IMPROVEMENT OF SWEETCLOVERS
For North Dakota's Farmers

By P. C. Sandal[1]

North Dakota grows approximately 300,000 acres of sweetclover annually. Around 75 per cent of the acreage is used for soil building purposes and pasture. Another 20 per cent is utilized for hay with the remaining acreages used for bee pasture and seed production. Seed production in 1955 totaled 2,100,000 pounds of clean seed from 14,000 acres which was 23 per cent above the 10 year (1944-53) average. This was the largest seed crop since 1952 when 3,000,000 pounds were produced. North Dakota ranked ninth in the nation in seed production during the 1942-51 period but ranked fifth in 1952[2]. Acreages ranging from 10,000 to 15,000 annually for seed production produce about five per cent of the nation's seed supply.

Sweetclover has no equal in this area as a soil-improving crop. Its large taproot opens up the subsoil, increasing aeration and encouraging favorable conditions for growth of succeeding crops. Like other legumes, when properly inoculated with symbiotic nodule-forming bacteria it utilizes the free atmospheric nitrogen. The plant nutrients become readily available for the succeeding crops, while the organic matter improves the tilth of the soil. Sweetclover gives a high tonnage of dry matter per acre.

There are several varieties of sweetclover available for use. Some of these have been developed in recent years. Comparative varietal tests have been conducted to determine which varieties are the most reliable in various sections of the state. The varieties tested were evaluated primarily for maturity, growth characteristics and total hay yields.

Experimental Forage Yields

All varieties were harvested for forage in the mid-bloom stage in their second year of growth. Forage yields are reported as tons of 12 per cent moisture hay per acre from replicated field trials at Fargo, Edgeley and Dickinson. Evaluation of varieties based only on hay yield may not fully appraise them with regard to seed yield, pasturage or soil building value. However, these characteristics are relatively measured since they are associated with forage yield.

On the basis of three year's yield results (Table I) at Fargo, the varieties Evergreen, A-46 and S-65 have exceeded all other varieties in yield. These improved varieties of late or medium maturity appear to utilize more fully the longer favorable growing season typical in eastern North Dakota. Spanish and Common

[1]Associate Agronomist. The writer is indebted to H. J. Gorz who was in charge of yield trials and breeding studies until 1954.
[2]U.S.D.A. Agricultural Statistics 1954.

TABLE I.—**Average annual forage production of sweetclover varieties at Fargo, Edgeley and Dickinson, 1952-1955.**

Variety	Tons 12% hay per acre			Overall Average	Maturity[1]
	Fargo (3 yr.)	Edgeley (1 yr.)	Dickinson[3] (2 yr.)		
Evergreen	4.1	1.8	1.9	2.6	Late
A-46[2]	3.2	1.7	2.0	2.3	Medium
S-65[2]	2.7	1.9	1.9	2.2	Medium
Spanish	2.6	1.7	1.6	2.0	Medium
Common Yellow	2.6	2.1	2.0	2.2	Very Early
Common White	2.1	1.9	1.7	1.9	Medium
Madrid	2.0	1.9	1.8	1.9	Early
Average	2.8	1.9	1.8	2.2	

[1]Full bloom about: Late, July 10, Medium, June 25, Early, June 15.
[2]Experimental varieties.
[3]Yields courtesy Dr. W. C. Whitman, Botanist, North Dakota Agricultural College.

Yellow were intermediate in production while Common White and Madrid yielded the least of the varieties. The late maturity and high production of Evergreen indicates its value as a variety to lengthen the grazing season from sweetclover by two or three weeks in the Red River Valley area.

Comparative sweetclover yields for western North Dakota obtained at Dickinson (Table I) show that the yellow flowering kinds, Common Yellow, A-46, S-65 and Madrid appear to give the most reliable forage yields and are generally better suited to that part of the state. This confirms the general experience that yellow types are better adapted to lower rainfall areas than white flowered varieties.

Evergreen, which performed well in eastern North Dakota, is generally too late in maturity to express its potential yield in southwestern North Dakota, since soil moisture is often lacking in early July before Evergreen comes into the hay stage. Consequently, white flowered or late maturing varieties are not as reliable in yield or adaptation to the soil and moisture conditions in the western part of the state as the earlier varieties, Madrid and Common Yellow.

