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Best Management Practice for Summer Perennial Weeds of southern NSW

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Content

Executive summary 3

Project objectives 6

Research and extension activities 7

1 Better understanding of the leaf structure of silverleaf nightshade 7

2 Seed viability and persistence in the soil 9

3 Communication plan implemented to a target of 500 advisors and growers 13

4 Baseline information on knowledge, attitudes and practices of advisors and growers 14

5 Monitoring results from the 400 participating growers trialling the BMP package and 100 advisors. Change in attitude, knowledge and practice described 16

6 Summary of weed area under BMP management 17

7 New knowledge on the impact of integrated herbicide and pasture programs on SLN population dynamics generated 17

8 Ten on-farm demonstrations established 23

9 A trial on late application timing established in Corowa 30

10 A total of 15 workshops/seminars conducted to growers, advisors and noxious weeds officers 31

11 Five scientific papers and conference papers submitted 33

12 Project plan to 2013 developed 34

Success in achieving objectives 35

Conclusions and recommendations 38

Appendix A. Media Release 40

Executive summary

Summer perennial weeds are a major cost to animal production in SE Australian mixed farming systems. Predicted climate change towards warmer, moister summers is expected to increase the spread and impact of summer weeds on pasture systems. A previous project (B.WEE.0135) funded by MLA has identified an integrated approach for silverleaf nightshade (SLN) management by targeting both the seedbank and the rootbank. This one-year project has focused on the production of a best management practice (BMP) guide and the delivery of updated research and management information to growers, ag-advisors and other stakeholders. In addition, progress has also been made in better understanding the biology and ecology of the weeds.

The large multicellular trichomes on mature leaves of SLN have been identified to be physical barriers to the uptake of herbicides. These trichomes, even those with intrusive bases, do not appear to provide a pathway for herbicides to directly enter the vascular system. Lower trichome density on the adaxial/upper surface indicates that spraying the top of the leaves may be more effective than spraying the undersides of the leaves. The stellate trichomes, coated with a thin layer of cuticle, are water-repellent, highlighting the need of further research to screen a large range of surfactants/adjuvants in order to overcome the hydrophobic trichome cuticle and to improve herbicide uptake. The techniques of using fluorescent dyes developed in this study could be used to determine the most effective adjuvant and spraying volume, droplet size on herbicide uptake.

The seed burial and persistence studies at 2 sites (Ganmain and Culcairn) were completed. The burial depth, duration of burial, and presence of seed pod had significant impact on the viability of SLN and PGC seeds. Seeds buried at deeper depths persisted longer as compared to seeds on soil surface. After 3-years of burial, the SLN seed viability ranged between 10 and 60% for the bare seeds and 20-65% for seeds with an intact pod, depending on the depths of burial. For prairie ground cherry (PGC), seed viability ranged between 0 and 20% for the bare seeds and 0-70% for seeds with an intact pod. PGC seeds or pods placed on soil surface completely lost viability after three years of burial. This research suggests that any soil incorporation to bury seed pods will significantly increase the persistence of the seeds of SLN and PGC in the soil. A long-term management strategy is needed to effectively manage these two intractable perennial weeds due to the persistent seedbank.

A pasture field site established at Wellington in 2008/2009 season was used to study the interactive effect of pasture competition and herbicides for improved control of SLN. Many summer active pasture species, such as lucerne, Strickland finger grass, digit grass, Rhodes grass, and Bambatsi panic grass, were highly effective in suppressing SLN stem emergence. Results showed that application of 2 L/ha Roundup PowerMax + 1 L/ha Grazon Extra + 0.5 L/ha Uptake in March 2011 did not significantly affect the growth of many pastures, with the exception of bambatsi panic. The herbicide treatment caused less SLN stem numbers as compared to the untreated control plots except the digit grass and Rhode grass pasture. The results indicated that joint action of herbicides and pasture competition could have synergistic effect on reducing SLN population. Further trials on grazing pastures before spraying with various rates of Tordon 75D or

Grazon Extra at different soil types would provide useful information for subsequent adoption of this integrated approach combining pasture competition and a late application of picloram-based products for rootbank control.

Continuous monitoring of two herbicide trial sites established previously at Leeton and Culcairn further confirmed the synergism between pasture competition and herbicide application. Same set of herbicide treatments were applied in both sites prior to April 2010. At Culcairn site, a natural population of annual ryegrass was established in 2010, while limited vegetation was established at Leeton site. Consequently the SLN numbers was much lower at Culcairn site than at Leeton site. The initial use of herbicides is necessary to rapidly run down SLN stem numbers. The follow-up pasture will not only provide feeds to livestock, but also provide competition to further suppress SLN emergence.

In April 2010, a new field trial was established at Corowa, NSW to examine the effect of herbicide rate, adjuvant and spray timing on the efficacy of SLN rootbank control. Results showed that Tordon 75D at a lower rate (< 1L/ha) did not achieve good results. For both glyphosate at 4L/ha and Tordon 75D at 2L/ha, there was no difference between the late applications in April and May, indicating the wide window opportunity for the late application to target the rootbank. Adjuvant Sprinta seems to have achieved better results than Uptake when used in conjunction with 4L glyphosate or with 2 L Tordon 75D. Although this one-year trial was not able to draw firm conclusion on the control of this perennial weed, the research does indicate that evaluation of a range of adjuvants could further improve the herbicide uptake and repeated use of picloram-based products over a number of seasons is necessary for better control of SLN rootbank.

A BMP guide was produced after thorough consultation with local agronomists and noxious weeds officers. It was printed in 2000 hardcopies in September 2010. About 1800 copies have so far been distributed to growers, ad-advisors, noxious weed officers and NRM officers in NSW, VIC and SA. The BMP has also been widely disseminated by a range of communicative channels including websites, email distribution list, radio interviews, workshops, grower groups as well as by direct contact with growers.

A series of 15 workshops were successfully conducted in NSW, Victoria and South Australia in 2010 and 2011. The workshops were run closely with local grower groups and noxious weeds or NRM networks. The positive feedbacks from workshop participants have been overwhelming and encouraging. Each workshop started with a baseline survey at the beginning of the workshop and finished with an evaluation survey at the end of the workshop. In total there were 438 participants attending the workshops.

- 206 participants (47.5%) returned the workshop evaluation form;
- Among them, 165 growers (80%) were motivated and willing to try the BMP;
- 78 growers (38%) were willing to host a demonstration site;
- 118 growers (57) wanted to try the BMP on a total of 28,707 ha, excluding the isolated infestation;
- 12 growers wanted to try the BMP on more than 1,000 ha.

- 47 growers (23%) indicated that they were willing to try the BMP but did not mention the trial area.

The baseline survey at the beginning of the workshop has showed that SLN not only caused economic loss due to direct control cost and lost production, but also significantly affected the social wellbeing of the growers. There was strong social frustration among growers seeing the weed coming back year after year despite of their time and efforts committed in spot spraying in hot summer each year. In general, the knowledge of the weed and its control is limited among the workshop participants. Poor awareness of the potential impact of the weed has been identified as a big barrier for the adoption. **Raising awareness of the weed problem and its impact and providing management solutions are much needed to drive the adoption**.

There were huge differences in the knowledge and management of SLN between growers and between different groups of growers across different states. There is a need to facilitate the information sharing between growers across different geographic regions in order to improve adoption.

Growers currently relied heavily on herbicides to manage SLN. Glyphosate has often been used in tank mix with suitable Group I herbicides for broadacre boom spraying to target summer weeds, as well as SLN (although it was not specially targeted). Tordon 75D has been a popular product for spot spraying. There are a number of issues associated with control. Timing of application is a big issue and often only one spraying is carried out to control the first emergence. The timing of the herbicide application, grazing or slashing is often too late to achieve 100% seedset control. In addition, growers have little knowledge of the importance of the rootbank control.

The baseline survey has also identified a number of knowledge gaps for further research:

- Differences in chemicals, rates and spraying volumes between boom spraying and spot spraying.
- Other chemicals or mixtures and suitable adjuvants for effective broadacre boom spray.
- The plant back for picloram-based products at different soil types.
- The current distribution and infestation at the national level is largely unknown.
- The survival of SLN root system in the soil.

The general lack of understanding and awareness of the weed, its impact and control identified at the workshops has strongly indicated that many more growers will need to be covered through further extension activities. This project has adopted a bottom-up approach and identified many advocate growers who are willing to try the BMP. Further funding support would enable these motivated farmers to continue to the next step of the adoption process – implementation of the BMP. The successful implementation of this first cohort of growers will encourage the 2nd and 3rd cohorts of growers to adopt the BMPs.

Project objectives

The project will pilot and evaluate a novel delivery process of a best practice management for control of summer active perennial weeds that were developed in a previous weed project (WEE.0135).

By 30 April 2011, this project will deliver:

Objective 1 400 growers trialling the BMP in the 2010-11 control season and 100 advisors advocating the IWM package.

Objective 2 5,000 ha trialled under BMP management

Objective 3 Reporting protocols designed and accepted by advisors and producers to report impact of the BMP

Objective 4 Refined Best Management practices in consultation with the weed advisors, consultants, regulatory officers, producers to develop the compelling case for control

Objective 5 Conducting at least 10 workshops, seminars and field trips/days in NSW, VIC and SA

Objective 6 Drafting and submitting 5 scientific publications from the previous project

Objective 7 Improved efficacy by fine-tuning herbicide applications

Objective 8 At least 10 demo sites established with baseline data

Objective 9 Collect additional data from the established pasture competition site for pasture and herbicide interaction studies

Objective 10 Complete the seed burial and persistence studies at 2 sites

Research and extension activities

1 Better understanding of the leaf structure of silverleaf nightshade

Close collaborations were achieved with scientists from Charles Sturt University, Australian National University and CSIRO in understanding the leaf structure of SLN.

Trichome anatomy of silverleaf nightshade

Mature leaves of silverleaf nightshade have a silvery-white appearance, due to a dense covering of stellate trichomes on both leaf surfaces, particularly the abaxial (**Figure 1**). A typical trichome is composed of a single spine, usually 12-16 radiating ‘arms’ and a basal stalk that was usually comprised of four to six, lignified cells. These basal cells usually penetrated between the underlying palisade mesophyll cells. The internal ends of these basal cells were multi-lobed and some lobes contacted the bundle sheath of the veins, but did not directly contact the xylem or phloem (**Figure 2**). On the adaxial/upper surface the basal cells of almost all trichomes extended into the upper palisade layer, while on the abaxial/lower surface the stalk cells of many trichomes usually did not develop extensively into the mesophyll cells.

