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Alfalfa Seed Production

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EC 733

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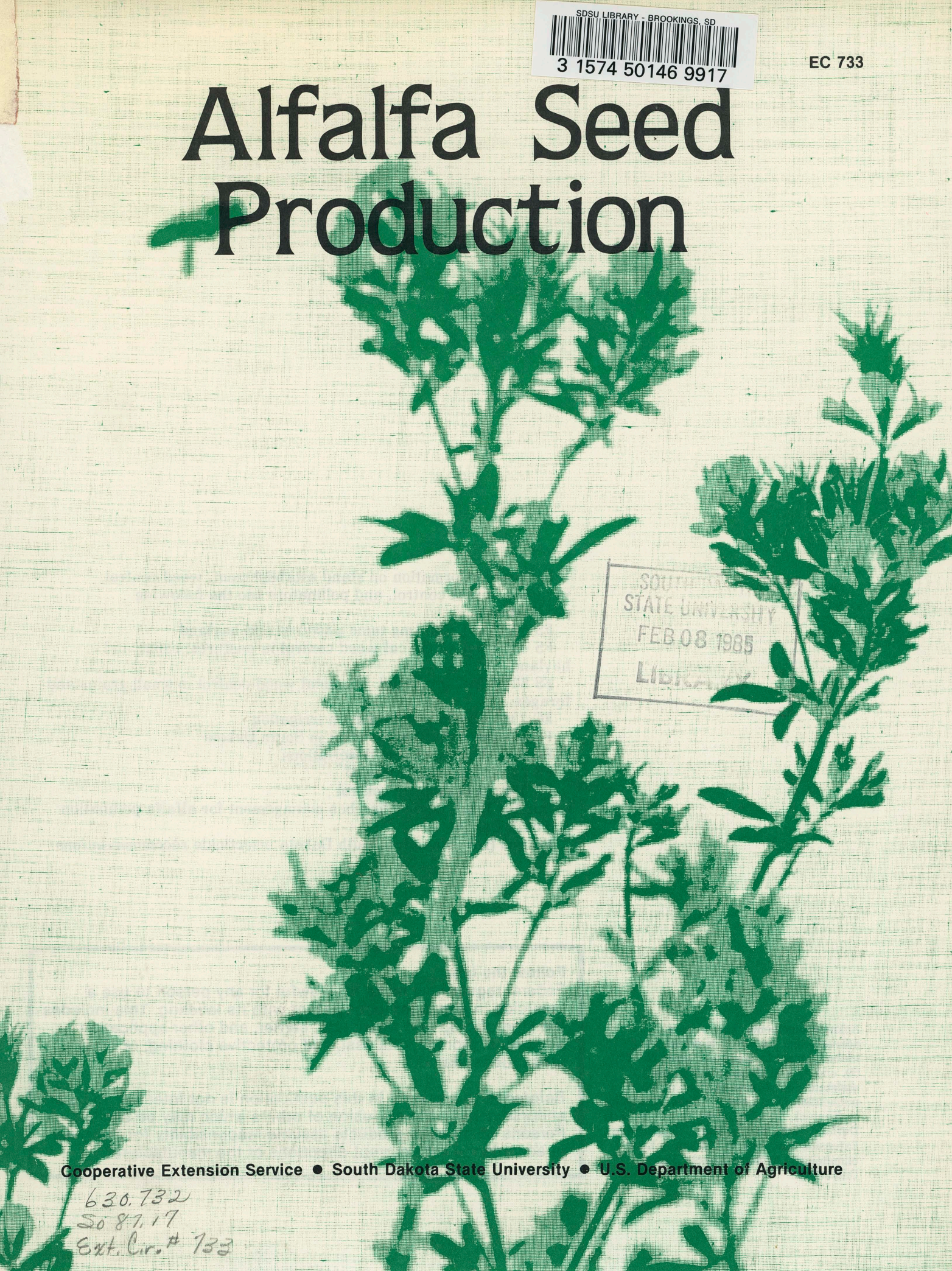

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For more information on stand establishment, weed control, varieties, insect control, and pollinators see the following publications:

FS 503 (rev), Planting tame pastures and hayland

FS 426 (rev), Chemical weed control in pastures, range and hayland

FS 525A (rev annually), Chemical weed control in small grains and forages

EC 730, Alfalfa production on irrigation

FS 529 (rev), Alfalfa varieties in South Dakota

EC 804, Alfalfa variety descriptions

FS 276 (rev), Alfalfa weevil

FS 556, Grasshopper control

Bul 544 (rev), Leafcutting bee management for alfalfa pollination in South Dakota

EC 683 (rev annually), South Dakota insecticide recommendations

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Alfalfa Seed Production

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Alfalfa seed has high market value; producing certified, adapted seed can become a more important enterprise for some South Dakota farmers.

Around 100,000 acres are harvested for seed each year, but the yield per acre is relatively low. Most producers harvest seed on a hit-and-miss basis. Only a few treat alfalfa seed as a major crop.

Much of the alfalfa seed planted in South Dakota is raised in southern Idaho, eastern Oregon, southeastern Washington, and the San Joaquin Valley of California. But the acreage of certified seed of varieties recommended for South Dakota is gradually shrinking in western states. These seed growers are switching to non-dormant varieties adapted to the Southwest and to proprietary varieties because they produce more pounds of seed per acre and/or bring a higher price per pound.

With the supply of certified seed of adapted varieties weakening, producers in some areas of South Dakota will find alfalfa seed a profitable cash crop. Alfalfa hay prices are unstable and demand fluctuates. The market price for certified alfalfa seed, on the other hand, has been high for several years and the demand is increasing.

It is anticipated that alfalfa seed will be a profitable crop for the foreseeable future. It will be even more profitable if handled as a primary crop.

Alfalfa producers, however, must decide if they want to be seed producers or hay producers. Virtually no one can be both. Individuals who have separate fields used for seed and hay production may be exceptions.

This publication discusses production practices to obtain high seed yields. Since little research has been conducted in South Dakota, the information presented here is based on research in Idaho (the leading alfalfa seed producing state) and the experience of professional alfalfa seed producers in Idaho and South Dakota.

Production Requirements

The basic requirements for maximum seed production are good stand; insect, weed and disease control; proper fertility; pollination; adequate moisture; and low relative humidity at flowering time. Most of these requirements can be met in South Dakota. Irrigation is needed for top yields, but profitable yields can be obtained on dryland.

Relative humidity is the one factor that irrigators cannot control.

Relative Humidity

Low relative humidity seems to be conducive to good alfalfa pollination. Relative humidity at the only five recording points in South Dakota is higher (Table 1) than at Boise, near the Treasure Valley of Idaho which is one of the best alfalfa seed producing areas in the United States. Relative humidity is highest in June at all South Dakota locations.

If relative humidity is the controlling factor, better pollination will occur on a second cutting in late July or August than on a first cutting in June.

It would appear that better pollination could be obtained in West River counties. At Rapid City the relative humidity in July and August is similiar to that of Boise in June and July. Since

Table 1. Comparison of relative humidity of Boise, Idaho, and five locations in South Dakota.

	Percent relative humidity					
	June		July		August	
Location	Noon	Evening	Noon	Evening	Noon	Evening
Boise (normal)	44	32	34	22	34	24
Cottonwood (1978)	41	39	38	31	33	28
Rapid City (1978)	51	47	47	41	36	36
(normal)	51	49	45	40	41	35
Huron (normal)	56	53	50	46	50	44
Aberdeen (normal)	56	53	51	47	48	42
Sioux Falls (normal)	55	51	51	48	52	50

most seed producers in the Treasure Valley obtain good pollination in June, growers in western South Dakota should get good pollination in July.

Production Systems

The procedures followed by two "professional" alfalfa seed producers in South Dakota illustrate some of the operations needed to obtain high yields.

These producers differ from the majority of the farmers who raise alfalfa seed in several ways: (1) alfalfa seed is a primary crop, (2) the crop is planted in rows, (3) leafcutting bees are used as pollinators, (4) bees in bee boards are placed in bee houses during pollination season and kept in controlled temperature rooms part of the year.

