Field tolerance to pasture dieback of 26 tropical grass varieties sown into an affected paddock

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Abstract
Pasture dieback is a condition where tropical grass pastures show stress symptoms (yellowing, reddening, wilting, poor growth) followed by death in patches that expand over time. Multiple potential causal agents have been identified in association with pasture dieback but the cause has not been demonstrated. A wide range of sown pasture grass species have been reported as being affected by pasture dieback although the severity varies between species and locations. Twenty-six varieties of grass across fifteen species were sown in February 2020 into a paddock where Rhodes grass had been severely affected by dieback in 2018-2019. Poor growth, stress systems and plant death in patches that are characteristic of pasture dieback occurred during the first growing season and all varieties had very poor root system development. Multiple potential causal agents were present at the site including novel viruses, nematodes and ground pearl (*Margarodes australis*) but no pasture mealybug *(Heliococcus summervillei)*, which has been postulated as the primary causal agent of pasture dieback by some researchers.

Keywords
Pasture dieback, disease, Rhodes grass, buffel, Bissett

Introduction
Pasture dieback is a condition affecting pastures in Queensland where pasture grasses show stress symptoms (yellowing, reddening, wilting, poor growth) followed by death of the grass sward in patches that expand over time. Multiple potential causal agents have been identified, however the cause of pasture dieback has not been demonstrated which hinders the development of management options for graziers to reduce the impact of dieback on pasture and animal production (Buck 2017).

A wide range of sown pasture grasses have been reported as being affected by pasture dieback although the relative severity varied between species at different locations (Buck 2017). Identification of resistant or tolerant species or varieties would provide a management option to the grazing industry to reduce the impact of pasture dieback on animal production. An experiment was established in south-eastern Queensland to test the relative tolerance of existing commercially available grass varieties as well as some promising experimental accessions to pasture dieback. This paper describes the pasture growth, symptoms, preliminary causal agent sampling during the first growing season and winter as well as some observations through the second summer. Results from the second summer growing season along with results described in this paper will be presented at the conference.

Methods
The trial was located in a paddock where pasture dieback symptoms were first observed in early 2018. The paddock was severely affected by pasture dieback in the first half of 2019 with a very high percentage of the paddock dying out. Pasture dieback combined with the driest year on record resulted in the Rhodes grass cv. Callide pasture dying out completely in 2019 with no adult plants remaining. The soil is a brown Dermosol which is well suited to a wide range of tropical pasture grasses with good fertility and a history of fertiliser use due to previously being used for intensive irrigated cropping.

Twenty-six varieties of grass across sixteen species or sub-species were sown on 27 February 2020 after a 2 month fallow. Plot size is 10m by 10m with 3 replicates. The species and varieties sown are shown in Table 1. A 6m buffer around the plots was sown with *cv*. Gatton and an additional area of approximately 1ha around the experiment was sown with *cv*. Epica (i.e. surrounding the *cv*. Gatton buffer).

Seedbed preparation and sowing
Herbicides (glyphosate and 2,4-D) were used to control weeds and volunteer Rhodes grass seedlings for two months before sowing. The site was lightly cultivated with a tyned implement before sowing on the soil surface. All plots were rolled with a rubber tyre roller after sowing to improve seed to soil contact.

Seeding rates were adjusted for germination and commercial seed coat percentages with the aim of sowing 1.5kg/ha of pure live seed. This resulted in sowing rates varying from 4 – 30 kg/ha of commercial seed as supplied. The experimental accessions were sown at a lower rate due to limited seed availability. The purple pigeon grass failed to establish due to very poor seed (0% germination).

Table 1. Grass species and varieties sown in the experiment in February 2020.

Genus	Species	Common name	Variety
Bothriochloa	*insculpta*	Creeping Blue	Bisset, *Exp. 1
Urochloa	*decumbens*	Signal	Basilisk
Urochloa	*brizantha*	Brizantha	Mekong
Cenchrus	*ciliaris*	Buffel	Biloela, Gayndah, *Exp. 2
Chloris	*gayana*	Rhodes-Callide type	Callide, Epica, Sabre
Chloris	*gayana*	Rhodes-Samford type	Mariner
Chloris	*gayana*	Rhodes-Katambora type	Reclaimer, Tolgar
Dichanthium	*aristatum*	Angleton grass	Floren
Digitaria	*eriantha*	Digit grass	Premier
Digitaria	*milanjiana*	Tall finger grass	Strickland
Panicum	*coloratum var. coloratum*	Klein grass	*Exp. 3
Panicum	*coloratum var. makarikariensis*	Bambatsi panic	Bambatsi
Megathyrsus	*maximus*	Green Panic	Gatton, MegaMax059
Megathyrsus	*maximus x M. infestus*	Guinea	Massai, NuCal
Paspalum	*wettsteinii*	Broad-leaf paspalum	Common
Pennisetum	*clandestinum*	Kikuyu	EYC
Setaria	*incrassata*	Purple Pigeon	Inverell
Setaria	*sphacelata var. anceps*	Setaria	Narok

(*Exp.: experimental accession).

