Queensland Government
Department of Agriculture and Fisheries

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Queensland Department of Agriculture and Fisheries (DAF) comments on the *Review of import conditions for fresh ginger from Fiji - Draft report* (June 2015)

The Queensland Department of Agriculture and Fisheries (DAF) has considered the Draft Report and the proposed conditions for the importation of fresh ginger from Fiji to Australia.

DAF notes that the Draft Report recommends removal of the phytosanitary measure applied against *Radopholus similis* (burrowing nematode) based on insufficient evidence for the quarantine pest status of Fijian strains of *R. similis*. The Draft Report also recommends the introduction of mandatory treatment for *Aspidiella hartii* (yam scale), due to inadequate mitigation measures for this pest in the current import policy.

The DAF position on both issues is summarised below, with further details on individual issue for your consideration.

- DAF **does not support** the conclusion that *R. similis* from Fiji is a non-quarantine pest for Australia. As such, the proposed removal of specific import conditions for this pest is opposed.

- DAF **supports** the recommendation to introduce a mandatory methyl bromide fumigation treatment for *Aspidiella hartii*.

DAF does not support the withdrawal of the 'provisional' quarantine pest status of Fijian strains of *R. similis* in the Draft Report without the completion of comparative pathogenicity testing of the Fijian and Australian strains of *R. similis*. The requirement for this direct analysis was agreed to by the review Technical Expert Panel. In addition, pathogenicity tests with Australian strain of *R. similis* on ginger and the survey results on plant parasitic nematodes in the Australian ginger industry demonstrate the non-pathogenic nature of the Australian strain of *R. similis* on ginger.

On this basis, DAF strongly advises the retention of the 'provisional' quarantine pest status of *R. similis* from Fiji in the Draft Report, along with effective risk mitigation measures.

The following information is offered in support of this provision.

Proposed revised biosecurity measures (Draft Report, page 27)

DAF supports the decision to introduce mandatory fumigation for *Aspidiella hartii* (yam scale) based on the fact that standard visual inspection alone proved to be ineffective during the previous importation of fresh ginger from Fiji.

Review of the quarantine status of the Fijian strain of *Radopholus similis* (Draft report, pages 19-26)

DAF does not support the decision to treat the Fijian strain of *Radopholus similis* (burrowing nematode) as a non-quarantine pest for Australia and consequently remove phytosanitary measures for this damaging pest; based on the following facts:

1. The Australian population of *R. similis* is a major pest of banana, however it has never been recorded to affect ginger (Stirling 2014). *R. similis* was not included in a list of nematodes recorded on ginger prior to the early 1990s (McLeod et al. 1994), nor has it been recorded during an extensive survey of ginger production areas during 2014-15 (Attachment 2).
2. In Australia, *R. similis* was first observed (in the mid-1990s) in one small area of a single field of ginger, without any symptoms (Stirling 2014). A follow-up glasshouse experiment showed no indication of pathogenicity of *R. similis* on ginger, therefore, no further research was able to be performed, and no scientific publications able to be prepared (Stirling 2014, Draft report page 51).
3. The inability of an Australian strain of *R. similis* to reproduce or cause damage on ginger was confirmed in a more recent study (Cobon et al. 2012). Another experiment recently conducted (Cobon 2015) (Attachment 1), with the Australian strain of *R. similis* on ginger and banana in Australia, provides more evidence that the Australian strain of burrowing nematode is not pathogenic to ginger. Populations of the Australian strain of burrowing nematode declined significantly on ginger plants, while populations on banana plants continued to multiply. The experiment also provides evidence that the experimental conditions in the glasshouse were conducive to nematode survival, and reproduction given a suitable host plant (banana) (Attachment 1).
4. In an extensive survey of ginger production areas in Queensland conducted in 2014-2015 by specialist nematologists no *R. similis* was found in any soil samples collected from ginger farms (Attachment 2). These survey results, along with the above mentioned pathogenicity tests and other relevant work, will be submitted to an appropriate scientific journal for publication shortly.
5. Distinct from the Australian strain, the Fijian strain of *R. similis* has been reported as a destructive pathogen of ginger causing severe production losses in Fiji (Turaganivalu et al. 2013). A pathogenicity experiment in this paper showed that in addition to being found in rhizome tissue, the nematode also invaded the base of shoots, causing collapse and death of plants within 20 weeks of inoculation.
6. Based on current literature, an independent assessment by a nematologist (Dr. Mike Hodda, CSIRO) has indicated that it is highly likely that the Australian and Fijian strains *R. similis* are different biological entities with differing pathogenicity and perhaps host relationships (Final IRA Report: Fresh ginger from Fiji, page 87, 2013).
7. The current limited understanding on genetic variation of Fijian strain of *R. similis* requires further research to validate the proposed non-quarantine status of this pest for Australia in the Draft Report.

