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Prepared by: Lewis Kahn

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Meat and Livestock Australia Limited
Locked Bag 1961
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Integrated control of Chilean Needle Grass

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Abstract

Chilean Needle Grass (CNG) is an invasive perennial grass weed that lowers stocking rate and productivity, with seed contamination an additional issue for sheep. Pasture topping with low rates of glyphosate reduced the number of seeding stems by about 95% providing a potentially valuable means for reducing seed production and spread of CNG. Two successive years of selective control with flupropanate led to a 40% decline in the number of CNG plants. Multiple applications with higher rates of glyphosate, prior to pasture sowing, killed existing CNG plants but within nine months, CNG plants had re-established at moderate densities. Biosecurity and control strategies are discussed.

Executive summary

Chilean Needle Grass (CNG) is an invasive perennial grass weed that lowers stocking rate and productivity, with seed contamination an additional issue for sheep. Producer members came together specifically to better understand control options to manage the long-term problem posed by CNG. On each of six properties in the Northern Tablelands of NSW, producers evaluated the impact of: (i) pasture topping with glyphosate at 110-120 g a.i./ha; (ii) use of flupropanate at selective rates of 1.1-1.5 kg a.i./ha; (iii) spraying out with glyphosate and resowing; and (iv) slashing.

Pasture topping with low rates of glyphosate reduced the number of seeding stems by about 95% providing a potentially valuable means for reducing seed production and spread of CNG. Two successive years of selective control with flupropanate led to a 40% decline in the number of CNG plants but producers had concerns about negative effects on non-target desirable pasture species.

Multiple applications with higher rates of glyphosate killed existing CNG plants but within nine months, CNG plants had re-established at moderate densities. The decision to adopt the practice of spraying and resowing is more to do with the likely financial gain rather than with long-term management of CNG.

Slashing removed seeding stems and a good proportion of the mature plant and producer perceptions were this increases palatability and hence utilisation. This suggests that palatability of CNG is a function of both reproductive state and maturity of foliage.

Core producers increased their correct knowledge of:

- the likely size of the soil CNG seed reserve, from 50% to 100% of core producers.
- the rate of decline of the CNG soil seed reserve, from 17% to 33%.
- the mode of spread for CNG seeds from, 83% to 100%.

Interestingly however, the confidence of core producers in cost-effectively controlling CNG decreased over the course of the project. Discussions with core producers indicated the drop in confidence reflected a more realistic understanding of the difficulties with controlling and managing CNG than any adverse changes.

In terms of practice change, core producers indicated they intended to use the following CNG control practices:

- Slash Chilean Needle Grass increased practice by 25% of core producers.
- Use low rates of glyphosate or other herbicides to pasture top Chilean Needle Grass by 25% of core producers.
- Use rates of glyphosate to kill Chilean Needle Grass prior to pasture/crop sowing by 50% of core producers.
- Use rates of flupropanate to selectively remove Chilean Needle Grass by 25% of core producers.
- Use high stock density (> 400 DSE/ha) increased practice by 25% of core producers.

These results provide a solid basis for control strategies. If a property does not have CNG, effort should focus on keeping it out with good quarantine and biosecurity practices. If there are manageable isolated patches of CNG, herbicides provide an option to control seeding and/or remove CNG. This will be an ongoing and long-term strategy given large soil seed reserves. Other practices, especially good grazing management will also keep other pasture species more productive with a thicker sward reducing the opportunity for new CNG plants to establish. If CNG is widespread, management will need to adapt to acknowledge that CNG is likely to be a permanent fixture. This will have implications for choice of livestock enterprises and grazing management strategies.

Table of contents

1 Background 5

2 Project objectives 5

3 Methodology 5

4 Results 7

4.1 Pasture top 7

4.2 Selective removal with flupropanate 9

4.3 Removal and resowing 10

4.4 Slashing 11

4.5 Chilean Needle Grass quality 11

5 Discussion 12

5.1 Chilean Needle Grass control 12

5.2 Project objectives 14

5.3 Regional influence and Field Day 15

5.4 Knowledge and skills surveys 15

6 Conclusions/recommendations 21

7 Bibliography 21

1 Background

Chilean Needle Grass (CNG) is an invasive perennial grass weed that lowers stocking rate and productivity, with seed contamination an additional issue for sheep. CNG seeds prolifically and is generally unpalatable to livestock, especially once it forms flowering stems, making it difficult for producers to utilise and control this grass. CNG is continuing to spread across the Northern Tablelands district of NSW and now exists as near monocultures on some paddocks, especially those located on soils derived from basaltic parent material.

2 Project objectives

By October 2019,

a. Nine producers in the Guyra region of the Northern Tablelands of NSW will have evaluated and, depending on results, adopted one of three control programs of CNG that:
    - Increase stocking rate of sheep enterprises by at least 4 DSE/ha on affected areas
    - Increase gross margin by at least $140/ha on affected areas
    - Reduce CNG to less than 1 plant/100m^2 at two years after control programs
    - Reduce the number of CNG seeding panicles by at least 75% and increase CNG growth rate and quality by 25% through utilization programs.

b. Implement a series of skills and training activities to increase the confidence of producer group members, and another 10 local producers, to implement CNG control programs.

c. Conduct field days to showcase the results and encourage adoption of key practices by 80-100 producers in the region.

