MANAGING POLYMERIA (TAKE-ALL) IN COTTON

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The polymeria plant

Polymeria (*Polymeria longifolia*) is a member of the *Convolvulaceae* (bindweed) family. Polymeria, also known as polymeria take-all and Peak Downs curse, is a native Australian plant, that occurs through much of the Queensland and New South Wales cotton growing area. It was present in many cotton fields before they were developed, and persists after development.

Polymeria is a deep-rooted, rhizomatous, perennial weed that tends to grow in dense patches. Its rhizomes can extend to 1.5 metres depth in the soil, with roots extending below the rhizomes. Shoots can emerge from 20 cm depth. Once established, its rhizomes form a dense mat that spreads throughout the soil under a polymeria patch. Polymeria spreads from these rhizomes and can rapidly re-establish from the rhizomes if the above ground plant material is removed by cultivation, chipping or knock-down herbicides.

Polymeria is an erect plant, 7 – 25 cm tall. Its leaves are green to grey or silver in colour and are covered in fine hairs. Polymeria has a prominent pink or white trumpet-shaped flower, with a yellow centre, 2 – 2.5 cm in diameter. It produces large, brown, velvety seeds, 3 – 5 mm across, with one or two viable seeds per seed capsule. Polymeria spreads from both seeds and rhizomes.

Polymeria is a member of the bindweed family and has prominent, pink flowers. Polymeria plants grow in dense patches.

Polymeria was established on this area in the Moree watercourse prior to the development of the road.

NO HERBICIDES ARE REGISTERED FOR CONTROLLING POLYMERIA. A PERMIT MUST BE OBTAINED FROM THE NATIONAL REGISTRATION AUTHORITY BEFORE USING A HERBICIDE TO CONTROL POLYMERIA IN ANY SITUATION.

Polymeria can grow all year round in warmer areas, but is frost sensitive and is burnt off by frosts. Some shoots may persist through winter and new shoots will emerge early in spring. Plants grow rapidly over the warmer months. Flowering normally commences in mid-summer.

Polymeria patches are relatively stable, but spread slowly year after year. Once polymeria becomes established, it competes strongly with cotton, and is resistant to most management approaches. Patches of polymeria with a density of 100 stems/m^2 or more can reduce cotton yield by at least 50%. This, and higher densities, are common in many patches. Polymeria competes strongly for soil water and nutrients, depleting the cotton crop of these resources.

Cotton generally establishes poorly on polymeria patches, often resulting in islands of solid green (polymeria) amongst cotton rows. If unchecked, these islands can easily grow to 50 or 100 m across. Eventually, polymeria can spread from small patches to cover a significant proportion of a field. On one field at Twynam North, the area of polymeria increased by approximately 1% per year over an 8-year period, rising from 5.6% of the field area in 1988 to 14% in 1996. No cotton grew to maturity on these patches. In 1996, this represented a yield loss of 158 bales or $94 000 on this field alone. A number of other fields had smaller infestations.

It is estimated that dense infestations of polymeria are established on over 2500 ha of cotton country. Lighter infestations occur on a much greater proportion of the cotton area. These lighter infestations are more easily managed, and should be managed to prevent them becoming major problems. Special care should be taken to avoid spreading this weed when developing country infested with polymeria.

Polymeria forms dense patches. Cotton generally doesn't grow to maturity in these patches.

Inter-row cultivation delays polymeria growth, but shoots re-emerge from underground rhizomes. Inter-row cultivation doesn't control the weed in the plant row.

Cultivation

Polymeria has been regularly subjected to cultivation operations ranging from light inter-row cultivation in moist fields, through to deep cultivation under dry conditions. Polymeria is not controlled by normal cultivation practices, but cultivation in dry conditions may set polymeria back. Heavy cultivation in dry conditions may assist with controlling polymeria.

Cultivation in moist conditions can spread polymeria, as polymeria can establish and grow from small pieces of rhizome spread by the cultivator. Cultivators can inadvertently carry polymeria pieces into new fields where they may establish.

Polymeria's tolerance to cultivation is probably due to its deep rooting habit, with rhizomes penetrating well over a metre into the soil. Standard cultivation is at best only trimming surface growth, allowing plants to re-establish from the rhizomes below the cultivated zone.

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Herbicides for managing polymeria

A range of herbicides has been trialled for controlling polymeria, over a number of seasons, with mixed and often poor results. In the field, these poor results may be related on occasions to poor spraying conditions, stressed plants and the extensive mat of polymeria rhizomes present in polymeria patches. Herbicides are generally far less effective on stressed plants and the extensive rhizome mats may well mean that plants present on the surface in adjoining plots are attached to the same rhizomes, potentially reinfesting treated plots from rhizomes in untreated plots, diluting the herbicide effect from untreated plants or controlling untreated plants through the connected plants in treated plots.

Many herbicides burn-off the above-ground plant material, but the weed rapidly reinfests from the large mass of rhizomes present under the polymeria patches. These rhizomes act as a continuous source of reinfestation.

Consequently, it is likely that growers treating a whole patch of polymeria will get better results than is indicated from the plot experiments in this article.

Nevertheless, the results reported here have been highly variable even in small pot experiments where spraying conditions are favourable, plants are not moisture stressed and no rhizome mat is present.

No herbicides are registered for controlling polymeria.

Best results for controlling polymeria have been obtained with applications of Arsenal, atrazine, Basagran, Grazon, Roundup, Starane and 2,4-D. A range of other herbicides, including Ally, dicamba, diuron, Express, Garlon, Glean, Staple and Tordon have been trialled, but do not satisfactorily control polymeria.

A permit must be obtained from the National Registration Authority before using a herbicide to control polymeria in any situation.

