

**EFFECT OF THREE SOIL FUMIGANTS ON THE VIABILITY  
OF BURIED SEEDS OF CHILEAN NEEDLE GRASS  
(*STIPA NEESIANA*)**

G. A. HURRELL<sup>1</sup>, G. W. BOURDÔT<sup>1</sup> and R. M. HUNTER<sup>2</sup>

*AgResearch, New Zealand Pastoral Agriculture Research Institute Ltd,  
P O Box 60, Lincoln<sup>1</sup>  
Marlborough Research Centre, Blenheim<sup>2</sup>*

**SUMMARY**

The fumigants, dazomet, metam-fluid and methyl bromide were compared for their ability to kill the buried seeds of Chilean needle grass (*Stipa neesiana*). Two dense stands of Chilean needle grass at Blind River in Marlborough, were treated with glyphosate and cultivated prior to treatment with the fumigants in the spring of 1993. Both dazomet and methyl bromide reduced the proportion of viable seeds remaining 7 days after treatment to almost nil. Metam-fluid was less effective. The implications of these findings for the control of Chilean needle grass are discussed.

**Keywords:** *Stipa neesiana*, Chilean needle grass, dazomet, metam-fluid, methyl bromide, tetrazolium

**INTRODUCTION**

Chilean needle grass (*Stipa neesiana* Trin. and Rupr.) is an introduced South American tussock which occurs locally in drought-prone pastures at Blind River, Marlborough and Waipawa in Hawkes Bay. It is a serious weed because its sharp awned seeds damage the pelts, eyes and flesh of grazing animals, particularly sheep (Bourdôt and Ryde 1986). The plant produces awned seeds on open aerial inflorescences (aerial seeds) and smaller seeds with variable sized awns in ensheathed inflorescences at stem-nodes and at the culm bases (clandestine seeds) (Connor *et al.* 1993). Aerial seeds are encased in hard, tightly rolled lemmas which are less well developed in the clandestine seeds. Bourdôt and Hurrell (1992) showed that a persistent soil seed-bank containing 18000 viable seeds/m<sup>2</sup> occurred under pasture with >99% of the seeds in the top 25 mm of soil. Since Chilean needle grass seeds survive for long periods in the soil their eradication from the soil seed-bank would assist in a control programme.

Strategies implemented for the control of Chilean needle grass by the Marlborough District Council rely on herbicides to kill established plants in extensive infested areas prior to pasture renovation, and in small patches of relatively few plants in outlying areas. New infestations are most likely to develop from isolated plants, so the first priority is to kill isolated plants and to re-establish desirable pasture species to prevent further invasion.

Isolated tussocks and small patches of the grass can be controlled in hill-country pastures using either glyphosate (Bourdôt and Hurrell 1987) or hexazinone (Hurrell and Bourdôt 1988). However, neither of these options prevents seedling re-establishment because the clandestine seeds are apparently protected from contact with the herbicide by the dead tiller tissue even though the parent plant may be killed. These herbicides must be applied annually for a number of years to eliminate seedling recolonisation. Soil fumigants on the other hand, while costly and more difficult to apply, may eliminate the seed-bank in a single application and could prove to be practical for the treatment of small patches. This experiment sought to compare three commercially available soil fumigants in their ability to kill soil-borne seeds of this tussock.

*Proc. 47th N.Z. Plant Protection Conf. 1994: 80-83*

### METHODS

The two sites chosen for this experiment were in old established stands of Chilean needle grass on northerly facing hill slopes at Blind River in Marlborough on a Flaxbourne dry subhygrous sand/silt prone to summer droughts. In mid-October 1993 the established plants in two patches of Chilean needle grass were treated with glyphosate at 1.44 kg/ha and later rotary-hoed to a depth of about 10 cm. Some fibrous root clumps of Chilean needle grass remained after two hoeings.

Experimental treatments consisted of three soil fumigant treatments and an untreated control replicated six times, in two blocks (sites) of three replicates each. The treatments were dazomet at 640 kg/ha (Basamid Granular, 970 g/kg), metam-fluid at 240 kg/ha (BASF Metam-Fluid, 560 g/kg) and methyl bromide at 440 g/2.25m<sup>2</sup> (Agfume MB, 980 g/kg). Both dazomet and metam-fluid were applied at the highest recommended rate. Methyl bromide is available in pressurised canisters (454 g weight) which are recommended for treatment of 4.5 m<sup>2</sup> of soil. In this experiment one canister was used to treat each plot (2.25 m<sup>2</sup>). The treatments were all applied on 10 November 1993.

