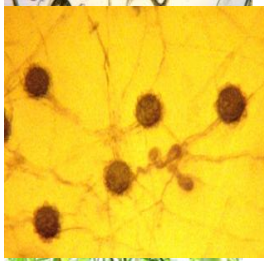
Introgression breeding– development of new germplasms with enhanced resistance to nematode, Pachymetra root rot and smut in Australia







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Australian Government

Sugar Research and Development Corporation

CSIRO PLANT INDUSTRY

Background - nematodes

- Nematodes the most important pests of sugarcane in Australia
- Nematodes cause losses to sugar industry of $80M/year in Australia
- In Australia two most important nematodes are
  - *Pratylenchus zeae* – root lesion nematode
  - *Meloidogyne javanica* – root knot nematode



Background - nematodes

Lesion nematode (*Pratylenchus*)

- Occurs in all soil types
- Lesions in cortical tissue
- Destroys fine roots

Root-knot nematode (*Meloidogyne*)

- Restricted to sandy soils
- Galls on root tips
- Limits root elongation





Collectively, these pests cost the Australian sugar industry >$80m/year

Background - nematodes

Stirling *et al. (ASSCT 2011)* reported in Australia, in pot trials:

- *P. zeae* - population increased 50-100 times in 10-12 weeks on all Australian varieties
- *M. Javanica* - with 13 Australian varieties, nematode populations increased 14-126 times in 90 days

Results from overseas are similar

Background - nematodes

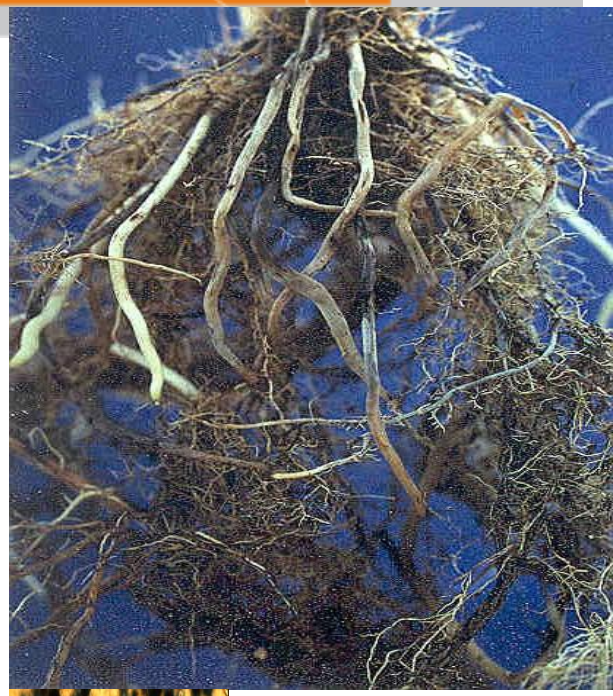
Control

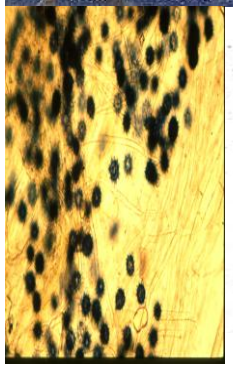
- Crop rotation & fallow only give a short term control
- Chemical control is costly and environmentally damaging, nematicides are highly toxic
- Resistant varieties – would provide sustainable solution

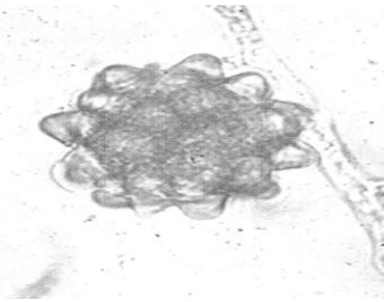
No Australian commercial varieties are resistant to nematodes

Background - Pachymetra root rot

- A Peronosporomycete fungus (*Pachymetra chaunorhiza* Croft & Dick)
- *Pachymetra* has large distinctive knobbly spores
- Recognised since the late 1960s
- First isolated by BSES in 1981
- Causes a soft flaccid rot of the larger roots
- Only known from Australian cane fields
- One of the most serious disease in Australia







Background - Pachymetra

- The disease is favored by warm moist soil
- Some soil types are more susceptible - eg forest loams, but can occur in most soil types
- The disease is wide spread in the northern and central districts and some parts of southern Queensland.
- Control through planting resistant variety
- **Yield losses can be up to 45%**
  - **Hence the 'Maccarone effect'**



Background - Pachymetra

Impact in Australia - post smut era:

