BUREAU OF SUGAR EXPERIMENT STATIONS

QUEENSLAND, AUSTRALIA

FINAL REPORT

SRDC PROJECT BS33S

PACHYMETRA CHAUNORHIZA AS A FACTOR INVOLVED IN STOOL TIPPING IN NORTH QUEENSLAND

by

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SUMMARY

The objectives of this project were to determine the soil and environmental factors favouring Pachymetra root rot, and how these contributed to stool tipping in the moderately resistant and susceptible varieties Q117 and Q124.

Forty nine farms were studied, spread over a sharp rainfall gradient from Deeral (> 4 000 mm) to Meringa (< 1 750 mm) and a number of soil types and topographical formations. The two varieties were co-planted at 11 sites, allowing direct comparisons of the effect of these varieties on *Pachymetra* soil inoculum density and stool tipping.

Soil from each site was analysed for a range of chemical and physical properties and assayed for oospores of *P. chaunorhiza*. In July 1990, natural levels of lodging and stool tipping were recorded, and multiple regression analyses were subsequently undertaken using soil data.

It was found that:

- there was considerably more stool tipping in Q124 than in Q117.
- ratooning habit was the most likely factor contributing to stool tipping in Q124.
- Pachymetra root rot was not significantly correlated with tipping in either variety.
- sugarcane variety had the greatest influence on *Pachymetra* inoculum levels of all the factors measured.
- rainfall and levels of calcium and zinc were significantly correlated with *Pachymetra* inoculum density.

BACKGROUND

Stool tipping has been a problem to the sugar industry in northern Queensland for many years. It is defined here as the leverage of part or all of the sugarcane stool from the ground when the crop lodges.

For the canefarmer, stool tipping leads to reduced ratoon stool numbers and yields, and to higher levels of extraneous matter in the cane supply. For the sugar factory, stool tipping causes various factory problems and increased maintenance because of soil in the cane supply.

Formerly, stool tipping occurred only in some minor varieties and posed no threat to the farmer or manufacturer. However in the late 1970's, the major variety Q90 showed excessive levels of stool tipping thought to be associated with the problem called Poor Root Syndrome (PRS). Research by BSES identified the previously unknown pathogen *Pachymetra chaunorhiza* as a major component of PRS. Since then varieties of greater resistance to *Pachymetra* have been grown in northern Queensland and the amount of stool tipping has decreased. Recently introduced varieties such as Q124 have exhibited high levels of stool tipping and research was initiated to see if Pachymetra root rot was involved.

PROJECT OBJECTIVES

- To correlate soil inoculum density of *P. chaunorhiza* with stool tipping in crops of selected varieties (Q117 and Q124) in the Babinda and Cairns districts.
- To correlate *P. chaunorhiza* inoculum density with soil and environmental parameters.
- To correlate environmental parameters and soil characteristics with stool tipping.

METHODOLOGY

Field site selection

The northern part of the Babinda mill area and the Mulgrave mill area were chosen for study as the area spans a gradient in rainfall (< 1 750 to > 4 000 mm), and field observations suggested that Pachymetra root rot severity varied across this gradient. Second ratoon fields only were included to avoid any complicating effects of crop class on inoculum density and stool tipping.

Twenty nine fields of Q124 and 23 fields of Q117 were selected in October, 1989. Eleven of these sites were fields co-planted with both varieties. This allowed a paired comparison of stool tipping and *Pachymetra* inoculum density.

Soil sampling and analysis

Soil sampling for chemical and physical analyses and for *Pachymetra* assay was undertaken in December 1989. Plots eight rows by 10 m were marked out and eight soil cores were taken from random positions within each plot. Cores were taken through the sugarcane stools to a depth of 450 mm using a 40 mm diam Edelman auger (Eijkelkamp, Netherlands). Cores were bulked and mixed thoroughly by hand before assays were undertaken (Magarey, 1989). Representative samples were air dried and analysed in the BSES Mackay and Tully laboratories for: pH, SEC (Specific Electrical Conductivity), P, Cu, Zn, Ca, Mg, Na, K, S, Total-N, Organic C, % sand, % silt and % clay. Rainfall data were obtained from 30 year mean annual rainfall figures provided by the Bureau of Meteorology.

