



BIRDSFOOT TREFOIL SEED PRODUCTION

J.E. Winch, Department of Crop Science, University of Guelph,
S.E. Robinson, Plant Industry Branch, C.R. Ellis, Department of Environmental Biology,
University of Guelph

Ontario is a major producer, a large consumer and a leading exporter of birdsfoot trefoil seed. Each year approximately 500,000 kg of seed are produced, two to three hundred thousand of which are used in Ontario and the remainder exported. The bulk of the pedigreed seed is produced in southwestern and northern Ontario. However, seed production is found wherever birdsfoot trefoil is grown as it is often a sideline to hay and pasture production.

Seed yields of up to 750 kg/ha have been obtained but 110 kg/ha of clean seed is closer to the average. This variability in yield is one of the problems associated with this crop. The other major problem is the low production of pedigreed seed.

Pedigreed Seed Production

A high production (roughly two-thirds) of the trefoil seed produced is of commercial origin. Commercial seed cannot be sold as a variety. Yet, most consumers recognize that varieties differ markedly in adaptation to soil drainage, tolerance to grazing and yielding performance, and they would like to be able to purchase the variety that meets their needs. Thus, a greater emphasis must be placed upon the production of pedigreed seed of the recommended trefoil varieties in order to better meet consumer demand.

Pedigreed trefoil seed production can be very profitable. Premium prices paid for pedigreed seed more than offset the extra attention required in producing the quality of seed demanded for the different grades.

One must be a member of the Canadian Seed Grower's Association (C.S.G.A.) and follow their regulations to produce pedigreed seed. The regulations are published in a circular available from the C.S.G.A.

Land Selection

The sites chosen for seed production of birdsfoot trefoil should be carefully chosen for best results. Although seed can be produced over a wide range of soil conditions, the best yields have been obtained on clay and loamy soils and under medium moisture conditions. In wet years, trefoil grown in low or poorly drained fields may lodge causing a poor seed set and/or low recovery of seed. In contrast, under very dry conditions and on sandy soils pod shattering can cause high seed losses.

For production of pedigreed seed, the fields should be chosen so as to conform with the isolation distances required for the class of seed to be produced.

Pure Sowings Versus Mixtures

Pure stands of trefoil are best for the production of seed (Table 1). The addition of tall growing grasses such as timothy or brome grass complicates management and may reduce the yield. The tall stems of the grasses impede the flight of pollinating insects and the competition from the grasses reduces the vigor, growth and flowering of the trefoil. If grasses are in the stand, they must be controlled by clipping or by spraying early in the growing season.

Table 1. Influence of grass and weeds upon seed yields in pounds per acre of birdsfoot trefoil in New York.*

Year	Seeded with timothy	Seeded alone**
1	75	119
2	126	135
3	150	143
4	100	123
5	57	120
6	25	95
7	69	140
8	33	120
9	40	98
10	26	116
Meanyieldfor10years	70	121

*Data taken from *Birdsfoot Trefoil Seed Production*, H.A. MacDonald and J.E. Winch, Dept. of Agronomy, Cornell Univ. Mimeo No. 57-18, February 1957.

**Field kept free of weeds and grass growth.

Small amounts of grass, or low growing species such as bluegrass, however, have little effect upon seed production and can help control the invasion of broadleaf weeds. It's not necessary to plant bluegrass as it normally will work itself into the stand.

Seeding Rates

The highest seed yields are obtained from plant populations that range from 3-6 plants per 0.1 m². This plant population can be established by seeding at a rate of 4 to 5 kg/ha, providing that

a fine firm seedbed has been prepared.

Although the highest seed yields are obtained from using row widths of 91.4 cm (36"), sow fields for seed production in 17.8 cm (7"), 22.86 cm (9") drill rows or by broadcasting. With wide rows, broadleaf weed invasion can be severe. In addition, lodging and the tangling of trefoil stems between the rows is increased, resulting in a reduction in the amount of seed harvested. Note, however, that spaced rows will normally result in higher seed yields than broadcast seedings.

Fertility

At establishment, nitrogen (N), phosphorus (P) and potassium (K) must be available in order for the germinating seedlings to grow vigorously. Fifteen to twenty kg of N per hectare will normally provide enough N for rapid plant growth but is not enough to interfere with nitrogen fixation. The other two nutrients (P and K) should be applied according to soil test.

For seed production, a medium soil fertility level is best. High fertility promotes excess crop growth and lodging may occur. Low fertility produces poor plant growth and low seed production.

Generally P and K should be applied according to soil analysis every fall. However, on clay soils an application of P every second year is often adequate.

Time and Method of Seeding

Trefoil for seed production should be planted at the same time of year and using the same techniques as those for hay or pasture production. For the details refer to the OMAF Factsheet "Bird's-foot Trefoil Production", Agdex 122/20.

