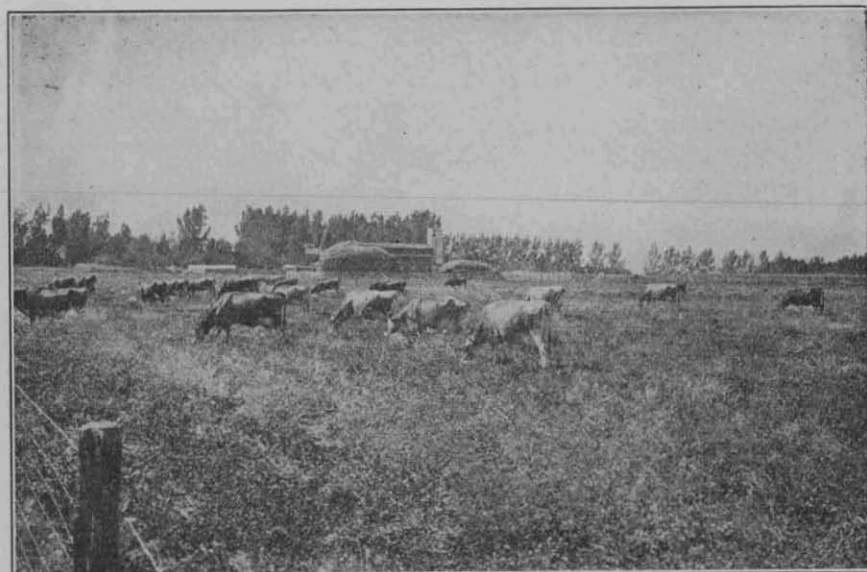


UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION
Department of Agronomy

Growing Clover Seed in Idaho

By

A. E. McClymonds and H. W. Hulbert



Contented Cows on Ladino Clover Pasture

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*In cooperation with U. S. Department of Agriculture.

GROWING CLOVER SEED IN IDAHO

By A. E. McClymonds and H. W. Hulbert

INTRODUCTION

The demand for clover seed is much greater than the supply produced in the United States. The average annual importation of red clover into the United States from 1913 to 1925 amounted to 10,582,153 pounds; imports of alsike and white clover averaged 4,239,000 and 602,769 pounds respectively. Clover seed growers, therefore, are practically assured of a profitable price for their product.

France exports more red clover seed than any other foreign country. The sources of supply are shown in the following table.

TABLE 1—Sources of imports of clover seed into the United States, 1920 to 1926 inclusive.

Country	Year beginning July 1					Average	
	1920-21	1921-22	1922-23	1923-24	1924-25	1920-25	
						1000lb	%
France	13,282,000	2,461,000	246,000	17,095,000	4,845,000	6617	65.7
Germany	406,000	3,346,000	53,000	733,000	519,000	1011	10
United Kingdom	158,000	36,000	3,884,000	402,000	905,000	905	9
Italy	261,000	1,532,000	0	975,000	194,000	592	6
Canada	254,000	465,000	131,000	556,000	116,000	304	3
Chile	0	510,000	0	655,000	231,000	279	2.8
Poland	0	426,000	132,000	0	0	112	1
Czechoslovakia	0	394,000	11,000	101,000	22,000	106	1
Other countries	154,000	121,000	0	289,000	160,000	145	1.4
						10,070,000	100

The clovers rank fourth in importance among the forage crops of the United States. Ninety-three percent are produced east of the Great Plains area in the northern dairy and corn belt states. Red clover comprises approximately 65 percent of the clover used for hay in this great region. The large acreages of clovers grown in the irrigated sections of the Pacific Northwest, however, are produced principally for seed.

In 1925 approximately 2,500,000 pounds of red clover seed was produced in Idaho. The average yield was approximately 4 bushels per acre, and this can be increased to 6 bushels with the use of better methods of handling the crop. The average yield of alsike seed is higher and that of white clover lower than the red clover yield.