Dryland near White River. Gene Strain produces 100 to 150 lb/A of seed on 250 dryland acres and 200 to 500 lb on 60 irrigated acres. He uses a specially built planter to seed 1½ lb PLS(pure live seed)/A in 40-inch rows or "double plants" to seed 3 lb/A in 20-inch rows. After the stand is established he uses the following system.

1. Early June: Temperature is too low for pollinators to be active, so the first crop is clipped early. A few acres are left uncut to provide flowers for early emerging bees.
2. Mid-June: Apply insecticide when crop is budding.
3. Late June: Move bees to field when crop is flowering.
4. Early September: Windrow with swather used for cutting hay.
5. September 5-10: Combine with pickup attachment.
6. Late September: Apply simazine for annual weed control.

Irrigation near Newell. Dave Winkler averages 500 lb/A of seed on 100 irrigated acres but obtained 700 lb/A in 1977. He plants with four vegetable seed planters mounted on a tool bar. He seeds 2 lb/A in 30-inch rows and controls weeds with EPTC or benefin. After the stand is established he uses the following system.

1. Fall: Heavy irrigation.
2. Early spring: Control annual weeds with herbicide.
3. Early June: Cultivate to control weeds, kill volunteer alfalfa, and form irrigation ditches.
4. Early June: Irrigate.
5. Mid-June: Apply insecticide.
6. Late June: Move bees to field when crop is flowering.
7. Late August: Desiccate with diquat or dinitro.
8. Early September: Straight combine.

Irrigated
established stand management
Dave Winkler, Newell

Fall: Irrigate
Spring: Herbicide, preplant incorporated, cultivate
June: Irrigate
Mid June: Insecticide
Late June: Bees in field
Late August: Desiccate
September 1+: Combine

Dryland
established stand management
Gene Strain, White River

Early June: Clip first crop, leave a few acres for early bees
Budding: Insecticide
Blossoming: Bees in field
Early September: Windrow, combine several days later
Late September: Simazine for weeds

Crop and Soil Management

Methods of growing alfalfa for seed differ basically from those used for hay production. Seed producers do not want the lush growth needed for hay production.

There are ways to stimulate flowering without excessive vegetative growth, but there is no single procedure for all seed producers. Most growers tailor such techniques to their own situation.

Seedbed Preparation and Planting

Land preparation for establishment of alfalfa for seed does not differ from that for hay production.

The three essentials for stand establishment are (1) seeding at a uniformly shallow depth, (2) in a firm seedbed, and (3) removing competition from new alfalfa seedlings for 30 to 60 days after emergence.

Early spring, because of cool, moist conditions, is the best seeding time on dryland, but mid-August is also good if the field will be irrigated. It takes about 30 days for establishment. For more information on stand establishment see FS 503, "Planting tame pastures and hayland," and EC 730, "Irrigated alfalfa."

Solid Stands vs. Rows

Under most conditions, rows offer many advantages over solid stands. Rows can be cultivated to control weeds, kill volunteer alfalfa, and form ditches for gravity irrigation systems. Rows give a more open canopy, at least in the first part of the growing season, which provides

1. Greater penetration of light, higher air and soil temperatures, healthier plants, and earlier flowering.
2. Greater attractiveness to pollinating insects, better retention of flowers and pods on the lower part of stems, and better seed set.
3. Better penetration of agricultural chemicals, better weed and insect control, and more effective desiccation at harvest time.
4. Lower humidity—a less favorable environment for foliar diseases.
5. Lower percentage of scalded or brown seed.

There is no "most desirable" row spacing. In practice, distance between rows is governed by the equipment the operator uses on other crops.

Gene Strain, White River, seeded this dryland alfalfa in 20-inch rows. Fields like this produce an average 100-150 lb of clean seed per acre when pollinated with alfalfa leafcutting bees.

Dave Winkler, Newell, planted this irrigated alfalfa seed field in 30-inch rows and pollinated with leafcutting bees. It produced 700 lb/A of clean seed in 1977 and averages about 500 lb.

A sugar beet grower may use a 22-inch spacing so he can cultivate with his sugar beet cultivator, while a corn producer may use a 36-inch spacing. A specialized alfalfa seed producer may use a 30-inch spacing so he can harvest six rows with a 15-foot combine.

Data from Twin Falls, Idaho, indicate that best seed yields were obtained when alfalfa plants were spaced 2 feet apart in rows spaced 2 feet apart.

Other Idaho studies indicate that rows up to 36 inches are superior to solid plantings, with little difference between 24- and 36-inch spacing. Row spacing less than 22 inches showed little advantage over solid plantings. Yields from spacings over 36 inches have not been determined, but there is indication that yields decrease as row spacings increase beyond 48 inches.

Solid stands of seed production are successful where plant growth is restricted by soil conditions or other natural factors or by management. If excessive vegetative growth is controllable, good seed yields can be obtained from solid planting.

Solid stands have an advantage on slopes subject to erosion; rows are a common practice in the river valleys of Idaho but solid seedings are used on the hills of the Palouse country in Washington.

Seeding Rates

In row plantings, rates ranging from less than 1 lb up to 3 lb of PLS per acre have been satisfactory. The lower rates are most desirable if a precision planter is used. The higher rates are needed if seedbed preparation is poor or if the planter does not give an even distribution of seed at the lower rates.

One South Dakota producer plants 1½ lb PLS/A in 40-inch row spacings and 3 lb in 20-inch spacing; another plants 2 lb in 30-inch and 1 lb in 60-inch rows.

Several types of seeders are used for row planting—specially built planters, modified corn, soybean or sugar beet planters, or vegetable seeders mounted on a tool bar.

For solid seedings, plant 4 to 12 lb/A. The higher rates are less desirable, but are necessary when seed establishment will be difficult, when poor planting equipment is used, or when the crop might be used for hay. Generally plant 4 to 6 lb/A to provide an average 20 to 30 seeds per square foot. Use a grassland drill or a cultipacker seeder to get best stands with a minimum amount of seed.

Thinning of Stands

A common practice in Idaho is to thin both solid and row plantings each year that the stand is kept for seed. Elimination of plants within rows has usually stimulated seed yields. The advantages of opening stands by thinning are the same as those given for row plantings.

Thinning practices should not be extreme in any one year, as the remaining plants may not be able to fully use the new space available.

First or Second Crop

Most South Dakota alfalfa seed producers cut the first crop for hay and harvest seed from the second cutting if it appears that they will get a good seed set. Generally, they rely on wild bees for pollination.

Producers who treat alfalfa seed as a primary crop provide their own pollinators and generally do not plan on a hay crop.

In areas where relative humidity is high when the first crop flowers, it may be desirable to clip the first crop early. The regrowth will flower during a period of low relative humidity. Some producers clip or graze alfalfa to delay flowering until temperature reaches 70 to 75

degrees when pollinating bees become active.

Others with large acreages clip various fields at different times so that all do not flower at once. Pollinator bees can be concentrated on one field, set the seed, and be moved to another field. This reduces the number of pollinators needed and staggers harvesting dates.

Delaying the initial growth is beneficial for several reasons:

1. The blooming period can be altered to coincide with the period of greatest pollinator activity and the most desirable portion of the growing season.
2. Amount of vegetative growth can be controlled.
3. Damage from red spider, chalcid, and other insects is reduced.
4. Control of some weed problems is easier.
5. Some foliar diseases can be reduced.
6. A small hay crop may be obtained, if clipping is delayed long enough.
7. The hazards of adverse weather conditions may be avoided.

On the other hand, seed development takes place when rainfall is generally limited in South Dakota. Without adequate moisture during this period, less than maximum seed yields can be expected.

Comparisons made in Idaho indicate that substantially higher yields may be obtained under some conditions from non-clipped alfalfa (first cutting) than from later, clipped fields. In some years a heavy early seed set was obtained prior to emergence of pollinators (alkali and leafcutting bees). Since the areas were relatively free of competing bloom, concentration of available pollinators on the alfalfa produced a good seed set early in June.

In these studies, seed yields usually decreased as clipping date was delayed, with lowest yields from alfalfa clipped between June 2 and 17. These observations indicate that clipping after the first of June may reduce yields, especially when there are early frosts.

Using the first crop for seed has several disadvantages. Plants may flower in cool weather when pollinators are not active or when relative humidity is high and pollinators are less effective. If the crop is grown on deep, fertile soil with ample moisture, the resulting rank growth is undesirable.

