THE GORSE SEED PROBLEM

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SUMMARY

THIS paper summarises the results of an investigation initiated to gain information on the possible sources of reinfestation of large areas of hill country cleared of gorse. Effective agents of seed dispersal in New Zealand were examined. The time of seeding, the effect of the gorse seed weevil in the Wanganui area, and the effect of 2,4,5-T on gorse seeds are mentioned. The results of experimental work on seed populations in the soil on unploughable hill country and the longevity of such seeds are discussed with a view to practical application for gorse control.

INTRODUCTION

"It is possible that in New Zealand there may be some far more effective agent of seed dispersal of gorse than we know of in England," wrote E. H. Chater, Botanist to the Imperial Institute of Entomology, 28 years ago. With Chater's statement in mind, an investigation on gorse (*Ulex europaeus*) was carried out during 1957 and 1958 in the Wanganui district.

Most of the basic work on gorse seed dispersal had been carried out in England, but under New Zealand conditions gorse is a very different plant. British authorities give 6 ft as the maximum height of the gorse bush, whereas in New Zealand bushes 20 ft high with trunks 8 to 12 in. in diameter are common. In England, it appears that there is only one seeding of gorse per year, but here seeds are produced twice yearly. This paper summarises the results of some of the investigations on seed dispersal and seed populations in the soil on unploughable hill country. In this way, it was hoped to gain valuable information on the possible sources of reinfestation of large areas of hill country which have been cleared of gorse.

For all practical purposes gorse spreads by seed, so it was decided to investigate the methods of seed dispersal in New Zealand. Explosion of the pod, birds, animals and man, wind, and water were studied. The importance of the gorse seed weevil and times of seeding were also investigated.

To discover the seed population in the soil and the longevity of such buried seeds it was necessary to develop a technique to extract seeds from the soil and test them for germination. Areas of gorse with a known history and areas which had been cleared of gorse at a known date were examined and the gorse seed populations in the soil were determined. These results have proved very interesting not only because of the vast numbers of buried seeds but also because of their longevity in the soil.

SEED DISPERSAL

(a) Ejection of the Seed by the Dehiscing Pod

It is obvious that in the past we have under-estimated the distance the drying pod can throw the seed from the bush.

English, Californian, and Tasmanian writers mention distances of 2 to 4 ft as the maximum distances seeds are thrown from the dehiscing pods, but in New Zealand gorse seeds are thrown greater distances. This dispersal problem was examined in 3 ways: by observations in the laboratory, by taking soil plugs at set distances from a gorse hedge, and by measuring the distances seeds had landed from a hedge on to a cultivated paddock which had been freshly rolled.

Unfortunately time does not permit a detailed discussion of the techniques and full results. These will be published elsewhere at a later date. The results, however, show that gorse seed can be ejected from the pod for distances of at least 15 to 16 ft. Such a finding poses one very pertinent question. Just how far from a fenceline should a gorse area be cleared to

prevent infestation of a neighbouring area? Twenty feet would appear to be the minimum distance.

(b) Birds

Reports on the importance of birds in spreading gorse seeds are conflicting, so a trial was carried out to see if birds would eat gorse seeds.

Ten tins each 18 in. × 12 in. × 4 in. were placed up trees, on bushes, and on the ground throughout a gorse area. After a week, when the birds were accustomed to feeding from the tins, $\frac{1}{2}$ oz of mixed seeds (about 2,000 seeds) was introduced to each tin, together with 100 gorse seeds.

The next day only 512 of the 1,000 gorse seeds remained. The number of seeds left in individual tins ranged from 97 to 3 seeds. No further seeds were added and only 26 gorse seeds were eaten in the next 24 hours. Each day a few more gorse seeds were eaten, but the birds did not seem to be very keen on them. The trial was carried out in November when many alternative feedstuffs were available.

Sparrows, blackbirds, thrushes, chaffinches, yellowhammers, skylarks, fan-tails, and quail were present in the feeding area and it was impossible to determine accurately which birds were eating the gorse seeds. Definite feeding patterns were observed. The acceptance of certain seeds in one tin and the rejection of the same seeds in another tin indicated that different species of birds were feeding from different tins.

