Proceedings of the Australian Society of Sugar Cane Technologists, volume 41, 262-267, 2019

Peer-reviewed paper

Pachymetra root rot surveys of the Tully district: update 2018

GJ Shannon[1], RC Magarey[2], L Macgillycuddy[2], JK Stringer[3] and M Lewis[4]

[1]*Tully Sugar Limited, Tully, Qld 4854*; g.shannon@tsl.com.au
[2]*Sugar Research Australia Limited, Tully, Qld 4854*
[3]*Sugar Research Australia Limited, Indooroopilly, Qld 4068*
[4]*Tully Cane Productivity Services Limited, Tully, Qld 4854*

Abstract Pachymetra root rot is a soil-borne disease that impacts all sectors of the Australian sugar industry. The disease attacks the root system of sugarcane crops, affecting yields and leading to stool loss and shortened crop cycles, thus impacting the farming, harvesting and milling sectors. Monitoring the disease is, therefore, important so that optimised management practices are adopted, so bringing benefits to the entire value chain. A survey of the Tully district conducted in 2004 showed that pachymetra root rot was widely distributed across the Tully mill area; a second survey undertaken in 2013 sought to determine trends in disease incidence after some significant changes occurred in the cultivar mix. Crop resistance had shifted significantly with a change in cultivar resistance and there was a consequent increase in disease severity. Financial losses from reduced yield were estimated at $5.5 million in 2013; this compares to just under $1.0 million in 2004. This paper reports on a third survey in 2018 that is a five-year update to provide snapshot of the status of this disease in the Tully sugar industry. While the disease is still widespread, its severity has decreased with financial losses estimated to be $3.5 million.

Key words Pachymetra root rot, surveys, Tully, spores, cultivars

INTRODUCTION

Pachymetra root rot (PRR) is caused by a soil-borne oomycete, *Pachymetra chaunorhiza*, that attacks the primary roots of the sugarcane plant, leading to a poor and inadequate root system. The disease has not yet been reported outside the Australian sugarcane industry. Symptoms include a softening and rotting of the primary roots, leading to a reduction in the crop's ability to access moisture and nutrients, a loss of stool anchorage, and a reduction in crop yields.

Elevated levels of stool tipping in susceptible cultivars may lead to poor ratooning and increased quantities of extraneous matter in the cane supply to the mill. Disease management relies on cultivar resistance; no other commercially viable control measure has been identified. The main survival structure of the pathogen is an oospore (a spore), and these are long-lasting (up to 5 years); short-term fallows have little influence on disease levels. Previous research provides information on how PRR severity affects crop yield (Magarey 1994; Magarey and Bull 2003).

Sugar Research Australia (SRA) has routinely screened promising clones in their plant-improvement program for resistance to PRR for over 25 years. Susceptible clones are largely discarded, with only clones with sufficient resistance being released to industry for commercial production. However, following an outbreak of sugarcane smut in 2008 many smut-susceptible clones that were resistant to PRR were discarded. This left many cultivars of intermediate resistance to PRR comprising significant sully to the Tully Mill in a survey in 2013 (Shannon *et al.* 2014). Since 2013, several new cultivars resistant to PRR have been introduced into the Tully region.

Knowing the PRR levels in each sub-district is important in assisting growers in making decisions for which cultivar to plant; this has flow-on effects through the entire industry value chain.

METHODS

The 2018 survey was initiated in late 2017 with the bulk of the sampling undertaken during January–April 2018. Soil was taken using a Dutch-head 5 cm diameter auger, beside the sugarcane stool to a depth of 20 cm. Soil was collected well within crops, not near headlands, so as to avoid any edge effects. For ease of sampling, fields were sampled following harvest.

Different cultivars and crop classes were included in the survey. The survey included nine cultivars: three resistant to PRR (Q183⌽, Q251⌽ and Q231⌽) accounting for 11% of the survey samples; five intermediate (Q200⌽, Q208⌽, KQ228⌽, Q250⌽ and Q253⌽) accounting for 79% of the survey samples, and two intermediate-susceptible (Q237⌽ and SRA3⌽) accounting for 10% of the survey samples.