The plots were 1.5 x 1.5 m and those to be treated were trenched to cultivation depth around their perimeters to enable polythene covers to be placed and sealed over them after treatment. The soil temperature at the time of treatment was 18°C at 10 cm depth and the soil moisture status was low. Both dazomet and metam-fluid plots require sufficient soil moisture to activate the chemicals. These treatments were watered at the rate of 4 litres/plot prior to treatments being applied. The dazomet was mixed with coarse sand to improve evenness of application, applied by hand shaker then lightly forked into the soil. The metam-fluid was applied by hand sprayer to the soil surface, which had previously been forked to produce holes, then watered in to assist soil incorporation. Both the dazomet and metam-fluid plots were covered and sealed with polythene sheets immediately after treatment. The methyl bromide was discharged from gas canisters (one for each plot) into evaporation pans under previously fitted polythene covers.

The polythene covers were removed after 7 days to allow the gases to dissipate. A 1 x 1 m quadrat was then placed centrally on each plot and one 6.3 cm diameter soil core, to about 10 cm depth, extracted at each of the four corners. All soil cores were kept separate for analysis.

Soil cores were wet-sieved to remove soil and the remaining debris was hand sorted to recover intact Chilean needle grass seeds. Seeds were imbibed for 24 h on wet blotters in a refrigerator and then bisected longitudinally through the embryo with a scalpel before immersing in a 1% solution of 2,3,5-triphenyl tetrazolium chloride (TTC) and distilled water. The seeds thus prepared were held in an incubator at 20°C for 24 h and then assessed for viability. Viability was determined by comparing the stained embryos with the interpretation criteria for large-seeded grasses (Grabe 1970). Aerial seeds and clandestine seeds were enumerated and assessed separately.

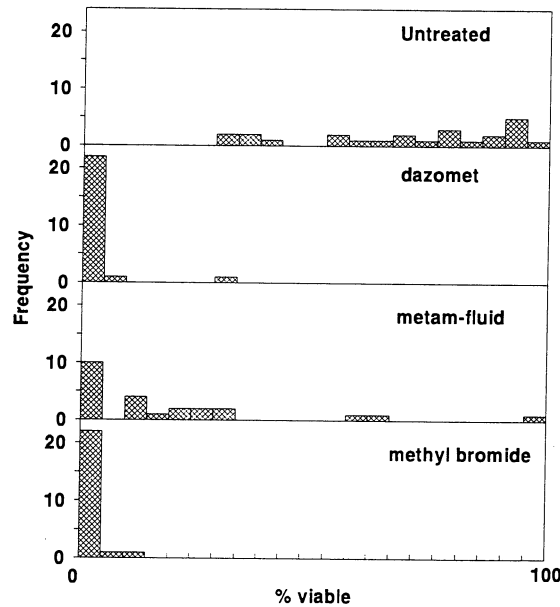
### RESULTS

The average density of intact seeds exhumed from cores was 10500/m<sup>2</sup> of which about 70% were clandestine seeds and 30% aerial seeds. The numbers of intact seeds in individual soil cores ranged from 8/core to 110/core (2600/m<sup>2</sup> to 35000/m<sup>2</sup>). All cores contained clandestine seeds but several cores had few or no aerial seeds in them.

The numbers of viable seeds as a percentage of the total number recovered are given in Table 1. Due to the large number of zeros in the data, comparison of treatment effects was by a chi-squared test which compared the frequency of zero and non-zero values. The results show that a high proportion of recovered seeds from the untreated plots were viable, especially among the aerial seeds. All of the fumigants substantially reduced the proportion of seeds that remained viable. Both dazomet and methyl bromide killed 98% of viable seed while metam-fluid killed 83% of seeds. The viability of aerial and clandestine seeds was almost identical.

**TABLE 1: Viable seeds of Chilean needle grass as a percentage of the total number of seeds recovered.**

	Clandestine seeds	Aerial seeds	Average (both seed types)
untreated	58.0	86.1	66.6
basamid	1.7	0.4	1.3
metam-fluid	19.9	15.7	16.6
methyl bromide	0.2	0.4	0.4
Contrasts (using $X^2$ tests)			
Untreated vs treated	**	**	**
(metam) vs (basamid + met. br.)	**	**	**
basamid vs met. br.	ns	ns	ns



**Figure 1: Distribution of the 24 cores for each treatment across 21 seed viability classes. The first class is zero viability and successive classes have an interval of 5% viability (eg. 0, 1 - 5, 6 - 10, 11 - 15 etc).**