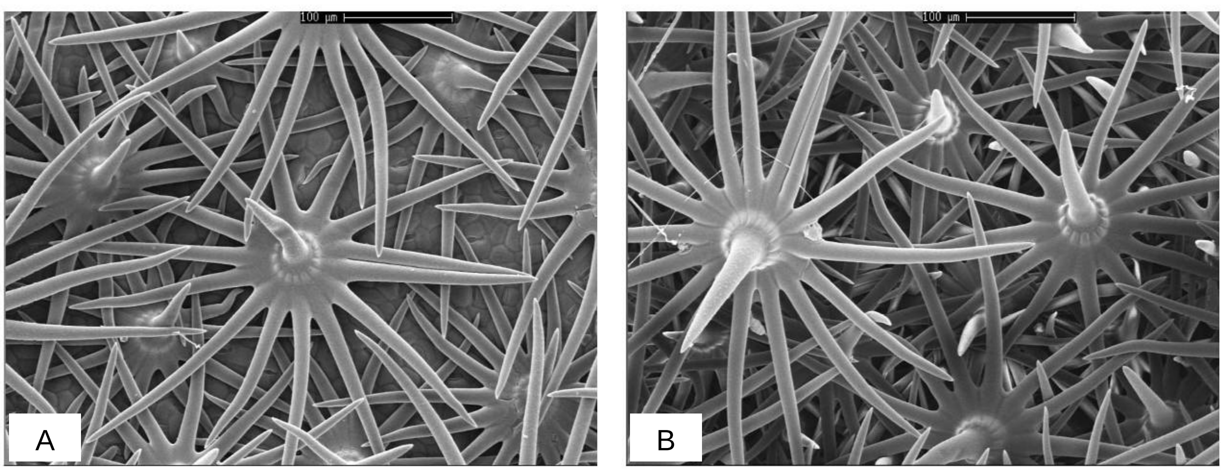


Figure 1. Trichomes on leaf surfaces of SLN (A: upper surface, B: lower surface).

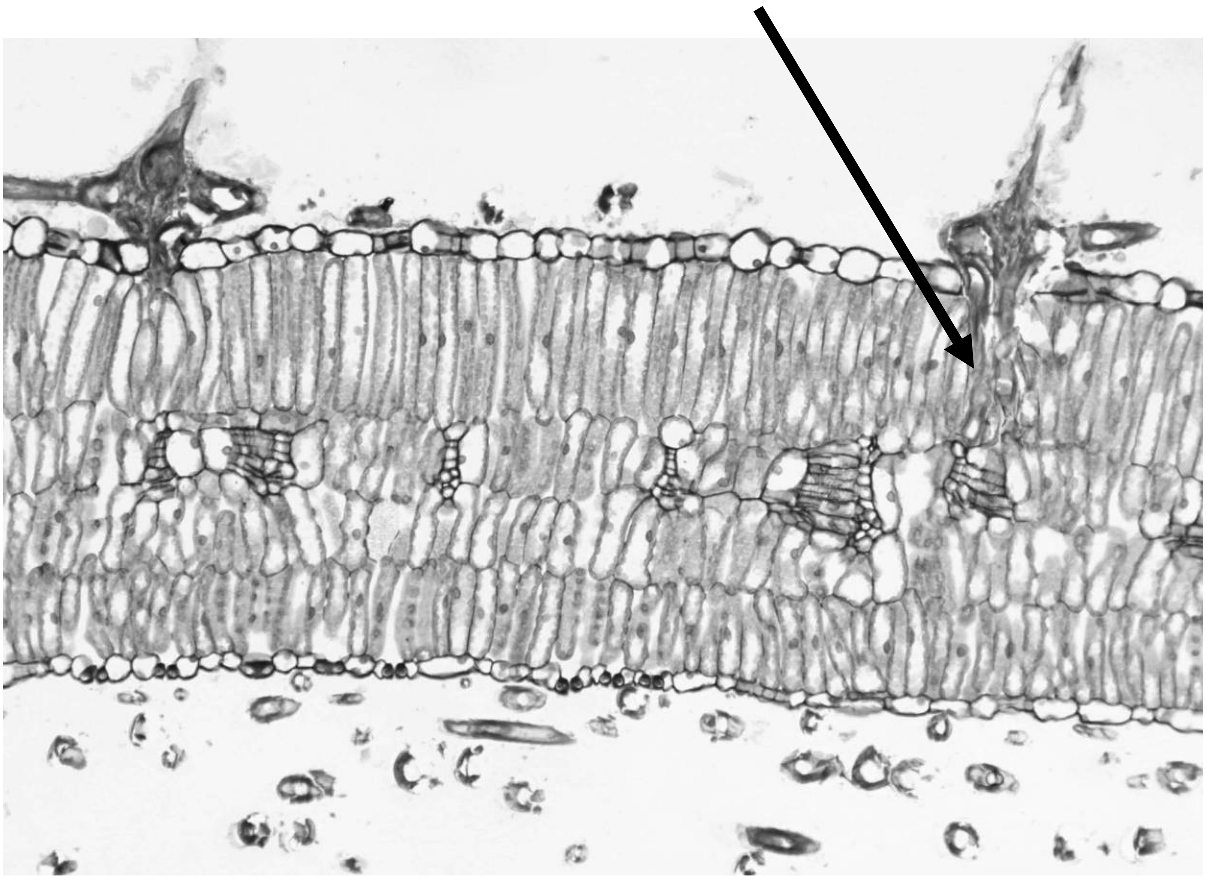


Figure 2. An unusual intrusive trichome structure in SLN (the basal stalk has intrusive cells that penetrate between the mesophyll cells and terminate near the veins).

The trichome density is much higher on the lower surface than on the upper surface (**Figure 1**). On average, there were 35 and 101 trichomes/mm^2 on the upper and lower surfaces, respectively. The ratio of abaxial to adaxial trichomes/mm^2 averaged 2.9. To accommodate the high trichome density on the lower surface, the stalk cells elongate to different lengths, thus the arms radiated at different heights above the leaf surface, forming a thick trichome “forest”. Lower trichome density on the adaxial surface indicates that spraying the top of the leaves may be more effective than spraying the undersides of the leaves.

Stomata density

SLN leaf contains high numbers of stomata, with 340 and 589 stomata/mm^2 on the upper and lower surfaces, respectively. High numbers of stomata could improve infiltration of herbicides into leaf tissue. Thus, the discovery of high stomatal densities on both leaf surfaces of SLN has important implications and should be further studied regarding both herbicide uptake and basic leaf physiology. However, this high number of stomata could be offset by the thick trichomes particularly on the lower surface.

Penetration of tracer dyes

Two tracer dyes were used to assess the role of leaf trichomes in herbicide uptake. The first was the apoplastic tracer, lucifer yellow carboxy hydrazide (LYCH), which travels in the cell wall space and long-distance via the xylem. The second was the symplastic tracer, carboxyfluorescein diacetate (CFDA). CFDA is non-fluorescent until it enters living cells where the acetate groups are cleaved off to form fluorescent carboxyfluorescein (CF), which is then confined to the symplasm and can travel from cell-to-cell in the symplasm and long-distance in the phloem. The research showed that neither CFDA nor LYCH tracer dyes were transferred from the basal cells to the xylem or phloem. Instead, dyes that reached the epidermis were taken up rapidly through the thin cuticle or entered directly via the high density of stomata. These results indicate that the large multicellular trichomes on mature leaves of SLN provide a barrier to uptake of aqueous solutions, including herbicides.

Leaf cuticles

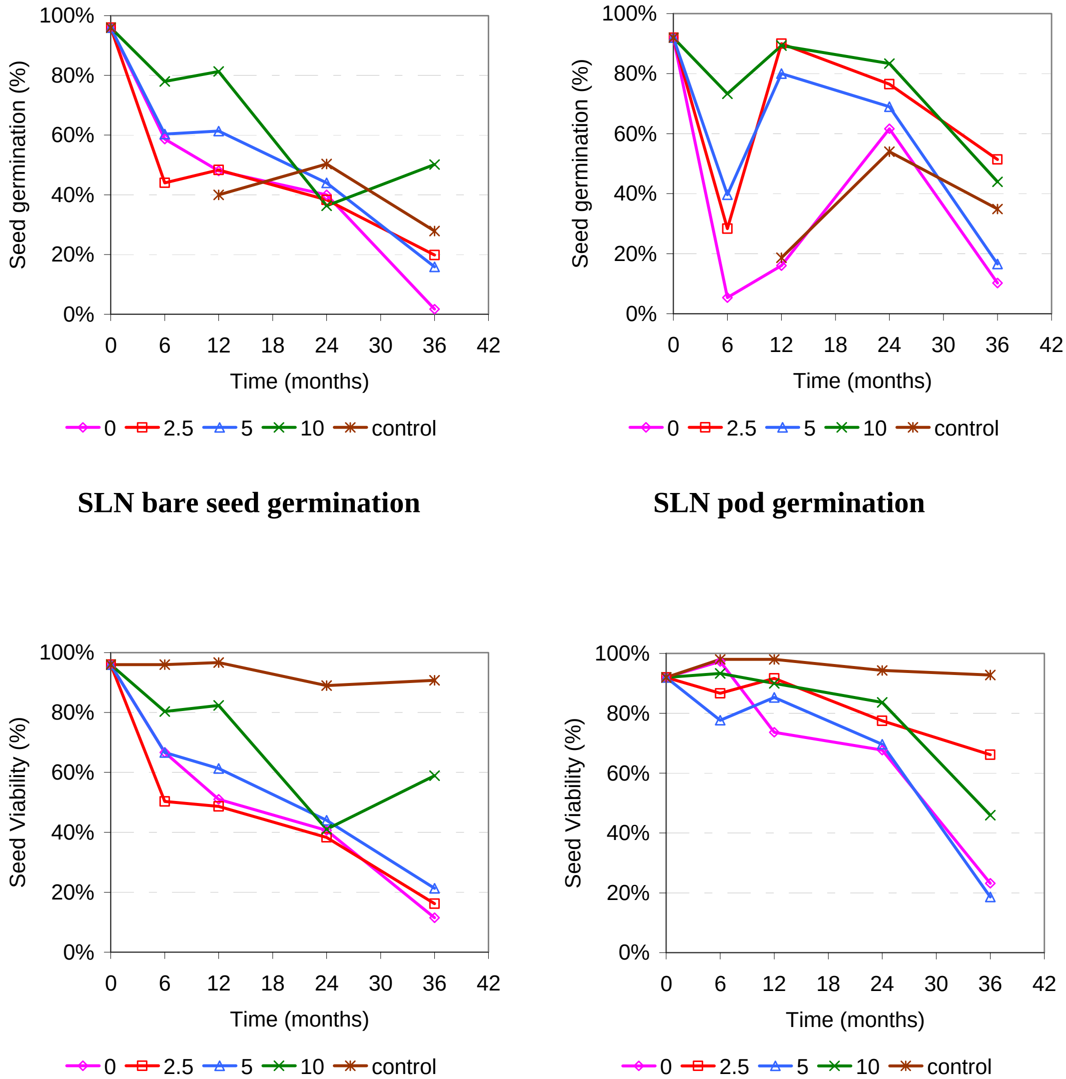
Both SEM or confocal microscopy revealed that there is a thin layer of cuticle on trichome surface. In younger leaves, the arms of the trichomes contained chloroplasts and nuclei, but in older leaves, chloroplasts were very reduced or absent, and the trichome cells appeared senescent or dead. All cells of mature trichomes were lignified. The CFDA and LYCH tracer dyes did not penetrate readily without adjuvants. With the adjuvant Sprinta®, CFDA rapidly entered many cells of the leaf, including the trichomes, and penetrated deeply into the vascular tissues. Other adjuvants (Uptake, Hasten and BS1000) were much less effective in facilitating CFDA entry. It appears that the stellate trichomes (which possess a cuticle) are in themselves water-repellent, which does not favour a water uptake role. This research highlights the need of further research to screen a large range of surfactants/adjuvants in order to overcome the hydrophobic trichome cuticle and to improve herbicide uptake.