1. Dense, lodged vegetation is a poor environment for seed and pod development.
2. Excessive vegetation is less attractive to pollinators.
3. The prolonged period of blooming requires an extended period of protection from insects and makes their control more difficult.
4. The prolonged period of flowering gives unevenness in seed maturity and reduced seed quality.
5. Rank growth reduces air movement and provides a moist environment conducive to development of stem and leaf diseases.
6. The larger amount of vegetation that must pass through the combine creates difficulties during harvest.

These disadvantages also apply to delayed growth where stand density and plant growth are not controlled.

Most Idaho producers raise alfalfa seed with irrigation, provide their own pollinators, and do not harvest a hay crop. Some South Dakota producers who use special pollinators also harvest the first cutting for seed, both on dryland and under irrigation. Dryland alfalfa seed yields at Brookings averaged 394 lb/A from the first cutting in 1974 tests and only 93 lb from the second.

Others, however, cut most of the first crop early for hay (around June 1), but leave a few acres for bees that may emerge early. Leafcutting bees are not active at temperatures below 70 F and are inactive during early June when the first crop is flowering. Clipping in late May or early June causes the crop to flower when temperatures are conducive to activity. Bees work from about 10 am until shortly before sundown.

Soil Fertility

Alfalfa seed should be inoculated before it is planted. The bacteria nodulate the roots and fix nitrogen into forms the plant can use. There is little or no need for nitrogen fertilizer.

Small amounts of nitrogen at seeding time may prove beneficial for stand establishment, if preceding crops have drastically reduced available nitrogen. But if a companion crop is used the nitrogen could stimulate the companion crop; the increased competition may be detrimental to alfalfa stand establishment.

An application of phosphorus or potassium generally does not increase seed production unless deficiencies are severe. A soil test should be used to determine the levels of phosphorus and potassium in the soil.

Irrigation

Use only enough moisture to maintain slow, even growth. Do not allow the crop to suffer a water deficiency at any time, but remember that excessive irrigation or irrigation at the wrong time can be detrimental, causing rank vegetative growth and inducing new growth. Sprinkler irrigation at flowering time may raise relative humidity, which is detrimental to pollination.

Several lighter applications at the proper time are preferred to fewer heavy irrigations.

Withhold irrigation, if possible, from the bud stage until full bloom to create a slight stress which slows vegetative growth and stimulates floral development needed for maximum seed yields. The key is "stress without distress."

Generally, apply a heavy application of water in fall or early spring followed with whatever lighter applications are necessary to keep the soil moist. One additional irrigation

may be enough for one part of a field, while several may be needed in other parts of the same field.

Choice of Variety

Plant an adapted variety that is in demand. Use a variety with the characteristics of high forage yield, good seed yield, winterhardiness, bacterial wilt resistance and—on irrigation—Phytophthora root rot resistance. If possible select a variety with tolerance or resistance to other diseases and several insects species. See FS 529 (revised in 1979), "Alfalfa varieties in South Dakota," and EMC 804, "Alfalfa variety descriptions," for more variety information.

Plant certified seed to produce high quality seed or plant foundation seed if you wish to produce seed for hay producers who plant certified seed.

Certified Seed

Certified seed is high quality seed of a known variety. It does not contain seed of other varieties or strains, is free of noxious weed seed, and contains a minimum of inert material and other crops. The certification and seed analysis tags are the seed producer's guarantee of varietal purity, varietal identity, and seed quality.

Certified seed is even more important for a perennial crop like alfalfa than for annual crops. The producer of uncertified seed, for example, may not remember or may not have known the alfalfa variety that was planted on a 10-year-old field. Consequently, the variety name that goes on a lot of uncertified seed may or may not be correct.

To meet seed certification standards, an inspector must check the field for varietal purity, other crops such as sweetclover and weeds, and seed must be tested for purity and germination. Seed must be 99% pure, germinate at 80% or better, contain no more than 1% inert materials or ½% weeds, and be free of noxious weeds.

Certified Seed Production

To produce certified seed, foundation seed (registered seed for a few varieties) must be planted on a noxious weed-free field that was not planted to alfalfa for at least 1 year and is isolated from other alfalfa by at least 20 rods. Keep the certification tag or bulk transfer certificate to prove that the crop is eligible for recertification.

Rogue weeds, sweetclover, and dodder before the field is inspected. Use harvesting and storage procedures that will maintain varietal purity and produce high quality seed. Keep records that show the location of seed while in storage.

Obtain more details from Seed Certification Service of the South Dakota Crop Improvement Association, University Station, Brookings, SD 57007.

Pollination

Alfalfa is 80-90% cross-fertilized. Seed is not developed unless flowers are fertilized with pollen from other flowers.

Pollination depends upon a tripping mechanism in the flower which releases upon disturbance by insect pollinators. In alfalfa the tripping mechanism is set off when a bee forces its head into the throat of the flower. As the flower is tripped the bee's head is momentarily caught between the petals and the tip of the sexual column. When the bee withdraws, the sexual organ snaps and the bee is showered with pollen in exactly the right position to contact the stigma of the next flower visited.

More than 100 species of wild bees are pollinators.

Bees work the flowers better when relative humidity is low. When it is high, the sexual organ is less rigid and does not snap; even if it does snap, less pollen is released.

Several mechanical devices have been tested for tripping alfalfa flowers but none are satisfactory.

Honey Bees

Honey bees visit flowers for either pollen or nectar. When they gather pollen they trip 80-100% of the flowers they visit. But when seeking nectar, they readily learn to avoid the tripping mechanism, collecting from the side. Only 0.2-2.0% of the flowers are tripped.

If you use honey bees as pollinators, use four to five colonies per acre when alfalfa is in full bloom. Disperse the colonies throughout the field or move them frequently to get best pollination.

Many honey bee owners are glad to place a limited number of colonies in an alfalfa field to collect nectar over a long period. If they supply four or five colonies per acre most flowers are pollinated in a week or 10 days. When fertilization takes place the flower dies and the source of nectar disappears. The honey bees must be moved to another source of nectar.

Consequently, honey producers are reluctant to stock a field heavily without additional compensation.

Bumblebees

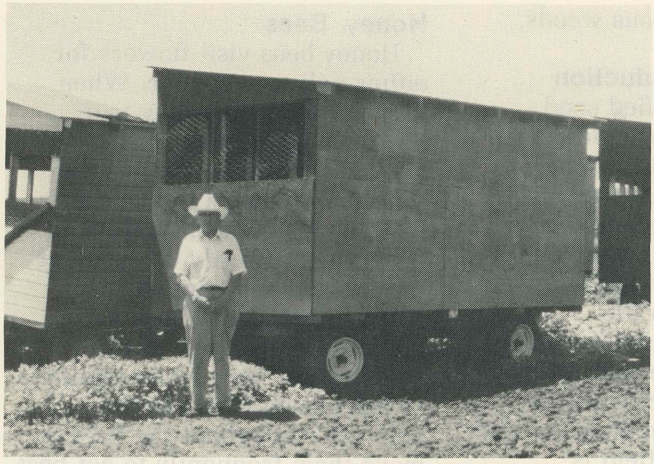
Bumblebees occur naturally in South Dakota. They are so large that they cannot sidestep the sexual column in the flower and are effective trippers and pollinators. Bumblebee populations vary from place to place and from year to year. They are generally more numerous in native prairie, where in some years they pollinate enough flowers to provide a fair crop of seed.

Wild bees are not reliable pollinators and seldom occur in large enough numbers to give maximum seed yields.

Alkali Bees

Alkali bees are found in western states, living naturally in saline soil areas of eastern Oregon. They are larger than honey bees and are effective pollinators.

During the nesting season, they burrow holes in the salty



Strain mounts bee houses on trailers so that the alfalfa leafcutting bees can be moved from field to field. He does the moving at night when most of the bees are in their nests.

Winkler will put bee boards containing 300,000 leafcutting bee pupae in this 8x20-ft house. The open front faces the east; heat from the morning sun activates the bees early. Wire protects the bees from birds and rodents.

soil to deposit eggs and hatch their young. Since alkali bees use these holes throughout their life cycle, they are susceptible to drowning from heavy rains.

