

Integrated weed management of creeping grasses in sugarcane



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INTRODUCTION & CONTROL SUMMARIES

Introduction

Creeping grasses pose a serious problem in the South African sugar industry and, in extreme cases, can lead to complete crop failure.

This booklet describes sixteen control tactics for creeping grasses, with a description of the circumstance where each tactic is suitable. These are summarised for easy reference in tables having different weed densities. These tactics are more effective when employed in selected combinations. An Integrated Weed Management (IWM) programme uses appropriate combinations of cultural, mechanical, and chemical control tactics and is important for successful weed management. Decisions on particular combinations must take into account percentage of weed cover, harvest date, potential yield, cost of control tactic and resources available.

A large scale creeping grass management plan for the whole farm will identify fields that should be prioritised for treatment and allocate appropriate combinations of tactics, thereby allowing implementation of an IWM programme. With this approach, while it may not be practical to eradicate all creeping grasses on the farm, it is possible to manage them to below economic threshold levels.



Summary tables of control tactics

The tables that follow show which creeping grass control tactics can be used to manage various scenarios based on the density of the grass infestation (%weed density) and situation in which it occurs.

1-10% weed density

Page	CONTROL TACTIC	In fallow field due for replanting	In short cane	In tall cane	Harvest	On field verge/edge
14	Tactic 1: Hand hoeing		X			X
15	Tactic 2a: Field hygiene: hand weed/spot spray tall weeds		X		X	
15	Tactic 2c: Field hygiene: selective use of kraal manure	X				
15	Tactic 2d: Field hygiene: use clean seedcane	X				
18	Tactic 6: Minimum tillage	X				
20	Tactic 8: Promoting rapid shading	X				
23	Tactic 11: Mulch cover after glyphosate	X			X	
27	Tactic 12b: Glyphosate for spot-spraying	X	X shield		X	X
31	Tactic 14: Fluazifop-butyl (grass with broken/cut runners)	X	X shield			
32	Tactic 15a + 15c: Paraquat + surfactant or diuron		X shield			X
32	Tactic 15b: Paraquat +surfactant to rejuvenate grass		X shield		X	X
33	Tactic 16: Glufosinate ammonium		X shield		X	X

11-20% weed density

Page	CONTROL TACTIC	In fallow field due for replanting	In short cane	In tall cane	Harvest	On field verge/edge
14	Tactic 1: Hand hoeing		X			
15	Tactic 2: Field hygiene: hand weed/spot spray tall weeds		X		X	
15	Tactic 2: Field hygiene: clean vehicles, boots, implements	X	X		X	X
15	Tactic 2: Field hygiene: selective use of kraal manure	X				
15	Tactic 2: Field hygiene: use clean seedcane	X				
16	Tactic 4a: Burning to rejuvenate moribund grass	X			X	
18	Tactic 6: Minimum tillage	X				
19	Tactic 7: Managing fertiliser		X			
20	Tactic 8: Promoting rapid shading		X			
21	Tactic 9: Barrier plants					X
23	Tactic 11: Mulch cover after glyphosate				X	
27	Tactic 12b: Glyphosate for spot-spraying	X	X shield or dribble bar	X floodjet or dribble bar	X	X floodjet or dribble bar
31	Tactic 14: Fluazifop-butyl (grass with broken/cut runners)	X	X shield			
32	Tactic 15a + 15c: Paraquat + surfactant or diuron		X shield			X
32	Tactic 15b: Paraquat to rejuvenate grass		X shield			
33	Tactic 16: Glufosinate ammonium		X shield		X	X

21-40% weed density

Page	CONTROL TACTIC	In fallow field due for replanting	In short cane	In tall cane	Harvest	On field verge/edge
14	Tactic 1: Hand hoeing		✓			
15	Tactic 2: Field hygiene: hand weed /spot spray tall weeds		✓		✓	
15	Tactic 2: Field hygiene: clean vehicles, boots, implements	✓			✓	✓
15	Tactic 2: Field hygiene: selective use of kraal manure	✓				
15	Tactic 2: Field hygiene: use clean seedcane	✓				
16	Tactic 4: Burning to rejuvenate moribund grass	✓			✓	
18	Tactic 6: Minimum tillage	✓				
19	Tactic 7: Managing fertiliser		✓			
20	Tactic 8: Promoting rapid shading		✓			
21	Tactic 9: Barrier plants					✓
23	Tactic 11: Mulch cover after glyphosate				✓	
27	Tactic 12b: Glyphosate for spot-spraying	✓	✓ shield or dribble bar			✓ floodjet or dribble bar
31	Tactic 14: Fluazifop-butyl (grass with broken/cut runners)	✓	✓ shield			
32	Tactic 15a + 15c: Paraquat + surfactant or diuron		✓ shield			✓
32	Tactic 15b: Paraquat to rejuvenate grass		✓ shield			
33	Tactic 16: Glufosinate ammonium		✓ shield			

41-60% weed density

Page	CONTROL TACTIC	In fallow field due for replanting	In short cane	In tall cane	Harvest	On field verge/edge
15	Tactic 2: Field hygiene: hand weed/spot spray tall weeds	X	X		X	
15	Tactic 2: Field hygiene: clean vehicles, boots, implements	X	X		X	X
15	Tactic 2: Field hygiene: selective use of kraal manure	X				
15	Tactic 2: Field hygiene: use clean seedcane	X				
16	Tactic 4: Burning to rejuvenate moribund grass	X			X	
18	Tactic 6: Minimum tillage	X				
19	Tactic 7: Managing fertiliser		X			
20	Tactic 8: Promoting rapid shading		X			
22	Tactic 10: Cover crops	X				
21	Tactic 9: Barrier plants					X
23	Tactic 11: Mulch cover after glyphosate				X	
25	Tactic 12a: Glyphosate fullcover spray	X	X Patches only	X		X
31	Tactic 14: Fluazifop-butyl (grass with broken/cut runners)	X				
32	Tactic 15a + 15c: Paraquat + surfactant or diuron		X shield			X
32	Tactic 15b: Paraquat to rejuvenate grass		X shield			
33	Tactic 16: Glufosinate ammonium		X shield		X	X