In March 1990 the monitoring of soil moisture using gypsum blocks was initiated. Gypsum blocks proved unsuitable because they dissolved under the acid soil conditions and soil moisture was subsequently monitored on an oven dry (105°C, until constant weight) gravimetric basis. Soil samples were collected for this purpose in October and November 1990, and March, April and May 1991. Gravimetric data were converted to water potential (Ψ) using data from a pressure plate apparatus (Soil Moisture Equipment Co, Santa Barbera).

Gravimetric moisture was calculated for each soil for Ψ of 15, 6, 3, 2, 1, 0.5 and 0.1 bar. A power curve with the following general equation was fitted to each data set:

SOIL MOISTURE = $(\Psi)^{-b} \times C$ where b and c are constants

From this equation, Ψ was calculated for each soil for each sampling time.

Assessment of lodging and stool tipping

The extent of lodging and stool tipping in crops was assessed in July 1990 at each site, using selected 35 m row lengths. Lodging was assessed according to two parameters:

- **Proportion of plot which had lodged:** a subjective assessment on a 0-10 scale where 0 indicates no lodging and 10 infers that all stalks had lodged. Stalks were considered lodged when they no longer were in a vertical position.

- **Severity of lodging:** a subjective assessment on a 1-10 scale with 1 referring to slight stalk displacement and 10 inferring that all lodged stalks were lying flat on the ground.

Stool tipping was also assessed according to two parameters:

- **Percentage of stools which had tipped:** an objective assessment using data on total stool numbers and number of tipped stools. Stools were considered to have tipped when upward stool displacement had occurred.

- **Severity of tipping:** a subjective assessment on a 1-10 scale where a rating of 1 referred to slight stool movement and a rating of 10 inferred that the whole stool had been displaced and was resting on the soil surface.

A stool tipping device, developed in SRDC Project BS32S to determine the force required to tip sugarcane stools, was tested at selected sites. There appeared to be too much variability in the data to obtain reliable results, so this report deals only with natural stool tipping data.

Following harvest of the 1990 crop, block yields for each field were obtained. Where two varieties were planted in the same block and mill records did not differentiate the yield of each variety, data for those blocks were omitted from the statistical analyses.

Statistical analysis

Separate multiple regression analyses were undertaken using the Statistix, Version 3 package (Analytical Software, MN). Analyses were made with percent tipped stools, tipping severity and *Pachymetra* spore count as the dependent variable. Some illustrations were prepared using the 'Grapher' package (Golden Software, Colorado).

RESULTS

Extensive lodging and stool tipping were observed in crops of Q124 but relatively little was seen in Q117. These data are summarised in Table 1.

Table 1

Lodging and stool tipping in Q117 and Q124 second ratoon crops, Babinda and Mulgrave Mill areas (mean figures over all sites, using 1-10 scale)

Variety	Proportion plot lodged	Lodging severity	Percent plot tipped	Tipping severity
Q117	4.0	4.1	9.6%	0.9
Q124	6.5	6.5	47.9%	2.7

Stool tipping

No relationship was found between *Pachymetra* inoculum density and percent tipped stools in either variety (Figs 1 and 2). A strong relationship was found between lodging severity and the percentage of tipped stools in Q124 but no relationship was observed in Q117 (Figs 3 and 4). This suggests that whenever Q124 lodges past an angle of approximately 45°, significant levels of tipping result. When limited numbers of Q124 stools were excavated, a two-tiered stool structure was apparent. A relatively weak connection between the surface sections of the stool and deeper portions was seen in each stool examined. It appears that surface sections of Q124 stools are relatively easily detached from the lower sections and surface portions tip when the cane lodges. Ratooning is not unduly affected since ratoon shoots continue to be produced by the deeper portions of the stool.

