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Lucerne pollination

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Doug Somerville
Livestock Officer, Apiary
Goulburn

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INTRODUCTION

Research both in Australia and overseas has shown that honey bees may be used to set seed in flowering lucerne crops.

Typically, average seed yields of 100 kg/ha for opportunity crops may be expected. However, yields of 400–600 kg/ha can be achieved for well-managed specialist irrigated crops. Some yields have been recorded over 600 kg/ha.

These higher seed yields are closely associated with an increase in the use of a range of management approaches, particularly:

- methods of plant establishment
- efficiency of irrigation
- control of weeds and insects
- the use of honey bees
- harvesting techniques.

It must be kept in mind that adequate pollination of the lucerne crop is only one factor in achieving high yields. If any one of the other factors mentioned is neglected then the benefits of having managed honey bees in seed crops may be reduced.

POLLINATION AND SEED SET

Cross-pollination of lucerne is vital to ensure that the maximum quantity and quality of seed is achieved. Self-pollinated flowers tend to produce smaller seeds which, in turn, produce less vigorous seedlings. Cross-pollination is said to contribute about 89% of the seed yield.

Airborne lucerne pollen is negligible in lucerne crops, and insect pollination is the main mechanism for transferring pollen from one flower to the next.

To understand the pollination process, the structure of the lucerne flower needs to be considered. The lucerne flower consists of a standard petal on which the bees often land and two smaller wing petals on either side. Opposite these wing petals are two fused petals called the keel. It is these two keel petals that hold the key to the pollination process.

The female sexual column (on which the pollen is required) is held under considerable pressure by these keel petals. The flower also contains ten anthers (the male portion) which supply the pollen.

Pollination does not normally occur without the sexual column being released. When released, the column if fertilised will come into contact with pollen grains. These pollen grains germinate on the column and proceed down to the ovule to form viable seed. The release of the sexual column is called ‘tripping’ the flower. The action of insects, primarily honey bees foraging on the lucerne flowers for honey and pollen, will often cause this tripping to occur and thus facilitate the process of pollination.

It is the grower’s responsibility to ensure that there are as many flowers as possible in the crop to set seed. But not every flower in the crop will set seed, because plants generally produce far more blossoms than the crop could sustain as seed.

A 15% pollination rate is desirable. If 15% of the flowers in a crop in full flower have been tripped, that is enough to maximise the crop yield.

To determine whether the crop in question is being adequately pollinated or not, observe its overall appearance from a distance. Flowers can stay open for about a week if not pollinated. Once they have been pollinated they will wither or wilt in about two hours. This withered flower will take on a dull blue–grey appearance, whereas an unpollinated flower will be bright blue, giving a flower garden appearance.

The sooner the flower is pollinated after it opens, the more seeds in each pod can be realised. Research has indicated that the longer a flower remains unpollinated, the more the potential yields diminish; thus ideally flowers should be tripped one to two days after they open.

This is the primary reason for introducing a very high number of beehives onto lucerne crops to assist in achieving maximum yields of seed.

APIARY MANAGEMENT STRATEGIES

Honey bees forage various floral species in search of nectar and pollen. Nectar is the basic carbohydrate or energy source, and pollen is the basic protein source for the hive.

Each floral species will supply different quantities and qualities of nectar/honey and pollen to the bees. Thus the effect on the nutritional status of a bee colony will vary, and beekeepers need to consider different management strategies for working different floral sources.

The task of preparing beehives for pollination of lucerne poses special requirements. The beekeeper must make sure the bees are ready on the dates required by the grower, and the hives have sufficient numbers of bees to adequately pollinate the crop.

Large brood nests require significant quantities of high quality pollen which is simply not available from lucerne crops. Lucerne pollen is deficient in a number of elements that are desirable in a balanced diet for bee colonies. Bees will often attempt to overcome imbalances in any one pollen source by collecting pollen from a number of different species. For pollination it is desirable that lucerne is the primary floral resource in the area, and thus a colony may only have very limited choices.

The poor nutritional status of lucerne pollen has meant that colonies often dwindle while on lucerne crops and, in some cases, have perished after leaving the crop. The beekeeper then must search out better conditions to rebuild the health and strength of the bee colonies.

Negative effects on bees can be avoided to some degree by supplementary feeding of colonies while they are on the lucerne crop. A number of different protein supplements are available for beekeepers, and these should be considered where lucerne is the dominant pollen source for the beehive.