On the basis of one year's forage yield results at Edgeley, Common White and the yellow flowered varieties, Madrid, Common Yellow and S-65 outyield the other varieties tested. Thus these varieties would appear to be better adapted to areas just west of the Red River Valley and their varietal responses are similar to those expected in western North Dakota.

The over-all average acre yield of the varieties was 2.75 tons at Fargo, 1.84 tons at Dickinson and 1.86 tons at Edgeley. Better distribution of greater rainfall, as well as soil characteristics in the Red River Valley area, undoubtedly account for the higher forage yields.

Description of Varieties[3]

Common White. Common White is a white-flowered biennial resulting from a composite of local strains. It is taller growing, has somewhat coarser forage and is less tolerant to drought and competition from a companion crop than Common Yellow. Seed production is usually good. Common White matures several days later than Common Yellow, thus is preferable as a pasture legume due to its extended grazing season. This variety may be confused with Grundy County White which at one time was grown extensively because of its earliness, less rank growth and better seed producing habits.

Common Yellow. This variety is a composite of local strains of biennial yellow-flowered types. As compared to Common White it is more tolerant of adverse conditions such as drought and competition from a companion crop. The forage in the first and second year is fine-stemmed and gives good quality hay. It is a dependable seed producer and matures distinctly earlier than Common White. This is an advantage from the standpoint of seed production, since drought damage is less likely to occur. However, early maturity results in a shorter pasture season.

Madrid. Madrid, a yellow blossomed biennial, was introduced by the U.S.D.A. Division of Plant Introduction from the Madrid Botanical Garden, Madrid, Spain, in 1910. Similar to Spanish, it was not widely distributed for testing until 1926. This variety has good early seedling vigor, is medium in height, has a spreading type of growth and is considerably resistant to fall frost. The second year's growth is leafy, upright, of medium height and matures a little later than Common Yellow. Madrid is finer stemmed, leafier, and darker green in color than white biennial sweetclover. Seed production is heavy and of sufficient earliness to usually escape the hazard of early summer drought.

Spanish. A biennial white flowered variety also introduced by the Division of Plant Introduction from the Madrid Botanical Garden, Madrid, Spain, in 1910. It has good early seedling vigor, is of medium height and upright. The second year's growth is leafy, upright and medium in maturity but not as resistant to fall frost as Madrid. Seed production is heavy and early enough to escape hazards of early summer drought.

Evergreen. A biennial white flowered variety released by the Ohio Agricultural Experiment Station in 1935. The first year's growth is vigorous, tall, upright and somewhat coarse. The second year's growth is tall, coarse and about two to three weeks later in maturity than Common White. It blooms over a long period and sets seed freely. However, it is difficult to harvest large seed yields because the seed shatters due to rank growth and long blooming period. Due to its late maturity its seed yields may be reduced greatly by early summer droughts and heavy shattering. However,

[3]Hughes, H. D. et al. Forages, Iowa State College Press. 1951.

a longer grazing season can be realized due to its later bloom and maturity.

A-46 and S-65. These two unnamed selections were developed by the Wisconsin Agricultural Experiment Station and U.S.D.A. They are biennial and yellow flowered. They have good first year vigor, are leafy and have a spreading growth habit. Second year's growth is leafy, very vigorous, and matures a week or more later than Madrid.

Sweetclover Improvement

The high content of a chemical called coumarin in commonly grown sweetclover gives it a sour taste which reduces the palatability of the forage when used for pasture, hay or silage. The presence of coumarin is objectionable in another way. In spoiled hay or silage, coumarin changes to a toxic substance, dicoumarol, which reduces the clotting power of the blood. When spoiled forage is eaten by animals they may bleed excessively from wounds or from internal hemorrhages. The development of a low coumarin sweetclover would eliminate two of the undesirable characteristics of sweetclover, poor palatability and the hazard of bleeding.

