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Can grain growers and agronomists identify common leaf diseases and biosecurity threats in grain crops? An Australian example

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ABSTRACT

The Australian grains industry relies upon growers and agronomists to be aware of pests and diseases in their crops and to notify their local State Department of Agriculture when they suspect an incursion of a high priority pest (HPP). This raises the question "Are growers and agronomists, within the Australian grains industry, able to meet this expectation?" A training needs analysis was undertaken to determine the capacity of growers and agronomists to identify three endemic diseases (powdery mildew in barley, stripe rust in wheat and blackleg in canola) in their crops. Their knowledge of the top four-biosecurity threats to the Australian grains industry (Karnal bunt, Khapra beetle, barley stripe rust and Russian wheat aphid) was also determined. Benchmarks for successfully identifying these diseases were set beforehand at 70% of growers and 80% of agronomists; participants' ability to identify these endemic diseases in crops met these benchmarks. However, their ability to recognise blackleg in canola was significantly lower than for the two cereal foliar diseases. There was a significant correlation of region with these capabilities, with a greater proportion of participants in Western Australia (WA) recognising powdery mildew in barley than in Eastern Australia (EA). In contrast, a greater proportion of participants in EA were able to identify stripe rust of wheat than in WA. The education levels of participants corresponded with their ability to identify blackleg in canola. Participants' knowledge and awareness of symptoms and signs associated with the top four biosecurity threats were well below expectations; fewer than half of the participants answered questions on these four HPPs. Gender, age and educational level did not correlate with the participants' knowledge and awareness of the four HPPs with the exception of Karnal bunt. Participants with a higher level of education had significantly more knowledge of symptoms associated with Karnal bunt than did participants with lower levels of education. The use of diagnostic services by the grains industry participants is a vital component of general surveillance. This survey showed that use of these services by growers was significantly lower than by agronomists. Awareness of the National Exotic Plant Pest Hotline and GrainGuard was significantly lower than other diagnostic services for both growers and agronomists. Diagnostic services need to be promoted further to increase awareness and use by growers and agronomists. Correct diagnosis of disease and pest symptoms is vital for the biosecurity of the grains industry.

1. Introduction

Accurate and rapid diagnosis is required for the effective management of endemic diseases and pests and to prevent the incursion and establishment of biosecurity threats to the Australian grains industry. Early detection requires growers and agronomists to be aware of and to be able to identify symptoms and signs associated with these pathogens and pests.

In Australia, the Emergency Plant Pest Response deed (EPPRD) covers the management and funding of responses to emergency plant pest (EPP) incidents. Plant Health Australia (PHA) is the custodian of this document (Plant Health Australia, 2015). PHA is a not-for-profit company that is the national co-ordinator of the government-industry partnership for plant biosecurity in Australia

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(Plant Health Australia, 2015). The EPPRD has increased the capacity of Australia to respond to incursions by allowing rapid, efficient and effective responses (Plant Health Australia, 2015). An EPP is either: a) a known exotic plant pest; b) a variant form of an endemic plant pest; c) a previously unknown pest or d) an officially controlled pest. These are pests that have a significant impact (environmental or economic) nationally (Plant Health Australia, 2015). Eradication is facilitated by early detection (Plant Health Australia, 2015). The deed lists the following three EPPs for the grains industry: a) *Tilletia indica* Mitra 1931 (Karnal bunt); b) *Trogoderma granarium* Everts 1899 (Khapra beetle); and c) *Diuraphis noxia* Kurdjumov 1913 (Russian wheat aphid) (Plant Health Australia, 2015). The pathogen that causes barley stripe rust (*Puccinia striiformis* f. sp. *hordei* Eriksson 1894) is not on the list of EPPs, but is listed as a high priority pest (HPP) for the grains industry within Australia. These four pests and pathogens are referred to as high priority pests (HPPs) in this investigation.

Australia has a very diverse agricultural sector that includes crop production (broadacre and horticultural) and animal production (sheep, cattle – beef and dairy, pigs and poultry). The Australian Bureau of Statistics (ABS) reported that in 2011/2012, 405 million hectares of land were used for agriculture in Australia, with 32 million hectares being planted for crops. The value of Australia's exported grain exceeded $10 billion (AUD) in 2013/2014 and included these three major crops; wheat ($6 billion), canola ($2 billion) and barley ($2 billion) (Australian Export Grains Innovation Centre, 2015). Nationally 29.9 million tonnes of wheat were produced, with a total area planted to wheat of 13.9 million hectares (Australian Bureau of Statistics (2012)).