A minimum of nine samples was taken from a minimum of six farms in each of the eight Tully sub-districts, with a total of 74 samples across the Tully Mill area. Farms delivering less than 1,000 t were excluded from the survey and those sampled previously in the 2013 survey were re-sampled where possible. Changes in farm ownership and layout from 2013 were minimal and about 90% of farms surveyed in 2018 were those surveyed in 2013.

All samples were processed at the SRA Tully laboratory using the same method as in Shannon *et al.* (2013). The parameters for determining the severity of PRR from numbers of spores in fallow fields and cropped fields are given in Table 1. We compared these spore numbers with those in the 2013 survey with the Kruskal-Wallis one-way non-parametric test in Statistix 10 (Analytical Software); data were not normally distributed, Shapiro-Wilk normality test. Comparison was made with levels in a 2004 survey (Magarey *et al.* 2006), but full data from that survey was not available for statistical analysis and only means are available for comparison.

Table 1. PRR severity levels based on spore counts (spores/kg soil) in fallow and cropped fields.

Severity	Fallow	Cropped
Low	0–30,000	0–50,000
Medium	30,000–60,000	50,000–100,000
High	>60,000	>100,000

Overall levels of resistance were calculated from the sum of the PRR resistance level of each cultivar and the proportion of planted areas of that cultivar in the supply to Tully Mill in 2018. Potential yield losses and their values were calculated from those values and yield losses as determined by Magarey (1994), with average yields assumed to be 87 t/ha with a value of $37 per tonne of cane. This calculation did not consider harvesting costs, being simply based on the lost yield.

RESULTS

District incidence and severity

The survey results highlighted that PRR remains widespread and of significant severity across the Tully mill area (Table 2, Figure 1). Although many farms remain infested (Table 2), disease severity (as measured via spore counts/kg soil) has dropped significantly since 2013 ($p < 0.0382$); mean of 92,238 spores/kg soil in 2013 and 46,889 spores/kg soil in 2018, a decrease of 49% between 2013 and 2018.

Table 2. Proportion of farms in each district infested.

District	% Farms in survey infested		
	2004	2013	2018
El Arish	100	100	89
Feluga	92	89	100
Euramo	77	100	89
Syndicate	58	86	89
Lower Tully	87	100	100
Riversdale	58	34	55
Murray	64	86	86
Kennedy	–	75	56

The 2018 mean spore counts in each sub-district are shown in Figure 1 and compared to data collected in 2004 and 2013. The 2018 data suggest that crop losses arising from PRR are likely to be very common in El Arish and significant in Feluga, Syndicate and Lower Tully.