2 Seed viability and persistence in the soil

Two 3-year seed burial studies of SLN and PGC conducted at Ganmain and Culcairn were completed. There were significant interactions between duration of burial, depth of burial and presence of seed pod on the viability of SLN seed (**Figure 3**). Germination levels declined over time for bare seed, with less seed remaining germinable on the soil surface compared to when buried at 10 cm depth. Surface seed was significantly less germinable than seed stored in the lab.

Seed in pods was less germinable after six months than the bare seed, suggesting the presence of dormancy mechanism. Germination levels of the seed-in-pod after twelve months of burial were similar to initial levels, but declined to similar levels as the bare seed after 36 months. Seed in pods retained high levels of viability for the first 24 months, before levels declined to levels similar to those observed for bare seed. Seed was less germinable when pods were on the soil surface after twelve months.

Similarly, germination and viability of bare PGC seed declined over time, with seed buried at depth more viable than seed on the soil surface or buried at 2.5 cm (**Figure 4**). Seed buried in intact fruits retained germination and viability rates similar to that for seed stored in the laboratory, except for fruits on the soil surface which had significantly less germination and viability after 36 months of burial. At the soil surface, decline over time in germination and viability was similar for bare seed and seed left in intact fruits. When buried at any depth, germination and viability after 36 months was significantly higher for seed in intact fruits than the bare seed.



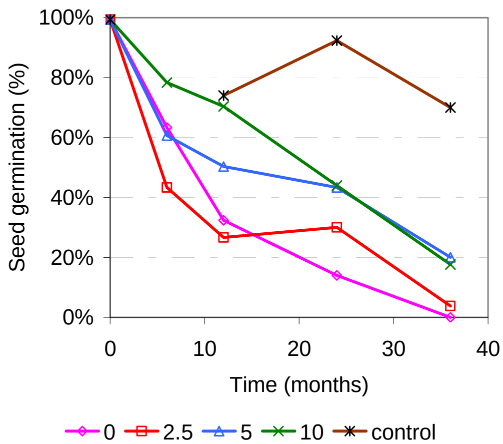
SLN bare seed germination

SLN pod germination

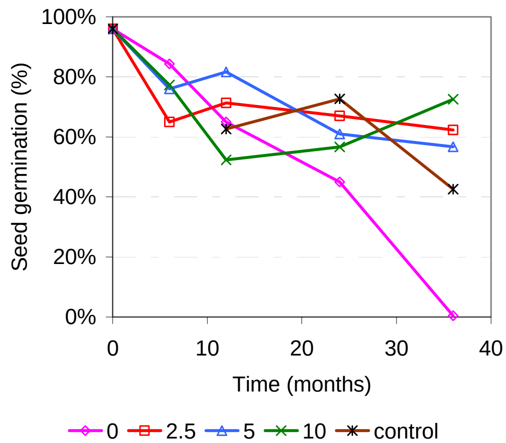
SLN bare seed viability

SLN pod viability

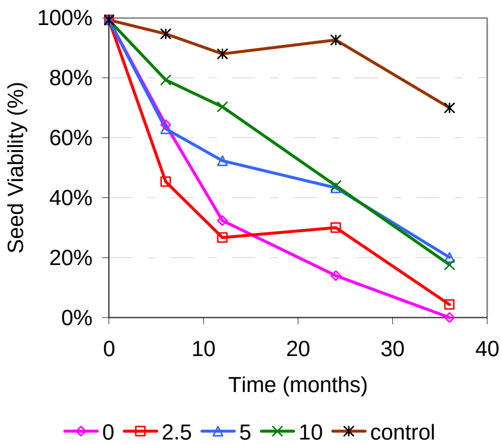
Figure 3. The influence of depth and duration of burial on the germinability and viability of silverleaf nightshade seed when buried in intact pods or as bare seed.



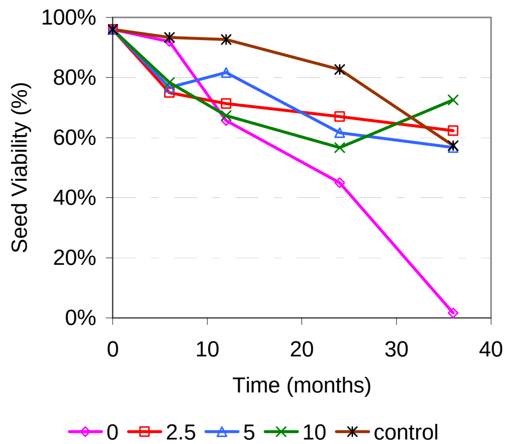
PGC bare seed germination



PGC pod germination



PGC bare seed viability



PGC pod viability

Figure 4. The influence of depth and duration of burial on the germinability and viability of prairie ground cherry seed when buried in intact fruits or as bare seed.

3 Communication plan implemented to a target of 500 advisors and growers

2000 copies of the BMP guide were printed in September 2010 and about 1800 copies have been distributed to growers, growers groups, spraying contractors, resellers, ad-advisors, noxious weed officers and NRM officers in NSW, VIC and SA. The BMP has also been widely disseminated by a range of communicative channels including websites, email distribution list, radio interviews and workshops.

Website listing:

- EH Graham Centre, Charles Sturt University: **http://www.csu.edu.au/research/grahamcentre/research/publications/docs/SLN_BMP guide.pdf**.
- Murrumbidgee Landcare: **http://www.murrumbidgeelandcare.asn.au/node/702**.
- MLA: http://www.mla.com.au/files/4e0bfb06-51ef-4586-8a94-9de4010c01d3/silver-leaf-nightshade-best-practice-management-guide.pdf.
- The Eastern Riverina Noxious Weeds Advisory Group and The Western Riverina Noxious Weeds Advisory Group: http://www.riverinaweeds.org.au/Documents/images/Silverleaf_BMP_guide_2010.pdf.
- NSW DPI: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/363539/SLN-BMP-guide-web.pdf.

Other media were also used to promote the research outcomes and BMP to end users, including media releases and local radio interviews.

- Silverleaf nightshade workshops (Gulgong), the ABC North Western Rural report, 19 April 2011.
- Spray now to kill off weeds (on silverleaf nightshade research), Article in the Southern Area News, 18 April 2011.
- Silage making eliminates weeds (silverleaf nightshade and others), Article in the Southern Area News, 13 April 2011.
- Seed weed research good news for silage makers (silverleaf nightshade and others), News item on the Star FM 93.1 local news. April 2011.
- Media release: Seed weed research good news for silage makers, 05 April 2011, NSW DPI. http://www.dpi.nsw.gov.au/aboutus/news/recent-news/agriculture-news-releases/good-news-for-silage-makers.

- No silver bullet for silverleaf threat, ABC Rural Radio Interview, South Australia., Friday, 11 March 2011. **http://www.abc.net.au/rural/sa/content/2011/03/s3163528.htm**.
- Media release: More than 400 people attend silverleaf nightshade workshops. 21 March 2011. NSW DPI. http://www.dpi.nsw.gov.au/aboutus/news/recent-news/agriculture-news-releases/silverleaf-nightshade-workshops.
- Silverleaf nighshade management workshops ‘a standout success’. NSW Weed Society Newsletter – A Good Weed, #54 Autumn 2011, p12.
- Media release: Workshops present latest control strategies for silverleaf nightshade. 22 November 2010. NSW DPI. http://www.dpi.nsw.gov.au/aboutus/news/recent-news/agriculture-news-releases/control-strategies-for-silverleaf-nightshade.
- AgToay: Smarter approaches with current tools, August 2010 edition of Agriculture Today. http://www.dpi.nsw.gov.au/archive/agriculture-today-stories/august-2010/smarter-approaches-with-current-tools.

4 Baseline information on knowledge, attitudes and practices of advisors and growers

At the start of each workshop, attendees were asked to complete a baseline survey to collect on their knowledge of the weed, the affected area, the current control tactics, the cost of control, the estimated production losses due to silverleaf nightshade and any other general comments. The series of workshop has identified some key issues associated with the management of SLN:

- ***Impact:*** Respondents indicated that they saw control of silverleaf nightshade as highly important (average of 4.7 on a scale of 1-5). The impact has been multi-fold: direct control cost (herbicide, time and labour) and lost production. Control cost and production loss varied considerably between growers, depending on the level of infestation using boom spraying or spot spraying. Approximately half the respondents provided estimates on control costs, with an average of $38/ha being spent on silverleaf nightshade control, some respondents had control cost of more than $100-300 dollars. Respondents also reported production losses due to silverleaf nightshade as being 5-30%, although the breakdown into production sectors was not provided. Some growers had indicated that the yield reduction could be up to 40-60%, depending on the level of infestation. In addition, the survey found that time and budget were limiting constraints on implementing silverleaf nightshade control, resulting in spraying at a less ideal timing for 100% seedset control. There was strong social frustration among growers seeing the weed coming back year after year despite of their time and efforts committed in spot spraying in hot summer each year.

- ***Understanding:*** Majority of growers and Ag-advisors had little understanding about the weed and its management strategies. The weed has been largely treated as an annual weed. The contribution of rootbank to the persistence of this weed is poorly recognised. No effort all is therefore directed to control the rootbank. Growers have responded that “*I am* *surprised about survival of plant parts*" and "*now I have a better understanding of the weed*".

- ***Awareness:*** Generally lack of awareness of weed is widespread among the workshop participants. Poor awareness of the potential impact of the weed has been a big barrier for the adoption. Many growers, especially with isolated populations, under-estimated the potential impact of this weed. Growers have commented that "*Need to get more farmers who have only a small SLN problem to attend the workshop. These people don't realise how big the problem is*!", "*Need to make people aware of the 'weed' problem in terms of economic cost and time commitment*", "*Must prevent the problem weeds before becoming BIG problem weeds*". "*Need for more awareness of SLN by farmers who haven't had any plants on their property*", "*Ignorance of SLN has lead to major infestations in inaccessible parts of farm*", "*Suggest more farmers take time to come and learn more on this weed*", and "*(The workshop) has scared me into action*". **Raising awareness of the weed problem and providing management solutions are much needed to drive the adoption.**

- ***Information sharing:*** There were huge differences in the knowledge and management of SLN between growers and between different groups of growers across different states. The workshop participants have highly valued the open discussions during the workshop, such as "*always good to see how other people are controlling their weeds*' and "*hearing other farmer comments with their control*". It is evident that there is a need to facilitate the information sharing between growers across different geographic regions in order to improve adoption. Discussions involving "Champion" growers in the region would have a great influence on enthusiasm, confidence and persistence in following through with individual control program.