Imazapyr (eg. Arsenal®)

Arsenal is a residual soil sterilant, effective in controlling most plant species. Arsenal is both root and shoot absorbed, acting as both a contact herbicide and a residual herbicide. Arsenal is highly persistent, with a half-life of up to 142 days. It can control weeds for up to three years when applied at the registered rate. It is ideal for controlling weeds on roadways, the outsides of channel banks, and other non-crop areas.

Arsenal is weakly adsorbed to soil and can move many metres from the site of application. It should never be applied in-crop or in an area where soil or water movement can carry the herbicide into a sensitive (crop) area.

Arsenal inhibits acetolactate synthase, a key enzyme in the plant's metabolic pathway. This inhibition rapidly leads to plant death.

Arsenal gave short-term control of polymeria when applied at 2 L/ha or more (Table 1). Better control was achieved with higher rates (Table 2). However, some polymeria persisted in areas sprayed with Arsenal, even when applied at rates as high as 6 L/ha (Table 2).Thabks Tony

Table 1. *Polymeria control in cotton using over-the-top applications. The treatments were assessed 63 days after the initial treatment on December 20, 1996.*

Treatment	Application(s)		% control
	20 Dec	15 Jan	after 63 days
Untreated	-	-	0
Arsenal	0.5 L/ha	-	50
Arsenal	1 L/ha	-	53
Arsenal	2 L/ha	-	83
Roundup CT	2.4 L/ha	-	20
Roundup CT	-	2.4 L/ha	43
Roundup CT	2.4 L/ha	2.4 L/ha	53
Staple	-	240 g/ha	0
Staple	120 g/ha	120 g/ha	7

Table 2. *Polymeria control in fallow, sprayed on October 10, 1996. Treatments were assessed at 97 and 376 days.*

Treatment	% control	
	97 days	376 days
Untreated	0	10
Ally 10 g/ha	29	64
Ally 30 g/ha	30	24
Arsenal 2 L/ha	79	83
Arsenal 6 L/ha	92	99
Express 30 g/ha	22	24
Express 90 g/ha	36	46
Garlon 100 mL/ha	17	24
Garlon 300 mL/ha	44	27
Glean 20 g/ha	52	53
Glean 60 g/ha	6	0
Starane 2 L/ha	58	36
Starane 6 L/ha	70	65

A dark patch of dead plants from arsenal used to control polymeria on a channel bank.

Arsenal must never be used in a crop area.

Triclopyr & picloram (eg. Grazon™)

Grazon is a mixture of picloram and triclopyr. It is effective on a wide range of difficult-to-kill, broad leaf weeds. Grazon is a residual herbicide, with both shoot and root activity. It is not safe to apply to cotton, and has a plant-back to cotton of many months. Grazon can be used in non-cotton areas and fallow fields. It has a plant-back to wheat and barley of 2 to 4 months (depending on the application rate). Always check the product label before using a herbicide.

Triclopyr is moderately persistent, with a half-life of about 30 days. Picloram is more persistent, with a half-life of around 90 days, although it can break down much more quickly under warm, moist conditions, and more slowly under cool, dry conditions. Picloram is highly leachable. Both chemicals have the same mode of herbicidal action, acting on the plant's cell walls, causing cell elongation, and affecting cell division, causing plant death.

Grazon gave good control of polymeria when applied at 2 L/ha, with applications in December and February (Table 3), reducing the polymeria population to negligible levels after 3 seasons of application. Nevertheless, six years of applications were required to eradicate a polymeria patch. Grazon is suited to spot-applications in fallow fields and non-cotton areas.

Interestingly, a single application of Grazon in March each season gave no control of this weed, highlighting the importance of repeated applications for polymeria management.

Table 3. *Polymeria control in a fallow. Herbicides have been applied at the nominated time each season since December 1999. Herbicides were applied regardless of the condition of the polymeria (stressed or actively growing). Polymeria rated from 0 (bare ground) to 100% ground cover of plants.*

Treatment	Visual assessment of weed rating at:						
	Initial 10 Dec 99	1 year 19 Dec 00	2 years 6 Dec 01	2.3 years 19 Apr 02	3.6 years 11 Jun 03	5 years 19 Jan 05	6 years 22 Dec 05
Untreated	33	35	60	77	73	50	50
Grazon 2 L/ha (Mch)*	-	-	43	53	30	40	40
Grazon 2 L/ha (Dec & Feb)	80	17	5	2	3	1	0
Roundup CTXtra 6 L/ha (Sept)	47	38	50	77	53	14	5
Roundup CTXtra 6 L/ha (Sept & Dec)	87	33	43	43	30	17	3
Roundup CTXtra 6 L/ha (Nov & Jan)	53	28	25	17	10	10	0
Roundup CTXtra 6 L/ha (Mar)	70	53	73	77	25	22	12
Roundup CTXtra 6 L/ha (Sept, Dec & Mar)	47	2	1	1	0	0	1
Roundup CTXtra 18 L/ha (Nov)	23	34	63	53	60	37	10
Roundup CTXtra 18 L/ha (Nov & Jan)	60	27	5	0	0	1	1
Starane 2 L/ha (Mar)	50	60	60	63	60	20	6
Starane 2 L/ha (Dec & Feb)	33	4	4	5	2	5	0
Tordon 2G 10 kg/ha (Nov & Feb)	47	53	22	43	9	13	34
Tordon 75D 3 L/ha (Mar)	33	33	25	43	4	10	5
2,4-D amine 2.5 L/ha (Mch)*	-	-	73	90	28	30	37
2,4-D amine 5 L/ha (Mch)*	-	-	10	17	10	7	18
2,4-D amine 10 L/ha (Mch)*	-	-	60	60	60	33	30

Note. These treatments were established in spring 2002. Hence the December 2001 assessment is the initial rating for these treatments*

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Triclopyr (eg. Garlon™)

Triclopyr has a much shorter soil half-life than picloram and a much shorter plant-back to cotton, but by itself was ineffective for controlling polymeria at the rates used in the field when compared to the tricolpyr and picloram combination (Table 2).