STOCKING RATES

How many bees to the hectare? Most farmers would be familiar with a similar question, ‘How many sheep to the hectare?’

What is important is the number of honey bees and other insects actually working the lucerne flowers and, even more importantly, how many flowers are being tripped. This does, in part, relate to the number of hives on or next to a crop.

The stocking rate for honey production is approximately one hive per 4–12 ha. For most pollination purposes and particularly with lucerne, the stocking rate should be much higher so that the area is saturated with bees to maximise the potential for pollination. About 3–5 hives/ha is considered as a reasonable stocking rate for adequate lucerne pollination, though the number of hives recommended for lucerne pollination varies from 2 to 12 hives/ha.

At these high stocking rates, bees will not be able to gather surplus honey from lucerne crops alone. Perhaps if other species in the district are also in flower then a honey crop may be gathered by the bees while on the lucerne crop, but this depends on the accompanying species.

The number of hives required is not the only consideration. Stocking rates are also influenced by a number of other factors including the following.

Hive strength

The more adult bees a hive has, the more field bees are potentially available for pollinating the crop. Each hive needs a minimum number of bees in the hive proper for housekeeping duties, such as taking care of young developing larvae, feeding the queen and maintaining the correct temperature. Bees above this minimum number are then available for field duties, that is collecting and foraging for nectar and pollen. The weaker the colony, the smaller the proportion of field bees available to carry out field work. Eight to ten frames of brood and bees is suggested as a minimum for each unit.

Young queens

The make-up of a hive is equally important. A hive headed by a young vigorous queen is highly desirable, because young queens are more capable of producing larger sized brood nests and thus more brood. The greater the amount of brood and young larvae the colony needs to feed, the greater the demand for pollen. Pollen-gatherers are far better pollinators than nectar-gatherers.

Bee disease

Disease can kill adult bees prematurely, or reduce the number of developing bees in the brood and so affect the ability of a hive to carry out pollination. Disease also affects the resident feral populations of bees available to pollinate nearby crops.

Nutrition

As already mentioned, the quality and quantity of pollen and nectar available will have a dramatic impact on the strength of a hive. The management strategies carried out by beekeepers before moving bees on to lucerne crops will affect the ability of a colony to produce a worthwhile brood nest. The impact of the lucerne crop on the honey bees is also an important factor as lucerne pollen is not particularly nutritious for bees. Nutrition also affects the strength of feral bee populations.

Feral bees

Some growers of flowering crops place a lot of faith in feral bees as pollinators. This is a real lottery because the condition of the feral bee population can never be really known. The chance of a grower having large numbers of strong feral colonies located in trees close to the target crop is extremely unlikely. Also, lucerne crops require large numbers of hives to carry out adequate pollination and feral hives would not normally exist at such high stocking rates.

Other insects

Little information is available for Australian conditions concerning other insect visitors to lucerne flowers. Some native insects no doubt visit lucerne flowers to forage for nectar and/or pollen and must, in the process, trip a certain number of flowers. But the numbers of insects available in the brief period required is a major limiting factor. Honey bees have the edge in Australia because they can be imported in large numbers and removed when the pollination is over.

Some research workers have suggested that counting the number of bees on the crop is probably a better way of ensuring that pollination is being maximised. Between 6 and 10 worker bees/m^2 has been recommended. Another method used (and claimed to be much quicker), is the use of a sweep net. A sweep net is quickly dragged across a flowering crop. A count of 12 bees in ten sweeps is considered the minimum; any less on average is cause for concern.

The time at which these counts are carried out is important because bees' foraging behaviour changes throughout the day. It is important to look at a crop periodically through the day, choosing a warm but not overly hot day to do the counts.

TIMING

How long should bees be left on the crop, and when should they be introduced?

There is general agreement that the beehives should be introduced in two stages during the lucerne flowering period. Half the required number of beehives should be moved in to the crop when the plants are 10–20% in bloom, and he balance when the crop is in full bloom. Moving hives in too early will encourage bees to forage other floral sources rather than the target lucerne flowers. Bees show remarkable fidelity to what they forage, thus, when lucerne does begin to flower in earnest, field bees may continue to work other blossom in preference to the lucerne blossom.

These non-target species can be a real problem in some areas when it is planned to concentrate bees on a crop for pollination purposes. If a neighbour is also growing a lucerne crop for seed or clover seed crops, there is no way of directing bees onto any specific area.