In multiple regression analyses with percent tipped stools as the dependent variable, sugarcane variety (Q124) was associated with higher levels of tipping and Total-N with less tipping. The calculated regression equation is:

Percent tipped stools = 1.1585 + 30.090 x **Variety** - 347.28 x **Total-N**

Significant at 5% level, with $R^2 = 0.4195$

In regressions with the individual varieties, no measured parameters significantly influenced stool tipping in Q124. Higher SEC (Specific Electrical Conductivity) was associated with more tipping in Q117 and higher Ca with less tipping; the regression equation is

Percent tipped stools (Q117) = 4.2361 + 319.97 x **SEC** - 5.0775 x **Ca**
Significant at 0.5% level, with $R^2 = 0.5015$

Factors affecting tipping severity

Stool tipping severity was linked to lodging severity in the analyses. The regression equation for the data from both varieties is:

Tipping severity = 1.4328 + 0.3617 x **Lodging severity** + 0.8844 x **Variety**
Significant at 2.5% level, with $R^2 = 0.5951$

As expected, the severity of tipping was significantly greater in Q124, but these analyses also showed that higher levels of Cu were associated with less tipping.

Tipping severity (Q124) = 0.9698 + 0.4464 x **Lodging severity** - 0.6662 x **Cu**
Significant at 5% level, with $R^2 = 0.6077$

Surprisingly, in the analysis with Q117 data, higher Cu levels were associated with more severe tipping.

Tipping severity (Q117) = -1.3307 + 0.2170 x **Lodging severity** + 0.7634 x **Cu**
Significant at 1% level, with $R^2 = 0.4881$

Factors affecting *Pachymetra* inoculum density

Regressions with *Pachymetra* oospores as the dependant variable indicated that sugarcane variety (Q124) and higher rainfall were associated with higher inoculum densities, and higher Zn levels with lower inoculum densities. The regression equation is:

Inoculum density = -207.93 + 148.77 x **Variety** + 0.0686 x **Rain** - 23.515 x **Zn**
Significant at 2.5% level, with $R^2 = 0.5504$

Inoculum densities under crops of Q124 were approximately four times higher than those under Q117, both at the 11 paired sites and in data from all sites. The varieties have resistance ratings of 4 (Q117) and 6 (Q124), based on a 1 (resistant) to 9 (susceptible) scale.

In analyses with Q124 alone, higher rainfall was associated with higher spore counts and higher Ca levels with lower spore counts.

Inoculum density (Q124) = -71.353 + 0.1208 x **Rain** - 32.747 x **Ca**
Significant at 2.5% level, with $R^2 = 0.6017$

With Q117, rainfall alone was significantly associated with inoculum density.

Inoculum density (Q117) = -34.201 + 0.0298 x **Rain**
Significant at 0.1% level, with $R^2 = 0.4722$

Factors affecting yield (tonnes cane/ha)

Analyses with all data, and with each individual variety, suggested that higher rainfall had a negative effect on yield in the 1990 crop. The regression equations are:

Yield = 114.29 - 0.0101 x **Rain**
Significant at 0.1% level, with $R^2 = 0.2635$

Yield (Q124) = 111.79 - 20.771 x **Mg** - 0.0846 x **Rain** + 6.0468 x **Ca**
Significant at 0.1% level, with $R^2 = 0.6074$

Yield (Q117) = 121.78 - 0.0129 x **Rain**
Significant at 0.5% level, with $R^2 = 0.3385$

Higher Mg levels were associated with lower yields and higher Ca with higher yields in Q124. The relationship between Mg and yield is unexpected and most likely represents an effect of a correlated factor on yield rather than an effect of Mg. Stool tipping appeared to have no influence on the 1990 crop yield.

DISCUSSION

Extensive stool tipping occurred in Q124 in the 1990 crop. The results from this study suggest that it is not Pachymetra root rot but stool habit which is the main reason for stool tipping in Q124. Research should be initiated to determine if stool tipping in this variety can be reduced by modifying cultural techniques. Research by BSES suggests that more soil around the stool, through deeper planting or 'hilling up', may reduce lodging and stool tipping. If these measures are unsuccessful, control of stool tipping may only be achieved by a change in variety.

