVER THRIPS, *Haplothrips niger* (Osb.), and COMMON FLOWER THRIPS, *Frankliniella tritici* (Fitch), are both numerous on blossoms of alsike clover. The extent of injury by these insects to flowers and developing seeds is yet to be determined.

INSECTICIDE RECOMMENDATIONS

In producing alsike clover forage, insecticides are ordinarily not necessary. If toxaphene, chlordane, or aldrin are used for control of grasshoppers, do not feed the plants to dairy animals or animals being finished for slaughter.

Use of DDT, toxaphene, and chlordane, compared in demonstration plots by the Minnesota State Entomologist during 1948 and 1949, resulted in great increases of alsike clover seed in several fields in northern Minnesota. Plots which were not sprayed had too little seed to harvest, while all sprayed plots had from 135 to 143 pounds of seed per acre.

Use of insecticides on alsike clover during 1950 was much less effective. But in a 1951 experiment at Swift, Minnesota, unsprayed plots yielded an average of 81 pounds of seed per acre as compared with 194 pounds for plots receiving one application of DDT (2 pounds actual DDT per acre).

For control of injurious insects on alsike clover grown for seed make one application of DDT at a rate of 1½ to 2 pounds actual DDT per acre (table 7). Apply during the bud stage or just as the flowers are beginning to open. To avoid killing the pollinators do not apply during the flowering period. Use of DDT emulsion spray appears somewhat more effective than the dust, especially against the pea aphid. If grasshoppers are abundant, toxaphene may be used alone or in combination with DDT.

If the use of an insecticide is necessary during the flowering period, apply toxaphene at night in order to avoid killing the pollinators.

Table 7. Suggested Uses of Insecticides on Alsike Clover

Insecticide	Formulation	Amounts to apply per acre			Actual insecticide per acre
		Concentrate	Total spray*	Dust	
			gallons	pounds	
DDT	25% emulsion	3 to 4 quarts	20-50	.....	1½-2 lbs.
DDT	50% wettable	3 to 4 lbs.	20-50	.....	1½-2 lbs.
DDT	5% dust	.....	.....	30-40	1½-2 lbs.
Toxaphene	44% emulsion	2 quarts	20-50	.....	2 lbs.
Toxaphene	10% dust	.....	.....	20	2 lbs.
Chlordane	44% emulsion	1 quart	20-50	.....	1 lb.
Chlordane	5% dust	.....	.....	20	1 lb.
Aldrin	23% emulsion	½ to 1 pint	20-50	.....	2-4 oz.
Aldrin	15% wettable	1 lb.	20-50	.....	2½ oz.
Aldrin	2% dust	.....	.....	20	6 oz.

* Application of 20 to 50 gallons of spray per acre is suggested for ground equipment. Planes usually apply a more concentrated spray at about 2 gallons per acre.

Ladino Clover

LADINO CLOVER is a large type of white clover with the same general habits of growth. It has been grown in Minnesota to a very limited extent since 1940.

ADAPTATION AND FERTILIZATION

Ladino clover is best adapted to fertile, heavy soils of high moisture-holding capacity and does best under cool summer temperatures. Stands have been obtained and fair growth made on upland soils well supplied with nutrients and with well-distributed rainfall. It does not do well under droughty conditions, and stands may be lost when soils are wet for long periods. While Ladino clover is tolerant to acid soils, it responds to lime almost as well as alfalfa.

In order to make satisfactory growth it must be kept well fertilized. A fertilizer suggestion for this clover is 300 pounds of 0-20-10 or 0-20-20 per acre when the seeding is made. Make supplemental applications as needed. Soil tests and crop response should determine the grade and rate of fertilizer to be used.