61-100% weed density

Page	CONTROL TACTIC	In fallow field due for replanting	In short cane	In tall cane	Harvest	On field verge/edge
16	Tactic 3: Mowing					X
15	Tactic 2: Field hygiene: hand weed/spot spray tall weeds		X		X	
15	Tactic 2: Field hygiene: clean vehicles, boots, implements	X	X		X	X
15	Tactic 2: Field hygiene: selective use of kraal manure	X				
15	Tactic 2: Field hygiene: use clean seedcane	X				
16	Tactic 4: Burning to rejuvenate moribund grass	X			X	
17	Tactic 5: Herbicide + Autumn shallow tillage	X				
18	Tactic 6: Minimum tillage	X				
19	Tactic 7: Managing fertiliser		X			
20	Tactic 8: Promoting rapid shading		X			
22	Tactic 10: Cover crops	X				
21	Tactic 9: Barrier plants					X
25	Tactic 12a: Glyphosate full-cover spray	X		X		X
29	Tactic 12c: Glyphosate for cut-back tactic		X			
30	Tactic 13: Arsenal GEN 2 [®] (four months + 600 mm rain before planting)	X				
31	Tactic 14: Fluazifop-butyl (grass with broken/cut runners)	X				
32	Tactic 15a + 15c: Paraquat + surfactant or diuron		X shield			X
32	Tactic 15b: Paraquat to rejuvenate grass		X shield			
33	Tactic 16: Glufosinate ammonium		X shield		X	X



INTEGRATED WEED MANAGEMENT

Integrated weed management

Odero (2017) describes integrated weed management (IWM) as using numerous alternative weed control measures, including cultural, mechanical, biological, and chemical options while maintaining economical yields and reducing reliance on a single control option.

Significant weed control is achieved when various components of IWM are implemented in a systematic manner. This enhances the competitive ability of the crop and also provides adequate weed control. Because no single weed control tactic is effective in sugarcane cultivation, an IWM programme that combines appropriate tactics is important for successful weed management. Such programmes should be effective in preventing and suppressing growth, seed production, spread of weeds and also reducing seed bank reserves.

To encourage adoption, all components of IWM programmes in sugarcane must be practical, sustainable, cost effective, and environmentally safe.

Pages 13 - 31 of this book describes a range of control tactics and their appropriate selection for different weed situations. IWM strategies are developed by combining appropriate tactics that are appropriate for fields with a similar creeping grass situation. For example, 61-100% weed density in fallow fields due for replanting will require a different IWM strategy from fields having the same density but with short cane. This section deals with integrating these IWM strategies into a farm-scale integrated weed management plan.

Terminology used in this book:

Terms	Definitions	Scale
<i>Control tactic</i>	Single operation.	Field
<i>Strategy</i>	Combination of appropriate control tactics.	Field
<i>Plan</i>	Farm-scale combination of appropriate strategies.	Farm

Developing a farm-scale IWM plan

The biggest problem with creeping grass control is one of scale, thus while it may be fairly easy to manage a single hectare, it is much more difficult if the infestations cover more than ten hectares.

Chances of success are improved if a creeping grass management plan is devised for the whole farm. A farm-scale approach takes into account field and crop characteristics together with the cost: benefit ratios of each control tactic. This integrated approach systematically allocates resources to high priority fields, while maintaining the *status quo* in low priority fields, hence halting further spread.

The steps involved in developing a farm-scale IWM plan for creeping grasses are described on the next page.

Odero C (2017). *Integrated Weed Management in Sugarcane Cultivation in Achieving sustainable cultivation of sugarcane*. Prof. Philippe Rott (Ed). Published by Burleigh Dodds Science Publishing. CH28

Example of a six-step guide to prepare a farm-scale IWM plan for creeping grasses.

STEP 1	<p>Compile a list of field, crop and weed attributes:</p> <ul style="list-style-type: none"> • Field details: soil type, field topography, slope, water-logged/saline areas. • Crop details: variety, age, height, plant population, patches with poor population, harvest date, yields (actual and potential). • Weed details: grass type, percentage coverage, vigour. <p>These details should be plotted on a map of the farm. GIS software would be useful for this exercise.</p>
STEP 2	<p>Compile a list of resources available:</p> <ul style="list-style-type: none"> • Equipment. • Labour. • Details of irrigation system, if applicable.
STEP 3	<p>Assign control tactics to each field based on:</p> <ul style="list-style-type: none"> • Field, crop and weed attributes • Resources available.
STEP 4	<p>Conduct a cost:benefit evaluation for each control tactic:</p> <ul style="list-style-type: none"> • Cost: chemical, labour, water, tractor, equipment, treatment damage to crop. • Benefit: from increased yield, according to soil potential.
STEP 5	<p>Group and prioritise fields for treatment, taking into account:</p> <ul style="list-style-type: none"> • Field, crop and weed attributes. • Cost:benefit ratios (focus on fields where the expected return on investment is highest). - High priority fields typically have low-density infestations, or are due for replant. - Medium priority fields have relatively low grass cover or have high potential yields but with dense grass cover. - Low priority fields have dense infestations on marginal soils or are fallow fields.
STEP 6	<p>Plan follow-up control tactics:</p> <ul style="list-style-type: none"> • Based on expected amount of surviving regenerated vegetative material. • Annual maintenance control involves treatment of low levels of infestation (high priority) and appropriate treatment of other weeds.






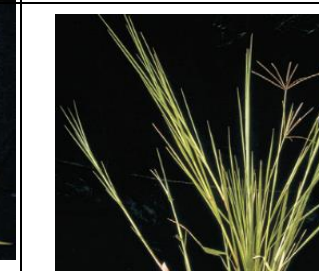
An example of a farm-scale IWM plan for creeping grasses using a digitised farm map is shown below. The map shows details of the (1) field category, (2) field priority for control, (3) control tactics, and (4) combination of control tactics (strategy) and their sequence within each field category. For example, yellow fields are priority 1 for control with repeated glyphosate spot sprays with shields until canopy forms.