Non-target species will include ground flora in the form of weeds. Some typically attractive ground flora species include horehound, wild turnip and heliotrope. The various eucalypt species in the area may also be particularly attractive to foraging honey bees; examples include river red gum and black box. If these or other species attractive to bees are available in sufficiently large numbers, they can divert a large proportion of foraging honey bees away from lucerne blossom.

If the pollination process is going as planned, most of the crop should be set within four weeks of introducing the bees. Some information suggests up to six weeks. One source of information suggests that if a seed crop has not been set within six weeks, then the lucerne should be cut for hay.

HIVE PLACEMENT

Hive placement is often a compromise. From a beekeeper's viewpoint, all-weather truck access is highly desirable. Hives should not be placed within 100 m of gates, lanes, stock troughs and sheds, due to the amount of flight activity from those hives and the comfort of people and livestock.

Hives placed in long rows (for example along a fence line) should be avoided. Long rows lead to increased drifting and non-uniform colony strength. Irregular layout patterns are best, with hives spread apart and facing different directions.

Some information on lucerne pollination suggests that it is desirable to place beehives hard up against a lucerne crop and scattered around the entire perimeter. However, the experience in the Riverina of a number of growers and beekeepers suggests this kind of placement is inconvenient for both parties.

A more desirable approach is to place the beehives in one or two lots well back from the crop to be pollinated. Ideally, the hives should be placed in shady areas to reduce any extreme temperatures that may occur. Honey bees collect significant amounts of water for use in the hive and, as the temperatures rise, the need for water increases, diverting many field bees into water-gathering duties. By placing hives in shade during hot weather, heat stress is reduced and more field bees are free to pollinate crops. With this in mind, it is important that a water source is close to the proposed apiary site, reducing the flight times of the field bees collecting water.

SPRAY AND PESTICIDES

Placing hives well back from the crop also may help the grower. If a crop needs spraying with pesticide the location of the hives is crucial. The further the beehives are placed away from the crop, the better. If spraying is necessary, then this should be conducted late in the afternoon or evening when foraging honey bees have ceased their field activities.

One of the biggest dangers of placing bees near any agricultural crop is the possibility of colonies or field bees being sprayed by pesticides. Pesticides should be kept to a minimum.

Most poisoning of bees occurs when pesticides are applied to flowering crops, pastures and weeds. It is strongly recommended that growers take the following steps to prevent or reduce bee losses:

- follow the warnings on pesticide container labels;
- select the insecticide least harmful to bees and spray late in the afternoon or at night;
- don't spray in conditions where spray might drift onto adjacent fields supporting foraging bees;
- dispose of waste chemicals or used containers correctly;
- always warn nearby beekeepers of your intention to spray in time for steps to be taken to protect the bees. Give at least two days notice and also advise nearby farmers.

FEES

It is normal for a beekeeper producing honey to pay landowners in kind for allowing them to place the hives on their properties. Normally beekeepers will move bees at their leisure to ensure that they are gaining the maximum benefit from their hives and optimising the amount of honey that can be extracted.

However, managing bees for pollination will interrupt honey production management strategies, often to the detriment of the bees, because bees require specific management so that they are in suitable condition on the required date for the purposes of pollination. The cost of moving bees in and out of crops is considerable. Also, the possible negative nutritional impact of lucerne pollen, the loss of honey crop elsewhere, the heavy stocking rates and the risk of spray damage, all mean that a beekeeper needs to be remunerated.

Fees obtained for providing pollination services for lucerne seed production were up to $60 per hive in 1998.

Beekeeping is a highly skilled profession. Growers should be aware that not all beekeepers have the skills to achieve maximum pollination of their crops.

FURTHER READING

Free, J.B. 1993, *Insect pollination of crop plants*, 2nd ed, Academic Press, London & New York.

McGregor, S.E. 1976, *Insect pollination of cultivated crop plants*, Ag Handbook, No. 496, USDA.

Morthorpe, K.L. & Jones, W.A. 1988, 'Honey bee pollination of pasture legume seed crops in Australia', *Proceedings 2nd Aust. & International Bee Congress*.

Jones, W.A. 1983, 'Specific crops for pollination', *Apiculture Workshop Papers*, Dept of Agriculture, NSW.

Langridge, D.F. 1983, 'An overview of pollination', *The Aust. Beekeeper*, vol. 84, no. 8.

Morthorpe, K.L. 1994, 'Lucerne pollination', *Proceedings of 1st Annual Conference of the Crop Pollination Assn. August 1993 and Field Day, January 1994*, NSW Agriculture.

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