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LUCERNE SEED PRODUCTION IN SOUTH AUSTRALIA

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F O R E W O R D

This report presents a brief history of lucerne seed production leading up to a description of the present lucerne seed industry in South Australia followed by local recommendations on all aspects of seed production from crop establishment to cleaning and certification of seed.

As a preliminary to my preparation of this report my colleague Mr. W.O. Coleman, made an extensive review of published literature on lucerne seed production. This was most useful in evaluating farmer observations, departmental trials, research and overseas practice.

The report has previously been published and distributed as an extension brochure for use by seedgrowers in South Australia.

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By D.C. Ragless and W.O. Coleman.

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1. INTRODUCTION

Lucerne appears to be the only forage crop cultivated before recorded history. About 2,000 years ago the plant had become an important item of Roman agriculture. Early Colonists took lucerne seeds from Spain, England and Germany to the New World - the American Continent.

The first record of its introduction to Australia is in a report written by Governor King in 1806. In 1926 there were 17,050 acres in the Commonwealth, by 1954-55 this had been increased to 1,051,584 acres, and in 1965-66 this had increased to 2,831,208 acres.

Lucerne seed production in South Australia started in the mid twenties when small quantities of seed were produced. Production has steadily risen since then until the present time. Lucerne markets have expanded at about the same rate as production. It is considered that present production could be greatly increased without meeting problems of marketing. At present over 75% of South Australian grown lucerne seed is exported interstate. A small quantity of seed is exported overseas. There is a potential for an increased export trade. There is however need for a realistic survey to find the potential expansion of the seed lucerne industry. Such a survey would not meet the situation if it consisted of only the summations of over cautious seedsmen.

New varieties of lucerne are being developed, these need to be efficiently and rapidly multiplied. The demand for these and the existing varieties is expected to increase. There is a potential to grow some varieties especially for export. To successfully develop this potential it will be necessary to produce seed in larger quantities and at prices which are competitive with other seedgrowing countries.

To achieve these it is necessary that production efficiency be improved. Average yields per acre in South Australia have been comparatively low.

This State has the necessary climate, soils and in the South-East, water for irrigation to develop a specialised lucerne seed producing industry. This is slowly developing, but there is scope for much more rapid development.

In the areas north of Adelaide lucerne seed growing has developed from original seed paddocks at Booborowie. This area has consistently produced high quality seed which is now the accepted standard for comparison of Australian lucerne seed. In favourable seasons the northern lucerne areas are capable of high yields. These can be as high as 500 lb. of seed per acre but are rarely higher. Average yields over the last ten years rarely exceed 200 lb. per acre and often are as low as 50lb

In the upper South-East extensive areas of lucerne are harvested for seed in favourable seasons. Yields can be as high as 200 lb. per acre but in the absence of good spring rains are less than 56 lb. per acre.

In the central South-East large areas of irrigated lucerne produced seed. Yields in excess of 1,000 lb. of clean seed per acre have been obtained, however, yields are variable and rarely in excess of 600 lb. often being as low as 200 lb. It is in these areas in which average yields can be most improved in the future.

2. METHODS OF SEED GROWING

Two main systems of production may be seen in South Australia.

The first is primitive, casual and elastic. Lucerne is sown primarily for feed with seed production as a secondary consideration to suit the convenience of the farmer. This system has the advantage that it enables the farmer to receive an extra cash return in favourable seasons over and above grazing returns. Costs per acre of production are low although not necessarily the lowest on a per lb. of seed cost basis. It is desirable that sideline seed production continues to contribute to our overall harvest. It is however, undesirable that it makes up the basis of a seed growing industry because fluctuations in production from season to season are too great. This has the effect of encouraging speculative seed markets with large fluctuations in price. It also prohibits the development of a worthwhile export of seed due to unavailability of seed in some seasons and often seed which is too highly priced to compete with overseas markets.

With the second system of seed growing lucerne is managed primarily for seed production. This method allows the grower complete freedom to adopt the best techniques for the production of maximum yield and best quality seed. Specialised lucerne seed crops are best grown in wide spaced rows. Although good seed crops are grown on livestock pastures the specialised professional seedgrower with suitable soil and organised primarily for seed production can obtain higher yields and more regular yields than those from sideline crops for livestock pastures.

Compromise production of livestock and seed is carried out in South Australia. However, under this system it is difficult to obtain full returns from either livestock or seed. This is because requirements of lucerne for maximum fodder production and requirements for maximum seed yield are quite conflicting. For instance a relatively dense stand of lucerne with adequate moisture gives highest fodder yields. However a thin stand of lucerne stressed for moisture gives highest seed yields.

3. VARIETIES OF LUCERNE

The following varieties are currently being grown for seed production in South Australia.