- ***Control options:*** Farmers are currently reliant upon spraying to manage their silverleaf nightshade infestations, with 90% of respondents indicating they use chemicals. Non-chemical control options were also practiced, including slashing or mulching, burning, grazing, blade ploughing, deep-rigging, hoeing, hand-pulling and competition. A wide range of chemicals were used, including glyphosate (Group M), starane (I), 2,4-D ester (I), 24-D amine (I), MCPA (I), Garlon (I), Tordon 75D (I), Grazon DS (I), Ally (B), Glean (B), simazine (C), and Hammer (G). Glyphosate has often been used in tank mix with suitable Group I herbicides for broadacre boom spraying to target summer weeds, as well as SLN. Tordon 75D has been a popular product for spot spraying. Use of cultivation and grazing is not uncommon. Improper use of herbicides, inappropriate timing and inaction on rootbank control need to be discussed with growers.

- ***Issues with control:*** Timing of application is a big issue and often only one spraying is carried out to control the first emergence. SLN was not specially targeted, as it was sprayed during the normal summer weed control programs. Growers have little knowledge of the importance of the rootbank control which requires a late application of picloram-based product in April/May when plants are naturally shutting down. In addition, the timing of the herbicide application, grazing or slashing is often too late to achieve 100%

seedset control, as many early flowering SLN plants have already formed some green berries, thereby allowing the formation of viable seeds and the spread of seeds within the entire paddock. There are growers who still use cultivation or deep ripping. All these issues will have to be properly addressed.

- ***Research needs:*** In general, growers expect a silver bullet for a quick result. The survey identified that further research is necessary to meet various target: need to investigate different chemicals, rates and spraying volumes between boom spraying and spot spraying, in order to tailor different level of infestation such as large and patchy infestations, isolated plants. Limited information is available on spot spraying. Further study on other cheaper chemicals or mixtures and suitable adjuvants has also been suggested for effective broadacre boom spray. Other chemicals such as graslan, and glufosinate, and their suitable mixing partners to be tested (anecdotal evidence showed that glufosinate had better effect than glyphosate on stem emergence). More research is needed on chemical application as well as the plant back for picloram-based products at different soil types. Growers also suggested testing the combination of repeated cultivation or deep rigging followed by effective herbicides to rapidly exhaust the root systems, then using pasture or crop competition to keep the weed in check. Other strategies combining chemical and non-chemicals have also been suggested, such as cut/smear and slash/spraying. Growing a canola crop has been found to suppress/delay spring stem emergence. It is not sure whether the suppression is due to a profile drying effect by deep canola tap-root or by fumigation effect. Growers are also very keen on biological control although it would be a long journey toward the identification of successful agents.

  The stock quarantine period of "14 days" in the current BMP is believed to be too short. Most farmers seem to think at least 28 days and would like to see more work to confirm that.

  The current distribution and infestation at the national level is largely unknown. It is believed that the current estimate is much lower than the actual infestation. Workshop participants commented that SLN plants were spotted in Northern Territory during their holiday trips. How long the root system can survive in the soil is still a mystery. The contribution of seedlings to weed population dynamics is yet to be estimated.

5 Monitoring results from the 400 participating growers trialling the BMP package and 100 advisors. Change in attitude, knowledge and practice described

The draft BMP guide has been widely circulated through various communication channels such as printed materials, electronic media, radio interviews and workshops. It is expected that the BMP has reached a total of more than 5,000 growers, ag-advisors, resellers, spraying contractors, noxious weeds and NRM officers.

A series of 15 workshops conducted in 2010 and 2011 has identified a total of 165 growers and noxious weeds (NRM) officers who were motivated and willing to trial the BMP on a total area of over 28,000 hectares.

After one year of campaign, the project team was able to identify advocate growers across different states who are willing to practice the BMP. However, the project team did not have time to follow through with these advocate growers to monitor the change in attitude, knowledge and practices due to the completion of the project funding supports.

6 Summary of weed area under BMP management

Evaluation forms completed at the end of the each workshop indicate that a total of 165 farmers and noxious weeds (NRM) officers would be prepared to trial the BMP on a total area of over 28,000 hectares. There were 12 growers who were keen on practicing some of the control strategies outlined at the workshop on a large area of more than 1,000 ha. About 78% growers have indicated that they are willing to host demonstration sites for field days in order to allow more growers to participate the BMP.

A comprehensive list of these growers has been compiled. The final implementation of the BMP by these motivated growers would require further assistance and supports from the project team. However, the current one-year funding cycle does not allow for this to occur. Negotiations with MLA are underway for further funding support in order to engage such a large number of growers who are willing to practices the BMP on such a large scale with different production systems, crop rotations and soil types across different states. Close collaborations with these growers, together with the close monitoring of the BMP implementation on farm, will generate abundant valuable information of the impact of sites, climatic conditions, soil types and production systems on the effectiveness of the BMP practices.

7 New knowledge on the impact of integrated herbicide and pasture programs on SLN population dynamics generated

Under the previous project, a pasture field site was established at Wellington in 2008/2009 season using *Medicago sativa* cv. Aurora (lucerne), *Digitaria milanjiana* cv. Strickland (finger grass), *Digitaria eriantha* spp. *Eriantha* (digit grass), *Chloris gayana* cv. Katambora (Rhodes grass), *Phalaris aquatica* cv. Sirolan (phalaris), *Chicorium intybus* cv. Puna (chicory) and *Panicum coloratum* var. *makarikariense* (Bambatsi panic) pastures. The chicory and phalaris failed to establish successfully, mainly due to seasonal conditions. The remaining grasses and the lucerne have established and provided competitive suppression of the silverleaf nightshade. Pasture biomass and SLN stem numbers were assessed in March 2010.

After the assessment, all plots were split in half, with one half of the plots was left unsprayed as a control. The other half received a late herbicide application to target the rootbank with 2 L/ha Roundup PowerMax + 1 L/ha Grazon Extra + 0.5 L/ha Uptake spray oil.

Pasture competition had significantly suppressed SLN stem emergence (**Figure 5**). At the time prior to spraying, SLN stem density was only 0.7-0.8 stems/m^2 within the digit grass and Strickland finger grass plots, 2.4-2.7 stems/m^2 within the panic and Rhodes grass pastures, through to 5.3 stems/m^2 within the annual pasture treatment (**Figure 6**). Although lucerne only had an average of 2.3 t/ha pasture biomass, It also suppressed the stem emergence (an average of 1.8 stems/m^2), suggesting below ground root competition is also important in suppressing SLN stem emergence.

May 2006

May 2010

May 2011

Figure 5. Stem emergence of silverleaf nightshade suppressed by competitive Rhodes grass pasture at Wellington field site.

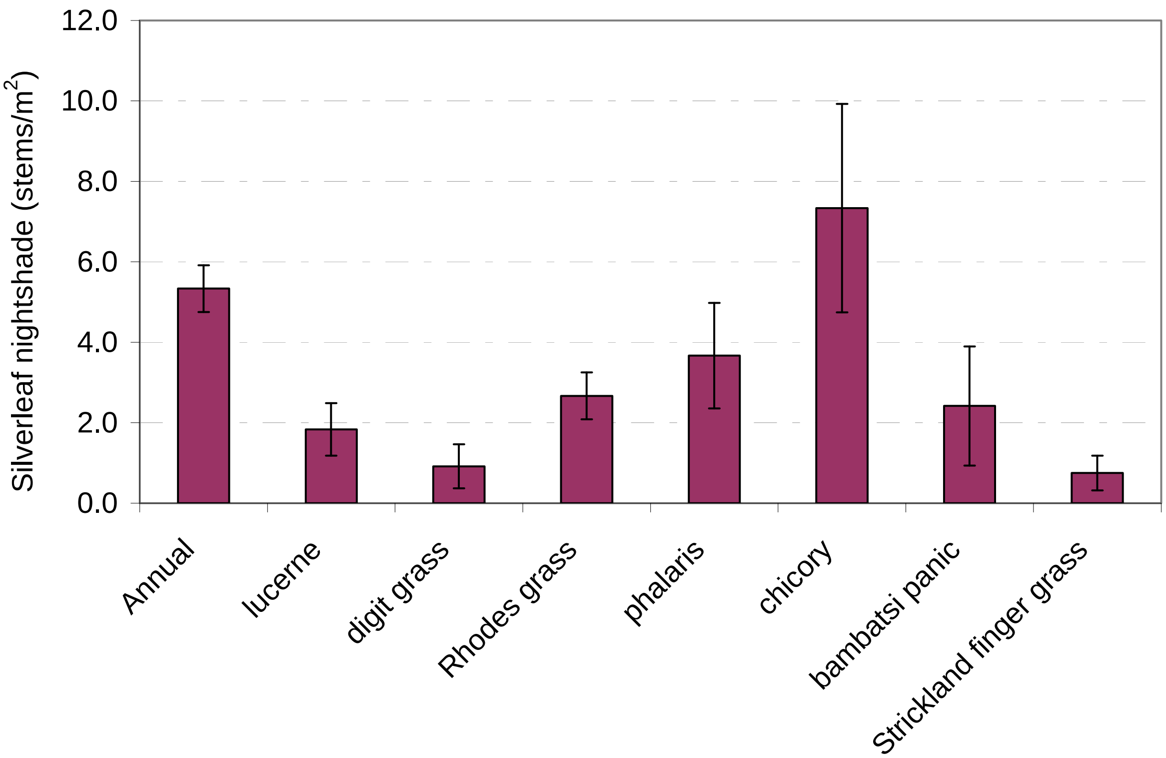


Figure 6. Impact of pasture species on density of silverleaf nightshade stems assessed in March, 2010 (at time of spraying, lucerne had a biomass 2.3 t/ha, digit grass 9.6 t/ha, Rhodes grass 6.9 t/ha, bambatsi panic 6.2 t/ha and Strickland finger grass 10.8 t/ha).

Field assessment on pasture biomass and SLN stem density were again conducted in April 2011 to determine the impact of the residual herbicide treatment on the growth of pasture and the weed. Results showed that herbicide treatments in March 2011 with Grazon Extra did not significantly affect the growth of many pastures, with the exception of bambatsi panic (**Figure 7**). Bambatsi panic was the only pasture having lower biomass when herbicides were applied. Care should be taken when applying this particular herbicide to a bambatsi pasture due to the possible herbicide damage. Further research is needed to confirm the plant back periods of picloram-based herbicides on pasture and crops.