CLOVER SEED - IDAHO , 1917 TO 1925

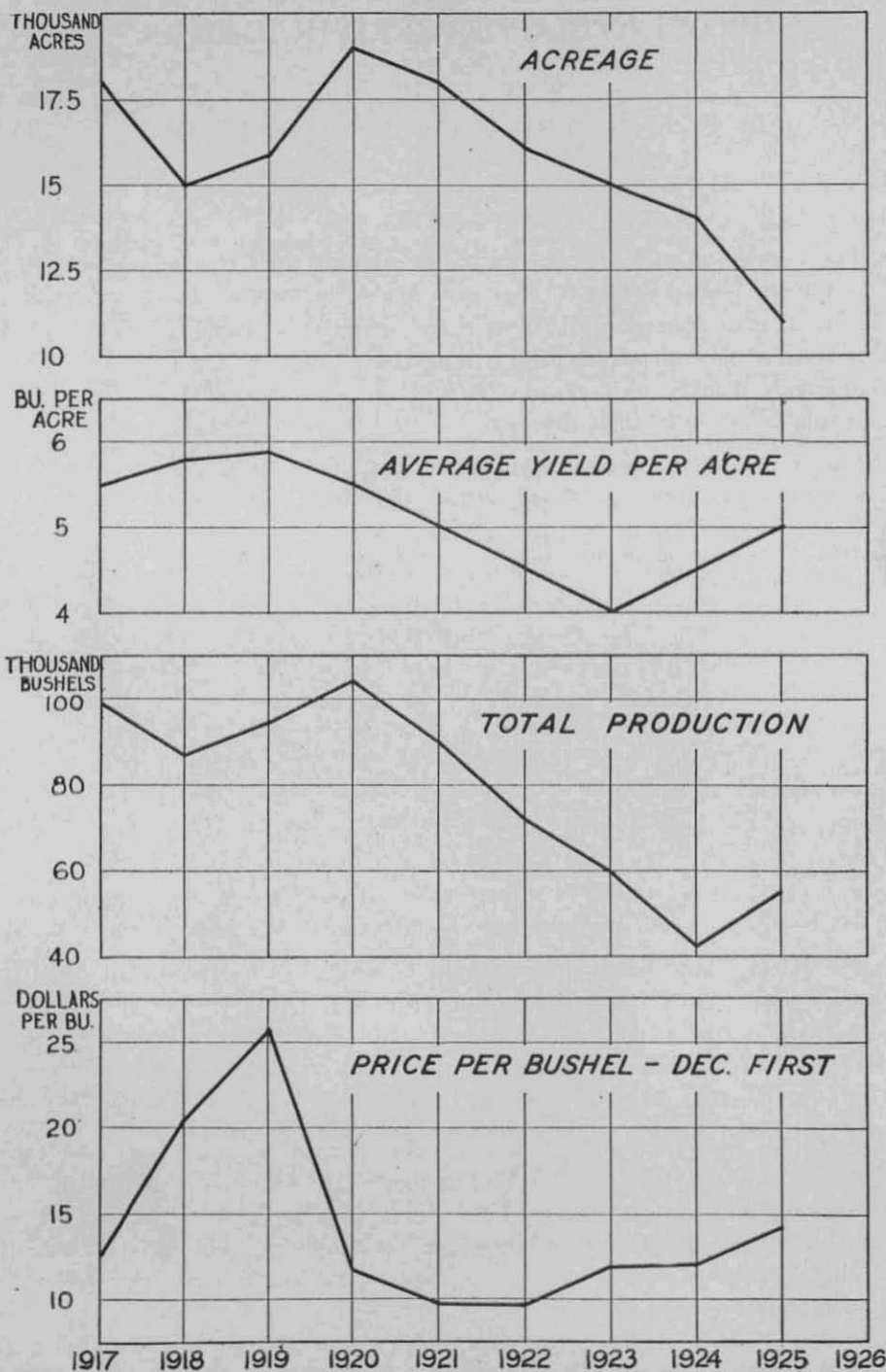


TABLE II—Five-year acreage yields of red clover in the principal producing states, 1921 to 1925 inclusive.

	Yield in bushels per acre					Ave. yield	Rank in yield	Rank in acreage
	1921	1922	1923	1924	1925			
Mississippi	8.0	6.0	7.0	4.5	5.4	6.2	1	11
Idaho	5.0	4.5	4.0	3.0	5.0	4.3	2	9
Louisiana	—	—	4.5	4.0	—	4.2	3	16
Oregon	3.0	1.0	4.0	1.5	2.5	2.4	4	15
New York	1.9	2.5	2.1	2.7	1.7	2.2	5	13
Kentucky	1.9	2.2	2.0	2.0	—	2.0	6	10
Minnesota	2.1	2.1	1.7	1.9	2.0	1.9	7	6
Nebraska	2.2	2.7	1.6	1.2	2.1	1.9	8	14
Kansas	2.3	1.5	1.2	2.0	1.8	1.7	9	12
Missouri	1.7	1.7	1.6	1.4	1.5	1.6	10	7
Tennessee	1.7	1.8	1.7	1.6	1.4	1.6	11	17
Wisconsin	1.7	1.7	1.4	1.1	1.9	1.5	12	3
Michigan	1.5	1.6	1.4	1.2	1.4	1.4	13	4
Pennsylvania	1.4	1.4	1.1	1.5	1.8	1.4	14	8
Illinois	1.4	1.5	1.1	1.1	.8	1.2	15	2
Iowa	1.6	1.1	1.2	1.	1.1	1.1	16	5
Ohio	1.2	1.2	.9	.8	1.	1.	17	1

Under the favorable climatic conditions in Idaho a high colored, good quality seed can be grown that is much in demand by eastern buyers. Tests at other northern experiment stations have shown that Idaho seed compares favorably with other northern grown native seed, and stand counts show that Idaho red clover stands the winter as well as seed produced in other northern states. Moreover, it yields as well as any native seed.

Since the United States does not produce sufficient seed for its own needs, Idaho-grown seed will always be in demand by growers in the northern states. Growers must remember, however, that to retain prestige any seed must maintain high standards of purity and germination.

Foreign Red Clover Seed

During the past three years imports of red clover have increased decidedly. The seed staining law recently passed by congress and promulgated by the Secretary of Agriculture may cause a decided decrease during the next few years. The following extract explains the working of the law.

"Whenever the Secretary of Agriculture, after a public hearing determines that seed of alfalfa or red clover from any foreign country or region is not adapted for general agricultural use in the United States, he should publish such determination, and on or after ninety days after the date of such publication and until such publication is revoked the importation into the United States of any such seeds or of any mixture of seeds containing 10 per cent of such seeds of alfalfa and or red clover is prohibited, unless at least 10 per cent of the seeds in each container is stained a red color."

Red clover seed from Italy has been declared by A. J. Pieters, of the office of forage investigations, to be unadapted for planting in the clover belt. From results obtained at the central station, Moscow, and at the Aberdeen Substation, the statement can safely be made that it is unwise to plant imported red clover seed from any country except Canada. This is due to weed seed content found in most foreign seed, as well as the poor winter survival of the southern European seed.

Much of the imported red clover seed comes from southern Europe and other sections having less severe climatic conditions than those found in the principal red clover area of the United States. Therefore, in order to determine the value of imported seed, the forage office of the United States Department of Agriculture started trials with experiment stations in all parts of the red clover area. Thru this cooperation, experimental work with foreign and native grown strains was started in Idaho. Because of the variation in climatic conditions found in Idaho, tests were conducted at the central station, and the Aberdeen Substation. The first trial was started in the spring of 1922 and was followed in 1923 by testing another group of similar strains.

Winter killing is rarely known in red clover at Moscow. Therefore, no differences were noted in the stands of the foreign strains as compared to native strains after the first winter. At Aberdeen southern European strains winter killed badly the first winter, showing the unadaptability of such strains for sections having severe winters. Similar results have been secured at numerous other points in the northern states, showing conclusively that southern European seed is not adapted to Idaho and other northern states.

Yields of hay secured from the various strains showed those produced from English, French, Bohemian and Italian seed were considerably lower than those from native grown seed. These data, secured at the Idaho Agricultural Experiment Station, Moscow, are shown in Table III. It will be noticed that Idaho red has outyielded all other strains.

TABLE III—Showing comparative second season average yield of hay from Idaho and foreign grown red clover seed. Idaho Agricultural Experiment Station data, Moscow, 1921.

Source of seed	Number of strains tested	Average yield pounds per acre	Difference in favor of Idaho seed
English	3	3936	1029
French	3	4065	900
Italian	3	3614	1351
Bohemian	2	4065	909
Chilean	2	4165	813
Idaho	7	4965	—

This table shows that Italian seed made the poorest showing as far as yield of hay is concerned, and that the Chilean seed made the best showing. The latter strain also gave the best results of the foreign strains at the Aberdeen Substation. Similar trials at other stations show foreign strains to be lower in yielding ability. Yields of these strains in the southern states compare favorably with native southern strains, but in many cases they were less disease resistant than native strains.

Another point of importance is the fact that the use of foreign seed may cause the introduction of new or serious weed pests. Several of the lots of seed planted contained noxious weed seeds; in fact, one plot had to be mowed and burned to destroy an infestation of dodder.