3 Methodology

On each of six properties, a control and a treatment paddock (areas of these paddocks were similar within property but ranged from 2–60 ha across properties) were selected. Producer members selected a treatment for the control of CNG from the following options:

- Reduce seeding to reduce spread and increase palatability using pasture (spray) topping with glyphosate at the rate of 110-120 g a.i./ha. Treatment paddocks were sprayed during late October – mid-November when CNG plants had flowering stems but seeds in the flowering panicle had not ripened to maturity. (2 properties; sites D, E)
- Selectively removing CNG plants from an established pasture using flupropanate at the rate of 1.5 (2016) and 2.0 (2017) L/ha (1.1-1.5 kg a.i./ha). Treatment paddocks were sprayed at various times (varying between year) including May and August. (1 property; site F)
- Reduce seeding and selectively remove CNG plants by using a combination of pasture topping and flupropanate treatments (as described above) during early November. (1 property; site B)
- Spraying out and resowing to a new fescue pasture using glyphosate at the rate of 3.0 L/ha timed for early November and then prior to sowing in February the following year. (1 property; site A)
- Slashing to increase the palatability of CNG with slashing timed to occur after seeding during late November – mid-December. (1 property; site C)

Pastures were comprised of a range of sown (fescue and cocksfoot), native and naturalized species with varying levels of CNG. Soil chemical fertility (Table 1) was generally good with the notable exception of low sulphur levels in 4 of the 6 properties. Some form of rotational grazing management was used on all properties with stock densities varying from 10 – 250 DSE/ha, leading to short to moderate periods of grazing.

Table 1: Soil chemical fertility (0-10 cm) from control and treatment paddocks.

Site	Treatment	Phosphorus (Olsen; ppm)	Sulphur (KCl40; ppm)	Potassium (Colwell; ppm)	pH (CaCl2)	Organic carbon (%)
A	Spray out	45	8.1	900	5.2	4.9
B	Pasture top & selective control	50	7.0	680	5.4	5.1
C	Slashing	30	5.7	1200	5.0	2.4
D	Pasture top	12	6.7	410	5.1	2.1
E	Pasture top	11	4.3	720	5.4	2.4
F	Selective control	24	30.0	450	5.0	5.1

NOTE: Soil chemical fertility was very similar across control and treatment paddocks at all sites and is combined.

In each paddock, a single permanent 50m transect was established along which pasture and CNG measurements were conducted using a 0.5 x 0.5 m quadrat at 10 evenly spaced locations, ensuring a gap of at least 5 m between the quadrat position and the steel posts marking the start and end of the transect. Prior to treatment applications, each paddock was sampled to determine the following measurements from within each quadrat:

- Pasture height (cm)
- Subjective assessment of pasture density (kg DM/ha per cm of pasture height)
- Subjective assessment of the percentage of pasture biomass that was green (%)
- Subjective assessment of ground cover (%)
- The contribution of dominant pasture species to pasture biomass from the BOTANAL procedure (Tothill et al. 1978)
- The number of CNG plants

Pasture height and pasture density were used to estimate total pasture biomass (kg DM/ha). These measurements were repeated after treatment application in Year 2.

Properties that used the pasture topping treatment, were revisited following treatment to count the number of seeding CNG stems using the established transects and quadrat procedure as described above.

The data did not permit statistical analysis and simple means are provided. The reduction in the number of CNG seeding stems was calculated by dividing the number of CNG seeding stems in treated paddocks by the number of CNG seeding stems in control paddocks within any year. The change in the number of CNG plants in control and treated paddocks was calculated separately by dividing the number of CNG plants in 2017 by the number of CNG plants in 2016.

4 Results

4.1 Pasture top

The average pasture biomass for control and pasture topped paddocks was respectively 732 and 967 kg DM/ha in 2016 and 1328 and 1343 kg DM/ha in 2017. The average green content of pasture biomass for control and pasture topped paddocks was 66 and 61% in 2016 and 71 and 56% in 2017. Ground cover was always above 96%. CNG as a proportion of total pasture biomass for control and pasture topped paddocks was 41 and 55% in 2016 and 64 and 51% in 2017 (Table 2).

Table 2: Pasture measurements from untreated control and pasture topped paddocks in 2016 and 2017.

	Site B		Site D		Site E	
	2016	**2017**	**2016**	**2017**	**2016**	**2017**
Control						
Pasture biomass (kg DM/ha)	870	930	725	1623	600	1430
Green (% of pasture biomass)	63	77	71	67	63	69
Ground Cover (%)	98	98	99	97	98	100
CNG (% of pasture biomass)	60	55	34	73	28	63
Pasture topped						
Pasture biomass (kg DM/ha)	920	728	1290	2160	690	1140
Green (% of pasture biomass)	67	53	52	52	63	63
Ground Cover (%)	97	92	100	99	97	100
CNG (% of pasture biomass)	64	30	90	97	10	26

There were approximately 100 CNG seeding stems per m^2 in untreated paddocks (Figure 1). Pasture topping with a low rate of glyphosate reduced the number of CNG seeding stems by at least 94% in both years (Figure 2). The visual effects of pasture topping on the CNG pastures are shown in Figures 3 and 4.

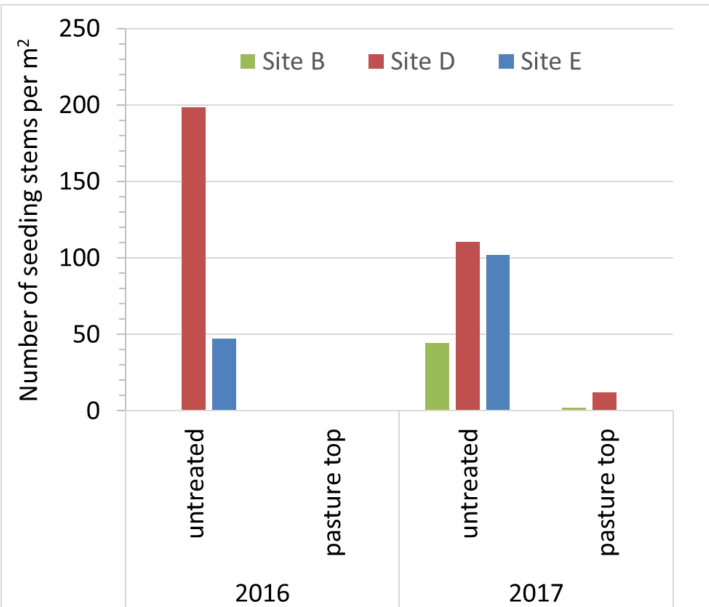

Figure 1: The number of Chilean Needle Grass seeding stems in untreated and pasture topped paddocks in 2016 and 2017. Note: Site B was not measured in 2016.

