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Best practice weed detection on Australian farms

Michael J. Coleman[a,*], Brian M. Sindel[b], Ian J. Reeve[a], Lyndal-Joy Thompson[c]

[a] Institute for Rural Futures, School of Behavioural, Cognitive and Social Sciences, University of New England, Armidale, NSW, 2351, Australia
[b] Agronomy and Soil Science, School of Environmental and Rural Science, University of New England, Armidale, NSW, 2351, Australia
[c] Australian Centre for Agriculture and Law, University of New England, Armidale, NSW, 2351, Australia

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ABSTRACT

Agricultural weeds impose a significant cost on Australian farmers and consumers. The first step in controlling weeds on-farm is successful detection. The sooner new weed invasions are detected, the more effective management strategies will be. This research sought to collate 'best practice' principles for weed detection by surveying those individuals who play a part in weed detection and control on Australian farms – landholders and weeds officers. We found that landholders regularly checked their property for weeds, but were often reluctant to report new weed outbreaks. Weeds officers had an important role in improving weed detection on-farm, by providing advice and information to landholders, and encouraging more landholders to report weed outbreaks. While there were many similarities in the best practice approaches used by landholders and weeds officers to inspect land for weeds, weeds officers had access to a range of resources that made it considerably easier to identify a new weed species. It was also found that there were particular segments within the broad landholder group (such as non-professional landholders), who were considered relatively poor weed managers. Extension work in this area therefore needs to encourage close cooperation with weeds officers, targeting specific landholder groups for extension and access to expert advice, while continuing to educate all landholders in the areas of weed identification, and the best practice detection and control techniques used by weeds officers.

1. Introduction

More than 2770 exotic plant species have become naturalised in Australia since European settlement, of which around 65% are considered a problem for natural ecosystems and about 35% are considered a problem for agricultural systems (Sinden et al., 2004, 2005). Species with weed potential will continue to enter the country (Groves, 1997), while existing weeds will continue to expand their range within Australia via various pathways of weed spread (Sindel et al., 2008a). Agricultural weeds in Australia impose a variety of tangible and intangible costs on rural landholders, including weed control efforts, efforts to re-establish pasture and crops in the wake of a weed infestation, potential and actual yield losses, and the opportunity cost to landholders associated with devoting part of their time to weed control. In all, agricultural weeds have been estimated to cost landholders and consumers in Australia between $3.5 and $4.4 billion annually (Sinden et al., 2004, 2005). It is therefore vital to detect new weed infestations on agricultural land as soon as possible after their introduction. When new weed outbreaks are detected early, management strategies are likely to be more effective, and the likelihood of eradicating the species from an area, rather than simply controlling the weed population and limiting spread, improves markedly (Holt, 2004).

There has been substantial effort to improve weed detection techniques in Australia, though this has largely focused on public spaces, particular weed species, or encouraging 'grass roots' community involvement. Guidelines have been developed to standardise surveying and mapping of nationally significant weeds (McNaught et al., 2008). Protocols have also been developed for weed mapping and monitoring in national parks (Anon, 2007), while studies have mapped the distribution of particular species at local scales to inform detection and management strategy (for example, Cowan et al., 2007). Surveillance techniques have been refined for weeds already established in Australia, such as branched broomrape (*Orobanche ramosa* L.) (Correll and Marvanek, 2006). 'Weed spotting' networks have been established in the states of Victoria and Queensland, to encourage voluntary surveillance of emergent and prohibited/declared weeds (Morton, 2006; Smith, 2006; Morton and Harris, 2008).

However, no comprehensive studies have previously been undertaken to determine current weed surveillance levels and practices amongst agricultural landholders in Australia, or to eval-

* Corresponding author.
E-mail address: mcolema8@une.edu.au (M.J. Coleman).

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uate the detection role undertaken by noxious weeds officers (or their equivalent in each State and Territory) who are already legally mandated to inspect privately owned agricultural land for weeds. Nearly 60 per cent of land use in Australia is devoted to agricultural production (Sinden et al., 2004), and so it is important both to understand current weed surveillance practices in use on this land, and ways in which detection, monitoring and containment may be improved.

A survey of graziers in southern Australia (Trotter, 2007) found that over 80 per cent of respondents regularly check their paddocks for weeds, but only 10 per cent either record the location of these infestations on a map or mark them in-field. Within the agricultural sector, then, lies an Australia-wide network of 'weed spotters', who are motivated to detect and control weeds on their land (given the economic benefits of doing so), but whose rigour in marking and mapping infestations is assumed to be relatively low. While voluntary weed spotter networks play an important function in weed surveillance, their focus is generally on public lands, and most private agricultural land remains inaccessible to such groups (Morton and Harris, 2008; Stephens, 2010).