Hunter River

Until recently all lucerne grown in Australia was of Hunter River variety. It is extraordinarily well adapted to a wide range of local conditions. Flowers are rather dark violet to white. It has an erect habit of growth, coarse stems, few branches and early flowering. Hunter River lucerne is very persistent and recovers well from cutting.

African

Is characterized by exceptionally good winter growth, rapid recovery following cutting, and good daily growth rate under high temperature conditions. It has an upright growth habit. Unfortunately it is susceptible to frost and is a short lived variety, thinning out after four years. It has the reputation of being a rather poor seed yielder.

Siro Peruvian

Similar to African in that it, too, makes exceptionally good winter growth. It is a short lived variety.

Du Puits

This variety was developed in France and is one of the most widely grown varieties in the world. It has been a consistently good performer in trials in the U.K. It is reputedly suitable for areas with cold harsh winters because of its winter dormancy. There are prospects in South Australia for seed production of Du Puits variety for export. Du Puits has the reputation of being a heavy seed yielder and present local experience supports this reputation.

4. ESTABLISHMENT OF SEED CROPS

(a) Soils

Lucerne will survive on a very wide range of soils from acid, light and deep sands to shallow, or heavy alkaline clays. While it is possible to grow lucerne and harvest seed on these soils, high yields can only be obtained on the more suitable soil types.

- (1) Soil should be adequately drained. Lucerne appears to withstand more flooding on alkaline soils than acid soils.
- (2) Deep soils with good water holding capacities.
- (3) Fertile soils of good structure.
- (4) Alkaline soils.

(b) Seed bed preparation

Lucerne establishment suffers from competition from other plants especially rapidly growing annuals.

An ideal seedbed is therefore weedfree and should have 1-1½ inches of friable crumb structured soil overlying compacted soil. Care must be exercised with heavy clay soils to ensure that they are not too fine and will cake following rain and with light sandy soils, ensure that they are sufficiently firm and consolidated.

A recommended method of preparation is to prepare as good a seedbed as is possible using cultivation then wait for yet another weed germination. When these are small spray with 1 pint each of diquat and paraquat plus wetter and sow seed immediately using a disc drill (or similar machine) which will disturb the surface as little as possible.

(c) Rate of sowing and row spacemnt

Thin seed crops are best for lucerne seed production because they give best yields. Widely spaced plants develop extensive root systems, strong crowns and many branched stems. These produce more flowers and a greater percentage are pollinated than with dense crops. Row cropping of lucerne seed crops is the established method in many overseas countries of achieving optimum stand density for seed production. It is a convenient method of achieving correct plant density and enabling other plant growth to be controlled. Overseas research work has shown that higher yields are obtained by sowing relatively heavily and mechanically thinning plants out rather than by sowing at a low rate. This is thought to be caused by the greater importance of weed competition during the early life of thinner crops. American seed growers sow 2 lb. of seed per acre in 36" rows and remove alternate 1 foot lengths of row after the second year's harvest. However present experience in South Australia suggests that rowcropping of lucerne seed crops will not in itself result in greater yields.

The lack of effective pollinating insects is the limiting factor in obtaining better yields in South Australia. When this deficiency is overcome rowcropping can be expected to help further raise seed yields.

(d) Time of sowing

There are two alternate times of sowing - autumn and spring. Both have advantages.

When establishing unirrigated lucerne in areas receiving less than a 16 inch average rainfall, spring sowing is risky.

In general in districts of over 20 inch rainfall spring sowing can have the following advantages: less competition from winter weeds, seedlings grow vigorously because of warmer and longer days than autumn, attacks by lucerne flea and red-legged mite are less serious.

If the area is likely to be troubled by summer growing weeds (such as sorrel) autumn sowing is more suitable.

Autumn sowing should be carried out early (providing basic seed bed requirements are not sacrificed).

(e) Depth of sowing

Seed should be sown deeper on lighter soils than heavy soils. Seed should be sown relatively deeply if dry weather is anticipated following sowing and at shallow depth if wet weather is anticipated. Autumn sowings should usually be shallow at up to $\frac{1}{2}$ inch deep and spring sowings deep at from 1-2 inches depth.

(f) Seeding Methods

Accurate sowings can be best obtained by mixing seed with fertilizer. However, on acid soils it is unwise to mix seed with superphosphate-trace elements mixtures because effective establishment will be prevented. It is best to mix seed with agricultural lime (calcium carbonate). This is an essential method for effective establishments on poor acid soils and is a good method on all soils. Inoculation of seed is essential for seed sown on acid soils and a recommended practice for seed sown on alkaline soils. Lime pelleting is recommended if it is desired to sow seed in contact with superphosphate or to store seed following inoculation.

The disc drill is the best machine for sowing lucerne seed crops.