In the Treasure Valley of Idaho, some producers have built alkali bee beds and successfully used these bees as pollinators; one producer uses bees from one bed to pollinate 600 A of alfalfa. The bees survive in southwestern Idaho because average annual rainfall is only 7 inches, of which 0.2 falls during the nesting season.

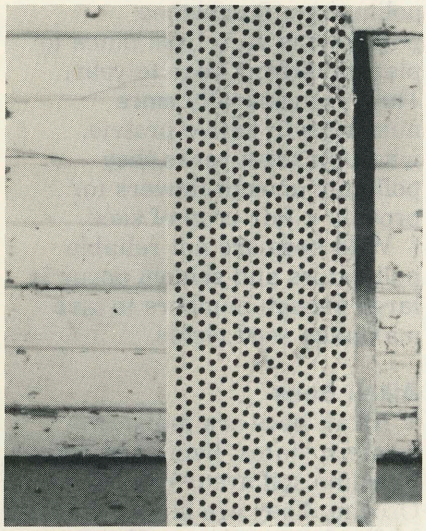
Alkali bee beds have been built at Brookings, Hecla, Ideal, and Piedmont. Bees survived but failed to multiply rapidly enough to make it feasible to attempt to propagate them for use as alfalfa pollinators.

Leafcutting Bees

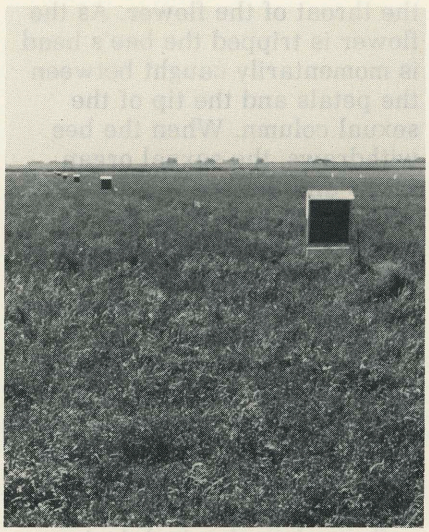
Leafcutting bees are smaller than honey bees, but are effective pollinators and are more widely used than alkali bees. For more detailed information about their use in South Dakota see Bul 544 (revised), "Alfalfa leafcutting bee management for alfalfa pollination."

The female clips a circular (1/4-3/8 inch in diameter) bit of leaf or flower petal of several species of plants in 4 to 10 seconds. She then carries it in her mouth to a hole she has selected for a nest. She builds a leaf lined cell at the base of the hole, deposits an egg with a load of pollen, taps it gently, and starts the next cell. She builds about seven cells end to end in the hole. In one season she will construct cells, deposit, and provision with pollen for about 35 eggs.

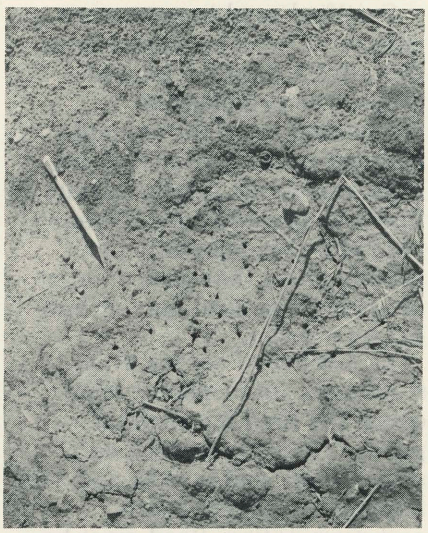
There is generally only one generation a year in South Dakota. The larvae complete their growth during the summer and go into the winter in the prepupal form. When the spring temperature reaches a certain level the larvae change into the inactive pupal stage. The bee remains as a pupa until it



This is the bee board used by many alfalfa seed producers. Leafcutting bees construct approximately 7 leaf-lined cells end-to-end in each hole.



About 200 boards in a house take care of 40 A. Center are bee shelters in a seed field. Right is an alkali bee nesting site showing emergence holes



in the moist soil. Alkali bees use these holes throughout their lives, consequently are subject to predators and weather.

emerges as an adult during late June or July.

A female may mate two or three times during the year, but once is enough. The egg, however, is not fertilized until she lays it. She has the unique ability to fertilize the first one to three eggs laid in a hole and leave others unfertilized and repeat the process for four or five holes. The fertilized eggs produce female bees and the unfertilized produce males.

Adult bees emerge first from the cells at the front of the holes or tubes while the older forms wait their turn. This orderly procedure prevents the damaging of unemerged cells. The first adults to emerge are males, who outnumber the females at the rate of two or three to one.

Bee boards and soda straws provide nests for leafcutting bees. Bee boards are generally made of ponderosa pine cut in 3-x 6-inch strips that are 4 feet long. Holes 7/32 inch in diameter and 2¾ inches deep, are spaced ½ inch apart.

Five boards containing bees and three empty boards per acre are placed in bee houses—one for each 40 A. Additional empty boards are added as needed. The empty boards are for multiplication of bees, and the houses are for protection from weather, birds, and rodents.

The soda straws are cut in half and placed in bee houses.

Unfortunately a number of insect predators infest the alfalfa leafcutting bee nests. Predators include about 10 species of flour beetles (red and black are the most common), the checkered flower beetle, several species of wasps, and a blister beetle. If winter temperature rises above 40°F, beetle larvae feed on the bee larvae.

Many leafcutting bees are stored during the spring in rooms where the temperature is held below 40 F to prevent beetle larvae from becoming active. The temperature is raised in time to permit bees to emerge when the alfalfa is flowering. At 70 F it takes 19 days for males to emerge and 21 days for females. At 90°F males emerge in 14 days. Adult beetles and wasps emerge in less time.

Effects on Yield

Most Idaho alfalfa seed producers use pollinators. Under irrigation one producer who uses alkali bees averages 100 lb/A on 600 A and has produced 1400 lb of clean seed per acre. Another producer, who uses leafcutting bees, averages 850 lb on 400 A. The county average is 450 lb.

A South Dakota producer near Newell who uses leafcutting bees averages about 500 lb/A on 100 irrigated acres and 150 to 200 on 270 dryland acres. In 1977 his old stands on irrigation averaged 700 lb and new fields produced 100 lb/A.

Another South Dakota producer near White River uses leafcutting bees and averages 100 to 150 lb on 250 dryland acres and 300 to 500 lb on 60 acres under irrigation.

A commercial leafcutting bee keeper in Idaho provides bees to producers for 20% of the seed. He ordinarily provides about 400,000 bees in one mobile house for 40 A. On one occasion he doubled the number of bees for 7 days; the field produced 1900 lb/A.

Weeds and Weed Control

Several cultural practices and herbicides control weeds during and after the establishment of alfalfa. The latest herbicide recommendations are given in the current FS 525A, "Chemical weed control in small grains and forages."

New Seedings

Prepare the seedbed immediately before planting for annual weed control. Tillage kills weed seedlings and allows the alfalfa to emerge before new weed seedlings come up.

Companion crops also control annual weeds. Plant a companion crop at about one half the normal seeding rate. On dryland, plan to harvest companion crops for forage. If there is sufficient soil moisture in late June to produce a grain crop without adversely affecting the alfalfa you may harvest it for grain.

Herbicides used to establish alfalfa are benefin (tradename *Balan*), EPTC (tradename *Eptam*), and 4(2,4-DB) (tradenames *Butyrac* and *Butoxone*).

Benefin. Use 1 1/8-1½ lb active ingredient of benefin per acre to control annual grassy and some broadleaved annual weeds.

Apply prior to planting and incorporate into the soil immediately after spraying. Incorporate with PTO-driven equipment set to cut 2-3 inches deep or use a double disk set to cut 5-6 inches deep and operated in two different directions at 4-6 mph.

Shallow incorporation with implements set to cut less than 2 inches deep may result in erratic weed control. Do not use a spring-tooth or spike-tooth harrow alone for soil incorporation.

Do not use benefin where cereals are used as a nurse crop.

EPTC. Use 2-3 lb active ingredient of EPTC per acre to control annual grassy and some broadleaved weeds.