Field category (see map)	Priority for control	Control tactics				
		Operation				
Short ratoon cane with < 10% Cynodon	1	●	●	●	●	●
Short ratoon cane with 10-40% Cynodon	2	●	●	●	●	●
Tall ratoon cane with 63-100% Cynodon	4	●	●	●	●	●
After green cane harvesting 15% Cynodon in patches	1	●	○	●	●	●
Minimum tillage with 41-60% Cynodon	3	●	●	●	●	●
Autumn shallow tillage with 100% Cynodon, slope <10%	3	●	●	●	●	●
Short ratoon cane with 0% Cynodon	1	●	●	●	●	●
Long fallow field with persistent 100% Cynodon	5	●	●	●	●	●
Fallow fields with moribund Cynodon and tall weeds	5	●	●	●	●	●
Drought stressed carry-over cane with 30% Cynodon	3	●	●	●	●	●
Cane breaks and verges around all fields	1	●	●	●	●	●



- Paraquat + diuron or paraquat + surfactant or glufosinate ammonium
- Apply glyphosate or paraquat+diuron or imazapyr or handweed or plant Melanis
- Hoe edges of patches inwards
- Glyphosate full cover spray
- Cover with mulch residues
- Slash, allow weeds to dry then burn to rejuvenate grass
- Autumn shallow tillage (after glyphosate application), cold dry winter
- Practice field hygiene, protect the field from other infestations
- Repeated glyphosate spotsprays with shields until canopy forms or mulch
- Apply Arsenal GEN 2. NB FOLLOW USE RESTRICTIONS ON LABEL

Identification chart and growth characteristics of the three creeping grasses affecting South African sugarcane-growing regions

Characteristic	<i>Cynodon dactylon</i> (Cynodon, kweek, ngwengwe)	<i>Digitaria abyssinica</i> (Digitaria, Dunn's fingergrass/vingergras)	<i>Cynodon nlemfuensis</i> (Stargrass, reusekweekgras)
Growth habit			
			
Presence of rhizomes	Perennial which has stolons (above ground stems) and rhizomes (below ground stems).	Perennial with stolons and rhizomes.	Perennial with stolons ONLY. No rhizomes. Sometimes confused with <i>Cynodon dactylon</i> . Check for absence of rhizomes. The flower-head is like a hand/star.
Spreadability	Rhizomes can penetrate 40-50 cm in clay soil and 70-80 cm in sand. The foliage is dense, normally 10-40 cm tall.	Rhizomes form a dense mat beneath the soil surface, extending to depths greater than 1 m, with densities of 220 m of rhizome/m ² which may twine around the roots of perennial crops.	Fibrous, resilient woody stolons that survive ploughing and can spread for 5 m or more on the soil surface. The foliage is dense, and can be up to thigh height.
Other characteristics	<ul style="list-style-type: none"> Considered the worst weed in all areas. Can kill newly planted cane that struggles to form canopy. Yield loss can be between 10 and 80% Affects all sugarcane growing regions in South Africa. 	<ul style="list-style-type: none"> Considered a biosecurity risk in South Africa. Found mainly in sugarcane which was originally planted as a pasture. Yield loss can be between 10 and 100% Found mostly in Midlands South and North Coast regions but can affect all bioclimatic regions of the SA sugarcane industry. 	<ul style="list-style-type: none"> Considered the worst by some farmers due to rampant spread. Stands improve with cultivation. More easily controlled with herbicide (e.g. glyphosate) than digitaria and cynodon Found in all bioclimatic regions of the SA sugarcane industry.



CONTROL TACTICS

Tactic 1: Hand hoeing

a) Field verges

Creeping grasses in cane breaks and on roadsides invade fertile fields, especially if there is young or stressed cane with no canopy and thus no dense shade.

Prevent encroachment into fields from roads and cane breaks by hoeing the verges outwards from the last 5 m of cane row. Repeat hoeing every 3-4 weeks. DO NOT throw discarded creeping grass runners into fields during hand-weeding operations.



b) In-field patches

Before rain, when in-field patches of grass are brown (and with no active growth) herbicides cannot yet be applied as there will be no absorption into stems and leaves. This situation is generally seen in stressed cane, after burning and harvest, or in short cane during dry conditions. However, as soon as there is some moisture, cynodon runners spread out rapidly from in-field patches to invade nearby cane rows. Stargrass and digitaria also spread rapidly. Digitaria is considered the most competitive, with vigorous spreading from both above- and below-ground runners.

After harvest, hoe edges of patches inwards towards the centre to prevent further rapid spread into cane. Repeat as required until the grass has plenty of vigorous top growth for chemical control. Inspect regularly, especially after rain.



A one-metre wide strip was hoed inwards towards each digitaria patch and away from the cane.

Cautionary note

Hand hoeing is labour intensive and therefore only suitable where there are light grass infestations and smaller fields. Consider chemical control options if too much labour is required.

Avoid hand-weeding in situations other than those described above as this can lead to more vigorous grass growth.

Tactic 2: Field hygiene

Expose creeping grasses and prevent spread via runners and seed.

a) *Control tall weeds*

Tall weeds such as uBabe grass, sorghum and conyza/fleabane/umthithimbili intercept spray and shield low-growing creeping grasses from herbicide treatment.

Hand weed or spot-spray tall weeds to create a uniform stand before spraying the grass. This allows the spray solution to reach runners and reduces 'missed' patches of creeping grasses. Refer to the Herbicide Guide or consult an agrochemical representative for the appropriate chemicals to control tall weeds.

b) *Clean vehicles, footwear and implements*

Creeping grasses spread mainly by vegetative means, with runners spreading sideways. However, broken pieces of the grass can easily be spread further afield by vehicles. A disc harrow is the implement most likely to spread runners. In addition, seeds could be transported by mud on vehicle wheels and have previously been found on moist boots of field workers. Although germination % is low, some of these seeds are viable and can spread the species to clean fields.