SEEDING

The seeds of Ladino clover are small—approximately 750,000 seeds per pound. For this reason you should seed shallow on a firm seedbed. The small seeds do not contain enough food re-

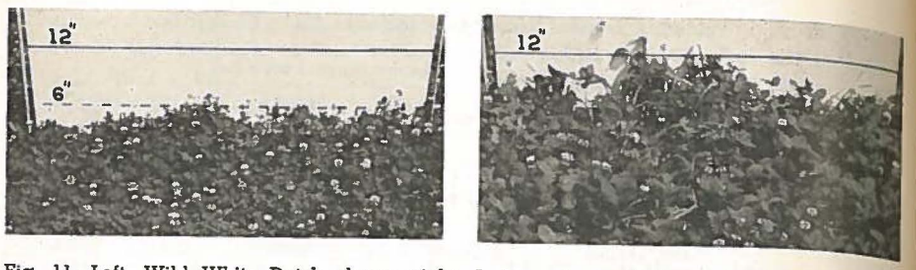

Fig. 11. Left, Wild White Dutch clover; right, Ladino clover. Under comparable conditions Ladino makes considerably larger growth. The two stands were approximately 25 feet apart in pasture plots at University Farm, 1951.

serves to push the seedlings through the soil from much depth. Early spring is the best time to plant Ladino clover.

In southeastern, northern, and northeastern Minnesota, Ladino clover has a good chance of contributing to mixtures during the first production year. In these areas a small amount of Ladino clover may well be used in adapted legume-grass mixtures. One pound of Ladino clover per acre in an alfalfa-grass mixture is usually sufficient. In protected areas where there is good snow cover over winter, Ladino clover may be seeded for seed production. A seeding rate of three pounds per acre is enough for this purpose.

WINTER INJURY

Ladino clover is not as winter hardy as red clover, sweet clover, and alfalfa. In most studies at University of Minnesota branch experiment stations and at University Farm it has behaved like a biennial. Usually sufficient stem material survives the first winter to provide a good growth the second year, but when snow cover is light, Ladino clover frequently kills out the first winter. In favorable winters Ladino clover will survive more than one winter.

The survival of Ladino clover has not been consistent enough to depend on it as the only legume in pasture mixtures. It is best to include such legumes as alfalfa and red clover along with Ladino.

LADINO FOR HAY AND PASTURE

Because of its low growth habit Ladino clover is most effective as a pasture crop. It should be seeded in a mixture with other legumes and grasses. Rapid succulent growth on weak stems makes it difficult to cut for hay and difficult to cure. It may find a place as hay silage, but its primary use will probably continue to be in pasture mixtures.

First-crop hay and second-growth pasturage yields of alfalfa-grass and Ladino clover-grass mixtures, along with the per cent legume in the forage, are shown in table 8.

The alfalfa-grass mixtures as shown in table 8 yielded an average of one-half ton more hay per acre in the first crop than the Ladino clover-grass mixtures. They also yielded one-half ton per acre more pasturage from the second growth than did the Ladino clover-grass mixtures. The percentages of legume in the forage, as determined from estimates made at each cutting, were not greatly different during the first production year (1946). However, the Ladino clover did not survive the second winter and so the percentage contribution of Ladino clover in 1947 was negligible.

The hay yields of the alfalfa-grass and Ladino clover-grass mixtures were not greatly different in 1947, even though there was little Ladino clover left in

Table 8. Hay and Pasturage Yields of Alfalfa-Grass and Ladino Clover-Grass Mixtures Seeded in 1945 at University Farm, St. Paul. First Growth Cut for Hay and Second Growth Clipped for Yield Determination Before Each Grazing

Mixture and pounds per acre	Tons per acre at 15 per cent moisture				Per cent legume in cuttings	
	1946		1947			
	Hay	Pasture	Hay	Pasture	1946	1947
Alfalfa 8, Canada brome 8	2.1	1.2	2.6	.7	57	65
Alfalfa 8, meadow fescue 8	2.1	1.1	2.3	.7	65	82
Alfalfa 8, timothy 6	2.4	1.1	2.5	.7	50	70
Ladino 2, Canada brome 8	1.4	.5	2.3	.2	55	1
Ladino 2, meadow fescue 8	1.7	.7	1.8	.2	56	2
Ladino 2, timothy 6	1.9	.7	2.5	.1	49	0
Average, alfalfa-grass	2.2	1.1	2.5	.7	57	72
Average, Ladino-grass	1.7	.6	2.2	.2	53	1

the mixtures. This may be partly explained by the fact that the dead Ladino clover plants supplied nitrogen for the grass.