Apply prior to planting and incorporate immediately to a depth of 2-4 inches as for benefin. Temporary crop stunting and searing of the first leaves may occur if conditions for germination and growth are not optimum.

Do not use EPTC where cereals are used as a nurse crop, but you may use it with flax.

2,4-DB. Use ½-1 lb acid equivalent of 2,4-DB amine or ½-¾ lb of 2,4-DB ester per acre to control kochia, Russian thistle, lambsquarters, or pigweed and 1-1½ lb of amine or ¾-1 lb of ester to control mustards, pennycress, smartweeds, or ragweeds. Use higher rates to get top kill of Canada thistle and field bindweed.

Apply when alfalfa is over 2 inches tall and weeds less than 3 inches.

Do not graze or harvest as feed for at least 60 days after treatment.

Established Stands

Cultivation can be used to control weeds between the rows of row planted alfalfa. Herbicides can be banded over rows or applied overall on solid seedings.

Simazine (tradename *Princep*), terbacil (tradename *Sinbar*), metribuzin (tradename *Sencor*), pronamide (tradename *Kerb*) and 2,4-DB (tradenames *Butyrac* and *Butoxone*) may be used in established stands.

The rates indicated below are for overall treatments. For band treatments the rates are the same for the area treated, but are lower for each acre of field. For example, a treatment rate of 1 lb/A in 10-inch bands over 30-inch rows is 1 lb/A in the band but only 10 # 30 = ⅓ lb for each acre of field.

Simazine. Use 1-1½ lb active ingredient of simazine per acre to control annual grassy and broadleaved weeds.

Apply after harvest before winter annuals emerge or after the first killing frost but before the soil freezes in the fall.

Do not graze treated areas for 30 days or cut for hay for 60 days after treatment. Do not use on sandy soils. Treat only stands that have been established for one year or more.

Terbacil. Use 0.4-1.2 lb active ingredient of terbacil per acre to control numerous broadleaved and grassy annuals.

Apply in the fall after harvest or in the spring before new growth starts. Use the lower rates on light soils.

Do not use on sandy soils. Do not replant treated areas to any crop for 2 years after application.

2,4-DB. 2,4-DB has not been tested for its effect on alfalfa seed production in South Dakota but has been used by numerous Idaho producers. If you wish to use this chemical on a trial basis, the following suggestions are offered.

Use ½-2 lb acid equivalent of 2,4-DB amine or ½-1 lb of 2,4-DB ester per acre to control annual and some perennial broadleaved weeds.

Apply when the legume is over 2 inches tall and annual weeds are 2-3 inches tall or perennials are 6-8 inches tall. Use the rates indicated for various weeds and "new seedings."

Do not graze or harvest for livestock feed within 30 days after application.

Metribuzin. Use 3/8-1 lb active ingredient of metribuzin per acre to control numerous annual broadleaved and grassy weeds.

Apply in late fall or early spring when alfalfa is dormant. Use only on alfalfa that has been established at least 12 months. Use the lower rates to control annual bromes.

Do not graze or harvest hay for 28 days after application.

Pronamide. Use 1-1.5 lb active ingredient of pronamide per acre to control several annual and perennial grasses. The low rate is for annuals such as the annual bromes and the high rate is for perennials such as bluegrass, wheatgrass and quackgrass. Apply in the late fall after soil temperatures are below 60°F. It may also be applied in the very early spring to control annual bromes. Pronamide may be applied in the fall of the seeding years.

Rainfall or irrigation is needed to move the herbicide into the soil.

Do not graze or harvest forage from treated areas for 45 days after treatment.

Dodder Control

Dodder is an annual parasitic plant that reproduces by seed and can be a serious weed in alfalfa seed fields, reducing seed yield and seed quality. Dodder seeds are similar to alfalfa seed in size and density, making it very difficult to separate seed of the two species.

It is a secondary noxious weed in South Dakota and its presence in alfalfa seed greatly reduces the value of the crop seed.

Ordinarily, 90% of dodder seeds have hard seedcoats. A dodder seed may lie dormant in the soil for several years until the seedcoat is broken or cracked, when it then absorbs water and germinates. Consequently, new seedlings germinate throughout the season for several years.

Though dodder may emerge from soil depths down to 4 inches, most seedlings emerge from the upper inch. A seedling is rootless and leafless and consists of a fine, yellow, threadlike stem 1-3 inches long. When it contacts an alfalfa or other host plant it twines about the stem of the host and its connection with the soil withers and dies. It then sends suckers into the host and obtains all of its nutrients from that plant. It spreads to other alfalfa or weed plants, and a single plant may form a mat up to 10 ft in diameter.

It is spread by seed and generally first appears as a circular patch in a field. This is the best time for control.

But there is no easy way to control dodder. It is usually necessary to kill top growth of the host plant. Tops of perennial alfalfa plants can be killed by flaming with a weed burner or by using contact herbicides. Or you can cut the alfalfa near the soil below the point of dodder attachment. Top growth that is cut off should be removed from the field in sacks or burned on the spot.

Obviously, most control practices are not usable on entire fields and are only practical for use on patches.

In some cases, frequent harrowing of dodder infested areas has controlled the weed. Harrow every 5-7 days when new growth (spring growth or second cutting) of alfalfa is developing to prevent many of the dodder seedlings from becoming attached to the alfalfa.

If a dodder seedling does not become attached shortly after it emerges, it exhausts the food supply in the small seed and dies.

The most effective contact herbicides are dinoseb and PCP mixed in diesel oil. Use them in the same way as outlined for "desiccation." Use enough spray to thoroughly wet the foliage. After the alfalfa plants and dodder have died, burn the sprayed patches.

Insects and Insect Control

Just as the encouragement of pollinating insects is important to alfalfa seed production, the controlling of injurious insects is vital to the production of plump, quality alfalfa seed.

Insects which chew on the plants cause damage which is quite obvious. Insects which suck plant fluids or rasp the tissue produce equally important damage which may not be visible for some time after feeding has occurred.

The small size and color patterns of many species make them difficult to observe on the plant.

The serious alfalfa seed producer should methodically and uniformly sample the insect populations in the seed fields. Use a standard beating net with a 15-inch diameter.

When insect numbers require chemical control, refer to the current South Dakota insecticide recommendations, EC 683, or to the county Extension agent.

If chemical treatments are needed after the alfalfa has begun to bloom, apply them when the pollinating insects are not working the field. Spray at night to reduce the hazard to pollinators.

Table 2. Potential damage to first or second seed crop by major insect pests in South Dakota.

Insect pest	Alfalfa seed crop damaged	
	First crop	Second crop
Alfalfa weevil	Yes	Possible
Aphids (includes pea aphid and spotted alfalfa aphid)	Yes	Possible
Crickets (primarily black field cricket)	Possible	Yes
Grasshoppers (includes differential grasshopper, migratory grasshopper, redlegged grasshopper, and two-striped grasshopper)	Yes	Yes
Leafhoppers (includes clover leafhopper and potato leafhopper)	Yes	Yes
Plant bugs (includes alfalfa plant bug, rapid plant bug, and two Lygus species)	Yes	Yes
Seed chalcids (includes alfalfa seed chalcid and clover seed chalcid)	Yes	Yes

Alfalfa Weevil

Alfalfa weevils have been found in all South Dakota counties since 1973, but counties on the western edge of the state have had most consistent damage.

In South Dakota the insect overwinters in the adult stage; oviposition occurs in the stems when plant growth exceeds 3 inches in the spring. Though adults feed on foliage, the major injury is caused by larval foliage feeding.

Severe damage skeletonizes the leaves, and the field takes on a whitish appearance similar to frost damage.

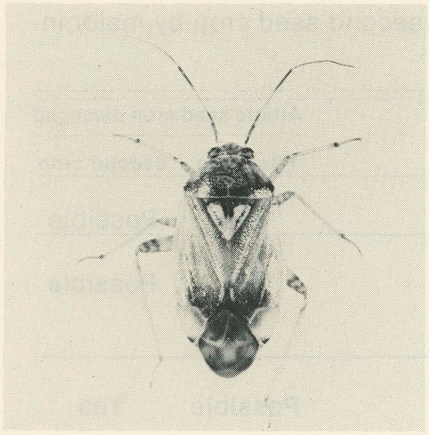
Adults are brownish-black snout beetles 1/8-1/4 inch in length. Shiny, lemon-colored eggs are inserted into the alfalfa stems in groups of about 20. Larvae are whitish-tan on hatching and change to green with a white strip down the back when about 3/8 inch long and full grown. Pupation takes place in leaf trash and alfalfa plant crowns on the soil surface during the first 10 days in July. The pupae are covered with a white, net-like cocoon about the size of a pea.

