

Notes about recent research work in the Manawatu-Rangitikei Districts.

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Introduction:

The orthodox method of sand stabilisation comprises three stages.

1. Primary stabilisation by planting marram grass and when the desired sand stilling effect is accomplished after approximately two years,
2. Tree lupin is sown as a secondary stabiliser and in another two to three years when the tree lupin has attained sufficient height and the area is well covered this can be
- 3a. Either planted into trees in which case lines have to be cut in the tree lupin and one or two year old trees are planted or,
- 3b. The area is developed into pasture and the lupin is ploughed under or sprayed and crushed with rollers and then sown into grass.

Although both methods will generally achieve permanent stabilisation in the long run; it is slow, expensive and laborious for the following reasons.

- a) Marram grass has to be gathered by hand and planted either by hand or semi-mechanically, with the recently developed marram planter.
- b) Seed from tree lupin has to be collected by hand and is broadcast or spot sown by hand.
- c) For forestry purposes the lines in the tree lupin are cut by manual labour and another release is often necessary one year after the trees are planted.
- d) For development into pasture, tree lupin is definitely a weed as after grassing down regular spraying has to be carried out to control the tree lupin germinating from seed buried in the soil.
- e) In all three phases, failures are by no means isolated cases and several areas have to be treated again.

The techniques of sand stabilisation now and thirty years ago are virtually the same and as the sand dune country is gaining importance from the national economic point of view, research and experiments into better, faster and cheaper methods are urgently needed.

While improved techniques are required from the afforestation and particularly in the foredune area, the following notes refer mainly to stabilising sand country with a permanent grass cover.

Research:

Very little has been published about experiments dealing with the reclamation of sand wastes to pasture. In 1911 Cockayne (4) stressed the point that "Experiment is urgently demanded so far as details as to sand reclamation go in New Zealand" and outlines in detail possible ways of investigation.

Levy (6) in 1948 mentions the lack of research data and gives recommendations for future experimental work.

Saxy (8) in 1943 describes a trial about grassing of maritime sand in Otago and gives results obtained with various grasses and legumes: he stresses the point of treating the different types of sand country (exposed sand hills, moist flats, etc.) according to

Their capability (Cf. the land capability surveys of the Soil Conservation Service). Present development of sand country in the North Island West Coast seems to disregard this importance fact.

Overseas literature about stabilisation of sand country with a permanent grass cover is also very scarce. Experiments by the Soil Conservation Service of the United States on the Pacific Coast of Oregon (1,7) have shown that after initial stabilisation with marram grass permanent stabilisation can be obtained in one operation by drilling a mixture of *Vicia villosa*, *Lathyrus japonica*, rye grass, red fescue and tall fescue. Thus complete control was achieved in two stages in two or three year. The application of Fertilisers also speeded up considerably the period of transition from denuded sand to permanent stabilisation. An area of thirty square miles of wind-blown sand has been transformed into grass in this way.

If a similar approach - using commercially available species - could give the same results under New Zealand conditions sand dune work could be considerably speeded up at reduced costs. In order to investigate whether it was possible to leave out one stage of stabilisation or to combine two stages into one operation a small trial was laid down by Soil Conservation Service using blue lupin as a primary stabiliser in 1954. These trials proved so encouraging that larger areas were treated in the following years and it is now considered feasible to stabilise sand drifts up to one hundred acres without having to rely on marram grass and tree lupin.

Blue lupin will stabilise and consolidate the sand and provide shade and shelter for other plants which will at the same time benefit from the nitrogen build up in the soil. Its reseeding habit enables it to keep the sand covered for some years.

At this stage further experiments were warranted and last year a trial was laid down in a semi-exposed position on raw sand to evaluate potential grasses and legumes as secondary and tertiary or permanent stabilisers.

A discussion of species used and their performances so far will be included later in this report.

Future Experiments:

As blue lupin can only be a temporary cover further research into establishment of a permanent pasture cover has to be carried out. The following points need further investigation.

1. The selection of further species likely to succeed under sand dune conditions.
2. The composition of pasture mixtures most suitable for the different types of sand country.
3. Development of techniques of introducing a pasture mixture into existing blue lupin cover.
4. The use of blue lupin as a component in a mixture for oversowing unstable swards.
5. Application of fertiliser.
6. Possibilities of irrigation, particularly for initial stabilisation to hold the sand over critical periods during the establishment of primary stabiliser.
7. Improvement of techniques in dealing with complex sand drifts by breaking up these drifts in smaller units using blue lupin at strategic points in combination with barriers of live vegetation e.g. tamarisk and marram.

An area of approximately 12 acres of raw loose sand has been selected at Lands and Survey Block, Parewanui. The area will be rabbit proof fenced. It is proposed to commence this autumn with the

Laying down of

- a) A number of plots using various seed mixtures with or without blue lupin.
- b) A trial with potential sand country species for observation into their establishment, growth habit, drought tolerance etc.

Observations on Sand Stabilisers under Trial

In this trial several shrubs, considered to be useful in providing quick shelter, were also included e.g. Tamarix and Acacia species. Observations on these will be included in a separate report.