Low levels of stool tipping were recorded in Q117. A higher SEC was associated with higher levels of tipping and more Ca with less tipping. It is of interest that Ca is important for the maintenance of root health, and root anchorage of the stool could be a mechanism for the involvement of Ca. Further data should be gathered before conclusions are drawn in regard to the effects of the various elements.

Lodging severity was the main factor controlling tipping severity. This is a logical relationship since the further the cane stalk lodges the more tipping force is exerted on the cane stool. The ambiguous effect of Cu in the two varieties is difficult to explain and more data are required.

The most important factor governing *Pachymetra* inoculum density was sugarcane variety. This result emphasises the importance of variety selection and varietal resistance in controlling Pachymetra root rot. The effect of variety on inoculum density is consistent with data from field experiments investigating the effect of resistance on spore load (Magarey, 1991).

The second most important factor was rainfall. The relationship between soil moisture and root rot has been shown previously in glasshouse experiments (BSES unpubl. results) but this study provides the first data illustrating this effect in the field. It should be noted that rainfall was significant in the statistical analysis while soil moisture at the five sampling times was not. To clarify the relationship between soil moisture and Pachymetra root rot, more intensive sampling over fewer sites may be required.

The relationship between *Pachymetra* and rainfall has important implications. It is clear that *Pachymetra* control is of high priority in the higher rainfall areas. In the lower rainfall areas such as the Little Mulgrave district, control is of much lower priority - the disease may never be a problem there.

Some of the data implicates the involvement of plant nutrition with Pachymetra root rot. With Q124, higher Ca levels were associated with lower spore counts. Calcium is known to be important for root health and low soil levels may favour root disease. In the combined analysis of data from Q117 and Q124, higher levels of Zn were associated with lower *Pachymetra* inoculum densities. Further glasshouse research is warranted to investigate the role of Ca and Zn in sugarcane root disease and with Pachymetra root rot in particular.

The negative influence of rainfall on yield is not unusual in the high rainfall areas of northern Queensland. Poor drainage and lower isolation rates are two mechanisms operating to reduce yields. The effect was consistent in all analyses. The effect of Ca deficiency on yield is well known in northern Queensland and it appears that some of the sites growing Q124 were deficient in this element. With the current low sugar price, some farmers are reducing inputs to reduce costs; this study shows that yield is also being affected.

This study was successful in meeting the project objectives. Pachymetra root rot is not the main factor leading to stool tipping in Q117 and Q124. Further research is needed to address several issues raised by the results from this study.

RECOMMENDATIONS

- Investigate cultivation practices as controls for stool tipping in Q124.

- Initiate glasshouse experiments to determine the effect of Ca and Zn levels on Pachymetra root rot.

- Conduct *Pachymetra* severity surveys in other districts and relate the data to varietal resistance, rainfall and other parameters such as soil moisture, and Ca and Zn levels. This will provide important information for both research and extension purposes.

PUBLICATIONS PLANNED

Factors affecting stool tipping and Pachymetra root rot in two varieties in Mulgrave Mill area. Proc. Aust. Soc. Sugar Cane Technol., 1992 Conf.

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Magarey, R C (1991). The effect of varietal resistance on the epidemiology of Pachymetra root rot. Proc. Aust. Soc. Sugar Cane Technol., 1991 Conf. pp 95-102.