Inspect and clean vehicles and implements regularly to prevent spread of runners into clean fields. Make sure that field workers clean boots and clothing before moving to a new field. Avoid tillage operations spreading runners away from localised patches inside a field. Rather isolate patches and manage separately from the rest of the field.



c) *Select field manure*

It is possible that cattle feeding on creeping grass could increase the spread via grass seeds which survive the digestive process and pass through in the cattle's manure. Application of this new kraal manure could result in new/further infestations.

Apply kraal manure that has been treated at high temperatures e.g. steam during processing, on clean fields. Alternatively consider using chicken litter.

d) *Use clean seedcane*

Runners or seed can be spread at the time of replant through seedcane imported from fields where creeping grasses are present. Plant seedcane from clean fields to avoid spread of runners.

Tactic 3: Mowing

Field verges

Creeping grasses in cane breaks and on roadsides invade fertile fields, especially if there is young or stressed cane with no canopy and thus no dense shade.

By mowing field edges, developing seed heads are cut off thus preventing spread by seed. Repeat mowing operations every 3-4 weeks.

Cautionary note

Mowing disrupts apical dominance and can encourage sideways spreading of runners towards fields. Consider chemical application on field verges to avoid spread into fields.



Tactic 4: Burning

- a) *Dense lank or moribund grass* with mostly brown leaf and stem material will not absorb systemic herbicides like glyphosate.

Burning is recommended to rejuvenate moribund grass and promote young green shoots above the soil. This will allow effective chemical control with a systemic herbicide, once sufficient leaf and stem material is formed.

- b) *During the harvest of cane fields*, burning will kill off any dormant and dead grass thus allowing for rejuvenation of the grass, with new young shoots emerging during seasonal rains. It must be noted that the grass will recover and grow faster than the crop.

Apply timely herbicide applications to prevent spread of runners. While some delay in timing of herbicide application is necessary to allow sufficient above-ground grass growth, the risk of crop yield loss due to herbicide damage becomes a problem. Too long a delay before treatment results in spreading grass runners. Repeated spot-spray operations are normally used to prevent spread of these runners.

- c) *Fields that have been left fallow during the autumn and winter season*, will have grass that is not actively growing or with only limited growth. In this instance, mow, dry out and burn weed material to expose creeping grass runners for herbicide application during the first spring rains.



Tactic 5: Autumn shallow tillage after glyphosate

Tillage with ploughs, disc harrows, ripping etc. will bury cynodon and digitaria runners and spread them through-out the field, especially in the direction of the cultivation. Although stargrass has no rhizomes, stolons do spread and can survive shallow tillage. Use shallow tillage on slopes <10% and only when there is 100% grass cover in the field to avoid spreading runners throughout the field.

Rhizomes with delayed emergence will be protected from glyphosate herbicide applications, which has no/very limited soil action. To avoid this, first apply glyphosate and wait for the full effect. Consider using a vibrating tined rotivator to break up grass mats and bring rhizomes to the surface. Till in autumn (reduced erosion risk) to allow cold dry winter weather to dry out excavated rhizomes. Wait for regrowth to have abundant new foliage above the soil surface to absorb systemic herbicides like glyphosate.



Use a vibrating tined rotivator twice in autumn, to break up sprayed grass runners and excavate rhizomes.

Tillage after glyphosate will break up runners and gather them into heaps at the edge of the field. A cold dry winter will kill much of the exposed root material. Spot-spray regrowth with glyphosate as required.



Tactic 6: Minimum tillage with long fallow

Minimum tillage can be used on all slopes in fields with 1-100% cynodon coverage. Minimum tillage with glyphosate kills both old cane stools and cynodon. This tactic reduces the risk of burying runners that have delayed emergence.

Hand-weed tall weeds to create a uniform stand of cynodon. When grass is actively growing, kill both cane and cynodon with a registered systemic herbicide. Cane should be around knee height – any taller and it shades out cynodon, any shorter and there is not enough leaf area to absorb herbicide. Thus apply herbicide when the cane is fully tillered. Ensure good coverage of cynodon and old cane stools. 'Mop up' any missed patches with a second application (if required) at four to-eight weeks after the first application.

Alternative herbicides for minimum tillage:

- Glyphosate
- Fluazifop-butyl
- Arsenal GEN 2® (with use restrictions).

For a combination of tillage tactics (chemical + mechanical methods) refer to SASRI Information Sheet 6.17 Minimum tillage.

Cane stool eradication and chemical control of severe cynodon infestations over the summer period), MUST be followed by a long enough fallow to allow at least four repeated glyphosate spot-spray and chemical roguing operations. In many instances, especially if over the winter period, this fallow should be longer, with additional repeat glyphosate spot-spray operations in spring.

A long fallow period allows repeated glyphosate spot-spray applications for late-emerging grass runners and the option of growing cover crops to increase soil health.

NB: DO NOT replant until regrowth has been drastically reduced to less than 1% coverage. Any regrowth must be treated after each harvest to prevent spread.



A long fallow gives the opportunity for multiple glyphosate spot sprays. This is very effective to treat any surviving growth.

Tactic 7: Manage fertiliser

Applying fertiliser promotes rapid growth of all three grasses. Therefore the management of fertiliser application is important in fields.

Follow FAS recommended rates. Do not over-apply nitrogen fertiliser as this stimulates growth of creeping grasses and increases their aggressive competitive growth.

In fields where there is no cynodon, broadcast application of fertiliser is an acceptable practice.

In fields with medium-dense cynodon cover, the recommendation is a directed band application on the cane row, avoiding inter-row application.

Banded application of a nematicide on the cane row on sandy soils will ensure a better root system enabling fertiliser uptake and more rapid cane canopy development.



Directed band application.



Broadcast application.

Tactic 8: Promoting rapid shading

Shade is a very powerful tool to combat creeping grasses and reduce their competitive pressure.

Cynodon thrives in sunlight, especially in high humidity and fertile soils. It is highly sensitive to shade.

