PACHYMETRA ROOT ROT; YIELD LOSS ESTIMATES SUGGEST THE NEED FOR CONTROL IN QUEENSLAND SUGARCANE FIELDS

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INTRODUCTION

Of the root diseases affecting Queensland sugarcane crops, Pachymetra root rot (caused by *Pachymetra chaunorhiza* Croft & Dick) (1) is the most widely recognised. Other causes of poor root health include pathogenic nematodes and dematiaceous fungi (2). Pachymetra root rot is a major root disease of commercial sugarcane crops in Queensland. Recently the disease was found in the cane-growing areas of northern New South Wales, an area that was previously considered Pachymetra-free. The disease has not been reported from any other sugarcane growing country and has been detected only in fields with a history of sugarcane cropping (3). The main symptoms are a soft, flaccid trot of the primary sugarcane roots leading to poor root system anchorage, deficient feeder root development, unthrifty growth and reduced commercial yield (3). A direct count method has been developed (4) to count pathogen survival structures (oospores produced in rotted roots), and this method provides an ideal assay for the disease. The assay forms the basis of a commercial service offered to cane-farmers that allows them to manage the disease according to disease severity. The long-term survival of oospores necessitates well planned disease management strategies, since it takes a long time to reduce escalated soil inoculum levels. Resistant varieties are the main management tool; short or long-term fallows are of lesser immediate benefit. This paper reviews yield loss experiments, and relates the results to inoculum densities in Queensland cane fields as recorded through the commercial assay service.

MATERIALS AND METHODS

Yield loss assessment: An efficacious fungicide for Pachymetra root rot has not been found (5). For this reason, yield loss effects have been measured indirectly. Three types of experiments have been conducted:

i. correlating soil inoculum density with yield, using multiple plots and a single susceptible variety;

ii. regressing yield loss with cultivar resistance data, using paired plots of cultivars growing in areas of high and low disease severity; and assessing the relationship between yield and Pachymetra resistance in plant improvement selection trials incorporating clones of variable resistance to the disease.

Pachymetra assay: Disease assessment in experimental plots has been described (4). The method involves the selective collection of soil particles 38-63 um in diameter, using a wet sieving technique. These deposits are decolourised and stained so that oospores of *P. chaunorhiza* may be observed when viewed microscopically.

Resistance screening of clones/cultivars: A glasshouse technique has been developed to enable disease resistance ratings to be applied to clones and cultivars (6). Ratings from 1 (resistant) to 9 (susceptible).

Yield loss experiments:

Experiment 1: The first experiment was conducted in the period 1989-1990 (3). The site of a former plant improvement experiment was selected, where approximately 40 clones (two replicates) of varying resistance to the disease had grown. These clones lead to varying levels of the disease in plots, according to their Pachymetra resistance. In the previous plant improvement experiment, the clones were grown for 4 years before the experiment was terminated. The trial area was subsequently cultivated and prepared for replanting. After initial preparation, the previous plots were re-marked and soil samples collected (8 x 50mm auger sampled to 45cm depth); it was previously recognised that cultivar resistance affects soil inoculum density (7). The area was then re-planted with a susceptible cultivar (Q90). Yields were assessed 12 months later in the `plant' crop; the sugarcane was hand-, rather than machine,-harvested. Yield was correlated to inoculum density using data from each plot.

Experiment 2: In the second experiment, a field was located where two cultivars (highly resistant and highly susceptible) had grown side-by-side. Pachymetra assay of soils from each section of the cropping area revealed low and high (respectively) inoculum densities in these areas. An experiment was planted at this site incorporating ten cultivars, ranging from resistant ('1' rating) to susceptible ('9'), with paired plots bridging the high and low disease areas (2). Yield was measured in all plots after 12 months, using a commercial harvester. Pachymetra resistance was related to yield loss in the paired plots through regression analysis (3).

Experiment 3: In the third approach, the yield of clones in plant improvement trials was related to their Pachymetra resistance using regression analysis. It was postulated that if Pachymetra reduced sugarcane yield in susceptible cultivars, they would on average yield less than resistant cultivars - though it is recognised that high genetic yielding ability in cases may lead to higher yields in some susceptible cultivars (2). Analyses were undertaken on several plant improvement trials (2).

RESULTS

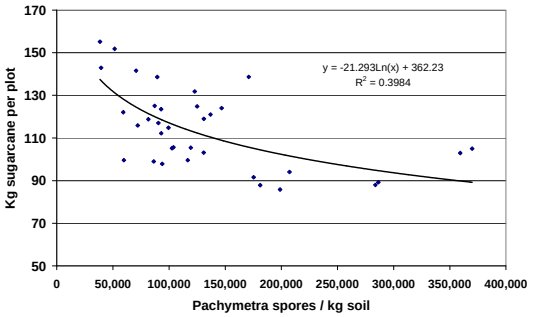

Figure 1. Relationship between *Pachymetra* inoculum and sugarcane yield in a field trial in northern Queensland (3).

Experiment 1 The relationship between inoculum density and yield was significant in the susceptible variety Q90. Kilograms sugarcane per plot of harvestable product were approximately 40% lower at inoculum densities of 300,000 spores/kg soil, compared to 38,000 spores/kg (3; Figure 1). Inoculum densities above 50,000 spores/kg lead to significant yield losses.

Sugar content in the harvested product remained unaffected (3).

Experiment 2 The comparison of yields in paired plots of a range of cultivars growing under high and low disease severity showed that the disease may reduce yield

in highly susceptible cultivars, while resistant cultivars remain largely unaffected (figure 2). Lower stalk populations again were the main reason for the reduced yields. Sugar content was again largely unaffected (2).