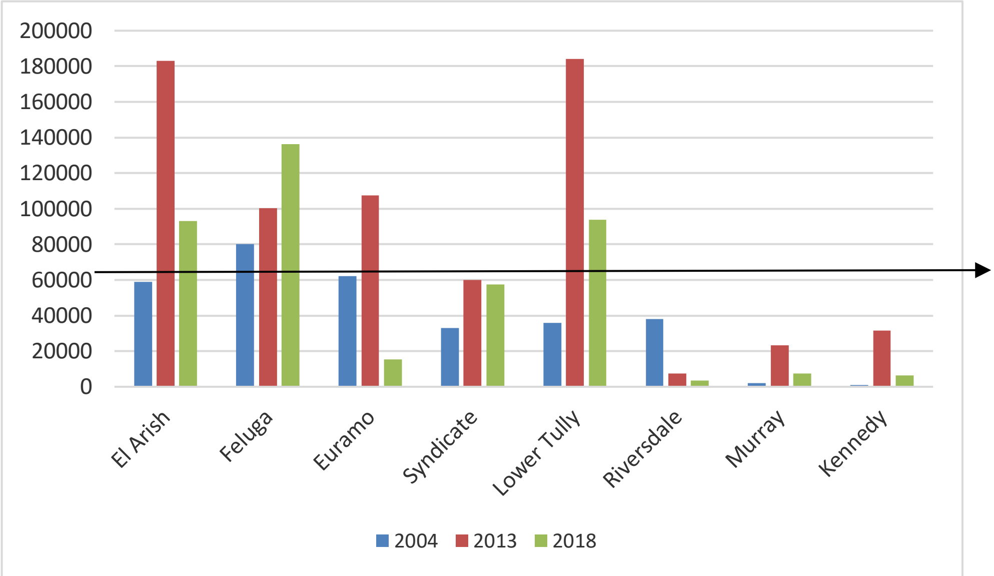

Figure 1. Comparison of mean spore counts in each of the 2004, 2013 and 2018 surveys as influenced by sub-district within the Tully Mill area, with the 50,000 spores/kg soil low infestation threshold for crops (from Table 1) included.

The propensity for the disease to reach severe spore levels is illustrated in Figure 2; spore counts over 200,000 spores/kg are exceptionally high. In Feluga and El Arish, the spore count on two farms exceeded 900,000 spores/kg and 600,000 spores/kg, respectively, suggesting very high yield losses are occurring in these crops, (both were sprayed out and replanted with resistant cultivars after the survey).

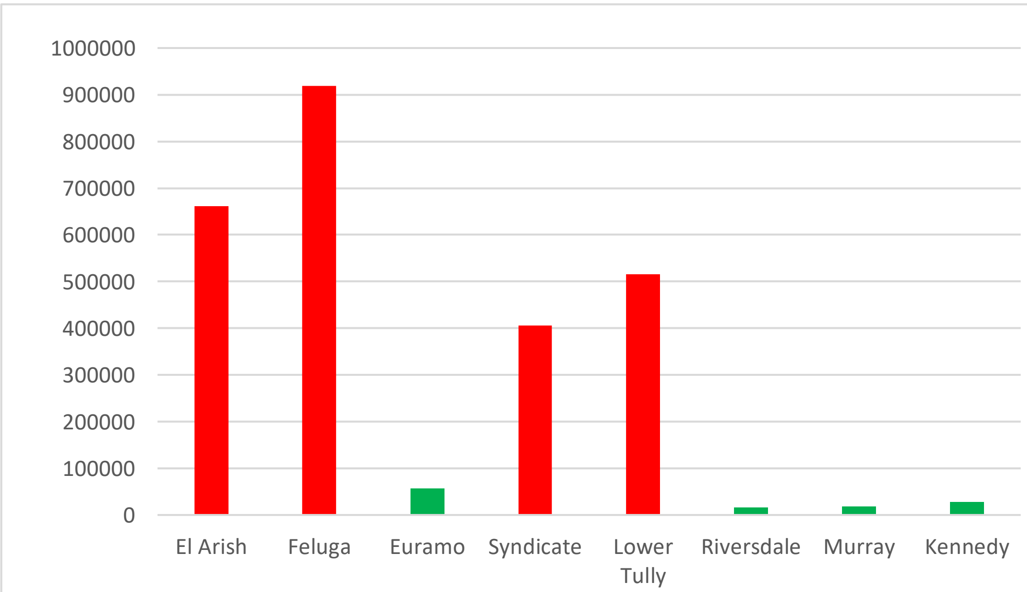

Figure 2. Highest spore count recorded in each district in the 2018 Tully Mill area survey (red = above the yield loss threshold; green = negligible losses.

Influence of cultivar

Which cultivar is grown strongly influences spore counts, through their resistance or susceptibility to infection. Severity, as influenced by cultivar in the 2018 survey, is shown in Figure 3.