8. The statement in the Draft Report (page 25) 'At this time there is not sufficient scientific evidence to support the claim that Fiji has a strain of *Radopholus similis* with significantly different pathogenicity on ginger compared to *Radopholus similis* already present in Australia' has totally disregarded the evidence to the contrary provided to date and the independent assessment of the relevant above scientific information by an expert nematologist.
9. The Draft Report has ignored the importance of undertaking further characterisation to compare the Australian and Fijian strains of *R. similis* in side-by-side pathogenicity experiments, even though it was a decision reached by all members of the Technical Expert Panel (Meeting held 3 March 2015 at the Ecosciences Precinct, Brisbane including representatives from DAF, Department of Agriculture, and Australian Ginger Industry Association).
10. The review claims that R. similis is no longer detectable in ginger production areas in Fiji, and that specimens have been lost. Yet, at the same time the review also acknowledges that it would not be possible to eradicate R. similis in Fiji, therefore we believe it is vital that Fijian authorities cooperate with Australian authorities to locate these populations that are known to exist, so that the necessary studies can be concluded.
11. The Draft Report does not provide any alternative options for conducting pathogenicity testing of the Fijian and Australian strains of R. similis, which is critical to resolve the quarantine status of this pest.

Lack of contaminating items in boxes of fresh ginger from Fiji (Draft Report, page 11)

DAF disagrees with the statement '*No soil, plant trash, or growing shoots was found in any of the consignments at inspection*'. DAF inspections of five boxes of fresh ginger imported from Fiji, collected from the Sydney markets in 2014, contained soil, weeds and plant debris, in addition to live root knot nematodes within the rhizomes.

Ginger nematode surveys (Draft Report, page 17)

DAF notes the nematode survey work in 2014-2015, carried out by the Fijian Ministry of Agriculture (MoA), found no *R. similis* in any of the samples tested; including the samples collected from sites previously known to be infested with *R. similis* during farm surveys in 2007. Knowing the endo-parasitic nature of *R. similis,* along with its wide host range capacity (more than 350 plant hosts) including many weeds, combined with the known difficulties associated with *R. similis* management and the subsistence nature of agriculture practices in Fiji; DAF remains highly sceptical that *R. similis* is no longer present in Fijian ginger production areas, or that it is no longer a threat to ginger production in Fiji.

The Draft Report claims that current, improved farming practices in commercial ginger production areas in Fiji (including seed treatment, crop rotation, weed control, volunteer and infested plant material removal) have contributed to the MoA survey results. Again based on the biology of *R. similis* as it is described in relevant scientific literature and their previously reported abundance in some Fijian commercial production areas, DAF believes that although these improved farming practices may have reduced *R. similis* populations; complete elimination of the nematode would not be achievable. This is supported by the Draft Report evaluation which states that "*it is likely that Radopholus similis is still present in some areas in low numbers, or surviving on other host plants*" (Draft Report, page 17).

Recommendation 1

That the Fijian strain of *R. similis* be retained as a provisional quarantine pest until results from current Australian trials are published. In addition, the Fijian authorities should be encouraged to make strain of *R. similis* from Fiji available so that side-by-side pathogenicity trials can be conducted against the Australian strain of *R. similis*.