In the varietal experiment on the Aberdeen Substation, with the foreign imported red clover seed and native seed, imported seeds made the winter survival record shown in the following table. The high yield of French seed may be attributed to smaller infestation of mildew. (In harvesting the plots at Aberdeen considerable reseeding occurs.)

TABLE IV—Showing the seed yields and comparative hardiness of foreign grown red clovers, grown at the Aberdeen Substation, 1925 to 1926, inclusive.

F. I. No.	Strain	Yield	Per acre yield— lbs. seed	Winter hardiness percent	
				1925	1926
2403	Chilean Red	8	480	100	60
2399	Chilean Red	8	480	100	70
2399-M	Chilean Red	9	540	100	55
2399-N	French Red	8	480	70	80
56182	French Red	7½	450	65	70
57775	German Red	10	600	60	85
57776	German Red	9	540	60	85
57777	German Red	8	480	50	50
56681	English Red	7	420	40	30
56683	English Red	9	540	40	50
36773	Danish Red	4½	270	30	10
2412	Alta Swede	7½	450	100	90
56807	Rosendaal	8½	500	80	80
	Idaho Red	10	600	100	95
Size of plot	1/30 acre plots				
	Michigan Red	19	570		100
	Tenn. Dis. Ris. Red	15½	465		100
	Swiss Red	8½	255		40
	Polish Red	14	420		80
	Chilean Red	16	480		100
	Idaho Red	21	630		100

Varieties of Clover

The term "clover" used in a broad sense includes red, sweet, alsike, white, ladino, and a number of species of little importance in Idaho. The leaves of all clovers are divided into three oblong leaflets and flowers are borne in compact clusters or heads at tip of stems. Red and alsike clover are grown for both hay and seed in Idaho; white and ladino are utilized chiefly for seed and pasture. The biennial sweet clovers are used

principally for pasture in non-irrigated areas. Little seed of sweet clover is grown.

Red Clover Red clover, introduced into the United States from Europe about 1870 is the most important clover grown in this country and its seed is in greatest demand. Ordinarily red clover lives but two years, but in the cutover sections of Idaho it often acts as a perennial. Many fields have produced satisfactory yields of hay for four or five seasons without reseeding.

There are two so-called standard varieties of red clover; medium and mammoth. Altho the seeds cannot be distinguished it usually is possible to identify them in the field. The mammoth variety is about two weeks later in maturity; it has larger and coarser stems; its heads are seldom borne in pairs; it is commonly more hairy, and it blooms little the first season. Mammoth does well on poor soils and it is less sensitive to acid soils than medium red. Since it is much later in maturity than medium red the crop should not be clipped for seed production.

Medium red clover makes its best growth on fertile, well-drained soils containing an abundant supply of lime. It is especially adapted to the northern and corn belt states, Montana, Oregon, Washington, and Idaho. Wide adaptation, ease of plowing up old stands, its ability to gather nitrogen and store it in the soil, and the large amount of humus left in the soil by the roots makes it a crop that will work in to good advantage with any rotation. Red clover is the most popular and probably the most profitable clover seed crop in Idaho.

Alsike Clover Alsike clover is adapted to a much wider range of climatic and soil conditions than red clover, altho under droughty conditions it does not produce as well. Alsike grows especially well in cool, moist climates. It rarely winter kills and often survives winters that kill out red clover. The plant is a long-lived perennial living for four to six years under favorable environment. Alsike has the ability of thriving in sections where "clover failure" in red clover is common. Under favorable conditions the stems grow three to five feet long, but in drier soils they may not attain a height of more than 18 inches. Alsike differs from red in its habit of growth. In red clover the main axis terminates in a flower and thus limits the growth. Branches arise from leaf axils and these in turn are terminated by flowers. In alsike clover the main axils keep on growing. Single flower-bearing branches, each with one or more flower heads, arise successively from each axil leaf. This character is important not only in seed production but in making alsike fit to cut for hay over a longer period than red clover.

White Clover White clover is a perennial, often known as white Dutch clover. It is a native of Europe and probably was first cultivated in Holland. In that country it is an important element in pasture mixtures. The crop is adapted to moist soils and is considered a valuable addition to humid or irrigated pastures in this country. White clover is a long-lived perennial with shallow roots and, therefore, is not adapted to drouthy conditions. It will, however, withstand greater temperature extremes than either red or alsike. Unlike red and alsike clover, it has solid, creeping stems that root down abundantly.

Ladino Clover Ladino or giant white clover was introduced into the United States from northern Italy in 1903 by the United States Department of Agriculture. The seeds are almost identical with those of white clover. The plants are also similar to white clover, except that they are from two to four times larger in all of their parts. Ladino has been tried in all sections of the United States and has proven quite successful. It has been found to succeed especially well in the irrigated sections of Idaho. Under eastern conditions little seed is produced, but satisfactory yields are secured in southern Idaho under irrigation. As a pasture crop it has a much greater carrying capacity than white clover or other commonly grown pasture plants. The plant, however, has the disadvantage of being slightly less winter hardy than white clover and this factor, together with scarcity of seed, has held back the general use of the crop for pasture.

Sweet Clover Four species of sweet clover are grown in the United States. Two of them, the annual white and annual yellow, have no place in Idaho agriculture. The biennial white and biennial yellow are chiefly of value as pasture crops, and experiments have shown that no other leguminous crop will furnish as much pasture over an entire growing season as biennial sweet clover. The white biennial variety has been used most extensively in Idaho, probably because of the larger yield secured from it. The yellow variety has the advantage of growing closer to the ground, and in some sections it reseeds itself under pasturing.

PLANTING THE SEED CROP

Irrigated sections of Idaho are especially adapted to clover seed production. The irrigated farmer is able to control the blooming of the plant and the critical period of seed production is free from damaging storms. The climate is almost ideal.

Choice of Seed Crop

Each farmer should determine the variety of clover best adapted to his conditions and raise only that variety. Over a large section of the irrigated area red clover will produce the largest profit over a period of

years; the market is more stable because the demand for red clover seed is greater than for alsike or white. Many growers raise all three varieties on the same farm. This is a mistake since seed is very difficult to keep from mixing in threshing. Fields that have grown alsike should not be seeded to other clover seed crops since alsike is likely to volunteer, which means a mixed seed crop and consequently a lower price.