Bird droppings were collected from the area and seeds extracted, but no gorse seeds were found. Seeds such as wild turnip (*Brassica campestris*), *Amaranthus* spp., millet (*Setaria italica*) and inkweed (*Phytolacca octandra*) were found and if these seeds are able to pass through a bird undamaged, it seems probable that gorse seeds could do likewise.

(c) Animals and Man

Animals carry seeds in their coats and in the mud attached to their hooves. Sheep were examined after they had been taken out of a gorse paddock and no difficulty was experienced in finding seeds in their wool.

Man spreads seeds in the mud sticking to his boots or the soil on his farm vehicles and implements. One area sampled had 324 gorse seeds per square foot or over 14 million per acre in the top 2 in. of soil, so any muddy boots, "Landrover" wheels, or animal hooves which had been on that area would be good carriers of seed. There is no reason to think that this area is exceptional, because Chater reported areas in England under gorse bushes with seed counts up to 1,000 seeds per sq. ft. 2 in. deep.

(d) Wind

Normally, wind is not an important agent in gorse seed dispersal, but hot dry winds, such as a Canterbury nor'wester, do assist seed ejection.

A Marton farmer reported finding valves of pods with one or more seeds attached at a considerable distance from a gorse hedge. On investigation, a number of valves were found with seeds firmly attached by cocoon debris left by the gorse seed weevil. Several valves with seeds attached were tossed into the air and were carried some distance by a strong breeze. The gorse seed weevil does not always eat all the seeds in a pod and partly eaten seeds will germinate if the embryo is undamaged.

(e) Water

Water is an important agent in the spread of gorse seeds. Gorse seeds are heavy and when thoroughly wet, sink to the bottom in still water but in fast flowing streams and rivers in flood the seeds, unopened pods, and small dry branches may be carried considerable distances. The range is extended still further when gravel taken from gorse-infested riverbeds is used for construction work.

On hill country one would expect gorse seeds to be carried down with soil and debris in washouts. One washout at the bottom of a very solid mass of gorse was sampled, but no seeds were found in one hundred soil plugs.

TIME OF SEEDING

In New Zealand there are two seedings of gorse per year as compared with one in England. The main seeding periods about Wanganui range from November to January and again from June to August. Summer seeding is the most prolific, but winter seeding is important and a factor to be reckoned with. It is a fallacy that the seeds produced during winter are not viable. A representative sample collected throughout the district in July 1958 had a germination of 93 per cent.

EFFECT OF 2,4,5-T ON GORSE SEEDS

Experiments at the Seed Testing Station have shown that 2,4,5-T has a deleterious effect on gorse seeds which have been scarified to permit rapid germination. When it was applied at concentrations as low as 1.9 lb acid equivalent of 2,4,5-T in 400 gallons of water per acre all the seedlings produced were abnormal with short, thick, stunted roots and no shoot development. Detailed results will be published elsewhere.

THE GORSE SEED WEEVIL

The gorse seed weevil (*Apion ulicis*) was first released in New Zealand in 1931 to check the spread of gorse by destroying the developing seed. The female weevil lays her eggs in the seed chamber of the pod and when the grubs hatch they devour the seeds. The grubs pupate and adult weevils emerge so that when the pods burst open weevils are scattered instead of seeds.

In 1947 Dr Miller of Cawthron Institute recorded that the highest percentage of gorse pods found to be infested with weevils was nearly 99, and he considered it likely that this figure would become general. This has not been the case in the Wanganui and Manawatu districts.

A survey of 37 gorse areas in the Wanganui district was carried out during the summer seedings of 1957 and 1958. An estimated 20 to 40 per cent of the seeds produced were destroyed by the weevil. In January 1959 Miss B. D. Matthews, Seed Research Officer, found that in over 1,200 pods collected in the Manawatu 41 per cent contained weevil.

Both sprayed and unsprayed areas contained weevils, but in districts where burning was carried out regularly few weevils were present. Some pods contained weevils with one or two of the seeds undamaged. As mentioned before the weevil does permit a few seeds to become airborne when uneaten seeds are left attached to the valves of the seed pod by cocoon debris.

During the winter of 1958 a number of pods were collected from areas that had had a heavy weevil infestation during the summer seeding. More than 700 pods were opened, but only three gorse seed weevil larvae were found. The weevils are operational only during the summer seeding period and during the winter seeding they remain dormant at the base of the buds and spines where they resemble minute, greyish buds.