Picloram (eg. Tordon 2G™)

Surprisingly, picloram at the rate used was also relatively ineffective for controlling polymeria in the field when compared to the tricolpyr and picloram combination (Table 3), possibly due to limited plant uptake of this granular formulation which is relatively insoluble in water.

Glyphosate (eg. Roundup)

Glyphosate kills most plants, including conventional and Liberty Link® cotton plants. It can be applied to fallows, but must be applied through a shielded sprayer, set up to avoid any contact with cotton foliage when applied to conventional or Liberty Link® cotton. Glyphosate can be applied pre-cotton emergence, in-crop as a shielded spray, at defoliation, or after picking.

Roundup Ready herbicide can be applied over-the-top of cotton varieties including the Roundup Ready Flex trait up to 22 nodes of crop growth.

Glyphosate inhibits EPSP synthase, which prevents protein synthesis and kills the plant. Glyphosate is effective against most plants, but the herbicidal effect is quite slow, often taking 2 to 3 weeks. Glyphosate is far more effective when applied to rapidly growing plants. Spray failures can occur when glyphosate is applied to stressed plants.

Glyphosate is rapidly adsorbed and inactivated on contact with the soil. Consequently, it has no residual effect, although its breakdown in the soil is comparatively slow, with a half-life of 47 days.

Glyphosate can be effective in controlling polymeria, with 100% kill observed in some situations. However, the result observed in the field is generally not this good, as:

- glyphosate may not fully translocate throughout the polymeria rhizome mat, leaving some rhizomes alive. Translocation appears to improve as herbicide rates are increased. Polymeria will rapidly regrow from unaffected rhizomes.
- glyphosate is less effective against stressed plants. Moisture and temperature stresses reduce herbicide efficacy.
- thorough spray penetration into a thick polymeria patch is difficult to achieve. Inevitably some plants and shoots are not sprayed.
- polymeria can re-establish from seed.

Glyphosate can be an effective tool for in-crop management of polymeria. Glyphosate must be applied using spray shields to prevent the herbicide contacting the crop foliage unless it is applied to cotton varieties including the Roundup Ready Flex trait.

Glyphosate rate

Glyphosate was often ineffective in controlling polymeria in pots when applied at rates of 1 or 2 L/ha (Tables 1, 5, 9 and 18), although good control was observed on one occasion (Table 14). The level of control was generally, but not always improved as rates were increased to 4 L/ha or more (Tables 5 and 18). Similarly good results were observed in the field, where Roundup CT was applied as an in-crop, directed spray (Table 6), and on actively growing polymeria in a fallow (Table 7).

However, 4, 8 or even 12 L/ha of glyphosate were relatively ineffective in controlling polymeria on some occasions (Tables 4, 9 and 10).

Table 4. *Polymeria control using contact herbicides at standard and heavier rates on plants grown in pots. Dry matter regrowth was recorded from 42 to 168 days after treatment.*

Treatment	Dry matter regrowth (kg/ha)	% control
Untreated	5972	0
Roundup CT 4 L/ha	6646	0
Roundup CT 8 L/ha	8916	0
Starane 2 L/ha	6438	0
Starane 4 L/ha	7028	0
2,4-D amine 2 L/ha	3254	46
2,4-D amine 4 L/ha	2369	60

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Table 5. *Polymeria control using contact and residual herbicides at standard and heavy rates on plants grown in pots. Dry matter regrowth was recorded from 25 to 86 days after treatment.*

Treatment	Dry matter regrowth (kg/ha)	% control
Untreated	1773	0
Atrazine 5 L/ha	1015	43
Atrazine 10 L/ha	585	77
Basagran 2 L/ha	898	49
Basagran 6 L/ha	551	69
Roundup CT 2 L/ha	1320	26
Roundup CT 4 L/ha	556	69
Roundup CT 8 L/ha	178	90
Roundup CT 16 L/ha	0	100
Starane 2 L/ha	2099	0
Starane 6 L/ha	102	94

Table 6. *Polymeria control in cotton using directed spray applications of Roundup CT. Weed density was assessed 19 and 60 days after treatment.*

Treatment (applied Jan 17, 1997)	% control	
	19 days	60 days
Untreated	0	0
Roundup CT 4 L/ha	37	57
Roundup CT 8 L/ha	67	63
Roundup CT 16 L/ha	93	83

Glyphosate rates between 3 and 6 L/ha generally have been effective in the field when other factors such as low temperatures and moisture stress have not been limiting.

Glyphosate is generally ineffective when applied to stressed polymeria and is not well suited to treating polymeria in fallows, unless the weed is actively growing after good rain (as was the case in Table 7).

Results from repeated applications in fallow have also been very variable, with multiple applications often giving the best results (Table 3). A strategy of multiple glyphosate applications, applied after rain and as required, seems to be the best approach when using this herbicide in a fallow.

Table 7. *Control of polymeria in a fallow using increasing rates of glyphosate. Percentage control was visually estimated relative to an unsprayed treatment, 64 days after spraying. Work by Scarsbrick, Auld and Milne, 1979.*

Treatment	Rate	% control at 64 days
Glyphosate	1 L/ha	23
	2 L/ha	60
	4 L/ha	73
	6 L/ha	77
	8 L/ha	80

Repeated applications of glyphosate in crop can also be effective. In one experiment, where multiple applications of Roundup CT at 4 and 8 L/ha were compared, the best result was from a repeated application of 4 L/ha in November and January, with similar, but inferior results from three applications of 4 or 8 L/ha (Table 8).