Stargrass also grows best in sunlight and cannot grow in shade. Above-ground stolons spread many metres to find light gaps in the crop.

Digitaria is probably not as shade sensitive as the other two species. It has underground (rhizomes) and above-ground stolons/runners that grow faster than cane, grow through and above cane, and can pop out of the ground if there are gaps in the rows, emerging to further strangle the cane.



Poor cane canopy development means no shade and allows vigorous growth of creeping grasses.

Creeping grasses have thrived in reduced shade and more frequent exposure to light caused by the shortened harvesting cycles (from 18 to 12 months) used in the KwaZulu-Natal North Coast Region (Stranack 2017). Poor cane canopy development also means no shade, allowing vigorous growth of creeping grasses.

Recommendations for shading

Shading creeping grasses for as long as possible is a very powerful tool to reduce competition. Strong recommendations are:

- Wherever possible, adopt longer harvesting cycles, provided eldana is effectively controlled.
- Promote healthy cane growth, and therefore shade by (among other practices):
 - a) draining waterlogged soils of excess water,
 - b) avoiding over- and under-irrigation,
 - c) restoring plant population by “gap filling” areas where cane has died,
 - d) addressing fertiliser and micro-nutrient issues,
 - e) addressing saline and sodic soils or patches in fields,
 - f) addressing soil pH especially in soils with very low pH,
 - g) controlling pests and diseases on all soils,
 - h) addressing nematode infestations on sandy soils.
- Where several varieties are deemed to be suitable for your growing conditions, consider selecting those with growth characteristics that allow rapid and dense canopy formation.
- This selection will more effectively shade out creeping grasses and reduce competition, thereby allowing yields to approach potential.
- Where practical, consider using narrow row spacing for quicker shade.

Stranack 2017: Personal communication. SASRI North Coast Extension Specialist from 1986 to 2010

Tactic 9: Barrier plants

Creeping grasses in cane breaks and on roadsides invade fertile fields, especially if there is no dense shade. A high level of management is needed for field edges, with timely inspections and treatment. Failure to do this, especially in wet seasons, will result in encroachment into fields.

Barrier plants such as Molasses Grass/Melinis (*Melinis minutiflora*) is an indigenous African grass that is recommended as part of the IPM strategy for eldana control (a major pest in sugarcane). An established melinis hedge also forms an effective barrier to prevent invasion of creeping grass runners into fields.

Melinis grows best in well-drained soils and in a sunny position. It is not a particularly competitive grass and does not pose the risk of becoming a weed species. It is not a host plant for any sugarcane pests and it shades out creeping grasses.

Establish melinis grass plugs on the edges of cane fields and promote growth to form a dense hedge. *Cynodon* does not grow through the hedge, while stargrass actively grows away from it. *Digitaria*, however, grows under or over the hedge and can still invade the crop. Melinis is fire-sensitive and will require brush-cutting prior to burning. However, it is perennial and will regenerate.



Melinis minutiflora forms an effective barrier hedge that pushes out cynodon on field edges.

Tactic 10: Cover crops

Some soils can be low in organic matter. Soil health can deteriorate progressively if a monoculture crop like sugarcane is continuously present in a field.

A weed fallow can be adopted, but pay attention to grasses and broadleaf weeds that form large plants with seeds. Seeds can be dispersed to other fields by wind (e.g. fleabane/umthithimbili) or birds (e.g. uBabe grass). Creeping grasses will spread through the field, mainly by vegetative runners, especially where there are light gaps in the weed cover. Spot-spray creeping grasses in a weed fallow to prevent spread.

Avoid monoculture farming. Rotate crops.

- The value of crop rotation with broad-leaved crops (e.g. vegetables) provides the opportunity to actively control creeping grasses with selective herbicides (e.g. fluazifop-butyl) and hand hoeing.
- The value of crop rotation with "Roundup Ready" crops such as soybeans, maize and cotton provides an opportunity for multiple applications of registered glyphosate formulations for creeping grass control (be aware that some weeds can develop resistance to continual glyphosate use).

A winter green manure like Black oats (*Avena strigosa*) provides shade and are allelopathic, i.e. they have chemicals that inhibit creeping grasses (picture on right). Oats may be planted in fallow fields after controlling cane and creeping grasses treated with glyphosate or fluazifop-butyl (e.g. Fusilade Forte Hitech®) but not with Arsenal GEN 2®.



Summer green manure crops like Sunn hemp (*Crotalaria juncea*) and Velvet Beans (*Mucuna pruriens*) provide dense shade. Refer to SASRI's Green Manuring manual for suitable summer and winter green manure crops and other details pertaining to green manuring.

These crops provide dense shade and suppress *Cynodon*. The photo below shows cover crops mown in March and their residues left to decompose on the soil surface. Oats may be planted during April to provide a soil cover in winter months. **NB:** prevent velvet beans seeding in the field.



Velvet beans.



Mow cover crops and leave residues to decompose.

Tactic 11: Mulch cover after glyphosate

For creeping grasses, a mulch blanket will block out light and provide shade. It also provides organic matter and reduces soil water evaporation losses which is good for root survival in the crop. Unfortunately, this also benefits root survival of creeping grasses.

- Use cane residues to shade out **treated/sprayed** cynodon only if it is practical and economic.
- DO NOT apply mulch residues to digitaria as it has been found to assist spread in a field.
- **Before** applying a mulch blanket, apply glyphosate or paraquat + surfactant or paraquat + diuron to cynodon foliage to stress leaf and stem material and avoid reserves building up in roots.
- **After** applying a mulch blanket, inspect the field every 2-4 weeks for gaps in the mulch cover and apply repeat spot sprays to emerging cynodon with glyphosate or paraquat + surfactant.
- When the soil surface is covered with residue in winter, there is more time to treat cynodon because of slow growth of cane stools.



Spray cynodon to weaken it, then cover with a mulch blanket to block out light and further stress the plant.



Herbicide resistance

What is herbicide resistance?