A large number of white flowered sweetclover selections are available in the breeding material which are uniformly very low in coumarin content. These lines are foundation material for the development of low-coumarin varieties. Yellow sweetclover, however, is relatively high in coumarin content with little promise for selecting low-coumarin lines from the species directly. Consequently, crosses between yellow and low-coumarin white sweetclover are being attempted to transfer the low-coumarin characteristic of white sweetclover to yellow selections, thus making possible realization of a truly sweet yellow sweetclover. Yellow and white sweetclovers do not cross and produce seed naturally in the field or by hand crossing. After crossing, seed is formed but the embryos die and the seed pods fall off after developing two or three weeks. Consequently, research involving the removal of very small two-week-old embryos from crossed seeds under the microscope and the transfer of these embryos to an artificial growth medium is being done in an attempt to grow true hybrids to maturity and seed production.[4] Offspring of these hybrids should allow selection for truly sweet, low-coumarin yellow sweetclover lines associated with its other desirable characteristics.

Varieties of sweetclover are also needed which have resistance to the sweetclover weevil. Considerable damage to seedlings has occurred in North Dakota in recent years. In many cases, spring seedings have been seriously depleted. Unpublished results from greenhouse studies show that the removal of varying amounts of the developing leaves of young seedlings reduces vigor by 30 to 40 per cent based on height or the amount of top- and root-growth made in 30 days. None of the sweetclover varieties or selections

[4]Webster, G. T. Interspecific Hybridization of Melilotus alba x M. officinalis Using Embryo Culture. Agron. Jour. 47:138-142. 1955.

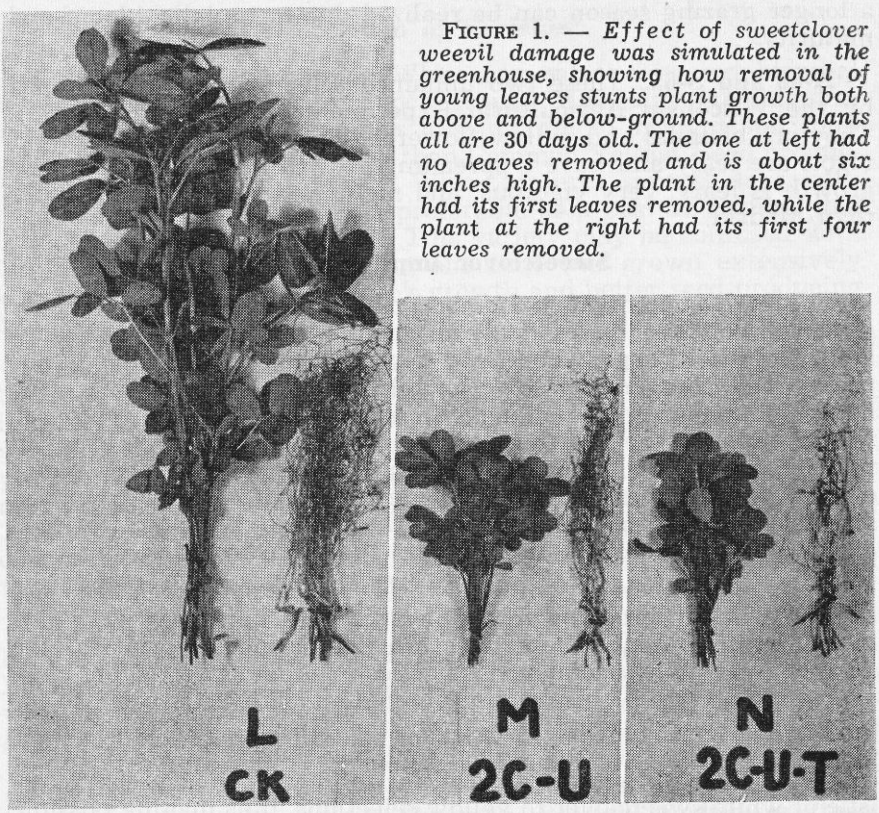

FIGURE 1. — *Effect of sweetclover weevil damage was simulated in the greenhouse, showing how removal of young leaves stunts plant growth both above and below-ground. These plants all are 30 days old. The one at left had no leaves removed and is about six inches high. The plant in the center had its first leaves removed, while the plant at the right had its first four leaves removed.*

tested in the breeding program have shown any marked degree of resistance to the sweetclover weevil. Consequently, efforts are under way to determine if chemical treatment of seed or some variation in farming practices will help reduce weevil damage, especially to young seedlings.