Desired row spacing can be obtained by one of the following methods: firstly, several hoses can be led into one boot. Larger boots to accommodate three, four or five hoses can be fabricated from sheet metal. This method has the advantage that the overall sowing rate of the drill is unaffected, large quantities of fertilizer can be applied and the machine can be readily converted back to standard.

The second method involves removing stars (those which feed hoses which will not be used), knocking out the pins and replacing the stars.

It is possible to devise other methods usually involving blanking off sections of the box with heavy cardboard or tin. The disadvantages of these methods are that usually seed and fertilizer seep past and dribble out resulting in plants establishing in between the row sowings.

If a three box drill is available superphosphate and trace elements are best applied at seeding time. If not they should be applied immediately prior to sowing seed. If the final cultivation of the seedbed is done with the disc drill or combine, superphosphate and trace elements should be applied at this time so achieving two operations at once.

5. FERTILIZERS

The most important fertilizer for lucerne seed crops in South Australia is phosphate. Recommended application rates vary depending on the particular situation. The following table summarizes current recommendations.

<u>Annual Rainfall</u>	<u>Superphosphate applied at Sowing per acre</u>	<u>Average Annual Dressing of Superphosphate per acre</u>
15 inches to 20 inches	1 bag	1 cwt.
20 to 25 inches	1 to 1½ bags	1 cwt. to 1 bag
Over 25 inches	1½ to 2 bags	1 bag
Irrigated	2 to 3 bags	1 bag autumn and 1 bag spring
	N.B. (1 bag = 187lbs.)	

On lighter soils particularly deep sands and the sand over clay soils trace element responses can be expected. On the former soils in the central and lower south east trace elements have been proved essential for both establishment and for subsequent growth. Copper, molybdenum and cobalt are necessary. The latter is only of benefit in obtaining rapid, healthy nodulation. Copper sulphate is best applied at the rate of 7 lb. per acre at sowing with maintenance dressings of 1 lb. per acre per year. Molybdenum sulphate is best applied at the rate of 1 oz. - 2 oz. per acre at establishment with a similar quantity as a maintenance dressing every five years. Cobalt sulphate is applied at the rate of 4 oz. per acre at sowing time. There is no evidence to suggest that maintenance dressings of cobalt are of any advantage.

Trace element, superphosphate mixtures applied at seeding time should not be sown in contact with lucerne seed. It is essential that this does not happen on acid soils because effective nodulation will be prevented and establishment will be poor.

Potash deficiency sometimes occurs on young lucerne stands on light soils. As the lucerne gets older and root penetration increases the deficiency disappears. Potash deficiency can be suspected on lucerne on light soils where the distance to clay is more than several feet. It could also be suspected on lucerne areas under irrigation.

Trial strips of 1 cwt. per acre and 2 cwt. per acre are recommended on areas where potash deficiencies is suspected to establish if top-dressing is worthwhile.

Lime is used in two separate ways in South Australia on lucerne crops:

- (a) On acid soils its use is essential to obtain healthy nodulation which enables lucerne plants to make effective use of nitrogen from the air. Inoculated seed must be sown in direct contact with one bag (187 lbs.) of agricultural lime (calcium carbonate) per acre.
- (b) The use of heavy dressings of a ton or more of lime per acre have been used in some countries for many years. There is little evidence that this technique is of economic advantage in South Australia.

Some seedgrowers are satisfied that the improvement resulting from a very heavy application of lime is sufficient to justify the cost.

In some cases there is little doubt that the response is due to the affect of lime in releasing molybdenum previously unavailable to plants. Two ounces per acre of molybdenum fertilizer per acre mixed with superphosphate is a cheaper way of getting the same result.

6. MANAGEMENT

(a) Cultivation

Cultivation of sward lucerne stands is a widespread practice in northern areas. On heavy soils it has proved to be an essential part of management for maximum production and longevity.

It should be carried out in the autumn or early winter. On heavy soils it breaks surface crust and allows better penetration of rain. It mixes plant and animal residues and hastens their breakdown by soil micro-organisms to available plant food. It encourages formation of new surface roots and controls annual grasses.

Often oats, or barley are sown following cultivation and contribute to winter grazing and to the first hay cut.

Narrow pointed shares to a depth of about 3 inches are used for the operation, which should be carried out when the soil is moist. If a combine is used fertilizer may be applied and cereal seed sown at the same time.

Reference has been made under the heading of row spacing to thinning of stands rather than sowing crops at lower seeding rates to give an equivalent plant density. American Research has shown that thinning by cultivation stimulates seed production, by producing smaller and more upright plants that flower slightly earlier.