The reason for the reduction in control from the additional herbicide application may have been that the polymeria was stressed in October due to cool temperatures, reducing the effectiveness of this application, and plants were further stressed by the herbicide application, making them less receptive to the November application.

Table 8. *Control of polymeria using in-crop directed spray applications of Roundup CT. The results were assessed 104 and 364 days after the first herbicide application on October 24, 1997.*

Treatment	Application(s) (L/ha)			% control	
	24 Oct	20 Nov	17 Jan	104 days	364 days
Untreated	-	-	-	3	25
Roundup CT	4	-	-	0	15
Roundup CT	8	-	-	0	15
Roundup CT	-	4	4	57	78
Roundup CT	4	4	4	47	57
Roundup CT	8	8	4	67	63

Repeated in-crop applications appeared to be less effective in a second field experiment, possibly due to the length of the experiment (time) and the size of the rhizome mat under the large polymeria patch used in the experiment allowing reinfestation of the treated plots from the surrounding area (Table 9).

Repeated applications of glyphosate in a pot experiment were very effective, espically at the higher rate of glyphosate (Table 10).

Aside from the direct effect on the polymeria, the glyphosate treatments had an added benefit, in that cotton established on the sprayed plots and was estimated to yield around 5 bales/ha on the best treatments. This result was in marked contrast to previous seasons, when no cotton lint was harvested from the polymeria patches. The additional yield on these plots easily justified the expense of the herbicide application. The degree of polymeria control with glyphosate was primarily limited by the need to apply the herbicide as a shielded spray (in conventional cotton), to actively growing plants, leaving unsprayed polymeria in the cotton row.

Table 9. *Control of polymeria using repeated shielded applications of Roundup CTXtra in a cotton crop. Applications were made in December 1998 and 1989, and January and February 1999 and 2000. Weed density was assessed 64, 372 and 483 days after the December 1998 treatment.*

Treatment	Application date(s)			% control		
	Dec	Jan	Feb	64 days	372 days	483 days
Untreated	-	-	-	0	0	0
Roundup CTXtra	-	-	3 L/ha	0	34	26
Roundup CTXtra	-	3 L/ha	3 L/ha	0	0	0
Roundup CTXtra	3 L/ha	3 L/ha	3 L/ha	9	27	18
Roundup CTXtra	-	-	6 L/ha	0	30	23
Roundup CTXtra	-	6 L/ha	6 L/ha	47	56	59
Roundup CTXtra	6 L/ha	6 L/ha	6 L/ha	23	0	16
Roundup CTXtra	-	-	12 L/ha	0	27	53
Roundup CTXtra	-	12 L/ha	12 L/ha	24	41	45
Roundup CTXtra	12 L/ha	12 L/ha	12 L/ha	23	18	28

Table 10. *Polymeria control using repeated applications of Roundup Ready herbicide applied to plants grown in pots. Plants were assessed 1 week after each spray application and 5 weeks after the final spray.*

				% control of alive shoots				
Spray 1	Spray 2	Spray 3	Spray 4	Spray 1	Spray 2	Spray 3	Spray 4	Final
-	-	-	-	0	0	0	0	0
1.5 kg/ha	-	-	-	5	81	88	86	54
1.5 kg/ha	1.5 kg/ha	-	-	27	86	84	59	38
1.5 kg/ha	-	1.5 kg/ha	-	29	84	76	77	69
1.5 kg/ha	1.5 kg/ha	1.5 kg/ha	-	41	94	88	95	100
1.5 kg/ha	1.5 kg/ha	1.5 kg/ha	1.5 kg/ha	49	95	76	36	100
3 kg/ha	-	-	-	21	93	96	95	100
3 kg/ha	3 kg/ha	-	-	25	94	92	95	100
3 kg/ha	-	3 kg/ha	-	32	98	100	100	100
3 kg/ha	3 kg/ha	3 kg/ha	-	42	92	96	100	100
3 kg/ha	3 kg/ha	3 kg/ha	3 kg/ha	45	95	92	95	85

Timing of glyphosate applications

Glyphosate applications during December and January have generally been the most effective (Table 9), with poorer results from earlier applications (Tables 8 and 19).

Commercial applications in early spring, before cotton planting, have given variable results. Rates between 3 and 6 L/ha were applied to a number of patches on a large property over a one-week period in one spring, with good control observed from about half the applications. There was no obvious correlation between the glyphosate rate and the variable results achieved, with poor control observed on some patches sprayed at 6 L/ha, and good control on some other patches sprayed at 3 L/ha.

Variable results were observed from an in-crop experiment, were plots were sprayed over two seasons (Table 9). Best results were from applications of 6 L/ha in January and February, and from a single application of 12 L/ha in February. A single application of 3 L/ha in February gave limited benefit.

Overall, polymeria density was substantially reduced on the trial area over the two seasons, with some evidence of glyphosate translocating well beyond the treated areas.

One of the main difficulties encountered in these experiments was unacceptable damage to the cotton (conventional variety), due to imprecise application of the high herbicide rates through a shielded, hand-held sprayer. Even with better spray equipment, the potential risk of damage to the crop from very high rates of glyphosate is too high to be acceptable. Results from applications of 3 L/ha show that useful levels of control of polymeria could be achieved with this rate, without unacceptable risk of damage to the crop. A polymeria management strategy using one or two in-crop glyphosate applications of 1.5 kg/ha of Roundup Ready herbicide should achieve much improved cotton yields and a year-by-year reduction in the polymeria infestation in varieties utilizing the Roundup Ready Flex trait.