The percentages of crude protein and protein yield per acre of the different mixtures are shown in table 9. The Ladino clover-grass hay averaged 15 per cent crude protein in 1946 while the alfalfa-grass hay averaged 11 per cent. The Ladino clover-grass pasturage averaged 23 per cent crude protein, while the alfalfa-grass pasturage averaged 21 per cent.

In 1947 the per cent crude protein in the Ladino clover-grass mixtures was lower than in the alfalfa-grass mixtures because of the absence of Ladino clover due to winterkilling. Because of the higher protein content in the Ladino clover-grass mixtures in 1946, the yields of crude protein per acre of hay were about the same for alfalfa-grass and Ladino clover-grass mixtures, even though the dry-matter yields were less for the Ladino clover-grass mixtures than for alfalfa-grass.

When Ladino clover survives the winter, it is an excellent pasture crop because of its high protein content, palatability, and productiveness. It also grows well on low-lying moist land where alfalfa normally kills out. Ladino clover is not resistant to drought. Consequently, in western Minnesota and in areas where drought is a serious factor, it is not productive and will not survive for long.

Table 9. Percentages of Crude Protein in Hay and Pasturage of Alfalfa-Grass and Ladino Clover-Grass Mixtures in Tests at University Farm

Mixture	Per cent crude protein				Pounds crude protein per acre			
	1946		1947		1946		1947	
	Hay	Pasture	Hay	Pasture	Hay	Pasture	Hay	Pasture
Alfalfa, Canada brome	12	21	10	21	441	432	467	231
Alfalfa, meadow fescue	11	20	14	21	392	388	531	239
Alfalfa, timothy	11	21	11	22	425	379	451	245
Ladino, Canada brome	17	24	9	19	408	196	347	57
Ladino, meadow fescue	13	23	9	18	367	257	282	56
Ladino, timothy	14	23	9	16	453	268	391	32
Average, alfalfa-grass	11	21	12	21	419	400	483	238
Average, Ladino-grass	15	23	9	18	410	240	340	48

SEED PRODUCTION

Ladino clover seed is produced mainly in the irrigated sections of western United States. Producing seed of Ladino clover in Minnesota may be hazardous because of the severe winters. However, experiments show that in most cases it will survive one winter. Where it can be overwintered successfully, seed production could be a profitable enterprise.

Ladino clover has a tendency in the spring to produce many leaves and stems but few blossoms. Grazing or clipping the first crop will result in better production of blossoms in the second growth, with a better possibility of good seed production. Furthermore, by delaying the blossoming in this manner, the crop will come into blossom when weather conditions are favorable for good seed production. Dry, warm, sunny weather at blossoming time will favor the activity of pollinating insects and provide better conditions for seed harvesting.

Harvest when 90 per cent of the heads are dry and brown. The crop is usually cut with a mower with a windrowing attachment to avoid excessive handling. It is cured in the windrow and then threshed with a clover huller or combine with the proper hulling attachments.

Seeds of alsike clover, common white clover, timothy, and black medic or yellow trefoil are about the same size as Ladino clover. Therefore, fields saved for seed should be free of these legumes and timothy.

POLLINATION

Cross pollination by insects is necessary for good seed production. Honeybees and bumblebees are effective pollinators of Ladino clover, but no observations have yet been made on pollination of Ladino clover in Minnesota. One or two hives of bees per acre near the field at blossoming time can be expected to increase seed production.