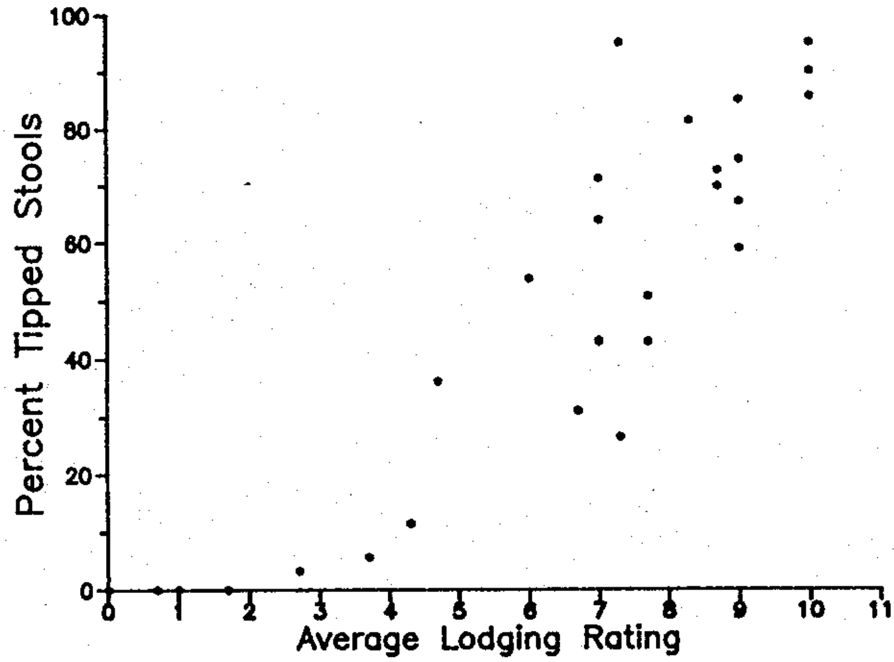


Figure 3: The relationship between lodging severity and percent tipped stools in the variety Q124.

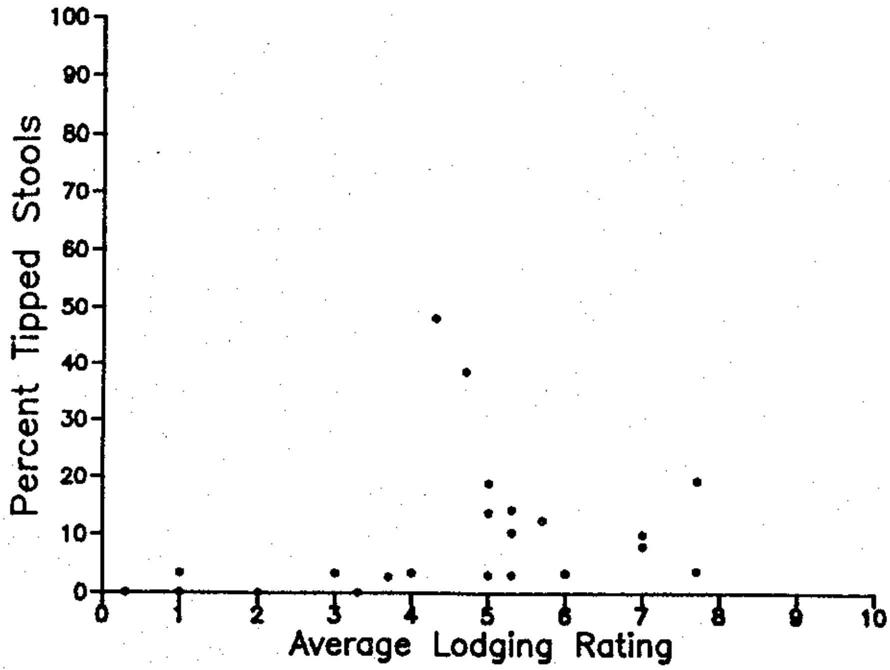
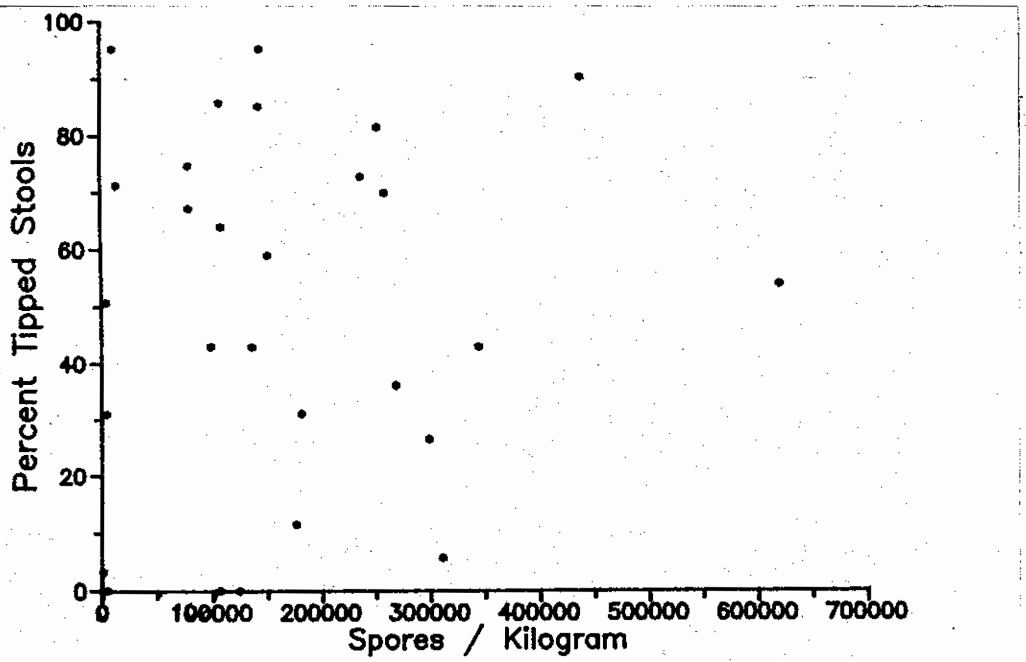