In row sown lucerne seed crops, inter row cultivation is an important part of weed control. The choice of implement for the purpose depends on the soil type, row width and the weeds to be controlled. A rotary hoe designed or modified to suit inter row cultivation is the most versatile implement. Tyned implements must have broad shares to do an effective job preferably with plenty of overlap. Tyned implements are not very satisfactory on heavier soil especially to control trailing weeds (wireweed etc.). Disc implements are the least satisfactory for inter row cultivations. Cultivation cannot be relied upon to provide adequate weed control during winter. Often cultivation cannot be carried out because of wet conditions or cultivation only transplants weeds and does not give a kill. During mid winter Knockdown type weed-killers are the most satisfactory method of control. Cultivation can be relied upon to do an adequate job in the autumn and spring. Cultivation must be used in association with chemical methods if optimum weed control is desired.

(b) Winter grazing

To obtain highest seed yields it is important not to overgraze the lucerne seed crop during the winter months. There should be a good reserve of food materials in the plant when the crop begins to grow in the spring. Winter overgrazing of the crown will reduce the number of stems which can produce seed in future seed harvests.

(c) Spring mowing

Under South Australian conditions lucerne should be cut in the spring to maintain a good clean crop by helping control annual weeds and bringing lucerne to an even growth and flowering.

It is not advisable to continue grazing instead of shutting up and taking a hay cut. There is some evidence to suggest that two successive hay cuts can be taken in the spring prior to closing up for seed. This appears to have advantages only on irrigated vigorous seed crops which are more dense than is desirable.

Lucerne food reserves reach a peak at flowering time. Hence the hay cut prior to closing for seed should be allowed to come into flower before cutting. Experimental evidence and grower experience have shown moreover that crops should go to the full bloom stage before cutting as this results in higher yields of seed per acre.

The time of spring mowing is discussed under the heading of pollination.

(d) Weed control

Weed control is a vital factor in lucerne seed production for several reasons. Any plants in a crop other than lucerne are competitors with lucerne for moisture, plant nutrients and light.

Weeds by their nature are aggressive and so can often compete most effectively. They will directly reduce the potential amount of seed which can be produced by a lucerne crop. Many weeds can further seriously interrupt harvesting operations and result in further direct loss of seed by blocking or over-loading machinery. Weed seed present in harvested lucerne seed can be very costly to remove by cleaning. It is usually cheaper to remove weeds from the seed crop than to harvest them and separate from the seed.

Presence of dangerous, noxious or undesirable weeds will render seed unacceptable for seed certification and in most instances will make the sale of the seed unlawful.

It is unwise to regard weed control as separate from other managerial factors of seed production. Probably more than any other factor it is inter-related and affected by all other management operations. Effective weed control is only accomplished by foresight and wise, careful planning and timely execution.

It is not possible to give adequate details for control of specific weeds in this article. However, growers with specific problems should seek advice from a departmental seeds' officer for the latest recommendation. Current research in South Australia by the Department of Agriculture is being aimed at finding residual herbicides which can be applied in the autumn and will give control of all weeds for a complete season. Present results from these experiments are very encouraging.

(e) Burning after harvest residues

It is most important that after harvest trash be cleaned up. Failure to clean up can accelerate the build up of weeds on the area and provides ideal conditions for the build up of insect pests particularly lucerne seed wasp.

After harvest residue can often be of value as stock feed and can be removed by grazing stock. However, stock do not always make a good job of cleaning up and in some circumstances do very little.

A cleaning fire does an excellent job of destroying annual grass weed seeds. It also destroys plant residues and remaining lucerne pods and makes the environment less attractive for overwintering insect pests. A hot fire will destroy overwintering eggs of Red-legged Earth Mite and Lucerne Flea.

No damage will be done to lucerne plants by burning providing the soil is damp when the area is burnt. Burning is best carried out as soon as is allowable and practicable following harvest.

(f) Irrigation

The aim of irrigation should be to keep plants growing but to avoid vigorous lush growth. A slow rate of top growth is desirable such as results from a moderate supply of moisture. This permits plants to manufacture plant food faster than it is consumed allowing it to be stored in the roots and this is conducive to high seed yields.

However, lucerne should have ample moisture at flowering time, because wilting at this time reduces seed yields.

In general heavy infrequent waterings are better than light frequent waterings. Partly because of this, flood irrigation is preferable to spray irrigation. The latter has the advantage that a grower has accurate control of the quantity of water applied. However, it results in burning in hot weather and during flowering reduces bee activity and results in poor pollination. Also if spray irrigation is used growers should water very heavily immediately before flowering commences and if possible withhold waterings until flowering has stopped. This may not always be possible on shallow and lighter soils. It is then a matter of weighing the probable loss in yield through lack of moisture against the possible loss in yield through lack of pollination and choosing the lesser of the two evils.

(g) Time of flowering

In managing a seedcrop the aim should be to have the crop flowering at a time when factors influencing pollination are most conducive to pollination.

Two main factors should be considered; firstly the weather and secondly flowering flora which may compete with lucerne for activity of honey bees.

