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Client Report

Knotting nassella tussock panicles; an experimental design

Marlborough District Council

Graeme Bourdôt & Dave Saville

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2020 SCIENCE

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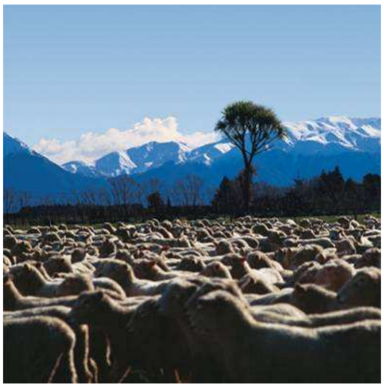


CONTENTS

1. EXECUTIVE SUMMARY 3
2. BACKGROUND 4
3. EXPERIMENTAL DESIGN 4
   3.1 The hypothesis 4
   3.2 Variables 4
   3.3 Sites and years 5
   3.4 Treatments 5
   3.5 Field layout 6
   3.6 Summary of work required 8
4. RECOMMENDATION 9
5. ACKNOWLEDGEMENTS 9
6. APPENDIX – White board notes from discussion with MDC in Blenheim on 12 September 2008 10

1. EXECUTIVE SUMMARY

- The Marlborough District Council (MDC) is seeking an efficient and practical way of stopping the annual recruitment of nassella tussock seedlings in pasture. MDC observations indicate that the addition of seeds to the soil seedbank may be prevented by tying the panicles of flowering plants in a knot or knots prior to grubbing.

- The MDC contracted AgResearch through an Envirolink grant to seek scientific advice on this knotting idea and, if it has merit, to design an experiment to test the idea on farm.

- AgResearch scientist Graeme Bourdôt and biometrician Dave Saville met with MDC staff Ben Minehan and Harry Neal on September 12, 2008, at Blenheim. It was determined that the idea has merit and an experiment to test the idea was designed.

- This design was further refined by AgResearch, and the final recommended design is described in this report.

2. BACKGROUND

The control of nassella tussock, an invasive grass weed in pastures, costs NZ landowners millions of dollars annually. The Marlborough District Council (MDC) is seeking an efficient and practical way of stopping the annual recruitment of seedlings.

Nassella is much easier to identify when it is flowering and because of this landowners are encouraged to grub in November during flowering, even if they have grubbed intensively through the winter, to pick up any missed plants. An effective way of stopping these seeding plants from contributing to the nassella problem is necessary. MDC observations indicate that this may be achieved simply by tying the panicles of flowering plants in a knot or knots prior to grubbing. This seems to work either by preventing the seeds coming into contact with the soil due to their entrapment in the knot and/or through loss in their viability possibly due to UV irradiation. (A further implication of knotting is that the panicles remain where they are grubbed rather than being spread by the wind, limiting dispersal and spread of the weed.)

The MDC contracted AgResearch through an Envirolink grant to seek scientific advice on the idea of knotting and, if it has merit, to have an experiment designed to test the idea on farm. Specifically MDC want to know the extent to which any extra time contractors and landowners spend tying nassella during a flowering-time grubbing operation reduces the risk of population growth and spread in this weed.

AgResearch scientist Graeme Bourdôt and biometrician Dave Saville, met with MDC staff Ben Minehan and Harry Neal on September 12, 2008, at Blenheim. It was determined that the idea has merit and an experiment to test the idea was designed. In this report we describe the experimental design.

3. EXPERIMENTAL DESIGN

3.1 The hypothesis

The hypothesis to be tested is: "fewer viable nassella tussock seeds originate from "knotted" as compared to "not-knotted" panicles".

3.2 Variables

The hypothesis will be tested through data on the number of viable seeds in panicles and in the soil, and on the number of seedlings arising from knotted and not-knotted plants.

Seedlings emerging on the trial plots are to be counted for a period of three years in December each year.

The number of seeds per plant are to be estimated initially and seeds per plot at three months and again at 12 months (if any panicles are still evident at this time).

The number of seeds in the soil seed bank are to be estimated initially, at three months, and again at 12 months.

In both cases, subsamples of seeds will be tested for viability using the TTC (Tetrazolium) test.

3.3 Sites and years

There will be four sites spread across the environmental range of nassella tussock infested pasture land in Marlborough, probably Ward, Vernon, Richmond block and Wairau valley.

A trial will be set up at each of these four sites in each of three years (to allow for the differing results that one might encounter in different seasons).