Weed Control

Fields harvested for seed should be as weed-free as possible. Perennial weeds such as quackgrass compete with the trefoil. In addition, other crop plants such as clovers (red, white and alsike) and sweet clover should be regarded as weeds as their seed cannot be easily cleaned from trefoil seed. Control can be achieved by roguing (pulling isolated undesirable species) as well as by using a combination of cultural and chemical controls. Ideally to minimize weed problems, establish crops for seed in fields that previously were planted to cereal or row crops.

Several herbicides are recommended for use in trefoil stands. Dalapon and 2,4-D are two that can be used to control grasses and broadleaf weeds in new seeding and established stands. Simazine, which also controls grasses and broadleaf weeds, is a residual herbicide that can be used on established fields as a preventive measure. Applied in the fall, simazine will control germinating weeds and trefoil seedlings. The killing of the second-generation trefoil plants results in a stand that is "true to type". Simazine should not be used in the same year as paraquat, a herbicide recommended for the suppression of grasses and annual weeds. The combination of the two herbicides causes a reduction in the number of trefoil plants in the stand as well as a lower yield. Specific information on up-to-date chemical recommendations are provided in the current edition of Publication 75, *Guide to Chemical Weed Control*.

Insect Control

The major pest affecting trefoil seed production is the trefoil seed chalcid. The adults are tiny, about 5 mm long, black wasp-like insects (Figure 1). The chalcid overwinters as fully grown larvae inside seed that has fallen to the ground. Females emerge from those seeds and insert their eggs into the newly formed seed which is still soft. The eggs hatch four to five days later into legless, grub-like larvae that completely hollow out the seed (Figure 1). Later, they cut circular holes (Figure 2) and the adults emerge in mid-summer to lay the second generation that will overwinter in the seed.

Presently, this pest cannot be controlled with insecticides. The trefoil must be managed so as to make it difficult for the chalcids to carry on from generation to generation.

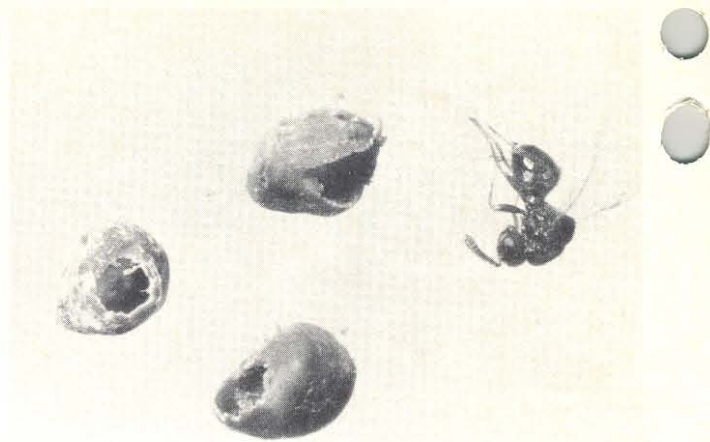


Figure 1. The trefoil seed chalcid can be responsible for large seed losses.

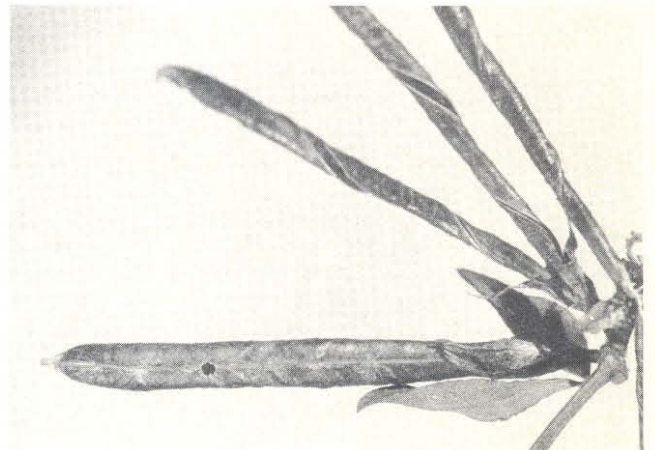


Figure 2. The circular hole in the pod indicates a chalcid infection.