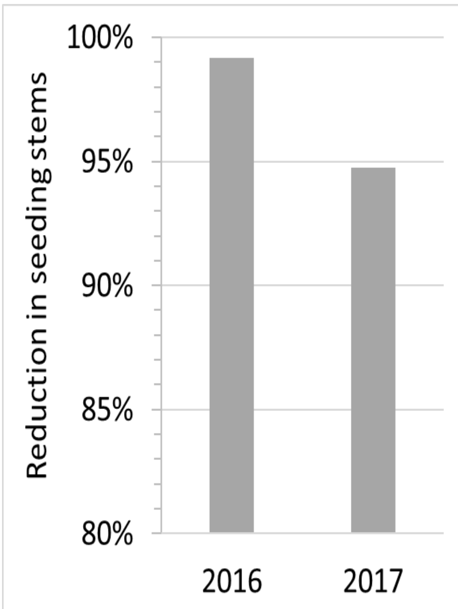

Figure 2: The reduction in the number of Chilean Needle Grass seeding stems in 2016 and 2017.

Figure 3: Photo of Site D after application of pasture top treatment. Note: area of Chilean Needle Grass in the photo that was missed in the application.

Figure 4: Photo of the pasture top (left hand side of the fence line) and untreated control paddocks (right hand side) at Site D, two months after treatment.

There were approximately 33 CNG plants per m^2 in untreated paddocks (Figure 5). Pasture topping with a low rate of glyphosate was not expected to have an impact on the number of CNG plants as application rates were too low to be lethal. The number of CNG plants declined in both in untreated and pasture topped paddocks (Figure 6) and it is more likely that the changes were due to seasonal differences and errors in counting of CNG plants (difficult in thick swards to accurately delineate separate CNG plants) than to the effect of treatment.

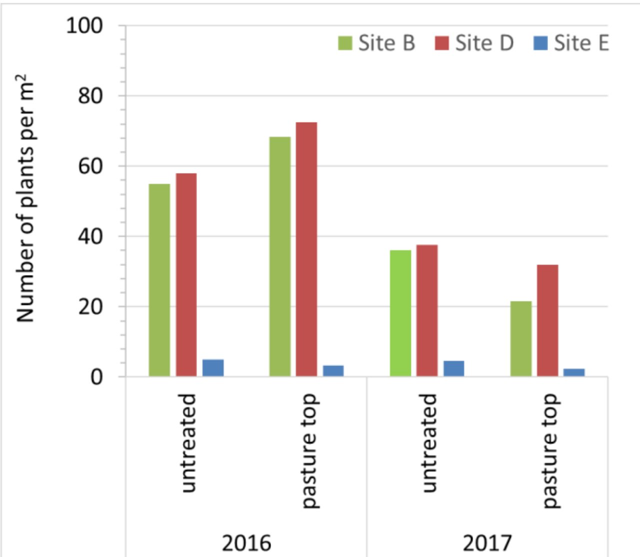

Figure 5: The number of Chilean Needle Grass plants in untreated and pasture topped paddocks in 2016 and 2017.

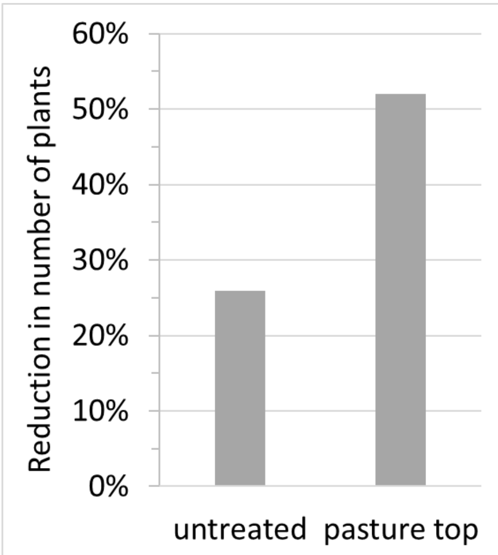

Figure 6: The reduction in the number of Chilean Needle Grass plants in 2016 and 2017.

4.2 Selective removal with flupropanate

The average pasture biomass for control and selective flupropanate paddocks was respectively 896 and 1383 kg DM/ha in 2016 and 1658 and 2777 kg DM/ha in 2017. The average green content of pasture biomass for control and selective flupropanate paddocks was 61 and 54% in 2016 and 69 and 63% in 2017. Ground cover was always above 95%. CNG as a proportion of total pasture biomass for control and selective flupropanate paddocks was 67 and 49% in 2016 and 73 and 23% in 2017 (Table 3).

Table 3: Pasture measurements from untreated control and selective flupropanate paddocks in 2016 and 2017.