Figure 4: The relationship between lodging severity and percent tipped stools in the variety Q117.



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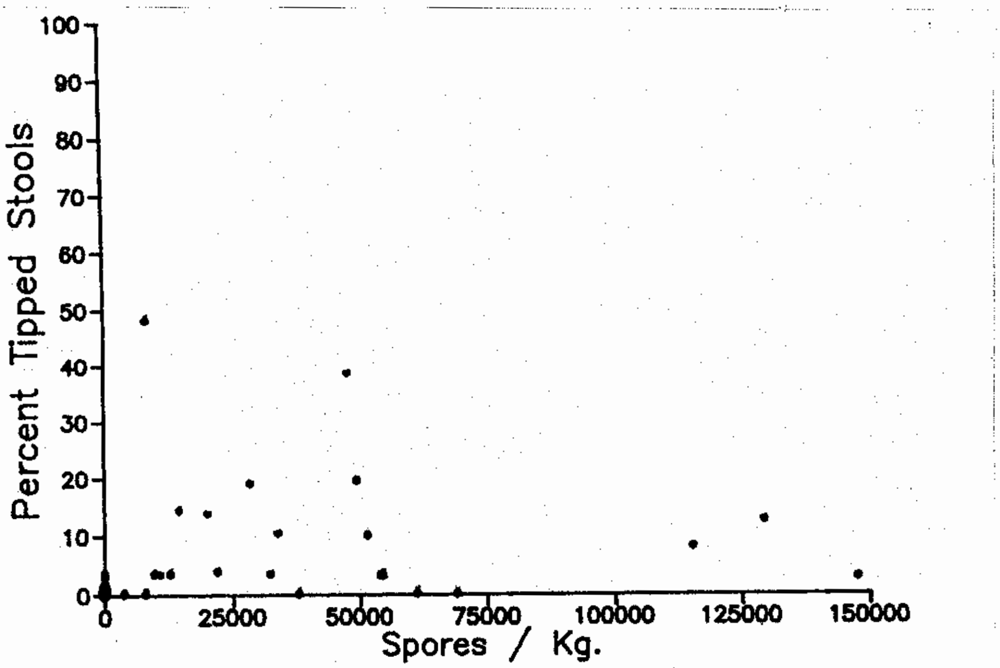
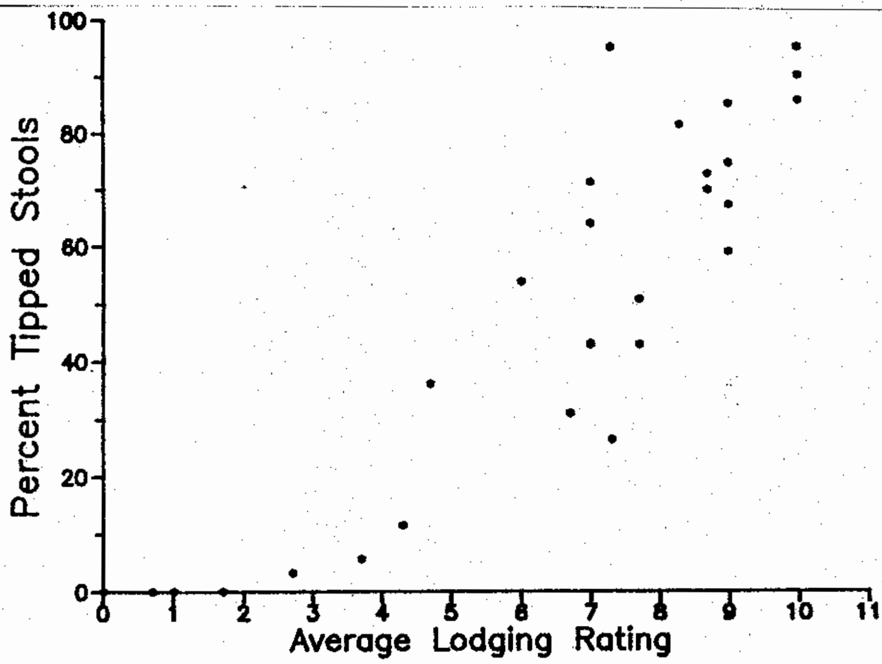