Where the weevil is usually a problem, dragging or harrowing fields before growth begins in the spring generally reduces first crop damage and may keep the population below the level requiring chemical control.

Use insecticides to control the weevil in first crop seed fields when 35% of the plants show chewing injury to the leaves or buds.

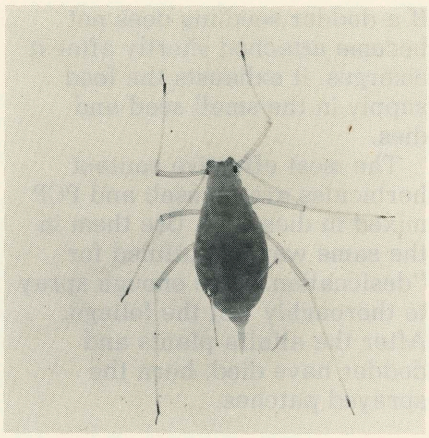
If the second crop is to be used for seed and the first cutting is infested, mow it early and remove it. Larvae are often killed when exposed to direct sunlight after the hay is removed.

Close observations of the plant crowns will show if regrowth is being retarded by larval feeding.



Lygus bug (length = 1/4 inch)

Potato leafhopper (length = 1/8 inch)



Pea aphid (length = 1/8 inch)

Should feeding in the crowns of the second crop be noted, apply an insecticide treatment to the stubble.

Aphids

The pea aphid and the spotted alfalfa aphid both overwinter as eggs in the field in South Dakota. During the summer both species reproduce without mating and give birth to living young hatched from eggs while inside the female. Both feed by sucking plant sap from stems or leaves of alfalfa plants.

Wilting, yellowing, loss of foliage, and heavy coatings of the sticky aphid exudate known as honeydew are symptoms of mild to heavy aphid damage. The honeydew often supplies the medium for the growth of mold.

The pea aphid is solid green in color, will reach a length of 1/6 inch, and may or may not have wings. During the summer the nymphs are born alive and require about 12 days to complete their growth and begin to give birth to their offspring.

Use an insecticide for control whenever the number of pea aphids per net sweep is 20 or more, unless the ratio of ladybugs (adults or larvae) is 1 or more per 200 aphids and daily temperature is above 50 F. Or use chemical control when the growing tip of the alfalfa plant wilts during the heat of the day (usually about 3 pm) and the ladybug ratio (1:200) is not present.

The spotted alfalfa aphid is pale yellow or gray in color with six rows of black spots on the upper abdomen. It is about 1/10 inch long when full grown and may or may not have wings. It takes about 7 days from birth to maturity.

Seedling alfalfa plants are most severely damaged, showing typical veining in the leaves before the foliage yellows and dies.

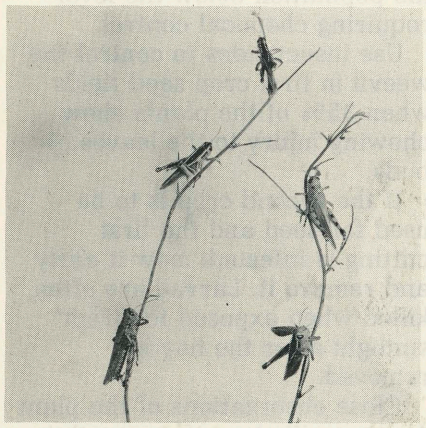
This aphid is most apt to be a problem on second crop alfalfa grown for seed or under excessively dry conditions on first crop seed.

A black net shows up the insect better when sweeping. Use an insecticide when the number of spotted alfalfa aphids averages 20 or more per sweep. However, infestations are usually kept under control by beneficial predator insects such as ladybugs or lacewing flies.

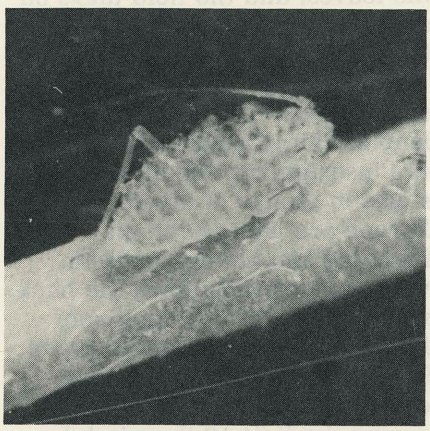
Crickets

The black field cricket often migrates from adjacent small grain fields into alfalfa seed fields after small grain has been harvested.

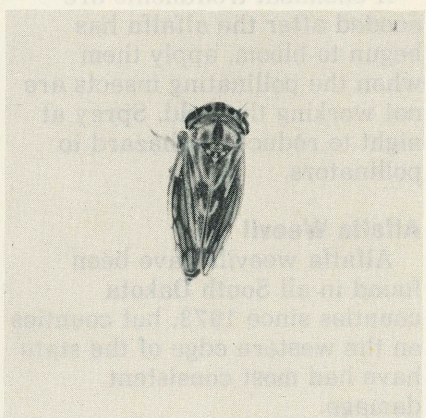
Small nymphs hatch from eggs in late May and early June and grow to the adult stage by mid-



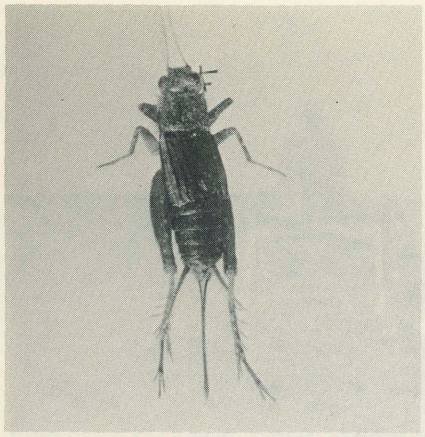
Grasshoppers (length= 3/4 to 1 1/2 inch)



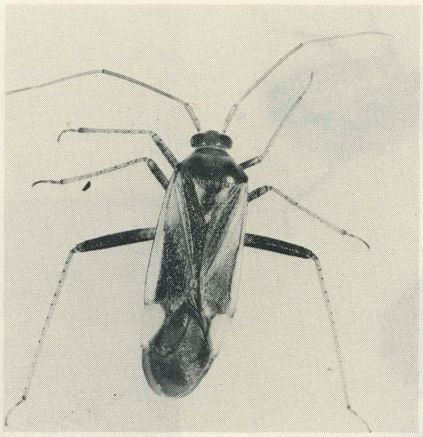
Spotted alfalfa aphid (length=1/16 inch)



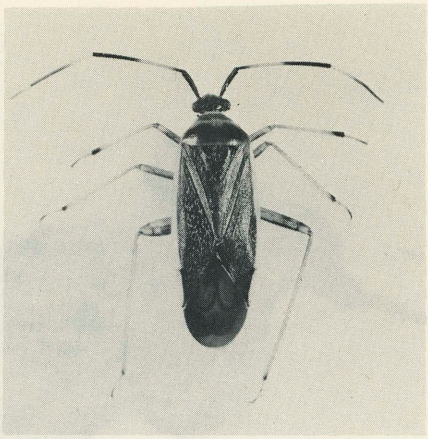
Clover leafhopper (length = 1/16 inch)



Black field cricket (length = 1 inch)



Alfalfa plant bug (length = 3/8 inch)



Rapid plant bug (length = 3/8 inch)

August. The body of the adult varies from 3/5 inch to 1 inch in length. Its antennae are longer than the body, the hind legs are fitted for jumping, and the ovipositor of the female may reach a length of 1 inch.

Crickets are seldom captured in a net because they are on the soil under the plants or windrows. The chirping of the males, particularly in late afternoon or evening, will advertise their presence.