Weather is usually best in January or February when hot dry and calm weather encourages activity of bees. However, on sandy soils in the upper south east severe moisture stress during January flowering may severely affect yields. Earlier flowering can reduce this risk, however, other factors may be less suitable.

In December, Capweed or Salvation Jane may still be flowering and these will compete for bee activity and reduce lucerne seed yields.

Red Gum is another strong competitor, it has usually finished flowering by mid January. Bees do not visit lucerne while they have access to flowering Red Gum. Blue Gum, however, is complementary. It is predominantly a nectar producer. This stimulates bees to breed and in turn increases the pollen requirement of the hive, and bees become active in collecting pollen from lucerne.

Good seed setting can be expected in December from Blue Gum areas providing no flowering Red Gum is present.

Seed growers should plan flowering time according to their local conditions. If a crop is shut for hay in mid September, mown for hay in mid November, it should flower in mid January.

7. POLLINATION

This is the most important single factor of lucerne seed production.

Lucerne cannot produce seed unless fertilization takes place, pollen must be deposited on the stigma. Lucerne flowers to produce worthwhile quantities of seed must be fertilized with pollen from another flower; in other words cross pollination is essential. Research work has shown that only 10% of ovules of a flower will develop seed when pollinated with pollen from the same flower. If pollinated with pollen from other flowers over 60% of ovules can produce seed. This "selfing" of flowers is most undesirable for other reasons other than very low yields. It results in seed which produces plants of lower vigour and production of both seed and forage.

Lucerne pollen is not windborn. It must be transmitted from flower to flower by insects.

The sexual parts of a lucerne flower are firmly held in the keel. It requires some force to release them, hence not all pollen collecting insects are capable of tripping lucerne flowers and affecting pollination.

Honey bees and solitary bees are the only insects which are able to trip flowers in sufficient numbers to be of economic importance in South Australia.

It has been concluded that tripping of lucerne flowers could be effected mechanically with rollers and other contrivances which will knock the plant vigorously.

In hot weather mechanical tripping of lucerne is possible. Attempts to stimulate mechanical tripping have produced only small yields. However, little seed is set by these methods because of the very small number of ovules that develop from "selfing".

Most flower-fall of lucerne is due to lack of tripping. Where tripping and pollination are good paddocks take on a dull greyish appearance. Bright blue appearances with a great many flowers open indicates poor pollination.

(b) Honey bees

The co-operation of an apiarist to put bees in a crop as soon as flowering commences should be arranged well in advance. Three basic principles should be followed:

- (1) Provide good apiary locations close to lucerne paddocks.
- (2) Use only recommended control for insect pests to minimise damage to bees. Always notify the apiarist in advance of the proposed measures.
- (3) Make satisfactory arrangements to pay beekeeper for pollination service where more colonies are needed than recommended for maximum honey production.

Honey bees are only good lucerne pollinators when they collect pollen. When collecting nectar they are inefficient because they soon learn to gather nectar without tripping flowers.

For this reason it is necessary to crowd bees onto the lucerne paddocks and to keep a continuous supply of new bees joining the working force.

Up to five strong colonies per acre should be used on irrigated crops and two strong colonies on unirrigated crops. It is extremely important that colonies have the greatest possible number of pollen collecting bees. The number of pollen gatherers is dependent on the strength of the colony. Hives should be two storey and contain a minimum of 800 sq. ins. of brood area per hive.

It is best to bring in half the hives when the crop is 10% in flower and introduce the remainder 10 days later. Introduction of all hives at once may result in bees working other sources of pollen and nectar other than lucerne. Because bees soon become "fixed" on a particular plant this will often result in bees refusing to work lucerne.

(c) Native bees (or Solitary bees)

Most native bees build nests in or near ground level. They are pollen gatherers and so trip every flower visited. Because of this they are more efficient as pollinators. Leaf cutter bees and alkali bees have both been discovered working lucerne seed crops in the South East and some very high yields have been attributed to them.

Alkali bees nest in consolidated fine textured sandy soils which have a constant high moisture level but never become waterlogged. Hard areas adjacent to swamps and irrigation channels are often good nesting sites.

In American seedgrowing areas solitary bees have been used to advantage by artificially providing nesting sites and introducing bees.

There is need for investigations into the possibility of similar commercialization of solitary bees in South Australian lucerne seed growing districts.

Native bees contribute to pollination of many seed crops but are regarded at present as being unreliable because numbers vary greatly from year to year. Hence the present reliance on honey bees as pollinators.

8. INSECTICIDES AND BEES

Lucerne seed crops are dependent upon bees for pollination, hence every care must be taken with insecticides to minimise danger to bees.

In order to reduce danger to bees spray in the early morning or late afternoon when there are few bees in the field. Never spray when many bees are actively working the paddock and never spray any insecticide directly on to the bee hives.