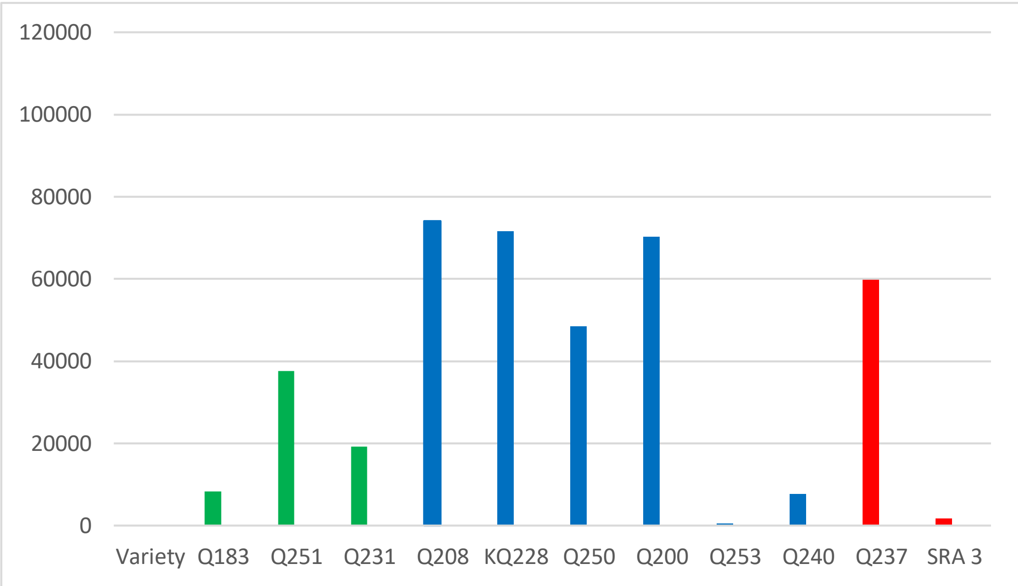

Figure 3. Average spore counts for each cultivar in the 2018 Tully Mill area survey (green = resistant cultivar; blue = intermediate cultivar; red= intermediate-susceptible cultivar).

Resistance levels in the cane supply

Given that cultivar resistance is the most economical method for managing the disease, choice of cultivar is paramount for good disease control. Figure 4 shows the cultivar choices made by Tully Mill area farmers and the changes that have occurred since 1980.

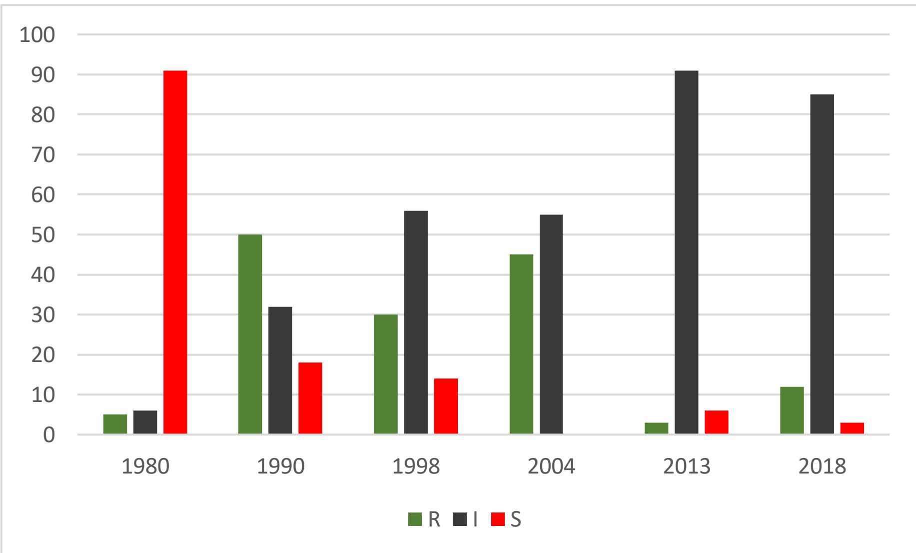

Figure 4. PRR resistance in crops as a proportion of the cane supply in the Tully mill area, 1980–2018. A higher proportion of cultivars of intermediate resistance (versus resistant) is evident in recent years.

