Management solutions for pasture dieback: Outcomes of field research

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Abstract
Pasture dieback causes premature death of productive tropical and subtropical grass-pastures. Due to the productivity impact and the substantial knowledge gap of effective solutions, the Department of Agriculture and Fisheries initiated scientific field-trial research in 2018 to investigate practices to restore pasture productivity. In management practice trials at Brian Pastures Research Facility, the original pasture species affected by dieback has regenerated naturally regardless of treatment imposed. The same species performed well in another trial at the same location when resown into a fully cultivated seedbed where the original pasture had succumbed to dieback. While pasture regeneration has occurred at this site, this has not been a consistent outcome in all pasture dieback situations and so should not be considered a reliable management strategy. Annual forages and perennial legumes appear to be unaffected by pasture dieback and can provide valuable feed for the short and long term where grasses have been affected.

Keywords
Pasture dieback, management solutions, field research.

Introduction
Pasture dieback causes premature death of productive tropical and subtropical grass-pastures. Affected pastures are located in north, central and south-east Queensland, and north-eastern New South Wales, in higher rainfall (>600 mm annual average) coastal and adjacent inland zones. Developing an accurate assessment of the area impacted has been problematic; not all cases are reported, identification is complicated due to symptom commonality with other conditions, and affected pastures are recovering while others are being affected.

Pasture dieback has occurred previously in Queensland. While pasture death similar to dieback was reported in southern Queensland in the 1920's (Summerville 1928), the most recent event occurred in the 1990's when buffel grass pastures were affected by an 'ill-thrift' condition (Graham and Conway 1998). Despite research conducted at that time, no definitive causes or management solutions were developed (Graham and Conway 2000; Makiela 2008). While symptoms were similar, the geographic extent and number of grass-pasture species affected by the current disease is considerably different. Numerous sown grass species, and some natives, are now affected across varied environmental conditions.

Due to the productivity impact and the substantial knowledge gap of effective solutions, the Department of Agriculture and Fisheries (DAF) initiated field research in 2018. These consisted of trials near Gayndah to investigate practices to restore pasture productivity. Another trial was established near Boonah in 2020.

Methods
Three field-based research trials were initiated in June 2018 at the Brian Pastures research facility near Gayndah. Trials were in a paddock sown to creeping bluegrass cv. Bisset (*Bothriochloa insculpta*) around 1996 and has been utilised for grazing beef cattle. Soil is uniform, deep black cracking clay (vertosol) with moderate-high fertility (44 mg/kg Colwell phosphorus; 18 mg/kg sulphate-sulphur; 0.93 mg/kg DTPA zinc; 0.35 meq/100g ammonium acetate potassium; 1.71 % organic carbon). In December 2017, poor grass growth and dead patches analogous to pasture dieback were first observed. By mid-2018, the pasture in one area was completely dead and an adjacent area was affected (i.e. alive but not healthy). Hence, three trials were initiated in these areas: 1. Management trial-dead area; 2. Management trial-affected area; and 3. Pasture species trial-dead area.

The management trials aimed to understand the impact of different management levels (easy/low cost through to difficult/high cost) on dieback symptoms and pasture growth. Both management trials were randomised complete blocks (RCB) incorporating the same thirteen treatments (Table 1), replicated twice in the dead trial and four times in the affected trial. Plots were 6 m by 40 m.

Table 1. Treatments for both management trials (dead and affected) at Brian Pastures.

Treatments on retained pasture	Treatments where the existing pasture is fully removed
Control	Cultivate once (no re-seed)
Slash only	Cultivate, sow forage sorghum, re-seed pasture
Burn only	Cultivate, sow lablab, re-seed pasture
Complete fertiliser	Cultivate, sow oats, re-seed pasture
Fungicide	Cultivate, fallow 3mths, re-seed pasture
Insecticide	Cultivate, fallow 6mths, re-seed pasture
	Cultivate, fallow 6mths, re-seed pasture, complete

The aim of the pasture species trial was to determine comparative plant health and yield impacts of dieback on 19 commonly available cultivars at that time (Table 2). Additionally, the effect of seed coating that included insecticide was evaluated on three grass species (buffel cv. Biloela and Gayndah, and creeping bluegrass cv. Bisset) by comparing those with and without coating (Table 2). The trial was a RCB replicated three times. Plots were 2 m by 8 m.

Table 2. Treatments for the pasture species trial at Brian pastures.

