A National program to improve awareness and adoption of best management practice for silverleaf nightshade control

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Summary Silverleaf nightshade (SLN) is recognised as one of the world's worst agricultural weeds that competes directly with spring, summer and autumn growing pastures and crops for moisture, sunlight and nutrients (Stanton *et al.* 2009). With the aim of benefitting the largest number of growers possible, farm scale participatory on-farm validation sites of best management practice were established with support from state and local agencies, private sector contractors and advisors, and local grower groups.

The participatory research, in conjunction with farmer case studies and a baseline survey targeting 500 growers and advisors (combined) has generated large and diverse baseline information focused on weed prioritisation, appropriateness of information, effective information delivery mechanisms and recommendations for packaging and instruction of weed management. This paper highlights key findings captured for improved adoption of integrated weed management practices.

Keywords Silverleaf nightshade, control strategies, participatory research; best management adoption.

INTRODUCTION

Silverleaf nightshade (*Solanum elaeagnifolium* Cav.) is an introduced summer active perennial from the Solanaceae family that can dominate pastures and cropping areas (Wu *et al.* 2016). In 2013 a National project funded by Meat & Livestock Australia and Australian Wool Innovation commenced to improve awareness and adoption strategies for silverleaf nightshade control across four states. It reproduces from seed and extensive root fragments, so poses a large problem for control. SLN was selected as a Weeds of National Significance (WoNS) in 2012 due to factors related its invasiveness, competitiveness, fecundity, lack of effective long-term control options, and for the fact that this weed only currently occupies a small proportion of its potential distribution.

SLN was first reported in Australia at Bingara (northern New South Wales) in 1901 (Leys and Cuthbertson 1977) and now covers over 350,000 ha in SA, NSW and Vic across a wide range of soil-types and rainfall regions. There are also isolated infestations in WA and Qld. It continues to spread within the important Australian cereal cropping production zone, primarily by seed transported by livestock, farm machinery and produce, and also by root and stem fragments.

The economic impact of SLN comprises direct control costs, production losses (crop and fodder conservation yields), reduced land value and marketability, environmental degradation and social costs. Crop yields can be impacted significantly by SLN, with cereal and summer crops reduced by up to 75 per cent (Stanton *et al*. 2009). McLaren *et al.* (2004) estimated that the average financial impact for farms infested with SLN was $1730 per year in direct control costs and $7786 in lost production.

Previous work by Stanton *et al.* (2011) and Heap (2012) outlined a number of underlying barriers influencing the adoption of recommended best management practices for control of SLN. These included farmers having a limited understanding of SLN biology and a range of integrated management packages that provide control recommendations targeting both seed set and root bank for different production scenarios

The aim of this study was to develop approaches to overcome these barriers to adoption by improving the regional relevance, effectiveness and the delivery of SLN best management practices, thereby increasing the levels of capacity, and willingness of farmers to effectively manage this weed.

This was done in two main ways through: (a) conducting a baseline survey and utilising multiple

extension channels to develop a national community of interest, to raise awareness of best management practice information in an interactive and coordinated manner; and (b) encourage farmers to establish participatory trials to compare the economic benefit of different control strategies against current practice for SLN infestations, in different production systems and agro-ecological zones.

MATERIALS AND METHODS

A number of sub-components were completed to support the aims of the project.

Baseline survey A baseline survey targeting growers and advisors was completed at the start of the project to detect change in awareness, attitude, knowledge and management practice. The survey was conducted predominately online with a small number of paper surveys completed via mail outs and at workshops. The survey determined issues around the information delivery mechanisms, the prioritisation of weed management, the social, economic, environmental and management issues affecting adoption appropriateness and recommendations for packaging and instruction of weed management (including weed management plans and cost/ returns over time). The baseline survey also collected comments on the current best management practice (BMP) for further improvement to better adapt local farming scenarios.

Nationwide 'community of interest' partnerships Strong partnerships with 15 collaborators across four states were established throughout 2014–2015 in conjunction with active interactions between grower groups, through the completion of more than 40 grower group meetings, workshops and farm walks. The workshops were primarily to promote the best management practice information to advisors, farmers, contractors, Weeds Officers and NRM personnel, to raise awareness and to attract 'qualified' advocate growers to trial the BMP based on their farming scenarios. Participants were invited to share their stories at the workshops or through the news forum (blog) to cover different regions, soil types, production scenarios and infestation levels.