Results of an analysis of the frequency of the percentages of viable seeds (both seed types), out of 24 cores for each treatment, are given in Fig. 1. All of the cores from untreated plots contained viable seeds. All fumigant treatments substantially reduced the number of cores containing viable seeds when compared to the untreated ( $P < 0.01$ ). Fourteen out of 24 cores from metam-fluid plots contained viable seeds but only two of the dazomet and methyl bromide cores contained any viable seeds. The difference between metam-fluid and the two other fumigants was highly significant ( $P < 0.01$ ). The distribution of the cores with regard to the percentage viability of their seeds was bimodal (Fig. 1). The “non-zero” cores for metam-fluid contained seeds ranging from 10% to 100% viability, while by contrast, non-zero cores in the other two treatments contained less than 30% and 10% of viable seeds for dazomet and methyl bromide respectively.

### DISCUSSION

These results show that high proportions of buried seeds of Chilean needle grass can be killed *in situ* with soil fumigants. All of the chemicals tested killed seeds, regardless of the seed type. The reason for the variable seed kill which was evident in some plots may be poor gas penetration of clumps of soil and old tiller material or loss of gas from the sealed plots. Evidence for the former hypothesis is that individual cores appeared to contain seeds with either a high level of survival or no survival (Fig. 1); in this respect metam-fluid was the worst affected treatment. Loss of gas from the sealed plots appears less likely because the covers remained intact for the period of the experiment and the duration of exposure to the gases exceeded that recommended for each of the products. Another possible explanation for the between-core variability in seed kill is genetic variation. This would seem unlikely because the cultivation thoroughly mixed the soil and would have mixed together seeds from different genotypes.

A major disadvantage of using residual herbicides in the control programme is that the treated patches remain devoid of pasture species until the herbicide loses efficacy; more than a year if hexazinone is used. This factor predisposes the soil to the effects of erosion and the ingress of other weed species. Also, clandestine seeds of Chilean needle grass can establish in the dead tussock bases in the treated soil. Soil sterilization, on the other hand, could provide a weed-free seed bed in which pasture species could be sown. This technique offers the advantage of rapid re-establishment of pasture because the treated soil can be re-sown about 7 days after treatment.

Soil fumigation is both costly and difficult to apply on a large scale in the field. Therefore this technique could only be considered for use on small areas of land which can be prepared and treated according to the recommendations for the products. Metam-fluid could not be recommended on the basis of this experiment because of inconsistent results. Methyl bromide, whilst a very effective treatment, is extremely hazardous to handle and requires trained personnel to apply; it is therefore unlikely to be acceptable to farmers. By contrast, dazomet is relatively easy to apply in the field and gave a high level of kill of buried seeds. It could be used to eradicate small patches of Chilean needle grass as part of a larger scale control programme.

### ACKNOWLEDGEMENTS

The authors acknowledge the Marlborough District Council for financial assistance for this work, Michael Watson on whose land the experiment was conducted and David Saville for advice on statistical matters and data presentation. We are also very appreciative of the many hours spent by Christine Galbraith washing soil cores and sorting seeds.

### REFERENCES

- Bourdôt, G.W. and Hurrell G.A., 1987. Chilean needle grass (*Stipa neesiana*) 1. Control with herbicides in pasture. *Proc. 40th N. Z. Weed and Pest Control Soc. Conf.*: 204-207.
- Bourdôt, G.W. and Hurrell, G.A., 1992. Aspects of the ecology of *Stipa neesiana* Trin. & Rupr. seeds. *N.Z. J. Agric. Res.* 35: 101-108.
- Bourdôt, G.W. and Ryde, D.H., 1986. Chilean needle grass (*Stipa neesiana*). Significance, identification and control. *Aglink FPP675*. MAF Corp, Wellington.
- Connor, H.E., Edgar, E., and Bourdôt, G.W., 1993. Ecology and distribution of naturalised species of *Stipa* in New Zealand. *N.Z. J. Agric. Res.* 36: 301-307
- Grabe, D.F., 1970. Tetrazolium testing handbook for agricultural seeds. Contribution No. 29 to the Handbook on Seed Testing. Prepared by The Tetrazolium Testing Committee of the Association of Official Seed Analysts. Published by the Association of Official Seed Analysts.
- Hurrell, G.A., and Bourdôt, G.A., 1988. Granular herbicide formulations for *Stipa neesiana* (Chilean needle grass) control. *Proc. 41st N.Z. Weed and Pest Control Soc. Conf.*: 235-237.