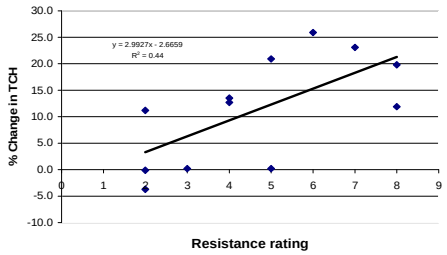

Figure 2. The relationship between Pachymetra resistance and the percent loss in crop yield (TCH - tonnes cane per ha) in a central Queensland field trial (5).

Experiment 3. Analyses conducted in plant improvement experiments with over 80 clones per trial suggested there was a relationship between Pachymetra resistance and yield in areas where the disease was endemic (5). Where the disease did not occur, the authors showed there was no relationship between resistance and yielding ability (5). Estimated losses were 10-20% (susceptible clone yield vs resistant clones - on average) (Figure 3).

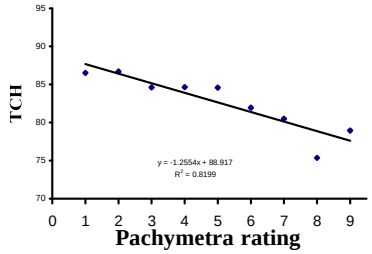

Figure 3: Relationship between Pachymetra resistance and yield (TCH - tonnes cane/ha) using average data from five trials (5).

Pachymetra severity in Queensland canefields: The results from the commercial assay laboratory, for the years 1997-2003, were summarised by district, severity and the number of samples assayed/district. Figure 4 illustrates a break up of these data to show the variation in inoculum density by dist^{r}ict.

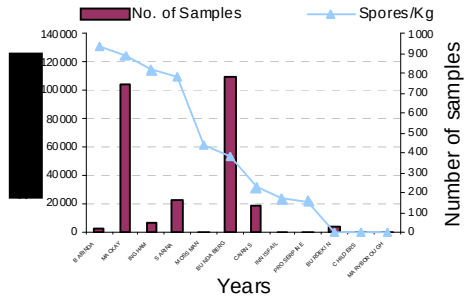

Figure 4. Number of samples assayed for Pachymetra root rot by district and the mean inoculum density by district (1997-2003).

DISCUSSION

Yield loss research clearly shows that Pachymetra root rot is able to significantly reduce the yield of sugarcane crops significantly. In susceptible cultivars; losses may be as high as 40% (4) but are more regularly around 20%. All three experimental approaches confirm the importance of Pachymetra root rot. In the late 1970s, with the widespread cultivation of the susceptible cultivar Q90, low yielding crops were not the only concern since associated stool tipping (where the sugarcane plant and root system is pulled from the ground at harvest due to poor stool anchorage) resulted in factory processing problems and failed `ratoon' crops. The disease remains an important challenge for the Australian sugar industry.

The data from the commercial assay laboratory suggest that inoculum densities in the Mackay and Bundaberg areas are a cause for concern. Average densities above yield loss thresholds (around 50,000 spores/kg) suggest losses may not only be occur^{r}ing - but are common. In recent times, industry groups in the Mackay area have been paying more attention to control of the disease; the intention is for extension programs to highlight the issue to canefarmers.

Data presented in Figure 2 clearly shows that losses can be reduced to near zero by planting varieties possessing a high level of resistance. Cultivar resistance is now widely adopted as the best means to cont^{r}ol Pachymetra root rot. In the mid-1980s, purposeful selection for disease resistance in the sugarcane breeding program led to commercial cultivars with higher levels of resistance. The resistance to Pachymetra root rot in commercial crops has been quantified recently by (8). The release of resistant cultivars to industry in several regions has increased `crop' resistance to the disease, and reduced yield losses.

Pachymetra root rot is likely to be the disease causing the highest current economic losses in Queensland (8). Further targeted control programs are needed in some Queensland districts to maximise yield, and to minimise Pachymetra-associated losses. Breeders will need to consult with the local industry to determine the optimum strategy for disease control.

ACKNOWLEDGEMENTS

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REFERENCES

I. Dick MW *et al.* (1989) A new genus of the Verrucalvaceae (Oomycetes). *Botanical Journal of the Linnaeun Society* **99:** 97-113.

2. Magarey RC *et al.* (2004) Influence of Pachymetra root rot resistance on yield losses in central Queensland. *Proceedings Australian Society Sugarcane Technologists* **24** (CD-ROM).

3. Magarey RC (1994) Effect of Pachymetra root rot on sugarcane yield. *Plant Disease* **78:** 475-477.

4. Magarey RC (1989) Quantitative assay of Pachymetra chaunorhiza, a root pathogen of sugarcane in Australia. *Phytopathology* **79:** 1302-1305.

5. Magarey, RC, Bull JI (2003) Relating cultivar Pachymetra root rot resistance to sugarcane yield using breeding selection trial analyses. *Australian Journal of Experimental Agriculture* **43**: 617-622.

6. Croft BJ (1989) A technique for screening sugarcane cultivars for resistance to Pachymetra root rot. *Plant Disease* **73**: 651-654.

7. Magarey RC, Mewing CM (1994) Effect of sugarcane cultivars and location on inoculum density of *Pachymetra chaunorhiza* in Queensland. *Plant Disease* **78***:* 1193-1196.

8. Magarey RC (2006) Economic effect of diseases: regional variation in Queensland. *Proceedings of the Australian Society of Sugar Cane Technologists*, **28**: 226-231.