As the trial was laid down on bare sand all the legumes were inoculated with the specific rhizobium. The response to superphosphate and Sulphate of Ammonia was also observed.

Although the trial was partly sheltered against the full force of the wind, the seedlings and young plants were exposed to considerable high sand temperatures, not occurring where plants are growing in the partial shade of blue lupin. Therefore, a similar trial, including several grasses, was laid down in blue lupin but was a failure due to bird damage and has to be repeated. No definite conclusion can yet be drawn as the evaluation of suitable species is necessarily a long term one.

PRIMARY STABILISERS:

Annual Lupins

The idea of using annual lupins for sand dune work is by no means new in New Zealand. As early as 1911 Dr. L. Cockayne in his report on sand dunes (4) mentions annual lupins as potential sand dune stabilisers as follows:

"The annual lupins will probably prove of considerable value in the attempt to form pasture on sand. They will be utilised chiefly in the early stages of the work. Their main function will be to completely cover the ground on which they are sown, and so stop all sand movementthey can be employed as a temporary covering, to be placed later on by grasses.

In afforestation work the annual lupins will also be of value as true nurses - i.e. as the trees grow the lupins will be wiped out, but not before they have discharged the dual functions of nurses and drift preventers".

Lupinus angustifolius

Bitter blue lupin has been used successfully as a sand stabiliser and several hundred acres of raw sand has been treated in the past 3 years. The standard procedure was drilling the seed at a rate of 3 bushels per acre. Possible improvements on the method of establishment were investigated.

Fertilizer

The effect of both phosphate and nitrogen on growth was observed and although fuller sturdier plants were obtained, the application of fertilizer does not appear to be warranted (except on very difficult sites) as good cover can be achieved without fertilizer application.

Inoculation

Blue lupin with and without inoculation did not show any significant difference in growth. Large nodules were found also on the untreated seedlings. The rhizobium of the tree lupin (*L. arboreus*) common in these areas has apparently the desired effect on the blue lupin also. It was noted, however, that seedlings of tree lupin germinating in a blue lupin field responded remarkably to the nitrogen

released by the blue lupin as they made twice as much growth in one season compared with seedlings outside the blue lupin field. It appears not necessary to inoculate blue lupin seed before sowing.

Seeding rate

To obtain a complete cover of the raw sand a heavy rate of seeding must be used. 3 bushels per acre is sufficient in most cases. The drill rows should be across the prevailing wind direction. Where only part of a drift can be treated in one year, drilling should start at the windward side and special attention given to the margins where double drilling will be necessary. In exposed situations extra drilling at intervals across the field will provide extra shelter.

Depth of Drilling was tested. Seed sown at 2" and 4" depth germinated well. At 6" depth seedlings just managed to struggle through the sand at about 50% strike. Seedlings of seed buried 8" deep were not able to reach the surface.

It appears that 3"-4" deep drilling does not effect the strike and also that seed covered up to 4 inches by blowing sand is able to push its way through.

Sowing Season

Results with sowings at different times through the autumn and spring did not show conclusively the best time of sowing. Further investigation is necessary. Autumn sowing appears to be more vulnerable to attack by a fungus disease striking in spring. Late spring sowings can be attacked by a caterpillar striking in summer, Early spring sowings (August) seem to escape both.

Pests and Diseases

Rabbits and hares are by no means under control in the coastal belt and they do a certain amount of damage on seedlings and young plants. They can cause failure when only a small area is sown or when a light seedling rate is used.

This summer a heavy infestation of a caterpillar caused considerable damage in several crops and complete loss of one 60 acre seed crop, by boring through the green pods and attacking the seeds. The same caterpillar was also noticed on Lucerne, Lotus and Melilotus in the coastal area. It was identified as the tomato fruit worm (*Heliothis armigera*), a common pest on Maize and tomato crops. Due to the favourable climatic conditions in spring and summer its population was built up rapidly and in search for food other hosts outside its normal range were attacked. Blue lupin crops sown in early spring (August) escaped damaged as the seed ripened before the eruption started.

A fungus disease - known as *Ascochyta pisi* but probably a closely related organism - attacks blue lupin and in particular autumn sown crops. The disease can be very troublesome under certain favourable climatic conditions ultimately causing death of the affected plants. Diseased plants less affected can grow out of it but develop some smaller or malformed seeds which shatter unevenly over a 1 to 2 month period after ripening. If left to reseed itself which is common practice with lupin for sand dune control the second crop can be so badly diseased that practically no healthy seeds are formed.

Further investigations on this disease (which is seed borne) is at present being carried out by the Mycology Department of Massey College.

Other Annual Lupins

The "Borre" sweet variety of blue lupin has the same growth habit as the bitter blue and cannot be distinguished from the latter

Trials with this variety were unsuccessful as it appeared to be so attractive to rabbits and hares that a plot of 12 square yards was completely eaten off in the young seedling stage in preference to an adjacent plot of bitter blue which was virtually untouched.