9. PESTS OF LUCERNE SEED CROPS

(a) Control of pests starts early in the life of the crop with establishment and continues through all stages of growth. As with weed control pest control must be planned ahead and growers should maintain a constant watch of the crop for first signs of trouble. Also like weed control pest control measures must be timed correctly and thoroughly carried out. It is usually too late to spray once severe damage to a crop has been done. Efficient pest control is possible only if a seed grower understands the possible problems which may arise and is on the lookout for the first signs and can act immediately if necessary.

Many insects can usually be found in lucerne seed crops which do not cause economic losses of seed. However, the following are of importance to South Australian crops.

(b) Red-legged earth mite and lucerne flea

These are of most importance to young germinating crops especially with autumn sowings. A close watch should be kept on all newly sown crops for signs of flea or mite activity and spraying carried out as soon as necessary.

Under some conditions Lucerne Flea and Red-Legged Earth Mite can do considerable damage to established lucerne seed crops. It is worthwhile spraying milder infestations in seed crops than would be considered in fodder stands. As with most other pests in a seed crop, damage to seed yield by an infestation represents a much larger cash loss than loss of grazing with the same infestation.

The best time to spray for Lucerne Flea and Red-Legged Earth Mite is during the 2-5 weeks after the "opening" rain. During this time it can be expected that all overwintering eggs of both pests have hatched and winter egg-laying has not begun. Alternate treatments are as follows:

- (1) Imidan 3½-5 fluid oz. 15% per acre
- (2) Technical malathion 4 fl. ozs. 96% per acre by ultra low volume application
- (3) Pink cutworm

This is a most important pest of newly sown lucerne especially with spring sowings on sandy soils. It can also be a pest of established crops. Damage to young plants closely resembles lucerne flea damage. The young cutworms chew small "windows" in the leaves. Older caterpillars will cut off leaves or whole plants at ground level.

On established stands new shoots following spring hay cuts may be eaten as fast as they grow. Consequently a stand may fail to recover from a hay cut as a result to appear to remain completely dormant until late December to early January when the caterpillars stop feeding.

Damage by Pink Cutworms is insidious and often goes unnoticed. Pink Cutworm is present in most years and crops on light soils should be examined for infestation in October. On heavier soils a watch should also be kept in October but damage is more likely to commence in early November.

Caterpillars are a greyish green with a pinkish tinge and will be found at the base of lucerne plants within the top inch of soil, during the day. Early identification of infestation is most important because large larvae require heavier applications of insecticide and the degree of control obtained is only fair.

D.D.T. at the rate of 8 fl. ozs. of 25% miscible oil per acre gives excellent control of caterpillars up to ½ inch long. Larger caterpillars require 16-32 fl. ozs. of 25% D.D.T.

(d) Etiella (Lucerne Pod Borer)

This native insect feeds on seed within lucerne seed pods. Eggs are laid on the plant and hatch out and young caterpillars bore into a seed pod and feed. When about ¼ grown they emerge from the pod and spin a web around several pods. They remain in this web and feed on seeds by chewing holes through pods.

Etiella is difficult to control because caterpillars are very well protected firstly in the pod and later in the web.

Experience has shown that parathion is the only insecticide which will control *Etiella*; it will enter pods and kill young caterpillars feeding inside. It is less effective in killing older *Etiella* enclosed in webs.

Hence spraying must be carried out early, just after the caterpillar has entered the pod, and when sufficient pods have formed to make it worthwhile, 4 oz. of 50% Parathion is the recommended rate per acre.

(e) Climbing cutworm

Is a most serious pest of all lucerne seed crops in South Australia. Unless effective control is carried out high yields are not possible. Climbing Cutworms feed on buds, flowers and seed, they spend the whole of their life on plants and feed day and night.

Young caterpillars bore into buds or flowers and feed upon ovaries and although the flowers may appear normal, they do not set seed. Larger larvae destroy the whole bud, flower or seed pod.

Climbing Cutworms are particularly damaging pests. A population of only one caterpillar per square foot could reduce potential yield by 15 lb. of seed per acre. It is essential to examine seed crops regularly for damage. Sweeping with a net is the only sure way of finding small caterpillars. Visual examination is unreliable and very time consuming.

Inspection for Climbing Cutworm should begin when buds begin to appear. Spraying should be carried out as soon as caterpillars are found in the net.

8 oz. of 25% D.D.T. miscible oil per acre gives good control when the grubs are very small. Repeat sprays are usually necessary.

(f) Lucerne seed wasp

This pest appears to be of most importance on heavier soils in northern lucerne seed growing areas.

Most damage occurs after mid February.