By chewing off developing seed pods, crickets often reduce anticipated high seed yields to very poor yields by the time the crop is mature.

Individual bales of straw or burlap bags placed along the margins of the field can be used as sites for determining cricket populations. Turn bales or bags over quickly and count the crickets as they are exposed to the light.

Use chemicals for control if an average of two or more crickets per bag or bale is counted.

Grasshoppers

While alfalfa hay crops can tolerate quite a few grasshoppers and still yield a crop, alfalfa seed fields can be seriously injured by relatively few of these insects.

Injurious species all overwinter as eggs in the soil in or near alfalfa fields. The nymphs begin to hatch in late May or early June. Young nymphs (and adults) feed by chewing on the foliage and stems. Nymphs do not have functional wings and must walk or hop to new plants on which to feed.

Closely observe fields and surrounding areas to locate concentrated areas of hatching nymphs. Apply chemical controls to these nymphal concentrations. Timely spraying requires less insecticide because less area is treated and less concentrated sprays kill nymphs. Such treatment prevents the movement of the larger, more damaging grasshoppers into seed fields.

Since grasshopper damage to flowering portions and seed pods of seed plants can seriously reduce yield, close observation of grasshopper populations must be maintained. One or more grasshoppers (adults or nymphs) per net sweep or per square yard is sufficiently damaging to a seed crop to require chemical control.

If possible apply sprays over the entire field before blooming. Later applications can be made to field borders to control migrations into the field.

Leafhoppers

Several species of leafhoppers feed on alfalfa. Some species pass the winter in the egg or adult stages in South Dakota, others migrate into the state in the spring from overwintering locations in southern states.

Eggs hatch to produce active nymphs which can hop short distances. Adults are fully winged and, depending on the species, measure 1/20 to 1/4 inch in length. The body is basically wedge shaped.

Adults fly out of the foliage, appearing almost like small dust clouds, when you walk through a heavily infested field.

Leafhoppers pierce the tissue of leaves and suck plant sap. Under South Dakota conditions, they cause little foliage discoloration other than some yellowing by high populations.

Use an insect net to determine threshold of injury populations. Ten or more adults or nymphs per sweep constitute a population that can produce economic loss. Chemical sprays can prevent this loss.

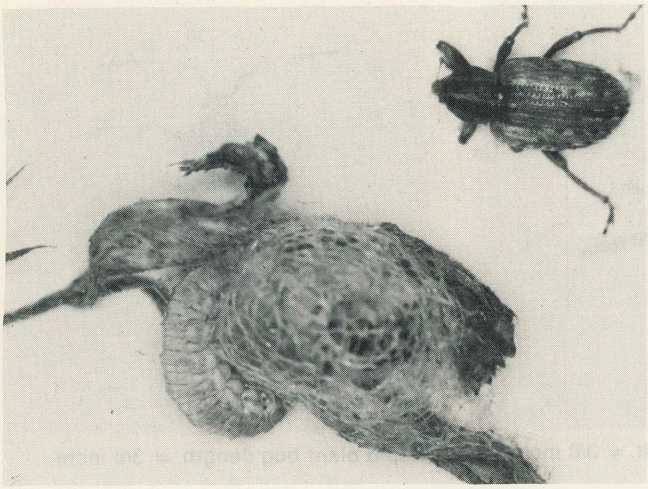
Plant Bugs

Plant bugs generally constitute the greatest insect threat to alfalfa seed production.

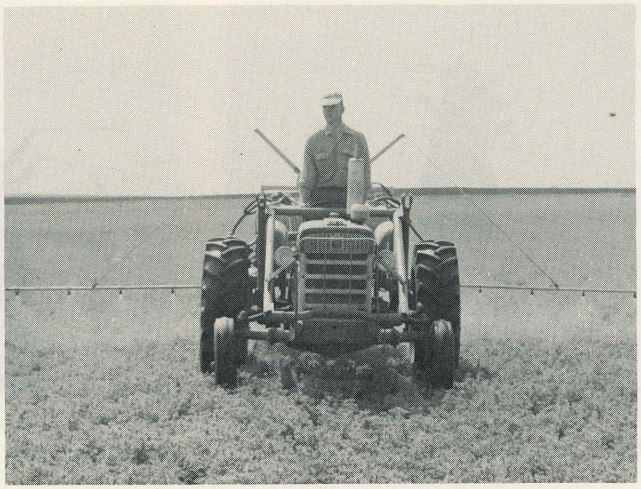
They pierce the upper stems and suck plant juices. This damage is not immediately identified. Early feeding causes florets to drop before or after they have been pollinated. Later feeding restricts nutrient flow to the seed, resulting in shriveled seed.

In South Dakota the plant bugs of greatest concern in alfalfa seed production are the alfalfa plant bug, the rapid plant bug, and two species of Lygus (*L. lineolaris* and *L. elisus*).

They overwinter in South Dakota alfalfa fields as adults. They lay eggs in the growing point and flowering areas of the



Alfalfa weevil larva, pupa and adult (adult length = up to 1/4 inch)



Most injurious insects are so small that it's difficult to see them on the plants. You must regularly sample seed fields with a beating net. If you spray, do not treat the field when pollinating insects are working the alfalfa.

alfalfa plant. The early nymphal instars are bright green and about the size of pea aphids. Later instars tend to take on more distinct markings and show the developing wings.

Adults may migrate into seed fields in large numbers during the season. Make weekly determinations of populations with the sweep net during all stages of crop growth.

When the population averages one or more adults or nymphs per sweep, use chemical control to prevent economic loss.

Seed Chalcids

The alfalfa seed chalcid and the clover seed chalcids are very small black wasps about 1/15 inch in length. These insects overwinter as full grown larvae in the alfalfa seed in storage or in the field.

Adults lay their eggs in the developing seed after hatching, larvae destroy the inner portions of the seed.

Infested seed is lighter than normal seed and is commonly blown over with the chaff by the combine. The wasps then emerge later in the season to provide a second generation, or the full grown larvae pass the winter in the seeds.

Damaged seed in winter storage contains many with cracked coats and with small holes caused by adult emergence. Total germination is low.

There is no suitable control for these insects. Where damage is a continuing problem it helps if all seed producers in the area harvest at the same time—all taking the same cutting for seed. This eliminates a buildup of chalcids on first crop fields to damage second crop fields.

Thorough mowing or removal of volunteer alfalfa and clover plants producing seed in the area also eliminates buildup sites for chalcids. Destroying light seed removed in the cleaning process prevents adults from emerging from such material.

Harvesting

As a general rule, harvest alfalfa seed when about two-thirds of the seed pods are brown. This stage is difficult to distinguish when the flowering extends over a long period but easily identified when sufficient pollinators were used to do the pollinating in 7 to 10 days.

Harvesting too early collects too many immature seeds, while late harvesting causes shattering and may allow sprouting; both result in lower seed yield and qualilty. Inclement weather at harvest time reduces not only the amount of seed but also the quality.

Harvest by windrowing and combining with a pickup attachment or by chemical curing (desiccation) and direct combining. The method to use will be influenced by these factors:

1. Weather conditions such as strong winds, rains, or dewless nights.
2. Grower preference.
3. Maturity of stand and amount of green seed.
4. Economy of operation.
5. Length of harvesting season.

Chemical Curing

The use of chemicals to artifically cure an alfalfa seed crop so it can be harvested by direct combining is an accepted practice.

Chemical curing eliminates the need for cutting and windrowing, which may increase loss of seeds (40-50 lb/A in Nebraska tests) due to shattering. Furthermore, direct combining of treated crops reduces the hazard of windrows being blown about by the wind.

Apply chemical desiccants when the principal seed crop is mature or at about the same time as the field normally would be cut with a swather.

Materials used for chemical drying are classified as contact herbicides. Sprays kill only leaf and stem tissue that is contacted by the spray solution. Therefore,

it is important to obtain good spray coverage.

Chemicals approved for use in desiccating an alfalfa seed crop include diquat, dinoseb (dinitros-DNBP & DNAP) PCP (penta), and endothal.

Dinoseb. Mix dinoseb compounds with oil and/or water. Dinoseb and oil acts quite rapidly and is effective in drying all types of weeds and grasses. It is less effective under cool conditions. Seed pods that are not mature at application do not produce good seed. Very heavy foliage may require a second application. Treated crops can be combined in about 5 days.