Choice of Seed

Only seed of highest quality should be used for seeding seed fields. Idaho has established a reputation in the past as a producer of high quality clover seed and that reputation can be maintained only by planting the highest quality seed. The buying of state-tested seed is always advisable. Growers may buy a sample and secure a state test before buying. Purity tests can be secured by sending a sample of the seed to the state seed laboratory, Noble Building, Boise, or to the branch seed laboratory, College of Agriculture, Moscow, requesting a purity test and grade. When purchasing seed from a dealer, it is well to make sure that he is reliable and that he sells you Idaho-grown seed. *Know what you sow.* The price makes little difference in comparison with the quality of seed. Poor seed at a 10-cent lower price per pound would lessen the cost of seeding only a dollar an acre and the resulting crop may be lowered in value to the extent of several hundred dollars.

High quality red clover seed is plump and carries a slight luster. Individual seeds vary from a deep purple to a bright yellow in color. Old seed is usually dull in color with many brown seeds.

Alsike clover seed is much smaller than red clover. It is darker and when well colored gives the appearance of having a large number of dark blue and almost black seeds. This, together with a luster, indicates well matured seed. Lack of luster and large numbers of brown seeds indicate age. Such seed is not as desirable for seeding as one year old seed.

White clover varies in color from a light brown to a yellow. Good white clover seed has a very definite luster which indicates vitality. Alsike is one of the most common mixtures in white clover. A purity test should be run on all white clover before it is planted for it is difficult to distinguish between small seeded dodder or yellow trefoil and white clover. The seed of white and Ladino clover cannot be distinguished.

Preparation of the Seed Bed

Under irrigated conditions clover should be seeded only on fields that have been carefully cropped for four or five years. The land should be levelled to an even slope, so that the water runs slowly and evenly and will not pond at any one point. The soil should be fall plowed and worked down to a firm, well prepared seed bed early the following spring. This

can be accomplished by the use of the disc, harrow, float, and roller. The soil should be worked as early as it is dry enough to work well in the spring, and as soon as the ground can be put into shape it should be seeded using a grain drill with a seeder attachment.

Rate of Seeding

White, alsike and ladino clover should be seeded from 4 to 6 pounds and red clover from 8 to 10 pounds per acre. Where the seed bed is in excellent condition and contains plenty of moisture, satisfactory stands can be obtained with light seedings. When the land is not in such good shape a heavier seeding is necessary.

A pound of alsike clover contains about 700,000 seeds. There are 43,560 square feet in an acre. Therefore, each pound of alsike if evenly scattered, should put 16 seeds on each square foot. If all of these germinate, a good stand of clover will be secured. While a thicker seeding will help choke out weeds, too thick a planting is merely a waste of seed.

Depth of Seeding

The depth of seeding varies with the character of the soil. On light, sandy soil seed should be put in at least twice as deep as in heavy soil. On a well firmed seed bed with moisture well toward the top and with fairly heavy soil, the seed of alsike, white and ladino should not be covered to a depth of more than one-half inch, and red clover not deeper than one inch. On light sandy soil this may be increased to an inch or to one and one-half inches. Covering the seed very lightly and following with a roller is to be preferred to covering the seed deeply to get down to moisture. The roller firms the soil around the seed and causes the moisture to come in contact with the seed. This insures more uniform germination, and better stands. The use of the roller also gives the young seedlings a better chance to push their tender roots down to moisture and prevents the soil from drying out.

The first four weeks after planting is the most critical period in getting a stand. If there is plenty of moisture in the soil the seed germinates rapidly and becomes well established. If moisture is lacking at this period the seed may sprout and die.

Nurse Crops

Nurse crops should never be used in seeding clovers in the non-irrigated sections of the state and white and Ladino clover should always be sown without a nurse crop. It is customary to sow red and alsike with a nurse crop under irrigated conditions. Unless the seed is very valuable it does not pay to sow clover on irrigated land without a nurse crop. There are several advantages of a nurse crop: (1) a grain crop is produced, avoiding the loss of the use of the land for one season; (2) the stubble

gives protection to the young plants during the first winter, and (3) clover does practically as well with as without a nurse crop.

Barley is one of the best nurse crops. Oats is the most unsatisfactory on account of its dense foliage when grown on irrigated land. Early varieties of peas make a very satisfactory nurse crop if they are not seeded too thickly. Wheat is better than oats but not as good as barley or peas on account of its later maturity. The rate of seeding of the nurse crop should be reduced to about one half of normal.

When seeding with a nurse crop the clover may be broadcast and harrowed immediately after seeding; the nurse crop is drilled. The spouts of the grass seeder attachment may be allowed to hang free distributing the clover seed upon the surface of the soil. Covering is taken care of by the discs and the chains of the drill.

Time of Seeding

Clover should be seeded as early in the spring as the seed bed can be prepared. The land should be irrigated and fall plowed, and the seed bed prepared as soon as it is dry enough to work. Many clover failures in Idaho occur thru late seeding. When seeded early the clover seed germinates rapidly and gets well established before the soil dries out. Thus a vigorous plant is developed before the first irrigation is required. Late seeded plants do not become well established and are oftentimes killed or badly set back by lack of moisture before the first irrigation.

Fall seeding is very unsatisfactory because of the danger of winter killing. During an average year the snowfall on the lower irrigated lands is very scanty and the young fall-seeded plant lacks the protection of snow to enable it to withstand the winter climate. This applies to the upper Snake river valley. When plenty of moisture is available early fall seeding is very satisfactory in southwestern Idaho.

Inoculation

If the land has been previously sown to clover, inoculation is not necessary. Where new lands are put into clover it is advisable to inoculate the seed with nitrogen-gathering bacteria. Cultures may be obtained from the University of Idaho bacteriology department. Full directions for use are sent with cultures.

CULTURAL METHODS FOR SEED PRODUCTION

First Season If a satisfactory stand has been obtained it usually is unnecessary to irrigate until the nurse crop needs water. After starting irrigation the two crops should be kept growing vigorously until time to mature the nurse crop. Frequent and light applications of water are much more beneficial to the young clover plants and nurse crop than few and heavy applications. The nurse crop should be harvested and either stacked

or threshed as soon after maturity as possible. The clover field should be irrigated immediately after the nurse crop is removed. This insures a vigorous growth of the young clover plants and a good stand for the next year. When the aftermath is vigorous and there is plenty of moisture in the soil, light fall pasturing does no injury to the plants.

Red Clover

First and Second Seed Years Medium red clover usually lives to make but two profitable seed crops. It will reseed itself and sometimes make a third seed crop, but the stand usually is poor and weeds come in badly so that it seldom is profitable.