The lucerne seed wasp is a tiny black insect about 1/16th of an inch long, she lays eggs through lucerne seed pods directly into the seed. A grub hatches and feeds on the tissues inside the seed and can destroy the entire seed. The grub pupates inside the seed-shell and the adult wasp emerges to recommence the cycle which takes about a month. There are several generations in a harvest season. The insect overwinters in seeds left on the ground following harvest.

Because it spends most of its time within seeds the seed wasp cannot be controlled by chemical sprays. The only effective control

measure is by crop management. Wasp populations require seed pods to develop. Because of this their numbers build up during January. Therefore aim at harvesting all seed before mid February. Winter cultivation is another method of reducing losses for this buries seeds left on the ground and destroys overwintering insects in seeds.

Seconds and screenings should be destroyed and not left around because they include a large proportion of damaged seeds containing wasps. Failure to destroy lucerne screenings ensures a good start for lucerne seed wasp populations the following season.

10. DISEASES OF SEED CROPS

At present the following common diseases of lucerne are found in South Australia.

(a) Witches Broom

This is a virus disease and is common in lucerne crops in northern areas. Observations suggest that older stands carry a heavier infection than young crops.

It causes severe loss of production in many old stands and often necessitates that a stand be ploughed up and resown.

It occurs in south eastern areas but rarely as severely as in northern crops. It is common for stands to show symptoms in summer but to appear reasonably normal the following winter.

Virus affected plants are weakened and invariably killed by some other disease, pest, or adverse climatic condition.

The disease is spread by certain leaf hoppers feeding from other affected plants. There is no recommended economic method of control.

(b) Downey mildew (*Perenospora trifiorum*)

Young leaves are first affected by irregular pale green blotches on upper side of leaves. These patches later turn yellow. The underside of leaves shows a grey fuzzy growth.

This is a fungus which is spread by air borne spores and is common in the south east. It is less common in northern seed growing areas in South Australia. It occurs mainly in early spring and favours wet and humid conditions.

This fungus does not cause significant damage to a later seed crop. The only recommended treatment is to graze or mow badly affected paddocks. Subsequent regrowth is practically always free of the disease.

(c) Leafspot (*Pseudopeziza medicaginis*)

Affected leaves show small dark brown or black dots. Severely affected plants will drop all leaves, however, this extent of damage is very rare under South Australian conditions. The most severe leafspot damage occurs in the lower south east. Elsewhere damage is uncommon. This fungus is also spread by air borne spores, it favours wet humid conditions and dense crops.

Control is as recommended for Downey Mildew.

(d) Black stem (*Aschochyta*)

Small dark brown or black spots occur on the stems and may enlarge and completely "ring-bark" the stem. It occurs most in the lower south east but occurs spasmodically elsewhere in South Australia. It is transmitted by spores which are carried by infected plant material and seeds.

It also favours humid weather and dense crops. It is considered to rarely cause economic losses in South Australia.

(e) Root Rots

The most common recognisable root disease in South Australia is Root Canker (*Rhizoctonia solani*). This is a fungus and mostly affects young stands up to eighteen months old. Root Canker exhibits well defined circular patches of weaker plants. Some recovery of affected patches sometimes takes place the following season. Eventually however, plants die and the stand may thin out and become uneconomic. Resowing of such a stand is possible.

Pythium and other *Rhizoctonia* spp. have been recorded in South Australia and cause "Damping-off" and root rot of young lucerne seedlings. Seed Treatment with fungicides gives some control, and is recommended where areas previously killed by these fungus diseases are being re-sown.

11. LUCERNE HARVESTING

(a) Compared with other pasture seed crops lucerne is an easy crop to harvest. It can be handled with cereal harvesters because it presents no special problems regarding gathering, threshing or winnowing. Moreover it is a crop which ripens comparatively evenly and does not shed readily upon reaching maturity.

Direct heading is the simplest harvest method and is satisfactory on dry land grown crops especially in drier and hotter areas. This is mainly because upon maturity crops dry off and ripen with a minimum of green material. With dense irrigated crops especially those in moister and cooler environments direct heading is not as satisfactory. Mowing, windrowing, allowing to dry and picking up with the harvester is a better method in these latter areas.

With the former method to prevent heating it is normally necessary to spread seed out after harvest to allow green material to dry before bagging.

The disadvantage of the latter method is that some seed is usually lost because of poor pickup recovering and that in the event of rain windrowed seed will be damaged more, and losses will be higher, than seed of a standing crop.

(b) Pre harvest desiccation of crops

Desiccants cannot be used to hasten the maturity of lucerne seed crops. They can however, remove green material from crop approaching maturity and facilitate direct heading at a predetermined time.

Diquat has proved a satisfactory dessicant in South Australia. It should be applied by boom spray when the crop is "binder ripe". Harvest should be carried out 5-8 days following spraying depending on weather conditions. Experience indicates that serious pod drop and shattering may take place ten days after spraying.