- Sugarcane smut has affected our major commercial varieties after its incursion in Queensland in mid-2006
- Smut has caused the loss of many Pachymetra resistant varieties including Q138, Q186, Q205, Q209
- Pachymetra resistance in many commercial varieties can be traced back to introgression with the wild parent, Mandalay (*S.spontaneum)*– unfortunately this line has a high proportion of smut susceptible clones

Background - smut

- Sugarcane smut was first detected in Australia at Kununurra, WA in 1997 BSES
- In 2006 smut detected in major sugarcane growing area Queensland
- Over 70% of Australian commercial varieties were found to be susceptible to smut
- A massive screening program has been undertaken by BSES to screen all commercial varieties
- Clones from various stages of breeding program and foreign varieties are being screened for smut from 2006

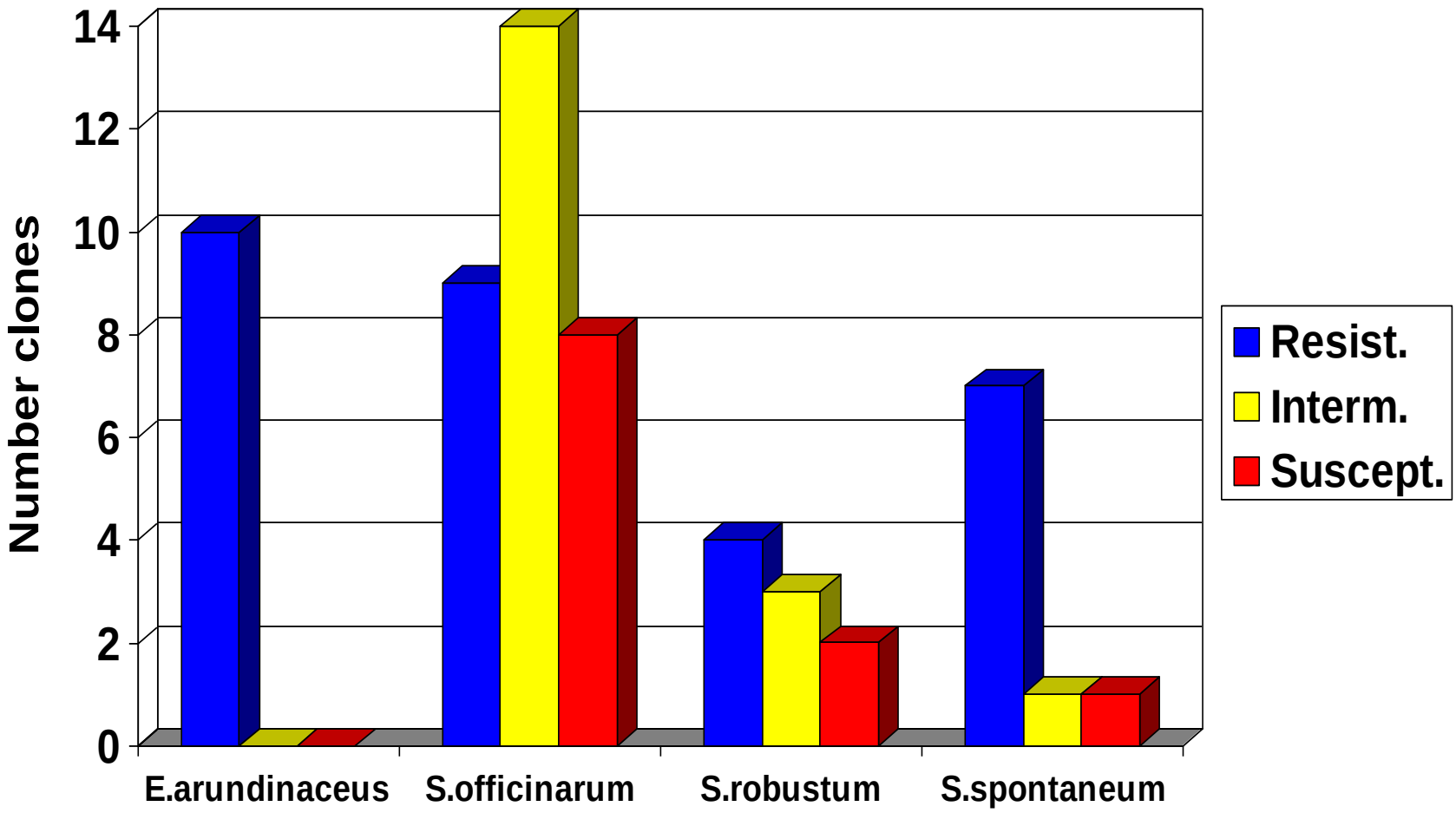
Details are in my previous presentation

Introgression breeding



- BSES-CSIRO and Chinese scientists has been working on introgression program in crossing sugarcane with wild relatives (*Erianthus* spp., *S.spontaneum*) of sugarcane.
- Successfully produced fertile progenies of *E arundinaceus* and *S.spontaneum* crosses with noble cane (*S. officinarum*)