	Site B		Site F	
	2016	**2017**	**2016**	**2017**
Control				
Pasture biomass (kg DM/ha)	870	930	923	2385
Green (% of pasture biomass)	63	77	59	60
Ground Cover (%)	98	98	96	100
CNG (% of pasture biomass)	60	55	74	91
Selective flupropanate				
Pasture biomass (kg DM/ha)	920	728	1845	4825
Green (% of pasture biomass)	67	53	41	72
Ground Cover (%)	97	92	99	100
CNG (% of pasture biomass)	64	30	33	15

There were approximately 28 CNG plants per m2 in untreated paddocks (Figure 7). The number of CNG plants declined in both untreated and paddocks selectively treated with flupropanate (Figure 8) with the extent of the reduction greater with treatment.

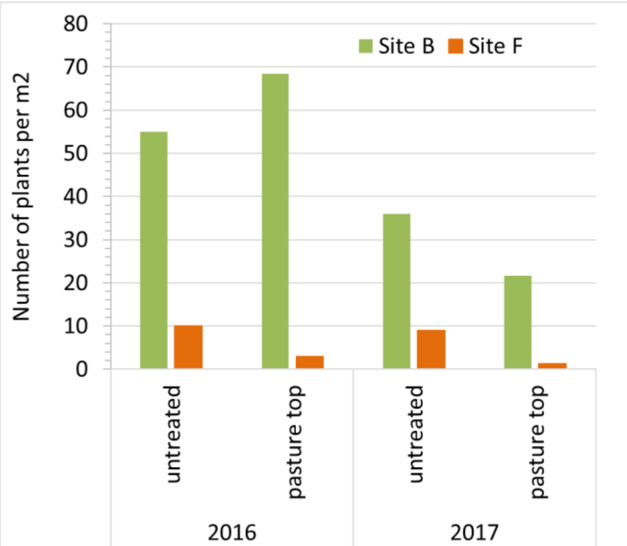

Figure 7: The number of Chilean Needle Grass plants in untreated and selective flupropanate paddocks in 2016 and 2017.

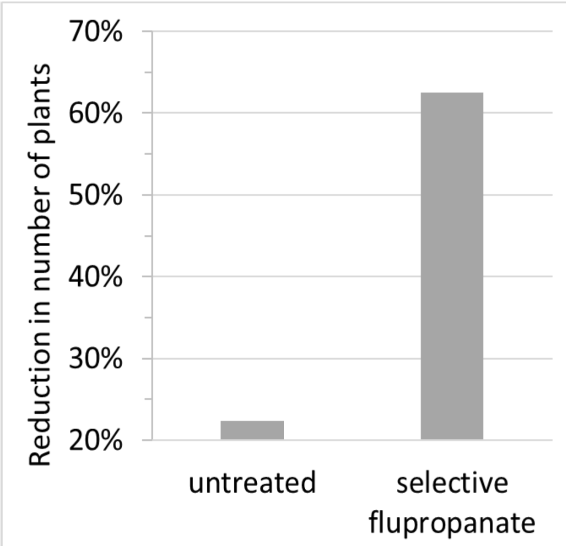

Figure 8: The reduction in the number of Chilean Needle Grass plants across 2016 and 2017.

4.3 Removal and resowing

The pasture biomass, green content of pasture biomass, ground cover and CNG as a proportion of total pasture biomass for control and resown paddocks is provided in Table 4.

Table 4: Pasture measurements from untreated control and resown paddocks in 2016 and 2017.

	Site A	
	2016	**2017**
Control		
Pasture biomass (kg DM/ha)	1140	2100
Green (% of pasture biomass)	71	69
Ground Cover (%)	98	100
CNG (% of pasture biomass)	35	56
Resown		
Pasture biomass (kg DM/ha)	760	1678
Green (% of pasture biomass)	65	81
Ground Cover (%)	92	87
CNG (% of pasture biomass)	72	11

There were approximately 7 CNG plants per m^2 in untreated paddocks but over 35 CNG plants per m^2 in the treatment paddock, prior to it being twice sprayed with 3 L/ha glyphosate and then resown (Figure 9). The number of CNG plants increased slightly in control paddocks but spraying and resowing led to a reduction of 90% in CNG plants (Figure 10). The higher rate of glyphosate killed the existing mature plants and the CNG plants present at the measurement stage in 2017 were likely new plants recruited from the existing soil seed reserve.

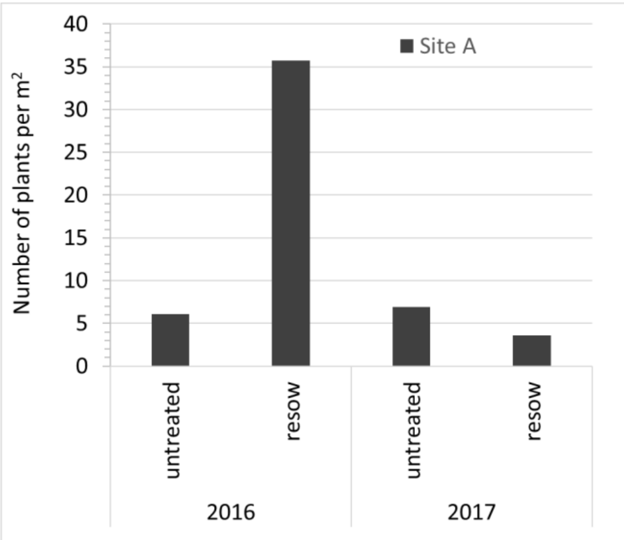

Figure 9: The number of Chilean Needle Grass plants in untreated and resown paddocks in 2016 and 2017.