Promote champion growers Across four states, 18 champion growers were identified to develop individual case studies to share their stories, news with other farmers at the workshops or through the blog/web site. The purpose of the case studies was to promote the successful management of SLN to other farmers, to increase the adoption of the BMP strategies across all geographic areas and productions systems of Australia.

Participatory on-farm trials Participatory research was a key component of this program to generate a large and diverse baseline data on farming scenarios, weed pressure and failure across large geographical zones. This data will be used to refine the BMP, tailoring the need of different farming enterprises in broader geographic regions across multiple states.

Approximately 350 farm scale participatory on-farm validation sites of BMP were established across four states through active coordination of state and local collaborators. The BMP selected on each site was dependent on the individual producer's business context, farming scenario and current management practice.

In most instances, each participatory grower compared the recommended BMP with current practices at paddock scale for a two-year period, using a standardised protocol provided. Basic information on farming/infestation history, initial weed density, control application/timing and efficacy, climatic and soil conditions and stem emergence, control cost, impact of weeds and pasture/crop production general farm feedback was collected by farmers, or via the assistance of local community partners, collaborators or private contractors.

Mixed model analyses is to be conducted at the completion of the project to identify factors (regional, soil type, farming enterprise) contributing most to the variability in control. Analysis of contrasts between current and BMP by regression with explanatory covariates to look for trends in treatment effects and variability within the same treatments.

RESULTS

Baseline survey Results to the baseline survey for 436 Famers and 72 Advisors, indicated that greater than 80% of the farmers resided in NSW and SA, reflecting the SLN problem in these two states. SLN occurs commonly throughout the cereal cropping zone of these states but there are very large areas that are not yet invaded and are at risk because of their close proximity to propagule sources and exposure to invasion pathways.

Farmers were asked to rank their most preferred methods of receiving weeds advice from a range of sources supplied. The highest first preferences were directly from advisors, either independent (40%) or reseller agronomists (32%), or from attending workshops and field days (16%. Lower preferences were through social media (1%), the internet (2%) or radio (1%), irrespective of their age category. This shows that for most farmers, direct contact with an advisor either one on one or at a workshop or field day is still the preferred way of receiving technical information.

Insight into how decisions are made by farmers about adopting new practices are summarized in Figure 1. Results of this survey show that farmers would most like to see economic proof that new control measures are beneficial first.

Nationwide 'community of interest' partnerships
An interactive community of interest was established across four states (VIC, NSW, SA and WA), supported by workshops. The distribution of 1500 plus best management practice brochures, 40 media articles nationally and information sharing on the SLN blog/website and information from the network of interested growers and advisors. A comprehensive database was compiled which included affected growers, growers groups, Landcare groups, public and private partners, noxious weeds advisory groups, local councils and spray contractors in each state.

On-farm participatory research trials
Trials were established in 57 locations nationally (Figure 2), utilising six generalized land descriptions (cropping, pasture, mixed farming, unproductive farmland, roadside and reserve) and three broad treatment types incorporating either best management practice (BMP), farmer conventional management practice (CMP), or zero control.

Common feedback from participatory farmers so far is that the experience gained in implementing the BMP practices on their farm has improved their capacity, motivation and confidence to manage SLN more effectively.

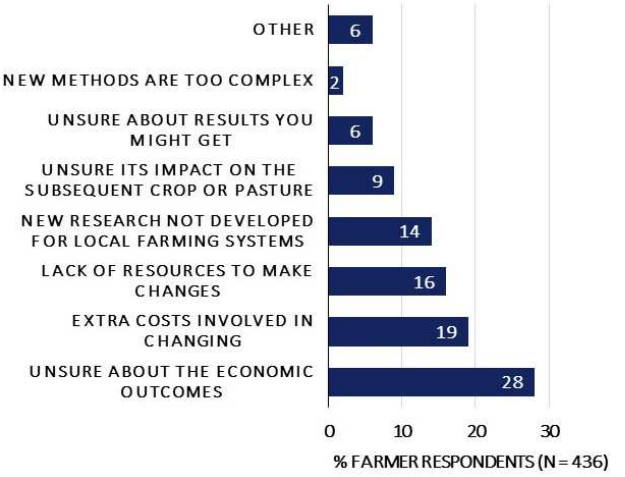

Figure 1. Results to the baseline survey question which asked farmers what prevents them from adopting new control methods on their farms.