Economic losses

Calculations taking into account pachymetra severity across the Tully Mill area in 2018, average crop yields, and the relative resistance of crops in the area and estimated crop losses in each disease severity category suggested a loss of 95,100 tonnes of cane. The gross value of this cane (at $37/t) is $3.5 million. This is less than the estimate for the losses in 2013. (Table 3).

Table 3. Estimate economic loss from PRR in 2013 (Shannon *et al.* 2013) and 2018.

Year	Estimated cane lost (t)	Value of cane ($/t)	Estimated loss ($ million)
2013	172,600	32	5.52
2018	95,100	37	3.52

DISCUSSION

Soil-borne diseases such as PRR are often overlooked because of the lack of above-ground evidence. Our survey has highlighted that severe levels of spores of *P. chaunorhiza* are present in some Tully districts, although levels appear to have decreased in recent years.

Strategic surveys are a good way for determining the distribution and severity of PRR. In two previous surveys, the El Arish, Feluga, Syndicate and Lower Tully districts were the worst affected. Although the levels of infestation were lower in the 2018 survey than in 2013, these districts generally remain the worst affected.

Reasons for the decrease in spore numbers are likely to rest heavily on the change in suite of cultivars grown. However, given that the percentage of resistant cultivars in 2018 was still only 12% (albeit an increase from 3% in the 2013 survey), the reason for the decrease in spore numbers may well be an environmental factor such as the dry years experienced since 2013. However, three of the four major cultivars (Q208$^{\phi}$, KQ228$^{\phi}$ and Q200$^{\phi}$) have high average counts that are above the economic threshold of 50,000 spores/kg. Median data suggest that, although average spore counts are relatively high, the data are strongly influenced by high counts on a few farms.

The loss of PRR-resistant, high yielding, but smut-susceptible cultivars since the 2006 smut epidemic has led to an increase in cultivars of intermediate resistance to PRR and a trend towards overall disease susceptibility. Of the six PRR-resistant cultivars now available in Tully (Q183$^{\phi}$, Q231$^{\phi}$, Q251$^{\phi}$, Q242$^{\phi}$, Q245$^{\phi}$, Q247$^{\phi}$, SRA6$^{\phi}$), all but Q245$^{\phi}$ are being commercially recommended. However, most of these fit into ‘niche’ growing environments, given their optimal performance on some soil types and locations experiencing specific pest and disease pressures. Cultivar SRA6$^{\phi}$ is showing promise to be a more general cultivar and will play a greater role in the next 2–3 years, but the need for high-performing resistant cultivars with general adaptation remains.

Economic loss calculations predict lost production valued at $3.5 million per year. The disease is almost certainly still the most important one affecting the Tully Mill area and it warrants continued focus by the local industry. The 2013 and 2018 surveys will be used as benchmarks for cultivar management in the Tully region, and while the severity has appeared to drop in this survey, there is no room for complacency. There remains a need to release other high-yielding, PRR-resistant cultivars to manage the disease in the longer term.

We suggest that a proactive stance be taken on the need for on-going surveys to be conducted at future regular intervals. It seems very likely that PRR will remain a disease of high significance and will require on-going management. There will be a need to balance retaining sufficient resistance in commercial cultivars with keeping as many high-yielding cultivars within the commercial production germplasm. If the balance shifts too far either way, productivity will be compromised. Surveys offer the ability to gauge the effectiveness of the disease control program.

We also highlight the importance for individual cane farmers to assay soils from their individual crops. Our survey has not only highlighted the presence of badly affected crops but has also shown that some crops are only lightly affected or not affected at all. In these cases, farmers can afford to plant cultivars of greater susceptibility than they otherwise may have considered. This may provide cultivar options otherwise thought unsuitable.

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