Pests and diseases cause considerable loss of value to Australian crops. The estimated annual loss is $76.64 (AUD) per hectare in the Australian wheat industry (Murray and Brennan, 2009b). These losses represent 19.5% of the average annual value of wheat crop production over the past decade. Similar losses are reported in barley and canola crops (Murray and Brennan, 2009a, 2012). Improving the knowledge and skills of growers and agronomists to facilitate effective management of pests and diseases, should reduce these losses.

The Grains Research Development Corporation (GRDC) surveyed growers and agronomists about information products and services needs that they will require over a two-year period (Watson and Watson, 2014). Only 17% of growers thought that they would require information on pests and diseases in crops while approximately 30% of agronomists thought that this information would be required (Watson and Watson, 2014). This indicates that growers and agronomists within the grains industry believe that their existing skills are adequate for pest and disease management.

Community-based surveys and reporting by growers and agronomists can be used to address International Standards for Phytosanitary Measures (ISPM) 04 requirements for Area Freedom (2001; FAO, 2011; Hammond et al., 2016a; Mangano et al., 2011). The ability of community groups to detect exotic or HPPs (both disease and insects) was tested by Mangano et al. (2011) in a simulated exercise where three fictitious pests (two insects and one disease) were used. Success in detection of these pests was correlated with both participants' age and professional experience. The term 'general surveillance' is used to encompass information that is collected through diagnostic services, reports from experts, growers and agronomists and reports to government departments. These activities are an important contributor to the early detection of a possible HPP (FAO, 2011; Hammond et al., 2016b).

The probability of a grower detecting a disease in their crop directly influences the sensitivity of general surveillance for that disease (Hammond, 2010), i.e. the higher the probability of detection by the grower, the greater the sensitivity of the surveillance. When knowledge and awareness are lower than a benchmark level this is likely to impact on the ability of growers and agronomist to report suspected HPPs. The animal and plant industries have considered this using scenario tree analysis, based on probabilistic modelling (Hadorn and Stärk, 2008; Hammond, 2010; Martin et al., 2007). The sensitivity of general surveillance for the detection of foot and mouth disease in animal production areas of Australia varied according to a number of factors including the attitudes, behaviours, the knowledge and understanding of this disease by farmers and livestock inspectors. This was demonstrated using a stochastic scenario tree model (Martin et al., 2015). In this model, disease awareness was broken down into three main components: a) the probability of clinical signs being observed in the animals, b) the probability that the farmer recognises these clinical signs as being a problem and c) the probability that a veterinary officer is notified of the problem (Martin et al., 2015). Therefore, the earlier that growers and agronomists recognise symptoms associated with HPPs in grain crops, the greater the probability that a HPP will be reported early, allowing for a more effective response to occur.

In a previous survey by Hammond et al. (2016a), knowledge of the symptoms and signs associated with the top four HPPs of the grain industry was determined among growers and agronomists within Western Australia (WA). Participants had greater knowledge of the symptoms and signs associated with the pathogens causing Karnal bunt and barley stripe rust than of the two insect pests Khapra beetle and Russian wheat aphid.

There is little published literature concerning increasing the capacity of growers and agronomists to identify plant pests and diseases, although Levy (2005), Bagamba et al. (2006) and Yang et al. (2008) indicate that the awareness of growers and industry was increased when information was provided during a biosecurity campaign. However, there is more literature published within the animal industry examining the skills of farmers, veterinarians and other professionals in their identification and awareness of exotic diseases to determine what capacity building is required (Kunda et al., 2008; Martin et al., 2015; Musa et al., 2010).

No benchmark has been set previously in the grains industry for assessing the ability of growers and agronomists to identify endemic diseases in crops, nor is there an equivalent in the animal industry. The aim of this study was to use a training needs analysis (TNA) of Australian grain growers and agronomists to determine their ability to identify endemic leaf diseases in crops and the top four HPPs in grain crops. A TNA is often used before designing a course to determine what training the learners require. The TNA determines the level of discrepancy between the perceived knowledge or skill level of a learner and the actual knowledge or skill level of the learner (Print, 1993). The TNA can be done using a questionnaire, as in our study reported here. The relationship of age, gender, level of education and location with the ability of growers and agronomists to identify the pests and diseases was also examined. This is an initial step in determining if there is a gap in the skills of growers and agronomists within the grains industry and if so, what capacity building is required. For our study, the following disease identification benchmarks of 70% of growers and 80% of agronomists were established. The results from the questionnaire given to growers and agronomists will determine if 70% of growers are able to identify diseases in their crops and if 80% of agronomists can identify diseases in crops.

2. Methods

2.1. Surveys

Two questionnaires were developed to examine the training needs of participants in the grains industry of Australia. One