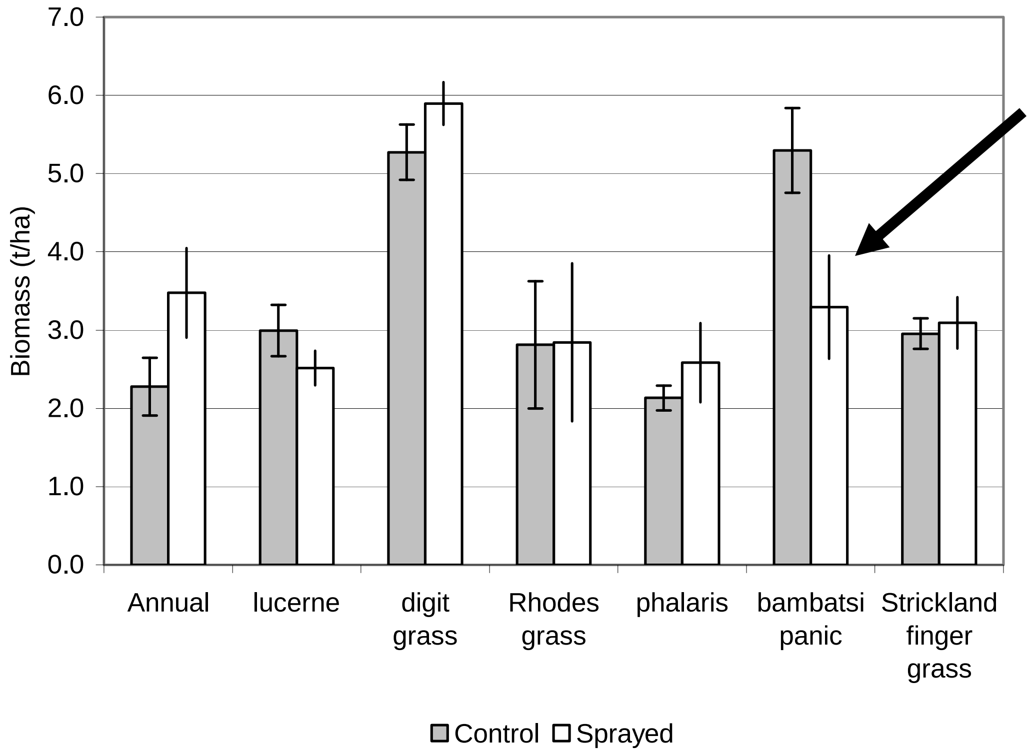


Figure 7. Impact of herbicide on pasture biomass assessed in April 2011 (glyphosate + Grazon Extra was applied in March 2010).

With the exceptions of digit grass and Rhode grass, the herbicide treatment caused less SLN stem numbers as compared to the untreated control plots (**Figure 8**). There were huge variations (big error bars) in these two grass pasture plots, which could be due to the uneven distribution of the weed. The results indicated that joint action of herbicides and pasture competition could be an effective way of managing the persistent SLN population. In this trial, the presence of pasture biomass at the time of herbicide application could prevent good coverage, therefore reducing herbicide efficacy. Further trials on grazing pastures before spraying with various rates of Tordon 75D or Grazon Extra at different soil types would provide useful information for subsequent commercial recommendation.

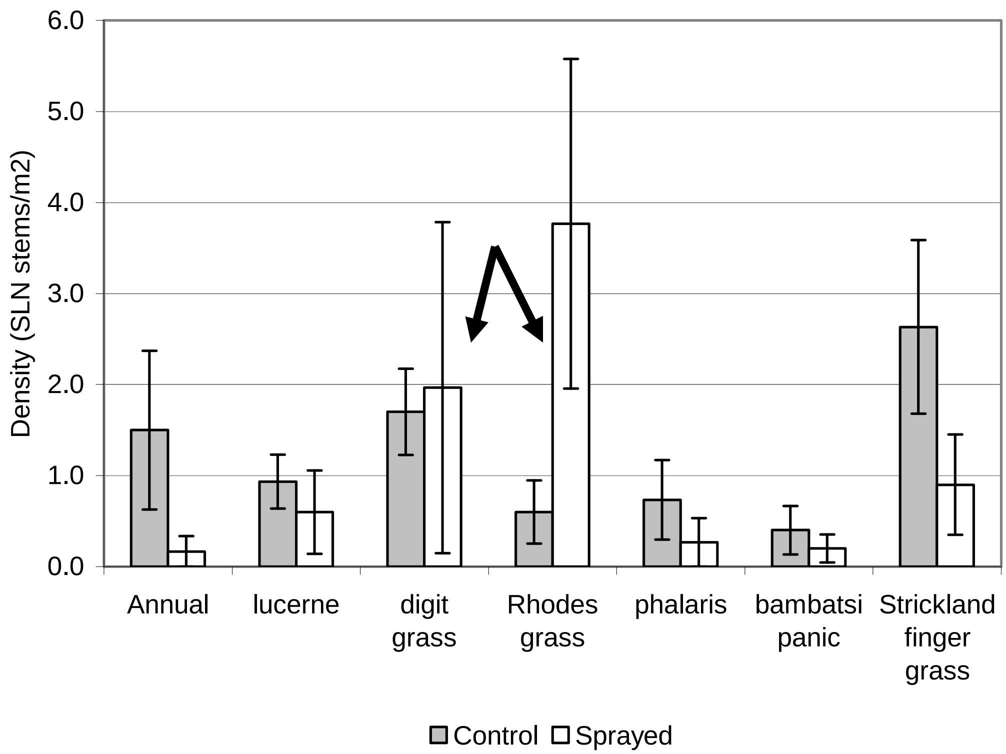


Figure 8. Interaction of herbicide and pasture on SLN stem emergence assessed in April 2011 (glyphosate + Grazon Extra was applied in March 2010).

8 Ten on-farm demonstrations established

Seventy eight farmers have been identified through workshops as being willing to host demonstration sites as advocate farmers. This list is being reviewed with ten farmers to be selected for demonstration sites to allow good representation of sites throughout the distribution range of silverleaf nightshade across states.

Within a year, the project team were able to identify a large number of advocate growers differing in farming situations across three different states. Depending on the funding availability, ten advocate growers will be selected from three categories: growers with a long history of infestation - large and dense infestations, a long history of infestation - isolated patchy infestations and with “new” isolated infestations.

Each demonstration site will be comparable in the format of the site and the type of information recorded. The tactics currently used by the farmer will be compared against a best management strategy derived from the principles outlines in the BMP. There will be some variation in strategies used between sites to allow for differences in location and production systems/rotations.

A standardised recording protocol will include: previous management and SLN infestation history, baseline stem density, control efficacy, stem emergence, control cost and impact of weeds on pasture/crop production. Stem densities will be recorded in December each year to assess the impact of autumn action in April/May on rootbank. The long term impacts of BMP practices on rootbank will need to be monitored for several seasons.

In addition, two field experiments previously established at Leeton and Culcairn were maintained as on-farm demonstrations. The field sites were established in 2006. Twenty treatments were applied in the 2006/07 season based on current registered herbicides, current practice or new options based on knowledge gained from research work reported in the literature.

Treatments were slightly modified in 2007/08, with the Tordon and Grazon Extra treatments modified from a single mid-season application at flowering to include an additional late season application at mature berry stage of the same herbicide (dual-application). Same treatments were repeated in 2008/09. The entire field site was bulk-sprayed with 4 L/ha glyphosate + 2 L/ha Grazon + 1 L/ha Uptake spray oil on 17 March 2010 at Culcairn and on 22 March 2010 at Leeton site. SLN stem emergence was assessed in May 2011 to evaluate the residual effect of picloram-based products on SLN density.

Assessment in May 2011 showed that Leeton field site had much more SLN than Culcairn, possibly attributable to the Leeton site having very little ground cover. The Culcairn site maintained a good natural population of annual ryegrass in 2010, with this competition possibly assisting with keeping SLN stem density down.

At Leeton site, the dual applications of Grazon Extra or Tordon 75D showed the best residual effect on SLN stem emergence, less than 2 stems/m^2 (**Figures 9, 10 and 11**).

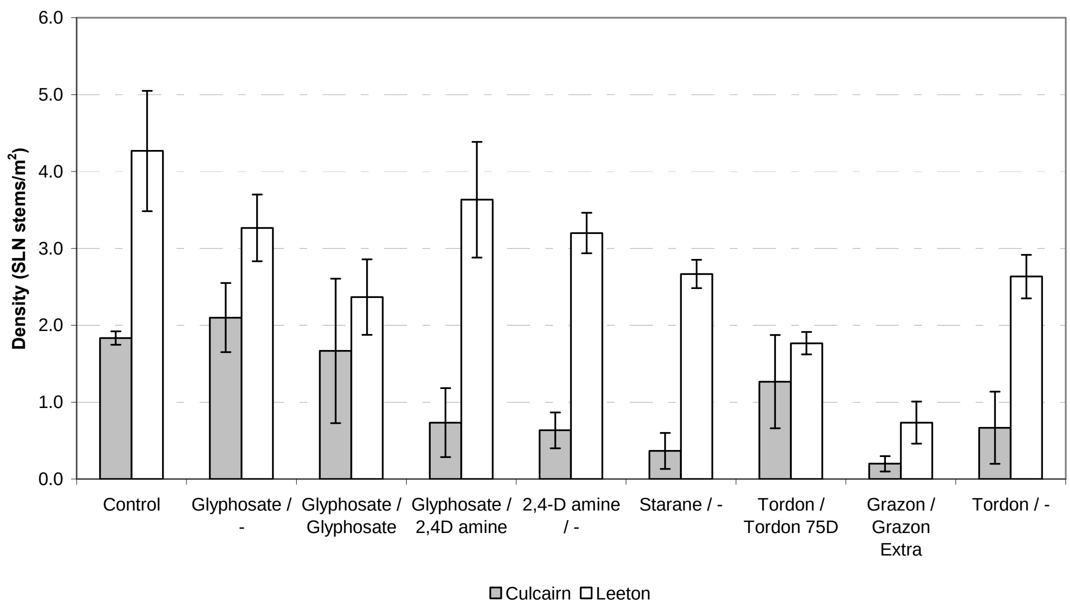


Figure 9. SLN stem density at Leeton and Culcairn field sites assessed in May 2011.