Measurements
The trial site and surrounding area were visually surveyed multiple times per year for pasture dieback symptoms to monitor growth and senescence cycles after rain. Yield was assessed by a visual rating in the first growing season. Plant and soil samples were taken to analyse for causal agents twice in the first year. The insect population was sampled using a vacuum sampling method.

Plant anchorage was measured in September 2020 approximately seven months post emergence due to multiple species having very poor root development. Four individual grass plants from each plot were pulled out of the ground using a looped cord attached to a set of scales to record the peak force required. Not all treatments were able to be measured due to low plant numbers or very poor growth, 19 of the 26 varieties were measured.

Results

Grass growth
Only modest germinating rains were received in the two weeks post sowing which resulted in patchy emergence for several varieties. Autumn and winter received below average rainfall from March – September (131mm over 7 months) which resulted in the establishing grasses relying on stored soil moisture for growth (356mm of rainfall during the 2 month fallow). Growth varied widely between species in the first growing season from good to very poor yield (Table 2). Kikuyu and broad-leaf paspalum had very low plant density despite having good germination percentage seed and the few plants that established grew very poorly. No purple pigeon grass plants established due to very poor seed quality (0% germination).

Weed control and contamination with other grass seed was an issue for several of the lower yielding varieties both from the seed sown and blowing in from adjacent plots. Several of the varieties needed to be extensively hand weeded due to commercial seed being contaminated with other species of grass.

Table 2. Yield in August 2020, approximately five months post emergence.

Rating	Yield (kg/ha)	Grass species or genus
Good	1500 - 5500	Rhodes, Buffel
Ok	500 - 1500	Brizantha, Green panic, Setaria
Poor	250 - 500	Digit, Tall finger, Bambatsi, Creeping blue, Signal
Very Poor	<250	Klein, Guinea, Angleton
Negligible	Isolated plants	Kikuyu, Broad-leaf paspalum, Purple pigeon^

^ Purple pigeon grass had no plants established. Kikuyu and purple pigeon were resown in February 2021.

Root impacts

Most species and varieties of grass had poor anchorage and were easy to pull out of the ground during the first growing season, however some varieties required greater strength to pull out of the ground (Figure 1). Some species such as digit grass and bluegrass had poor root and shoot growth while others like Rhodes grass produced good yield despite having poor roots (Table 2, Figure 1). Some of the panic grasses were severely retarded with poor root systems and small wilted leaves during the first growing season.

A section of the buffer around the trial (Rhodes grass cv. Epica) was grazed by weaner cattle approximately six months post emergence and resulted in >95% of plants being pulled out of the ground.