- **Preliminary testing of some clones from crosses using the wild species has shown**
  - High vigour, tolerance to drought and water logging
  - High yield (Foreman et al. 2007, ASSCT)
  - Almost immune to pachymetra root rot
  - Resistant to nematodes (Stirling et al. 2011, ASSCT)

Resistance of *Saccharum* basic germplasm to pachymetra root rot



Screening for resistance

Objectives:

- Step-wise improvement in yield through control of nematodes, pachymetra root rot and smut
- Identify new sources of resistance
- Use resistant clones as parents to introduce the resistance genes breeding program
- Assess resistant hybrids as potential commercial varieties
- Use existing marker information on introgression families to identify potential markers for resistance genes

Screening for resistance

Research plan:

- Screen clones of *E. arundinaceus* & *S. spontaneum* and existing progeny of F1, BC1, BC2 and BC3 crosses for resistance to these three diseases
- Refine methods for screening for resistance to nematodes
- Make new crosses between resistant clones and commercial varieties, and resistant clones use as parents
- Use existing marker information to identify potential markers for resistance
- Resistant clones will be tested for yield potential

Screening for resistance

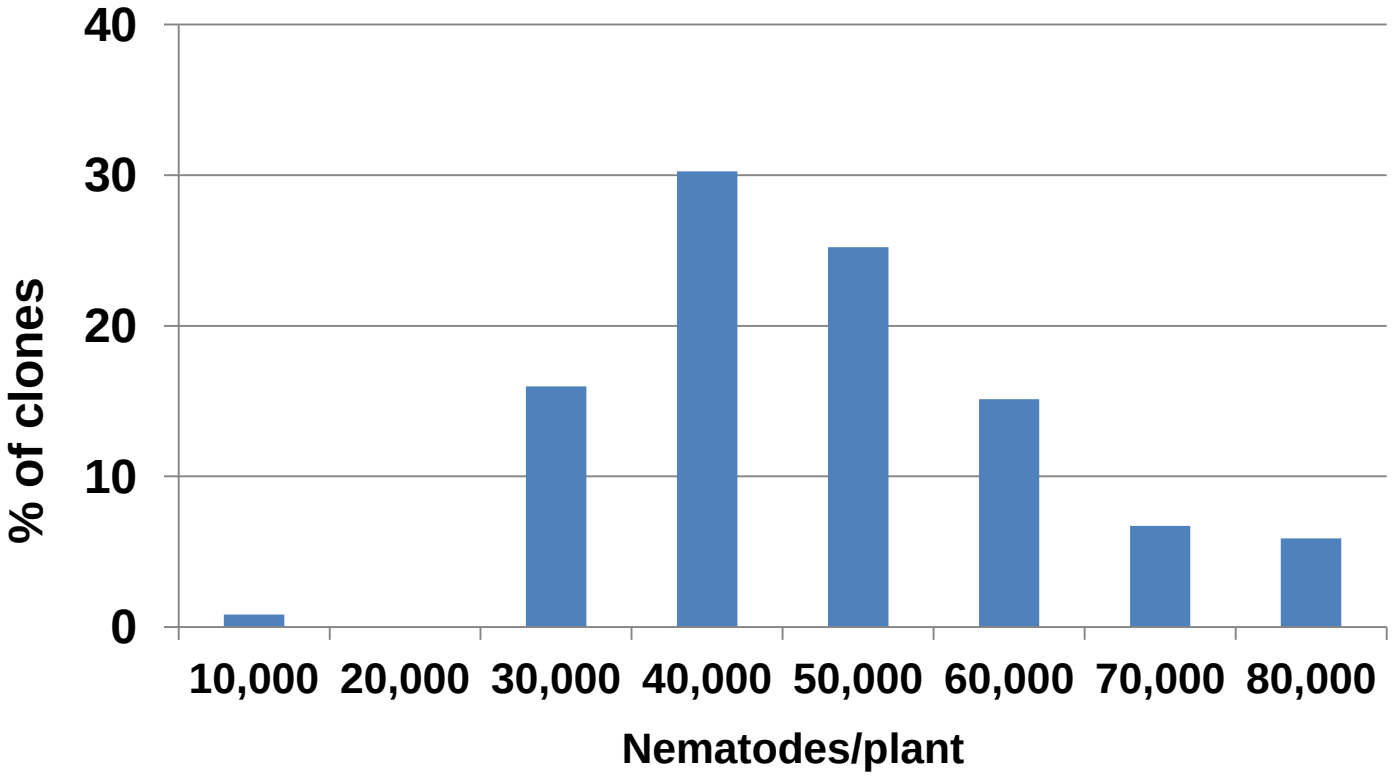
Progress:

- This SRDC funded research commenced in late 2011

So far

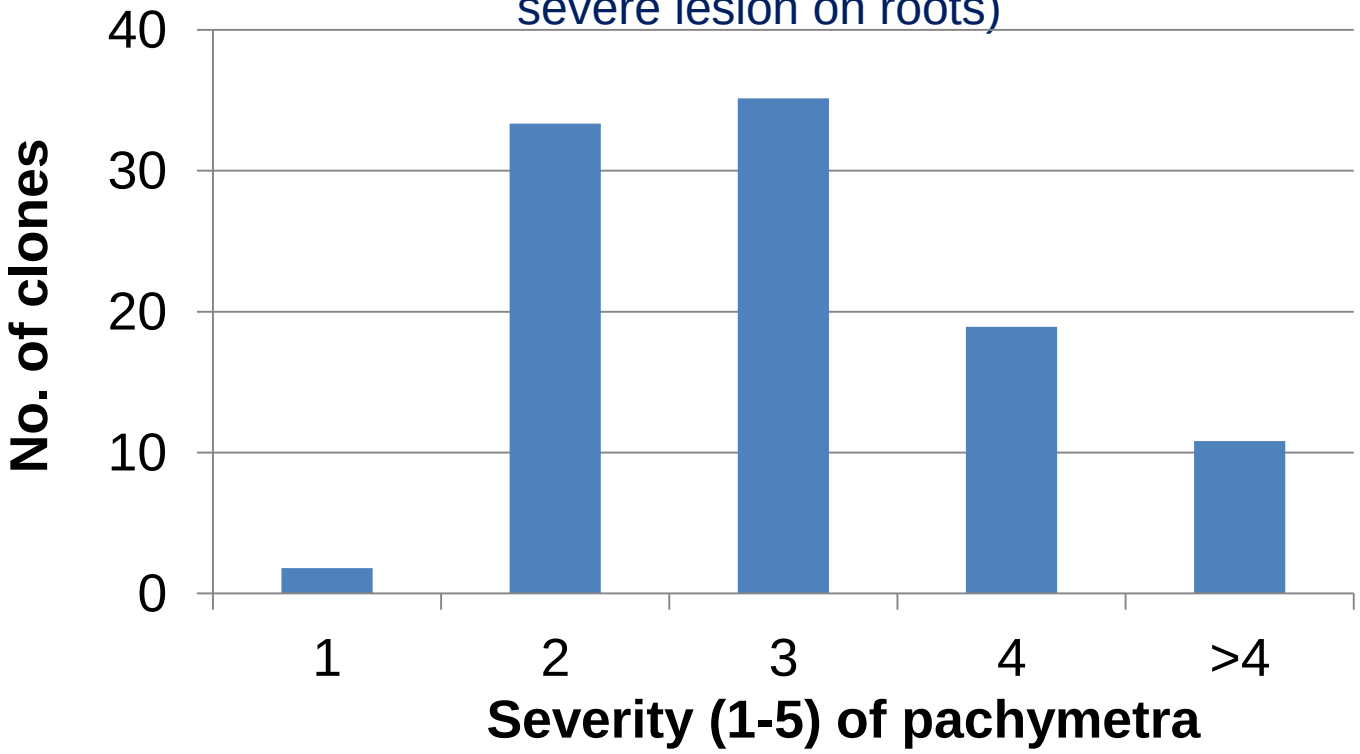
- Established nematode research and screening facility
- Approximately 120 clones (80 from introgression crosses and 40 clones from parents and advanced clones) were screened for root lesion nematodes, pachymetra and smut
- Research
  - Literature review on nematode screening methods
  - Conduct preliminary research on nematode screening
    - Eg., irrigation, suitable potting mix, extraction methods etc