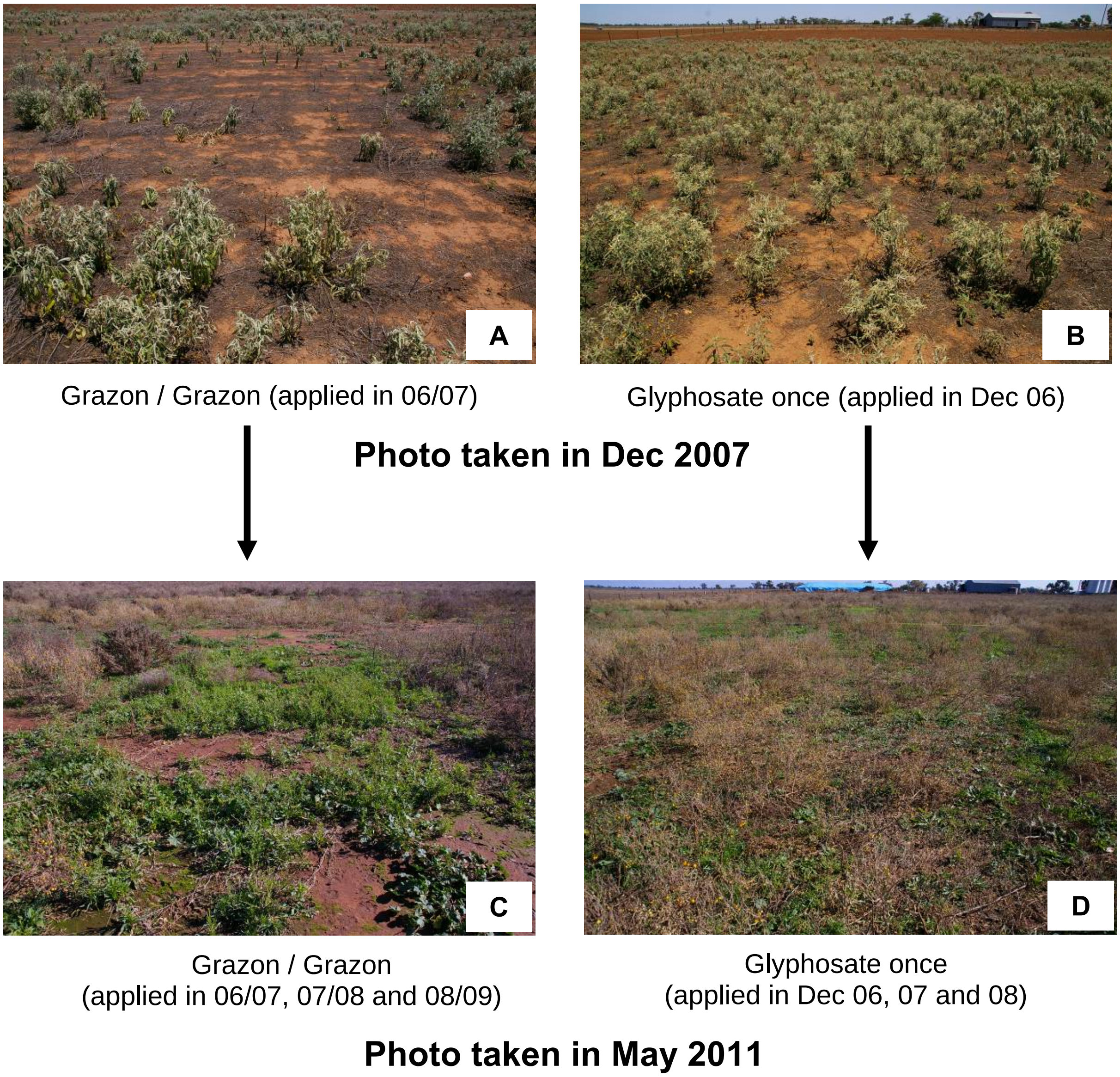


Figure 10. The residual effect of Grazon/Grazon treatment on SLN stem emergence at Leeton field site.

Notes:

A-Dual application of Grazon/Grazon per season in Dec 06 and in Mar 07;

B-Only one application of glyphosate per season in Dec 06;

C-Dual application of Grazon/Grazon per season for three consecutive seasons in 06/07, 07/08 and 08/09. SLN disappearing and dominated by other summer weeds;

D-Only one application of glyphosate per season for three consecutive seasons in Dec 06, 07 and 08. The cold weather has defoliated the mature SLN plants, but the massive amount of mature berries produced by the mature plants showed that one application of glyphosate in December is not effective on rootbank control.

Photo taken in Dec 2007

Tordon 75D / Tordon 75D
(applied in 06/07)

Photo taken in May 2011

Tordon 75D / Tordon 75D
(applied in 06/07, 07/08 and 08/09)

Figure 11. The residual effect of Tordon 75D/Tordon 75D treatment on SLN stem emergence at Leeton field site.

At Culcairn site, a natural population of annual ryegrass was established in 2010, As a result, after 2 years of repeated herbicide application, followed by the competition fromannual ryegrass pasture, the SLN numbers was much lower than those at Leeton site, ranging from 0.3 to 2.1 stem/m2 (**Figures, 9, 12 and 13**). These results indicate that interaction of herbicides with competitive pastures is effective in suppressing SLN stem emergence. The initial use of herbicides is necessary to rapidly run down SLN stem numbers. The follow-up pasture will not only provide feeds to livestock, but also provide competition to further suppress SLN emergence.

Grazon / Grazon (applied in 06/07)

Glyphosate once (applied in Dec 06)

Photo taken in Nov 2007

Grazon / Grazon
(applied in 06/07, 07/08 and 08/09)

Glyphosate once
(applied in Dec 06, 07 and 08)

Photo taken in May 2011

Figure 12. The residual effect of Grazon/Grazon treatment on SLN stem emergence at Culcairn field site.

Photo taken in Nov 2007

Tordon 75D / Tordon 75D
(applied in 06/07)

Photo taken in May 2011

Tordon 75D / Tordon 75D
(applied in n 06/07, 07/08 and 08/09)

Figure 13. The residual effect of Tordon 75D/Tordon 75D treatment on SLN stem emergence at Culcairn field site.

9 A trial on late application timing established in Corowa

A new field site was established at Corowa, NSW in April 2010 to examine the effect of herbicide rate, adjuvant and spray timing on the efficacy of silverleaf nightshade rootbank control. A total of eleven treatments were imposed (**Table 1**).

Glyphosate and Tordon 75D was applied either alone or in a mixture at several rates in April 2010 to identify the best herbicide option. Uptake spray oil was used as the standard adjuvant, and it was compared with Sprinta®. Two additional treatments were included where the 4 L/ha glyphosate and the 2 L/ha Tordon treatments were applied in May to examine the width of the window for late spray application. SLN stem numbers were assessed in April 2010 (start of the trial), November 2010 and May 2011.

Assessment data collected in Nov 2010 showed that Tordon at a lower rate (< 1L) did not achieve good results. Better results were achieved with Tordon at 2L/ha or 3L/ha. For both glyphosate at 4L/ha and Tordon 75D at 2L/ha, there was no difference between the late application in April and May, indicating the wide window opportunity for the late application to target the rootbank.

The adjuvant Sprinta seems to have achieved better results than Uptake when used in conjunction with 4L glyphosate or with 2 L Tordon 75D. This field study tend to our support preliminary laboratory studies that adjuvant Sprinta may provide faster uptake into plant leaf tissue than Uptake spray oil.

Because no further herbicide application was imposed in 2010/2011 season, the assessment data in May 2011 showed that only the Tordon at 3 L/ha had significant residual impact on rootbank, causing fewer stems in the second year. Repeated use of Tordon over a number of seasons is necessary for better control.

Table 1. Herbicide efficacy on SLN stem emergence.

Treatment	Apr 2010	Nov 2010	May 2011
2L Glyphosate/0.5L Uptake[a]	0.80	1.53	2.6
4L Glyphosate/0.5L Uptake	1.03	0.97	1.4
4L Glyphosate/0.2L Sprinta	1.03	0.77	1.7
6L Glyphosate/0.5L Uptake	0.47	0.33	1.0
2L Gly + 0.5L Tordon/0.5L Uptake	1.20	0.97	1.5
2L Gly + 1L Tordon/0.5L Uptake	0.97	0.90	1.9
2L Tordon/0.2L Sprinta	1.07	**0.17**	1.6
2L Tordon/0.5L Uptake	1.83	**0.53**	1.5
3L Tordon/0.5L Uptake	1.70	**0.17**	1.2
4L Glyphosate/0.5L Uptake (May)[a]	0.47	0.43	0.7
2L Tordon/0.5L Uptake (May)	0.73	**0.10**	1.4

a: Herbicides were applied in May 2011, all other treatments were applied in April 2011.

The results from this one-year experiment indicate that it is possible to use a reduced rate of picloram-based products as a late application to control rootbank. However, it will need 2-3 years of consistent efforts in order to manage SLN population to a satisfactory level. Improvement of herbicide uptake is possible by further evaluating suitable adjuvants to overcome the physical barriers of the trichomes and cuticles. A long-term trial is needed in order to draw firm conclusion on the control of this perennial weed.

10 A total of 15 workshops/seminars conducted to gr owers, advisors and noxious weeds officers

A series of 15 workshops were conducted in NSW (Delungra, Nullamanna, Griffith, Yanco, Ungarie, Parkes, Hay and Gulgong), Victoria (Hopetoun, Carwall and Calivil) and South Australia (Keith, Cleve, Spalding and Coomandook). The locations for the workshops were chosen based on our previous field sampling surveys across the three states and in consultation with Noxious Weeds officers and NRM officers. The workshops were run closely with local grower groups and noxious weeds or NRM networks. In total there were 438 participants attending the workshops. Among them, 25% were advisors, chemical companies and weeds (NRM) officers.

Each workshop started with a baseline survey at the beginning of the workshop and finished with an evaluation survey at the end of the workshop.

- 206 participants (47.5%) returned the workshop evaluation form;
- Among them, 165 growers (80%) were motivated and willing to try the BMP;
- 78 growers (38%) were willing to host a demonstration site;
- 118 growers (57%) wanted to try the BMP on a total of 28,707 ha, excluding the isolated infestation;
- 12 growers wanted to try the BMP on more than 1,000 ha.
- 47 growers (23%) indicated that they were willing to try the BMP but did not mention the trial area.

The series of workshops have been highly appreciated by the participants based on the discussions and surveys/evaluations during the workshops. The project team has been encouraged by the positive comments received, such as "*Very helpful presentation, BMP guide very useful*", "*More people need to hear it (the message) – Well done keep up the good work*", "*Powerpoint effective but taking questions along the way was very helpful*", "*Very encouraging to see the level and professionalism of research being undertaken*" and "*Keep researching, never give up when only half done*".

By running all these workshops, we realise that the scale of impact of this weed is much higher than the originally thought. Growers have suffered greatly not only economically but also socially. They are so frustrated to see the weed coming back year after year even though they were so committed to control the weed.

Table 2. Fifteen silverleaf nightshade management workshops conducted in 2010 and 2011.