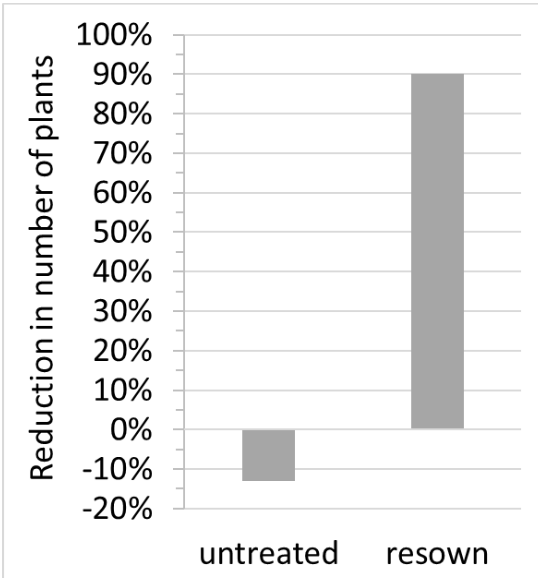

Figure 10: The reduction in the number of Chilean Needle Grass plants across 2016 and 2017.

4.4 Slashing

The pasture biomass, green content of pasture biomass, ground cover and CNG as a proportion of total pasture biomass for control and slashed paddocks is provided in Table 5.

Table 5: Pasture measurements from untreated control and slashed paddocks in 2016 and 2017.

	Site C	
	2016	**2017**
Control		
Pasture biomass (kg DM/ha)	943	2510
Green (% of pasture biomass)	66	62
Ground Cover (%)	85	98
CNG (% of pasture biomass)	48	82
Slashed		
Pasture biomass (kg DM/ha)	1155	1915
Green (% of pasture biomass)	70	65
Ground Cover (%)	91	99
CNG (% of pasture biomass)	70	97

There were approximately 7 CNG plants per m2 in untreated paddocks (Figure 9). The number of CNG plants increased slightly in both control and slashed paddocks (Figure 10). Slashing was not expected to change CNG plant populations but to change the palatability for subsequent grazing.

Figure 9: The number of Chilean Needle Grass plants in untreated and resown paddocks in 2016 and 2017.

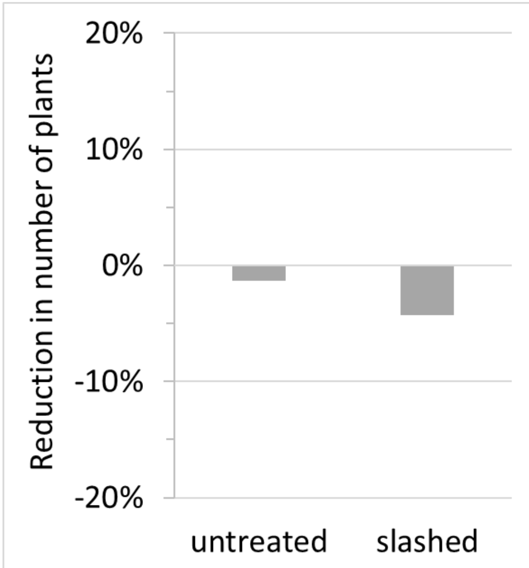

Figure 10: The reduction in the number of Chilean Needle Grass plants across 2016 and 2017.

4.5 Chilean Needle Grass quality

Pasture dominated by CNG was sampled by Dr Carol Harris (NSW DPI) for feed quality over 2017–2018 on a separate property, located at Wellingrove (near Glen Innes on the Northern Tablelands, NSW; approx. 60 km north of the participating properties). A 250 m transect was established and pasture sampled and assessed at 50 locations for pasture biomass, percentage of CNG and the frequency of sample sites where CNG had been grazed. Harvested pasture was then analysed for digestibility and crude protein content (Figure 11, 12, 13).

CNG digestibility ranged from 52–68% and crude protein from 12.1–15.8%. CNG quality, and especially digestibility, declined from a high in September to low values in January. While the same trend was evident for crude protein, the extent of the decline was less pronounced. Typically, digestibility values of 50-55% are required to maintain grazing livestock. While crude protein levels were adequate for mature animals, they were below optimal values (15-17%) for growing livestock. While CNG digestibility was declining, so too was the frequency of CNG plants that had been grazed by livestock.

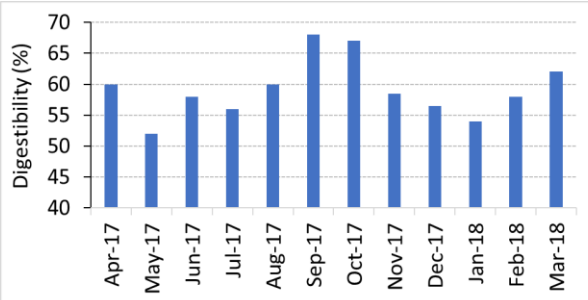

Figure 11: The digestibility of Chilean Needle Grass.

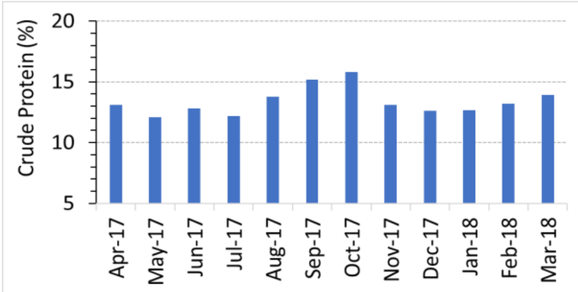

Figure 12: Crude protein content of Chilean Needle Grass.