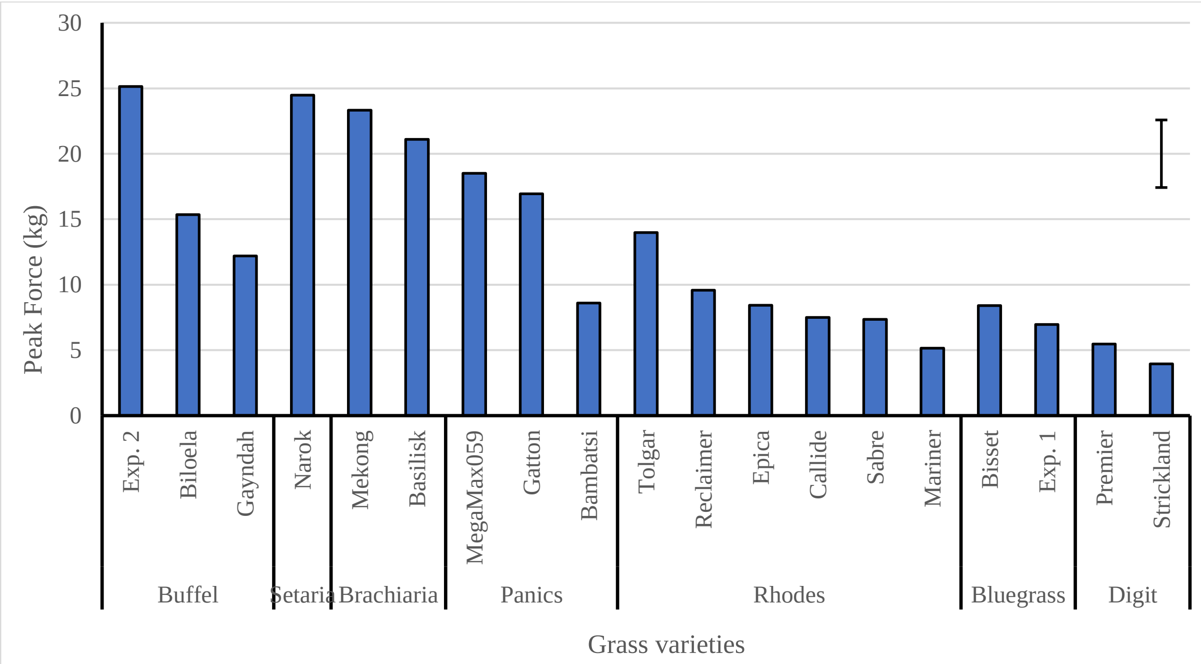

Figure 1. Average force required to pull individual grass plants out of the ground in September 2020 approximately seven months post sowing. (LSD bar P<0.05).

Pasture dieback symptoms and causal agent sampling

Rhodes grass in some plots and the buffer around the trial died in patches with symptoms that are typical for pasture dieback (i.e. leaf discolouration, early senescence and death in patches). The dead patches did not align with a particular variety of Rhodes grass. There were some small patches of discoloured and poorly growing grass in other species that did not result in plant death. The dead patches have been recolonised through seedling recruitment and stolons growing into the dead patches following good rain in December 2020 and January 2021 produced rapid grass growth. The experiment will continue to be monitored for symptoms to see if the recovery in dead or poorly growing patches is maintained or regresses.

Plant and soil samples collected from the experiment site have had preliminary analysis completed for fungi, bacteria and virus with novel viruses being detected. Insect sampling has found multiple insect types but no pasture mealybug *(Heliococcus summervillei)* which has been postulated as the primary causal agent of pasture dieback by some researchers. Soil testing also indicated no chemical or nutritional issues throughout the soil profile that would cause the poor plant growth experienced during the first growing season.

Conclusion

Grass growth varied dramatically with multiple factors impacting pasture yield. Seed quality, seedling vigour, adaptation to the soil type, responsiveness to the below average rainfall post sowing and presumably tolerance to pasture dieback all had an impact on the yields in the first growing season. It is therefore difficult to equate grass yields to pasture dieback tolerance.

Growth of most of the grass varieties sown in the trial had abnormal, poor root systems and plant anchorage to the ground. For some varieties, such as the panic grasses, these poor root systems coincided with poor growth and premature wilting. By contrast Rhodes grass was able to produce high yields without wilting despite being very easy to pull out of the ground and not being able to withstand grazing.

Rhodes grass produced the highest dry matter yields but had poor plant anchorage and died in patches in multiple plots and in patches in the buffer around the experiment, presumably due to pasture dieback. If the dead patches are caused by pasture dieback then high yield is not a reliable indicator of tolerance to the disease. This result aligns with observations of commercial paddocks where the impacts of pasture dieback are often more severe in high biomass pastures.

The patchy poor growth and death of some varieties across the site demonstrate the difficulty in conducting variety tolerance to disease experiments in the field when the causal agent has not been demonstrated. The lack of pasture mealybug at this site suggest that the observed pasture death has been initiated by other disease-causing agents. Further work is required to identify disease causing agents at this site and other pasture dieback outbreaks. Screening for tolerance to pasture dieback to enable evaluation of resistant accessions or plant breeding is very difficult in the absence of being able to apply known levels of the causal agent(s).

There are some varieties that had better root development (plant anchorage) and yield that may prove to be more tolerant to pasture dieback and therefore be recommended to graziers. The experiment will continue to observe on-going grass growth and response.

References

Buck, S (2017) Pasture dieback: past activities and current situation across Queensland. Agric.-science Queensland innovation opportunity. State of Queensland, Department of Agriculture and Fisheries: Brisbane, Qld.