INJURIOUS INSECTS

Insect problems of Ladino clover have not been investigated in Minnesota. It is believed that injurious insect problems are essentially the same for Ladino clover as for alsike clover and that the same suggestions on insecticides will apply to both clovers.

Diseases of Clovers

DISEASES of the clovers cause heavy losses in most areas of Minnesota, especially when the crops are grown for forage or seed instead of being plowed under for green manure. The diseases of red clover, alsike clover, Ladino clover, and sweet clover in many instances are the same, or at least similar, so that most of them can be discussed together.

The most common diseases of clovers are seedling blight, crown and root rots, black stem, mildew, leaf spots, and rust. In general, they cannot be completely controlled, but severity can be reduced considerably by these steps:

1. Use of adapted varieties and resistant varieties
2. Seed treatment
3. Sanitation
4. Good cultural practices

DAMPING-OFF OF SEEDLINGS

Damping-off of seedlings by soilborne fungi may occur either before or after the seedlings emerge from the soil. In some cases, particularly if the seed is cracked or of poor quality, it may rot in the soil before it germinates. Damping-off is most likely to occur if the seed is of poor quality, if seed is planted more than one-half inch deep, if soil is heavily infested with one or more of the damping-off fungi, or if seeding is followed by unfavorable growing weather.

To control damping-off prepare the seedbed carefully and use the planting methods described earlier in this bulletin. Seed treatment usually controls damping-off, but results of extensive field tests do not justify recommending seed treatment. Stands of red clover were increased only slightly, and stands of sweet clover were often reduced by seed treatment.

However, since treating red clover seed is not harmful, the farmer may want to treat for the added assurance of getting a good stand. If so, use eight ounces of Arasan or Spergon per 100 pounds of red clover seed. It is often better to have it treated with a commercial treater or to buy treated seed.

The question is frequently asked, "Is it safe to inoculate legume seed with nodule bacteria if it is treated?" Field tests at University Farm gave no indication that the number of nodules was less on plants grown from seed that was inoculated following seed treatment. Treat seed several days or several weeks before planting, and if nodule bacteria are used apply them immediately before planting according to the directions on the containers.

CROWN AND ROOT ROTS

Crown and root rots are caused by approximately 20 different species of fungi, and many of these can live for a long time in the soil. Some of this group of fungi can grow and cause injury to roots and crowns of the clovers at all periods of growth from very early spring through hot dry midsummer to cool fall.

At least three of them can actually grow at temperatures below freezing (30° F.). Because of the large number of fungi that can grow over such a wide range of environmental conditions, crown and root rots may occur any time during the growing season.

There is a very close relationship between winterkilling and crown and root rots. Plants having low vigor because of the low temperatures, drying, and smothering, or plants injured by freezing, thawing, and heaving of soil are readily attacked by these fungi. Frequently damage occurs during the thawing and freezing periods of spring when the plants are resuming growth. Furthermore, injuries resulting from frost offer an excellent avenue of entrance for the fungi.

Root and crown rots also make plants more susceptible to winterkilling. For example, plants that are infected with these diseases in the summer are likely to go into winter dormancy in a weakened condition. This is because they have not been functioning properly and have not stored an adequate food reserve to carry them through the winter.

Control of these diseases is probably best accomplished by the use of adapted varieties and good crop management. Varieties that are adapted to a given area will survive unfavorable periods better than unadapted varieties even in the absence of crown and root rots. In addition, adapted varieties will not be predisposed to the diseases as readily as unadapted varieties.

Second or third crops should not be cut later than September 1 so the plants can recover and store an adequate food reserve before they go into the winter. Even more benefit may be gained by fall growth helping to hold a good snow cover during the winter—a factor that may mean the difference between complete survival or complete winterkilling.

Continuous pasturing late in the

fall has the same effect as late cutting and should be avoided.