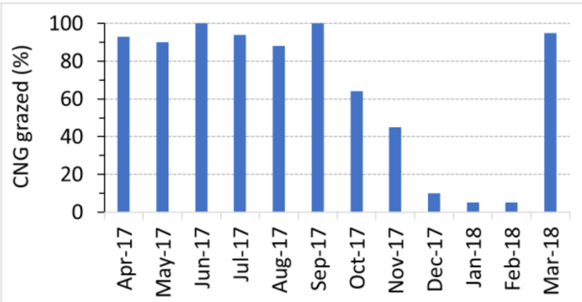

Figure 13: Frequency of grazed Chilean Needle Grass plants along the 250 m transect.

5 Discussion

5.1 Chilean Needle Grass control

It is now well established that invasive perennial grass weeds are difficult to control with eradication unlikely. With regards to CNG, utilisation is hampered by low palatability and seed contamination of sheep.

The results from this project have demonstrated that pasture topping with low rates of glyphosate reduced the number of seeding stems by about 95%. While CNG also contains seeds inside the stems and stem bases, these are expected to account for only 10% of total seed production (Grech, 2007) with most seeds contained in the aerial panicles born at the top of the seeding stems. Reducing seed production is an important aspect for controlling the spread of CNG as movement of seed by vehicles and livestock are the most likely means for spread of CNG plants. The producers managing sites D and E had the impression that these low rates of glyphosate had a negative effect on the growth rate of the other pasture species over the following few months.

In general, the quality and palatability of grass plants declines as they become reproductive and increase the proportion of stem. Despite pasture topping greatly reducing the number of seeding stems (see Figure 3 and 4), the producer member managing site D thought CNG remained unpalatable during subsequent grazing by yearling steers (280–320 kg) in January.

Selective control with flupropanate was difficult to achieve and the efficacy and persistency of treatment is thought to be affected by climatic and soil factors. While the number of CNG plants declined by an extra 40% above that of untreated control paddocks after two successive years of treatment, producers managing sites B and F were not enthusiastic about the progress made with reducing CNG populations. Furthermore, they were concerned that the higher rate of flupropanate had a negative effect on the non-target desirable pasture species (fescue, cocksfoot, clover). There was also concern among the producer group of the label withhold and restrictions following boom spraying with flupropanate.

Multiple applications with higher rates of glyphosate killed existing CNG plants but within nine months, CNG plants had re-established –presumably from soil seed reserves– at a density of approx. 4 plants/m^2. It is most likely that more CNG plants will establish and as these plants increase in size, once again become a major pasture component. The decision to adopt the practice of spraying and resowing is more to do with the likely financial gain rather than with long-term management of CNG populations.

The effects of slashing on palatability were not determined in this project but the producer who owns Site C believes the practice increases palatability and reduces seed contamination for weaned lambs. These apparent benefits are weighed against an estimated annual cost of $40/ha. The slashing is managed to reduce CNG plants to 4-6 cm above ground level. As such, slashing not only removes seeding stems but also a good proportion of the mature plant. The apparent positive effect on palatability of CNG contrasts with the lack of apparent effect following pasture topping. This is suggestive that palatability of CNG is a function of both reproductive state and maturity of foliage. Palatability of a feed to livestock is a difficult factor to reconcile within any group of producers, where opinions are typically mixed on this subject, and the science of feed preference indicates a complex but important role for prior grazing experience and a range of other livestock and management factors.

The key aspects of managing CNG include effective quarantine practices to reduce the spread of CNG onto the farm. Biosecurity practices that contain introduced livestock to known paddocks for at least one week and that prevent outside vehicle movements are important. When CNG already exists on a property, the next priority is to reduce its spread within the farm with focus on farm tracks, vehicles, stock movements and paddocks at the edge of any infestation. Pasture topping may have a role in reducing seeding and hence spread within the farm, but consideration needs to be given to the longer-term consequences for development of herbicide resistance. Grazing management to keep pastures healthy and productive through short graze periods, adequate rest periods and prevention of over grazing is also a key aspect for reducing the spread of CNG. This is likely to include consideration of the appropriate balance of sheep and cattle.

In summary

- If the property does not have CNG, try and keep it out with good quarantine and biosecurity practices.
- If there are manageable isolated patches of CNG, herbicides provide an option to control seeding and/or remove CNG. This will be an ongoing and long-term strategy given soil seed reserves over 3,000/m^2 have been reported (Grech, 2007). The use of GPS to locate patches

for annual inspections might be useful. Other practices, especially good grazing management will also keep other pasture species more productive with a thicker sward reducing the opportunity for new CNG plants to establish.

- If CNG is widespread, management will need to adapt to acknowledge that CNG is likely to be a permanent fixture. This will have implications for choice of livestock enterprises (i.e. cattle over sheep or breeding over finishing) and grazing management strategies. Those producer members with thick swards of CNG with few other pasture species, commented that high rates of utilisation are required to maintain palatability and production. While this might improve the value of CNG, it is likely to further select against other more desirable pasture species.

5.2 Project objectives

This project has greatly improved the knowledge and skills of producers (see Section 5.4) but it did not meet all of the initial objectives.

Objective: Nine producers in the Guyra region of the Northern Tablelands of NSW will have evaluated and, depending on results, adopted one of three control programs of CNG.

There were six producers who participated in the project. One producer withdrew after the first few meetings once they realised the likely difficulty in controlling CNG posed by the large soil seed reserve. Another producer was wanting to evaluate non-chemical approaches but was not able to identify a suitable strategy.

Objective: Increase stocking rate of sheep enterprises by at least 4 DSE/ha on affected areas; Increase gross margin by at least $140/ha on affected areas; Reduce CNG to less than 1 plant/100m2 at two years after control programs; Reduce the number of CNG seeding panicles by at least 75% and increase CNG growth rate and quality by 25% through utilization programs.