Good control of chalcids involves the following:

1. **Harvest on a community basis** following the same schedule. If seed is taken early in some fields and after clipping in other fields, there is a continuous supply of young seeds for both generations of chalcids and the pest is much worse. This situation can develop between neighboring farms as well as on one farm.
2. The second generation of chalcids is more numerous and in most cases it helps to **harvest seed from the first crop**.
3. Volunteer trefoil is usually heavily infested with chalcids and will serve as a source of infestation. They should therefore be destroyed. In addition, in seed producing areas **no trefoil should be allowed to mature except the seed crop itself**. Volunteer plants on roadsides should be destroyed and trefoil-based pastures clipped. If this is done on a community basis and all trefoil seed crops are taken at the same time, the chalcid has very few seeds in which to develop one of its generations and survival is low.
4. **Fields with seeds should not be left unharvested**. Chalcid-infested seed will fall to the ground and the chalcids will be ready to infest the crop the following year. Rather than letting fields self-seed, it is better to clip them and use clean seed for reseedling.
5. Chaff and screenings can contain chalcids and therefore should be burned.

Pollination

Commercial seed production from trefoil depends on honey bees carrying out pollination. A honey bee population of one

bee per square metre is sufficient and this can be achieved by placing one or two hives per hectare. The distribution of honey bees should be such that the whole seed production area is serviced.

Harvesting Birdsfoot Trefoil Seed

In trefoil seed production there is usually a vast difference between the amount of "saleable" seed a producer obtains and the quantity of seed produced by the stand. The difference in yield will vary dramatically from farm to farm, and from year to year depending on several factors.

Low humidity and high temperature conditions during the harvesting period may result in pod shattering and the loss of the highest quality seed. There may also be a high "clean out" of small, green, shrivelled, low-quality seed due to harvesting too early or of hollow seed due to chalcid damage. As well, heating and moulding of seed in the windrow will lower the quality of otherwise saleable seed.

Although these types of losses cannot be completely eliminated, harvesting trefoil at the right time of year, at the correct growth stage, in the proper manner and insuring that the seed is clean and dry, will reduce the losses and produce better-quality seed.

First versus Second Crop Yields

Birdsfoot trefoil should be harvested from the first rather than an aftermath crop. Trefoil should flower and set seed during warm temperatures and long sunny days. Ideally flowering should occur in late June to early July and seed should mature during August. This will produce the best-quality seed along with the highest yields. Any spring harvesting that induces later flowering results in seed maturing under cool temperatures. The consequences are a prolonged seed maturation period and a reduction in seed viability. September-October seed appears mature but is low in quality.

It is possible, however, to get reasonably good seed yields from trefoil stands that have been grazed or clipped in May. A later clipping may reduce seed yields because the trefoil can't recover fast enough. The varieties of trefoil differ in their rate of recovery. Empire, the latest-maturing variety recommended, should not be clipped after the last of May. With earlier varieties, clipping before the end of the first week of June should not delay the development of the seed too long.

Time to Harvest

The point in time that the harvest is started can make the difference between a successful or a failed seed harvest. Beginning too early results in a harvest containing a high proportion of immature seeds which germinate poorly and produce seedlings without much vigor. Too late a harvest gathers



Figure 3. The presence of flower buds, flowers, immature and mature pods makes it difficult to pick the best time for harvesting.

"popped" seed pods and misses the scattered seeds on the soil surface.

The decision as to when harvesting should begin is difficult to determine because of the indeterminant growth habit of birdsfoot trefoil. Flower buds, flowers, immature and mature seed pods are all present at the best harvest time (Figure 3).

Flower buds arise in the axils of the trefoil leaves. The process of flowering and seed development in trefoil begins with the initiation of a group (umbel) of up to five buds. Each of these buds develops into a flower which when pollinated develops into a seed pod. Each pod can contain up to fourteen seeds.

The number of umbels that develop on a plant is largely dependent on the weather. The lowest umbel on the plant will have the greatest number of pods and a higher percentage of live seed (Table 2). Under average conditions the lower three umbels produce up to 90% of the plant's seed production. A delay to allow less-developed pods in the upper umbels to mature is usually impractical because of the increased probability of shattering of the more mature pods.

Table 2. The effect of umbel position on the yield and quality of trefoil seed

Umbel position	Avg. no. of pods/umbel	Avg. no. of pods/umbel	1000 seed wt (gms)	% germination T.L.S.*
1.	2.3	13	1.26	80
2.	1.3	13	1.20	80
3.	.5	12	1.15	74
4.	.2	12	0.82	50
5.	.1	12	0.78	43

*T.L.S. = total live seed (quick plus hard seed)

Seed pod color is an excellent indicator of the maturity of the seed. Table 3 outlines the changes that occur in pod color and how they reflect the maturity and the quality of the seed.

The best time to harvest is when 70 to 80% of the pods picked at random throughout the field are mature. A delay, even of one day in harvest beyond this point could result in severe shattering losses, particularly under dry and hot conditions.