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Additives to enhance glyphosate efficacy

Anecdotal evidence suggested that the use of a spray additive with glyphosate may improve its efficacy for polymeria control. Polymeria has a very hairy leaf surface, which may be a factor contributing to the poor control results observed with lighter rates of glyphosate (3 L and below). A wide range of spray additives was available for use with glyphosate, some of which it was thought may have improved spray efficacy when used on polymeria.

A small range of spray additives was tested at various rates. The addition of PULSE® Penetrant at 1% improved control (Table 11), while the addition of Turbo® Plus at 5% improved control in a second experiment (Table 12). The control from Roundup CTXtra without additive was also very good in both experiments.

Table 11. *Polymeria control in a pot trial using Roundup CTXtra with additional spray additive. Spray was applied at 100 L/ha. Regrowth was measured from 31 to 164 days after treatment.*

Treatment	Dry matter regrowth (kg/ha)	% control
Untreated	5080	0
Roundup CTXtra @ 3 L/ha	294	94
Roundup CTXtra @ 3 L/ha + 1% Bond	3425	33
Roundup CTXtra @ 3 L/ha + 1% Pulse	0	100
Roundup CTXtra @ 3 L/ha + 1% Turbo Plus	898	82

Table 12. *Polymeria control in a pot trial using Roundup CTXtra and additional spray additive. Spray was applied at 100 L/ha. Regrowth was measured from 42 to 126 days after treatment.*

Treatment	Dry matter regrowth (kg/ha)	% control
Untreated	6718	0
Roundup CTXtra @ 3 L/ha	208	97
Roundup CTXtra @ 3 L/ha + 5% Bond	292	96
Roundup CTXtra @ 3 L/ha + 0.2% Pulse	426	94
Roundup CTXtra @ 3 L/ha + 1% Pulse	104	
Roundup CTXtra @ 3 L/ha + 5% Pulse	145	98
Roundup CTXtra @ 3 L/ha + 5% Turbo Plus	0	100
Roundup CTXtra @ 6 L/ha + 1% Turbo Plus	544	92

A lower rate of glyphosate was used in a third experiment (Table 13), where Roundup CT was used at 3 L/ha rather than Roundup CTXtra at 3 L/ha. This gave an 8% reduction in active ingredient and a change in the product surfactant. Turbo Plus at 1% gave a large improvement in spray efficacy in this experiment, although efficacy was further improved by increasing the Roundup rate without including the additive.

Table 13. *Polymeria control in a pot trial with Roundup CT and Turbo Plus spray additive. Spray was applied at 100 L/ha. Regrowth was recorded from 42 to 167 days after treatment.*

Treatment	Dry matter regrowth (kg/ha)	% control
Untreated	9672	0
Roundup CT @ 3 L/ha	2465	75
Roundup CT @ 3 L/ha + 1% Turbo Plus	406	96
Roundup CT @ 3 L/ha + 5% Turbo Plus	542	94
Roundup CT @ 6 L/ha	0	100
Roundup CT @ 6 L/ha + 1% Turbo Plus	0	100
Roundup CT @ 6 L/ha + 5% Turbo Plus	0	100

Extreme care should be taken with in-crop applications of glyphosate, as the herbicide can damage conventional cotton plants, as in this photo (crop plants yellow and stunted).

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Glyphosate formulations

A range of commercial glyphosate formulations is available, with differing types and concentrations of wetters. There is little evidence that these formulations vary in their efficacy for controlling polymeria (Table 14).

Table 14. *Comparison of a range of glyphosate formulations for controlling polymeria in a pot trial. Applications were at 1.0 and 1.5 kg a.e./ha, giving equivalent rates of the various formulations. Dry matter regrowth was recorded from 43 to 173 days after treatment.*

Treatment	Rate	Dry matter regrowth (kg/ha)	% control
Untreated	-	10529	0
Roundup CT	2.2 L/ha	542	95
	3.3 L/ha	0	100
Roundup Max	2.0 L/ha	100	99
	2.9 L/ha	0	100
Roundup Ready	1.4 kg/ha	0	100
	2.2 kg/ha	0	100
Credit & Bonus	1.9 L/ha	339	97
	2.8 L/ha	0	100

Using glyphosate in the field

Based on these results, glyphosate was applied to polymeria patches on commercial fields, with applications at planting and shielded applications in crop. While the results were not outstanding, there was a general reduction in polymeria density on treated fields and cotton was picked from polymeria patches where there previously was no harvestable cotton. The main lessons learned from these trials were:

- polymeria must be actively growing to achieve effective control. Results have been generally poor from applications to moisture stressed polymeria and in cool spring conditions,
- at-planting applications of glyphosate are not always effective but can enabled cotton to establish in polymeria patches,
- in-crop glyphosate applications in conventional and Liberty Link cotton varieties must be through well constructed shielded sprayers, with competent operators. High rates of glyphosate can cause unacceptable damage,
- spot-spraying is the preferred in-crop option, minimising the risk of accidental damage to cotton conventional and Liberty Link varieties, and
- attention to crop agronomy is important to enable satisfactory cotton establishment and growth in polymeria patches.

Glyphosate can be effective in controlling polymeria in-crop, enabling the crop to establish and yield even in thickly infested patches.

Fluroxypyr (eg. Starane®)

Starane is a contact herbicide, effective on a range of harder-to-kill broadleaf weeds. Starane is primarily shoot absorbed, but there can be some root absorption. Starane is moderately persistent, with a half-life of up to 55 days. Starane is moderately leachable. It is not safe to apply on or near cotton.