Pasture topping was demonstrated to reduce CNG seeding stems by over 90% but producer observations indicated little effect on subsequent palatability by livestock. CNG plant numbers remained above 1 per 100m^2 with little hope of achieving this target. Information on stocking rate and animal production from CNG was not able to be collected because of seasonal conditions. A very dry spring-summer in 2017-18 and then drought conditions in 2018-19 prevented any meaningful comparisons.

Objective: Implement a series of skills and training activities to increase the confidence of producer group members, and another 10 local producers, to implement CNG control programs.

Participating private and public agronomists attended group meetings and were able to extend information from the project. It is highly likely that they had a positive influence on at least 10 producers to increase knowledge and skills with managing CNG (see Section 5.4).

Objective: Conduct field days to showcase the results and encourage adoption of key practices by 80-100 producers in the region.

A Field Day was held at the conclusion of the project with 25 in attendance (20 producers). The presentation developed for the Field Day has been provided to Landcare and NSW Local Land Services networks to be used at Pasture Updates and to inform their information provided to producers. A producer fact sheet covering the key findings of the project is also being developed.

5.3 Regional influence and Field Day

Local private and public agronomists were invited members to all group meetings ensuring the project group benefited from their knowledge and allowing them to start a broader communication of project results during the project. A final Field Day attracted 25 attendees (6 producer members, 14 other producers, 5 agronomists) where results were presented and discussed. Producer members are now discussing an on-going role for the group to share knowledge and experience about managing CNG.

5.4 Knowledge and skills surveys

The survey responses from producer members (pre and post) and other producers (from final Field Day) are provided below. The area under the management of these producers was nearly 21,000 ha, supporting 10,640 cattle, 28,360 sheep and 1,100 goats. These livestock numbers are no doubt affected by the severely dry seasonal conditions.

The post project survey of core producer members indicated a large improvement in the knowledge of CNG seeding that is important in management decisions. For example, correct knowledge of:

- the likely size of the soil CNG seed reserve increased from 50% to 100% of core producers, whereas, 50% of observer producers had the correct knowledge.
- the rate of decline of the CNG soil seed reserve from 17% to 33% of core producers, whereas, none of the observer producers had the correct knowledge.
- the mode of spread for CNG seeds from 83% to 100% of core producers, whereas, 83% of observer producers had the correct knowledge.

Knowledge about herbicide withhold periods for flupropanate remained largely unchanged with:

- 67% of core producers having the correct knowledge about withhold periods after spot spraying with flupropanate. In comparison, 33% of observer producers had the correct knowledge.
- 50% of core producers having the correct knowledge about withhold periods after blanket application with flupropanate, whereas, 33% of observer producers had the correct knowledge.

Knowledge of withhold periods for flupropanate was generally associated with a producer having used flupropanate for the application purpose.

The survey also indicated core PDS group members had a better knowledge of these factors than other producers that attended the Field Day. While knowledge of CNG increased, there was a drop in confidence about cost effectively controlling CNG (pre = 4.3 and post = 3.8; 1-10 scale with 1 =lowest) and livestock productivity with CNG (pre = 6.0 and post = 4.5; 1-10 scale with 1 =lowest). Observer producers recorded average scores of 5.3 and 4.1 respectively, suggesting greater confidence in cost effective control of CNG and similar (low) confidence about consequences for livestock productivity. Discussions with core producers indicated the drop in confidence reflected a more realistic understanding of the difficulties with controlling and managing CNG than any adverse changes.

What was clear, was that the value of CNG as a livestock feed was perceived as being higher during drought years: with value (1-10 scale with 1 lowest) being ranked 3 (good years), 4 (average years) and 7 (drought years).

In terms of practice change, core producers indicated the following changes in the pre to post project surveys:

- Slash Chilean Needle Grass: increased practice by 1 of the 4 core producers not previously using this practice.
- Use low rates of glyphosate or other herbicides to pasture top Chilean Needle Grass: increased practice by 2 of the 4 core producers not previously using this practice.
- Use rates of glyphosate to kill Chilean Needle Grass prior to pasture/crop sowing: increased practice by 2 of the 2 core producers not previously using this practice but 1 core producer indicated they would no longer use this practice.
- Use rates of flupropionate to selectively remove Chilean Needle Grass: increased practice by 1 of the 4 core producers not previously using this practice.
- Use high stock density (> 400 DSE/ha): increased practice by 1 of the 4 core producers not previously using this practice.

Members	Producer F		Producer A		Producer B		Producer C		Producer D		Producer E		Total		Answers
	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	
Area (ha)	1024	1100	3000	5000	450	688	1812	1868	1100	1290	800	832	8186	10778	
Number cattle	1008	1300	2000	2200	1600	60	956	1230	1200	1400	200	200	6964	6390	
Number sheep	2400	1700	1000-7000	1300	1250	1800	5384	5460	2000	0	4500	3000	15534	13260	
Number goats	0	0	100	300	0	0	150	450	0	0	0	0	250	750	
What is the typical and main period in the year when Chilean Needle Grass sets seed?															
	Oct-Dec	Nov-Dec	Nov-Dec	Nov-Dec	Oct-Nov	Nov-Dec	Nov-Dec	Nov-Dec	Oct-Dec	Nov-Dec	Aug-Sep	Aug-Sep			Oct-Dec
The soil seedbank (seeds/m^2) of Chilean Needle Grass under a dense sward can be?															
	unsure	>3000	> 3000	> 3000	> 3000	> 3000	> 3000	> 3000	unsure	>3000	1000-2000	>3000			>3000
Without any new additional seeds, the soil seedbank of Chilean Needle Grass declines at what approximate rate each year?															
	10%	10%	10%	30%	10%	40%	40%	10%	unsure	40%	10%	10%			40%
Seeds of Chilean Needle Grass are typically spread via?															
	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock	Stock & vehicle			Stock & vehicle
If using spot spraying of flupropanate to control Chilean Needle Grass how long a period must elapse before stock can be grazed on the area?															
	14 days	14 days	unsure	21 days	14 days	14 days	14 days	unsure	unsure	14 days	14 days	14 days			14 days