Use 1¼-2 lb active ingredient in 10 gal of diesel oil per acre for aerial application. Use 8-15 gal of oil per acre or 30 gal of a 1 to 5 ratio oil-water emulsion in ground rigs.

Apply when the principal seed crop is mature enough for harvest by swathing. If foliage is heavy, make two applications 2 days apart using 1¼ lb/A in each application.

Follow all handling precautions as dinoseb is extremely toxic and stains badly. Do not graze treated areas or feed the forage to livestock.

Diquat. Diquat mixed in water is extremely effective on alfalfa in Idaho and normally dries a crop in 7 to 10 days. Although it dries a crop relatively fast, some pods which are not quite ripe will mature.

Use 1½-2 pts in 10 gal of water per acre by air or 15-30 gal of water with ground rig. Use a wetting agent. Apply when the principal seed crop is mature enough for harvest by swathing.

Don't apply to crop wet from rain. Do not graze treated areas or feed treated forage to livestock.

Although diquat is a water soluble, non-volatile salt, it may drift considerably because of the very small spray droplets from aerial application. Do not apply when drifting may be a problem, especially during periods of inverted field air temperature—when the temperature is cooler near the ground than at a short distance above the ground. This cap of warm air prevents air mixing vertically, and the spray particles are not mixed with the surrounding air. A cloud of spray droplets may be suspended and carried great distances under these conditions.

PCP. Under Nebraska conditions dinoseb and PCP have given the most consistent results. They have been superior in drying up weed growth which occurs in the seed crops. No effect on germination has been found.

Both chemicals give rapid drying action which may permit harvesting as soon as 24 hours after treatment when hot, dry conditions prevail. A period of 2-3 days is a more common interval.

Use 4-6 lb active ingredient (4-6 qts) of PCP per acre after most seed pods have turned brown. Apply in 5-10 gal of diesel fuel by air.

Endothal. Endothal is slower acting than other desiccants and works best on seed crops that are low in moisture. Results have sometimes been disappointing when endothal was applied to lush growth.

For medium stands use 6 lb active ingredient (1½ gal) in 8½ gal of water per acre. For heavy stands, use 4 lb (1 gal) in 9 gal of water per acre and repeat in 5-7 days. Apply when the principal seed crop is mature enough for harvest by swathing. Weather will affect drying time, but this crop is usually ready to combine 8-10 days after treatment.

Do not graze treated areas or feed forage or seed from treated crops to livestock.

Combining

Many growers can save alfalfa seed and improve its quality by paying more attention to the proper adjustment of the combine. Harvesting conditions may vary greatly from year to year and even from day to day.

Adjustment of the combine to fit specific conditions of the crop is essential. All too frequently, germination is reduced by mechanical damage at harvest time and may not meet the standards for seed certification.

Seed is not marketable unless it meets certain minimum standards of germination. It then has to be rerun over special machines to remove cracked or broken seeds or "light seed." During this process, some good seed is unavoidably removed, adding to the loss of seed due to improper threshing.

Seedsmen often report an excessive amount of inert material in alfalfa seed. Some growers produce seed with only 5-10% inert matter, while others deliver seed containing 50-60% inert.

The latter group pays trucking on twice as much weight as is necessary and only gets paid for the half of the truckload that is "clean seed." The situation can be avoided by adjusting the combine properly.

Though many suggestions for the adjustment of the machine can be offered, the best is "read your operator manual and follow the directions when making your initial adjustments." Then you may have to make minor changes depending on harvest conditions.

Cylinder Adjustment. Adjust the cylinder so that the closest cylinder bar is not less than 1/8 inch and not more than 3/8 inch from the concave on the rasp-bar cylinder. Maintain this clearance for most fields even though the front clearance is usually greater than the rear clearance. Adjust field rate of very heavy crop so that not more than a 5/8-inch clearance is needed.

Cylinder Speed. Amount of seed damage is closely related to surface speed of the cylinder. When combines are properly adjusted visible damage can be reduced to 5% or less.

Excessive cylinder speed breaks up the straw to a greater extent, overloads the separating shoe, and causes excessive seed damage. Too slow a cylinder speed increases the amount of unthreshed seed.

You can use lower cylinder speeds when flax rolls are mounted in front of the cylinder. Use a cylinder speed of 700-1300 rpm.

Calculate proper cylinder surface speed by first multiplying cylinder diameter (ft) by 3.14 to obtain the cylinder circumference. Then multiply the circumference by cylinder speed (rpm). Use the lowest cylinder speed whenever possible:

Windrowed:
without flax rolls
3600-4400 ft/min
with flax rolls
4200-4800 ft/min
Spray-cured: 4000-5000 ft/min

Straw Walkers. Operate straw walkers at the manufacturer's recommended speed and check regularly to make sure they are not plugged. Examine walker curtain or curtains to be sure they are not torn and are in the down position.

Cleaning Shoe and Fan. Under most conditions, set adjustable chaffers with openings of 3/8-1/2 inch, measured at right angles to the axis of the openings. Set sieve openings at 1/16-1/8 inch. Use a grain sieve with hole sizes of 1/10-5/32 inch in diameter.

Clean all sieves at least twice each day. To obtain the proper wind adjustment, open the fan shutters to the maximum and close gradually to decrease the amount of wind going over the shoe until seed loss is reduced to a minimum.

Cleaning fan settings vary considerably among makes of combines, so always consult the operator manual for specific recommendations. On machines equipped with variable speed fans, reduce fan speed gradually to obtain the same effect. After each change, check the previous seed loss over the shoe.

When the wind is properly adjusted there should be only an occasional light seed in the air stream and a minimum loss of free seed riding over the chaff.

If the amount of wind is still too high after shutters are closed or fan speed decreased, you may need to remove some of the fan blades. Be sure to keep the fan in balance. If removal of the fan blades is not possible, modify the shutters so that wind can be controlled. Adjust wind for maximum seed recovery rather than for amount of clean seed.

Set the wind deflector to direct the air blast to the front half of the chaffer. Raise the chaffer extension about one inch at the rear and open it a little wider than the main chaffer to obtain maximum recovery of unthreshed pods and free seeds missed by the chaffer.

If large amounts of tailings pass through the return auger, the setting of the adjustment sieve or fan blast is incorrect for conditions of the crop and the return auger or elevator will plug.

Method of Harvest. When harvesting spray cured stands by the direct cut method attach a short vertical cutter bar on one end of the platform or header to help reduce shatter losses. Use lifter guards, and you may remove the reel in light stands.

For the windrowed method, use a ground driven belt pickup device. Adjust the speed so that it is 10-15% faster than the ground speed of the machine. Mount a block on the cutter bar edge of the platform to prevent pods and free seed from being carried off the front edge of the header.

When using either the direct cut or the pickup belt, reduce the speed of the platform feed auger to get good feeding action.

Spray cured stands may require reducing the auger speed 50% below the speed recommended by the manfacturer.

Rate of Harvest. The harvesting rate is as important in alfalfa seed harvesting as it is in all other crops where the combine is used. Maintaining a constant feed rate of 145 lb/min is a good rule of thumb. Vary the forward speed of the machine (you may have to change gears) to maintain this rate.

Though it may be necessary to change ground speed, be sure to maintain the same cylinder speed.

Alfalfa seed losses increase rapidly if the 145 lb/min feed rate is exceeded or reduced. A 10% increase in feed rate above 145 lb/min increases total seed loss by 20%.

To obtain an average of 145 lb/min of material entering the machine, calculate or estimate the tons per acre (dry weight) of alfalfa in the field, select the appropriate width of cut of the machine, and then determine the correct speed of the machine. Use the formula:

$mph = 35.89 \div (A \times \text{width of cut})$.

Ground speed is given in Table 3 for two widths of cut.

Table 3. Ground speed for two machines to give a feed of 145 lb/min with several production levels of alfalfa.

Width of cut (ft)	T/A	mph
12	1.5	1.99
	2.0	1.49
	2.5	1.20
	3.0	1.00
	3.5	0.85
14	1.5	1.71
	2.0	1.28
	2.5	1.02
	3.0	0.85
	3.5	0.73

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