Table 3. The relationship between pod color and the condition of trefoil seed

Pod Color	Seed	% Moisture (pods)	1000 Seed weight (gms)	% Germination		T.L.S.*
				Quick	Hard	
Immature						
dark green	green watery	80+	—	5	9	14
green purple	green watery	75-80	0.17	29	10	39
light green	doughy	70-75	0.46	43	11	54
Mature						
green-white	late dough	65-70	1.21	83	13	96
light golden						
brown	olive green	20-25	1.21	70	28	92
dark brown	brown	15-20	1.21	56	40	96

*T.L.S. = total live seed (Quick and hard seed)

Handing Seed Crops

Trefoil seed crops can withstand very little handling. Yet the mass of green material in most seed crops restricts the use of direct combining to very small land areas or to very dry conditions. At best, direct combining must be very slow in order to obtain worthwhile amounts of seed.

The common method for harvesting trefoil seed involves cutting and swathing. Mowing the crop when the plants are wet with dew results in the lowest amount of pod shattering. Strap type windrowers attached to the mower will gently turn seed

Pods towards the centre of the windrow, thereby protecting them from quickly drying and shattering while at the same time exposing the green stems and leaves for more rapid drying (Figure 4). Narrow windrows are preferable over wide ones. Wheel rakes have been found to be useful when windrowing short plants.



Figure 4. Turning the pods inwards protects them while the rest of the plant material dries down.

While the required drying time will vary with the season and the crop it should be less than that required for making hay. One to two days should be enough. Less seed is lost if handling is done while the plants are tough.

Baling from the windrow, followed by threshing is a satisfactory way of separating the plant material from the seed. Soft-core bales made without twine on standard round balers perform well. This method allows for further drying if necessary as the seed pods are enclosed within the stem material. Metal pans attached to the balers will help save some of the seed shattered while baling. The round bales can be sawed in two or unrolled in preparation for feeding into a forage chopper which in turn should meter the material into a threshing machine.

Combining from the swath requires more care to avoid heavy losses of the small, light seeds. Modification of combines with pans in order to save seed is recommended. It is best to accept a poor job of cleaning by the combine in preference to losing seed from too-vigorous a separation process. In any case, a later cleaning operation is necessary to remove chaff, leaves etc.

Any type of cylinder can be used for threshing dry, well-matured birdsfoot trefoil. If the crop contains a high amount of moisture or is very heavy, the spike cylinder may work better than the rasp-bar type. When the straw is wanted for feeding, it will have more leaves and be less broken if the bar type is used. The concave setting should be relatively close (about $\frac{1}{4}$ ") and the cylinder speed above that which is used for small grains (about 5500 s.m.f.). It is best to follow the directions given for

the particular combine model. An engine-driven combine is usually better for heavy crops than the use of a power take-off.

Special sieves are required for the combine separation of birdsfoot trefoil because of the small size of the seed. Those recommended by the maker of the combine should be used. If the information is not available a sieve (no. 1/14) having holes about $\frac{1}{14}$ " in diameter will do quite well. Where an adjustable sieve is used, its proper setting is important. Normally it should be set nearly closed so that the straw and leaves will move freely across it and yet provide good seed separation.

Where the combine is equipped with a recleaner, its usefulness will depend upon the condition of the crop and the job done by the wind, chaffer and sieve, as well as the type of recleaner. Large amounts of chaff, leaves, and other materials will soon foul the sieves of a recleaner and make them ineffective. This is particularly true of damp or wet material. If too much material is delivered to the cylindrical type of recleaner, it will soon jam and may be seriously twisted and broken. The seed to be recleaned should flow freely over a large portion of a sieve surface.

The combine should be watched for leaks which may result in heavy seed loss. Birdsfoot trefoil seed can pass through a very narrow opening or small break. A hole which will prevent the loss of wheat or oats may permit a continuous flow of the small legume seed.

Seed Drying and Conditioning

If the threshed seed is not all fully ripe or contains a lot of damp or green material, it is necessary to dry it immediately to avoid heating. This can be carried out by using several methods. The seed should first be cleaned with a common fanning mill to remove the trash and green material. The seed should then be spread out on a dry, flat surface to a depth of 5 to 7 centimeters where, with frequent turning, it will dry without being damaged. Good results have also been obtained from mixing damp seed with several times its bulk of finely ground kiln-dried sawdust. A fanning mill can be used later to remove the sawdust. Mechanical drying is difficult to do without burning the seed and reducing its germination.

Seed Cleaning

Seed cleaning involves scalping, removing weed and other crop seeds as well as small and broken kernels, and grading the seed to size. In most cases scalping may be done on the farm, while further processing is usually carried out at seed cleaning plants. It should be remembered to destroy all screenings and chaff as they may contain chalcids.

Seed Storage

All seed, both before and after cleaning, should be stored in a clean, cool, dry place protected from rodents. Otherwise, lowered germination and purity will be responsible for lowered returns from this high-value crop.