If using a blanket application of flupropanate to control Chilean Needle Grass how long a period must elapse before stock can be grazed on the area?															
	4 months	4 months	unsure	3 months	4 months	3 months	4 months	unsure	unsure	4 months	4 months	4 months			4 months
How confident are you in cost-effectively controlling Chilean Needle Grass?													Average		
	5	5	6	3	4	8	1	5	3	1	7	1	4.3	3.8	
Do you currently use the following practices as an aid to control Chilean Needle Grass?															
Slash	no	no	no	no	yes	yes	yes	yes	no	yes	no	no			
Use low rates of glyphosate or other herbicides to pasture top	no	no	no	no	yes	yes	yes	yes	no	yes	no	yes			
Use rates of glyphosate to kill prior to sowing	yes	yes	yes	yes	yes	no	yes	yes	no	yes	no	yes			
Use rates of flupropanate to selectively remove	yes	yes	no	no	no	yes	no	no	no	no	yes	yes			
Use high stock density (> 400 DSE/ha)	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes	yes			
How confident are you in your knowledge of the livestock productivity that Chilean Needle Grass can support?													Average		
	7	5	9	6	4	4	9	5	4	3	3	4	6.0	4.5	

How valuable is Chilean Needle Grass as a livestock feed for you during:													Average	
good seasonal years		3		3		4		3		3		1	2.8	
average seasonal years		5		6		5		5		3		3	4.5	
drought years		7		10		2		9		8		8	7.3	

Non-member producers	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Total**	**Answers**
Area (ha)	1200	1200	2000	1200	4000	223	360	10183	
Number cattle	700	300	1000	0	1500	400	350	4250	
Number sheep	0	3000	1300	7000	3500	300	0	15100	
Number goats	350	0	0	0	0	0	0	350	
What is the typical and main period in the year when Chilean Needle Grass sets seed?	Nov/Dec	Nov/Dec	Nov/Dec	Oct/Nov	Oct/Nov	Nov/Dec			Oct-Dec
The soil seedbank (seeds/m2) of Chilean Needle Grass under a dense sward can be?	1000-2000	100-500	2000-3000	100-500	> 3000	> 3000	> 3000		>3000
Without any new additional seeds, the soil seedbank of Chilean Needle Grass declines at what approximate rate each year?	20%	10%	20%	20%	10%	20%			40%
Seeds of Chilean Needle Grass are typically spread via?	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock & vehicle	Stock & vehicle	stock	Stock & vehicle		Stock & vehicle
If using spot spraying of flupropanate to control Chilean Needle Grass how long a period must elapse before stock can be grazed on the area?	unsure	unsure	1 day	14 days	unsure	21 days	14 days		14 days

If using a blanket application of flupropanate to control Chilean Needle Grass how long a period must elapse before stock can be grazed on the area?	unsure	unsure	1 month	2 months	4 months	3 months	4 months		4 months
How confident are you in cost-effectively controlling Chilean Needle Grass?	7	2	7	7	5	5	4	Average = 5.3	
Do you currently use the following practices as an aid to control Chilean Needle Grass?									
Slash	no	N/A	yes	no	no	no	N/A		
Use low rates of glyphosate or other herbicides to pasture top	no	N/A	yes	no	no	no	yes		
Use rates of glyphosate to kill prior to pasture/crop sowing	no	N/A	yes	no	no	no	yes		
Use rates of flupropanate to selectively remove	no	N/A	yes	yes	no	yes	yes		
Use high stock density (> 400 DSE/ha)	yes	N/A	yes	N/A	yes	no	no		
How confident are you in your knowledge of the livestock productivity that Chilean Needle Grass can support?	8	2	1	2	6	5	5	Average = 4.1	
How valuable is Chilean Needle Grass as a livestock feed for you during:								Average	
good seasonal years	3		don't know	2	2	1	5	2.6	
average seasonal years	5		don't know	2	4	1	2	2.8	
drought years	8		don't know	2	6	1	2	3.8	

6 Conclusions/recommendations

- The key aspects of managing CNG include:
  - effective quarantine practices to reduce the spread of CNG onto the farm.
  - when CNG already exists on a property, the next priority is to reduce its spread within the farm with focus on farm tracks, vehicles, stock movements and paddocks at the edge of any infestation.
  - if CNG is widespread, management will need to adapt to acknowledge that CNG is likely to be a permanent fixture.

- The results from this project have demonstrated that pasture topping with low rates of glyphosate reduced the number of seeding stems by about 95%. Reducing seed production is an important aspect for controlling the spread of CNG as movement of seed by vehicles and livestock are the most likely means for spread of CNG plants.

- Two successive years of selective control with flupropanate led to a 40% decline in the number of CNG plants but producers managing these sites were not enthusiastic about the progress and had concerns about negative effects on the non-target desirable pasture species.

- Multiple applications with higher rates of glyphosate killed existing CNG plants but within nine months, CNG plants had re-established –presumably from soil seed reserves– at a density of approx. 4 plants/m2. The decision to adopt the practice of spraying and resowing is more to do with the likely financial gain rather than with long-term management of CNG populations.

- Where herbicides form part of CNG control, withholds and restrictions stated on product labels should be closely followed.

- Future R&D on CNG should focus on ways to improve the palatability of CNG by livestock as this is a key factor in being able to utilise the plant.

7 Bibliography

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