In addition, varieties of desired maturity and plant type with resistance to disease are being sought. Two diseases, black stem and leaf mosaic, need attention.[5] Black stem stunts plants and reduces flowering and seed set while leaf mosaic reduces vigor, distorts and curls the leaves.

Summary

For eastern North Dakota, Evergreen excels as a sweetclover variety, in forage yield and soil building purposes, and providing a longer grazing season its second year. Madrid, Common Yellow, Common White and Spanish are reliable forage producers but are not as effective in extending the grazing season during the second year. Of promise are the yellow flowered breeding selections, A-46 and S-65, which are superior to all varieties tested except Evergreen. Commercial seed of the latter varieties is not yet available.

[5]Weniger, W. Diseases of Grain and Forage Crops in North Dakota. N. D. Bul. 255. 1932.

In the western two-thirds of North Dakota yellow flowered varieties are best adapted and can be expected to perform most satisfactorily. Madrid and Common Yellow are desired. However, Spanish or Common White are satisfactory and will provide a longer grazing season the second year due to their later maturity.

A breeding program is under way to develop better adapted, disease resistant and low-coumarin white flowered varieties. Development of low-coumarin yellow flowered lines are being sought by crossing yellow lines with low-coumarin white flowered selections in hopes of producing a truly sweet yellow sweetclover.

Alfalfa seed production in North Dakota in 1955 was second highest amount on record, 3,525,000 pounds as compared to 2,520,000 pounds in 1954 and the record high of 4,600,000 pounds in 1949. Acreage harvested for seed was 75,000 in 1955, exceeded only by the 77,000 harvested in 1951. The 1954 acreage from which alfalfa seed was harvested was 60,000 and the 10-year average 49,100, according to C. J. Heltemes, USDA statistician in Fargo.

"Our immediate task is to help farmers adjust their operations to the market. This must be done in a way that brings adequate returns for the farmer's labor and capital investments and at the same time builds up and conserves resources of soil and water."—Dr. Byron T. Shaw, Administrator, Agricultural Research Service, U.S. Department of Agriculture.

1955 CROP PRODUCTION VALUED AT $477 MILLION

Total value of all crop production in North Dakota in 1955 is estimated by Agricultural Marketing Service statisticians at $477 million, up from $386 million in 1954. The record was $700 million in 1947. The difference between the 1954 and 1955 crop value can be measured as almost exactly the comparative toll of 15B stem rust of wheat, which took a $100 million chunk out of the 1954 North Dakota wheat crop.

North Dakota ranked first in the nation in 1955 in production of durum and other spring wheat, in barley, rye, flax and wild hay and was second for all wheat. The total of all harvested crop acres was 21,846,000 acres, largest on record and nearly a million acres over the 10-year average.

"Production of all wheat was the largest since 1951 in spite of the fact that the total area planted to wheat was the smallest since about 1908," reports C. J. Heltemes, agricultural statistician.

This 1955 wheat crop totaled 113,482,000 bushels, made up of 13,770,000 bushels of durum and 99,712,000 bushels of bread wheat. This is far above the 69,274,000 bushels of all wheat raised in the state in 1954, but below the 10-year average of 131,707,000 bushels. Yield per acre was 13.5 bushels for durum and 16 for hard wheat in 1955, with the all-wheat yield per acre highest in 10 years.

Perhaps reflecting the work of this station—and especially findings at the Dickinson Branch Station—corn raised for silage has jumped from 221,000 acres for the 10-year (1944-53) average to 473,000 acres in 1954 and 537,000 acres in 1955.

WINTER RYE REPORT

Rye acreage seeded in the fall of 1955 in North Dakota was 535,000 acres, reports the federal Agricultural Marketing Service in Fargo. This is 18 per cent below the 652,000 acres seeded in the fall of 1954, but more than twice the 10-year average.