Figure 2: The relationship between *Pachymetra* inoculum density and percent tipped stools in the variety Q117.



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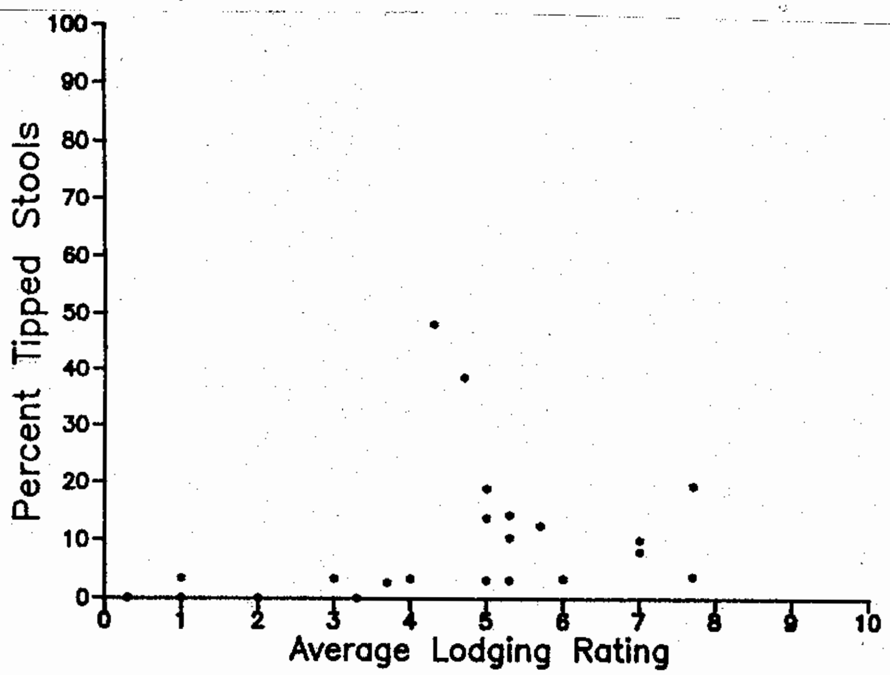