This district survey indicates that the weevil has not lived up to its expectations, and it must be considered only as an aid to other control measures.

THE PROBLEM OF BURIED SEEDS

In some localities there are large populations of hard seeds of gorse in the soil and they can remain in this condition for a long time. This seed dormancy is of advantage to the plant because seedlings can emerge for many years even if further production of seed is prevented; from the farmer's point of view, it is a distinct disadvantage. Numerous cases have been recorded where cultivated land has been ploughed out of gorse and kept free for many years, only to come back into gorse after reploughing.

Buried seeds are no problem if the pasture sward is thick and there is sufficient stock to keep the gorse seedlings down. In practice, on steep hill country it is almost impossible to maintain such theoretical conditions due to weather, soil type, pugging, slips, and the high cost of fencing.

The gorse seed population under pasture on this class of country and the longevity of this seed are of vital economic importance to the farmer because of the recurring cost of spraying such areas.

SEED POPULATIONS IN THE SOIL

Information was sought on the number of gorse seeds in the soil on unploughable hill country and how long they survive there. It was therefore necessary to develop a simple technique for extracting gorse seeds from the soil and then to see if they were capable of germination. Samples were taken from areas with a known gorse history; for example, areas in standing gorse, areas that had been sprayed, areas that had been burnt, and areas that had been cleared of gorse for a known number of years and that had had no further seedings.

(a) Technique of Extraction

From each area to be examined a representative sample of 300 soil plugs 2 in. in depth was taken. (A preliminary investigation showed that 96 per cent of the gorse seeds in the soil lie within the top 2 in.) The soil plugs were taken into the laboratory and mixed with water into a soil porridge. This soil porridge was washed through graduated sieves until a residue of stones, seeds, worms, etc., was left. The critical mesh size of the collecting sieve was .589 m.m.

If the sample contained much organic matter such as grass and spines, these were floated off in water. On the other hand, if the sample was full of small stones similar in size to gorse seeds, it was washed in carbon tetrachloride to permit the seeds to float off. The fraction containing the gorse seeds was dried and the seeds sorted out by hand and counted. They were then forwarded to the Seed Testing Station, Palmerston North, for germination tests.

(b) Germination Technique

The hard seeds of gorse have seed coats which are impermeable to moisture and when these are rendered permeable the seeds germinate. Table 1 gives the results of germination tests carried out on a representative sample collected from pods in July 1958. The figures are the averages of three lots of 100 seeds.

TABLE 1

Treatment	Germination	Hard seeds	Abnormals	Remainders
Control	2	93	1	4
Scarified	88	1	5	6

The hard seed content of the sample was 93 per cent, but these seeds germinated readily in the laboratory when they were scarified. This is done most easily by rubbing the seeds gently between two layers of emery paper. Later work showed the most satisfactory method of making the seed coat permeable is to heat the seed in an oven for 30 minutes at 190 degrees F (88 degrees C).

Miss Matthews carried out experiments to determine the optimum conditions for the germination of gorse seeds. The best germination results were obtained when the scarified or heat-treated seeds were grown at 59 degrees F (15 degrees C). The final germination counts were done on the seedlings after 40 to 50 days.

(c) Results

Altogether 11 areas were sampled and 3,600 soil plugs were taken in this section of the investigation. The number of viable seeds per square foot at 2 in. depth was calculated and results are shown in Table 2.

Area A had been out of gorse and under thick pasture for 28 years and no gorse seeds were found.

Area B, which had been out of gorse for 26 years, had 1.9 viable seeds per square foot. However, 50 per cent of these seeds looked fresh and may have been introduced at a recent date. In this case, it is interesting to note that the original gorse hedge responsible for all the trouble still remained.

Area C had been cut with a draining spade, heaped, and burnt in 1938.

TABLE 2

Area	Year gorse cleared	No. of years out of gorse before sampling	Seeds per sq. ft. 2 in. depth	Viable seeds per sq. ft. 2 in. depth
A	1929	28	0	0
B	1932	26	1.9	1.9
C	1938	19	7.2	7.2
D	1939	18	0.5	0.5
E	1949	9	1.9	1.4
F	1954	3	17.3	16.8
G	1955	2	32.6	29.8
H	1957	1	254.4	244.8
I	1957	1	324.0	301.8
I	1957	2	302.4	263.5
J	1957	1	31.7	26.9
K	1958	1	67.7	63.4

The pasture sward was not thick and a few gorse seedlings were observed at sampling.