Starane's mode of action is not clear, but it has a hormone-like action, altering the integrity of the plant's cell walls and affecting cell division. Starane is most effective on actively growing plants.

Starane has been widely trialled by growers, generally at 2 L/ha, but with variable results. Starane has been useful for controlling smaller infestations of polymeria, but is less satisfactory for controlling larger patches. Applications under optimal (glasshouse) growing conditions gave poor results, with no control with Starane at 2 L/ha (Table 5) or 4 L/ha (Table 4). Control improved to 94% when Starane was applied at 6 L/ha (Table 5).

Poor results in the field were observed with Starane at 1 and 2 L/ha sprayed in December (Table 15), and at 2 and 6 L/ha sprayed in October (Table 2). A single application of Starane at 2 L/ha in March repeated over a number of years initially gave poor results, but good control was achieved by the 6th year (Table 3). Repeated applications of Starane at 2 L/ha in December and February gave good results after only the 1st season (Table 3). Growers report that best results have generally been achieved with applications in February and March.

Nevertheless, some viable polymeria rhizomes remain after treatment. As with the other herbicides, a polymeria management plan based

on Starane will require repeated strategic applications and spot treatments over many seasons.

Table 15. *Polymeria control in fallow, sprayed on December 22, 1987, and assessed after 65 days. This trial was conducted by Max McMillan.*

Treatment	% control
Untreated	10
Basta 3 L/ha	6
MCPA Amine 1 L/ha	22
Starane 1 L/ha	54
Starane 2 L/ha	62
2,4-D Amine 1 L/ha	22
2,4-D Amine 2 L/ha	44
2,4-DB 1.7 L/ha	12
2,4-D Amine 1 L/ha + Ally 10 g/ha	14

2,4-D amine

2,4-D amine has been widely trialled for controlling polymeria. It is generally applied in autumn, after cotton is defoliated and no longer susceptible to the herbicide. 2,4-D must never be applied during the cotton season, as cotton plants are extremely sensitive to the herbicide. Drift onto cotton from an application of 2,4-D can cause a big reduction in cotton yield.

There have been reports of good control of polymeria using 2,4-D, but these reports have not been repeated when using standard rates. 2,4-D applied in autumn burns-off the polymeria foliage, which then dies off over winter. The 2,4-D appears to have given very good control at this point, as in Table 16.

Table 16. *Polymeria control in a fallow using 2,4-D and other herbicides, applied on March 14, 1983 and assessed in July, 112 days after spraying. Work by Neville Strachan.*

Treatment	% control
Untreated	0
2,4-D Amine 2 L/ha	100
2,4-D Ester 1.25 L/ha	96
Dicamba 1.4 L/ha	0
Glean 30 g/ha	0
Roundup 2 L/ha	43
Tordon 50-D 1.4 L/ha	96
Dicamba 1.4 L/ha + 2,4-D Amine 2 L/ha	96
Roundup 2 L/ha + 2,4-D Ester 1.5 L/ha	100
Tordon 50-D 1.4 L/ha + 2,4-D Amine 2 L/ha	96
Tordon 50-D 1.4 L/ha + Dicamba 1.4 L/ha	96
Weedazol TL Plus 5.6 L/ha	43

However, the weed will often re-emerge in spring with little apparent affect from the treatment. 2,4-D amine at 4 L/ha applied in June gave some short-term control, but had no longer-term benefit (Table 19). 2,4-D amine applied at 1 or 2 L/ha earlier in the season also gave little long-term control of polymeria (Table 15).

Nevertheless, a very good result was observed from 2,4-D amine applied at a double rate in autumn following rain and followed by cultivation (Table 20).

The value of this herbicide may be primarily limited by the need for the weed to be actively growing and the relatively short application window available in autumn.

2,4-D ester

There was no indication that 2,4-D ester was any more effective for controlling polymeria than was 2,4-D amine, when applied at the same rate of active ingredient (Tables 16 and 19). Given that 2,4-D ester has even more issues and usage limitations as 2,4-D amine, there seems to be no

justification to using this formulation for polymeria management.

Using 2,4-D or fluroxypyr in the field

The opportunity to apply 2,4-D and fluroxypyr to cotton fields and fallows is limited by factors including:

- applications in the cotton area can only safely occur in autumn, after defoliation. Applications earlier in the season are not possible due to the extreme sensitivity of cotton to these herbicides,
- 2,4-D and fluroxypyr must be applied to actively growing polymeria. Polymeria growing in cotton will often be moisture stressed, and not likely to respond to herbicide unless rain occurs at or after picking, and,
- 2,4-D and fluroxypyr must be applied before frosts in autumn burn off the foliage, again stressing the plants.

Polymeria is a native plant that occurs through much of the cotton industry. Uncontrolled infestations, such as the plants established on this channel bank, produce seed that can spread the weed into cotton fields.

Glufosinate (eg. Liberty Link® herbicide)

Glufosinate appeared to have no efficacy on polymeria at the rate used (Basta @ 3 L/ha, Table 15).

Dicamba

There was no indication that dicamba had any efficacy on polymeria at the rate used (Table 16).

Group B herbicides

There are a range of Group B herbicides, some of which have been trialled for use on ploymeria.

None of the Group B herbicides trialled had any activity against polymeria at the rates used. Results with these herbicides can be found in:

- Ally (metsulfuron-methyl) Tables 2 and 15,
- Glean (chlorsulfuron) Tables 2 and 16,
- Express (tribenuron methyl) Table 2, and
- Staple (pyrithiobac-sodium) Table 1.