Each trial at each site will involve 50 nassella plants of about 100mm diameter. These plants will need to remain not-grubbed prior to their use in each trial in December (starting in 2009, 2010 and 2011). To allow for this, MDC biosecurity officers will need to go out and peg about 60 suitable plants (50 trial + 10 spare) well ahead of time, marking each plant to be left not-grubbed with a peg with a flag attached about 10cm uphill of the plant and a ring of dazzle paint.

Note that tussocks will be small enough so that only one knot will be required for the knotting treatment.

3.4 Treatments

Experimental treatments are:

(A) Panicles knotted prior to grubbing;

(B) Panicles not knotted prior to grubbing.

However, to allow for the destructive nature of some measurements (the seed counts) and to allow for assessment of any background level of seedling germination due to the existing seed bank, it is helpful to specify 10 “treatments”, as follows:

Permanent plots for seedling counts:
1. No tussock
2. No tussock
3. Panicles knotted prior to grubbing
4. Panicles knotted prior to grubbing
5. Panicles not knotted prior to grubbing
6. Panicles not knotted prior to grubbing

Plots for destructive seed counts:
7. Panicles knotted prior to grubbing, 3 month assessment
8. Panicles not knotted prior to grubbing, 3 month assessment
9. Panicles knotted prior to grubbing, 12 month assessment
10. Panicles not knotted prior to grubbing, 12 month assessment

For each field trial, these 10 “treatments” would be laid out in a randomised fashion in each of 5 field blocks.

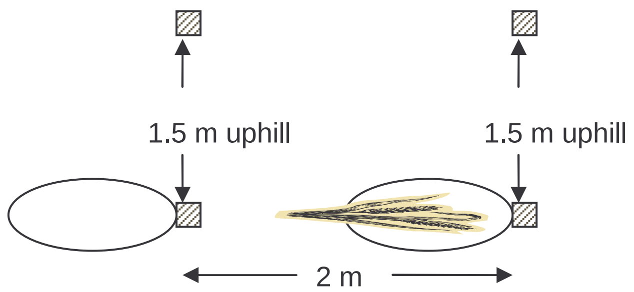
For the seedling counts (on permanent plots) in December 12, 24 and 36 months after trial set up, there would be 10 plots (2 in each of 5 blocks) of each of the 3 treatments:
1. No tussock
2. Panicles knotted prior to grubbing
3. Panicles not knotted prior to grubbing

For the counting and viability testing of seed left on the plant and in the soil, there would be 5 plots sampled (1 per block) at 3 months and 12 months after trial set up for each of the main treatments:

(A) Panicles knotted prior to grubbing
(B) Panicles not knotted prior to grubbing

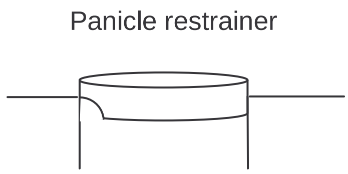
3.5 Field layout

The basic plot design is shown in Figure 1, where two plots are shown, one with no tussock tied down and one with a tussock tied down. A 200mm metal cylindrical ring of 50mm depth, distorted to the *same* elliptical shape for all plots, defines the effective plot area (within which seed will fall). As shown in Figure 1, a notch of 25mm maximum height will be cut in one end of the restrainer so that the tied down plant will not be chopped off by the metal ring. Ground level will be about half-way up the ring. The uphill peg will be of normal size, hammered half in to the soil. The peg immediately to the right of the ring is a short peg that is hammered in to ground level, to indicate the exact position of the ring in the event that it is removed by stock (hopefully not until after 3-12 months, by which time most seed will presumably have fallen from the panicles). The rings will be held in position by 150mm-long spikes welded to the metal rings.



There will be ten plots per block (only two shown here). Each panicle restrainer (plot) is the same elliptical shape. Eight restrainers will have a flowering tussock added (four “knotted” and four “non knotted”) and two “control plots” will not.

The uphill “long” peg is a locator peg. The “short” peg adjacent to the restrainer enables relocation of the restrainer if moved by stock.



Panicle restrainer showing spikes holding it in position.

Notch (on left) that holds the tussock in place within the restrainer.

Soil level also shown.

Figure 1: Design for two plots plus detail of a panicle restrainer.

The full layout for each trial at each site is shown in Figure 2, showing the 10 treatments randomised within each of 5 field blocks.