Huge populations of gorse seeds were present in some areas, especially where spraying had been carried out but not burning; for example, areas H and I.

Areas J and K had originally been one large paddock covered in gorse. This area was burnt in 1954 but by 1957 the regrowth gorse was 6 to 8 ft high. The paddock was subdivided and one half (Area J) was burnt. It yielded 27 viable seeds per square foot, whereas Area K, the unburnt area, had 63 viable seeds per square foot, a difference of 57 per cent.

Area I is a fixed line transect set up at Kai Iwi in an area cleared of gorse which had been sprayed but not burnt. It is possible to go back to this area periodically to study the number of viable gorse seeds. At first sampling there was a population of 324 seeds per square foot. Twelve months later this figure was reduced to 302 seeds per square foot, a decrease of 6.8 per cent by natural means.

PRACTICAL POINTS ARISING FROM THE INVESTIGATION

Basic principles arising from this investigation can be summarised as follows:

On unploughable areas burning is essential to reduce the potential danger from hard seeds in the soil. The aim should be for a hot fire to kill or to render permeable as many gorse seeds as possible so that they can germinate quickly. This reduction in the number of hard seeds in the soil is an important factor in gorse control. It may be possible to burn some areas satisfactorily without prior treatment or it may be necessary to cut and burn, or spray and burn. It is impossible to generalise on gorse eradication because of differences in topography and climate.

If a cleared area is not reseeded, some of the gorse seeds could survive in the soil and germinate for periods up to 30 years. The first 10 years are the critical years where pasture management is very important. If at any time the sward is opened up by overgrazing or slips and stock are unable to control seedling growth, spraying will be necessary.

The cheapest method of controlling seedling growth is with stock. If stock are to be used efficiently, they must be concentrated. Therefore it is essential to subdivide the burnt area into suitable grazing areas and to oversow with fast-growing grasses to give the stock something to fossick for. Incidentally, this is the only opportunity to get good strains of grasses on to the hills at a reasonable cost. While the stock are grazing the seedlings, they are increasing the fertility, consolidating the soil, and bringing in a cash return to help balance costs. As stock management is critical at this early stage in controlling seedling growth, it is essential to clear areas which are not too big to be managed efficiently with the available capital.

Gorse should be cleared at least 20 ft from a boundary to prevent seeds being ejected into a neighbouring area.

Gorse hedges, unless trimmed annually, shed seeds over two long periods during the year. In most cases these seeds fall on to a tight pasture sward and gorse seedlings are not a problem near the hedge. They do become a problem, however, when they are spread around the farm by some of the methods outlined in this paper. There would be no gorse problem in New Zealand today if we had not planted gorse hedges. We can never hope to get rid of gorse as a weed until every gorse hedge has been destroyed.

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DISCUSSION

Q.—Does light affect germination of gorse seed?

A.—Light does affect germination of some seeds. It is possible that gorse seed germination is affected by light, but I did not study this point.

Q.—It is a practice in arable country to deep plough or bury gorse seed. What is the effect of deep soil coverage on dormancy?

A.—I believe that deep buried seed will have a suspended dormancy due to the raising of the CO₂ : O₂ ratio.

Comment: Seed gets buried in soil not only by ploughing. Earthworms by casting on the soil surface will help to bury seeds.

Q.—The most significant feature disclosed by this paper is the high seed populations in the soil. Pasture management to reduce establishment of plants may be more important than burning to destroy a proportion of the seeds.

A.—Ecological control by preserving a tight sward is probably the most important means of control.

Q.—Why have weevils not flourished?

A.—Burning of gorse stands is at least one factor.

Comment: Invermay Research area was originally largely gorse covered. The main means of grassing the area was sowing after ploughing and this method was successful. One area, however, was giant disced and on this area there was a reversion problem.

A.—Viable seeds of at least 28 years have been found buried under soil. A second ploughing or giant discing would raise viable seed to the surface.

Comment: In Southland gorse hedges are disappearing, but we consider that if we carry 3 ewes per acre or better gorse does not spread.

Q.—Why does viability of the seed population decrease?

A.—There is a loss of viable seed going on all the time due to germination, insect attack, etc.