Screening for resistance to *P. zeae* – frequency distribution

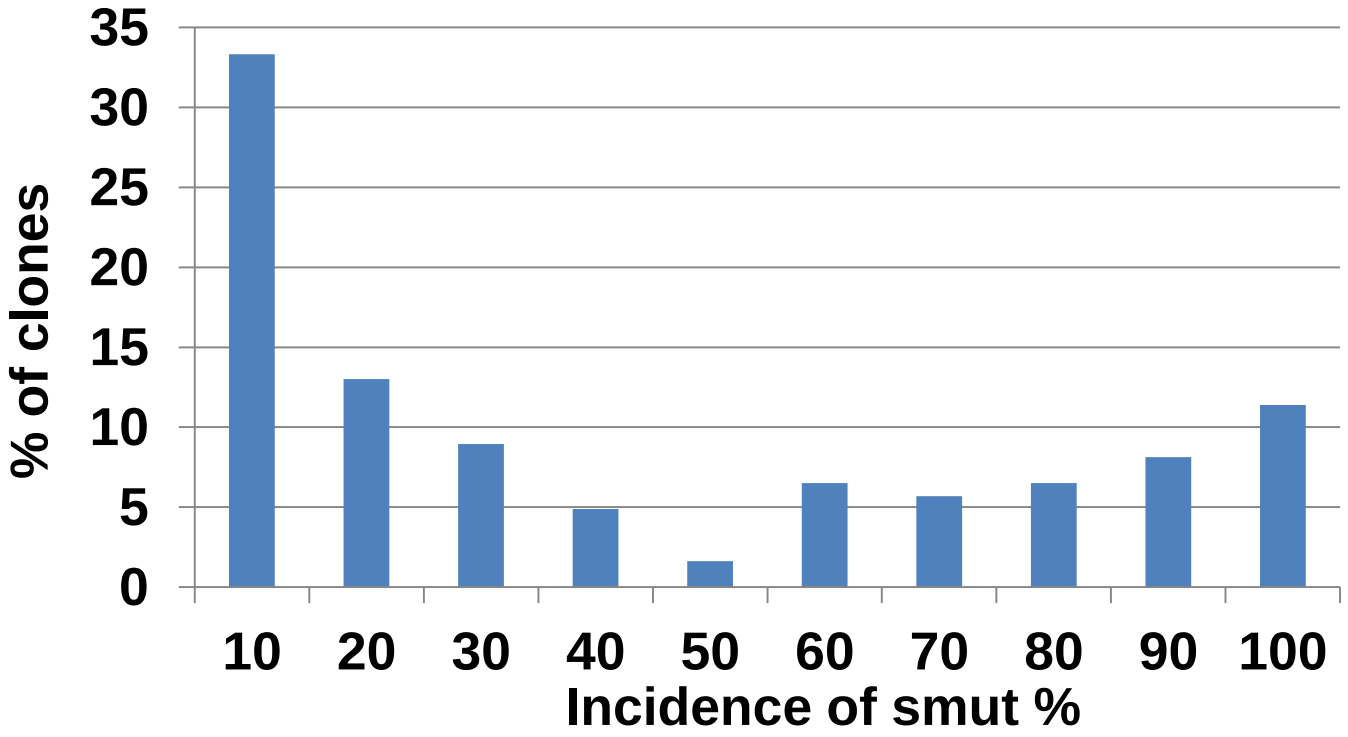


Screening for resistance to pachymetra –frequency distribution

(Severity = 1 to 5, where 1= very few or no lesion on roots and 5 = severe lesion on roots)



Screening for resistance to smut -frequency distribution



Clones resistant/tolerant to Pratylenchus, smut and pachymetra

Clone	Nematode/ plant	Smut incidence %	Pachymetra severity 1-5	Crosses
KQ08-2611	9562	3.1	1.4	BC3 E.arundinaceus
QBYC06-30376	20236	25.0	1.6	BC2 (E.arundinaceus
Q248	23473	26.0	1.0	Commercial hybrid
KQB09-30007	30091	43.8	1.3	BC2(S.spontaneum)

Summary

- Completed first screening test for over 120 clones from introgression crosses, parents and advanced clones for *Pratylenchus, Pachymetra* and smut
- Results are too early to make assumption on the introgression population –
  - Large number of clones showed resistance to smut
  - A small number of clones showed resistance or tolerance to Pachymetra root rot and Pratylenchus
- Nematode and smut screening facilities have been relocated to Woodford to Bundaberg – which caused some disruption to our program
  - More tests are planned in September 2012

Expected outcomes

- New source of resistance to nematodes, a major problem with no other viable control method
- New sources of resistance to pachymetra root rot, many existing resistant varieties lost due to smut susceptibility
- Improved productivity due to resistance to three major diseases
- Possible DNA markers for resistance to nematodes and pachymetra from wild germplasm
- Better methods for screening sugarcane populations for resistance to nematodes

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