Any weed population may contain individuals naturally resistant to herbicide. Resistance develops after repeated applications of a single herbicide or herbicides with the same mode of action. Individual plants may eventually dominate the weed population if a herbicide is used repeatedly and exclusively in control programmes.

How can I avoid creeping grasses developing herbicide resistance?

New herbicide labels now provide information on the mode of action of the formulation. The modes of action for registered herbicides for cynodon control are given below:

ACTIVE INGREDIENT	MODE OF ACTION
Fluazifop-butyl	A
Imazapyr	B
Diuron + Paraquat	C + D
Glyphosate	G
Glufosinate Ammonium	H

If herbicide resistance does develop in creeping grasses, it would be most likely to occur on field verges. However, this is considered unlikely due to common practice of using chemicals with different modes of action.

To avoid developing herbicide resistance in creeping grasses and other weeds, practice the following:

1. Rotate herbicides or use tank mixtures which contain products that have different modes of action.
2. Integrate other control methods (chemical, mechanical, cover crops) into weed control programmes.
3. Keep accurate spraying records for each field and give reasons for poor efficacy.
4. Apply herbicides according to label recommendations (correct rates and application to young vigorous growth).
5. Ensure that equipment is properly calibrated. Do not reduce the recommended rates or experiment with your own cocktails.
6. Ensure good water quality for effective control.



Systemic herbicides

Systemic products are absorbed by roots and/or foliage and move throughout the weed.

Tactic 12: Glyphosate

a) Fallow fields, under-canopy spraying and field verges

Glyphosate is effective for creeping grass management, and provides control for up to 12 weeks after treatment of actively growing grass (with plenty of green leaf and stem material to absorb herbicide). However, glyphosate application carries a very high risk of killing or severely damaging the cane crop, and requires a high level of management. This risk can be reduced in growing cane by using suitable shields or by under-canopy sprays in tall cane with dead leaves on lower stems, or by restricting use to fallow fields and field edges, where there is no growing crop. Glyphosate has no/very little residual soil activity so the period of control is short. Avoid using glyphosate in growing cane unless a high level of management is possible.

If glyphosate is selected for use, the following is recommended:

- Spray green actively growing grass in warmer temperatures with high humidity, and after good rainfall. This allows for more herbicide to be absorbed. Midlands's growers report better results for digitaria control in late February/March. Do not spray stressed grass.
- Create a uniform stand of creeping grasses before spraying e.g. by hand weeding larger weeds.
- Use good quality spray water with no dirt or salts. Bind any salts with a high grade 2% ammonium sulphate product for maximum herbicide effect. Glyphosate does not work well if there is dirt in the spray water or spray tank or mixing drum, or if weeds have dirt or dust on the leaves. Dusty weeds along roadsides should be sprayed only after rain. Spray operators should avoid kicking up dirt on to the leaves.
- Spray rate of water is normally 250-300 L per hectare for creeping grass control.
- Prevent encroachment into fields from verges and cane breaks near tall cane by applying glyphosate. Near short cane, rather use paraquat + diuron or paraquat + surfactant.
- Consider applying glyphosate at very low pressure through a dribble bar. This is suitable for creeping grass growing under cane leaves (at least knee height) and on field verges. A high level of training and management is necessary. A high spray water volume is required.
- Glyphosate can be used as a 'mop up' operation. Some grass runners which survive and/or are 'missed' by the initial full cover spray operation emerge and spread to other cane lines. These can be sprayed 3-4 weeks after the first application.



Verge control prevent runners spreading into fertile fields.



Mop up any missed cynodon patches with a second application (see brown patches) approximately three weeks after initial application with a dribble bar.



Under canopy spraying with glyphosate is low risk for the crop when there is tall cane with dead leaves on the lower stems.

b) Glyphosate for spot-spraying

- Some grass runners which survive and/or are 'missed' by the initial full cover spray operation emerge and spread to other cane lines. Glyphosate can be used to tackle surviving grass patches and also any late-emerging grass foliage. Repeat shielded applications of paraquat + surfactant is the preferred tactic to spot-spray creeping grasses in short cane (see Tactic 15).
- An alternative product, glyphosate, can be used for spot-spray applications, but there is a very high risk of crop damage in short cane, and a high level of management is required.
- Repeat glyphosate applications **must be** with appropriate shields to protect the crop and to stop spread of runners.
- Spot-spraying with plastic bottle shields is practical up to 15% cynodon cover (requiring 9 labourers for spraying plus 1 labourer search time). Higher % cynodon cover requires larger "fan-shaped" shields.
- Dribble bar application underneath cane leaves could also be considered. This was successful on two commercial farms in the Midlands South and one on the North Coast. The dribble bar attaches to a modified CP3 knapsack lance and works on very low pressure, with minimum /no drift. It is effective for cynodon, stargrass and digitaria only if the grass is young and green (e.g. after burning). **NB:** spray operators require specialised training to ensure no crop damage.

When there is green cane harvesting, glyphosate should be applied to actively growing grass patches **before** covering them with a mulch blanket. This application to cynodon foliage will stress leaf and stem material and avoid reserves building up in roots. **After** applying a mulch blanket, inspect the field every 2-4 weeks for gaps in the mulch cover and apply repeat spot sprays to emerging cynodon with glyphosate or paraquat + surfactant.

- Unshielded sprays may be used for repeatedly spraying digitaria with glyphosate in blocks of severely retarded cane. Although the cane will be sacrificed, it will prevent digitaria spreading to new areas. The same is also relevant to cynodon and stargrass.



*Move shield sideways
into the cane row*



Spot spraying with shields to protect cane.



Using a short L-shaped dribble bar allows control of cynodon close to a stool.



Consider sacrificing cane in blocks of severely retarded cane.



On this farm, a permanent spray team dedicated to spot-spray applications to cynodon reduced coverage from 100% to less than 1% in two years on the North Coast.

c) *Glyphosate for cut-back tactic*

Glyphosate can be used for small areas (1 ha and less) of dense cynodon that has completely over-run small cane. The cutback tactic can be labour intensive and should only be used for small areas.