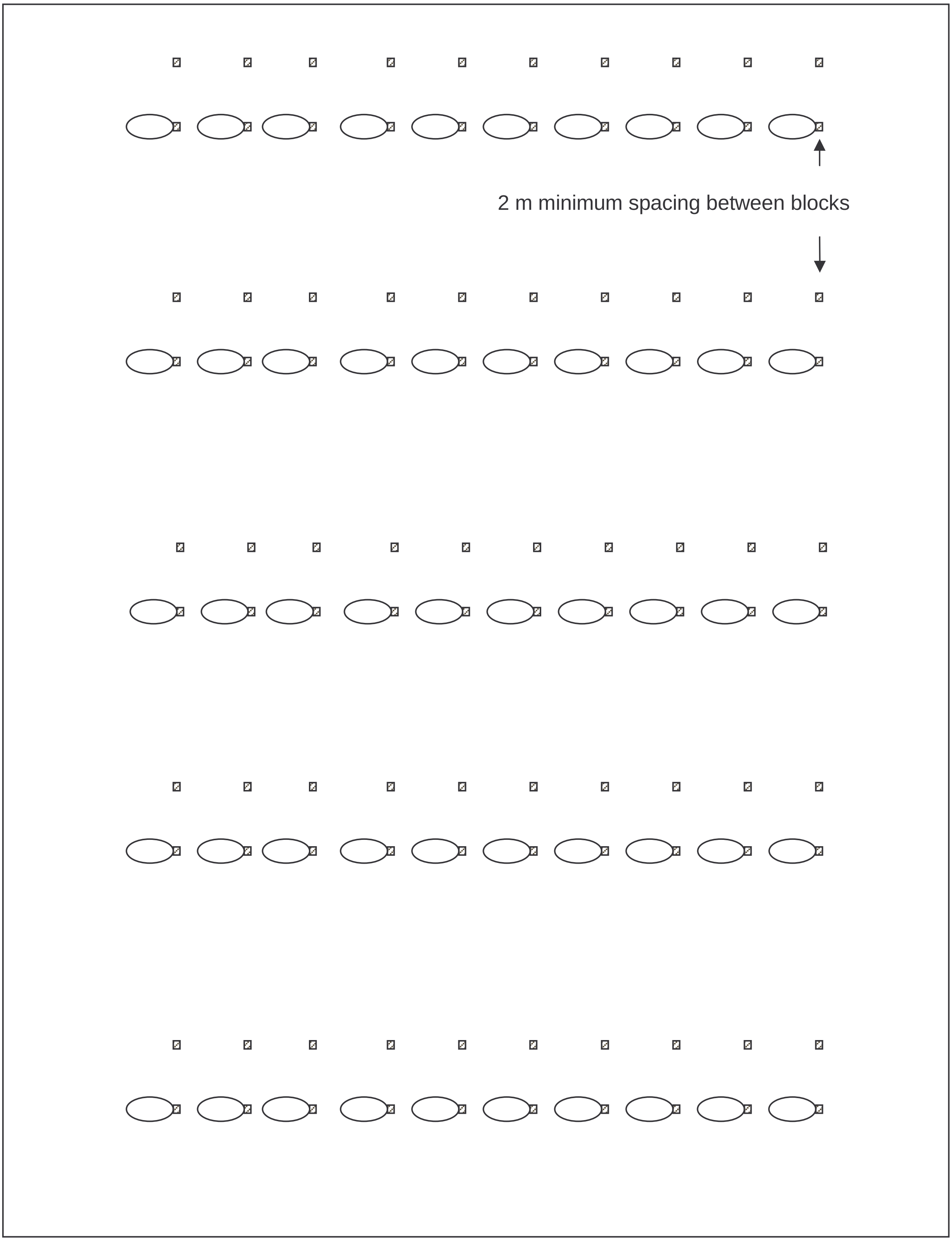


Figure 2: Field layout showing the five blocks (rows) of ten panicle restrainers (plots) at one of the four field sites. Not to scale.

The seed from each plant will be contained within each restrainer using one or more metal staples or hoops pushed into the soil to tie down the panicles within the restrainer. In the case of the not-knotted plants, the panicles may need to be looped around prior to being tied down.

For each of the five blocks in the field at each site, ten similar areas will need to be found on which to locate the ten plots (Figure 2). Also ten flowering nassella tussock plants with similar amounts of seed will be chosen for each of the blocks from the 60 plants marked by the MDC staff. Of these, eight will be tied down to the plots in that block and two will be used for initial estimates of the seeds per plant by counting the number of panicles per plant and the number of seeds per panicle for a randomly selected subset of panicles.