In addition to private rural landholders, there also exists a network of public officers in most Australian States and Territories who have a specific and legally defined inspection function for weeds on agricultural land. Nonetheless, how the States and Territories vary in their effectiveness with respect to this role has not been explored or compared. The role of these individuals (hereafter 'weeds officers') is different in each State and Territory, so it is important to collate information from all jurisdictions to obtain a complete picture of inspection patterns, how surveillance data are managed, and how new infestations are identified, reported and recorded.

Information on landholder and weeds officer surveillance patterns (especially proven surveillance and recording techniques) is necessary to inform the development and extension of 'best practice' methods for surveying and eradicating agricultural weeds in Australia. The purpose of this research was therefore two-fold: firstly, to assess current weed surveillance levels and practices amongst both agricultural landholders and weeds officers; and secondly, to identify ways in which on-ground weed detection strategies used by these groups may be improved, or in which tried and tested best practice principles may be extended further.

2. Materials and methods

The research progressed over three phases, designed to obtain a large amount of information on weed surveillance in the relatively short time-frame available to the project. More details are available in Sindel et al. (2008b). First, several focus groups were held with landholders and weeds officers to scope the issues surrounding weed surveillance on Australian farms, in order to determine the content of two national surveys, one of weeds officers and one of landholders. Second, current information detailing the roles, responsibilities and practices of weeds officers was collated by liaising with administering bodies in each Australian State and Territory. This information was used to determine to whom the survey of weeds officers should be sent, and made it possible to refine survey questions with respect to State/Territory idiosyncrasies. The survey content was also informed by previous research undertaken by the project team (for example, Sindel, 1996; van der Meulen et al., 2007).

Finally, the two national surveys were conducted with weeds officers and landholders respectively. The sample frame for the postal survey of weeds officers was constructed using a non-random network or 'snowball' approach, in order to identify and consult this otherwise difficult to reach target population (Faugier and Sargeant, 1997; Gilbert, 2001). Through this approach, we established key contacts within local government noxious weeds authorities, and State/Territory and Federal natural resources and primary industries departments via email, internet search and telephone. Supervisors were contacted and asked to provide lists of noxious weeds inspectors, bio-security officers, and similar authorised officers. A sample frame of 385 weeds officers resulted from this work. The final response to the survey of weeds officers (for which a reminder was sent to non-respondents after a short time) was 146, amounting to a 38 per cent response rate.

Given that social norms in rural areas include the expectation that landholders will adequately control weeds on their properties (Minato et al., 2010), there was a possibility that social desirability bias (Krumpal, 2013) could affect the findings of the survey of landholders. To minimise social desirability bias, the wording of the survey questions avoided any suggestion of approval or disapproval of potential responses. The survey was also conducted anonymously over the telephone on behalf of an organisation with no connection to mandated weed control (i.e. the University of New England), thereby precluding the need for respondents to over-report their diligence in this respect. The fact that some respondents to the survey admitted their reluctance to report new weed outbreaks (Section 3.5) suggests that our efforts in survey design were at least partly successful in reducing social desirability bias.

Landholders were surveyed by telephone, with a research company sub-contracted to undertake the interview work. The random sample frame was constructed from a variety of sources, and stratified by State. Strata were sized to provide an estimate on proportions of at least ±10 per cent at the 95 per cent confidence level. Strata populations were based on the number of farms in Australian and New Zealand Standard Industrial Classification (ANZSIC) categories 0113–0169, covering the main forms of broadacre and mixed farming in Australia (Australian Bureau of Statistics, 2004). Of the 2085 telephone numbers called, 568 interviews were completed, comprising a 27 per cent completion rate (Table 1).

Data analysis was completed in SPSS (SPSS, 2007). Verbatim responses from the surveys and interviews were coded where relevant to facilitate quantitative analysis of qualitative data. Cross-tabulations, multiple response tables, rank order tables and tables comparing means were produced using the respondent's State or Territory (as well as property type in the case of the landholder survey) as an independent variable. Chi-square tests were carried out on cross-tabulations, to identify significant relationships between variables. For tabulations of rank order variables (i.e. questions where respondents chose an option from among a ranked set of categories such as 'never', 'occasionally' and 'frequently'), the non-parametric Kruskal–Wallis test (SPSS, 2007) was used to identify significant differences between States/Territories and property types.

3. Results

3.1. Weeds of most concern

Landholders were asked to indicate which weed species were of most concern to them. Less common species were aggregated into functional groups such as 'other perennial broadleaf weeds' or 'perennial grasses'. Thistles were considered the weed of most concern overall by landholders, followed by Paterson's curse (*Echium plantagineum* L.), Bathurst burr (*Xanthium spinosum* L.), and blackberry (*Rubus fruticosus* L.). However, the response did vary considerably depending on State/Territory and property type. For example, graziers were most likely to be concerned about thistles, while those with a cropping operation were least likely to be concerned. Similarly, landholders from New South Wales, Victoria