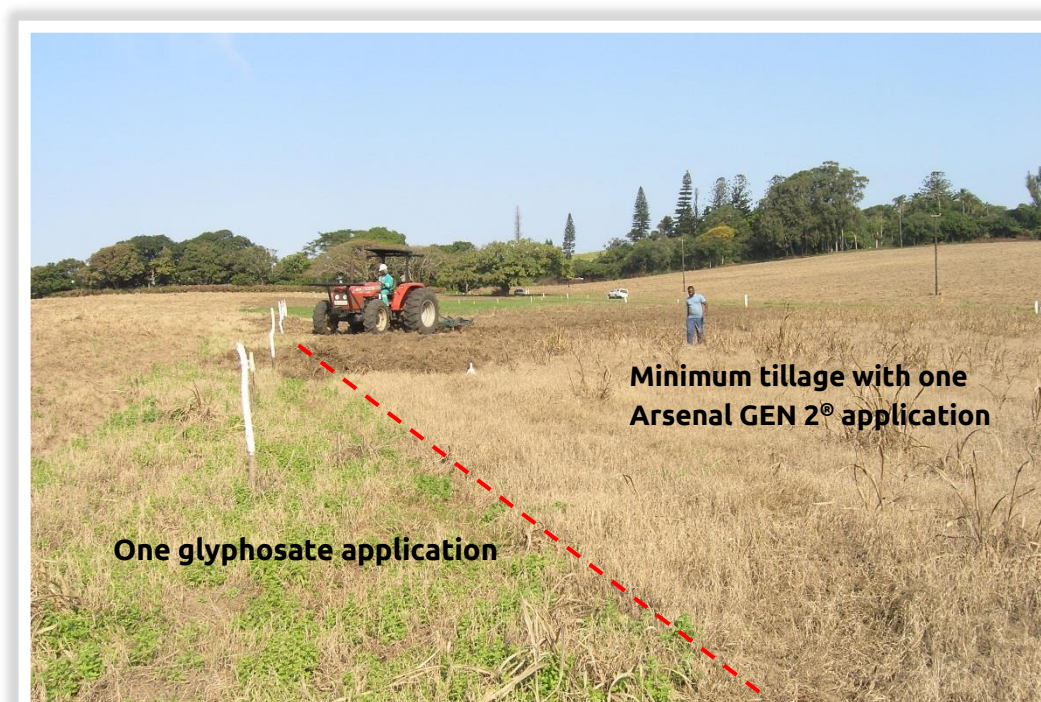
- Slash the cane down to ground level. Avoid cutting the grass.
- Remove all the cane leaves from the field.
- Blanket spray the entire site with an appropriate glyphosate 24 hours after cutting the small cane.
- Make sure the product selected is combined with a recommended surfactant.
- Repeated follow-up spot-spraying will be needed.
- This tactic is labour intensive due to removing leaves by hand.
- Best results are obtained in autumn.



Tactic 13: Arsenal GEN 2®

Glyphosate is registered for creeping grass control and cane stool eradication but is not residual enough in soil to control buried rhizomes, requiring several applications prior to replanting. The systemic herbicide Arsenal GEN 2® effectively controls creeping grasses and kills cane stools in **long fallow fields during normal rainfall years.**

- Arsenal GEN 2® is suited to a long fallow situation as a waiting period is required before replanting.
- There are several restrictions on the label that should be followed. For example, a waiting period of four months and 600 mm rainfall is required prior to planting. Also follow recommendations related to the use of lime.
- Contact the agrochemical company for more information on correct use.
- **NB:** The product is particularly harmful to cane in dry years, requiring a longer fallow.
- **Never** use Arsenal® GEN 2 for spot-spray operations. Only apply glyphosate or other non-residual registered products.
- Spray rate of water: 250-300 L/hectare.



Tactic 14: Fluazifop-butyl

Fluazifop-butyl is useful for control of annual and perennial grasses, including sugarcane, and cynodon with short rhizomes and stolons.

- *Cynodon* must be tilled to break up rhizomes and stolons into short lengths before applying these products.
- The product controls annual and perennial grasses, including sugarcane.
- Can be used for cynodon control during crop rotation with broadleaf plants.
- Only slightly mobile in soil. Irrigation or rainfall within one hour will necessitate respraying.
- Avoid watercourses as products harm fish.
- Ensure adequate coverage of every shoot.
- These products are volatile, so avoid treating lands adjacent to young cane.
- Use at a spray rate of 200-300 L water per hectare.



Cynodon must be tilled to break up rhizomes and stolons before applying chemical.



Contact herbicides

These products will kill only those parts of the plant that have come into contact with the chemical.

Tactic 15: Paraquat

a) *Short cane*

Creeping grasses in short cane are strong competitors and can even strangle the cane. This is especially true when cane is struggling to form canopy.

Paraquat with a surfactant, or paraquat + diuron (for more residual control) can be used. This provides knock-down control of cynodon for 3-5 weeks. Repeated applications are needed every 3-5 weeks until canopy is formed to shade out cynodon.

Paraquat is a contact product and works well, especially when applied in a light drizzle, on dense mats of creeping grasses like *digitaria*, *stargrass* and *cynodon*. Although it is less damaging to cane as a directed spray than systemic products like glyphosate, it severely scorches cane. Herbicide treatments containing paraquat must therefore be used as a directed spray between cane rows, and/or with shields. Use a spray rate of 200-400 L water per hectare.

There are health and safety issues with paraquat and paraquat mixes. Make sure spray operators and storemen have adequate protective clothing, and that there is a safe storage facility.

b) *Moribund creeping grass*

Brown lank or moribund (dying back) grass cannot absorb systemic herbicides like glyphosate, and require rejuvenation. Paraquat + surfactant can be used as an alternative to fire, to chemically burn off old moribund/half brown grass, and allow rejuvenation of new shoots. Once there is sufficient foliage, systemic herbicides can be used.

c) *Verge control*

Prevent encroachment into field from verges by applying paraquat + diuron to suppress creeping grasses.