The ten treatments will be fully randomised within each block.

Initial background estimates of the soil seed bank would also be made by doing soil cores spread over the area of each trial. It is not anticipated that there will be much change in this level of soil seed bank during the duration of the trial, so this will only be done once.

For the destructive sampling, the appropriate restrainers will be dug up with their associated soil and panicles intact and taken to a laboratory for counting seeds and measuring their viability.

On the permanent plots, any seedling attaining a size at which it would normally be grubbed, will be removed.

Cattle will be excluded to prevent damage to the plots for at least the first three months of each experiment.

3.6 Summary of work required

Seedling counts
On 6 permanent plots X 5 blocks = 30 plots X 3 years = 90 plots/trial.
90 plots X 12 trials (4 sites X 3 yearly repetitions) = **1080 plots in total** on which seedlings are counted.

Seed counts on plants

- Initial: On 10 plants/trials = 10 plants/trial = 10 X 12 = **120 in total**.
- On tied down plants: On 10 plots (2 treatments X 5 blocks) @ 3 months and 12 months = 20 plots/trial. 20 plots/trial X 12 trials = **240 plots in total**.

Seed counts in soil

- Initial: 25 soil cores per trial, 25 X 12 trials = **300 in total**
- In soil under panicle restrainers: On 10 plots X 2 times = 20 /trial, 20 plots/trial X 12 trials = **240 plots in total**.

TTC tests for seed viability
On 120 + 240 + 300 + 240 = 900 samples

4. RECOMMENDATION

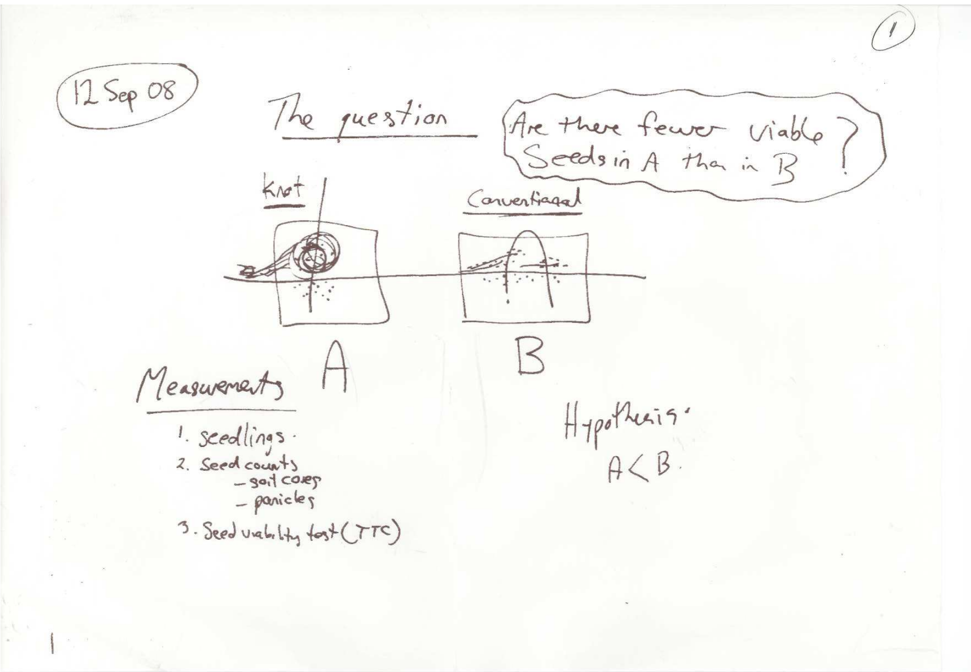
We recommend that the Marlborough District Council enlist a scientifically credible organisation to help it develop and submit a proposal to a relevant funding agency to secure funds to enable this experiment to be conducted and its results analysed and reported to end users.