Time/Date	Venue	Local contact	Attendance
8:30 am, Keith-SA 25/10/2010	Ruth Wheal Room – Keith Institute	Tracey Strugnell, Coorong Tatiara Local Action Plan	30
8:30 am, Hopetoun-VIC, 26/10/10	Gateway Beet, 75 Lascelles St, Hopetoun	Julie Puckle - Hopetoun Landcare group/Regional coordinator	12
8:30 am, Carwarp-VIC, 27/10/10	Carwarp Hall, Carwarp	Ian Arney Landcare	12
9:00 am, Calivil-VIC, 28/10/10	Calivil Bowling Club	Penny Wall East Lddon Landcare Group and Loddon Plains Landcare Network	25
11:00 am, Nullamanna-NSW, 1/11/10	Private property	Sarah Legge, Landcare coordinator, Gwydir and Macintyre Resources Management committee Inc.	20
11:00 am, Delungra-NSW, 3/11/10	Private property	Sarah Legge, Landcare coordinator,	15
10:00 am, Griffith-NSW, 13/01/11	Conference Room, Griffith Centre for Irrigated Agriculture, Murray Rd	Jason Cappello (DA)	35
9:00 am, Yanco-NSW, 25/02/11	Amaroo Conference Room Yanco Agricultural Institute	Mary-Anne Lattimore (DA)	45
8:30 am, Ungarie-NSW, 25/02/11	District Bowling Club Euglo Street	Bob Thompson (DA)	23
9:00 am, Parkes-NSW, 01/03/11	Parkes Leagues Club	Karen Roberts (DA)	18
9:00 am, Gulgong-NSW, 03/03/11	RSL Club - Gulgong 64 Herbert Street	Jenene Kidston (DA)	22
9:00 am, Cleve-SA, 08/03/11	Cleve Golf Club Golf Drive, Cleve	Iggy Honan (NRM)	22
8:30 am, Spalding-SA, 09/03/11	Spalding Institute	Grant Roberts (NRM)	97
8:30 am, Coomandook-SA, 10/03/11	Uniting Church Hall	Tracey Strugnell, Coorong Tatiara Local Action Plan	42
10:00 am, Hay-NSW, 07/06/11	Gold Club - Hay	Robert Ferguson (Western Riverina Noxious Weeds Advisory Group (WRNWAG) annual meeting)	20

11 Five scientific papers and conference papers submitted

Five Journal publications:

1. Burrows, G.E., White, R.G., Harper, J.D.I., Heady, R.D., Stanton, R., Zhu, X., Wu, H. and Lemerle, D. (2011). Barrier or gateway? The ins and outs of silverleaf nightshade (*Solanum elaeagnifolium* Cav.) leaf trichomes and their effect on the uptake of foliar applied herbicide (drafted).
2. Stanton, R., Wu, H. and Lemerle, D. (2011). Factors affecting seed persistence and germination of silverleaf nightshade (*Solanum elaeagnifolium*) in southern Australia. *Weed Science* (submitted).
3. Zhang, J. B., An. M., Wu, H., Liu, D.L., and Stanton, R. (2011). Chemical composition of essential oils of four eucalyptus species and their phytotoxicity on silverleaf nightshade (*Solanum elaeagnifolium*). *Plant Growth Regulation* (submitted).
4. Wu, H., Zhang, J.B., Stanton, R., An. M., Liu, D.L., and Lemerle, D. (2011). Allelopathic effects of *Eucalyptus dundasii* on weed germination and growth. *Allelopathy Journal* (in-press).
5. Stanton, R., Wu, H. and Lemerle, D. (2011). Root regenerative ability of silverleaf nightshade (*Solanum elaeagnifolium* Cav.). *Plant Protection Quarterly* (in-press).

Four conference publications:

1. Stanton, R., Lemerle, D. and **Wu, H.** (2011). Integrated management of silverleaf nightshade. The 23rd Asian-Pacific Weed Science Society Conference to be held in Cairns, 25-30 September 2011.
2. Wu, H. and Stanton, R. (2011). Improved adoption of management strategies for silverleaf nightshade (*Solanum elaeagnifolium*). The 16th NSW Weeds Conference to be held in Coffs Harbour, 18-21 July 2011.
3. Wu, H., Zhang, J.B., Stanton, R., An, M., Liu, D.L. and Lemerle, D. (2010). Herbicidal potential of *Eucalyptus dundasii* on *Lolium rigidum* Gaud. and *Hordeum* spp. *The 17th Australian Weeds Conference*, Christchurch 26-30 September, New Zealand. pp.139-142.
4. Stanton, R., Wu, H. and Lemerle, D. (2010). Herbicide control of summer active perennial weeds in southern Australia. *The 17th Australian Weeds Conference*, Christchurch 26-30 September, New Zealand. pp.452-454.

12 Project plan to 2013 developed

The latest research on the management of the perennial weed silverleaf nightshade was promptly delivered to more than 400 farmers, advisors and weed control officers recently through 15 workshops in NSW, Victoria and South Australia. The series of workshops have identified more than 120 growers who are highly motivated to trial the BMP with a total of more than 28,000 ha, ranging from isolated patches to an area of 2,000 ha.

The general lack of awareness of the weed identified at the workshops has strongly indicated that many more growers will need to be covered through further extension activities. The current one-year funding to deliver the research outcomes is certainly not sufficient to address this weed of a perennial nature and to cover many remote rural areas in multiple states. Further funding is necessary to capitalise the research investment and to eventually benefit the growers.

This project has adopted a bottom-up approach and identified local growers who are in desperate need of help and are willing to try the BMP. Further funding support would enable these motivated farmers to continue to the next step of the adoption process – implementation of the BMP. The successful implementation of this first cohort of growers will encourage the 2nd and 3rd cohorts of growers to adopt the BMPs.

It is expected that three-years of implementation of the BMP would generate a large set of valuable data on the impact of locations, soil types and production systems on the adoption and the efficacy of the BMP.

The generated information will then be shared between growers through grower's workshops across different geographic regions, which would further encourage more growers to implement the BMP.

A three-year funding support would allow participating growers to test the recommendations on farm and to see the results of changing silverleaf nightshade populations over time. In the meantime, the project will also test the novelty and effectiveness of this grower-driven adoption process and identify social-economic barriers to adoption of BMP.

Success in achieving objectives

Ten main objectives of this project have been completed. The successes achieved within each of these objectives are presented below.

Objective 1 400 growers trialling the BMP in the 2010-11 control season and 100 advisors advocating the IWM package

The draft BMP guide has been widely circulated through various communication channels such as printed materials, electronic media, radio interviews and workshops. It is expected that the BMP has reached a total of more than 5,000 growers, ag-advisors, resellers, spraying contractors, noxious weeds and NRM officers.

A series of 15 workshops conducted in 2010 and 2011 has identified a total of 165 advocate growers and 110 ag-advisors, including noxious weeds (NRM) officers and reseller, who were motivated and willing to trial the BMP on a total area of over 28,000 hectares.

However, the project team did not have time to follow through with these advocate growers to monitor the change in attitude, knowledge and practices due to the completion of this one-year project.

Objective 2 5,000 ha trialled under BMP management

Evaluation forms completed at the end of the each workshop indicate that 118 growers would be prepared to trial the BMP on a total area of over 28,000 hectares, not including the areas with isolated infestations. Among them there were 12 growers willing to test the BMP on more than 1,000 ha on each property.

Objective 3 Reporting protocols designed and accepted by advisors and producers to report impact of the BMP

A standardised recording protocol has been accepted, which include a preliminary data collection on previous management, SLN infestation history and initial stem density. In addition, the following simple measurement will be taken during the implementation period of the BMP: stem emergence, control efficacy within season, control cost and impact of weeds on pasture/crop production. Stem densities will be recorded in December each year to assess the impact of autumn action in April/May on rootbank. The long term impacts of BMP practices on rootbank will need to be monitored for several seasons.

Objective 4 Refined Best Management practices in consultation with the weed advisors, consultants, regulatory officers, producers to develop the compelling case for control

A consultative committee of local agronomists and noxious weeds officers was established and provided input into the content and layout of a best management practice guide. The guide was then circulated to several farmers and noxious weeds officers for comment before being finalised.

2000 copies of the BMP guide were printed in September 2010 and about 1800 copies have been distributed to growers, growers groups, spraying contractors, resellers, ad-advisors, noxious weed officers and NRM officers in NSW, VIC and SA. The BMP has also been widely disseminated by a range of communicative channels including websites, email distribution list, radio interviews and workshops. The BMP has been very well received by the workshop participants, who have commented that "*the BMP guide very well laid out and informative*" and "*BMP guide very useful*".

However the BMP should be revised overtime. The stock quarantine period of "14 days" in the current BMP is believed to be too short. Most workshop participants seem to think at least 28 days and would like to see more work to confirm that.

Objective 5 Conducting at least 10 workshops, seminars and field trips/days in NSW, VIC and SA

The most up-to-date research information and BMP was delivered to growers, ag-advisors, resellers, Noxious Weeds officers and NRM officers through a series of 15 workshops conducted in NSW (Delungra, Nullamanna, Griffith, Yanco, Ungarie, Parkes, Hay and Gulgong), Victoria (Hopetoun, Carwall and Calivil) and South Australia (Keith, Cleve, Spalding and Coomandook). The workshops were run closely with local grower groups and noxious weeds or NRM networks. In total there were 438 participants attending the workshops. Among them, 25% were advisors, chemical companies, weed officers.

Each workshop started with a baseline survey at the beginning of the workshop and finished with an evaluation survey at the end of the workshop. The workshop participants responded with highly encouraging comments, such as "*Very encouraging to see the level and professionalism of research being undertaken*". "*Powerpoint effective but taking questions along the way was very helpful*", and "*More people need to hear it (the message) – Well done keep up the good work*".

Objective 6 Drafting and submitting 5 scientific publications from the previous project

In total, two journal papers have been accepted (in press) and three were submitted (under review). The project team also actively communicated the research outcomes via conferences, with four conference papers accepted.

Five Journal publications:

6. Burrows, G.E., White, R.G., Harper, J.D.I., Heady, R.D., Stanton, R., Zhu, X., Wu, H. and Lemerle, D. (2011). Barrier or gateway? The ins and outs of silverleaf nightshade (*Solanum elaeagnifolium* Cav.) leaf trichomes and their effect on the uptake of foliar applied herbicide (drafted).
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Four conference publications:

5. Stanton, R., Lemerle, D. and **Wu, H.** (2011). Integrated management of silverleaf nightshade. The 23rd Asian-Pacific Weed Science Society Conference to be held in Cairns, 25-30 September 2011.
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8. Stanton, R., Wu, H. and Lemerle, D. (2010). Herbicide control of summer active perennial weeds in southern Australia. *The 17th Australian Weeds Conference*, Christchurch 26-30 September, New Zealand. pp.452-454.

Objective 7 Improved efficacy by fine-tuning herbicide applications

In April 2010, a new field trial was established at Corowa, NSW to improve efficacy by fine-tuning herbicide applications, such as herbicide rate, adjuvant and spray timing. Results showed that Tordon 75D at a lower rate (< 1L/ha) did not achieve good results on SLN rootbank control. There were no differences between the two timings of late application in April and May, indicating the wide window opportunity for the late application to target the rootbank. Adjuvant Sprinta seems to have achieved better results than Uptake when used in conjunction with 4L glyphosate or with 2 L Tordon 75D. Although this one-year trial was not able to draw firm conclusion on the control of this perennial weed, the research does indicate that evaluation of a range of adjuvants could further improve the herbicide uptake and repeated use of picloram-based products over a number of seasons is necessary for better control of SLN rootbank.

Objective 8 At least 10 demo sites established with baseline data

Seventy eight advocate farmers across NSW, VIC and SA have been identified through workshops as being willing to host demonstration sites in order to allow more growers to participate the BMP. Within a year, the project team were able to identify a large number of advocate growers differing in farming situations across three different states. Depending on the funding availability, ten advocate growers could be easily selected based on the levels of infestation, production systems and soil types in order to allow good representation of sites throughout the distribution range of silverleaf nightshade across states.

In addition, two herbicide trial sites previously established at Leeton and Culcairn were maintained for demonstration purposes. At Culcairn site, a natural population of annual ryegrass was established in 2010, while limited vegetation was established at Leeton site. Consequently the ryegrass competition at the Culcairn field site has resulted in much fewer SLN stem numbers as compared to the Leeton site. These results further support the synergism between pasture competition and herbicide application on reducing SLN population.