It is not customary to cultivate the crop during the first seed year. Where a good even stand is obtained the clover will crowd out practically



FIG. 1—A grain binder equipped with pans and with extension to the rear elevator plate and binder deck. This arrangement saves the clover seed that shatters in cutting and binding. (Courtesy United States Department of Agriculture.)

all weeds if the land is reasonably clean. Clover is a vigorous growing plant and makes a rapid growth during the early spring so that it is necessary to hold the crop back in some manner during the first part of the growing season. The length of time varies with the date of the first killing frost in the fall. In the lower part of the Snake River Valley this period of holding back should be much later than in the upper valley.

Methods of Holding Back Pasturing with a farm flock of sheep probably is the best method of holding the early growth back in the red clover seed field. Enough sheep should be kept on the field to keep the plants eaten close to the ground. The sheep should be kept on the fields until the first to the 30th of June, depending on locality. Under non-irrigated conditions the first crop should be used for seed and no attempt should be made to hold back the growth.

Second Clipping In the Twin Falls section and west to the Oregon line the first crop of clover may be taken off for hay and the seed produced on the second crop. Clipping should be practiced in the upper Snake River Valley, if much plant growth is produced before the first of June, and if no sheep are available.

Burning Burning, as used here, means to withhold irrigation water. Some seed growers have had excellent success by withholding irrigation water after red clover is clipped or a cutting of hay is taken off. An application of water is made before the clover field is clipped or cut for hay and no water is applied for 10 days following. The clover should be cured as rapidly as possible and the hay removed.

After clipping or pasturing the plants should be irrigated with frequent and light applications of water until the bloom is fully brought out. When in full bloom another light application of water will be sufficient to mature the seed and produce a good yield. The clover should then be allowed to ripen. The crop should be cut when the heads are all black and seed is matured in head. A good yield of red clover seed is indicated by shelling out about 60 seeds from each head. A light crop is indicated by shelling out from 25 to 30 seeds to the average head.

Alsike

Since the second growth of alsike is of little value for seed, pasturing is resorted to in order to hold the crop back. Alsike does not require holding back as late as red clover and the animals should be taken off the fields about 10 days earlier.

After the period of holding back is over, usually around June 1 to 30, the fields should be irrigated to bring along a steady, healthy growth. The irrigations should be applied until the bloom is brought out in large numbers. Owing to its irregular habit of blooming there will be overripe heads and buds on the same plant. This can be controlled to a certain extent by applying the last irrigation when the bloom seems to be most profuse, then allowing the soil to become very dry. When the largest number of heads are ripe the crop should be cut, for when alsike becomes overripe the heads begin to drop. These are full of seed and

serve as a means of infesting other crops planted on the land in later years.

White Clover and Ladino

These crops may be handled in several ways to secure good seed yields. They may be pastured down in the spring until the first of June and then allowed to make seed. The usual custom, however, is to make two crops of seed in one season. The bloom is brought out strong by frequent and light applications of water. This seed is allowed to start ripening by letting the plants suffer slightly for water, then other irrigations are applied until the new shoots have bloomed profusely. The watering is then discontinued and the plants are allowed to mature.

HANDLING THE CROP

Harvesting When the heads of red clover are all black and when alsike has 90 percent of mature heads, the crop should be cut. It is best to have sharp cycles on the mower. Some growers cut the clover only at night after the heads have become tough. It is best to start cutting clover fields early, using a windrowing attachment and the mower may be run steadily until 9 o'clock in the morning. Two shockers should start into the field at seven, preferably six, and cock the windrows in small cocks. This necessitates tearing the clover apart. The cocks should be built low and flat on the ground and small enough so they can be easily picked up in one forkful and laid on the slip or wagon at threshing time.

The shockers should not cock after the clover has become dry and should have the work done by 10 o'clock on bright sunshiny days. If it is raining the work may be continued as long as the mower can run. This method will save practically all of the seed. The small cocks will dry out with no damage to the seed and will be ready to thresh within 10 days to two weeks. Too early threshing after curing may cause the seed to heat and damage it.

White and ladino clover are harvested somewhat differently. The first crop is allowed to mature seed and a second crop is brought on by irrigation. This crop is then thoroly dried and the two clover crops form a dense mat on the ground. These two crops of seed are then harvested at the same time. The mower with a windrow attachment should cut the plants very close to the ground. The clover hangs together and is simply rolled into cocks and allowed to dry. These rolls should be kept as small as practical, still not causing the heads to break off by rough handling.

The Thometz brothers of Twin Falls cut three swaths together in harvesting white clover. The first swath is cut and rolled on top of the uncut clover. The second swath is cut and the two are piled on top of

the third. Cutting of the third leaves all of the heads turned in. This is the best method that the writers know of where labor is plentiful. No windrower is used. The outside shoe and grass board are removed from the cycle bar, letting the clover lie just as it falls. Especially thin cutter bars are used to some extent in harvesting white and ladino clover.

Threshing Most clover seed is threshed with a huller. Where hullers are plentiful it is hardly necessary to stack as the clover should not be handled any more than is essential. Where there are few hullers, stacking

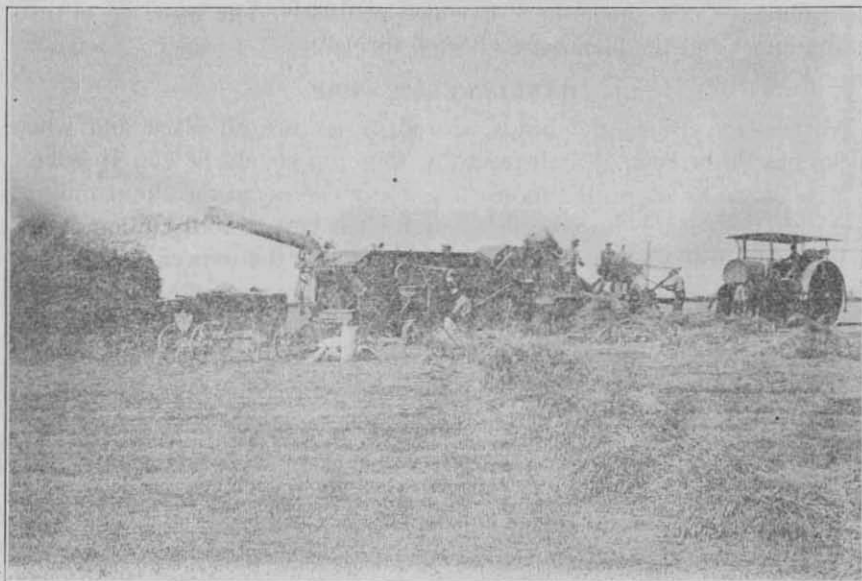


FIGURE II. Threshing white clover seed. Joseph Kucera ranch, Buhl, Idaho.

is preferable to letting it lie out in the field until late in the fall. When threshed, clover should be thoroly dry. Tight bottomed racks or slips should be used in hauling to the huller or stack, and the grower should insist on the machine man putting plenty of canvas under the huller to catch all the heads and seed that might sift off.