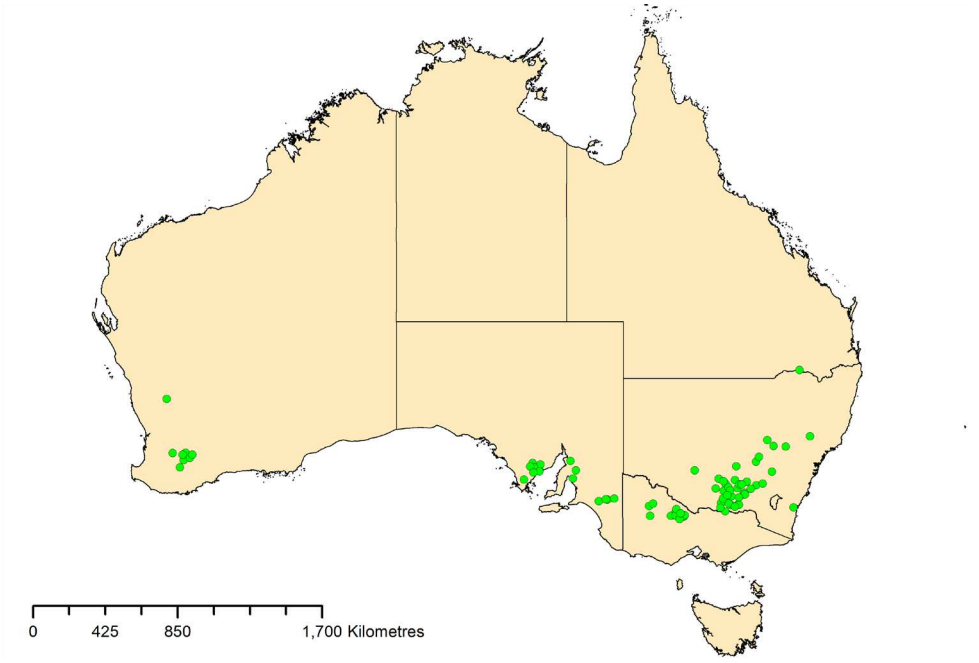

Figure 2. Overview of the 57 on-farm participatory trial locations throughout Australia (highlighted green).

DISCUSSION

The on-farm demonstrations will continue for another nine months; in that time additional data will be collected from summer and autumn applications with the dataset analysed to look for treatment effects and variability within the same treatments across similar production systems and climatic zones.

With weeds like SLN where there are no simple solutions or new chemical options, therefore adoption of BMP strategies is based on timing of a range of control measures over the long term (3–5) years (beyond the scope of this project).

Farmers need assurance using local knowledge from advisors or experiences from trials either in their district or on their own farms to reassure them that it is worthwhile making the change. SLN management is different to many other problematic weeds in that it is unlikely to be completely eradicated, so farmers need to focus on reducing plant densities to levels that do not have economic effects on production of crops and pastures.

Once present SLN becomes a perennial problem and this requires the economic analysis of management strategies to consider the inter-temporal and dynamic nature of SLN infestation, its effects on agricultural production, and the efficacy of control options (chemical, biological and cultural) in affecting SLN fecundity, survival and dispersal (Holst *et al.* 2007, Jones 2004). Simple economic threshold models based on a single season time-step do not capture the dynamic nature (carry-over effects) of controlling the SLN population between time-steps (Jones 2004), in particular a weed of perennial nature.

Near the completion of the project, data sourced from the trial sites and literature will be used to inform the parameterisation of the dynamic and stochastic simulation model of SLN infestation, and its interaction with climatic conditions, herbicide efficacy and agricultural production. At the farm level, the objective of identifying and implementing SLN best practice management is to maximise profit over the long term (King *et al*. 1998). The aim of the bioeconomic model will be to account for the dynamic and stochastic nature of SLN infestation on production, and test the economic and financial consequences of different control strategies over a 10 year planning horizon.

Effective adoption of SLN best management practices relies on the development and maintenance of partnerships between community, industry, government and recognition of the roles of each stakeholder.

CONCLUSION

Return on investment will result from reducing current and future impacts of SLN achieved through an integrated and coordinated approach that: (a) limits new incursions, (b) manages established infestations to reduce propagule spread and increase productivity; and (c) builds capacity, willingness and resilience to manage this weed into the future.

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