Finding needles in a haystack: an investigation of a non-destructive method to detect the seeds of Chilean needle grass (*Nassella neesiana* (Trin. & Rupr.) Barkworth) in round hay bales

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Summary Preserved fodder is a key component in modern agricultural practice. Hay bales are commonly provisioned for livestock. Unfortunately this is also a significant source of new weed infestations, including those of noxious species. Because hay bales may be of a low absolute value the usual approaches for weed control, for example herbicide treatment, may be expensive to apply and therefore not justified by the expected economic returns for this commodity.

The methods of detecting weed seeds in bales that have been employed to date suffer from several deficiencies. These include the inefficiently long time needed for testing, loss of the commodity by overly destructive sampling methods and a serious potential for a lack of ecological representation for the presence of weeds. It is proposed that an alternative method, which is both potentially more rapid and more ecologically representative for detecting the presence of the seeds of noxious weeds in hay bales should be devised.

Keywords Preserved fodder, *Nassella neesiana*, weed seed detection, non-destructive method.

INTRODUCTION

Chilean needle grass, *Nassella neesiana*, is an invasive weed that can be dispersed in hay bales. It is a tussock-forming perennial grass that is similar in appearance to useful pasture grass species, as well as a number of other introduced and Australian native, members of the tribe Stipeae (Foreman *et al.* 1993). It is a declared weed in all states of Australia (restricted, noxious) (Australian Weeds Committee 2009) and is listed as a Weed of National Significance (Australian Weeds Committee 2010). Because this weed bears a strong resemblance to useful pasture species while in the vegetative growth stage, it may be easily overlooked when or if weed control may be usefully applied to pastures that are intended to be baled for hay (Barrett 1983).

To date, methods employed for detection of weed seeds in hay bales have typically involved either the complete destruction of a single bale from a 'lot' of bales from a particular geographic region or removing a significant portion (~25%) of several bales that were similarly sourced, followed by isolating, identifying and quantifying any seeds detected. Seeds are collected from the bales by threshing the hay or pulling bales apart manually, after which sieving is used to concentrate the seed-bearing material. Seeds are then quantified and identified using references or by germination and identification of the resultant plants (Thomas *et al.* 1984, Wells *et al.* 1986, Conn *et al.* 2010).

These methods are time-consuming and may be of limited value in an ecological sense. Given that weeds, like other plants, often show a heterogeneous distribution in a pasture (Ambrosio *et al.* 2004), there is a low likelihood of detecting a particular weed species in that pasture by testing to destruction a single bale. Testing only a single bale could give a false impression of either the abundance of this weed in this particular pasture or its absence. A more realistic assessment of a weed infested pasture could be made by obtaining multiple small samples from a large number of bales in a 'lot'. These could be tested for the presence of weed seeds, thus effectively sampling a larger area of the pasture or region.

It is apparent from the foregoing that there is a need for a new method that could be employed to detect the dispersal of weeds in hay bales that addresses these issues. The development of such a method was investigated as described below.

MATERIALS AND METHODS

Bales of hay that were known to not contain the seeds of *N. neesiana* were rolled out to form individual windrows, in a paddock at the DPI facility at Attwood, Victoria. Weighed quantities of heat-killed seeds (50 g, 100 g, 150 g, 250 g and 1000 g) of *N. neesiana* were placed into the windrows in three different distribution patterns (evenly dispersed, beginning of windrow, end of windrow) to mimic both different levels of weed infestation and varying distribution patterns within a pasture. The windrows were then re-rolled by a baler and subsequently core sampled using a modified (90

cm long) standard hay corer. This longer corer allowed for the collection of samples that could be considered to represent the entire length of the windrow, since the material was collected from the outside edge of the bale to the centre. Fifteen core samples from the rolling edge of each bale were collected and each sample placed into a separate paper bag. These were taken to the University of Ballarat, School of Environmental Management and dried in an oven at 40°C for 5 days.

Manual seed searching of the samples was conducted, firstly by using a sieve of (1 mm) to see whether seeds could be captured in the mesh. It had been observed during previous work with core samples that this mesh size was useful for capturing and holding mature seeds of this weed, thus giving a quick indication of the presence of weed seeds in the sample, although pilot studies showed that this was not completely representative of the implanted seed quantity. The other advantage of this step is the removal of the very fine material that had been previously found to impede manual search among the larger particles of hay for seeds. An excessive amount of this fine material has been found to sometimes make visual detection of seeds difficult and often prolonged the search for the seeds. Following sieving, the larger particles were carefully examined by spreading out small quantities of material in a shallow plastic tray and searching for seeds, gradually working through the sample until all of it had been examined. The time taken per core was dependent upon the amount of material in each individual sample, but ranged from approximately 10 to 40 minutes. The seeds of *N. neesiana* are quite distinctive and, with relatively little practice, readily detectable to the naked eye.

RESULTS

At the time of writing this paper, no final results were available. However, previous trials suggested a dose/response relationship for the presence of seeds of *N. neesiana*, when these were added in the manner described in the foregoing section, although this has yet to be shown to be statistically reliable.

DISCUSSION

The core sampling of representative and relatively small amounts of round hay bales may be an efficient alternative to the destructive sampling of entire bales. Since round bales are rolled up collections of plant matter harvested from strips of pasture, the material obtained in each core should represent, albeit in a fairly crude fashion, sequential samples of the plants composing the pasture. There is also the benefit that only a few hundreds of grams, or at most a kilogram or two, of material is removed from each bale. Because the bales are still largely intact, they may still be sold for fodder once it has been determined that they are unlikely to contain any weed seeds. Alternatively, if weed seeds are detected, steps may be taken by the producer to contain any infestations that might result after bales are broken up, because the relative risk of weed dispersal is better known. If the seeds of noxious species are able to be detected in bales by this method, then it should be possible to determine the infestation sources and take steps to manage or eradicate them as they are detected.

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