As a general rule the thresherman is in too big a hurry to get the job over and to move on to the next place and too much chaff is put in with the clover. When a thresherman has a good machine and is careful in threshing and recleaning his seed he should be given preference to the job. A good thresherman does not lose any money in a good field of clover and he can well afford to have his machine in good shape and to do a careful job.

POLLINATION STUDIES

There has been much controversy as to whether red clover flowers are self sterile. About half the investigators assert that self pollination is common with red clover and the other half assert that cross pollination is necessary to seed setting.

Westgate, Coe and others outlined an experiment to determine, first, whether red clover flowers were self-sterile; second, if self fertile, whether an effective method of self pollination could be found which would be applicable on the field scale; third, the relative efficiency of the bumble bee and honey bee in cross pollination of red clover. They found that many flowers of red clover contained infertile ovules; that the percentage of infertile flowers in the first crop is greater than in the second crop; that mechanical pollination was not practical, and that clover flowers kept away from contact with insects produced less than 1 percent of seed. This small yield of seed might be accounted for by the occasional access of bees to these heads for a very short time by rains or by grasshoppers mutilating the tarlatan which was used to cover the heads. The bumble bee is an efficient cross-pollinator of red clover, being able to cross pollinate 30 to 35 flowers per minute.

The honey bee is much more efficient in cross pollinating clover flowers when few other nectar-producing flowers are to be found. It collects pollen from clover flowers and in order to do this must spring the keel of the flowers. In this way the flowers are cross-pollinated.

WEEDS AND THEIR CONTROL

Control of weeds is one of the most important problems connected with clover seed production in Idaho. Clover seed foul with weeds has a low commercial value. In fact, such seed often cannot be sold upon the market. This especially is true if it contains inseparable weed seeds, since nearly all states have well enforced seed laws preventing the sale of seed containing serious weed pests. Carelessness on the part of seed growers in protecting themselves against weed pests will lower Idaho's reputation for the production of high quality seed.

Thoro preparation of the seedbed, together with a suitable rotation of crops, will help to eliminate any weed seeds already in the soil. The field to be used for seed production should then be seeded with the best quality seed obtainable. Seed foul with weeds or low in vitality should not be purchased for seeding purposes at any price.

Numerous weeds are serious pests in clover seed fields and dodder, buckhorn, foxtail and yellow trefoil are among the most serious. These weeds are inseparable impurities and remain in the seed when marketed, thus reducing its commercial value.

Dodder (Cuscuta sp.) Dodder is an annual parasitic plant with twining, thread-like leafless stems and usually yellowish to orange in color. If present and allowed to produce seed, the infestation will spread over a large part of the seed field. Seeds which are produced in large numbers, begin to ripen in July. Usually the weed occurs in patches. Small patches can be controlled by cutting the clover crop and accompanying weed before it seeds. The cut material should be dried and carefully burned. Badly infested fields should be mowed and used for hay, and the hay should be cut before there is any danger of the dodder producing seed. The aftermath should then be plowed under, and the land planted to a cultivated crop. Clover seedings should not be made upon such land again for several years.

Buckhorn (Plantago lanceolata) This plant is a very pernicious introduced weed. It has a group of thickly tufted leaves borne in heads on long upright stems. If only a small infestation of the weed occurs it can be controlled by hand pulling and burning. Fields heavily infested should be plowed up and planted to a cultivated crop.

Foxtail (Setario sp.) This is an annual weed which propagates by seeds. Once in the soil it retains its vitality for years, springing up whenever brought near enough to the surface warmth and light. Cattle and sheep will eat it when it is young.

Where a field is badly infested, it should be plowed up and put into a cultivated crop. When patches are small the fields should be rogued and the foxtail carried out, piled and burned. Sheep should be turned into the seed field to graze down the aftermath.

Yellow Trefoil or Black Medic (Medicago lupulina) This plant is a member of the legume family. It is an annual with yellow flowers and produces seed similar in size and color to those of alfalfa. Roguing of infested fields is the only means of getting rid of plants already established. Care in the purchase of seed and seeding on carefully prepared land will prevent infestation in new fields.

FUNGUS DISEASES

The powdery mildew seems to be the worst fungus disease that attacks red clover in Idaho. Little is known of this disease which develops as powdery masses across the surface of the leaves. Where the plant is growing vigorously it seems to be able to thrive in spite of fungus disease. The seed yield probably is reduced when climatic conditions are favorable to spread of mildew.

On the Aberdeen Substation a test of sulphur dust was carried on in cooperation with the department of plant pathology. The results of this test indicate that sulphur applied at different intervals during the clover plant's growth would practically control powdery mildew.

INSECTS AFFECTING CLOVER SEED PRODUCTION*

Production of clover seed must include consideration of a few insects which often are limiting factors. Insects in this class known to occur in Idaho are the clover leaf weevil (2), clover root curculio (3), clover root borer (4), clover aphid (5), clover flower midge (6), clover seed chalcid (7), and grasshoppers (8).

The Clover Leaf Weevil The clover leaf weevil frequently becomes quite numerous in early spring in clover fields where adults are found huddled close to the plants and larvae eat large, irregular holes in the leaves. Adults are brown or dark brown, about 0.35 inch long and are characterized by a long, strong snout. Larvae, when full grown, are nearly one-half inch long. The body is green or yellowish-green, and lengthwise on the back is a broad white line tinged with pink and lined with black. This insect sometimes occasions alarm by its numbers but as yet it has caused little or no loss of clover seed in the state.

The clover root curculio is present in nearly all clover fields of southern Idaho but has not been a pest of great importance. The adult is a small dark brown or black beetle one-eighth inch long. It has a short, stout snout. The larva, when full grown, is about one-fifth inch long, white or with a yellowish or purple tinge. Adults eat out irregular patches from the leaf margins and larvae feed on the roots and deep in the crowns.

The Clover Root Borer Fields frequently are heavily infested with the clover root borer. These beetles are not more than one-tenth inch long, brown to blackish, cylindrical, hard-bodied and hairy. Larvae are white with yellow head, stout, and when mature are about one-eighth inch long. Larvae tunnel in the roots forming longitudinal galleries and side branches. This insect is often a very serious pest in Idaho where attempts are made to maintain a clover stand for more than two crop years but it is of little importance where good cultural practices are followed.