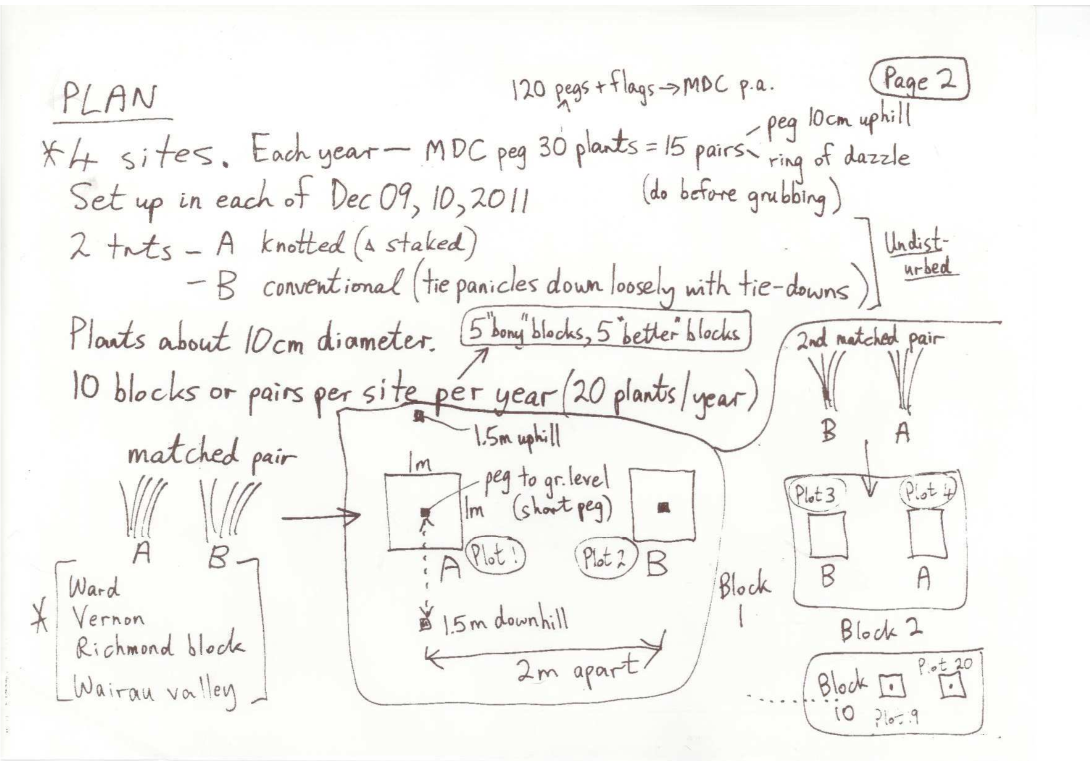
5. ACKNOWLEDGEMENTS

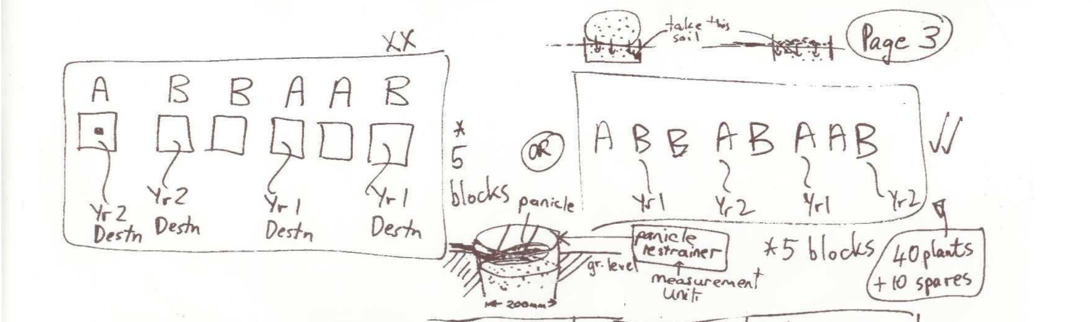
We acknowledge Ben Minehan and Harry Neal, MDC, for their enthusiastic support for this project and FRST for financial support through an Envirolink Small Advice grant.

6. APPENDIX – White board notes from discussion with MDC in Blenheim on 12 September 2008

(NB: subsequent considerations have led to a recommended experimental plan that does not follow these notes precisely)







Measurements	Plots set up 2009 Dec 09 (initial)	Dec 2010	Dec 2011	Dec 2012	Plots set up in 2010 Init.	11	12	13	Plots set up in 2011 Init.	12	13	14
1. seedlings	x	20/trt	15/trt	10/trt	x	✓	✓	✓	x	✓	✓	✓
2. Seed counts												
– soil cores	✓	✓	✓	✓								
– panicles	✓	✓	✓	✓								
3. Seed viability test												
(TTC) – soil cores	✓	✓	✓	✓								
– panicles	✓	✓	✓	✓								

n=10 @ Yr3

Destructive Samples (n=5 @ Yrs 1 & 2)

At Yr 1, remove seedlings > specified size (& Yr 2)