Grass treatments	
Purple pigeon grass cv. Inverell (coated)	Buffel grass cv. Biloela (coated)
Angleton bluegrass cv. Floren (coated)	Buffel grass cv. Biloela (uncoated)
Creeping bluegrass cv. Bisset (coated)	Buffel grass cv. Gayndah (coated)
Creeping bluegrass cv. Bisset (uncoated)	Buffel grass cv. Gayndah (uncoated)
Indian bluegrass cv. Medway (uncoated)	Rhodes grass cv. Callide (coated)
Panic cv. Gatton (coated)	Rhodes grass cv. Reclaimer (coated)
Panic cv. Bambatsi (uncoated)	Setaria cv. Kazungula (coated)
Digit grass cv. Premier (uncoated)	Signal grass cv. Basilisk (uncoated)
Finger grass cv. Strickland (uncoated)	
Legume treatments	
Butterfly pea cv. Milgara (uncoated)	Stylo cv. Unica and Primar (coated)
Burgundy bean cv. Presto (coated)	Siratro cv. Aztec (uncoated)
Desmanthus cv. Progardes (uncoated)	

Plant health and biomass yield measurements were taken to determine outcomes of each treatment. Data were analysed by analysis of variance and pairwise comparisons of treatment means performed by a protected least significant difference test at the 5% probability level. All trials were assessed for multiple pathogenic organisms including ground pearl (*Margarodes australis*), pasture mealybug (*Heliococcus summervillei*), and numerous nematodes, viruses, fungi, and bacteria. Soil chemistry, texture and nutrition were also assessed.

Results and Discussion

Rainfall

Rainfall over the trial duration was below average and highly variable (Figure 1). This negatively impacted biomass yields of forage treatments, the speed of recovery of cultivation treatments, and the establishment of the re-sowing pasture treatments. However, rainfall was sufficient for treatment expression (if to occur) where the existing pasture was retained.

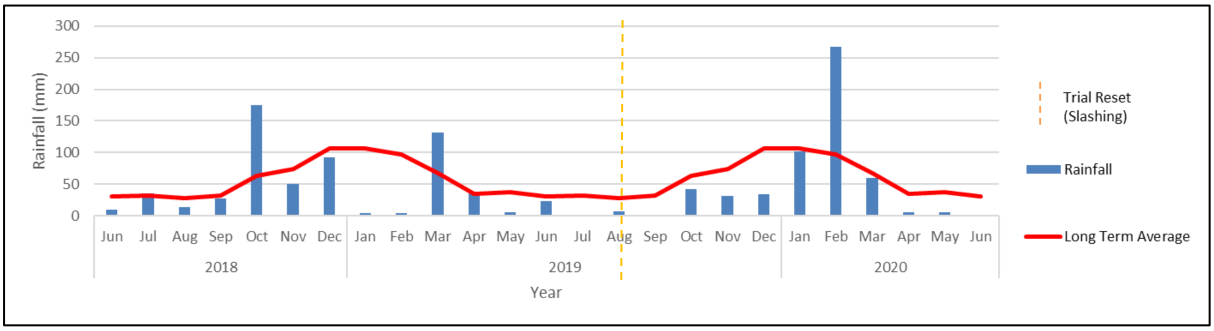

Figure 1. Monthly and long-term average rainfall at the Brian Pastures Research Facility, Gayndah.

Presence of pathogenic organisms: All trials

Multiple pathogenic organisms were present in each trial area. These included ground pearl, pasture mealybug, nematodes, viruses and fungi (data not shown). While high numbers of ground pearls and pasture mealybugs were present over the duration of the trial, pasture mealybug numbers fluctuated with seasonal pasture growth. Investigation is still on-going to determine if one, or all, of these caused the poor growth and death of the pasture prior to the trials being initiated.

Plant health and pasture yield: Management trials (dead and affected areas)

The original pasture species (creeping bluegrass cv. Bisset) naturally regenerated over the duration of these trials. This occurred regardless of treatment imposed in both trial areas. Treatments implemented on retained pasture (burning, slashing, fertilising, applying pesticides) provided little to no dry matter yield benefit after two growing seasons (Table 3). Treatments that removed the existing pasture (cultivation only; fallowed and planted to forages) provided variable results (Table 3). The pasture took some time to recover from the cultivate-only treatment, and annual forages provided modest yields due to limited water (soil-moisture and in-crop rainfall) rather than suffering from dieback i.e. no leaf discolouration, poor growth, or premature death were recorded (data not shown). Yields in the dead area were generally greater than in the affected area in 2020, presumably due to the boost in nutrient and soil-moisture supply after the grass-pasture had completely died in 2017/18.