Lupinus luteus

Samples from 2 varieties of bitter yellow lupin (one from Morocco with bursting pods and one from Germany with non-bursting pods) were obtained from Crop Research Division, Lincoln, for trial. The advantage of a variety with non-shattering pods could be that seed is released over a longer period and thus minimizing the risk of loss through germination of the seed after a rain with a dry period following.

However, both yellow lupins were less vigorous than the blue and persisted longer in the seedling stage before making further growth. They also seem to dislike soils high in lime content.

Seeds from another bitter annual lupin - L. mutabilis was recently introduced from Peru by the Crop Research Division. This lupin produces vigorous seedlings and lacks the temporary slow down in growth in the early seedling stage during which in other lupins the root system is being developed. A vigorous growth is maintained through the seedling stage and stems from fully developed plants are thicker and sturdier than from blue lupins.

Next season this lupin will be tried out under sand dune conditions.

Lupinus littoralis (1, 7)

A native of the Pacific coast of Oregon and used as a secondary step after marram grass. A perennial, strong seeding and soil improving legume although it has probably no N nodules and thus no stimulating effect on other vegetation. Seed now in hand will be incorporated in this year's trials.

Results so far with the Annual lupins indicate that bitter blue lupin is the most suitable and will no doubt play an important part in future consolidation of drifting sand.

SECONDARY STABILISERS

Ornithopus pinnatus and O. sativus

O. pinnatus is a native of the Mediterranean coast and was probably introduced in N.Z. by Dalmation settlers. In Northland it is known as "Serradella" which is incorrect as this is the common name for *O. sativus*.

A winter annual with a wide branching prostrate growth habit and a prolific seeder, it is known to have colonised semi consolidated sand dunes in the 90 Mile Beach area where it is valued for stock fattening. Seed sown in spring germinated well but was slow in developing.

O. sativus - serradella - was recently introduced by the Crop Research Division for experiments in connection with cereal green-feeds. Also an annual from Mediterranean origin and closely related to the former, but with a more erect habit of growth. It is used in West and Central Europe on sandy soils as a green feed and a soil improver. Seed germinated well but persisted rather long in the seedling stage before making further growth.

Considering the performance of *O. pinnatus* in North Auckland and the use of *O. sativus* as a late autumn-early winter green feed on the Continent, it is likely that sowing in Autumn will be more satisfactory especially as they appear to grow well into the following summer before dying off.

Hedysarum coronarium - Sulla (9)

Described as a perennial deeprooted legume. Is drought resistant and can give good results on poor soils so long as they contain lime. Used as a hay crop or with other legumes for pasture in Mediterranean countries. Results were disappointing. Seed sown in spring germinated well into sturdy seedlings but made very slow growth and died off during summer.

Melilotus indica

King Island melilot is well distributed throughout the West Coast sand country and it is regarded as a valuable humus former. It is a heavy seeder and colonizers on open spots in semi-stabilised sand but cannot stand much competition (2). Like *Ornithopus*, also a winter annual, it will do better in an autumn sowing, growing right through the winter but dies off rather early in summer.

Achillea millefolium - Yarrow

Although a drought tolerant perennial with a creeping root system it did not stand up to expectation and proved to be very slow growing under dry conditions.

Secale cereale

Ryecorn often used in sand work overseas as a quick cover, germinated well and made some 4" growth but persisted in that stage for the rest of the summer. Sulphate of Ammonia did not stimulate much further growth.

Sinapis alba

White mustard, like ryecorn was included for its capacity of forming a quick cover. It germinated well into large seedlings but died off soon afterwards except where nitrogen was applied, in which case the plants shot up 2-3 ft high and have set seed.

PERIARY OR PERMANENT STABILISERS

Medicago sativa (3)

Lucernes, particularly the grazing type lucernes, may become a valuable component in a seed mixture for drier sites. It will take over the function of blue lupin in providing cover in summer when blue lupin is driving off. Four varieties, Marlborough, Grimm, rhizoma and glutinosa were tested. Where phosphate was applied all made vigorous growth from an early spring sowing on raw sand.

Trifolium fragiferum

Strawberry clover develops a strong fibrous root system and wide spreading stolons. It is able to withstand both drier and wetter conditions than white clover (5). Tests with 3 strains, Austr. Cert. Palestine, Austr. Cert. O'Connor and a N.Z. commercial strain, showed that they can be established on bare sand and will tolerate some sand movement. Both Australian strains were superior in growth. O'Connor with its low wide spreading habit will provide better cover than the more erect growing Palestine strain. Particularly vigorous growth was made where phosphate was applied.

Lotus corniculatus

In co-operation with the Grasslands Division, seven varieties of birdsfoot trefoil were incorporated in the trial, namely: Viking, Ranger, Empire, tenuifolius, arvensis all from the U.S.A. and two unnamed varieties ex Italy and Cyprus.

A species with a deep root system, the above varieties were selected for their reputed drought resistance. Seed sown in early spring germinated well and after a slow start they made good growth

later in summer.
Italian variety.

Best performances so far by Viking, Ranger and the

Here also marked response to phosphate was obtained.

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