Clover seed production in Idaho, for a number of reasons discussed in this bulletin, is not profitable when stands are maintained for more than two crop years. Since the three insects discussed above do not become sufficiently numerous to cause heavy loss in a two-year period their influence on seed production is rendered of little importance by following of the best farming practices, and their control needs no special discussion.

* 1. Prepared by Claude Wakeland, Experiment Station Entomologist.

2. *Hypera punctata* (Fab.)

3. *Sitona hispidula* (Fab.)

4. *Hylastinus obscurus* (Marsham.)

5. *Anuraphis bakeri* (Cowan.)

6. *Dasyneura leguminicola* (Lintner.)

7. *Bruchophagus funebris* (Howard.)

8. Many species.

The Clover Aphid During certain seasons the clover aphid is a serious pest of red clover and greatly reduces the seed yield. Eggs of this species are deposited in the fall on apple, quince, pear and probably other trees. Eggs hatch in the early spring and two or more generations of aphids feed on the trees before winged individuals are developed which fly to clover. All generations during the spring and summer are females which give birth to living young and which reproduce without mating. Many generations are thus produced in a season and infestations increase at an alarming rate. Migration from clover to winter hosts ordinarily commences the last week of August (at Twin Falls) and continues until the foliage has fallen from the trees. Aphids that fly to fruit trees in the fall include both males and females. During some winters a small percentage of aphids survives on clover plants but mortality usually is very great and investigations have shown that infestations of clover fields are caused principally by migrants from fruit trees.

"When only a few aphids occur in a clover field they will be found under the stipules or little ensheathing leaves at the base of the leaf stalks and beneath clover heads. As the aphids increase in number some are crowded from under the stipules and soon the stems and under sides of the leaves are covered with them.

"As soon as the clover blossoms open the aphids crawl deep down among the florets of which the blossoms are composed. Here they feed on the bases of the florets where the new clover seeds are forming and in time fill the flower with sticky honey dew. Honey dew is merely the thin, syrup-like excrement from the digestive tracts of aphids. As it evaporates the fluid becomes thick and sticky and upon drying loses its stickiness altogether, becoming more or less crystalized. Slight heating causes the crystalized honey dew to become sticky again. The latter fact explains why clover may be hulled without any indication of honey dew, but after remaining in the sacks for a few days the seed becomes sticky."

The clover aphid seriously affects the yield in addition to lowering the quality of red clover seed and there are seasons when it is of such economic importance as to render the production of seed unprofitable unless control measures are practiced. The nature of injury and extent of damage depends considerably on the time of year that the clover is attached as well as on the degree of infestation. It has been proven by experiments that where only a few aphids are present under the stipules or in the axils of the leaves, they may greatly reduce the number of stems and forming branches.

Many methods of controlling the clover aphid in Idaho have been tested, including spring pasturing, late cutting of the hay crop, early cutting of the hay crop, leaving the first growth for seed, pasturing after cutting the hay crop, brush dragging after cutting the hay crop, "burning" after cutting the hay crop, cutting back the seed crop, irrigation practices, spraying, dusting and flooding. Of these, late cutting of the hay crop and burning were the most effective and these methods are now in general practice by many clover seed growers in the state.

"General observations and numerous cooperative field tests with farm-

ers show that where practicable, the hay crop should not be cut until after the aphids have become numerous or even abundant on the plants. The theory of this practice is that the mere cutting down of the infested plants destroys enormous numbers of aphids, thus bringing those remaining more quickly under control of natural enemies. Cutting 10 days or two weeks later than usual tends to delay the blossoming and filling period of the seed crop until after the aphids have been largely exterminated by their natural enemies. This date varies from approximately June 1 in the upper Snake River Valley to June 20 in the Twin Falls district and July 1 in the Boise Valley."

Pasturing with sheep is an effective means of control if sufficient numbers of animals are turned on a clover field to keep it closely cropped and if they are grazed until the time for late cutting of hay described in the preceding paragraph. The relative value of late cutting and pasturing are to be judged then by whether the hay crop is worth more to the individual as hay or as green forage for sheep.

"'Burning' is an expression coined in connection with clover aphid control and applies to the practice of withholding irrigation water from clover fields for a period of a week or two before the hay is cut and from one to two weeks thereafter, exposing the stubble and crowns of plants to the direct rays of the sun and to the accumulated heat of the surface soil. If the daily temperatures are high and the sun's rays unobstructed, many aphids may be directly killed by the heat, but the chief effect of the treatment appears to be that of greatly retarding the rate of development of the aphids over a period of 10 days or two weeks thus enabling natural enemies to get control of the infestations."

For a number of years the practice of burning has been followed by many of the most successful clover seed growers with nearly uniformly good results in controlling the clover aphid. Where the stand of clover is good and the plants are not materially weakened by disease, apparently no harm to the development of the seed crop results from this method.*

The Clover-Flower Midge The clover-flower midge, when numerous, greatly reduces seed yields. Individual florets are affected and few or many florets on individual clover heads may fail to develop seeds. Affected heads are quite easily noticed by their appearance since brown, withered petals are conspicuous among the naturally pink and white clover blossoms. The little pink maggots are often observed in the seed at threshing time. The insect occurs abundantly in many localities in the Boise and Payette valleys, and probably is present in other clover producing districts of the state. It caused very severe loss in southwestern Idaho in 1926.

Life history and control of the clover-flower midge have been determined in the Pacific Northwest as reported in Farmer's Bulletin 942, United States Department of Agriculture. Observations in Idaho indicate that dates for maturing of first brood larvae are the same as given in this bulletin and that the control procedure recommended there would apply

* Extensive investigations of the clover aphid were made by the Idaho Experiment Station from 1918 to 1922. Results of these investigations were published in Bulletin 112 and Research Bulletin No. 3 by Ralph H. Smith. Quotations above are from these bulletins.

in this state. Facts concerning life history and control in the following paragraph are excerpts from the bulletin mentioned.

The adult midge emerges from winter quarters about the last week of April or the first week of May. It resembles a mosquito. The fore part of the body is black and the abdomen is bright red. After females have emerged and mated they lay their eggs singly or in clusters on or close to clover heads. Eggs hatch in a few days and the young maggots wriggle their way to the tops of the florets and force their way inside the unopened petals. Newly emerged larvae are pale yellow but change gradually to creamy white and, shortly before becoming full grown, to pink. Mature maggots are approximately one-tenth inch long and entirely fill the florets, taking the place of the seeds. There are two broods annually with a more or less complete third brood. Mature larvae wriggle out of the florets and drop to the ground, when moisture conditions are favorable, and the maggots work their way a short distance into the ground where they form cocoons and pupate. Maggots of the summer generations do not remain long in the soil, soon transforming to adults and emerging, but maggots of the fall generation remain in their cocoons until the following spring before transforming.