Other herbicides

Anecdotal evidence in the field suggested that some of the residual herbicides had activity on polymeria.

High rates of atrazine appeared to substantaiily reduce the polymeria growth rate (Tables 5 and 17), indicating the use of atrazine in sorghum or maize crops may have benefit for managing polymeria in these crops. However, cotton growers need to be cautious of the re-cropping interval back to cotton following the use of atrazine, especially if dry conditions occur during the fallow period, potentially slowing the breakdown rate of atrazine.

High rates of basagran also appeared to have some efficacy on polymeria (Table 5), indicating the use of basagran in suitable rotation crops may have benefit for managing polymeria.

Diuron appeared to have little or no efficacy on polymeria at the rates used (Table 17).

Table 17. *Polymeria control using residual herbicides at standard and heavier rates on plants grown in pots. Dry matter regrowth was recorded from 41 to 166 days after treatment.*

Treatment	Dry matter regrowth (kg/ha)	% control
Untreated	1531	0
Atrazine 2 kg/ha	1396	9
Atrazine 4 kg/ha	1149	25
Atrazine 6 kg/ha	538	65
Diuron 2 kg/ha	1293	16
Diuron 4 kg/ha	1310	14
Diuron 5 kg/ha	1155	25

Herbicide combinations

It is unlikely that combinations of herbicide with different modes of action will improve control of this weed, as the different herbicides generally stress the plant, reducing herbicide efficacy.

Nevertheless, glyphosate is commonly used in combination with a Group I herbicide such as 2,4-D or Starane when applied to weeds in winter fallows and could be considered as an option for polymeria control.

Combinations of glyphosate and 2,4-D, or glyphosate and Starane gave no consistent improvement in polymeria control in three experiments. There was evidence of antagonism between Roundup CT and 2,4-D amine in one experiment (Table 18) and no useful improvement in control in a second experiment (Table 19).

Table 18. *Polymeria control using Roundup CT and 2,4-D amine combinations at standard and heavier rates on plants grown in pots. Dry matter regrowth was recorded from 41 to 130 days after treatment.*

Treatment		Dry matter regrowth (kg/ha)	% control
Untreated		638	0
Roundup CT 2 L/ha		1247	0
Roundup CT 4 L/ha		2	100
-	2,4-D 1.1 L/ha	1001	0
Roundup CT 2 L/ha	2,4-D 1.1 L/ha	459	28
Roundup CT 4 L/ha	2,4-D 1.1 L/ha	338	47
-	2,4-D 2.2 L/ha	1282	0
Roundup CT 2 L/ha	2,4-D 2.2 L/ha	510	20
Roundup CT 4 L/ha	2,4-D 2.2 L/ha	85	87
-	2,4-D 4.4 L/ha	1006	0
Roundup CT 2 L/ha	2,4-D 4.4 L/ha	1139	0
Roundup CT 4 L/ha	2,4-D 4.4 L/ha	266	58

Table 19. *Polymeria control using a range of herbicide combinations in a fallow, sprayed on June 26, 1995.*

Treatment	% control	
	104 days	340 days
Untreated	1	0
2,4-D Amine 4 L/ha	21	0
Roundup 4 L/ha	41	0
Starane 2 L/ha	4	0
Roundup CT 1.5 L/ha + 2,4-D Amine 2 L/ha	0	0
Roundup CT 3 L/ha + 2,4-D Amine 2 L/ha	0	0
Roundup CT 1.5 L/ha + 2,4-D Ester 1.5 L/ha	30	0
Roundup CT 2 L/ha + Goal 0.75 L/ha	0	0
Roundup CT 1.5 L/ha + Starane 1 L/ha	19	17

The best result was achieved where combinations of 2,4-D, Starane and Roundup Ready herbicide were applied in a wheat stubble fallow in autumn where cultivation followed soon after the herbicides. The initial control was assessed before the cultivation and final control was assessed 20 months later in the following cotton crop (Table 20).

Best results were achieved with combinations of Roundup Ready herbicide and Surpass, Roundup Ready herbicide and Starane and one combination of Surpass and Starane. The combinations generally but not always gave better control than the herbicides alone, with the single application of 2,4-D amine alone at 4 L/ha giving one of the better results.

Nevertheless, the results were highly variable, showing that a range of herbicides can be useful for managing polymeria takeall, but that growers shouldn't expect to achieve good results from every application. Managing polymeria isn't about a silver bullet, but about a dedicated, long-term approach, with multiple treatments.

Table 20. *Polymeria control using a range of herbicide combinations in a fallow, sprayed on 19th March 2004.*

Treatment	% control	
	14 days	594 days
Untreated	0	0
Roundup Ready 4 kg/ha	25	22
Surpass 4 L/ha	58	61
Roundup Ready 4 kg/ha + Surpass 0.5 L/ha	35	21
Roundup Ready 2 kg/ha + Surpass 1 L/ha	49	73
Roundup Ready 1 kg/ha + Surpass 2 L/ha	53	78
Roundup Ready 0.5 kg/ha + Surpass 4 L/ha	79	83
Starane 2 L/ha	61	40
Roundup Ready 4 kg/ha + Starane 0.25 L/ha	28	25
Roundup Ready 2 kg/ha + Starane 0.5 L/ha	23	72
Roundup Ready 1 kg/ha + Starane 1 L/ha	33	70
Roundup Ready 0.5 kg/ha + Starane 2 L/ha	70	53
Surpass 4 L/ha + Starane 0.25 L/ha	60	66
Surpass 2 L/ha + Starane 0.5 L/ha	45	82
Surpass 1 L/ha + Starane 1 L/ha	38	28
Surpass 0.5 L/ha + Starane 2 L/ha	65	5
Roundup Ready 2 kg/ha + Starane 0.25 L/ha + Ally 3 g	28	38
Roundup Ready 2 kg/ha + Surpass 2 L/ha + Ally 3 g	88	49
2,4-D Amine 4 L/ha	89	76

NO HERBICIDES ARE REGISTERED FOR CONTROLLING POLYMERIA. A PERMIT MUST BE OBTAINED FROM THE NATIONAL REGISTRATION AUTHORITY BEFORE USING A HERBICIDE TO CONTROL POLYMERIA IN ANY SITUATION.