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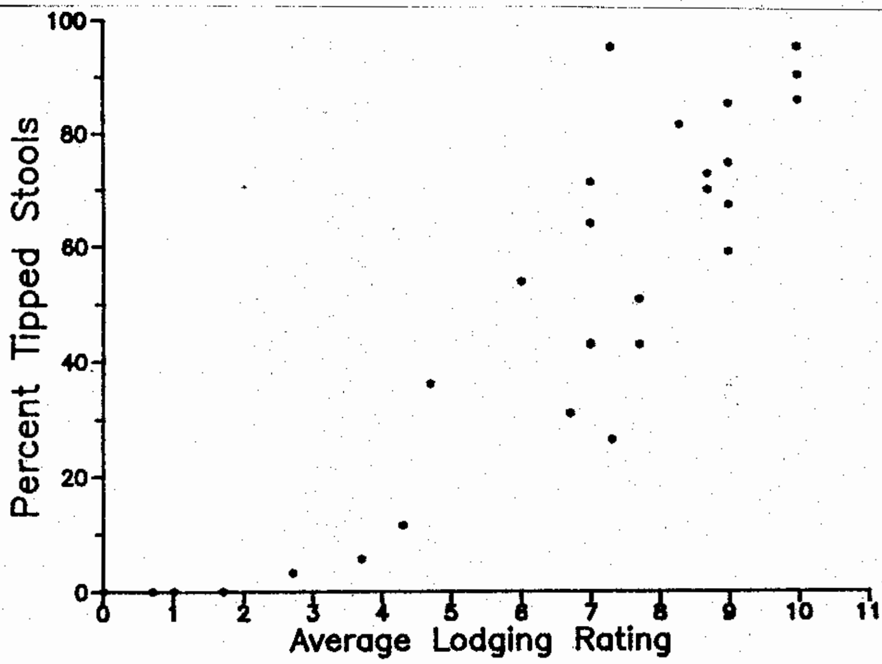

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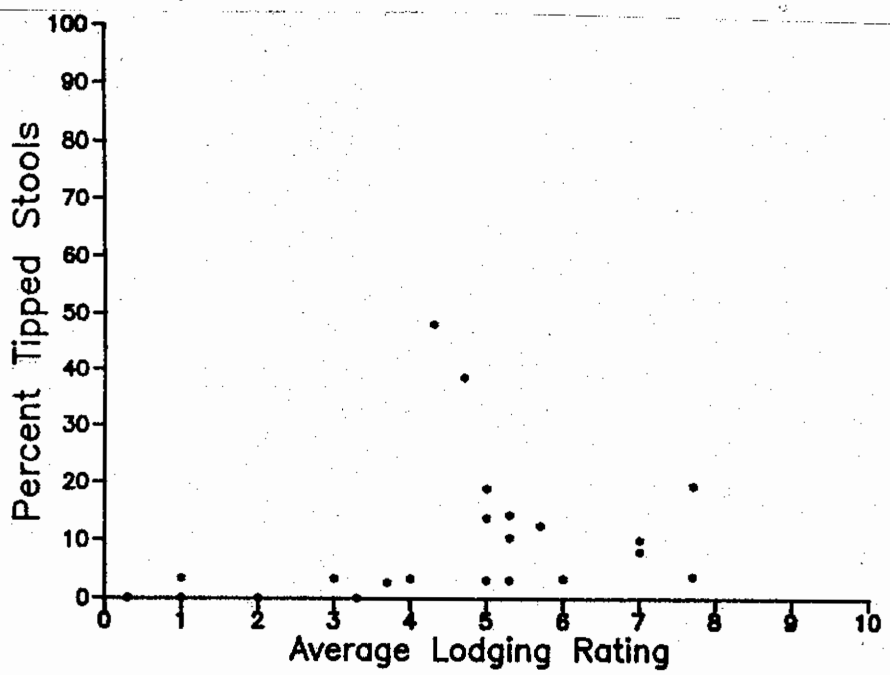

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