The control procedure recommended in Farmers' Bulletin 942 is to pasture or clip the spring crop to prevent first brood larvae from maturing and transforming to second brood adults. Under Idaho conditions this method appears quite practicable and the control procedure outlined for the clover aphid should be effective against this insect also. In southwestern Idaho it was observed in 1926 that mature larvae appeared in the florets the first and the second week of June. Pasturing would thus need to be practiced until June 1 or later or the hay crop cut the first or second week of June to kill first brood maggots before they emerge.

Where late cutting, pasturing or burning is practiced as described for clover aphid control it should be entirely effective in preventing injury from the clover-flower midge since it would so reduce the numbers of the first brood larvae on the hay crop that few could escape to produce the second brood which attacks the seed crop. Pasturing or cutting the hay crop should be so conducted that the seed crop starts growth from about June 1 in the upper Snake River Valley to about July 1 in southwestern Idaho. By delaying cutting the hay crop until after the first pink colored larvae appear in the clover heads most of the larvae of the first brood are killed and the earliest maturing individuals are prevented from transforming to adults of the next generation. This method of control could, of course, be practiced independently of the clover aphid, but the practice of burning, if followed each year, is a safe form of insurance to prevent losses from either the aphid or the flower midge.

The Clover Seed Chalcid Many seed growers have observed alfalfa or clover seeds with small holes in them, and when they have examined the seeds have found them to be nothing but the seed coats, the interiors having been destroyed. Loss in Idaho is periodic and may vary in a given locality from nothing to as much as 30 percent or more in different seasons. The damage is caused by the clover seed chalcid, the adult of which is

a small, black, four-winged insect about $\frac{3}{32}$ inch long. The females force their ovipositors thru the green seed pods and insert their eggs in the soft, immature seeds. Eggs hatch in a few days into tiny, white, footless grubs which grow and feed inside the seeds until they reach maturity.

The clover seed chalcid hibernates in the larval stage in infested seeds. It may thus be carried thru the winter in seed that has shattered off and remains in the field or in seed that has been threshed. There are two or three generations each season but some of the members of each generation do not complete their life cycle until the following year. Larvae may transform to adults within the seeds in a few days after reaching maturity or they may remain inactive for a time and transform at any time during the remainder of the growing season or during the following year. The irregularity and overlapping of broods makes it impossible to combat the larvae of any one brood at one time and for that reason control measures are only partially effective.

Destroying seed plants along ditches, roads, on waste land, etc., doubtless kills large numbers of chalcids that would otherwise survive the winter. Clipping young clover in the fall to prevent formation of scattering seed pods has the same effect. Fall cultivation of clover fields is of value in destroying hibernating larvae. Cultivation with a spring-tooth harrow is sufficient since it covers most of the seed pods with soil, causing them to mold and preventing the development of pupae and adults. Early maturing clover or alfalfa plants along ditches, fences, etc., should be cut in the spring before setting seed to prevent chalcis flies from maturing in them and later flying to the regular seed crops.

The practices outlined for the clover aphid and the clover-flower midge greatly reduced the amount of injury from the seed chalcid by entirely destroying, for a time, all seeds in which it developed. Following this practice, it is believed will result in small loss from this insect on the average. Any control measures known, however, are only partially effective because there is no regular emergence period for adults and because adults may migrate to a clover seed field from clover or alfalfa fields in nearby areas.

Grasshoppers Grasshopper attacks on clover and alfalfa seed fields are periodic but during seasons when these insects are numerous they probably cause Idaho clover seed growers more loss than any other insect pest. Many species are responsible for the damage. They are particularly hard to combat in clover and alfalfa fields for the reason that their eggs may be laid any place in the fields and a light or heavy infestation of young grasshoppers develops the following spring which is well distributed over the entire field. Light infestations, of no particular importance in grain or hay fields, may cause heavy loss in seed fields due to the insects feeding on the stems of seed pods after the foliage has begun to dry up.

Poisoned bran mash readily and cheaply kills grasshoppers when it can be scattered where they will feed on it, but it is difficult or often impossible to obtain control of the insects in standing clover where the growth

is dense and the ground well covered. In clover seed fields the best control of grasshoppers is obtained by cutting the hay crop and then broadcasting poisoned bran mash over the field after the removal of the hay and before growth of the plants is resumed. This procedure may be readily combined with control practices mentioned for the clover aphid and the clover-flower midge. The following formula has proven effective:

Coarse bran	100 pounds
Sodium arsenite	1 pint
(or white arsenic or Paris green 4 lbs.)	
Stock molasses	2 gallons
Amyl acetate	3 ounces
Water (about)	10 gallons

Mix together the sodium arsenite, molasses, amyl acetate and water and then add the solution to the dry bran and mix thoroly until all of the bran particles are moist. When white arsenic or Paris green are used instead of sodium arsenite they are first mixed dry with the bran and then mixed together with the solution composed of molasses, amyl acetate and water. Just enough water is used to make a moist mash that crumbles freely when broadcast, and care must be exercised not to have the mash sticky or sloppy.

Best results are obtained by broadcasting the mash early in the morning. Arsenic is slow in action and results will not be apparent in less than two or three days, and when grasshoppers are very numerous, the application may need to be repeated. Application is made at the rate of about 5 pounds per acre.

Grasshopper eggs are deposited in the soil from 1 to 3 inches deep. If exposed to alternate drying and moistening, freezing and thawing of late fall and winter a very heavy percentage of eggs is killed. Thoro cultivation effectively accomplishes this when done with a spring-tooth harrow in the late fall after all the eggs have been laid.

SUMMARY

1. The United States does not produce enough clover seed for its own needs.
2. Idaho seed is well adapted to and in demand in the northern and corn belt states.
3. Seed of high purity must be produced to meet users' demands.
4. Irrigated sections are especially adapted for clover seed production.
5. Only one variety of clover should be grown on a farm.
6. Seed of only highest quality should be used in seeding new fields.
7. Early spring seeding is essential.
8. Under irrigation a nurse crop may be used when seeding red and alsike clover. Under other conditions it should not be used.
9. Holding back the growth enables the grower to produce seed of high quality.
10. Fields should be carefully rogued to eliminate weeds.