Summary

Polymeria is a deep rooted, rhizomatous, perennial weed that spreads from seeds and rhizomes. It tolerates and can be spread by floods and cultivation practices.

No herbicides are registered for controlling polymeria. A permit must be obtained from the National Registration Authority before using a herbicide to control polymeria in any situation.

There are a range of herbicides with some efficacy on polymeria, including Arsenal, Basagran, diuron, Grazon, glyphosate, Starane and 2,4-D. However, most of these herbicides can't be safely used in cotton and some have long plant-back periods to cotton.

Polymeria can be managed in cotton with repeated applications of glyphosate on actively growing polymeria, applied prior to- or at-planting, and to cotton varieties including the Roundup Ready Flex trait or through well constructed shields, used under appropriate conditions to conventional and Liberty Link varieties. Glyphosate can be spot-applied to polymeria patches to improve crop safety.

Good crop agronomy is important to ensure cotton establishes in polymeria patches, resulting is competitive, strong cotton.

Polymeria growing in fallow can be controlled with glyphosate on actively growing patches and with Starane or 2,4-D in autumn if opportunity arises. The addition of Pulse Penetrant or a non-ionic surfactant to the glyphosate may improve spray efficacy for some formulations but is not necessary when using Roundup Ready herbicide.

Grazon may be useful for controlling polymeria in fallows that are not going back to cotton. Atrazine and Basagran may have some benefit in the appropriate rotation crops. Arsenal may be useful for controlling polymeria on non-cropping and waste areas.

A grower's experience with polymeria

Polymeria (Take-all) control in Cotton

David Moore (Formerly Senior Agronomist, Colly Farms Ltd)

My experiences refer to the control of this weed in the western Gwydir/Collarenebri area. Having seen this weed grow rapidly as a cotton acre utiliser over a number of seasons, I can say its control is not easy to achieve and involves having a large amount of patience and deep pockets.

The key to controlling polymeria revolves around attacking it when it is actively growing, has a large enough leaf mass, and warm temperatures – not unlike controlling nutgrass. The critical time, therefore, is from early December, through to the end of the irrigation cycle in irrigated cotton. In this period, the weed grows very well, being well fed by both nutrients and water. The leaf surface is covered with tiny hairs that can make uptake of any herbicide very difficult. This is why treatment in times of higher temperature/relative humidity is better than in cooler periods.

The aim with all these treatments has been to reduce the number of shoots/m^2 so that the current, or following crop has a greater chance of producing economically viable cotton yield.
Treatments I have tried are;

1. **Phenoxy herbicides in the Autumn.**

   I have found these applications (of up to 5 L/ha of 2,4-D amine) to be ineffective.

2. **Fluroxypr (Starane) herbicide applied in summer**

   Have seen very good results with this product at rates of around 2 L/ha. The drawback is this products volatility and propensity to volatilise and effect nearby crops. It may be an option in a fallow with adequate buffer.

3. **Deep ripping/cultivation in a fallow situation.**

   The mass of rhizomes that are under a patch of polymeria is incredible, as is the depth to which they can be found. Shallow cultivation that minimally disrupts the growth is ineffective, with smaller pieces of rhizomes being transplanted and growing with the next rainfall.

   Therefore, any cultivation must be aggressive and the transplanted rhizomes need to dry out for a long time before any water is added to the system.

   Unfortunately, when these fields come back into irrigated production, the frequency of watering and warm summers mean that the weed is back with two seasons.

4. **Glyphosate in the fallow**

   Again needs to be actively growing with adequate leaf mass - using rates of applied 450 g/L product need to be around 6 L/ha.

   Have seen good reductions in numbers from these applications.

5. **Shielded applications of glyphosate in crop.**

   Have seen up to two applications of high rates of glyphosate in crop via a shielded sprayer give very good results. Again the rate needs to be around 6 L/ha.

6. **Industrial residual herbicides in field**

   Have seen a Imidazolinone product (Arsenal) used in field on heavily infested patches of polymeria. While there was a dramatic decrease in shoots per square metre, there was no total reduction. This accompanied with the fact that these areas will not yield cotton for the following two seasons and the fact that treated soil may move through the field makes this option an unfavoured one.

   However, it may be an option in controlling patches in head ditches, roadsides etc. with a back pack application. Needless to say, care in application is critical.

Summary

I favour applications of glyphosate in the fallow or shielded applications in crop. These applications, timed when the weed is actively growing under high humidity, have given good results. These applications followed up by an application of Fluroxypr in early autumn also help to reduce the numbers of shoots per metre in the following crop.

The ability to use GPS to accurately record patches of polymeria and assess the degree of control achieved is advantageous.

The key is to not let your fields get to the stage that areas of your fields are unproductive and require such treatments as mentioned above. If you have some infested fields, isolate them and make rig hygiene a priority.

NO HERBICIDES ARE REGISTERED FOR CONTROLLING POLYMERIA. A PERMIT MUST BE OBTAINED FROM THE NATIONAL REGISTRATION AUTHORITY BEFORE USING A HERBICIDE TO CONTROL POLYMERIA IN ANY SITUATION.