Table 3. Dry matter yields (kg/ha) of pasture and forage treatments from the management trials at Brian Pastures research facility.

Treatment	Dead area			Affected area			
	2019	2020		2019		2020	
	P=0.212	P=0.028		P<0.001		P<0.001	
Control	2806	4979	abc	3739	a	2421	d
Burn	1688	3998	bcd	1216	d	2629	cd
Slash	1610	4635	abc	1150	d	2906	cd
Fertilise	2149	3750	cd	1393	d	3504	bc
Fungicide	2037	4631	abc	3450	ab	2450	d
Insecticide	2242	5958	a	4143	a	3131	bcd
Cultivate only	2424	6282	a	2029	cd	4049	ab
Forage sorghum	4184	5488	ab	3500	ab	4972	a
LabLab	3029	2924	d	2196	bcd	2362	d
Oats	3594	N/P		3309	abc	N/P	
sed	824	739		686		466	

Means followed by a common letter are not statistically different (P=0.05). N/P = not planted

Plant health and pasture yield: Pasture species trial

Despite poor seed germination and seed-depth irregularities of some species at planting, legume plants that established in all treatments grew to potential without any health issues related to dieback (Table 4). Grass establishment was proportional to seed quality and treatment despite adequate sowing rates based on germination percentage and estimated seed/coat ratio (where applicable) to achieve 1 kg/ha of pure live seed. The established grass treatments generally grew well given the seasonal conditions (Table 4). The exception was buffel grass cv. Gayndah which struggled from emergence, with typical dieback symptoms within months of sowing irrespective of seed treatment. Creeping bluegrass cv. Bisset, i.e. the original pasture species, grew to potential without any dieback symptoms. This indicates the possibility for successful re-sowing of grass into paddocks affected by dieback. However, this result is dissimilar to the findings of the other grass species research trial conducted by DAF at Boonah (Peck et al. 2021). Also, some graziers who have re-sown grass pastures into affected paddocks state variable outcomes.

Table 4. Plant and yield ratings of treatments in the pasture species trial at Brian Pastures.

		Plant stress				Yield/growth			
Pasture	Species	2019		2020		2019		2020	
		P<0.001		P<0.001		P<0.001		P<0.001	
Grass	Creeping blue	2.3	c	2.0	ab	4.9	bcd	7.4	def
	Buffel	8.0	e	3.3	d	4.4	bcd	3.4	ac
	Rhodes	1.0	ab	2.7	c	9.2	e	10.0	f
	Floren	0.0	a	1.7	a	7.0	de	2.7	abc
	Digit & Finger	4.3	d	2.8	cd	8.2	e	8.8	f
	Panics	2.3	bc	2.5	bc	1.7	a	0.2	ab
Legume	Butterfly pea	0.0		0.0		1.0	a	4.3	acde
	Caatinga stylo	0.0		0.0		6.7	cde	8.7	ef
	Desmanthus	0.0		0.0		2.3	ab	3.0	abc
	Burgundy bean	0.0		0.0		0.4	a	0.0	a
	Siratro	0.0		0.0		3.3	abc	4.0	acd
sed		0.7		0.9		1.5		1.9	

Plant stress rating: 0 = unaffected to 10 = dead. Yield growth rating: 0 = no cover and yield to 10 = 100% cover and high yield. Means followed by a common letter are not statistically different (P=0.05).

Conclusion

If natural pasture regeneration is likely to occur, these results indicate a ‘do nothing’ approach may be an effective management practice. However, regeneration has not consistently occurred across all pasture dieback situations and so should not be relied upon as an effective strategy. Little to no pasture yield improvement has been recorded from treatments imposed on the retained pasture, a result despite the variable, yet on-going, presence of numerous pathogenic organisms. Annual forages or legumes appear to be unaffected by pasture dieback and can provide valuable feed where sub-tropical grasses have been affected. Re-sowing the grass species that was originally affected was successful, however other studies and experiences by graziers demonstrate variable outcomes. Due to the dynamic presence of pasture dieback and the lack of certainty of management solutions, these studies should continue to generate longer-term knowledge outcomes.

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