Paraquat is a contact spray and less damaging to short cane as a directed spray than systemic herbicides. It suppresses cynodon growth and allows cane to grow out and canopy. However, growth is not killed, and after cutting cane, cynodon can spread again from within the rows.

Tactic 16: Glufosinate ammonium

Glufosinate ammonium has a different mode of action to glyphosate and is a safer alternative than paraquat. It provides good knockdown control but requires repeated applications until the crop canopies. It is used for post-emergence, actively growing grass.

- Apply post-emergence when actively growing.
- Multiple sprays are required for cynodon control.
- Normally stays in the top 15 cm of soil.
- Wait 12 hours before irrigation. Do not apply if more than 5 mm rainfall is expected within 12 hours.
- Ensure that sugarcane foliage is not exposed to any spray drift as the cane will be damaged.
- Do not spray stressed weeds or weeds with wet foliage or weeds covered with a heavy layer of dust.
- Spray grasses before seed sets.
- Use a spray rate of 300-800 L water per hectare. For tall weeds, increase the volume of water to 800 L/hectare to ensure thorough wetting of foliage.



Essential principles and best management practices

While you may be aware of all control tactics and the steps involved in developing a whole-farm strategy for controlling creeping grasses, your chances of success will be drastically increased by following a few essential principles and best management practices:

1. Be realistic

You cannot *eradicate* all creeping grass infestations on your farm but you can manage them to below economic thresholds. Be realistic in your goals.

2. Be consistent

Consistency is a key factor for a successful creeping grass control programme. Aim to reduce the extent (area covered) by the infestations.

3. Monitor through scouting

Monitor progress by inspecting fields regularly. Vigilance and early treatment is essential to contain spread.

Take every opportunity to scout for new infestations:

- Inspect and contain runners while you wait for rain.
- Start inspections early after cutting, especially in warm weather and at the beginning of spring rains. Send in staff (e.g. the induna of a spot-spray team) to scout fields after harvest.
- While soil/leaf sampling, or conducting eldana surveys.

Stay alert for new small infestations of problem weeds in areas of poor cane growth and mark these areas/fields with flags. Change colour of tips of saplings with insulation tape. This assists field inspections and monitors progress e.g. how many applications have been made in all the patches in a field.

4. Apply herbicides timeously

A healthy closed sugarcane canopy shades out and suppresses creeping grasses. When the crop is harvested, grass rapidly recovers green foliage and spreads via runners, so it becomes critical to suppress grasses at this stage and **prevent their spread**.

The problem is that chemicals effective for creeping grass control are harsh on cane, requiring the use of shielded sprays. In addition, systemic products like glyphosate should not be applied until the creeping grasses have actively growing above-ground leaf material. In the meantime, aim to stop the spread by using contact products such as paraquat. This relieves competition and allows better cane growth.

5. Maintain application equipment

The most common problems reported by consultants who repair knapsack sprayers are worn, leaking nozzles, or more than one nozzle type on boom sprayers. Inspect regularly and replace all damaged and leaking nozzles.

Clean spray equipment immediately after use, and maintain in good condition.

It is vital that all equipment is correctly calibrated.

6. Train your workforce

Without proper training, spray operators could be careless in the use and maintenance of equipment. Provide regular refresher courses to correct any errors that might accumulate.

Where possible, keep the workforce consistent. The team will then become proficient in the necessary operations.

Pay attention to health and safety issues. Each member of the workforce team needs to understand safe procedures and to follow them.

7. Pay attention to water quality

Water is used to dilute herbicides and deliver them to control target weeds. Poor quality water can seriously affect herbicide performance. Always choose a water source that is clean and clear for all herbicide applications.

Sensitive herbicides will bind to soil and organic matter suspended in water and will not be available for absorption into weed foliage e.g. paraquat and glyphosate.

Dirt blocks nozzles, lines and filters and reduces the equipment's overall performance and life. Dirt at the bottom of a spray tank may neutralise chemical performance.

Layers of dust on plant surfaces and dust kicked up during spraying, especially directly behind the sprayer, may also result in reduced control.

Spray water should be slightly acidic (pH 4.5 to 6.0) for most herbicides. Only acidify or buffer a spray solution when specified on the label. Do not over-acidify. Adding lime to soil affects some herbicides like Arsenal GEN® 2.

Poor quality water can have a high percentage of dissolved cation salts such as calcium, magnesium, sodium and potassium that antagonise herbicides. These can cause some chemicals to precipitate, affect the balance of the surfactant system, affect properties like wetting and dispersion, and inactivate sensitive herbicides by limiting their absorption by weed foliage. Some glyphosate brands are highly sensitive to high salt content in water.

Test spray water and assess for suitability for spraying herbicides. Contact SASRI's Fertiliser Advisory Service on 031 508 7474/5 to have your water tested. Where spray water has concentrations of more than 150 ppm cation salts (e.g. calcium + magnesium + sodium + potassium), treat with high grade ammonium sulphate adjuvant (if stated on the label).

Do not use water where iron is shown to occur. It produces an orange precipitate that can plug screens and nozzles.

Never add concentrated products to water. Rather, dilute with water before adding to a half filled spray tank. Top up the spray tank with water to the desired level.

Reduce the water volume to the minimum required for good coverage and performance. Check the label for water volume specifications.

8. General

Always use registered combinations of herbicides and make sure you follow label directions.

It is important to apply the herbicide spray evenly to achieve good coverage of grass foliage. Select nozzles with appropriate spray water output. A pressure regulator mounted on a knapsack lance allows a more even coverage, with less variation in output. These must be cleaned immediately after use to avoid clogging.

Manage operations to achieve consistent spraying. For example, walking speed consistency is very important.

Use shielded sprays in growing cane. Consider using elliptical shields for runners or circular shields for spot spraying.

Do not keep herbicide mixes in the tank overnight. Do not allow dust and organic material to collect in the bottom of spray tanks.

Measuring and mixing on a per knapsack basis can lead to variation and error. Rather consider mixing e.g. in a 210 L drum for half a hectare.

[illegible]



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