Too early spraying will result in lowered yield and germination of seed.

Diquat should be applied at the rate of $1\frac{1}{2}$ -3 pints per acre in at least 20 gallons of water along with $1\frac{1}{2}$ pints of AGRAL 60 wetting agent per every 100 gallons of prepared spray.

Dense crops require higher Diquat dose rates and higher water rates than thin crops.

(c) Machine settings

Cereal harvesters or "all-crop" type machines used for lucerne seed harvest should be adjusted according to manufacturer's instructions. If these are not available the following rules are a useful guide to machine settings.

(1) Check thresher

- (a) Clearance $\frac{3}{16}$ to $\frac{3}{8}$ of inch
- (b) Speed 1400-1600 r.p.m.

(2) Ground speed must be regulated to keep the machine evenly loaded. Overloading of sieves causes seed to be carried over the back.

(3) Air adjustment is probably the most critical of all adjustments. This must be such that seed is not blown over the back yet strong enough to remove the maximum amount of chaff and hulls. Insufficient air can cause great losses due to seed being carried over the back due to overloaded sieves.

- (4) Use the correct sieve to allow all seed to pass through.
- (5) Adjust the chaffer so that all seed and pods fall through. The seed will pass through the sieve and pods will be returned for re-thrashing.

Always remember that one seed per square inch left behind on the ground after the harvester has passed is approximately 20 lb. of seed per acre. Behind a well adjusted harvester only several seeds per square yard can be found.

12. CERTIFICATION OF LUCERNE SEED

In South Australia seed certification is designed to protect the identity of the various lucerne varieties. To be eligible to produce certified seed, paddocks must be free of noxious and objectionable weeds at harvest time. Certified seed also has to meet the Seeds Act requirements regarding minimum germination and the maximum amount of physical impurities such as weed seeds, other crop seeds and inert matter.

Certification of lucerne in South Australia is based upon a pedigree system; a year by year history of certified paddocks is kept by means of supervision and annual inspection. Growers wishing to produce certified seed apply for supervision of the sowing of paddocks and certification inspection in years of seed harvest. In years when paddocks are not harvested for seed, these paddocks must be registered to maintain eligibility to produce seed in later years.

Close supervision by the Department of Agriculture of harvesting of certified seed and cleaning makes sure that no loss of an individual seed lot identity occurs or accidental admixture. The finished seed if it meets physical requirements is identified with a label and sealed with an official seal. Unless seed carries this label and seal intact it is not certified seed.

Grade of Seed	Minimum Purity By Weight	Maximum Inert By Weight	Maximum Weeds By Weight	Maximum Other Crop By Weight	Minimum Germination By Count
Mother and Foundation	99.4%	.5%	.1%	45 seeds per lb.	85%
Certified	97.5%	1.0%	.5%	.5%	80%

13. CLEANING AND SCARIFICATION OF LUCERNE SEED

Lucerne seed is not a difficult seed to clean. Seed is usually treated first over an air screen machine and this removes firstly the very light trash, husk and straw. Material larger than the lucerne is then scalped off by the top screen, the second screen normally removes foreign material which is smaller than the lucerne seed. In multiple screen machinery a similar procedure is repeated a second time, seed is finally subjected to another air blast which removes any remaining light material.

Usually following the air/screen machine seed is put over a specific gravity table. This removes much of any remaining discoloured, chipped or insect damaged seed and produces an attractive sample. Where individual problems of cleaning separation arise other machines which separate on length of seeds, or the ability of seed to roll or slide down a slope, or seeds' ability to adhere to rough surface, may be used. The choice of machine depends upon the physical properties of the impurities to be separated.

Lucerne seed produced in the drier parts of the State has a low hard seed content, while seed from the south particularly that produced under irrigation has a higher hard seed content due to the longer ripening period. The average hard seed content of northern seed within seed certification for 1965-66 was 28% and for south eastern seed for the same period 33%.

It is common practice to scarify other pasture seeds such as strawberry clover to reduce hard seed content. However most scarifiers used for these seeds are unsatisfactory for lucerne because they are excessively vigorous and result in damaged seed. A "scrubber" type of machine which forces seed between a drum and rough coconut matting concave is suitable. This machine is sufficiently vigorous to break down hard seededness of lucerne seed and at the same time not damage seed.

14. SUMMARY

South Australia produces more lucerne seed than any other Australian state and produces upwards of three quarters of the Australian total production.

Traditionally in South Australia seed has been produced from grazing and hay lucerne paddocks as a sideline enterprise. Today in favourable seasons over half the State's production is still produced from sideline production. The balance is grown under irrigation and specialised methods in which seed production is the main objective. Higher seed yields can be realised by the specialised producer than are being obtained. Production of seed in South Australia should be stepped up. No difficulty should be experienced in marketing considerably larger quantities than are being currently produced.

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