Cultivation of any sort should be avoided, too, because wounds from the various implements afford easy entrance for the fungi that cause rots. Efforts are being made to develop varieties with more resistance to crown and root rots, but such varieties are not available at the present time.

OTHER DISEASES

Stemphylium leaf spot [*Stemphylium botryosum* Wallr.]

Stemphylium leaf spot is most common on red clover, sometimes killing lower leaves of that crop. At first the lesions are small, irregular, dark-brown, and sunken, but later they develop into irregular zonate light- and dark-brown lesions. The dead leaves remain on the plants. No control measures for this disease are known.

Black stem [*Ascochyta imperfecta Pk., Phoma trifolii* E. M. Johnson and Valleau]

Black stem is a disease that has similar symptoms on different species of clover, but it may be caused by one or more fungi. The symptoms may be either partial or complete blackening of stems, girdling of stems, leaf spots, infection of floral parts, or all conditions at one time.

Various phases of the disease appear any time during the growing season, and forage losses result primarily from falling leaves or partial or complete destruction of leaves and stems. Seed yields may be reduced considerably when floral parts become infected.

Control is accomplished by proper management and use of adapted varieties. Crop rotation is practical since the fungus survives in crop residue and consequently can infect a new planting on the same field. Removal of old stems from fields early in the spring before the crop starts to grow will aid in reducing the disease. This can be accomplished under certain conditions by burning, but that method is not generally recommended.

Powdery mildew [*Erysiphe polygoni* DC.]

Powdery mildew is one of the most common and widespread diseases of red clover. Severe epidemics reduce forage yield and quality of hay. The disease appears as a light-gray powdery growth on the leaves, and the leaves turn yellow and brown when the infection is severe. The disease can be controlled by using resistant varieties, such as Wisconsin Mildew Resistant.

Pseudoplea leaf spot [*Pseudoplea trifolii* (Rostr.) Petr.]

Pseudoplea leaf spot is generally distributed on clovers throughout Minnesota but usually does not occur in epidemic proportions. It is characterized by numerous black sunken spots on the leaves. As the spots grow older, they develop a reddish-brown margin. If the disease becomes severe enough it will cause browning of the leaves. No control measures are known for this disease.

Northern anthracnose [*Kabatiella caulivora* (Kirch.) Karak.]

This disease is restricted largely to red and crimson clovers in the cooler sections of North America, and damage is severe during cool wet periods. Long brown sunken lesions cause much harm to stalks and leaf stems, and there is frequent girdling of stems. The best control is the use of resistant varieties. However, if a severe epidemic develops in a field it may be practical to harvest early to salvage as much of the crop as possible.

Clover rust [*Uromyces trifolii* (Hedw. f.) Lév.]

Rusts of the clovers are caused by different varieties of *Uromyces trifolii*. The rusts usually are not spread generally over entire fields but appear in patches. Individual plants or patches may be seriously reduced in forage quantity by loss of leaves and stems, but usually losses from rusts are not great. First crops are seldom heavily infected with rust because they are early enough to escape it. If a second crop is threatened, harvest the crop early to avoid continuous loss.

Sweet clover mosiac, ring spot, and streak

These diseases are caused by any one of several viruses. They are characterized by various degrees of mottling and yellowing of leaves and may result in dwarfing the plants. They are generally spread throughout Minnesota, and some varieties are extremely susceptible. Susceptible varieties are predisposed to root rot by the mosaics and cannot be grown in Minnesota.

Stagonospora leaf spot [*Stagonospora meliloti* (Lasch.) Petr.]

This disease appears as a circular tan spot on sweet clover in spring and fall. In midsummer small stem lesions appear and they spread as the plants reach maturity. Considerable loss of foliage can result from severe infection by this disease. Control is largely by crop management. Spring infection can be reduced somewhat by removal and burning of old stems and crop remains. If the disease becomes epidemic, cut early to salvage part of the crop and to reduce inoculum for the later crop.