Recommendation 2

DAF strongly believes that *R. similis* remains a significant threat to commercial ginger production farms in Fiji and that *R. similis* should still be considered a quarantine pest for Australia. Therefore, Fiji should be required to demonstrate area freedom for *R. similis* through procedures consistent with those detailed in either the *International Standards for Phytosanitary Measures (ISPM) 4: Requirements for the establishment of pest-free areas* or *ISPM 10: (Requirements for the establishment of pest free places of production and pest free productions sites* for export to Australia; in order maintain the associated biosecurity risk at or below Australia's Appropriate Level of Protection (ALOP).

Attachment:

1. Reproduction of the burrowing nematode, *Radopholus similis* Experiment 2, harvested in May 2015.

2. Results from a survey for plant parasitic nematodes in the Australian ginger industry during 2014-2015.

Attachment 1

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Reproduction of the burrowing nematode, *Radopholus similis* Experiment 2, harvested in May 2015

Introduction

The Fijian strain of *Radopholus similis* has been previously shown to reproduce very well and be highly pathogenic on ginger and responsible for serious crop losses (Turaganivalu *et al.*, 2013), however, studies with the Australian variant in 2012 have shown that it does not reproduce well on ginger (Cobon *et al.*, 2012). As second experiment with the Australian variant was conducted in 2015 including Williams banana as a susceptible control to prove the virulence of the Australian strain of *R. similis*. The numbers of nematodes recovered from ginger in this experiment would suggest that ginger is an extremely poor host of the Australian variant. The measured growth of infected ginger in the Australian pot trials did not show that burrowing nematode reduced plant growth.

Method

1.9L pots were filled with autoclaved potting mix and planted with a *Radopholus*-free 'seed piece' of 'Queensland' ginger. Pots were then transferred to a glasshouse and 12 weeks later half the pots were inoculated with 2,000 *R. similis*. Williams bananas were included as the susceptible control and half the pots were inoculated with 2,000 *R. similis* The nematodes were obtained from a banana farm at Pimpama, Queensland and had been multiplied in the laboratory on sterile carrot tissue. Sixteen weeks after the pots were inoculated, the plants were destructively harvested. The nematodes were extracted from the ginger by slicing the seed piece, roots and rhizome finely and placing in a misting chamber for 7 days. Roots of the banana plants were chopped finely and placed in the misting chamber for the same length of time. Nematodes were recovered on a 38µm sieve and quantified.

Results and Discussion

A generalised linear model (GLM) was used to analyse the nematode counts. This model assumes a Poisson distribution and therefore transforms data in the analyses and presents data as back transformed means.

Over dispersion of the data was present and has been accounted for in the GLM model by estimating the dispersion.

The results indicate significantly ($p<0.001$) greater number of nematodes in the banana roots relative to the ginger, for both total count and when standardised to the number per 100 g root per plant (Table 1). Similarly, the multiplication factor of nematodes was significantly ($p<0.001$) greater for banana 5.74 for banana compared to 0.21 for ginger (Table 2). These multiplication factors indicate that the nematode was able to multiply on banana roots, but on ginger some were able to penetrate the roots, but not increase the population.

Table 1: Reproduction of *Radopholus similis* on Williams banana and Australian ginger using the Australian variant of *R. similis*.

	Williams Banana	s.e.	Australian Ginger	s.e.	LSD (5%)
Total Radopholus count	11,486	± 1,385	427	± 393	3,037
Radopholus 100 g root	12,321	± 1,609	160	± 270	3,442
Multiplication factor	5.74	± 0.69	0.21	± 0.20	1.52

Table 2: Comparisons of reproduction factors of the Fijian and Australian variants of *Radopholus similis* in experiments conducted in Fiji with the Fijian variant and in Australia with the Australian variant.