Objective 9 Collect additional data from the established pasture competition site for pasture and herbicide interaction studies

A pasture field site established at Wellington in 2008/2009 season was used to study the interactive effect of pasture competition and herbicides for improved control of SLN. Many summer active pasture species were highly effective in suppressing SLN stem emergence. The results indicated that joint action of herbicides and pasture competition could have synergistic effect on reducing SLN population. Further trials on grazing pastures before spraying with various rates of Tordon 75D or Grazon Extra at different soil types would provide useful information for subsequent adoption of this integrated approach combining pasture competition and a late application of picloram-based products for rootbank control.

Objective 10 Complete the seed burial and persistence studies at 2 sites

The seed burial and persistence studies at 2 sites (Ganmain and Culcairn) were completed. The burial depth, duration of burial, and presence of seed pod had significant impact on the viability of SLN and PGC seeds. Seeds buried at deeper depths persisted longer as compared to seeds on soil surface. This research suggests that any soil incorporation to bury seed pods will significantly increase the persistence of the seeds of SLN and PGC in the soil. A long-term management strategy is needed to effective manage these two intractable perennial weeds due to the persistent seedbank.

Conclusions and recommendations

A BMP guide was produced after thorough consultation with local agronomists and noxious weeds officers. It has since been widely disseminated to end users by a range of communicative channels including websites, email distribution list, radio interviews, grower groups as well as workshops. The most up-to-date research information and BMP was also successfully delivered to growers, ag-advisors, resellers, Noxious Weeds officers and NRM officers through a series of 15 workshops conducted in NSW, Victoria and South Australia.

The workshops have identified that there is a serious lack of understanding and awareness of the weed, its impact and control options, which strongly indicate that many more growers will need to be covered through further awareness campaign and extension activities. This project has adopted a bottom-up approach and identified many advocate growers who are willing to try the BMP. Negotiations with MLA are underway for further funding support in order to engage such a large number of growers who are willing to practices the BMP on such a large scale with different production systems, crop rotations and soil types across different states. A three-year funding support would enable these motivated farmers to continue to the next step of the adoption process – implementation of the BMP. The successful implementation of this first cohort of growers will encourage the 2nd and 3rd cohorts of growers to adopt the BMPs.

Appendix A. Media Release

05 Apr 2011

Seed weed research good news for silage makers

http://www.dpi.nsw.gov.au/aboutus/news/recent-news/agriculture-news-releases/good-news-for-silage-makers

Research has confirmed what many farmers had hoped for - that silage making eliminates or reduces weeds.

Industry & Investment NSW (I&I NSW) Livestock Research Officer, John Piltz, an expert on silage, said research recently conducted by the Graham Centre (an alliance between I&I NSW and Charles Sturt University) has shown that in most cases weed seeds incorporated in silage became non-viable.

"This is good news for silage makers because inevitably some weed seeds are included in silage when it is made," he said.

"Weeds are a big problem for farmers, particularly in a season like this, and the fact silage making helps get rid of them gives producers another weapon against weeds."

Mr Piltz said research he had conducted with fellow researcher, Dr Rex Stanton, included incorporating seeds from numerous weed species in chopped cereal silage for three months to determine germination and viability.

The results were also measured against digestion of the weed seeds in the rumen of cattle without „ensiling‟ (making into silage) or the combination of both.

The incorporated seeds included barley grass, brome grass and silvergrass, wild oats, Paterson‟ s curse, silverleaf nightshade, wild radish, wireweed, prairie ground cherry and marshmallow.

"At the top end of the scale, silvergrass dropped from 98 per cent viability before it went into the silage, to zero when it was tested," Mr Piltz said.

"In fact, our research has shown that nearly all of the weed seeds ensiled became non-viable after ensiling.

"The only exception was marshmallow seed, which after digestion and ensiling was still above 40 per cent viability."

He said overall silage was far more reliable for reducing weed seed viability than animal digestion, and the combination of both processes destroyed most seeds.

"Our research has yet to explain how the process of making silage kills the weed seeds and plans are underway to do further research, which will include a wider range of seed weeds and silage types," Mr Piltz said.

Photo available from sarahc@sf.nsw.gov.au

Media contact: Sarah Chester (02) 6036 2110 or 0417 207 669

21 Mar 2011

More than 400 people attend silverleaf nightshade workshops

http://www.dpi.nsw.gov.au/aboutus/news/recent-news/agriculture-news-releases/silverleaf-nightshade-workshops

More than 400 farmers, advisors and weed control officers recently attended 14 workshops in NSW, Victoria and South Australia to hear the latest research on the management of the perennial weed silverleaf nightshade.

The workshops are the culmination of a five-year EH Graham Centre (an alliance between Charles Sturt University and Industry & Investment NSW) research project, funded by Meat and Livestock Australia.

Project leader, Dr Hanwen Wu, said continuing demand for these workshops and farmer feedback highlighted the growing economic, social and environmental cost of silverleaf nightshades to grain and livestock producers.

"Estimates show that this highly adaptable weed has the potential to infest up to 400 million hectares of the most productive farming land of southern Australia," he said.

Dr Wu said silverleaf nightshade grows from seed and root fragments.

"Research of the ecology and biology of this summer growing weed identifies the need for a dual action approach, with a combination of chemical and non-chemical control strategies, that target the seed bank and root system," he said.

Dr Wu said the workshops combined local experience and farmer success stories to reinforce research findings.

"The clear message from the workshops is that silverleaf nightshade management is a long-term commitment that focuses on key stages of the plants‟ life cycle.

"Many of the current strategies have been successful in stopping seed set, which may control spread, but we now know that silverleaf nightshade reshoots very effectively from significant root reserves," he said.

Dr Wu said that feedback from the workshops highlighted the financial and social cost of managing large infestations.

“Farmers grappling with silverleaf nightshade infestations strongly supported our message to quickly contain and eradicate small infestations before they establish and spread.

“Effective management should begin with a map and rating density of infestations, which then enables farmers to consider long-term options to either contain or control the weed.

“Farmers need to critically assess the time and finances they need to commit to eradication versus a control objective, and then consider what area can be physically managed, and the tactics that best suits their system,” he said.

Dr Wu said a best management factsheet produced as part of the project clearly identifies the key stages of the plant's life cycle that management strategies need to target and reinforces the need for a "dual action‟ approach to eradicating the weed.

The factsheet can be sourced from:
www.csu.edu.au/research/grahamcentre/research/publications/docs/SLN_BMPguide.pdf

Photo available from sarahc@sf.nsw.gov.au

Media contact: Sarah Chester on (02) 6036 2110 or 04 17 207 669 or Helen Burns on (02) 6938 1947

22 Nov 2010

Workshops present latest control strategies for silverleaf nightshade

http://www.dpi.nsw.gov.au/aboutus/news/recent-news/agriculture-news-releases/control-strategies-for-silverleaf-nightshade

The latest management recommendations for the control of the perennial, summer-active weed silverleaf nightshade are currently being delivered to farmers and advisors in South Australia, Victoria and NSW.

Attending farmers and advisors are being encouraged to take an integrated approach that targets both the silverleaf nightshade seedbank and the extensive root system (rootbank).

The workshops, which run until late March, present new control strategies developed from a five-year research project led by Dr Hanwen Wu of the EH Graham Centre for Agricultural Innovation, funded by Meat and Livestock Australia.

Dr Rex Stanton, research scientist with the project, said positive outcomes from the workshops included a greater awareness of the potential threat and cost of this persistent weed, as well as the informal farmer discussion that highlighted local success stories.

He said, if left unchecked, silverleaf nightshade could infest an estimated 400 million hectares of Australian crop and pasture land.

Silverleaf nightshade originated in central or southern America and was first introduced into Australia in the early 1900s.

It has adapted well and by the1960s could be found across soil types and climatic zones from the northern slopes of NSW to the Mallee regions of South Australia and Victoria, reducing productive capacity and ultimately land values.

“Our research has concentrated on the biology and ecology of silverleaf nightshade and identified key stages of the plant's life cycle that must be targeted to eradicate existing infestations and to reduce the risk of spread,” Dr Stanton said.

Silverleaf nightshade grows from seed and root fragments and the clear message from the research is that effective eradication must take on a dual action approach that hits both the seedbank and the rootbank."

While most weed control programs focus on stopping seed set and running down the seedbank, the extensive root system of silverleaf nightshade plants is a major source of new growth.

Preventing seed set is really only doing half the job," said Dr Stanton.

"The first action aims to prevent seed set and must occur in late spring or early summer before green berries form, and could include a grazing, slashing and/or herbicides.

Action targeting the rootbank comes later in the season. Research has shown that herbicide impact on the roots is greatest when the plant begins to shutdown in autumn."

Dr Stanton said farmers and advisors attending the workshops were adamant that a successful silverleaf nightshade control program must be a long-term commitment that includes mapping and containing infestations, with a concerted program of dual action strategies, followed by monitoring and spot spraying.

"A concern among farmers attending the workshop is that managers of farm and crown land who are not familiar with silverleaf nightshade underestimate its damaging potential.

"As one farmer warned, even small infestations should not be ignored," Dr Stanton said.

The dual action approach is presented in more detail in the 'Silverleaf Nightshade Best Management Practice Guide'

For further inquiries or to organise a workshop in your area please email Rex Stanton at wagga.weeds@industry.nsw.gov.au

Photo available from sarahc@sf.nsw.gov.au

Media contact: Sarah Chester (02) 6036 2110 or 0417 207 669

Smarter approaches with current tools

From the August 2010 edition of Agriculture Today.
http://www.dpi.nsw.gov.au/archive/agriculture-today-stories/august-2010/smarter-approaches-with-current-tools

Perennial weeds such as silverleaf nightshade and prairie ground cherry have been a constant problem each summer for farmers in south- eastern Australia.

“Unfortunately, there are no new tools for controlling perennial summer weeds, so we just have to be smarter with how we use our current tools,” said Dr Hanwen Wu, senior research scientist with Industry and Investment NSW.

Farmers are used to dealing with annual weeds, so it requires a change in thinking when it comes to dealing with perennial weeds.

“Control programs for perennial weeds need to include tactics that attack and deplete the root reserves to achieve long-term success,” said Dr Rex Stanton, one of the scientists involved in the research.

Spraying perennial weeds when they are flowering may control what can be seen, but may not have much effect on the roots, resulting in persistent regrowth year after year.

Silverleaf nightshade cannot be successfully eradicated with a single herbicide application and needs an integrated approach, combining both chemical and non-chemical options.

Researchers at the EH Graham Centre in Wagga Wagga have been developing innovative ways to deal with the weeds, backed by funding support from Meat and Livestock Australia.

Herbicides, grazing and competition could all be considered as a way to reduce seed set.

Dr Stanton said timing of each tactic was important for good results.

A dense population of silverleaf nightshade requires a dual-spray strategy followed by crop or pasture competition.

The dual-spray strategy consists of a first herbicide application to flowering plants to control seed set, usually in late spring or summer, followed by a second application in autumn to the re-shooting stems, to target the root bank.

As silverleaf nightshade is not strongly competitive, summer active pastures or crops can suppress growth and flowering of the weed.