Experiment	Multiplication rate @ 15-16 wks	Reference
Fijian variant	X 4.5 on ginger	Turaganivalu *et al.*, 2013
Australian variant expt. #1	X 0.95 on ginger	Cobon *et al.*, 2012
Australian variant expt. #2	X 0.21 on ginger	
Australian variant expt. #2	X 5.7 on banana	

The results of these studies demonstrate that the isolate of *R. similis* from ginger in Fiji is a more aggressive pathogen than the Australian isolate from banana (Table 2).

The analyses of the plant growth parameters used a REML mixed model to account for plant deaths in the ginger caused by seed borne *Fusarium* in this experiment.

The results from the tops dry weight indicated significant differences in the weight of banana and ginger tops due to differences in the crops being assessed. However, there was an interaction with bananas inoculated with Radopholus having a greater top weight than those that were not (Table 3). There were few other significant differences on plant growth for either ginger or bananas. In ginger this may be because there are so few nematodes infecting the ginger, no damage to the plant was able to be measured. The banana plants used were older; pot-bound plants that although potted up to bigger pots, may not have responded with damage to growth in this short experiment. Therefore, the pathogenicity of the nematode to cause yield losses cannot be determined in this experiment.

Table 3: Tops dry weight for ginger and bananas inoculated and uninoculated with *Radopholus similis*.

	Top dry weight (g)	
Crop	**Nil**	***R. similis***
Banana	14.76 b	17.86 c
Ginger	5.92 a	5.03 a

Conclusion:

The second Australian experiment has demonstrated the host status of ginger was significantly less than banana and that ginger was a poor host for the Radopholus as the numbers declined from the initial inoculum level of 2,000 and was approximately only 20 % of the initial nematode population at the end of the experiment. However, pathogenicity of the nematode on the crops was not established. There was no relationship between increasing nematode numbers and a change in the growth of plants either ginger or banana. To establish pathogenicity there needs to be a range of nematode population densities. If the nematode is pathogenic to the crop there should be a decrease in plant growth parameters as nematode abundance increases.

References

Cobon, J.A., Smith, M.K. and Stirling, G.R. (2012). The pathogenicity of an Australian isolate of *Radopholus similis* on ginger. In, **"Proceedings of the Seventh Australasian Soilborne Diseases Symposium, 17-20 September 2012"**. (Ed. WJ MacLeod). p. 71.

Turaganivalu, U., Stirling, G.R. and Smith, M.K. (2013). Burrowing nematode (*Radopholus similis*): a severe pathogen of ginger in Fiji. **Australasian Plant Path. 42**: 431-436.

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Attachment 2

Results from a survey for plant parasitic nematodes in the Australian ginger industry during 2014-2015

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Sampling procedure

Soil samples were randomly collected across a ginger block with a field augur that collected approximately 50 mL of soil at each sampling point. Approximately 2 kg of soil was collected at each site. Plant-parasitic nematodes were extracted from soil samples using the Whitehead tray method (Whitehead and Hemming 1965). A 200 mL sub-sample of field moist soil was placed on tissue on a mesh tray that was then placed in a tray of 250 mL of water for 72 hours. The nematodes were collected on a 38 µm sieve, backwashed into a vial, and then reduced to 5 mLs. This 5 mL solution was poured into a counting slide and all plant-parasitic nematodes were counted and identified to either genus or species level. The first 32 sites in the table are the average number of nematodes from 4 sub-samples from a given site.

Results

Site Samples	Burrowing	RKN	Lesion	Reniform	Spiral - Hd	Stubby	Spiral - Rb	Stunt	Ring	Dagger	Citrus
NO3043-46	0	195	0	60	0	14	127	0	0	0	0
NO3047-50	0	12	0	0	0	29	0	0	0	0	0
NO3051-54	0	0	0	2	6	0	0	0	3	0	0
NO3055-58	0	0	0	3	8	0	0	0	0	0	0
NO3059-62	0	0	0	34	106	0	0	0	0	0	0
NO3063-66	0	0	0	9	15	0	0	0	0	0	0
NO3067-70	0	0	0	1	0	0	0	0	0	0	0
NO3071-74	0	1	0	0	1	0	0	0	0	0	0
NO3075-78	0	0	0	5	91	0	0	0	0	0	0
NO3079-82	0	0	0	14	12	0	0	0	0	0	0
NO3083-86	0	0	0	15	0	0	0	0	0	0	0
NO3087-90	0	0	117	11	0	0	0	0	0	0	0
NO3091-94	0	298	0	0	11	0	0	0	0	4	0
NO3095-98	0	3	1	0	2	0	0	2	3	0	0
NO3099-102	0	1	12	0	1	59	0	0	0	0	0
NO3103-06	0	151	0	2	5	0	0	0	0	0	0
NO3604-07	0	17	0	0	0	10	0	0	0	0	0
NO3608-11	0	67	0	0	0	11	0	0	0	0	0
NO3612-15	0	0	9	0	0	0	126	0	0	0	0
NO3616-19	0	19	0	0	0	0	2	0	0	0	0
NO4959-62	0	70	10	1	18	0	0	0	5	0	0
NO4963-66	0	181	21	0	1	0	0	0	0	0	0
NO4967-70	0	0	0	0	0	0	0	0	0	0	0
NO4971-74	0	166	0	0	0	0	0	0	0	0	0
NO4975-78	0	178	1	0	1	0	0	0	0	0	0
NO4979-82	0	0	7	0	0	0	0	57	0	0	0
NO4983-86	0	0	2	0	0	0	0	138	0	0	0
NO4987-90	0	0	0	0	0	0	0	6	0	0	0
NO4991-94	0	0	19	0	0	0	0	0	0	0	0
NO5014-17	0	7	0	0	0	0	46	0	0	0	0
NO5018-21	0	0	0	0	0	5	4	0	0	0	0
NO5022-25	0	0	0	0	0	0	0	0	0	0	0
NO5338	0	7	0	0	0	0	0	0	0	0	0
NO5339	0	556	0	0	6	19	0	0	0	0	0
NO5340	0	0	11	0	0	0	0	0	0	0	0
NO5341	0	975	0	0	0	0	0	0	0	0	0
NO5342	0	3690	0	0	23	0	0	0	0	0	0
NO5350	0	11	496	11	0	0	0	0	0	0	0
NO5351	0	346	0	0	0	0	0	0	0	0	0
NO5365	0	146	0	12	0	0	0	0	0	0	68
NO5367	0	0	0	6	0	0	18	0	0	0	0
NO5368	0	0	0	20	0	0	38	0	0	0	0

Burrowing = *Radopholus similis;* RKN = *Meloidogyne* spp.; Lesion = *Pratylenchus* sp.; Spiral – Hd = *Helicotylenchus dihystera;* Spiral – Rb = *Rotylenchus brevicaudatus;* Reniform = *Rotylenchus parvus;* Stubby = *Paratrichodorus* sp.; Dagger = *Xiphinema* sp.; Ring = *Criconemella* sp.; Citrus = *Tylenchulus* sp.; Stunt = *Tylenchorhychus* sp.

Findings

Burrowing nematodes and root-knot nematodes are recognised as plant-parasitic nematodes of significance in ginger as they cause serious damage to the plant (Ravindran and Babu, 2005). During an extensive survey that was representative of over 90% of the ginger industry, no burrowing nematode (*Radopholus similis*) was detected, however root-knot nematodes (*Meloidogyne* spp.) were common and damage to rhizomes was observed at higher population densities. Of the plant parasitic nematodes listed in the table; lesion, reniform, spiral, stunt, ring and dagger nematodes have been recorded as being associated with the ginger rhizosphere (Ravindran and Babu, 2005). However at the population densities encountered they are unlikely to be considered as serious pests of ginger.

References

Ravindran P.N. and Babu K.N. (2005). *Ginger: The Genus Zingiber*. CRC Press: Boca Raton, USA. 552 pp.

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